Hannes Zander

A LANDSCAPE APPROACH

Long-term processes of socio-environmental transformation have severely degraded entire world regions, leading to pressing social, economic, and environmental challenges. In this planetary context, the thesis develops a Landscape Approach as a theoretical framework to systematically read and better understand large-scale geographies. It promotes landscape as a culture of thinking and a mode of working across spatial, temporal, and disciplinary dimensions.

As a case study serves the remote and arid Hexi Corridor in Northwestern China. The region is portrayed through a narrative that spans from its first integration as a strategic territory into imperial China (121 BC) to recent trends concerned with environmental challenges, as well as ambitions of economic growth and development. Ultimately, the Landscape Approach aims to inform new interdisciplinary practices that can find integrated solutions to intervene in specific locations and restore degraded ecosystems at watershed scales, creating conditions that are socially and environmentally more just and sustainable.

Hannes Zander is a landscape architect and researcher. He holds a post-professional MLA degree from the Harvard Graduate School of Design and a BLA from the University of Applied Sciences in Rapperswil, Switzerland. Prior to joining AHO's PhD program, he worked as managing director at the research institute Ecological Urbanism Collaboration at Peking University, as a research associate for the Sustainable Exuma project at Harvard University, and has practiced at landscape design firms in the U.S. and Europe. Hannes is co-editor of the books Landscape Approach (2022, Applied Research and Design) and From the South (2019, Universidad del Desarrollo Press). Currently, he works as co-director and head of research at the Integrated Sustainable Development Foundation, based in Zurich.

ISBN 978-82-547-0369-4
ISSN 1502-217x

PhD thesis 125

Hannes Zander

A LANDSCAPE APPROACH

PhD 125

AHO

Hannes Zander

A LANDSCAPE APPROACH

Reading a Geographic Context Through Multiple Dimensions:
The Case of the Hexi Corridor Region in China's Northwestern Gansu Province

AHO Arkitektur- og designhøgskolen i Oslo
The Oslo School of Architecture and Design

PhD thesis

Hannes Zander

A Landscape Approach

PhD Thesis, 2024
The Oslo School of Architecture and Design

ISBN 978-82-547-0369-4
ISSN 1502-217x

CON-TEXT 125
A Landscape Approach: Reading a Geographic Context Through Multiple Dimensions

A Doctoral Thesis submitted to
The Oslo School of Architecture and Design

PUBLISHER:
The Oslo School of Architecture and Design

COVER PHOTOGRAPH:
Hannes Zander

PRINTED BY:
Bodoni

GRAPHIC DESIGN:
Hannes Zander

Hannes Zander

A Landscape Approach

Reading a Geographic Context Through Multiple Dimensions: The Case of the Hexi Corridor Region in China's Northwestern Gansu Province

Contents

Acknowledgments

In many respects, this thesis has been a challenging project with many unexpected turns and surprises. However, it also offered many pleasant encounters, collaborations, and friendships for which I am deeply grateful. I want to express my sincere gratitude to the many people who have accompanied me along this journey, and without their help, this work would not have been possible.

First, I would like to thank my supervisor, Professor Karl Otto Ellefsen, for giving me the opportunity to conduct this research project as part of his Urbanization of Rural China initiative at The Oslo School of Architecture and Design. I am grateful for his interest in my work and for giving me the freedom to expand my research beyond what might have seemed reasonable at times, but what made this dissertation not just an academic exercise but a truly illuminating effort for me. I thank him for his encouragement and for mutually sharing a bewildered fascination for China as an incredibly rich, diverse, often incomprehensible, and sometimes terrifying nation. I thank Bin Li, who invited me in 2018 to co-teach her studio course at AHO's Academy of Landscape and Territorial Studies in Tromsø. Bin has introduced me to Karl Otto and has shown me wonderful facets of China that would otherwise have remained inaccessible.

I thank Martin Prominski for thoroughly reading my thesis draft and for his productive comments. I am grateful to Karin Helms, whom I had the pleasure of assisting in teaching her first studio course at AHO and who has become my closest landscape ally in the institute. Karin has also read early drafts of my thesis and has offered important input along the way. Peter Hemmersam has shared valuable feedback on my introductory chapter and has been an encouraging head of research at the Center for Urban and Landscape Studies. I thank Lisa MacKenzie at the University of Edinburgh's School of Architecture and Landscape Architecture for inviting me as a visiting scholar in the spring of 2022. The semester in Scotland has been one of the most productive and enjoyable. Andrea Kahn has been an excellent reader of one key chapter I developed as part of a course she taught with Lisa Diedrich at the Swedish University of Agricultural Sciences. Her comments allowed me to sharpen some of the thesis' main arguments.

Many people have helped me during my research trips to Gansu. They offered me access to information I would not have been able to see and un-

derstand without them. First, I thank Du Rong, my main local guide. She continued to be a precious source of information when the physical gates to China were locked. Du Rong has been tremendously supportive, has assisted me on several of my travels, has introduced me to her family, friends, and colleagues, and connected me to many scholars, practitioners, and locals, and thus literally opened doors for me to better understand the many complex layers of my geographic investigation. Ma Xiangyin has conducted excellent research, diligently tracing political and economic actors across the Hexi Corridor territory, finding relevant literature sources, translating material, and fact-checking arguments that I based on Chinese texts.

Lv Pinjing at the Central Academy of Fine Arts in Beijing is the co-principal investigator of the Urbanization of Rural China project. He connected me to Mo Chao, Dean at Lanzhou City University, who helped organize field trips to Lanzhou New Area and meetings with local government representatives. Zhang Shuping was my prime contact when I first arrived in Lanzhou. She has been an excellent translator and assisted me during fieldwork and interviews. Zhang Xuebin from the Northwest Normal University offered insights about the Hexi Corridor and accompanied me during my research trips to Zhangye and Jinchang. In Wuwei, Wang Dongsheng's family hosted me at their apartment for several nights. In Dunhuang, Chai Bulong was my local host and guide, drove me around the city, and offered me his expert knowledge and exclusive access to murals in the Dunhuang caves. I am grateful for everybody who shared their time and knowledge in interviews and informal conversations, which helped me better understand some of the complexities I aim to reveal through my work. I feel deeply humbled for all the help and generosity I have been offered during my stays in China, which is not always an easy place to navigate and where assistance is sometimes desperately needed. I wished I could have spent more time nurturing these valuable contacts, sharing knowledge, learning from each other, and exploring the fascinating grounds they opened up for me.

Finally, I want to thank my cohort at AHO that made this journey much more livable and joyful, most notably my dear PhD fellows Joe Crowdy, Jomy Joseph, Beata Labuhn, and Maryia Rusak for the many cheerful moments, stimulating conversations, their sincere care and sympathy. Thank you to Marianne Skjulhaug and Sigrun Birgisdottir, especially for our fun and productive retreat seminar in Reykjavík with Alan Berger, who has offered suggestions on the very early stage of the project. A special thanks to Mattias Josefsson for his generosity to repeatedly moving and hoarding boxes with my belongings between uncertain semester plans.

Lastly, I want to thank my family to whom I dedicate this work. My parents and brothers supported me throughout this journey, especially during that bizarre and difficult spring of 2020 when I had literally no place to go.

Introduction

Landscape in an Anthropogenic World

At the core of this thesis is a deep concern with today's state of the Earth. Throughout this PhD research, I learned about massive projects of urban growth and development in already heavily degraded world regions. I realized what far-reaching transformation and degradation of ecosystems they are causing, reminding me that what the world is experiencing today in terms of socio-environmental harm might only be harbingers of more dramatic future disruptions. The severity and urgency of global socio-environmental crises motivate me to invest my experience, skills, and discipline to find strategies that can address these issues and effectively operate in a dynamic environment of increasing complexities and uncertainties.

Trained as a landscape architect and practicing in spatial and construction design, I mostly worked on landscape projects in the context of a city or an urban neighborhood. Essentially, most projects were approached as singular and isolated design objects constrained by commercial limitations. However, of course, I soon realized that places of interest for me as a designer, such as blue-green infrastructures, gardens, parks, and public open spaces, are connected to and dependent on much larger ecosystems and territorial correlations. It is apparent that the field of landscape architecture, design culture, and popular culture, in general, are strongly focused on urban centers. This is not surprising as it is in cities where most of the capital, as well as important cultural and political institutions, are concentrated. At the same time, there is a strong trend to promote urban landscape projects in parallel with discussions about sustainability and resiliency. Of course, efforts to make inner cities more livable, just, and ecologically sustainable are necessary and important. Landscape architecture as a discipline can thereby build on a rich legacy of successful practices and case studies. However, in the discussion around environmental sustainability, there is a need to acknowledge that the truly unsustainable and environmentally disruptive is mostly happening far outside urban centers in remote areas of extraction, disposal, large-scale production, or extensive logistics and transportation networks.

We live in a world where we need to grapple with challenges of inconceivable magnitude, such as global climatic change, rising sea levels, and dramatic losses of biodiversity. These enormous challenges and the far-reaching consequences they bear for humanity, which we are still only beginning to fully grasp,

cannot be approached from the scale of a building or a neighborhood. Landscape architecture in its traditional disciplinary form as a commercial, service-providing practice has its limitations in effectively addressing the causes of these global socio-environmental transformations. However, as I will argue in this thesis, the conception of landscape, as a cultural medium and a multi-dimensional way of thinking, finds itself in an opportune position to help tackle some of the pressing planetary challenges of our time.

Overall Ambition of the Thesis

The thesis aims to provide a mode of systematically reading a complex and large-scale geographic context at the intersection of urbanism, landscape, and ecology. This mode of reading—the geographic analysis through fieldwork observations, interviews, visual representation, and secondary literature—is framed as a Landscape Approach. As regional case study for the project serves the Hexi Corridor in China's northwestern Gansu province. Led by the landscape-informed approach, the thesis constructs a narrative for the arid and environmentally sensitive region that spans enormous spatial and temporal scales across over 2,000 years of history and a stretch of over 1,000 kilometers of land. This multi-dimensional account simultaneously includes social, political, and economic, in addition to environmental relations.

Ultimately, the thesis argues, a holistic, multi-disciplinary approach across such massive spatial and temporal dimensions allows to better understand a geographic context and to address socio-environmental issues at large, territorial scales. At the same time, while this thesis is not spatially propositional, the Landscape Approach aims to guide spatial interventions that are grounded with sensitivity in individual places, leading to planning and design solutions that are socially and environmentally more just and sustainable. In the context of a world ecology that has been transformed by human activities at planetary magnitude, such solutions need to operate across scales, including some that are much larger than what the landscape discipline is usually accustomed to. The thesis argues that a landscape-informed culture of thinking can lead to and guide new models of practice that are radically interdisciplinary and operate across multiple dimensions, from the local to the territorial and from short to long periods of time, to help restore and heal degraded ecosystems.

The Hexi Corridor Region as Case Study

When I was living and working in Beijing, I had the opportunity to travel extensively through different parts of China, across the rural outskirts and remote hinterlands of large urban regions.[1] In hybrid landscapes in the periph-

1 From 2016–2017, I worked as managing director at the Ecological Urbanism Collaboration, a research institute based at the Peking University College of Architecture and Landscape

ery of cities, I experienced the far-reaching effects of the often-cited rapid growth of Chinese urban agglomerations, which can be bluntly witnessed in a highly disruptive fashion. As China has undergone a tremendous socio-environmental transformation over the past century, this transformation was, in recent decades, driven by an unprecedented speed and scale of urbanization. Traditional cultural landscapes are being reorganized by vast infrastructures for transportation, logistics, production, extraction, and new forms of automated land cultivation. I had not experienced such an intensity of rapid land transformation elsewhere before and was intrigued by the high dynamic and heavy force such environments produce at the intersection of rural-traditional and urban-modern life. With this PhD project, I sought to better understand such processes of urban transformation in the context of contemporary China.

When looking for an interesting case study for my dissertation project, I randomly stumbled over a *Guardian* article from 2012. The article immediately caught my interest. It described the case of Lanzhou New Area, a new master plan city to be built seemingly from scratch on a flat terrain that required the flattening of 700 mountains.[2] This seemed to be a particularly drastic case of an abrupt human intervention into the existing fabric and geomorphological formation of an environment created over eons. As I learned later, this case of flattening mountains was not a unique case but is a common practice, particularly across China's Loess Plateau. However, the newspaper article triggered my interest in China's interior northwest, and I began to start digging deeper into the case of Lanzhou New Area. I began to understand the new urban node in relation to Gansu's capital of Lanzhou, as well as to its larger metropolitan region and territorial development plans. Once I started to read more about Gansu province, a region I did not know much about previously, I learned about the Hexi Corridor and began to understand its exceptionally strong significance for the historical formation of China as a nation.

The Hexi Corridor is a narrow plain between forty and one hundred kilometers wide and runs over one thousand kilometers in northwestern direction between the Tibetan and the Mongolian Plateau. Its eastern starting point lies behind the Wushaoling Mountains, a mountain chain that begins just north of Lanzhou New Area and works as a strong geographic boundary, separating the arid Hexi Corridor from the more humid, fertile, and more densely populated southeastern part of Gansu where Lanzhou New Area is located in the larger Lanzhou metropolitan region. As discussed in chapter three, the Hexi Corridor gained crucial strategic importance as a gateway to the west, allowing China to open its heartland to Central Asia. Because of its historical, cultural,

---

in collaboration with the Harvard University Graduate School of Design. Through research projects, courses, and seminars, we studied dynamic ecologies across urban agglomerations and remote villages in China's countryside.

2 Jonathan Kaiman, "China to Flatten 700 Mountains for New Metropolis in the Desert," *The Guardian*, December 6, 2012.

and environmental significance, the Hexi Corridor would offer abundant information in the form of secondary literature. And even though it reaches far into China's autonomous Western Regions, it would allow me to conduct fieldwork research and move relatively freely across the region since it is ethnically dominated by Han Chinese and relatively permeable as an important route for transportation and tourism. At a national scale, I learned to position the Hexi Corridor geographically within the context of contemporary China. I framed it as an arid frontier that bridges the country's climatically, demographically, socio-economically, and politically contrasting southeastern and northwestern half. Led by my initial goal of conducting multidimensional research, spanning across multiple scales, from the specific, individual place to the broad, macro-geographic context, the region promised to serve as a productive case study. It could be read as an area of tension at the conflictive intersection of several different thematic dimensions.

Key Concepts that are Guiding the Thesis

Urbanization of Rural China

This thesis is part of The Urbanization of Rural China project, a long-term PhD research initiative at the Oslo School of Architecture and Design, led by Prof. Karl Otto Ellefsen in the Institute of Urbanism and Landscape, in collaboration with the architectural restoration program "Countryside Construction" at the Central Academy of Fine Arts (CAFA) in Beijing.[3] The initiative studies selected sites that are considered *rural*, lying outside of China's large urban agglomerations, and how they are spatially and socially transformed through processes of urban development. Karl Otto Ellefsen uses the term "habitat" to describe how the specific architecture in a place, for instance, in the form of a remote village, is a multidimensional formation of a broader socio-environmental context.[4] Each PhD research project selected a specific case study in very different regional conditions across China. As discussed in the fourth chapter, the notion of an *urbanization* of rural China is controversial. Both these terms—urbanization and rural—are highly complex and ambiguous in the context of modern China. One ambition of the initiative is thus to question the rural-urban divide, which its title suggests.

Several other intellectual concepts run like threads through the different chapters of the thesis:

3 The "Countryside Construction" program (建筑乡村 *Jianzhu xiangcun*) is led by professor and architect Lv Pinjing at the CAFA School of Architecture. It studies villages and cultural landscapes in rural China, working towards socio-culturally sustainable development strategies for China's countryside, including architectural preservation.

4 Karl Otto Ellefsen and Espen Aukrust Hauglin, "The Imprint of Fisheries on Land: The Logics of Settlement Structure and Place in an Arctic Landscape," *Landscape Architecture*, no. 11 (2022): 91–103; Karl Otto Ellefsen and Tarald Lundevall, *North Atlantic Coast. A Monography of Place* (Oslo: Pax Forlag, 2019).

Landscape as a Process of Socio-Environmental Interaction

The thesis aims to create a multidimensional geographic portrait of the Hexi Corridor. The idea of landscape—the cultural meaning of the word—thereby informs a culture of thinking and mode of working, which the thesis defines. The thesis' Landscape Approach builds upon the long legacy of early landscape architecture as a discipline of systematic, ecological urban development; geographic concepts from the early twentieth century that defined the region as a scale to inform planning practices; and modes of comprehensive planning and design from the 1960s onward that translated multiple layers of socio-environmental information into spatial interventions across scales.[5] Generally, landscape is understood throughout the thesis as a cultural artifact: a multi-layered, socially constructed formation that has been developed through a process of socio-environmental interaction over long periods of time and at various scales through the continuous belaboring of the terrain and the collective making of a place.[6] It is, therefore, closely connected to history and culture, as well as to the ecological interrelationship and dynamic interactions between humans and their natural environment—or of society and space.[7]

The Production of Space

The notion of a "cultural artifact" in an individual place was intended as the starting point of my territorial investigation: A landscape-informed reading of a specific built environment as the culturally produced, physical expression of a society through which the society's socio-political organization, its ambitions, and strategies can be better understood. This notion of a socially produced space follows theories of neo-Marxist philosophers. They discussed the spatialization of political theory—adding a geographical dimension to Marxist thought—to understand how physical space is created by the means of production and the socio-political forces inherent to a specific social organization. In a capitalist economy, capital thus not only occupies but also actively produces space.[8] These processes entail inherent contradictions that are necessary to sus-

5 As it will be discussed in the next chapter, this refers first to the work of early landscape advocates in the late 19th century, including Frederick Law Olmsted, Charles Eliot, and others; second, early 20th century geographers and planners that connected urban development to regional conditions and interrelationships, such as Patrick Geddes and Lewis Mumford; and third, practices of landscape planning and ecological urbanism, building upon the work of Ian McHarg.

6 This understanding of landscape is informed by humanist geographers and landscape writers from the 1970s to 1990s, particularly in the tradition of John Brinckerhoff Jackson. It will be discussed in more detail in the next chapter.

7 This cultural-historical understanding of landscape as a socio-environmental construction is informed by the landscape geographer Denis Cosgrove, whose work is a major reference throughout the next chapter.

8 Manuel Castells, *The Urban Question: A Marxist Approach* (London: Edward-Arnold,

tain continuous capitalist production: In a competitive environment, capital thrives for surplus production and endless growth, it simultaneously aims for homogenization and differentiation of market conditions, and it tends to be spatially bound—or "fixed"—in a place while simultaneously being in constant motion in order to access new resources and markets for potential growth.[9] This understanding of space as the physical expression of a complex, multilayered socio-environmental regime is instrumental for this thesis.

Urban-Rural Divide

The theory of the production of space suggests that the city must not be understood as a technocratic, spatial organization but as a dynamic configuration produced by social and economic forces. Urbanization does, therefore, not describe a geographic unit nor a certain condition of the built environment inside a city, but rather a *transformation process* that is expressed and manifested through the way a society is organized. Through fieldwork observations, particularly in hybrid sites in the periphery of Chinese urban agglomerations, I learned to better understand this notion of urbanization as a highly dynamic, contested, and contradictory transformation process. In this thesis, I generally refer to urbanization as a term that describes *physical* transformations of land and the built environment through processes of spatial urban growth and development. However, informed by the theory of socially produced space, urbanization is also understood as a *socio-political* transformation process that operates across the boundaries of a rural-urban divide. The *"urban"* city is thus not a dualist counterpart to the *"rural"* non-city. Instead, urban agglomerations must be analytically connected to territorial (socio-politically induced) processes of spatial reorganization, material circulation, and remote places of production and extraction[10]—like some of the places I visited in remote locations along the Hexi Corridor, far away and seemingly detached from China's leading centers of urbanization and capital accumulation.

Research Methods

In the spring of 2020, while research and travel plans became unclear due to the COVID-19 pandemic, I began to work on a book project as the main editor. It was first intended as a side project that should be developed parallel to my thesis. But, as I was reviewing and discussing essays with invited authors and working on the book's introductory chapter, I realized how closely related the intentions and contents I defined for the book had become with my PhD

1977[1972]); Henri Lefebvre, *The Production of Space* (Oxford: Blackwell, 1991[1974]).

9 David Harvey, *The Limits to Capital* (Oxford: Blackwell, 1982); Neil Smith, *Uneven Development: Nature, Capital, and the Production of Space* (Oxford: Blackwell, 1984).

10 Neil Brenner and Christian Schmid, "The 'Urban Age' in Question," *International Journal of Urban and Regional Research* 38, no. 3 (2014): 731–55.

thesis. In fact, the two strongly influenced each other, and my dissertation work would have perfectly fit within the framework of the publication. Because of significant logistic constraints and limitations of my thesis work, I later decided to further develop the Landscape Approach I had defined for the book project as part of my dissertation.[11] It is closely integrated into the thesis and serves as a methodological framework—or *approach.* However, the extended chapter on the Landscape Approach is also intended as a separate, isolated theoretic discussion and original contribution of the thesis.

A Landscape Approach as a Culture of Thinking

In chapter one, landscape is framed as a culture of thinking and as a mode of systematically understanding a complex and large-scale geographic context. With the definition of a Landscape Approach, the *concept* of landscape—understood as a cultural artifact as defined above—becomes operational. It is used as a research *method* that allows to contextualize a specific geography, describe current conditions, and critically evaluate ongoing processes. The thesis demonstrates how this landscape-informed, geographic reading can be applied as an analytical method to a geography with the Hexi Corridor as the selected case study in the specific, socio-environmental context of northwestern China. It does so across multiple timelines, beginning in a very long timescale with the expansion of the Han empire from China's heartland into the region at the beginning of the nation's imperial history in the second century BC and ending with its most recent phase of geopolitical reordering that positions China as hegemonic power in a globalized world. This leads to a broad and multidimensional narrative with the Hexi Corridor as the centerpiece, discussed as a world region that has continuously been reconceptualized and spatially reorganized as a strategic territory along changing socio-political regimes. Across this long-term history, the region has experienced processes of dramatic ecological degradation in a complex interdependency of social and environmental forces. These forces have been continuously altered in a reciprocal relationship of growing and shrinking populations, shifting political constellations, technological development, economic aspirations, and environmental transformations such as changing climates. Informed by the Landscape Approach, the geographic reading of the Hexi Corridor across multiple timeframes and across both social and environmental dimensions is used as a research method to understand today's conditions in a broad, comprehensive context.

11 The book *Landscape Approach* was published in fall 2022. The preface I wrote for the edited volume served as a starting point for developing the Landscape Approach in chapter one. Hannes Zander et al., eds., *Landscape Approach: From Local Communities to Territorial Systems* (Applied Research & Design, 2022). See specifically "Preface: Crafting Socio-Environmental Entanglements in a World of Growing Uncertainties," an early and brief version of the Landscape Approach presented in this thesis. The book builds upon an earlier publication, published in 2019, that began to frame a landscape approach, and for which I acted as editor as well. Flavio Sciaraffia et al., eds., *From the South: Global Perspectives on Landscape and Territory* (Santiago, Chile: Ediciones Universidad del Desarrollo, 2019).

Fieldwork and the Specificity of Individual Sites and People

When I began this dissertation research, I was most passionate about the prospect of conducting fieldwork and gathering multidimensional stories of individual places, which would allow to concentrate my territorial analysis in specific situations. While the project's intention was never to become an anthropological study, qualitative data from fieldwork observations and interviews were planned to provide the bulk of the thesis' original contribution, adding valuable layers to the broad and remote research of the case study's territorial context.

Two visits to Gansu province were conducted. The first one was at an early stage of the project in spring 2019 to Lanzhou and the new city of Lanzhou New Area. The main intention of this first trip was to connect with local experts and find institutional partners for future collaboration in the later stages of the project. A second, more extensive field trip to the Hexi Corridor was conducted in the fall of 2019, visiting all its major cities of Wuwei, Zhangye, Jiuquan, Jiayuguan, and Dunhuang. I spent several days in each place, where day trips to the surrounding region were made. The main intention of this second trip was to get a geographic overview across the case study region, identify places for potential site investigation, and test out fieldwork methods and practicalities. On both trips, I was always accompanied by at least one local Gansu resident who was familiar with the context, acted as a translator, helped organize logistics, and provided valuable contacts to locals and inside information.

Through photography, I began to visually document different sites of interest, their aesthetic characteristics, and operational functions. The photographs aimed to capture the dynamic transformation processes that are reshaping the region. Upon return in the weeks after the trip, the pictures and fieldnotes were evaluated to build up a catalog of different place typologies and sites of investigation, e.g., sites of material extraction, industrial production, degradation, pollution, land cultivation, and environmental restoration. The fieldwork was conducted as a first general survey. Many places of interest were just briefly documented and marked on the map as potential sites for further investigation. Through future field trips and by narrowing down the site selection in parallel with the remote literature research, the goal was to create a comprehensive narrative and develop a geographic portrait, territorial in scale but grounded in very specific site conditions.

Because of travel restrictions due to the COVID-19 pandemic, starting just two months after my second visit, no additional fieldwork could be done. The quality and depth of the gathered qualitative data are, therefore, limited. However, photographs provide a general impression of the different geographic regions and landscape typologies that can be found along the Hexi Corridor. They are able to visualize the geographic watershed analysis, described in chapter two, explaining the region's fundamental, inner logic, and general ecological functioning. Fieldnote accounts of some subjective impressions and

encounters are integrated throughout the thesis as short, anecdotal vignettes. In addition to photographs, they can add an additional dimension of qualitative data to the text.

Multidimensional Research and the Expansion to a Territorial Context

On the one hand, this thesis aims to understand how individual places have been produced by social in reciprocal relation to environmental forces. Simultaneously, on the other hand, how a specific socio-environmental system spatially organizes a territorial geographic context. Such a multidimensional investigation constantly operates in parallel on different levels: First, on a micro-scale, information is gathered from specific situations in selected sites through fieldwork, being in and experiencing an individual place. Second, on a macro-scale, secondary literature is studied to understand the geography's socio-environmental history, the social organization, political structures and hierarchies, the different actors, their economic and geopolitical interests, policies, strategies, as well as plans for socio-economic development, resource extraction, the cultivation and restoration of land. In a globalized world economy, these relations, plans, and strategies can encompass international and even planetary scales. Across different timelines in chapters three to six, the Hexi Corridor is discussed by first describing a comprehensive socio-political context. This broad context, which can be divided into different periods of an alternating socio-environmental system across China's long history, is then used to explain how it has enabled people to reconceive the Hexi Corridor as a geopolitically strategic territory in relation to China's centers of political power, as well as spatially reorganize and physically reshape individual places and the Hexi Corridor as a whole.

As a third dimension, the fluxes of materials, human, and non-human agents are analyzed in order to understand how a territorial geographic context operates as a dynamic spatial configuration. The spatialization of where materials come from and where they are transported to and applied connects the two previous dimensions, bridging the micro and macro scales. This metabolic study is done through large-scale diagrammatic mapping as an abstraction of spatial relationships, including different actors, forces, and materials across a geographic context. It visualizes how a socio-political organization is manifested in individual places and creates a strategic territorial formation. Disciplinarily, this research can be positioned alongside urban metabolism studies with a focus on the territorial scale instead of traditional urban conditions.[12] This

12 See, for instance, Jane Hutton, *Reciprocal Landscapes: Stories of Material Movements* (London; New York: Routledge, 2020); Daniel Ibañez, Jane Hutton, and Kiel Moe, eds., *Wood Urbanism: From the Molecular to the Territorial* (New York; Barcelona: Actar, 2020). For speculative and visual investigations, see, for instance, Clara Olóriz, ed., *Landscape as Territory: A Cartographic Design Project* (New York, NY: Actar, 2020); Paola Vigano, *Territorialism* (Cambridge, Mas-

notion of a territorialization of the Hexi Corridor will be particularly discussed in chapter four in the context of modern China's central state nation-building since the early 1950s.

Landscape Geography

The multidimensionality this thesis aims for not only pertains to the research across long time periods and large spatial scales. The work also provides a multidimensional reading of the selected case study region through different sources of information: the combination of quantitative and qualitative data, text that is accompanied by visual material, insider perspectives from the ground, and outsider perspectives from remote literature research. In addition to text, photographs, and cartographic maps, there are diagrammatic drawings included in the project.[13] Together, they begin to reveal the potential of a landscape-informed, multidimensional reading of a territorial geographic context, which the thesis aims to describe. It demonstrates how such a reading is not just an analytical process. Through the visual representations of how the geography operates in dynamic transformation and appears aesthetically, the landscape lens becomes a creative, artistic tool. References to such an approach can be made to works of landscape geography: a field that examines dynamic geographic contexts through visual explorations that complement text-based research and is, in some cases, speculative in nature.[14]

Mapping and Geospatial Information

The amount of publicly available geospatial information in China is strongly limited. To obtain relevant data, it is usually necessary to collaborate with a state agency, for example, a Chinese-based and ideally state-funded academic institution. Therefore, and hoping to benefit from academic contacts and exchange, a formal collaboration between AHO and the Joint International Research Laboratory of Eco-Urban Design, an interdisciplinary research institute based at Tongji University in Shanghai, was established in 2019. A first formal exchange semester as a visiting scholar was planned for the spring 2020 semester. In addition, a mutual, informal agreement about future collaboration was made with the non-governmental Gansu Desert Control Research Institute on a visit in the fall of 2019. The institute is based in Lanzhou and focuses its

sachusetts: Harvard University Graduate School of Design, 2014).

13 See the attached posters representing the case study region across spatial and temporary scales, visually organizing data in a drawing and adding an additional dimension to the dissertation text, photographs, and cartographic maps.

14 Landscape geography was particularly influential in North America in the 1990s and early 2000s. See, for instance, James Corner, Alex S. MacLean, and Denis Cosgrove, *Taking Measures Across the American Landscape* (New Haven, Conn.: Yale University Press, 1996); Anuradha Mathur and Dilip Da Cunha, *Mississippi Floods: Designing a Shifting Landscape* (New Haven: Yale University Press, 2001); Alan Berger, *Drosscape: Wasting Land in Urban America*, (New York: Princeton Architectural Press, 2007).

research primarily on issues around desertification and land degradation in the Hexi region. However, it was impossible to maintain formal collaborations and data exchange without being based in China. While limited cartographic mapping based on publicly available data has been conducted, it was not possible to develop original maps as a significant contribution to the thesis. However, cartographic and quantitative data have been combined and presented in a unique way to add visual material to the thesis' original narrative, repositioning the Hexi Corridor in a multi-dimensional context of China's history and contemporary state.

Secondary Literature

As described above, the project started with the ambition to explore qualitative dimensions in depth. However, the bulk of the thesis ended up being based on secondary literature. While chapter one builds on urban and landscape theory and ecological science to develop a research approach and theoretical framework, chapters two to six portray the case study region, spanning very large temporal and spatial scales. This includes literature sources from a wide disciplinary range, including environmental history and science, anthropology, cultural geography, and political science, as well as journalistic reports and newspaper articles. The geographic portrait first aims to demonstrate how the Landscape Approach can be applied to the geographic context and second, to position the Hexi Corridor in the unique context of China's socio-political organization.

In this broad field of literature, sources were selected according to two main intentions: First, methodologically, the description of the selected geographic context follows the Landscape Approach, which it periodically refers back to. Second, geographically, the broad, macro narrative is always tied back to the Hexi Corridor, ensuring that all parts of the story, even if they expand to national or global scales and, in some cases, to lengthy footnotes with additional information, are relevant to better understand the specific geographic context of the case study region. In addition to the first two introductory chapters, theoretical concepts are also included throughout all other chapters. This is intended to position the selected case study region in a more general discourse, allowing it to draw parallels to similar other world regions. Theory is introduced in the respective paragraphs, where it is directly applied to the geographic context.

The Anthropocene as Context and Structure of the Thesis

The Anthropocene and its far-reaching socio-environmental implications serve this thesis as a productive, overall context. First, the concept questions the relation of humans to extra-human nature, which is a central, recurring theme of

the thesis. Second, it facilitates a radically interdisciplinary discourse, which is a key ambition of the proposed Landscape Approach and the thesis in general. And third, as explained in the following, different theories of when to date the historical starting point of the Anthropocene provide alternative timelines that structure the thesis chapters and the narrative of the Hexi Corridor.

The Anthropocene is defined by the daunting realization that humanity has begun to transform the Earth System as a whole—the terrestrial biosphere, atmosphere, hydrosphere, and lithosphere. This has happened to such an extent that the Anthropocene has been coined as a new geological epoch in order to describe the geophysical realities of today's state of the Earth.[15] As the concept suggests, humans have emerged as a global "force of nature" that has altered the atmosphere and climate, hydrology, and geomorphology, have caused species extinction and invasion, and changed patterns of primary production and biochemical cycles, including carbon, nitrogen, and phosphorus. In addition, humans have introduced radically new ecological processes and materials to the Earth, including the domestication of species through active selection and genetic modification, a vast number of artificial chemicals, plastics, and other synthetic materials. Humans also physically shape the planet by moving earth in enormous quantities, for instance, through soil tillage or large-scale infrastructural earthworks.[16] This understanding of a human-shaped world puts us into a new relationship with extra-human nature: It means that our actions, the way we spatially and politically organize societies—the way we live, produce, eat, dress, and move—have not only consequences for our immediate environment but transforms entire world regions and the Earth System as a whole.

The realization of such tremendous impacts of human activities on the shaping of the world provides a paradigm to productively rethink the role of humans in relation to the Earth System. It suggests that virtually all parts of the Earth are affected by anthropogenic activities and points to the fact that humanity is essentially affected by global environmental disruptions—albeit to very different degrees. The most valuable contribution of the Anthropocene seems to be the fact that it succeeded in starting a public and scholarly dialogue

15 Paul Crutzen and Eugene F. Stoermer, "The 'Anthropocene,'" *IGBP Newsletter* 41 (2000): 17–18; Will Steffen, Paul J. Crutzen, and John R. McNeill, "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature," *AMBIO: A Journal of the Human Environment* 36, no. 8 (December 2007): 614–21; Will Steffen et al., "The Anthropocene: Conceptual and Historical Perspectives," *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 369, no. 1938 (March 13, 2011): 842–67.

16 An often-cited study showed that today, the worldwide human-induced movement of earth, sand, and stone is greater than the sum of all other natural processes acting on the world's surface combined: "Current amounts of human-induced erosion are more than an order of magnitude greater than that resulting from all natural processes. […] Human activity is the most important geomorphic agent acting on the surface of the modern Earth", adding up to around 21 tons per person per year. Bruce H. Wilkinson, "Humans as Geologic Agents: A Deep-Time Perspective," *Geology* 33, no. 3 (March 1, 2005): 161–64.

that is radically interdisciplinary and put earth scientists, political economists, artists, historians, anthropologists, activists, and many others into conversation.

The Anthropocene as a Multidisciplinary Discourse

Across the broad body of literature discussing the Anthropocene, two main epistemological camps can be identified: On the one hand, natural scientists aim to understand the Earth System through scientific models of quantitative measurements and projections. The ecomodernists, among them, have a strong belief in science and technology. They see humans at the center of potential solutions to environmental threats and suggest to actively altering planetary ecosystems for the better. On the other hand, scholars from humanities understand the Earth System as a multidimensional entity that humans are an integrated part of and fundamentally dependent on. They are interested in the qualitative consequences of a transforming planet and argue for holistic, systemic change. Posthumanist thinking rejects anthropocentric worldviews and emphasizes the need to see humans as deeply entangled with their extra-human environment.

The thesis does not choose one disciplinary strand or the other: Earth Scientists have provided fundamental texts for understanding the Anthropocene. Notably, scholars from ecological science have been instrumental in this thesis and have helped to describe the case study region as a socio-environmental system. Texts from humanities add more fundamental, holistic perspectives, emphasizing the close interdependency of human and non-human agents. This thesis follows the ambition to provide an interdisciplinary narrative where such divergent perspectives are equally referred to and benefitted from. Instead of idealistic beliefs, the thesis' attitude to the apparent conflicts between different disciplinary strands is one of holistic thinking, characterized by multidimensionality, simultaneity, and pragmatism. Key texts from both sciences and humanities are presented below. They are also used for framing the Landscape Approach in the next chapter, promoting the concept of landscape as a common ground to mediate between disciplinary divides.

The Anthropocene's Multiple Temporal Narratives that Provide a Structure for the Thesis

One central debate around the Anthropocene is when to define the starting point of this new geological epoch. This notion of defining key moments in time to structure world history as periods of significant change in the anthropogenic transformation of the natural environment has been informative to structure the thesis. In Earth science, formal criteria must be met to define a geological time unit: Global-scale changes must be recorded in geological stratigraphic material, such as rock, glacier ice, or marine sediments.[17]

17 Felix M. Gradstein et al., eds., *The Geological Time Scale 2012* (Boston: Elsevier, 2012); cited in Simon L. Lewis and Mark A. Maslin, "Defining the Anthropocene," *Nature* 519, no. 7542

Tracing the Starting Point of Anthropogenic Earth Transformation

One possible starting point could be set several million years ago when *homo erectus* learned to make tools and weapons and strategically use them to modify natural ecosystems to gain advantage in gathering or hunting food sources. Around a million years ago, early humans started to control and manipulate fire, allowing them to become increasingly superior and dominant over their surrounding environment. However, their actions were local events and not able to modify the chemical composition of the atmosphere or the oceans at a global level.[18]

Another starting point could be dated around 50,000 years ago when genetically advantageous *homo sapiens* with "modern behavioral patterns" spread out of Africa.[19] Their advanced hunter-gatherer societies started to intentionally transform ecosystems at increasingly large scales, mainly through vegetation burning for more efficient hunting and food gathering.[20] The spread of humans across continents coincided with a mass extinction of megafauna in the late Pleistocene, particularly in the Americas.[21] Some scholars argue that ecosystems started to get significantly transformed by these early human societies' growing scales of hunting activities. Yet, Steffen et al. see no evidence that these cases of vegetation clearance and mass extinction—if caused by humans at all—had a significant impact on the functioning of the Earth as a whole.[22] The appearance of growing human activities also seems to be a series of events on different continents at different times rather than one simultaneous, transformative force.

Early Anthropocene

The so-called Neolithic Revolution, the advent of agriculture in the early Holocene, had a far greater impact on the terrestrial biosphere and the atmosphere. Significant spatial transformations occurred, particularly through the clearing of forests and their conversion into cropland and the domestication of desirable species. More than 10,000 years ago, growing agricultural societies accelerated early defaunation and land-clearing processes, particularly through

(March 2015): 171–80.

18 Steffen et al., "The Anthropocene: Conceptual and Historical Perspectives," 846.

19 Richard G. Klein, "Modern Human Origins," *General Anthropology* 20, no. 1 (2013): 1–4.

20 Christopher E. Doughty, "Preindustrial Human Impacts on Global and Regional Environment," *Annual Review of Environment and Resources* 38, no. 1 (2013): 503–27; Anthony D. Barnosky, "Paleontological Evidence for Defining the Anthropocene," *Geological Society, London, Special Publications* 395, no. 1 (January 1, 2014): 149–65.

21 Christopher Sandom et al., "Global Late Quaternary Megafauna Extinctions Linked to Humans, Not Climate Change," *Proceedings of the Royal Society B: Biological Sciences* 281, no. 1787 (July 22, 2014): 1–9.

22 Steffen et al., "The Anthropocene: Conceptual and Historical Perspectives," 847.

the intentional use of fire to create successive ecosystems.[23] By the mid-Holocene, at least 5,000 years ago, agricultural systems had emerged across most continents, leading to the clearing of native vegetation, their replacement with domesticates, and the increasingly intense application of techniques and inputs to enhance land productivity. This intensification and spread of large-scale land transformation at a global scale through deforestation, conversion into cropland, and the large-scale development of irrigated rice cultivation could have increased greenhouse gasses to an extent where it began to significantly change the global climate system. This period of global agricultural intensification has thus been described as the *Early Anthropocene*.[24] The first signs of large-scale, human-induced environmental degradation in the Hexi Corridor are also dated to that period of Neolithic cultures emerging in the region, as it will be later described.

Ultimately, native ecosystems were replaced with novel ecological transformations, especially by domesticating species, soil tillage, societal growth, and increasing scales of material exchange, leading to globally significant changes of the terrestrial biosphere by at least 3,000 years ago.[25] From such early agricultural societies, the human-environmental world history continues to ever larger scales of environmental transformation and material exchange. Shifting away from mere local production, growing societies began to systematically organize entire territories, strategically operating trade networks to sustain increasingly large populations, which required a high level of agricultural surplus, leading to increasingly large, intensive, and productive agricultural systems.[26] The intensification of land-use regimes began to have impacts on global ecosystems. First, it led to a dramatic decrease of the global vegetation cover, which has clear correlations to the atmospheric composition and the global climate.[27] And second, human land uses have significantly altered native terrestrial ecosystems through land clearing, soil tillage, irrigation and changing water regimes, increased erosion and runoff, nutrient enrichment, and domesticated species.[28]

The concept of an Early Anthropocene aligns with the narrative I chose to

23 Stephen J. Pyne, *Vestal Fire: An Environmental History, Told Through Fire, of Europe and Europe's Encounter with the World* (University of Washington Press, 1997).

24 William F. Ruddiman, "The Anthropogenic Greenhouse Era Began Thousands of Years Ago," *Climatic Change* 61, no. 3 (December 1, 2003): 261–93; John E. Kutzbach et al., "Climate Model Simulation of Anthropogenic Influence on Greenhouse-Induced Climate Change (Early Agriculture to Modern): The Role of Ocean Feedbacks," *Climatic Change* 99, no. 3 (April 1, 2010): 351–81.

25 Erle C. Ellis et al., "Used Planet: A Global History," *Proceedings of the National Academy of Sciences* 110, no. 20 (May 14, 2013): 7978.

26 Ellis et al., "Used Planet," 7982.

27 Lahouari Bounoua et al., "Effects of Land Cover Conversion on Surface Climate," *Cc* 52 (January 1, 2002): 29.

28 Erle C. Ellis, "Anthropogenic Transformation of the Terrestrial Biosphere," *Philosophical Transactions: Mathematical, Physical and Engineering Sciences* 369, no. 1938 (2011): 1010–35.

discuss and historically contextualize the Hexi Corridor in chapters two and three. It describes how anthropogenic transformations along the Hexi Corridor happened whenever the region was occupied by societies that were able to systematically transform their environment to meet their needs, starting from Neolithic agricultural societies. Rather than one specific moment in time, a fluctuating, long-term process of anthropogenic activities is described, increasing the intensity of human entanglements with extra-human nature over time.

Colonial Expansion and the Columbian Exchange

In an alternative narrative, Lewis and Muslin suggest the meeting of human populations from the Old and New World as the starting point of the Anthropocene. The exchange of previously separate biotas led to a radical reorganization and homogenization of life on Earth without geological precedent. Lewis and Muslin connect the colonial invasion in South America to atmospheric change: They correlate the sudden decline in human populations with a large-scale vegetation regeneration, leading to an increase in carbon uptake. They call the resulting short but pronounced dip in atmospheric CO2 levels in 1610 the "orbis spike" and suggest it as a marker for the starting point of the Anthropocene.[29] However, their thesis is criticized for being insufficient and even a misconception of the Anthropocene as there is no evidence that such a dip in the CO2 concentration had changed the functioning of the Earth System as a whole.[30]

Whether or not the colonial invasion of the Americas serves as the starting point of the Anthropocene, it marks a critical moment in both the history of modern humanity and the Earth System as a whole: The environmental historian Alfred Crosby coined the term the *Columbian Exchange* in his 1972 book of the same title and later discussed the biological and cultural implications in another canonical book, called *Ecological Imperialism*, from 1986. In both texts, he describes how European colonialism transferred species across continents, including bacteria, diseases, microbes, and invasive species, dramatically transforming ecosystems and entire geographies in both the Old and New World.[31] While this Western-led imperialism may be less relevant for the Hexi Corridor, it is crucial for the conception of the landscape idea, which is fundamental for the thesis's theoretical approach.

In the centuries that followed the Columbian Exchange, lands were transformed throughout the New World on an increasingly large scale and at an accelerated pace. One of the most dramatic examples of this territorial land

29 Lewis and Maslin, "Defining the Anthropocene."

30 Clive Hamilton, *Defiant Earth: The Fate of Humans in the Anthropocene* (Cambridge, UK; Malden, MA: Polity, 2017), 18.

31 Alfred W. Crosby, *The Columbian Exchange: Biological and Cultural Consequences of 1492* (Greenwood Publishing Company, 1972); Alfred W. Crosby, *Ecological Imperialism* (Cambridge University Press, 1986).

transformation is "the subjugation of the whole continent of North American to European modes of material production, [and] its inclusion within the European agricultural economy, the wholesale exploitation of its natural resources of wildlife, timber, and mineral deposits, its integration by canal and railroads and its colonization by farmhouses, towns, and cities."[32] Denis Cosgrove describes—in the context of European Colonialism—how this continental expansion also led to radically new perceptions of the physical environment. He explains how the relationship and perception of individuals to the physical environment, land, and property changed: Land across Europe and the New World was transformed by clearance of woodland, drainage of marshland, and the reclamation of wasteland in increasing quantities. Land was thus made productive and profitable and became a form of investment.[33]

Essential for this thesis, and as it will be further discussed in the following chapter, this colonial expansion coincided with the origins of the landscape idea as—what Denis Cosgrove describes—a "new way of seeing" the world. This idea of landscape was thus closely related to the exercise of power over space—the practical appropriation of space.[34] Following Cosgrove's narrative of the transformation of the New World by choosing the early Han dynasty as a starting point for the narrative on the Hexi Corridor, one key argument the thesis makes is that the beginning of China's imperial expansion enabled the *mental* reconceptualization of an entire world region. This ultimately enabled the systematic, *spatial* reorganization of the region as a strategic territory, which began to fundamentally alter ecosystems through *biochemical* transformation processes, as will be further discussed in chapter three.

Dualist World Views During the Scientific and Industrial Revolution

The Scientific Revolution in Europe can be identified as another important period on the Anthropocene timeline in which new perceptions of the world and radical technological and socio-political shifts enabled far-reaching transformations of extra-human nature: As medieval beliefs were replaced with new understandings and value systems based on empirical, mechanical, and mathematical logic, a culture of human domination over nature was further established, shifting away from a world conception in which humans were part of nature, to one in which they were superior to it.[35] Cartesian thought further abstracted the human mind from the body and physical nature, reducing them to mathematical and geometric formulas that could be observed and

32 Denis Cosgrove, *Social Formation and Symbolic Landscape*, 2nd ed. (Madison, WI: University of Wisconsin Press, 1998), 5.

33 Cosgrove, *Social Formation and Symbolic Landscape*, 1–12.

34 Denis Cosgrove, "Prospect, Perspective and the Evolution of the Landscape Idea," *Transactions of the Institute of British Geographers* 10, no. 1 (1985): 45–46.

35 Fritjof Capra, *The Turning Point: Science, Society, and the Rising Culture* (London: Flamingo, 1983), 37–62.

rationalized. In contrast to nature, humans possess the free will to reason and transform their physical, extra-human environment—intensifying the belief in human superiority over nature.[36] This dualist worldview, which is rooted in the Judean-Christian tradition and which is prevalent in the globalized Western culture until today, has been identified by many as the root of global ecological crises[37] and will be an important conceptual framework in later chapters of the thesis. Cartesian thought led to the capitalist production of—what Jason Moore calls—Cheap Nature. It is based on the "four cheaps" labor, energy, food, and raw materials, which can only be considered cheap because their actual environmental and social costs are not factored in.[38] Together with the colonial appropriation of foreign territories, this enabled the "commodification of everything," leading to massive global environmental transformations.[39]

The growing use of fossil fuels with the beginning of the Industrial Revolution in Great Britain in the seventeen hundreds and later the thermo-industrial revolution in the nineteenth century allowed to multiply production outputs. It led to a shift away from agriculture as the dominant human activity and increasingly transformed the terrestrial biosphere and atmosphere.[40] In their famous publication from 2000, Crutzen and Stoermer thus proposed the Industrial Revolution as the starting point for the Anthropocene, suggesting the year 1784 when "James Watt invented the steam engine."[41] However, as others argue, rather than a sudden regime shift, the technological innovations of the Industrial Revolution enabled a decentralized, continuous transformation process without a clear starting point and an onset somewhere between the mid-eighteenth and late nineteenth century. The concentrations of CO_2, methane, nitrate, and other chemicals show first, only a little and later, a relatively smooth increase. Therefore, the Industrial Revolution doesn't serve as a clear global marker that would allow to set the starting point of a new geological epoch.[42]

---

36 Richard A. Watson, "What Moves the Mind: An Excursion in Cartesian Dualism," *American Philosophical Quarterly* 19, no. 1 (1982): 73–81.

37 Lynn White, "The Historical Roots of Our Ecologic Crisis," *Science* 155, no. 3767 (March 10, 1967): 1203–7; William E. Kilbourne, "Consumption and the Ecological Crisis: Historical Roots," in *Proceedings of the 1995 World Marketing Congress*, ed. K. Grant and I. Walker, Developments in Marketing Science: Proceedings of the Academy of Marketing Science (Cham: Springer International Publishing, 2015), 99–107.

38 Jason W. Moore, *Capitalism in the Web of Life: Ecology and the Accumulation of Capital* (London: Verso, 2015), 1–30.

39 The Dutch Republic, Descartes' country of residence, was the modern era's first great superpower. Jason W. Moore, "'Amsterdam is Standing on Norway' Part II: The Global North Atlantic in the Ecological Revolution of the Long Seventeenth Century," *Journal of Agrarian Change* 10, no. 2 (2010): 189.

40 Steffen et al., "The Anthropocene: Conceptual and Historical Perspectives," 847–49.

41 Crutzen and Stoermer, "The 'Anthropocene,'" 17–18.

42 Lewis and Maslin, "Defining the Anthropocene," 177.

Great Acceleration

As it was later declared, the singular moment of the invention of the steam engine left no significant and precise GSSP (Global Boundary Stratotype Section and Point), which is essential for defining geological epochs. The starting point that the Anthropocene Working Group[43] favored instead is the mid-twentieth century and the beginning of the *Great Acceleration*. During that time of rapid post-war development, many "indicators of human activity" began to grow exponentially, including both socio-economic and biophysical dimensions such as the global population, GDP, resource consumption, greenhouse gas concentrations, rising temperatures, and biodiversity loss.[44] As a specific "golden spike" that can be identified as a clear mark in the long-term geological record of the planet, the group proposed the global spread of artificial radionuclides in the early 1950s, caused by thermonuclear bomb tests as a sharp and globally synchronous signal.[45]

This notion of the Great Acceleration as a specific moment in time, marking a significant anthropogenic transformation of the Earth System, is identified as the second key moment in this thesis to discuss the Hexi Corridor. It coincides with the introduction of heavy industrialization in the early 1950s in the Hexi Corridor after years of destructive wars and the founding of the People's Republic of China (PRC) in 1949. As discussed in chapter four, the Hexi Corridor was identified as a region of national significance in the process of state-led nation-building. The region was reconceptualized as a strategic corridor where large-scale industrial projects were systematically introduced for the extraction of resources and the production of vital materials.

Planetary Urbanization

In addition to the biochemical transformation of the Earth System, the Great Acceleration can be understood as a moment of a spatial explosion of the built environment. Although unevenly distributed across the globe, with an increasing population, a rising GDP, and a growing middle class, the consumption of resources and space per capita began to grow dramatically, as the indicators of human activity illustrate. This led to growing urbanization rates, particularly in the periphery of cities, leading to increasingly large and diffuse urban agglomerations.

In *The Urban Revolution*, Henri Lefebvre describes a globalization of the

43 The Anthropocene Working Group (AWG) was formed in 2009 with the mission of delivering scientific evidence that is robust enough to "scientifically justify" the Anthropocene as a geological epoch, ratified by the International Union of Geological Sciences and officially added to the Geological Time Scale. AWG Anthropocene Working Group, "Working Group on the 'Anthropocene' | Subcommission on Quaternary Stratigraphy," May 21, 2019.

44 Steffen, Crutzen, and McNeill, "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature."

45 Colin Waters et al., "A Stratigraphical Basis for the Anthropocene?," *Geological Society, London, Special Publications* 395 (May 14, 2014): 1–21.

urban condition over time, leading to a "complete urbanization" of society. This describes a moment in which the urban fabric includes "all manifestations of the dominance of the city over the country."[46] While urbanization describes processes of the *concentration* of capital, political power, labor, and institutions in urban centers, it is simultaneously also a process of enormous spatial *extension*.[47] In the context of a globalized market economy, all the conflictive forces described as inherent to how a socio-political regime produces space are extended to a planetary context. Therefore, while capital is being spatially manifested in a connected web of urban centers around the world, the urban extension—or "explosion"—does not only happen around cities, creating massive and ecologically complex urban regions but has expanded across the entire planet. As Neil Brenner writes, urban agglomerations thus "must be connected analytically to larger-scale processes of territorial reorganization, circulation (of labor, commodities, raw materials, nutrients, and energy), and resource extraction that ultimately encompass the space of the entire world."[48]

Goods and people are today transported around the globe, across the land, sea, and air. Communication and information exchange occur within seconds across satellites hovering above the earth or cables far below the sea. Remote sites of extraction, production, and logistics are connected to urban nodes and are integral to sustaining urban life and a capitalist world economy. In 2011, Neil Brenner and Christian Schmid first used the term *planetary urbanization* to describe this notion of a complete urbanization of the society that is affecting the web of life, both socially and environmentally, at a planetary scale.[49] Vast territories are comprehensively reproduced—or "territorialized"— through investments in operational infrastructures and territorial planning strategies.

As described in the fourth chapter, the Hexi Corridor has been territorialized through massive investments in industrial extraction and production of resources in the process of Maoist, state-led nation-building. In the last two decades of the twentieth century, in a period of Reform and Opening-Up, China began to be integrated into a globalized market economy, increasingly participating and intervening in global trade networks. As chapter five will discuss, in the first decade of the twenty-first century, China began to position itself as a leading global actor with the ambition of shaping a new world order. With the Belt and Road Initiative, first announced in 2012, and with the Hexi Corridor playing a pivotal role, China increasingly extends its ambitious plan-

46 Henri Lefebvre, *The Urban Revolution* (Minneapolis: University of Minnesota Press, 2003), 4.

47 Referring to Lefebvre's generalization of capitalist urbanization, Neil Brenner describes these transformation processes as constant motions of "implosion-explosion." Neil Brenner, ed., *Implosions/Explosions: Towards a Study of Planetary Urbanization* (Berlin: Jovis, 2014), 14–30; Lefebvre, *The Urban Revolution*, 14.

48 Neil Brenner, "Theses on Urbanization," *Public Culture* 25, no. 1 (69) (January 1, 2013): 103–4.

49 Neil Brenner and Christian Schmid, "Planetary Urbanisation," in *Urban Constellations*, ed. Matthew Gandy (Jovis, 2011), 10–13.

ning strategies from a domestic to a global context. These latest development strategies—again based on heavy infrastructures and massive, speculative investments—are identified as the third key moment in the long-term narrative of the Hexi Corridor. This most recent period of the region's territorial reconceptualization is discussed in chapter five and, in a more speculative attempt, including growing environmental concerns, in chapter six. Following the notion of planetary urbanization, contemporary projects of urban and infrastructural growth in remote locations along the Hexi Corridor can be understood as spatial manifestations of planetary processes of implosion and explosion. They illustrate how global visions of spatial development and socio-political restructuring are grounded in specific places with, in some cases, far-reaching consequences for the local socio-environmental conditions.

***

Three of the above-mentioned Anthropocene timeframes have been selected to structure this thesis: First, following a narrative of the Early Anthropocene, the region's *longue durée* of socio-environmental transformation since the formation of large-scale sedentary societies, and accelerated through imperialist visions of China since the early Han dynasty. Second, following a narrative of the Great Acceleration, the region's strategic, territorial reorganization based on heavy industrialization as part of state-led nation-building since the early 1950s—however, not in the Western context of a market economy but in the specific socio-political regime of the PRC. And third, as just mentioned above and following the notion of planetary urbanization, the region's integration into geopolitical visions of a new world order based on speculative capital investments and large urban-infrastructural projects. [Poster A]

The Anthropocene of Today: A World of Increasing Complexities and Uncertainties

The Anthropocene not only provides a historical narrative of how the Earth system has been transformed and shaped by humanity across different timeframes but also provides concepts to describe conditions of the contemporary world.

Anthropogenic Biomes

The Anthropocene entails two characteristics that are essential to describe the condition of the Earth today: The first is the realization that the vast majority of the terrestrial biosphere is either actively used or has been significantly transformed by human activities." These human-altered, "anthropogenic biomes" form very complex and heterogeneous conditions. The world can thus be understood as consisting of "human systems, with natural ecosystems embed-

ded within them,"[50] suggesting a radically different idea of the world and the relationship of humans and extra-human nature. Erle Ellis' theory of "anthro-ecology" synthesizes theories from ecological, evolutionary, and social sciences to describe the long-term anthropogenic transformation of the extra-human environment. He argues that humans must be seen as an integral part of ecological science. Their socio-cultural processes have to be discussed like biological and geophysical processes "in much the same way as climate systems."[51]

As Ellis describes, most of today's terrestrial biosphere has been transformed by processes of primary or even secondary anthro-ecological transformation. Over the centuries, human interaction with extra-human nature at increasing scales has physically shaped landscapes composed of patches of ecosystems that have been altered to different degrees, forming mosaics of hybrid socio-environmental systems. As discussed in chapter three, certain areas along the Hexi Corridor have been cultivated, abandoned, and desertified; restored, cultivated, and abandoned again over several cycles across centuries.

Thresholds of Uncertainty

The second, and maybe most profound, characteristic of the Anthropocene is the notion of growing instability and uncertainty. The human epoch radically broke with the unusually stable conditions that characterized the Holocene—the moderately warm, interglacial period that provided environmental conditions that allowed humans to thrive and develop human civilizations. As it will be discussed in the long-term history of the Hexi Corridor, this development was not a linear process but periodically interrupted by local environmental crises such as devastating floods, droughts, or food shortages, and also global fluctuations such as temperature drops during the Little Ice Age in North Asia's sixteenth and seventeenth century. However, the Earth System was able to unfold its tremendous capacity of restoring and stabilizing ecosystems as fluctuations stayed within a relatively narrow range. With the advent of the Anthropocene, transformations of the Earth System threaten to shift relatively stable biophysical subsystems into threshold levels where they become highly sensitive and can flip into entirely new and irreversible states if these "planetary boundaries" are crossed, bearing potentially very harmful consequences for human societies.[52] While three of nine global transformation processes defined

50 More than 75% of Earth's ice-free land shows evidence of such human, cultural alteration, meaning that less than one-fourth of the ice-free land can be considered as wildland without evidence of human occupation, located in the least productive regions of the world and producing very little biomass. Erle C. Ellis and Navin Ramankutty, "Putting People in the Map: Anthropogenic Biomes of the World," *Frontiers in Ecology and the Environment* 6, no. 8 (2008): 439–47.

51 Erle C. Ellis, "Ecology in an Anthropogenic Biosphere," *Ecological Monographs* 85, no. 3 (2015): 317.

52 Johan Rockström et al., "Planetary Boundaries: Exploring the Safe Operating Space for Humanity," *Ecology and Society* 14, no. 2 (November 18, 2009).

in Rockström et al.'s original 2009 research paper have already moved out of their stable Holocene state, a revised publication in 2023 quantified all nine boundaries for the first time and concluded that six had been transgressed.[53]

As illustrated in the Hexi Corridor's environmental history, changing climates are the most decisive parameters for the stability of the Earth System. Ninety percent of all environmental disasters are related to floods, storms, heat waves, and other weather-related events.[54] The concept of multi-dimensional planetary boundaries emphasizes the stability of the Earth System as a whole, defining a relatively stable and safe range for humanity, which now threatens to be brought out of balance. This idea of the world as a cohesive system suggests holistic approaches to mitigate the consequences of adverse environmental processes.

Alternative Perspectives on the Anthropogenic Transformation of the World

As mentioned, the thesis refers to concepts from both natural sciences and the humanities to define its Landscape Approach and portray the Hexi Corridor. Alternative perspectives on the world's anthropogenic transformation reject narratives that are solely informed by rational science. They are productive as they add different layers, allowing to reconceive natural scientific explanations and world views informed by the dominating, global socio-political order.

In 1974, the planetary scientist James Lovelock and microbiologist Lynn Margulis famously developed the *Gaia* hypothesis. It presented a groundbreaking conception at the time, describing the world as a single, self-regulating system where all the Earth's organic and inorganic subsystems are connected and interdependent. They described the biosphere, the collective of living organisms, as the primary force that regulates the atmosphere and other subsystems.[55] Lovelock and Margulis' work introduced a radically new concept into Earth science and ecological thought. Informed by the *Gaia* hypothesis, scholars in humanities developed theories that oppose concepts that regard humans as acting upon their environment as an external force. What is referred to as *posthumanist* positions radically blur the boundaries between human and non-human spheres, linking science to social, cultural, and political relations. Posthumanists describe "hybrids of nature and culture"[56] and the "agency" of essentially all matter in the world forming self-functioning "assemblages."[57] They

53 Katherine Richardson et al., "Earth Beyond Six of Nine Planetary Boundaries," *Science Advances* 9, no. 37 (September 13, 2023): eadh2458.

54 Pascaline Wallemacq et al., *The Human Cost of Weather Related Disasters, 1995–2015*, 2015.

55 James E. Lovelock and Lynn Margulis, "Atmospheric Homeostasis by and for the Biosphere: The Gaia Hypothesis," *Tellus* 26, no. 1–2 (1974): 2–10.

56 Bruno Latour, *We Have Never Been Modern* (Cambridge, Mass: Harvard University Press, 1993).

57 Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham: Duke University Press

tell multispecies stories about "symbiotic entanglements"[58] of human and non-human actors, including technologies, and how these entangled webs of life adapt to and restore the "haunted landscapes" of disturbed, posthuman ruins.[59]

All these concepts reject and aim to overcome the human-nature divide, which has been identified as constraining humanity from effectively tackling the destructive consequences of this regime. In such readings, nature is not a passive backdrop that superior humans act upon but, instead, a sociopolitical construct that is sensitive to changing circumstances yet also very robust, resilient, and restorative. Posthuman concepts inform the ecological discussion of the Hexi Corridor as a heavily degraded world region that has been formed through the interaction of social activities and environmental transformations.

Socio-Environmental Co-Production

The environmental historian Jason Moore argues that the emergence of early capitalism and global colonial expansion in the long sixteenth century of the Western European context must be understood as the root of the global environmental crises we experience today. He stresses the importance of complex relationships between social (cultural, economic, political) and environmental (non-human) processes over long periods of time rather than individual historical events. He, therefore, suggests the term of the *Capitalocene* as opposed to the concept of the Anthropocene.[60] And since the economic system and the environment cannot be understood independently from each other, he describes capitalism as a "world ecology" of wealth, power, and nature: The success of the exploitative, capitalist regime, based on the notion of Cheap Nature as introduced earlier, which leads to conditions of environmental depletion and social inequality.

Moore's work has been instrumental for this thesis and the framing of the Hexi Corridor: Even though the narrative of my case study unfolds in Eastern Asia, begins in the second century BC, and outside the context of emerging capitalism and global colonialism in the European Renaissance, it follows the conception of a world ecology that is formed through the interconnection of social and environmental processes. Following Moore's narrative, a regional context, such as the Hexi Corridor, has not been created by humans that acted upon nature and transformed the extra-human environment as an

---

Books, 2010).

58 Donna J. Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Durham, NC: Duke University Press, 2016).

59 Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015); Anna Tsing et al., eds., *Arts of Living on a Damaged Planet: Ghosts and Monsters of the Anthropocene* (Minneapolis: University of Minnesota Press, 2017).

60 Moore, *Capitalism in the Web of Life*; See also Jason W. Moore, "The Capitalocene, Part I: On the Nature and Origins of Our Ecological Crisis," *The Journal of Peasant Studies* 44, no. 3 (May 4, 2017): 594–630.

external force. Instead, it is understood as the highly dynamic result of complex, socio-environmental processes of this symbiotic "co-production" over very long periods of time. Extra-human nature is not perceived as a passive background that human societies act upon. Instead, it forms a world ecology through which social systems constantly flow, creating a dense entanglement of human and non-human actors. In other words, a context-specific socio-environmental regime, shifting across different periods, defines how the physical environment is co-produced. The longue durée of such socio-environmental interrelationships, which led to severe degradation of ecosystems at a watershed scale, provides the broad context to frame the complexities of different conditions and mechanisms the Hexi Corridor region faces today. It is discussed in a multidimensional reading across chapters two to six, following different timescales.

Research Themes

The thesis refers to a vast body of literature across different disciplines and aims to weave these multiple strands of thought into a cohesive narrative. This is done in an attempt to demonstrate the holistic perspectives the Landscape Approach argues for, offering a multidimensional geographic reading that connects individual places to their broad, socio-environmental context. In reverse, this allows to ground complex socio-environmental challenges and interdependencies in specific locations where they become spatially manifested as consciously created landscape formations. Such an understanding across multiple spatial, temporal, and conceptual dimensions is by no means an attempt to draw a complete picture. While the Landscape Approach presented in this thesis provides an original contribution and aims to offer a valuable research method—or approach—, framing the Hexi Corridor case study region raises questions rather than giving answers. This intentional generalization or "broadening" of the selected case study is consciously opening up instead of narrowing down. And it expands the discourse rather than providing detailed conclusions, suggesting to be read in comparison to similar cases in other geographies. It also emphasizes the many contradictory dimensions as well as their dynamic interconnections. With this approach, the thesis ultimately argues for the need to embrace complexities and to work across spatial, temporal, and disciplinary boundaries.

Questions usually expect to be responded to with specific answers. Given the research approach and overall intentions described above, this thesis was structured around five research *themes* rather than research questions. As described in the section on research methods above, the research themes are discussed based on empirical material gathered during the fieldwork trips in 2019, which defined specific geographic themes and places of interest. This site-specific data was then contextualized with information from secondary sources through literature studies, interviews, and online research, together with drawings and maps, adding additional visual dimensions.

1. Individual Place: The production of places along the Hexi Corridor through invisible forces of a specific socio-environmental regime

Based on Marxist concepts, the thesis discusses the social production of space. In a first dimension, the concept of physical space that is socially produced is concerned with the scale of the individual place. It is illustrated with selected sites along the Hexi Corridor discussed throughout chapters four to six. It is based on the conception of landscape as the physical expression of a society that created a *place* over time through the reciprocal interrelationships with the extra-human environment. This reading of landscape formations allows the identification of different socio-environmental forces and their conflictive challenges that become tangible in selected, individual locations.

2. Territorial Context: The territorialization of the Hexi Corridor as a strategic spatial formation

The second theme is led by the belief that in order to understand local conditions deeply, it is necessary to study their broad, territorial context. The geographic connection of different localities across a territorial (strategically conceptualized) context reveals how a specific socio-environmental regime shapes space not only in an individual place but across an entire *territory*. This territorial dimension of the production of space is particularly important in the context of the Anthropocene, in which the impact of human activities can no longer be understood at the scale of individual places but has begun to shape entire world regions and essentially the Earth System as a whole.

In this thesis, the territorial reading of the creation of space follows multiple timescales of socio-environmental interaction. The research theme is therefore divided into four different timelines through which the Hexi Corridor is discussed across chapters three to six, exploring:

a) the long-term evolution of social and environmental systems since the second century BC
b) the systematic territorialization since the early 1950s
c) the global integration since 2012
d) increasing environmental concerns in recent years, shifting political narratives and priorities

3. Landscape Reading: Landscape as a holistic, multidimensional concept to read a geographic context across spatial, temporal, and disciplinary boundaries

This third research theme concerns the conception of landscape as a cultural artifact. It understands land that has been shaped in a specific place as the spatial expression of a society's socio-political organization. With the concept of a territorialization of space, this landscape expression is extended to the scale of a territory across which these different places are connected. The thesis argues that in the context of global environmental challenges of increasing

complexity, severity, and uncertainty, landscape—traditionally concerned with the formation of an individual locality—can serve as a productive medium to help understand such issues more holistically at the territorial scale. The theme is addressed with the framing of the Landscape Approach in chapter one and demonstrated across the multidimensional modes of reading of the Hexi Corridor across the following chapters.

4. Spatial Intervention: A Landscape Approach to restore degraded land across watershed scales

Informed by concepts from ecological science, the Landscape Approach offers a way of thinking across multiple spatial and temporal dimensions. But as a design discipline with a strong agency, as discussed in chapter one, referring to different landscape and planning practices, landscape can also envision potential futures and develop spatial interventions that can restore degraded ecosystems, anticipating and preparing for future transformations. Ultimately, the Landscape Approach aims to inform spatial planning and design solutions that can actively respond to urgent socio-environmental challenges. While the thesis does not propose such spatial interventions, ongoing projects of territorial land conservation and restoration along the Hexi Corridor are critically discussed in chapter six in the context of China's unique political system.

5. Culture of Thought: The multidimensional narrative of the Hexi Corridor as a case to establish a new landscape-informed culture in an anthropogenic world

While the Hexi Corridor is a unique case that has formed within a particular historical context and specific forms of socio-political organization that changed over time and spatially organized and governed the region, the thesis aims to connect this specific case to a broad, global discussion about conflictive processes of socio-environmental interaction. This is stressed through the positioning of the thesis in the planetary narrative of the Anthropocene and with the Landscape Approach as a universal culture of thought and mode of working. Particularly in the concluding chapter, the thesis connects lessons that can be learned from the Hexi Corridor to a broader set of questions as well as to other regions elsewhere in the world that face similar socio-environmental conditions. This aims to speculate how the thesis, with the specific case of the Hexi Corridor, could lead to new modes of landscape-informed practice.

Significance and Contributions

Holistic Thinking

The thesis is intended as a provocation to think radically holistic, encouraging a discourse across geographic, disciplinary, and cultural boundaries. It is led by the belief that a systematic holism, which the next chapter will introduce with

the framing of the Landscape Approach, can inform a discourse that perceives the individual person or site as closely entangled with the extra-human environment, encourages a discourse outside of disciplinary silos, and can connect seemingly local and isolated issues to regional and even planetary complexities. Such an approach is not only seen as a powerful ability and valuable contribution but as a necessity to address current and future challenges humanity faces.

Conception of the Urban

The Hexi Corridor is discussed throughout the thesis as a continuous geographic space that has been shaped and transformed through socio-environmental processes. In many cases, these processes are driven by far-distant—and seemingly detached—urban agglomerations as places where power and capital are concentrated. Therefore, operational landscapes in remote areas are conceptually connected to urban centers. Urbanization is thus understood as a process encompassing entire territorial contexts, including urban centers and remote hinterlands. And this context is analyzed through an ecological reading that follows the spatial logic of watersheds, ignores political-administrative boundaries or classifications, and rejects dualist ideas of the urban as a geographic unit defining a clear inside and outside.

Landscape as Catalyst

The Landscape Approach promotes the conception of landscape as a productive mode of thinking and seeing the world. This serves not only as a method to read and better understand a geography but, in addition, also as a creative, projective medium to anticipate and visualize potential futures, which can work as a catalyst to guide spatial interventions across scales. These spatial interventions are embedded in and led by the inner logic of the ecological system at watershed scales while simultaneously being grounded in the particular characteristics of the specific place.

Establishing Landscape Across Disciplines

The thesis aims to position landscape outside the design disciplines in an interdisciplinary dialogue, referring to literature from both the social and natural sciences. In particular, it aims to enrich the discourse around extended urbanization and territorial reproduction in the fields of critical geography and urban political ecology by providing a landscape reading that is able to ground socio-political discussions in the specific ecological conditions of individual places. As a concept that serves as an analytical research approach and an anticipatory medium to envision potential futures, landscape is promoted as a productive way of thinking that provides a common ground for interdisciplinary practice. Ultimately, its ambition is to help tackle socio-environmental issues from the scale of the individual site to the scale of entire world regions.

Drawing Parallels to Other World Regions

The case of the Hexi Corridor describes an environmentally sensitive region that has experienced dramatic processes of degradation through an acceleration of human activities over long periods of time and across a large scale. Territorial land degradation is among the most severe environmental challenges the world is facing. To mitigate and productively tackle planetary socio-environmental problems, new modes of practice are required to help heal and restore destructed ecosystems at territorial scales. Therefore, the thesis aims to provide a narrative that can serve as a productive case study for other world regions to learn from.

Limitations

This dissertation was affected by significant constraints. Since the thesis' main contributions were initially intended to be based on fieldwork data, the travel restrictions created a significant limitation for the work. Many themes that started to be investigated during the 2019 field trips could not be further studied with on-the-ground data. In some cases, field notes are included in the thesis despite the lack of substantial original information. With the help of local research collaborations that were established in 2019, it might have been possible to gain access to information that potentially had even allowed to develop site-specific landscape strategies, using the Hexi region as an actual testing ground.

While external factors restricted part of the research, some other limitations were anticipated from the outset, including cultural differences and language constraints. In fact, the better I began to understand China in all its diversity, complexities, and contradictions over the past years—particularly during the time I was living in Beijing—the more I realized how little I know about the Chinese nation and how different my own thinking and cultural values are. Therefore, it was clear that the regional study would be conducted from an outsider's perspective and positioned in a global, Western context. Nevertheless, led by a strong interest in China's socio-political system, an effort was made to understand some of its specific characteristics and mechanisms. Yet, as a caveat, I am aware that the thesis may include misinterpretations or incomprehension. China, with the particular case of the Hexi Corridor region, was always seen as an exemplary geographic context that would also allow the discussion of more general issues of socio-environmental complexities in a planetary context.

Given the project's external constraints and its timeline that was repeatedly turned upside down, the thesis began to position the Hexi region in a much more complex, broad, yet thorough and cohesive sense with the limited information that was accessible. In a world of increasing complexities and uncertainties, weaving different strands of knowledge into one dense fabric of storytelling that does not shy away from problems and questions of large and seemingly overwhelming magnitude seems important. Therefore, the thesis'

multidimensional, interdisciplinary narrative, which it was able to construct, might be its most significant contribution.

Ultimately, my work and this project aim to inform planning strategies and design interventions that can help to effectively address the complex socio-environmental challenges of our time. However, in this thesis, this is pursued in a theoretical and methodological manner. The project does not provide context-specific planning concepts, design schemes, or recommendations. Given the logistic restrictions and the alternative direction the thesis took, pursuing such an outcome would have been pretentious and unproductive. In China—and even more so given the complex and sensitive context of the selected case study region in a rural-dominated environment—a spatial planning document needs to be inevitably read as part of a strong and contested socio-political apparatus, even if it is considered a speculative strategy.

Chapter Outline

Chapter 1 – Landscape as Productive Medium to Approach Large-Scale Geographies of Socio-Environmental Entanglements

The first chapter develops a multidisciplinary Landscape Approach as a research method to engage with a complex, large-scale geographic formation in the planetary context of the Anthropocene. The conception of landscape, at the productive intersection between arts and sciences, serves as a creative medium and intellectual framework to study a geographic context across spatial and disciplinary boundaries. In addition to using landscape as a way of reading a specific geography, it is also promoted as a medium to systematically intervene in a particular place in the form of a spatially designed, dynamic, and performative socio-environmental system.

Chapter 2 – Hexi Corridor: A Geographic Portrait and the Establishment of an Arid Frontier

Chapter two introduces the Hexi Corridor within China as an arid frontier region at the intersection of China's central-eastern heartland and its vast northwestern regions. Across these two geographic entities, it discusses historically how very different identities and attitudes toward the extra-human environment have developed. With a holistic landscape reading, the Hexi Corridor is described as a complex, sensitive, multidimensional ecosystem.

Chapter 3 – The Hexi Corridor's Longue Durée of Socio-Environmental Co-Production

Chapters three to five identify periods of significant regime shifts that reconceived the Hexi Corridor as a strategic territorial formation. They describe how

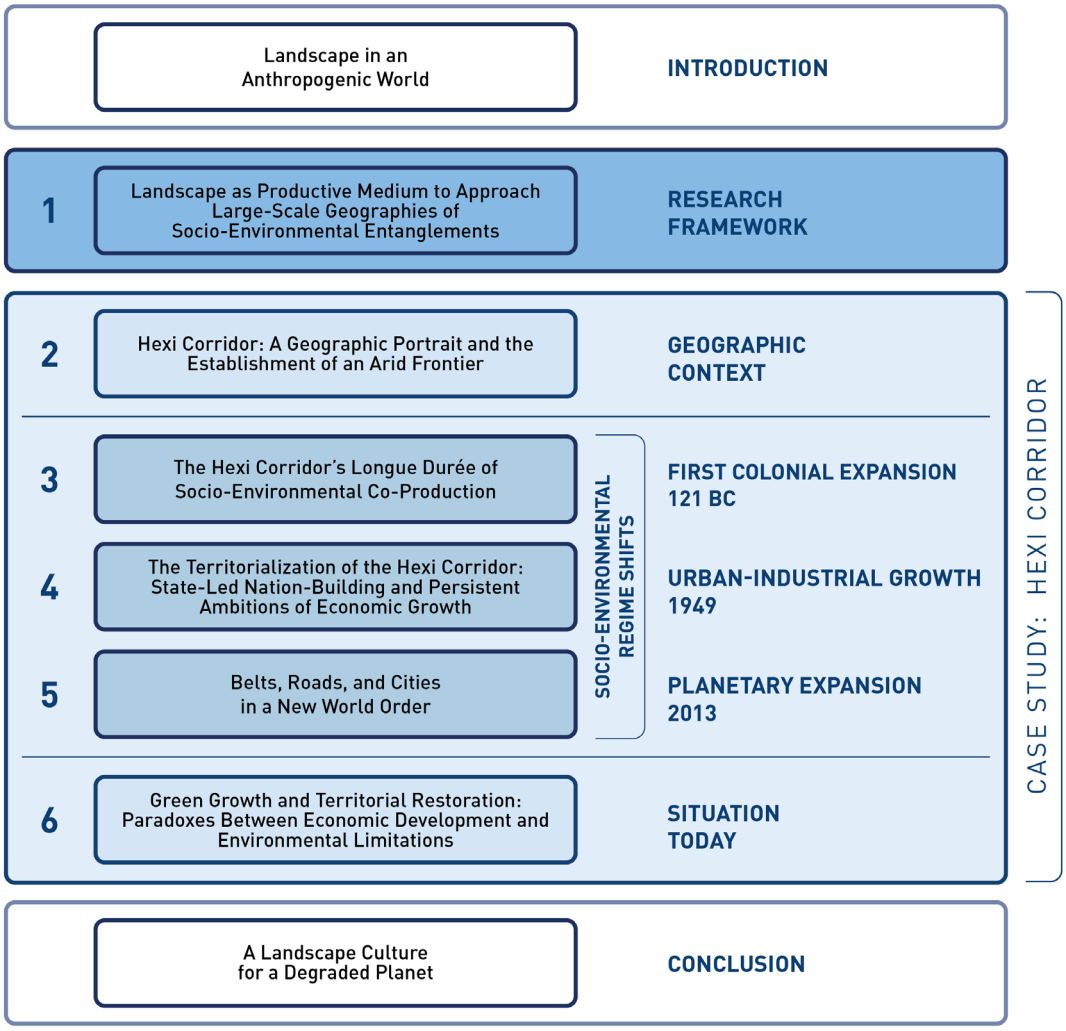


Fig. 0.1: Outline of the Thesis consisting of the introduction, chapters one to six, and a conclusion.

the invisible forces of a socio-political apparatus at a specific point in time, including its geopolitical interests, ambitions for economic growth, policies, capital investments, and cultural practices, transformed individual sites and reshaped the Hexi region as a territorial configuration. In chapter three, the beginning of China's imperial expansion during the early Han dynasty in the second century BC is used as a starting point for an over 2,000-year-long history of human societies that have colonized the Hexi Corridor in different intensities and have induced processes of territorial environmental degradation. This did not happen as a linear but as a highly fluctuating evolution. Through a broad, multidimensional narrative, the chapter aims to identify social and en-

vironmental systems through which the Hexi Corridor has been co-produced over the longue durée. These long-term territorial transformation processes have led to strong socio-environmental challenges the region faces today.

Chapter 4 – The Territorialization of the Hexi Corridor: State-Led Nation Building and Persistent Ambitions of Economic Growth

Starting with heavy industrial and infrastructural projects that were introduced to the Hexi Corridor as part of China's state-led nation-building in the post-war era, the case study region is discussed in chapter four. This investigation aims to trace how the Hexi Corridor has been territorialized—geopolitically reconceived and spatially restructured—as a strategic region since the founding of the PRC and the beginning of large-scale industrialization in the early 1950s. In this territorialization process, according to strategies by the central government, individual places of material extraction and industrial production are connected to territorial plans of economic growth and socio-political restructuring.

Chapter 5 – Belts, Roads, and Cities in a New World Order

Continuing the narrative of a strategic territorialization of the Hexi Corridor, chapter five discusses the most recent period of China's socio-political restructuring. While state-led strategies in chapter four operate domestically, they are now addressed in the context of China's ambitions to act as a leading global power that is shaping a new world order. The primary case in the narrative of chapter five is the Lanzhou New Area, a new city seemingly being built from scratch and symptomatically located outside of the Hexi Corridor. The new urban node can be understood as a counterpart to the structurally weak region, which, in contrast, is restructured as a crucial transportation corridor in an emerging, new global network of trade. This illustrates how the Hexi Corridor is reshaped in the context of planetary visions of geopolitical reordering.

Chapter 6 – Green Growth and Territorial Restoration: Paradoxes Between Economic Development and Environmental Limitations

While chapters three to five discuss the historical and recent formation of the Hexi Corridor and the origins of socio-environmental issues the region is facing, chapter six describes contemporary modes of responding to these conditions. It explains how conflicts between ambitions for socio-economic growth and fundamental environmental limitations play out in the specific sociopolitical context of China. In recent years, they have led to shifts in political narratives and priorities toward an increasing awareness of environmental

degradation. Some new policies around this new environmentalism are critically discussed and demonstrated with several cases currently happening in the Hexi region. They illustrate how these ambitious policies are interpreted and translated at specific localities, where they shape physical space and produce new landscapes of production and restoration. The chapter aims to reveal contradictions between an authoritarian approach to environmental restoration and paradoxical concepts of "green" growth. Both are not unique to China and, therefore, relevant to other parts of the world.

Conclusion – A Landscape Culture for a Degraded Planet

The concluding chapter reflects on the Landscape Approach's ambition to serve as a productive concept to tackle some of the complex and urgent socio-environmental issues of the Anthropocene. It refers back to the research themes that have been set out in this introduction and speculates how the Landscape Approach could be translated into a new culture of thought as well as new forms of practice through holistic projects that are restorative, socially, and environmentally just and sustainable—along the heavily degraded Hexi Corridor, as well as across other regions elsewhere in the world. While the thesis does not attempt to demonstrate how the Landscape Approach can be directly translated into practical concepts for spatial intervention, the concluding chapter aims to showcase how it could inform such projects, referring to ongoing initiatives in the case study region. [Fig. 0.1]

1. Research Framework

Landscape as Productive Medium to Approach Large-Scale Geographies of Socio-Environmental Entanglements

This chapter aims to frame a holistic and multidisciplinary Landscape Approach[1] to engage a complex geography and its socio-environmental challenges. Therefore, many theories and concepts from multiple disciplines are bundled together. First, in part 1.1, landscape is discussed as a cultural concept, as a way of seeing the world and a way of reading a geographic context, and in addition, as a productive medium to convey a vision and actively shape space. Second, in parts 1.2 – 1.4, ecology is discussed as a multidimensional theory in the context of an anthropogenic world and as a productive design agency. Third, in part 1.5, relevant landscape approaches are briefly summarized from design and planning practices. And lastly, in parts 1.6 and 1.7, the thesis' own Landscape Approach is developed as an original contribution. It aims to inform holistic solutions that can address multiple objectives (environmental, social, economic, political) through interdisciplinary collaboration, mediate between different interests of various actors involved, and, ultimately, spatially intervene in a specific place in the form of a designed, dynamic, and performative socio-environmental system.

1 The term "landscape approach" has been informally used since at least the 1930s by landscape architects, referring to solutions that consider the specific context of a site and work with tools and strategies common in landscape architectural practices at the time. For instance, in the case of the selection of tree species to be planted along highways: "The ecological or natural landscape approach to the highway planting problem aims to avoid the typical static or garden-estate type of plantation design in favor of fitness with the more dynamic requirements of highway travel." See Wilbur H. Simonson, "Roadside Planting," *Landscape Architecture* 26, no. 4 (1936): 167–74. In another article from 1941, the landscape architect Charles W. Eliot 2nd (nephew of the famous Charles Eliot) questions the role of landscape architects in large federal infrastructure campaigns, given the time of the publication, particularly in the context of federal defense programs. Eliot promotes the participation of landscape architects as leaders in such programs and the landscape approach as a crucial contribution to the country's future: "There is a real contribution to soil conservation to be made through the landscape approach." Charles W. 2nd Eliot, "Considerations of Defense and Post-Defense Planning: The Landscape Architect as a Constructive Factor," *Landscape Architecture Magazine* 31, no. 3 (1941): 123–24. In 1998, the French landscape architect Bernard Lassus published a book titled *The Landscape Approach* as a compilation of some of his writing and built work. However, the book emphasizes a different quality of landscape: the individual engagement and sensual experience with a site and the artistic translation into designed space. The Landscape Approach, in this case, thus explains the author's subjective approach in his landscape design work rather than a general theory beyond the domain of landscape and garden design. Bernard Lassus, *The Landscape Approach* (Philadelphia: University of Pennsylvania Press, 1998).

Fig. 1.1: Cultural landscape outside of Zhangye in the center of the Hexi Corridor; October 2019.

While the Landscape Approach is rooted in Western humanist culture and developed based on Western theory and practice, it is intended as a general theoretical understanding of landscape and territory. It informed the research on the Hexi Corridor in the specific context of northwestern China, which will be discussed in the following chapters, but it is meant to be applied to other world regions as well.

The following first part of the chapter aims to synthesize selected landscape literature. It is not intended to be exclusive to other landscape readings, nor does it pretend to provide new knowledge. Rather, it aims to sharpen the landscape term as it is later used to frame the thesis' own understanding of the concept and the overall research approach.

1.1 The Meaning of Landscape

Landscape is an ambiguous term with multiple meanings and is difficult to grasp for most people. The conception of landscape has also changed over time, originating from a historically and geographically specific Western European context. Today, it is widely—and most of the time generically—used in many different forms. In the design disciplines, landscape is often referred to as simply describing the broader spatial context, the backdrop, or the aesthetic decorating layer added around a design object. Yet, as framed in this thesis,

landscape is understood as a multi-layered, complex cultural construction—far beyond aesthetic qualities. Since the landscape reading in this thesis is suggested as a research approach, it is important to revisit its origin and precise meaning to thoroughly position it as an intellectual concept. Therefore, the history and transformation of the conception of landscape over time and its inherent ambiguities, contradictions, and limitations are necessary to understand and formulate the thesis' Landscape Approach.[2]

As briefly mentioned in the introduction chapter, landscape is generally understood in this thesis as a cultural artifact that has been co-produced over time in a specific place by humans interacting with their non-human environment. In addition, landscape is also a socio-environmental process that can be systematically read to better understand an individual place and its broader geographic context. This performative understanding of the term, how a landscape has been constructed and how it operates, serves as an anticipatory, intellectual framework that is inevitably collaborative and socio-environmental. This interpretation of landscape derives from theories developed by humanist geographers and landscape writers from the 1970s to 1990s. In this thesis, it is particularly informed by the work of Denis Cosgrove. He followed the aim to establish a new approach to cultural geography, allowing for a broad reading of landscape and engaging with other disciplines such as history, social sciences, and humanities. Cosgrove was intrigued by the "geographical imagination"[3] of a society, the ability of a group of people to collectively anticipate and then spatially transform their material environment. He studied the intellectual and spiritual ideas that empowered society and its economic, social, and environmental ambitions and constraints. He read these forces as active shapers of space, creating a physical expression and unique geographic manifestation of societal structures and developments. Cosgrove was particularly interested in the representation of spatial relations in cartography, design, and architecture as visual expressions of that collective geographical imagination. His work is, therefore, particularly relevant to the field of landscape architecture.

Landscape Origins

John Stilgoe defines landscape as "the antithesis of wilderness […] the land shaped by men,"[4] "[…]modified for permanent human occupation."[5] Similarly, John Brinkerhoff Jackson traces the word landscape from its original mean-

2 There is an extensive body of literature that defines meanings of landscape as it can mean different things for different disciplinary and scholarly discourses. See, for instance, Gareth Doherty and Charles Waldheim, eds., *Is Landscape... ?: Essays on the Identity of Landscape* (Abingdon; New York: Routledge, 2015).

3 Denis Cosgrove, *The Palladian Landscape: Geographical Change and Its Cultural Representations in Sixteenth-Century Italy* (University Park: Penn State University Press, 1993), xiii.

4 John R. Stilgoe, *Common Landscape of America, 1580-1845* (New Haven: Yale University Press, 1983), 12.

5 Ibid., 3.

ing during the Medieval Age before it referred to any aesthetic and emotional depiction of a scenery as it is commonly understood today. He describes the true word of landscape itself as "not a natural feature of the environment but a synthetic space, a man-made system of spaces superimposed on the face of the land, functioning and evolving not according to natural laws but to serve a community."[6] So, according to Jackson, landscape is the specific physical expression of a society that has adapted to its natural environment and transformed it over time to make the land productive, sustain itself, and develop collectively. [Fig. 1.1]

Important for the landscape reading in this thesis, we can understand landscape as a "dynamic equilibrium of interacting [natural-scientific] processes," which is intertwined with a system of structures and movements that fulfill certain "functions" and "processes undertaken for rational purposes."[7] Therefore, a landscape can be read as a construct of human-made interventions into the natural environment that creates specific patterns following certain basic physical, environmental, and social processes that reveal an inner logic and a certain place-specific identity. Landscape refers to a "space with a degree of permanence, with its distinct character, either topographical or cultural, and above all a space shared by a group of people."[8] This means that landscape describes a unity of people and their environment, the collective making of a physical spatiality across a certain imaginary, constitutional territory.[9]

Landscape as a Way of Seeing

Denis Cosgrove describes the origin of landscape as a cultural concept that emerged in a specific historical period and a specific geographic context: During the late Renaissance—as mentioned, a time during which the relationship of humans to nature radically changed and began to enforce a human-nature divide—and in the Veneto in upper Italy, the region around Venice as one of

6 John Brinckerhoff Jackson, *Discovering the Vernacular Landscape* (New Haven: Yale University Press, 1986), 8.

7 Donald W. Meinig, "The Beholding Eye: Ten Versions of the Same Scene," in *The Interpretation of Ordinary Landscapes: Geographical Essays*, ed. Donald W. Meinig (New York: Oxford University Press, 1979), 38.

8 Jackson, J. B. (1986), The Vernacular Landscape, 5.

9 Both Stilgoe and Jackson imply *rural* landscape typologies with their use of the landscape term. These typologies are shaped by different forms of land cultivation and archaic types of organizing settlements. Stilgoe states that landscape is "essentially rural," displaying "a fragile equilibrium between natural and human force," and therefore different from cityscapes, which are completely dominated by humans. It includes the mental concept in language, stories, paintings, and other forms of representation and the actual physical transformation and shaping of space. Stilgoe, *Common Landscape of America, 1580-1845*, 3. This rural-urban distinction is something this thesis avoids. Instead, it looks neutrally at landscapes as different forms of organizing and shaping the extra-human environment. And it applies the landscape approach across geographies of different scales, whether they are considered 'urban,' 'rural,' or anything in between.

the world's cultural and political centers at the time. Cosgrove describes how a landscape idea derived from artistic and scientific theories as well as distinct forms of territorial transformations that were enabled through radical societal shifts and innovations, particularly new tools for the representation of space—most notably perspective drawing—as well as developments in scientific theory, geometry, mathematics, land survey, and cartography which allowed for a new perception of land. Therefore, landscape in this European visual tradition can be understood as a new way of seeing—as a "visual ideology."[10] This notion of how socio-political shifts and technological innovations changed how space and land were perceived is essential for the landscape idea and this thesis.

During the Renaissance, the meaning of landscape shifted from the "synthetic space" described above—the concept of a collective legal and territorial idea, including properties regulated by statute—to a visual term. Landscape began to describe curated, scenic, and pictorial representations of human-made space in the form of landscape paintings. These idealized visual compositions of specific sceneries moved from the mere backdrop of sacred scenes in fifteenth-century paintings to the foreground as more prominent and artistically sophisticated works of art.[11]

When the word 'landscape' was introduced into the English language in the early seventeenth century, it referred to the representation of space through a particular genre of paintings. This painterly meaning was closely aligned with land survey and mapping. "It was a modern capacity to capture and materialize the idea of relative space," as Cosgrove says, essentially a visual medium that could bring together nature and culture.[12] Landscape is thus a way of seeing the world but also a medium to anticipatorily imagine potential futures. In the mid-seventeenth century, the word 'prospect' became a substitute for landscape, meaning a sight or a view outward, both in time and space. And it implied a command that was "as much social and political as spatial."[13]

This tradition of landscape as a visual representation remains important until today: James Corner highlights the inseparable connection between

10 Cosgrove, "Prospect, Perspective and the Evolution of the Landscape Idea," 47.

11 Such landscape paintings were developed in Flanders and the Veneto, with the harbor cities of Antwerp and Venice—two centers of European merchant capitalism. Both these regions were among the most economically advanced, most densely settled, and most urbanized and globalized regions of early sixteenth-century Europe. From its onset, the concept of landscape was thus an urban invention but visualizing a rural counterpart. The development to its own genre required a specialization and a commercial art market where paintings were created to please a broad group of anonymous consumers rather than individual patrons and where art was bought and traded in large quantities; a socio-economic environment which only an urban agglomeration had to offer. It was eventually in Venice where the term 'landscape' was first applied to an individual painting and later developed into a particular artistic genre. See E. H. Gombrich, *Norm and Form: Studies in the Art of the Renaissance* (Chicago: Phaidon Press, 1966), 107-121.

12 Denis Cosgrove, "Landscape and Landschaft," *GHI Bulletin* 35, no. Fall 2004 (2004): 69.

13 Cosgrove, "Prospect, Perspective and the Evolution of the Landscape Idea," 55.

landscape and image. First, representations of land are necessary to collectively recognize landscapes as such. And second, they are necessary to intentionally construct designed landscapes through "various forms and activities of imaging." Corner uses the term "eidetic" to describe mental conceptions of idealized landscapes that allow to "image" the world, which is the precondition for how "reality is both conceptualized and shaped."[14] Landscape as a visual and a forward-looking, anticipatory medium are important characteristics for defining the Landscape Approach.

Landscape as a Map

André Corboz famously coined the metaphor of the land as a palimpsest. He states that land is not a commodity but results from various "processes," both social and environmental, that accumulate, interact, and overlay over time and thus construct the land as a "product," the cultural result of a collective "imagining" and set of cultural "values" that are projected onto land. The systematic land reading of all these different layers that have accumulated over time—as in an actual palimpsest—then allows to "unravel" the different relations and "identify the traces still present of lost territorial processes." The understanding that every place is a result of a "condensation" of processes over time and has a unique character allows to make decisions and interventions that consider this embedded and site-specific history of accumulation.[15]

Landscape is a medium to both read and represent a geographic context. It provides the tools to visualize multi-layered ecosystems and convey interrelationships, conflicts, challenges, and opportunities in the complex web of life. While acknowledging the pitfall of the representation of land as a simplification that tends to substitute itself for reality, Corboz says that "(t)o represent the land means to understand it. But such representation is not a tracing but always a creation. A map is drawn first to know and then to act."[16] The map, as an abstract representation of land, mentally anticipates potential futures and acts as a medium to enable their translation into physical reality. The map is always a conscious abstraction of reality through specific "acts of selection," such as the frame, the projection, and the emphasis on certain places while others are left blank. These decisions always reveal certain power-knowledge relations and have implications for how the world is perceived, for instance, in the context of European colonial mapping. Western cartography, rooted in ancient astronomy and imperial administration, was "rediscovered" in the Renaissance with increasing accuracy as a rationalist European science, liberated

14 For Corner, 'eidetic' is not limited to the picture but can equally include the acoustic, tactile, cognitive, or intuitive. James Corner, "Eidetic Operations and New Landscapes," in *Recovering Landscape: Essays in Contemporary Landscape Theory*, ed. James Corner (Princeton Architectural Press, 1999), 153–69.

15 André Corboz, "The Land as Palimpsest," *Diogenes* 31, no. 121 (March 1, 1983): 12–34.

16 Corboz, "The Land as Palimpsest," 25.

from religious belief, myth, and imaginative art, and contributing to the development of modern, scientific knowledge and the understanding, exploitation, and creation of space.[17]

As James Corner points out, the recovery or the reconceptualization of landscape as a cultural medium—in any period—always depended on the development of new images and techniques of conceptualization.[18] Therefore, the development of the modern landscape idea is inseparably connected to new technologies that can conceive, measure, and represent space. He positions the agency of mapping as a "collective enabling enterprise," as "a productive and liberating instrument," particularly in design and planning, that can "reveal and realize potential" for the emergence of new realities.[19] Corner promotes mapping as a creative form of spatiotemporal practice that uses innovative techniques that express "mental constructs, ideas that enable and effect change."[20] A landscape thus acts as a spatial field across which multi-dimensional, open-ended processes and interactions—including natural processes, historical events and local stories, economic and legislative conditions, political interests, regulatory mechanisms, and programmatic structures—are represented. Maps can thus function as "opaque, imaginative, operational instruments."[21]

Corboz's description of land as multiple temporal, social, and environmental processes that are entangled and can be systematically revealed is instrumental for the Landscape Approach and the description of the Hexi Corridor region across time. The visual representation of such spatial and temporal interrelationships through maps and drawings Corner argues for are productive forms of expressing the landscape thinking and reading which the Landscape Approach promotes. While the project refrained from speculative mapping, the attached posters overlay multi-dimensional information comprised of spatial, physical, and intangible data in complex drawings.

Landscape as the Physical Expression of a Socio-Political Regime

A second major transformation that Cosgrove highlights in his description of the emerging landscape idea during the late Italian Renaissance is the socio-political reorganization with the radical shift from a feudalist to an early capitalist society. In parallel with new technologies, forms of production, and trade, the relationship between individuals and social classes changed, particularly as labor itself started to become a commodity. As an ideological concept and as the physical manifestation of a socio-political organization described above,

17 Denis Cosgrove, "Introduction," in *Mappings* (London: Reaktion Books, 1999), 8-18.
18 Corner, "Eidetic Operations and New Landscapes," 153-54.
19 James Corner, "The Agency of Mapping: Speculation, Critique and Invention," in *Mappings*, ed. Denis Cosgrove (London: Reaktion Books, 1999), 213.
20 Corner, "The Agency of Mapping: Speculation, Critique and Invention," 250.
21 Ibid., 250.

landscape thus "represents a way in which certain classes of people have signified themselves and their world through their imagined relationship with nature, and through which they have underlined and communicated their own social role and that of others with respect to external nature."[22]

Simultaneous to changing relationships among people, the perception of the non-human environment, of land and property, changed as well: Land across Europe and the New World was transformed by the clearance of woodland, drainage of marshland, and the reclamation of wasteland in increasing quantities and scales. Land was thus made productive and profitable and became a form of investment.[23] Landscape as a new way of seeing extra-human nature was closely related to exercising power over space—the practical appropriation of space.[24] New tools in the visual representation of space were thus aligned and directly applied to the physical appropriation of space as property—applying geometry to the production of real property. Landscape became a way of composing and structuring the world not just through visual representation but also the physical space itself. "Implicit in the landscape idea is a visual ideology which was extended from painting to our relationship with the real world."[25]

This notion of socio-political shifts that enable the reperception of geographic space and appropriation of land, which Cosgrove describes in the context of the emergence of the landscape idea during early capitalism in Europe, is used in this thesis as an analytical framework. It is particularly relevant for the historical narrative of the Hexi Corridor during the early Han dynasty in the third chapter—a period that introduced radical shifts in the perception and spatial reorganization of the region.

Landscape as the Technological Transformation of Space

Philosophical and technological developments during the Renaissance enabled societies to transform their extra-human environment with increasing intensity. Particularly with the exploration of the Americas, the socio-economic order and the knowledge, tools, and methods of land transformation started to be exported across an increasingly globalized network of material extraction, production, and trade. Cosgrove describes this mode of systematic land transformation in the case of the Veneto during the late Italian Renaissance. At that time, Venetians developed a strong interest in their hinterland because of

22 Cosgrove, *Social Formation and Symbolic Landscape*, 15.

23 Ibid., 1-12.

24 Cosgrove, "Prospect, Perspective and the Evolution of the Landscape Idea," 45-46.

25 Cosgrove, "Prospect, Perspective and the Evolution of the Landscape Idea," 55. The shift to an early capitalist society created a system in which the status of land was uncertain. In Marxist terms, it meant the shift from the use value to the exchange value of land. This played out in struggles between feudal aristocrats and bourgeois capitalists, as well as between landowners and peasants. Cosgrove, *Social Formation and Symbolic Landscape*, 63. This conflict of a "dual significance of land" is at the core of Cosgrove's definition of the landscape idea. Cosgrove, "Prospect, Perspective and the Evolution of the Landscape Idea," 45.

increasing political crises and economic pressure, aiming to increase grain productivity and territorial military defense. Technological progress in engineering and water management happened, therefore, primarily because of financial and security constraints.

In The Palladian Landscape, Cosgrove describes the large-scale transformation of the region—the terraferma—through new social and economic structures but also technological interventions in land reclamation, drainage, and irrigation regimes. In this narrative, he connects the creation of individual places, including their architectural and aesthetic qualities, to the larger context of the Veneto territory. He describes how people—or at least the professional elites—began to understand the complex and large Veneto territory as one coherent system. Highly complex mechanisms of water and sediment flows across the watershed and river Delta were represented in increasingly accurate cartographic maps and transformed and managed through hydrological interventions. Such territorial transformations in the sixteenth century were primarily enabled through the changing role of the state, which took a much stronger agency in managing the natural resources of water and land, controlled and coordinated with policies of a growing and increasingly specialized state apparatus. At the same time, the public works largely benefitted private investors and landowners, highlighting the dual meaning or moral contradiction of landscape as described above.[26]

Antoine Picon locates the origin of the modern concept of landscape in the period of the Enlightenment and, more precisely, in seventeenth-century France. For him, it is the professionalization and disciplinary separation of architecture and engineering that lie at the beginning of the modern concept of landscape.[27] While this takes a different stance on the conception of landscape, identifying a different historical moment, cultural, and geographic context, his argument aligns with Cosgrove: The decisive moment was the intellectual as well as technological advancements that allowed to reconceptualize and rationalize the territory and visualize it in radically new and more accurate ways. In both cases, the new perception of territorial scales derived from a mental separation of subject and object, human and extra-human nature. Picon describes how engineers developed territorial planning regimes that were led by the idea of a "conquest of nature"[28]—nature, seen as a "productive source of knowledge and wealth" to be regulated, ordered, and "perfected by means of

26 Cosgrove, *The Palladian Landscape*, 139-66; Cosgrove, *Social Formation and Symbolic Landscape*, 102-41. This description of a mental reconceptualization of the Veneto during the Early Renaissance, which enabled its spatial restructuring as a territorial system, strongly informed the narrative of the early colonialist formation of the Hexi Corridor during the early Han dynasty, as discussed in chapter three.

27 Antoine Picon, *French Architects and Engineers in the Age of Enlightenment* (Cambridge: Cambridge University Press, 2010), 99-100.

28 Picon, *French Architects and Engineers in the Age of Enlightenment*, 101.

bridges and causeways."[29] In a later essay, Picon more explicitly discusses the importance of hydraulic engineering as the essential feature that enabled territorial planning and the physical transformation of large-scale landscapes.[30] Territorial land transformation thus required a comprehensive understanding of extra-human nature's systems and processes, but simultaneously, a cultural attitude and will to radically work against them and transform them through technological application.

This ability to systematically read and represent land in a territorial context fundamentally differs from earlier cases of large-scale land transformations. Of course, as Cosgrove, Picon, and others describe, many regions in Europe had already been significantly altered through the introduction of massive hydraulic engineering schemes during the late Medieval Age.[31] But in Cosgrove and Picon's texts, the territorial transformation of land is connected to new, scientific, and cosmologic understandings of the world in the specific cultural-historic context of European humanist philosophy. Land transformation is thus more than the mere movement of earth and water over time. It becomes a cultural medium that expresses a new socio-economic order, a new perception of the meaning and value of land, and a repositioning of individuals in relation to their environment.

While, as Cosgrove and Picon describe, the landscape idea is a distinctly Western concept that emerged in a specific historical and geographic context, their alternative narratives of the emergence of landscape illustrate several characteristics that are relevant for the Landscape Approach and this thesis. They describe historical moments of socio-political shifts in connection to technological innovations and their application to systematically transform land beyond the scale of an individual site, enabling a territorial reorganization.

Landscape and Territory

Territory describes geographic space in relation to a state and its power structures. It is a political concept connected to spatial-strategic intentions, such as the production and extraction of materials and capital value. As Cosgrove

29 Ibid., 108-09.

30 Antoine Picon, "Constructing Landscape by Engineering Water," in *Landscape Architecture in Mutation: Essays on Urban Landscapes*, ed. Hubertus Adam et al. (Zürich: gta Verlag / eth Zürich, 2005), 99–115.

31 In other world regions, large-scale cases of earth movements and transformations of hydrological systems can be famously found as well, such as in the massive terraced rice fields in Southeast Asia or extraordinary cases of hydraulic engineering projects in China, for example, the ancient irrigation system of Dujiangyan in Sichuan from the third century BC during the Qin. The early case of the hydraulic system in Dujiangyan, which continues to work today, required an astonishingly complex understanding of a territorial water ecosystem, including flooding, silt movements, and irrigation schemes. It allowed the control of floods to colonize, irrigate, and sustainably cultivate the fertile Sichuan basin. See, for instance, Steven F. Sage, *Ancient Sichuan and the Unification of China* (Albany: State University of New York Press, 1992), 148.

Fig. 1.2: Hybrid landscape of various land uses halfway between Jiayuguan and Jiuquan; October, 2019.

points out, the origin of the conception of landscape lies in the city. Landscape is often read, especially in the context of the traditional city, as a counterpart to the urban. It entails the idea of the hinterland, the productive surrounding that provides the city with resources and cultural inspiration.[32] With its political connotation, the territory is inseparably connected to the city as the spatial concentration of political, institutional, and economic power.[33]

With the growth of large and increasingly confused urban agglomerations, the boundaries between city and non-city began to be blurred. In the early 20th century, the patterns of industrial urbanization, spanning around the globe, have become a "way of life" that reshaped virtually every phase of [Western] life.[34] Corboz, in his essay on land as a palimpsest, introduces the territory as the "foundation for planning" to which the city must be "subordinated."[35] His multidimensional palimpsest reading of condensed, past traces across the land makes every place unique while simultaneously connecting it to a larger web of

32 Cosgrove begins *The Palladian Landscape* by applying a new 'landscape' understanding of space first, as the creation of urban form in the city, to then expand to the rural villa estate, and eventually to the conception and physical transformation of the territory.

33 Stuart Elden, "Land, Terrain, Territory," *Progress in Human Geography* 34, no. 6 (December 1, 2010): 799–817.

34 Louis Wirth, "Urbanism as a Way of Life," *American Journal of Sociology* 44, no. 1 (1938): 1–24.

35 Corboz, "The Land as Palimpsest," 34.

spatial and metaphysical interrelationships. It reveals that the spatial separation of city and countryside, of urban and rural, is simply a political order. In reality, the dynamic movements and interrelationships across the land break down these political barriers, creating a "necessary unity of two apparently incompatible domains."[36]

Territories—or territorial landscapes—seem to be produced rather than designed. Today, in a globalized market economy, they must be seen as "operational landscapes" where the traditional hinterland has become a strategically essential terrain and integral part of capitalist urbanization that has dissolved all spatial boundaries between city and non-city. These operational landscapes of today are highly dynamic and often appear chaotic. But they are formed by the intentional, industrial design of agricultural, extractive, and logistical activities that are intended to create the most efficient and optimal conditions for capital accumulation on a world market, transforming remote, non-city spaces into areas of high-intensity and large-scale industrial infrastructure.[37] [Fig. 1.2]

In this narrative, the (operational) landscape is described as an integral part of the world economy, yet as a passive object or external background that is exposed to and transformed by highly dynamic processes accelerated by economic and political forces. It is detached from aesthetic concerns. But it strongly entails another key attribute of the conception of landscape: the notion of being the physical and visual expression of a collective social organization—in this case, a globalized, capitalist economy that follows specific patterns of actively producing space and includes inherent contradictions and inequalities of uneven development.[38]

Landscape as a Mode of Reading

This review of some of the meanings and the cultural-historic origin of landscape will be used to frame the Landscape Approach later in this chapter. So far, the literature review has highlighted landscape as a collective "visual ideology" and a "way of seeing" the world. Theories of how landscape emerged as a concept in the late European Renaissance are significant as they discuss a period of major societal shifts, socio-political reordering, and cultural and technological innovations, which enabled the mental reconception and the spatial reorganization of a geographic entity—or territory.

Such historical narratives, as in Denis Cosgrove's work, follow a research method that could be described as landscape reading: Individual places or physical formations—of land, ecosystems, architecture, technology—are connected to their broad geographic, socio-environmental context. Despite its contradictions, the capacity to simultaneously take on an inside and outside perspec-

36 Ibid., 14.
37 Neil Brenner, "The Hinterland Urbanised?," *Architectural Design* 86, no. 4 (2016): 118–27.
38 Smith, *Uneven Development*; Harvey, *The Limits to Capital*.

tive serves thereby as a productive method: It is concerned with the insider perspective and the direct engagement with an individual site. At the same time, landscape is the outsider's conception of a cohesive, territorial system, a cultural, socio-environmental formation. Thus, on the one hand, the built environment is read as a physical formation by observing an individual place, its different actors, and dynamic processes. On the other hand, the individual site is conceptually connected across scales to other places and to invisible forces through which it is shaped, such as policies, socio-political power structures, geopolitical interests, flows of capital, and historical and cultural patterns. This broad context includes social (cultural, political, economic) and environmental dimensions, describing the complex interrelationship of a society and physical space. It is read and constructed through the study of secondary sources.

However, landscape is more than just an intellectual framework to read and analyze a geography. The understanding of landscape as a socio-environmental process is essential. Landscape is both spatial and material. It deals with living things. A landscape is always in a state of dynamic motion and continuous transformation. Landscape is exposed to weather, climate, unpredictable events, and destructive processes that are both social and environmental. It thus entails the notion of temporality. The unraveling and systematic study of individual materials and their temporalities, from where materials are taken, how they are moved, processed, and applied in specific locations—including the social, political, and ecological practices that are involved in these processes—reveals the visible, tactile but also the invisible composition of landscapes. This allows connecting specific, local sites—whether developed over time or intentionally designed and constructed, and whether they are the place of material extraction or its application—to complex territories where these material flows and processes overlay and interact.[39] This notion of using the landscape idea to systematically read a geographic context across spatial, temporal, and disciplinary dimensions is used as a method—or approach—to study and describe the Hexi Corridor region.

Landscape's Potential for Spatial Interventions and its Limitations, Embedded Contradictions, and Ambiguities

This literature review points out several characteristics of landscape to productively inform this thesis' research approach. This last section points out landscape's potential to act as a medium for spatial intervention but also some of its limitations, contradictions, and ambiguities embedded in the landscape idea.

The landscape reading of a complex geographic context not only serves as

39 Jane Hutton coins these territories of social, political, and ecological entanglements of material flows, processes, and practices as "reciprocal landscapes." Hutton, *Reciprocal Landscapes*. See also Hutton's edited volume "Material Culture" of the *Landscript* book series, Jane Hutton, ed., *Material Culture: Assembling and Disassembling Landscapes* (Berlin: Jovis Berlin, 2017).

an analytical tool but has the potential to be translated into spatial interventions in a specific place: First, landscape is inherently interdisciplinary as it lies at the intersection of social and environmental studies, between the abstract, mental, and the tangible, geo-physical; between arts, humanities, geography, and natural science.[40] Second, landscape is performative. What is often referred to as the agency of landscape[41] expresses the shift from a landscape as the mere product of collective activities to landscape as an active agent that is able to produce and enrich the human, cultural, as well as non-human, environmental web of life. Through multidimensional perspectives—the close engagement with a site and local specificity and, simultaneously, the distant view and abstract representation of large-scale spatial relationships—landscape can serve as a productive medium to both holistically understand a contemporary formation and imagine its potential futures.[42] Landscape can thus serve as a conception that can imagine and curate different flows and networks of biotic and abiotic materials, plants, people, and other species.[43]

While landscape serves this thesis as a productive concept to develop a methodological approach, it is also a complex term that entails inherent ambiguities and contradictions. First, landscape has a dual meaning, simultaneously understanding space "as both subject and object of human agency."[44] On the one hand, landscape is the physical outcome of a whole society that collectively shapes its environment over time. At the same time, landscape is the ideological concept of an individual who looks at and experiences a specific place, as well as the subjective visual representation chosen to communicate that view. It is the ambiguity between the individual and the social: Landscape is the "collective human transformation of nature,"[45] while at the same time, it describes the way of seeing the world, which, at its origin during the Renaissance, was distinctly bourgeois and individualist,[46] expressed through skillful paintings as commercial pieces of art, as well as mappings of estates and extensive territories, expressing control over land.[47]

Cosgrove identifies another central contradiction that is embedded in

40 Denis Cosgrove writes that landscape is "seeking a unity of knowledge across all arts." Cosgrove, "Prospect, Perspective and the Evolution of the Landscape Idea," 47.

41 Ed Wall and Tim Waterman, eds., *Landscape and Agency: Critical Essays*, (London; New York: Routledge, 2017).

42 The notion of landscape as a 'prospect' and the tendency to anticipate potential futures have been mentioned previously.

43 With the edited volume *Recovering Landscape*, Corner emphasizes the "shift from landscape as a product of culture to landscape as an agent producing and enriching culture," promoting landscape as a verb, process, or activity instead of a noun, object, or scenery. James Corner, ed., *Recovering Landscape: Essays in Contemporary Landscape Architecture* (New York: Princeton Architectural Press, 1999), 4.

44 Cosgrove, *Social Formation and Symbolic Landscape*, 15.

45 Ibid., 14.

46 Cosgrove, "Prospect, Perspective and the Evolution of the Landscape Idea," 45-62.

47 Cosgrove, *Social Formation and Symbolic Landscape*, 15-18.

the landscape concept: In a capitalist system, which is based on cheap labor and private ownership, the "holism which modern humanists proclaim"—and which landscape implies to express, seemingly rejecting the Cartesian division of subject and object—has in fact been disrupted. Once land became a commodity, with its value lying in exchange, the relationship between the individual and the land was alienated. And this is precisely the contested intersection where the landscape idea is located: "The separation of subject and object, insider and outsider, the personal and the social are already apparent at the birth of the landscape idea."[48] The traditional idea of landscape fails to explain the complex and conflictive processes within the landscape, suggesting instead a stable unity. And it fails to "mediate the experience of the active insider and the passive outsider."[49]

The representation of landscape and its aesthetic aspects leads to another set of contradictions: Landscape accepts and ideologically promotes the conflicted capitalist property relationship through artistic and scientific expressions. It enforces the divide between subject and object while, at the same time, suppresses tensions and conflicts between social groups and within human relations, suggesting a synthetic whole. In its painterly tradition, the landscape idea entails an "inherent conservatism" to create order, proportional control, and a "celebration of property." When this idea is imported into geography, it continues the perspective of a "realist" who follows "visual values" or ideals and has the tendency to present a certain "natural and social harmony."[50] In his work on 'territory,' Elden points to the significance of boundaries as political demarcation. In contrast, the idea of landscape aims to dissolve and mask boundaries. While the map of a territory is the rationalization of land, connected to science and technology, as a means to collectively achieve control and make land a productive object, the idea of landscape is linked to symbolism, aesthetics, and romanticist ideas of land as a subject that allows an individual to get in dialogue with nature.[51]

***

When working with landscape, it is important to challenge the concept and recognize its contradictions and limitations. Conflicting tendencies of the landscape idea cannot be seen as a problem to be solved or overcome. Instead, they should be seen as the complexities and contradictory realities that have always been at the core of any landscape and its human-environmental relationship. They have become even more prominent in today's globalized world, operating across different geographies and scales. The Landscape Approach suggests applying landscape at territorial scales to holistically understand large-scale complexities and eventually intervening in such geographic systems through cross-disciplinary collaboration. In the contemporary context, the conception

48 Ibid., 26.
49 Ibid., 270, see also 254f.
50 Cosgrove, "Prospect, Perspective and the Evolution of the Landscape Idea," 58, 109.
51 Elden, "Land, Terrain, Territory," 799–817.

of landscape can no longer be directly explained through its traditional ideas and origins. Landscape has long been integrated into planning and design practice since its formation as a profession in the late nineteenth century. It has become closely related to the urban context and the shaping of agglomerations, the revitalization of the post-industrial city since the late 1960s, but also to environmental sensitivities, new ideas of ecology, resilience, and sustainability.

1.2 Ecology as a Multidimensional Metaphor

Ecology, commonly defined as "the relation of plants and living creatures to each other and their environment," lies at the core of the concept of landscape as it has been introduced above. Ecological thinking is crucial in the discussion of urbanism, society, culture, and the built environment. In recent years, ecology has become increasingly dominant in the public discourse and has shifted from a science to a popular metaphor. Not unlike landscape, ecology as a term is also difficult for its often ambiguous meanings. Concepts from ecological science, such as resiliency or succession, have been incorporated into landscape practices. Such rather abstract ecological concepts can become spatially manifested in landscape planning and design in places of social and physical interaction, providing civic services as cost-effective living infrastructure. The following paragraphs thus aim to position ecology in the context of landscape and the Landscape Approach.

Ecology's Historic Origin

Ernst Haeckel first coined the term 'ecology' in 1866 as a scientific term.[52] This coincided with the development of new moral ideas and values of a unity and wholeness of nature when ecological thinking became part of humanities and arts in the eighteenth and nineteenth centuries.[53] At the same time, new concepts in holistic biology led to an increasingly holistic understanding of complex ecosystems.[54] These cultural and intellectual shifts coincided with concerns about the increasingly evident degradation of the natural environment, shortages of natural resources, the perception of humans as a destructive force,

52 Donald Worster, *Nature's Economy: A History of Ecological Ideas Second Edition*, 2nd edition (Cambridge; New York, NY, USA: Cambridge University Press, 1994), 192.

53 For instance, in the works of poets and naturalists like Rousseau or Thoreau, as well as expressed through new aesthetics, such as in Romantic painting and garden design. Donald Worster places the origins of the ecological spirit already in the 18th century with the English naturalist Gilbert White, whose writings developed a nature-centered, pastoral natural science and holist, "arcadian" spirituality (Worster, *Nature's Economy*, 3-25), coinciding with the foundation of a new and "modern" landscape idea and aesthetic expression, such as the writings on the picturesque by William Gilpin, Thomas Gray, and others. See John Dixon Hunt, "Picturesque Mirrors and Ruins of the Past," in *Gardens and the Picturesque: Studies in the History of Landscape Architecture* (Cambridge, MA: MIT Press, 1992), 171–91.

54 Such as Darwin's contributions to evolutionary science or von Humboldt's studies in early biogeography.

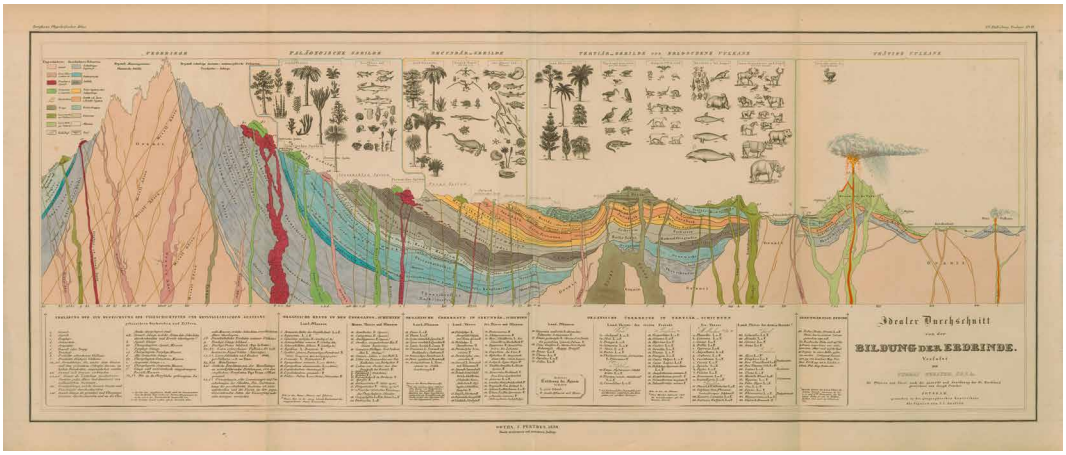


Fig. 1.3: Alexander von Humboldt's "Ideal Cross Section of the Erth Crust's Creation" illustrates the growing sensitivity to and holistic understanding of the complex interrelations between geological formations, environmental processes, and the creation of ecosystems in the mid-19th century.

and alarming voices about an 'Anthropozoic era.'[55] Notably, the origin of early ecological thinking also coincides with the formation of landscape architecture as a profession. [Fig. 1.3]

Anna Bramwell describes how ecology changed over time from its original meaning in a biological sense as a descriptive tool of the web of life to its later use in a normative sense connected to the economy. And from there, to a political category loaded with moral and ethical values, esoteric ideas, and utopian life forms. She names three dimensions as origins of the ecology concept: holistic biology, the fusion of moral/ethical values, and resource-scarcity economics.[56]

55 Geological literature has used The term 'Anthropozoic era' since the mid-19th century. The Welsh geologist and professor of theology Thomas Jenkyn published the idea of a human geological time period in a series of geology lessons in 1854. He described "the human epoch" based on the future fossil record, stating that rocks could be called "Anthropozoic, that is, human-life rocks." Cited in Lewis and Maslin, "Defining the Anthropocene," 172. Others picked up the term, such as the Italian geologist Antonio Stoppani in 1873, to describe humans as a global force comparable to other great forces of nature. Cited in Crutzen and Stoermer, "The 'Anthropocene,'" 41. Or the British naturalist, geographer, and evolutionary thinker Alfred Russel Wallace, who in 1898 described the "plunder of the earth" by irresponsible humans and the "reckless destruction of stored-up products of nature" in the context of colonial plantations in the New World. Cited in U. Kutschera, "The Age of Man: A Father Figure," *Science* 340, no. 6138 (June 14, 2013): 1287. It was also in the mid-19th century when the term the *Holocene* was coined by the French geologist Paul Gervais to mark the beginning of an anthropogenic Earth transformation, dated at the end of the last ice age and the then-believed coinciding emergence of humans and the rise of civilizations. Robert Davis, "Inventing the Present: Historical Roots of the Anthropocene," ed. David Oldroyd, *Earth Sciences History* 30, no. 1 (December 20, 2011): 63–84.

56 Anna Bramwell, *Ecology in the 20th Century: A History* (New Haven: Yale University Press,

Ecology as Natural Science

In addition to its social, ethical, and economic dimensions, ecology has always been a rational, scientific discipline influenced by theories from natural science. With the beginning of modern ecology in the early twentieth century, botanists and zoologists systematically studied the interactions among individual species. In 1935, the term 'ecosystem' was coined to describe a dynamic system of species-interrelationships in which one individual organism cannot be separated from the context of a biome.[57] Ecosystem thinking gained in complexity over time, changing from a predetermined, successional to a more unpredictable understanding of species groups.[58] Biochemical cycles, flows of energy, and communities of species started to be seen as essentially open networks that were much more dynamic, adaptable, and self-organizing than what they had been perceived as previously. Environmental systems and processes began to be analyzed as complex formations of material flows. They were described in precise mathematical and statistical terms based on a unified theory, essential in establishing a culture of system thinking.[59]

As environmental concerns and awareness reached a broad public, ecology started to become a mainstream science. With an increasing volume of research and publications, the specificity and accuracy of scientific tools, models, and projections grew. However, scientific ecology always remained in conflict with the moral-ecological values and the notion of utopian harmony.[60] In the latter half of the twentieth century, understanding an ecosystem that progresses through different succession stages to a stable "climax" state was challenged with new concepts of destructive forces and disturbance.[61] This notion of dynamic, complex, and, to a certain degree, unpredictable and uncontrollable ecosystems also altered the idea of environmental history: The concept of a stable Earth System that has been altered through human interventions changed to

---

1989), xi.

57 A. G. Tansley, "The Use and Abuse of Vegetational Concepts and Terms," *Ecology* 16, no. 3 (1935): 284–307, cited in A. J. Willis, "The Ecosystem: An Evolving Concept Viewed Historically," *Functional Ecology* 11, no. 2 (1997): 268–71.

58 In the 1950s, there was a revolutionary shift in ecology from a model in which species are organized in association units and go through a succession process, eventually reaching a predetermined and stable climax state, to a more unpredictable, individualistic model of species groups as a continuum, introduced by Henry Allen Gleason. See Michael G. Barbour, "Ecological Fragmentation in the Fifties," in *Uncommon Ground: Rethinking the Human Place in Nature*, ed. William Cronon (W. W. Norton & Company, 1996), 233–55.

59 The pioneering work of the ecologists Eugene and Howard T. Odum was instrumental in developing a theory of ecosystem ecology. Eugene P. Odum, *Fundamentals of Ecology* (Philadelphia: Saunders, 1953).

60 Worster, *Nature's Economy*, 364-65.

61 C.S. Holling coined the term "resilience" in ecological terms, describing the ability of ecosystems to withstand and absorb the (sometimes surprising and sudden) effects of disruption and change, keeping the system in a relatively steady state. Crawford Stanley Holling, "The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change," in *Sustainable Development of the Biosphere* (Cambridge: Cambridge University Press, 1986), 64–103.

one where dynamic transformations through constant socio-environmental interactions are deeply embedded.

***

Informed by natural scientific concepts that understand ecosystems as dynamic configurations that are in constant motion of socio-environmental interaction, and with the paradox of resource extraction to enable social development on the one hand and environmental constraints and degradation on the other at its core, the narrative of the Hexi Corridor does not describe a linear process but one of constant, fluctuating transformation, including phases of depletion and collapse, adaptation and synergy, restoration, and recovery, in which long-term anthropogenic and environmental forces are closely intertwined.

Ecology as Cultural Concept and Ethical Values

Since the very beginning, ecological thinking has included new ethics of moral-ecological values regarding humans and nature as equal or at least comparable. In the case of Haeckel and many of his early Monistic successors, it also included religious beliefs.[62] In his 1989 essay The Three Ecologies, Félix Guattari defines a new idea, or "logic," of ecology in the context of global environmental crises and capitalist "subjectification" and social "erosion." He argues for an "ecosophy," an ethical-political articulation between the [extra-human] environment, the social relations among people, and the individual human subjectivity. Ecology, he argues, can, therefore, no longer be separated from culture and needs to be understood as much as environmental as social, economic, and political and as much individual as it is collective.

Ecosophy provides an alternative logic emphasizing social, mental, and environmental relationships—or assemblages—rather than linear subject-object perspectives.[63] These "ecological practices"[64] allow tackling environmental destruction issues holistically and collectively, including their societal consequences. Complex interrelationships can no longer be perceived as traditional, dualist oppositions as the world is increasingly globalized, multi-polar, and decentralized.[65] Therefore, Guattari's 'ecosophic' response can only be effective "on a global scale."[66] In doing so, he argues for embracing the complex "middle" where things overlap in productive ambiguities, are neither white nor black, and where the imaginary derives from.[67] And he foresees that in order to effectively tackle environmental threats, action needs to be taken on much larger scales than what we have been accustomed to, such as repairing "the Amazonian 'lung'" or bringing "vegetating back to the Sahara."[68]

62 Bramwell, *Ecology in the 20th Century*, 3-21, 39-63.
63 Félix Guattari, *The Three Ecologies* (London: The Athlone Press, 2000), 44.
64 Ibid., 50-51.
65 Ibid., 32-33.
66 Ibid., 28.
67 Ibid., 54-58.
68 Ibid., 66. This argument about new scales of intervention aligns with the framing of the Land-

Today, the popular use of the term 'ecology' has shifted from a science to a cultural term that has become integrated into people's daily lives and across the design disciplines. While ecology is a science describing the interaction of biological systems, it is equally concerned with what people eat and wear, how they communicate, live, and move, how cities are built, and how resources are managed. These perspectives are all connected to and dependent on complex, planetary economic and political complexities, in line with Guattari's plea for "an authentic political, social and cultural revolution, reshaping the objectives of the production of both material and immaterial assets."[69] In Ecological Urbanism, Mohsen Mostafavi argues for new ecological design practices, new ethics, and forms of "creative imagining." Less radical than Guattari but more modest and pragmatic, he argues that "ecological urbanism can be seen as a means of providing a set of sensibilities and practices that can help enhance our approaches to urban development."[70] Urbanism is thereby not limited to the scale of the city but addresses a "larger terrain of urban as well as rural ecologies […with a] regional, holistic approach."[71]

***

Guattari's logic of 'ecosophy' informs the multi-scalar and multi-disciplinary position that the Landscape Approach and this thesis more generally pursue. It believes in the need to understand individual sites and their socio-environmental issues not in an isolated manner but as part of complex entanglements between environmental, social, economic, and political dimensions. This requires embracing and thinking through the complex "middle ground" where all these different forces interact rather than in separate thematic and disciplinary silos.

Ecological Economy and Political Beliefs

Ecology and economy share the same etymology, both deriving from the Greek word oikos, referring to a family household and its daily operations.[72] Ecological thinking always had strong ties to economy, particularly concerning resource scarcity and depletion, emphasizing the world as an essentially closed system with limited material and energy resources.[73] In the second half

scape Approach presented later in this chapter.

69 Ibid., 28.

70 Mohsen Mostafavi, "Why Ecological Urbanism? Why Now?," in *Ecological Urbanism*, ed. Mohsen Mostafavi and Gareth Doherty, Revised Edition (Zurich: Lars Muller Publishers, 2016), 26.

71 Ibid., 29.

72 After Haeckel had coined ecology—first spelled as "oecology"—in 1866 as a scientific term, biologists preferred to continue using the older phrase "the economy of nature" for several decades to emphasize the interrelationships of living organisms. Worster, *Nature's Economy*, 192.

73 Karl Marx—referred to as "the first ecologist"— was concerned with overpopulation, food scarcity, and the depletion of soils through overproduction. Howard Parsons, *Marx and Engels on Ecology* (Westport, Conn: Praeger, 1977), cited in Bramwell, *Ecology in the 20th Century*, 31.

of the 20th century, environmental awareness started to reach a broader public through publications such as Rachel Carson's Silent Spring from 1962 or the alarming report Limits of Growth by the Club of Rome in 1972. Concerns around natural resource depletion and shortages were translated into an urge for environmental protection.[74] As United Nations reports show, they were extended to planetary scales in the context of an increasingly globalized and unequal economy and a growing international institutional discourse.[75] New political movements emerged that mixed economic ecology with alternative societal ideologies, redefining and, in many ways, diluting the term's meaning.[76]

Approaches to establishing an ecological economy created paradoxes, such as in questions around global versus local, humanist versus anti-human, or materialist versus spiritualist positions. At the core of these paradoxes is the fundamental conflict between the extraction and use of natural resources to facilitate social and economic growth, on the one hand, and the regulation and protection of extra-human nature to prevent environmental depletion and allow for long-term, sustainable prosperity.[77]

***

Despite its many ambiguous and conflictive dimensions, ecology provides an important framework or culture of thought that is crucial for this thesis. In the context of the Anthropocene, as ecological systems are operating in a world that is highly dynamic and, in many respects, unpredictable, the relationship between humans and all other life forms among each other has become increasingly complex. Under rapidly transforming conditions, there is a need for new cultures of interdisciplinary collaboration to identify problems and collectively search for holistic solutions, including the three dimensions: natural science, ethical values, and political-economic models. The paradox between ambitions for economic growth and development, on the one hand, and the

---

For more on Marx's ecological thinking, see John Bellamy Foster and Brett Clark, "Monthly Review: Marxism and the Dialectics of Ecology," *Monthly Review*, October 1, 2016; John Bellamy Foster, "Marx's Theory of Metabolic Rift: Classical Foundations for Environmental Sociology," *American Journal of Sociology* 105, no. 2 (1999): 366–405.

74 See Worster, *Nature's Economy*, 354-59.

75 The 1972 UN Conference on the Human Environment in Stockholm was the first conference to make the environment a significant issue, placing environmental issues at the forefront of international concerns and linking global economic growth with the pollution of air, water, and oceans, as well as the well-being of people around the world, resulting in the United Nations Environment Programme. See Günther Handl, "Declaration of the United Nations Conference on the Human Environment (Stockholm Declaration), 1972 and the Rio Declaration on Environment and Development, 1992" (United Nations, 2012).

76 Bramwell, *Ecology in the 20th Century*, 211-30.

77 The Global Footprint Network studied the ratio of humanity's resource demand from the biosphere to its rate of regeneration capacity. It estimates that this ratio increased from 1 (being in a stable state) in 1960 to 1.6 in 2020 (meaning that 1.6 Earths would be needed to satisfy our current demand). Mathis Wackernagel and Bert Beyers, *Ecological Footprint: Managing Our Biocapacity Budget*, (New Society Publishers, 2019).

fundamental limitations of natural resources that need to be protected and restored to provide life-essential services, on the other hand, is a key issue at the core of the thesis' research framework.

1.3 Anthropogenic Ecology: The Coupling of Social and Environmental Systems

Socio-Environmental Systems

Liu et al. describe the "coupling of human and natural systems," which had historically almost exclusively happened at local scales but was extended across the globe through the accelerated expansion and intensity of human activities.[78] The concept of coupled socio-environmental systems[79] requires an understanding of the world in which humans are strongly intertwined with extra-human systems and fundamentally dependent on them since they provide vital ecosystem services such as clean water, air, food, nutrients, soil, and raw materials.[80] Human societies develop through complex ecologies as webs of interaction between human and extra-human nature. This happens according to specific patterns, with complex and often unpredictable reciprocal interactions, and across multiple spatial and temporal scales. Liu et al. argue that landscape—as the cultural formation of a physical, "local system"—has the capacity to anticipate and accommodate for such transformation processes, "nesting [such] local systems in regional and global systems." Therefore, landscape should be included in natural resource planning, management, and policymaking.[81]

The scientific understanding of socio-environmental entanglements can be included in historical research by integrating social science into long-term ecological science. This allows to better understand the "social dimensions of ecological change and the ecological dimensions of social change."[82] Redman et al. present this integration of socio-environmental systems into long-term eco-

78 Jianguo Liu et al., "Coupled Human and Natural Systems," *AMBIO: A Journal of the Human Environment* 36, no. 8 (December 2007): 639–49; Jianguo Liu et al., "Complexity of Coupled Human and Natural Systems," *Science* 317, no. 5844 (September 14, 2007): 1513–16.

79 Such coupled systems are usually referred to as "socio-ecological systems." However, after discussing ecology as a culturally constructed metaphor that already includes social and environmental aspects of life (plus political and economic), the term 'socio-environmental systems' seems more appropriate, with 'environmental' referring to the extra-human environment. Following this understanding of ecology, socio-environmental systems are, in fact, describing and crafting different ecologies.

80 John Peterson Myers et al., *Nature's Services: Societal Dependence on Natural Ecosystems*, ed. Gretchen Cara Daily (Washington, DC: Island Press, 1997).

81 Liu et al., "Coupled Human and Natural Systems," 645.

82 Charles L. Redman, J. Morgan Grove, and Lauren H. Kuby, "Integrating Social Science into the Long-Term Ecological Research (LTER) Network: Social Dimensions of Ecological Change and Ecological Dimensions of Social Change," *Ecosystems* 7, no. 2 (March 1, 2004): 161–71. Redman et al. also use the term "ecological" to refer to the extra-human environment. They talk about "long-term ecological research" and "social-ecological systems."

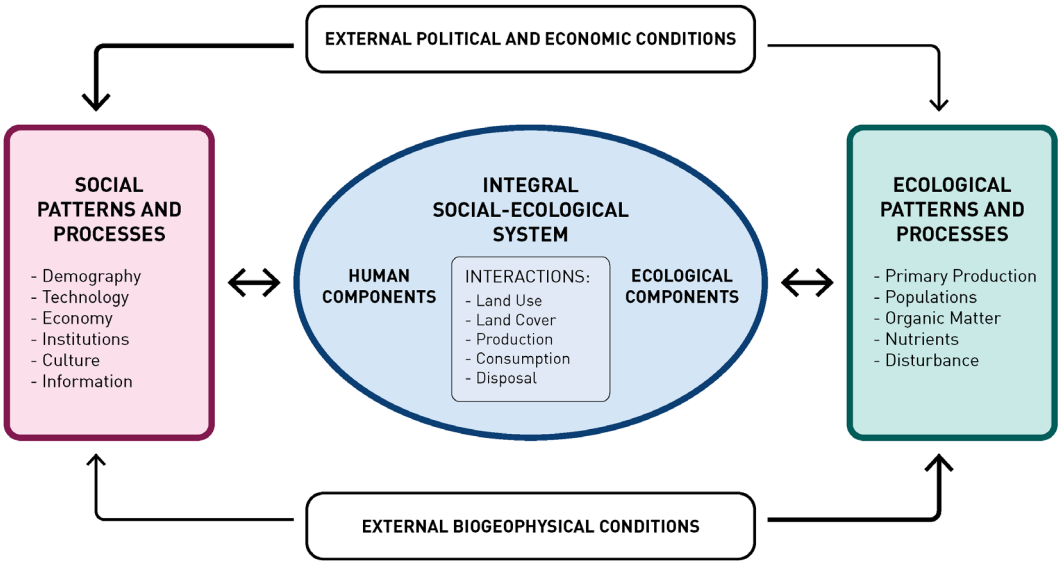


Fig. 1.4: Integral Socio-Ecological System redrawn from Redman, Grove, and Kuby 2004.

logical research as a synthetic, cross-disciplinary approach, bringing together social, biological, and Earth science. It does not simply recognize humans as an integral part of virtually all ecosystems, but it aims to provide comprehensive models and frameworks to holistically study geographic contexts across large scales of time and space. While the traditional framework for the investigation of ecosystems was thought of as the study of the ecosystem dynamics between human activities on the one hand and bio-geophysical drivers on the other, their conceptual framework for studies of socio-environmental systems guides a much more dynamic approach: It adds complexity by integrating processes and feedback relationships over long periods, simultaneously in both the social and environmental dimension. These processes are conceptualized as a single socio-environmental system characterized by simultaneity and dynamic transformation. In addition, the framework also includes external forces: first, political and economic, and second, biogeophysical. These external factors influence both social and environmental processes and the system as a whole.[83] [Fig. 1.4]

This framework of integrative socio-environmental systems has been instrumental in developing my own research framework for this thesis. Three parts are particularly relevant: First, the integration of social and environmental processes into one holistic and multi-disciplinary system, including different organizational, temporal, and spatial scales. Second, the emphasis on processes, transformations, and interconnections, rather than static domains, and the

83 Redman, Grove, and Kuby, "Integrating Social Science into the Long-Term Ecological Research (LTER) Network."

need to understand this multidimensionality across long time spans. And third, integrating external conditions and forces that act on the system as a whole connects specific sites and systems to regional and even planetary forces.

Ecosystem Engineering and Socio-Cultural Niche Construction

Humans are transforming their extra-human environment to make it productive for their needs and enable societal growth and development. This conscious engineering of ecosystems aligns with the notion of landscape as a "synthetic space." Scientifically, human-environmental ecosystems have been co-produced over millennia through "ecosystem engineering."[84]

Land-Use Intensification

Following the Early Anthropocene narrative presented in the introduction chapter, humans had constantly been "naturally" transforming their environment by replacing native biomes through manipulated socio-environmental systems. The increasing intensity, ultimately growing to planetary scales, can be explained by the Land-Use Intensification Theory, which suggests that resource shortages were countered with technological innovation enabling higher efficiency.[85] Important in the land-use intensification theory is that this progress does not happen as a continuous, linear process but, instead, in a dynamic, fluctuating manner, responding to different social and environmental forces. Regime shifts in the land-use system happen through alternating phases of technological "intensification," which are superseded by stages of "involution" once the technology-driven productivity boost and the capacity to enhance land productivity is exhausted, resulting in phases of "crises" when production can no longer keep up with increasing populations.[86] The Hexi Corridor's long-term history of socio-environmental coproduction follows such patterns of fluctuating growth, degradation, and decline, and the Land-Use Intensification Theory helps explain those.

Anthroecology and Anthropogenic Biomes

In the context of the Anthropocene, this thinking of deeply entangled socio-

84 Charles L. Redman, *Human Impact on Ancient Environments* (University of Arizona Press, 1999).

85 The influential theory was first introduced by Ester Boserup in 1965, challenging the late-18th century Malthusian belief that the availability of food defines the limit of potential population growth. Boserup argued that social crises due to resource shortages trigger innovation and the development of strategies to increase production. Over time, periodic leaps in technology and management innovation transform a society's physical and social formation, such as through new land tenure methods or labor markets. B. L. Turner and Marina Fischer-Kowalski, "Ester Boserup: An Interdisciplinary Visionary Relevant for Sustainability," *Proceedings of the National Academy of Sciences* 107, no. 51 (December 21, 2010): 21963–65.

86 Ellis et al., "Used Planet."

environmental systems that increase in complexity and intensity over time can be expanded from the scale of the ecosystem to the Earth System. Ellis' theory of anthroecology, which has already been referred to several times, adds an additional layer of complexity to Redman et al.'s concept of social-ecological systems. They both provide a framework to explain the coupling of socio-cultural and environmental systems over long periods. But in addition to the interaction of socio-cultural systems (social and material) with environmental (biotic and abiotic) systems, Ellis emphasizes that there are also constant evolutionary processes of transformation happening within each of the two spheres.

The Creation of Anthropogenic Biomes Over Time Through a Complex Web of Socio-Environmental Interrelationships

Through ecosystem engineering, humans create niches (altered ecosystems, for example, for land cultivation) that they progressively adapt, improve over time, and use to their advantage. Natural selection enables all these processes to happen over time and across generations. Societies intentionally alter environments and must, in turn, constantly adapt to these altered environments. This creates complex feedback loops in both directions as socio-cultural plus environmental evolutionary processes affect each other.[87] As Erle Ellis points out in his "socio-cultural niche construction" theory, these human-altered ecosystems are highly dynamic. They are constantly reacting to both cultural (social, political, economic) as well as environmental changes over time. And humans need to simultaneously sustain both their sociocultural systems as well as their engineered ecosystems. The theory of socio-cultural niche construction is thus the combination of cultural niche construction and cultural evolution into a single theory to explain the long-term changes and diversification of the biosphere.[88]

In "anthroecosystems," socio-cultural and environmental systems are coupled and evolve simultaneously, leading to cultural, material, and environmental transformations over time (also called inheritances). The socio-cultural system is constantly transforming through such cultural and material inheritances, leading to cultural innovation and achievements, as well as material changes that are exclusively produced by modern societies and incapable of being produced by natural processes (such as artificial materials, buildings, roads, or chemical pollutants). On the other hand, the environmental system—which Ellis calls 'ecological system'—is transforming through biotic and abiotic processes, their genetic and environmental inheritances. In the model of an an-

87 Cultural niche construction is the process in which organisms modify their own and each other's niches through their activities and choices. They are simultaneously the object of natural selection and the subject as creator of the conditions within that selection. See Kevin N. Laland and Michael J. O'Brien, "Cultural Niche Construction: An Introduction," *Biological Theory* 6, no. 3 (September 1, 2011): 191–202.

88 Ellis, "Ecology in an Anthropogenic Biosphere."

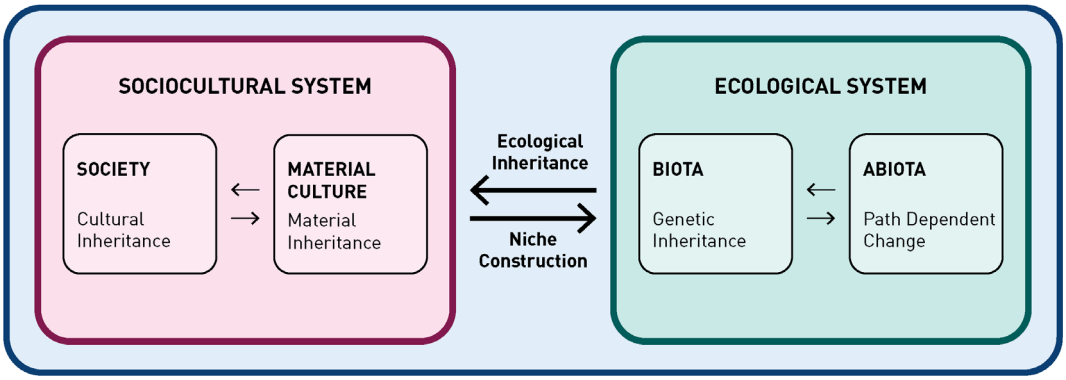


Fig. 1.5: Diagram of an Anthropoecosystem showing ecological transformations through the complex interactions between sociocultural and environmental systems over long periods of time, redrawn from Ellis 2015.

thropoecosystem, these different dimensions are all connected in a dynamic, multidimensional evolutionary process over long periods. This helps explain regime shifts in cultural evolution and their spatial and environmental consequences.[89] For example, as we will see in the case of the Hexi Corridor region, the socio-cultural system changed through a new system of trading routes and the diversification of cultural exchange (cultural inheritance), which enabled the development of new settlement and farming technologies (material inheritance). This new cultural regime altered the environmental system spatially with extended farmlands and genetically through the domestication and invasion of new species (genetic inheritance). This happened in a reciprocal relationship with other environmental processes, such as changing weather patterns with more frequent droughts and increased wind erosion (path-dependent change). [Fig. 1.5]

Socio-cultural evolution happens at much faster rates than biological evolution. Therefore, the theory of socio-cultural niche construction suggests that the socio-cultural system has become more dominant than the environmental system in transforming the terrestrial biosphere. This can explain the upscaling of human societies and, eventually, how humans, as a single species, were able to change the global biosphere at planetary scales. Over long periods, native wildland biomes were turned into human-made biomes. Across the globe and human history, different types of societies—hunter-gatherer, horticultural, agrarian, or industrial societies—have altered ecosystems in various spatial and biological patterns, leading to complex, heterogeneous mosaics of anthropogenic biomes (or anthromes).[90] Human interactions with extra-human nature (the construction of socio-cultural niches) have spatially shaped landscapes at

89 Ibid.," 300–312.

90 Ellis and Ramankutty, "Putting People in the Map." Ellis' concept of anthropogenic biomes is crucial for understanding today's world, referred to several times previously.

accelerated speed and scale. Today, these human-made landscapes are composed of patches of ecosystems that have been altered to different degrees as hybrid- or novel ecosystems.[91] Some have been altered to such a degree that turning them back into their previous state is no longer feasible, raising fundamental questions about the objectives of ecosystem management, restoration, and conservation.[92]

***

These theories from ecological science illustrate that the growing magnitude and intensity of human interventions across the globe have created increasingly complex, fragmented, and dynamic environments. Erle Ellis argues that humans and their socio-cultural systems have become the decisive factor in the formation of these conditions. In a world where the majority of the global terrestrial surface has been altered by primary and even secondary anthroecological succession, "[t]he ultimate causes of unprecedented human transformation of the biosphere are social and cultural; not biological, chemical, or physical."[93] In a world of expanding anthropogenic biomes, there are consequently more interactions between humans and extra-human nature in previously untouched habitats. This results in stronger destruction, fragmentation, and disturbance of natural ecosystems, leading to higher vulnerability, lower diversity, and a higher chance for harmful microbes, viruses, pests, and diseases encroaching on human systems.[94] Ecosystem engineering produces cultural innovation and incremental progress, for example, through technologies that allow higher food yields. However, anthropogenic ecosystems can only sustain socio-cultural development to a certain extent. Non-human environments are limited in resources and their capacity to provide healthy and livable conditions for humans. In addition, "external" transformations, such as rising temperatures or decreasing annual rainfall, can accelerate the degradation of ecosystems and add additional complexity and disturbance. Such multidimensional, non-linear, but highly fluctuating processes of socio-environmental transformation over long periods will be described in the case of the Hexi Corridor.

---

91 Novel ecosystems show species compositions in relative abundances that have not occurred previously within a given biome. They are created either through ecosystem degradation or the invasion of non-native species. See Richard J. Hobbs et al., "Novel Ecosystems: Theoretical and Management Aspects of the New Ecological World Order," *Global Ecology and Biogeography* 15, no. 1 (2006): 1–7.

92 Richard J. Hobbs et al., "Managing the Whole Landscape: Historical, Hybrid, and Novel Ecosystems," *Frontiers in Ecology and the Environment* 12, no. 10 (2014): 557–64.

93 Ellis, "Ecology in an Anthropogenic Biosphere," 290.

94 Kate E. Jones et al., "Global Trends in Emerging Infectious Diseases," *Nature* 451, no. 7181 (February 2008): 990–93; David A. Wilkinson et al., "Habitat Fragmentation, Biodiversity Loss and the Risk of Novel Infectious Disease Emergence," *Journal of The Royal Society Interface* 15, no. 149 (December 21, 2018): 20180403; Montira J. Pongsiri et al., "Biodiversity Loss Affects Global Disease Ecology," *BioScience* 59, no. 11 (December 1, 2009): 945–54.

1.4 Ecological Concepts as Agents of Design Creativity

Both landscape and ecology are ambiguous hybrids between arts and sciences, between moral-philosophical, subjective, and emotional concepts on the one hand, as well as rational, objective, and scientific thought on the other. The three dimensions of ecology—the scientific, ethical, and political-economic—are all closely related to the formation of landscapes. Ecological concepts of non-linearity, instability, multi-temporality, unpredictability, disruption, and resilience productively inform landscape to function as flexible and hybrid socio-environmental systems that adapt to changing circumstances. The complex models of how human and extra-human nature are coupled through highly dynamic interconnections of transforming socio-cultural and environmental systems explain how socio-cultural evolution led to the restructuring of the global biosphere. They illustrate the capacity humans have gained to actively create ecosystems that provide vital services to sustain and develop their societies. Systematically designed "projective ecologies"[95] can create landscapes through the active coupling of human and environmental systems, resulting in productive, cultural formations that can anticipate and respond to the multi-layered complexities of our time.

In his 1997 essay Ecology and Landscape as Agents of Creativity, James Corner takes ecology out of the domain of science and introduces it into design culture. At the same time, he takes the concept of creativity out of the arts and into science, thus putting ecology and creativity on the same level. As he describes, ecology is never ideologically neutral. Instead, it is a "social construction […] that can initiate, inform, and lend legitimacy to particular viewpoints."[96] A landscape "idea" that is informed by ecological thinking, Corner says, can become a "profound agency" as a strong and active cultural conception. This landscape agency can then "invent alternative forms of relationships between people, place, and cosmos." It is thus far beyond "visual appearance, resource value, habitat structure, or instrumentality" and "more about the invention of

95 Christopher Hight promotes ecology as a multidisciplinary intellectual framework. He sees the design disciplines—notably architecture and landscape architecture—as well suited for the important mediation process. He proposes a "theory of projective ecology" and "systems of mediation […] to coalesce heterogeneous and often contradictory social, cultural and natural factors into coherent expressions." Christopher Hight, "Designing Ecologies," in *Projective Ecologies*, ed. Chris Reed and Nina-Marie Lister (New York: Actar, 2014), 84–105. Hight's text is featured in the edited volume "Projective Ecologies," which aims to combine ecological theory and essays from multiple disciplines into a broad approach that can inform design thinking and practice. Chris Reed and Nina-Marie Lister, eds., *Projective Ecologies* (New York: Actar, 2014).

96 James Corner, "Ecology and Landscape as Agents of Creativity," in *Ecological Design and Planning*, ed. George F. Thompson and Frederick Steiner (New York: John Wiley & Sons, 1997), 84.

new forms and programs than the merely corrective measures of restoration."[97] This text by Corner is an early record of the attempt to promote landscape, informed by ecological thinking, as an active medium to effectively intervene in the urban realm, particularly in urban contexts characterized by socio-economic restructuring.[98]

In ecosystems understood as open, self-organizing, and highly dynamic environments, it is important to design for changing conditions, accommodate long-term adaptation, and anticipate continuous transformations. Since ecosystems are unpredictable to a certain degree and may change in several ways, there is an infinite number of potential design solutions. In response to these complex realities, it is essential to integrate ecological thinking into design. Nina-Marie Lister calls for a culture of "adaptive ecological design" that is interdisciplinary and diverse, "accepts and embraces change as a normal part of life," and allows for experiments and sporadic failure. This design culture should aim to create tangible experiences that allow humans to engage with extra-human nature, involve local communities to develop a new role "as creative agents in the process of unfolding, as interpreters of change, as designers once again" to collectively decide over one of the many potential futures and possible outcomes.[99]

This notion of "embracing complexities," accepting highly dynamic and sometimes chaotic conditions, is important. The complex human-environmental interconnections happen across different scales: At the small scale of an individual actor, species, place, and small ecosystem niche; at the territorial scale of a watershed or biome when a system gets scaled up; and particularly at the complex "middle ground" where ecosystem dynamics are most challenging to understand and predict—where seemingly "everything is connected to everything else."[100] In such highly dynamic conditions, decisions about scale, extent, and hierarchical units, defining a geographic context, drawing boundaries, and what should be included and left out are crucial. Following an "ecosystem

97 Corner, "Ecology and Landscape as Agents of Creativity," 82–83.

98 Douglas Spencer argues that precisely the opposite is true: Instead of the creation of a new and strong design agency, he argues that the introduction of ecological theories into landscape design leads to ambiguity, essentially weakening the critical agency of the individual designer and masking a neo-liberal position with a "green," environmental narrative. Douglas Spencer, "Agency and Artifice in the Environment of Neoliberalism," in *Landscape and Agency: Critical Essays*, ed. Ed Wall and Tim Waterman (Routledge, 2017), 177–87.

99 Nina-Marie Lister, "Sustainable Large Parks: Ecological Design or Designer Ecology?," in *Large Parks*, ed. Julia Czerniak and George Hargreaves (New York: Princeton Architectural Press, 2007), 35–57.

100 So-called "middle-number problems" operate at scales that are too few and varied to be amenable to global averages but too numerous and varied to be computationally tractable. They, therefore, require system thinking. A system needs to be approached hierarchically as a whole composed of multiple subsystems as well as their individual components. Erica A. Newman et al., "Scaling and Complexity in Landscape Ecology," *Frontiers in Ecology and Evolution* 7 (2019): 293; 1–16.

approach," these decisions are informed by ecological thinking and require a strong agency of the individual analyst, planner, or designer. They are necessarily subjective and can happen to some extent arbitrarily.[101] Since virtually all ecosystems are affected by human activities, Erle Ellis argues that the baseline of all investigations needs to be anthropogenic. Therefore, sites for field research should be selected according to more random and less biased criteria. And essentially, the context of these designated sites always needs to be understood as global.[102] These research principles, the courage to embrace complexity, and, to a certain degree, trust serendipity were instrumental in the research on the Hexi Corridor and the selection of case study sites.

New concepts of scientific ecology cannot only inform design, but design can also generate new ecological knowledge. The design of specific sites—both as an activity and its spatial outcome—can serve as the common ground for scientists and practitioners to work together and generate knowledge in each field, thus enhancing ecological science's societal impact. Nassauer and Opdam describe a model with three phases in which first, landscape processes are analyzed; second, the gained knowledge is integrated into a set of design principles; and third, these principles are applied in an individual place to respond to a specific problem, or to increase the overall landscape value. Through such cycles of assessment and action, new knowledge in both domains can be produced, closing the gap between ecological knowledge and practice and creatively anticipating future change.[103]

***

Similar to landscape, ecology is a way of seeing the world. It understands ecosystems as highly dynamic formations in which humans are deeply integrated and can take an agency in shaping them. This notion of ecology informs the Landscape Approach: First, it is a holistic, creative, and anticipatory way of thought to understand and represent a complex geographic context. And second, it is a creative, spatial design language to systematically couple human and environmental systems in the form of physical interventions in specific places. In the age of the Anthropocene, this agency of actively creating performative landscape systems can be expanded to territorial scales with the ambition to address the complex global socio-environmental issues of our time.

101 James J. Kay and Eric Schneider, "Embracing Complexity: The Challenge of the Ecosystem Approach," *Alternatives Journal* 20, no. 3 (1994): 32–38.

102 Ellis, "Ecology in an Anthropogenic Biosphere," 317–18.

103 Joan Iverson Nassauer and Paul Opdam, "Design in Science: Extending the Landscape Ecology Paradigm," *Landscape Ecology* 23, no. 6 (July 1, 2008): 633–44.

1.5 A Brief Review of Landscape Approaches in Planning and Design

This thesis aims to define a Landscape Approach as an original academic contribution. However, several other approaches have informed it since landscape was established as a professional discipline in the mid-nineteenth century. Therefore, before the Landscape Approach is introduced as a comprehensive concept and to position it in the disciplinary context it is built upon, parallels are drawn to other theories and practices from landscape planning and design and environmental restoration.

Landscape Architecture: Anticipating Growth and Development

As discussed, Denis Cosgrove identified the origin of landscape in the late Italian Renaissance, coinciding with the emergence of early capitalism in Europe. Landscape can, therefore, be understood as the manifestation of precisely the separation of humans from nature, which later intensified with Cartesian thought and has been described as a culture impeding holistic thinking. However, Cosgrove dates the end of this traditional conception of landscape in the nineteenth century when "features of pure market capitalism […] were distinctly blurred by the intervention of the state."[104] At that time, society became increasingly concerned with issues of sanitation, housing, public health, and general well-being. And it is at that time, in the second half of the nineteenth century, when the idea of landscape was turned into a physical medium of anticipatory design for the public realm—no longer as a mere expression of a society's geographic shaping of their environment but as an active catalyst for the creation and management of cities and the built environment.

Early systematic landscape thinkers such as Frederick Law Olmsted, Charles Eliot, and Warren Manning were concerned with issues of drinking water and fresh air, land conservation, nationwide resource management, socio-economic tensions, and inequalities. Informed by early public parks in major European cities, this first generation of landscape architects showed an astonishing capability for holistic thinking in the dynamic context of the formation of the modern United States with rapidly growing urban centers, their expansion into new, regional scales, and a dramatically transforming natural environment. This period not only produced iconic works of urban landscape infrastructures but also initiated institutional strategies and policies for long-term land conservation and management.[105]

104 Cosgrove, *Social Formation and Symbolic Landscape*, 3; 254–56.

105 David Schuyler, *The New Urban Landscape: The Redefinition of City Form in Nineteenth-Century America* (Baltimore: Johns Hopkins University Press, 1988), see particularly chapter 4: The Ideology of the Public Park, p.59–76.

***

While the designs of this first generation of landscape architects followed a pastoral ideal rooted in a strong binary, urban-rural divide, they laid the foundation for using landscape as a medium to give form and meaning to growing cities, and, most importantly, think landscapes holistically as cultural products and socio-environmental formations. Revisiting the origins of landscape architecture practice reveals a strong legacy of engaging with different agencies, connecting individual sites to large geographic contexts, and designing places with sensitivity to enable the development of balanced socio-cultural, economic, and environmental processes. The Landscape Approach can thus build upon a rich record of solid project precedents from the tradition of landscape architecture.

Regional Planning: The Region as a Scale of Information

At the end of the nineteenth century, legal planning became more dominant and "[a]s an active force in cultural production, landscape atrophied."[106] In authoritarian and modernist planning schemes, landscape was often pushed back to a mere decorating backdrop. However, ecologically informed planning and the region as a new scale for urban development added a crucial intellectual foundation to landscape thinking in the first half of the twentieth century, such as in the works of Patrick Geddes, Benton MacKaye, and Lewis Mumford.[107] But, it required a wave of serious environmental concerns in the 1960s until the idea of landscape as a medium for multi-dimensional and –scalar design returned.[108]

Ian McHarg saw himself in the lineage of advocates of nineteenth-century environmental movements. He was concerned with the unstable duality between humans and extra-human nature, with the destructive forces of the industrial society and urban development, and establishing a new ethic in environmental planning and design.[109] He integrated regional planning and landscape architecture in his teaching and practice, "embrac[ing] the entire scope

106 Cosgrove, *Social Formation and Symbolic Landscape*, 270.

107 Patrick Geddes, "The Study of Cities [1915]," in *The Ecological Design and Planning Reader*, ed. Forster O. Ndubisi (Washington, DC: Island Press/Center for Resource Economics, 2014), 58–65; Benton MacKaye, "Regional Planning and Ecology," *Ecological Monographs* 10, no. 3 (1940): 349–53; Benton MacKaye, *The New Exploration: A Philosophy of Regional Planning [1928]* (Harpers Ferry, W Va: Appalachian Trail Conservancy, 1991). For a good overview of Mumford's work, see Mark Luccarelli, *Lewis Mumford and the Ecological Region: The Politics of Planning* (The Guilford Press, 1997).

108 As mentioned, publications such as *Silent Spring* (1962) or the *Limits of Growth* (1972) raised awareness among a broad public for the existential threats of environmental destruction through industrialized agriculture and the limitations of natural resources in an increasingly globalized economy. Rachel Carson, *Silent Spring*, Anniversary edition (Boston: Houghton Mifflin Company, 2002); Donella H. Meadows et al., *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind* (New York: Universe Books, 1972).

109 Ian L. McHarg, "Man and the Environment," in *The Urban Condition: People and Policy in the Metropolis*, ed. Leonard Duhl and John Powell (New York: Basic Books, 1963).

of the discipline—the shaping of landscape from garden to region[…]."[110] The book cover of McHarg's seminal 1969 book Design with Nature showed an obscure planet behind the dark skyline of a city.[111] This seems to suggest that for McHarg, the entire world was the stage, and urbanization was the main issue of concern. In the book, McHarg introduces scientific approaches to spatial ecological planning, including innovative mapping and the use of early computer technologies to be integrated into decision-making processes of urban development and as a basis for design. McHarg advocated a natural scientific approach to define rational urban planning processes. His work redefined the role of landscape and established the discipline as a branch of environmentally informed regional planning.

James Corner positions McHarg in the camp of conservationists who tend to reduce socio-environmental challenges to a rational accounting framework, a quantifiable "resource-value matrix" to identify the least disruptive land use, leading essentially to a detachment of people from the earth.[112] Despite this criticism, McHarg's work was undoubtedly very productive in providing robust, scientific methods to ground landscape-informed projects in empirical data. His work was fundamental for later theories and practices such as landscape ecology. As landscape was increasingly considered as pervasive networks, complex mosaics, and highly dynamic systems in the late twentieth century, landscape ecology added a spatial dimension to ecological processes, providing the theoretical vocabulary to effectively ground ecological principles in understanding and spatially planning geographies and particularly urban regions.[113] "Landscape" in landscape ecological definitions is understood as a holistic entity, made up of different elements, recognizable through clusters of ecosystems that are repeated in similar form as tangible and heterogeneous but closely interwoven natural and cultural entities.[114] Several landscape planning frame-

110 Anne Whiston Spirn, "Ian McHarg, Landscape Architecture, and Environmentalism: Ideas and Methods in Context," in *Environmentalism in Landscape Architecture*, ed. Michel Conan (Washington, D.C: Dumbarton Oaks Research Library and Collection, 2001), 97–100.

111 Ian L. McHarg, *Design with Nature*, 1st edition (Garden City, New York: Natural History Press, 1969).

112 Corner, "Ecology and Landscape as Agents of Creativity," 91. Corner's critique is aimed at the astonishingly positivist belief in scientific data at the time, which—if accumulated, overlaid, and combined in rational matrices—would allow to get closer to "truth." However, as the review of ecological literature has shown, the truth of complex and large-scale ecosystems is much more unpredictable, unstable, and dynamic than static sets of information.

113 Richard T. T. Forman and Michel Godron, *Landscape Ecology* (New York: Wiley, 1986).

114 Landscape ecology as a term was already coined in 1939 in Germany as a branch of geography to achieve a more holistic understanding of a region through the combination of a spatial-geographical with a functional-ecological analysis. While landscape ecology in Europe followed a rather humanistic approach, In the U.S., landscape ecology was introduced in the 1980s as a scientific discipline that provided systematic conceptual frameworks to study landscape patterns and processes. Jianguo Wu and Richard Hobbs, "Landscape Ecology: The State-of-The-Science," in *Key Topics in Landscape Ecology*, ed. Jianguo Wu and Richard J. Hobbs, Cambridge Studies in Landscape Ecology (Cambridge: Cambridge University Press, 2007), 271–87.

works in this tradition have since been developed as operational tools.[115]

***

Landscape ecological thinking provides the logic to subdivide the planet into scalar units, including their dynamics of ecological processes, social and environmental patterns, institutional responsibilities, and policies. These systematic scalar perspectives are instrumental for this thesis and provide the spatial framework for the Landscape Approach.[116] Another productive characteristic of regional planning frameworks is the notion of interdisciplinary, collaborative work. Landscape and its multiple thematic layers can serve as an inclusive platform to bring different stakeholders with often divergent interests together to negotiate various spatial and temporal scenarios.[117]

Land Conservation: Protecting Resources, Values, and Working with Nature

Since the 1980s, "landscape approach" as a term became prominent in the international institutional discourse, particularly in the context of nature conservation, landscape restoration, ecosystem services, competing claims on land and resources, sectorial land-use policies, sustainable development, and socio-environmental systems. It started to be used mainly as an "integrated landscape approach," urging for an integrated land-sharing philosophy and a cross-sectoral integration of science, governance, policy, management, and multiple stakeholders, including NGOs and local communities, in participatory planning, aiming for sustainable land development.

Such landscape approaches are concerned with land conservation and biodiversity goals and—particularly in the context of developing world regions—

115 Carl Steinitz, "A Framework for Theory Applicable to the Education of Landscape Architects (and Other Environmental Design Professionals)," *Landscape Journal* 9, no. 2 (1990): 136–43; Richard T. T. Forman, *Land Mosaics: The Ecology of Landscapes and Regions* (Cambridge: Cambridge University Press, 1995); Frederick R. Steiner, *The Living Landscape: An Ecological Approach to Landscape Planning*, (Washington, DC: Island Press, 2008[1990]). For an extensive review of relevant literature in the formation of ecological planning methodologies, see André Botequilha Leitão and Jack Ahern, "Applying Landscape Ecological Concepts and Metrics in Sustainable Landscape Planning," *Landscape and Urban Planning* 59, no. 2 (April 15, 2002): 65–93. The authors argue that all these approaches essentially form a common body of theory with the ultimate goal of planning for sustainability. Landscape is promoted as the appropriate unit in this endeavor. They argue that there is a need to develop robust frameworks that cross all these planning approaches, applying ecological knowledge to physical planning practices.

116 See Forman's concept of landscape as mosaics and the patch-corridor-matrix model in Forman, *Land Mosaics*, 11–14.

117 See, for instance, the framework *Geodesign* by Carl Steinitz, which promotes a systematic approach to convene multiple stakeholders and develop symbiotic and integrated solutions whereby landscape serves as a mediator. Carl Steinitz, *A Framework for Geodesign: Changing Geography by Design* (Redlands, Calif: Esri Press, 2012). Steinitz promotes Geodesign to be applied across a "scalar continuum" from the planetary to the local scale, with a "middle scale" being particularly complex but most effective, p.19–22.

socio-economic improvement. They are typically informed by ecological science and planning, similar to conventional conservation and development projects, focusing on plans and regulations.[118] Landscape approaches aim to be effective by integrating different sectors while being sensitive to space and individual places and as hands-on strategies that link local communities to their surroundings.[119] They aim to provide tools and concepts to allocate and manage land in ways that can achieve social, economic, and environmental goals, particularly in areas where different land uses, such as mining and agriculture, compete with environmental and biodiversity goals.[120] Defries et al. argue for a "whole-landscape approach" in the context of the tropics, which "[…] incorporates the full spatial, temporal, and socio-economic domains."[121] Landscape approaches started to be promoted by intergovernmental organizations, primarily concerned with natural resources, land restoration, and sustainable practices in agriculture[122] and forestry.[123]

With broadening sets of Earth science data representing more comprehensive ranges of species, biodiversity, and ecosystems, computer models and landscape concepts became more cohesive and accurate.[124] Conservation strategies started to include ecology and society, more specifically, embracing a socio-environmental system approach in which conservation was thought in a more

118 Jeffrey Sayer, "Reconciling Conservation and Development: Are Landscapes the Answer?," *Biotropica* 41, no. 6 (2009): 649–52.

119 For a historic review of landscape approaches and a multi-disciplinary model, see Bas Arts et al., "Landscape Approaches: A State-of-the-Art Review," *Annual Review of Environment and Resources* 42, no. 1 (2017): 439–63. For a definition of the integrated landscape approach, see James Reed, Liz Deakin, and Terry Sunderland, "What Are 'Integrated Landscape Approaches' and How Effectively Have They Been Implemented in the Tropics: A Systematic Map Protocol," *Environmental Evidence* 4, no. 1 (January 7, 2015): 2. The definition of a landscape approach is very similar to the 'ecosystem approach' which is sometimes used interchangeably.

120 Jeffrey Sayer et al., "Ten Principles for a Landscape Approach to Reconciling Agriculture, Conservation, and Other Competing Land Uses," *Proceedings of the National Academy of Sciences* 110, no. 21 (May 21, 2013): 8349–56.

121 Ruth S. Defries and Cynthia E. Rosenzweig, "Toward a Whole-Landscape Approach for Sustainable Land Use in the Tropics," *Proceedings of the National Academy of Sciences* 107, no. 46 (November 16, 2010): 19627–32.

122 See, for example, the "Climate Smart Agriculture Sourcebook" by the FAO, first published in 2013 and has since been shared as an ongoing online source. Food and Agriculture Organization of the United Nations, "Climate Smart Agriculture Sourcebook," accessed January 25, 2022. See particularly section A3, "Managing Landscapes for Climate-Smart Agriculture Systems: A Landscape Approach to CSA."

123 See, for example, a 2015 publication by the World Agroforestry Center (ICRAF) that promotes an integrative landscape approach as an effective way to balance the interests of different stakeholders and the goals of decreasing global emissions of greenhouse gases while simultaneously increasing the production of natural resources for a growing world population. Peter. A. Minang et al., eds., *Climate-Smart Landscapes: Multifunctionality in Practice* (Nairobi, Kenya: World Agroforestry Centre (ICRAF), 2015).

124 Katherine A. Zeller, Kevin McGarigal, and Andrew R. Whiteley, "Estimating Landscape Resistance to Movement: A Review," *Landscape Ecology* 27, no. 6 (July 1, 2012): 777–97.

dynamic and less restrictive manner. This opposed previous modes of resource management, which focused on quantitative yields of certain resources and neglected their users and socio-environmental linkages among them.[125]

***

In texts on land conversation and management, the term landscape is, in most cases, used rather superficially and simply understood as an "area delineated by an actor for a specific set of objectives," both conceptually and in terms of physical space.[126] They tend to be concerned with natural resources, such as food and drinking water, biodiversity and ecosystem stability, and places of land cultivation, primarily focusing on remote, rural areas with small, traditional communities. The aim is usually to optimize existing practices and socio-economic regimes, provide technical expertise for the coordination among different sectors and stakeholders, improve the implementation of regulatory frameworks, and monitor quantitative ambitions. The Landscape Approach framed in this thesis aims to go one step further and rethink existing patterns of the predominant socio-economic regime. It aims to enrich the shared objectives of land conservation with the potential of ecological concepts to act as an innovative and anticipatory agency of design, expressed through the cultural medium of landscape as a catalyst. While it shares the ambition to find ways of sustainable development across a region, it aims to find unique spatial solutions that respond to the specific characteristics of an individual place. [Fig. 1.6] Below, this productive agency of landscape thinking is discussed across three dimensions of land conservation and working with nature: nature-based solutions, conserving the local wisdom of a place, and conserving half of the Earth for nature.

Nature-Based Solutions

In recent years, the term landscape approach was promoted in the context of policies addressing environmental issues explicitly at global scales. It suggests practices of integrated land-use planning to reduce levels of greenhouse gases and mitigate climate change—applied particularly in agriculture and forestry.[127] This notion of systematically working with the land and natural systems

125 Fikret Berkes and Carl Folke, *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience* (Cambridge University Press, 2000).

126 This landscape definition from Sayer et al. reads very similar to other texts discussing land conservation. Sayer et al., "Ten Principles for a Landscape Approach to Reconciling Agriculture, Conservation, and Other Competing Land Uses," 2.

127 See the IPCC's 2019 special report as an example of a cohesive report by an intergovernmental organization that promotes practices of working with the land as methods to effectively address climate change. Intergovernmental Panel on Climate Change, *Climate Change and Land: IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems* (Cambridge: Cambridge University Press, 2022). Another cohesive report was released in 2019 by the IPBES. It provides similar recommendations for policymakers, focusing on the interconnectivity of socio-environmental systems and the benefits of working with the land as well as

Fig. 1.6: Ponds and wetlands north of Jiuquan have been recreated in an act of hydrological engineering to retain water, control flooding, and improve irrigation. In addition to increasing biodiversity and soil and groundwater restoration, the operational landscape offers socio-economic opportunities; October, 2019.

has been translated into the concept of nature-based solutions, starting in the late 2000s, to actively manage and restore natural ecosystems that provide essential services and contribute to addressing major societal challenges. The International Union for Conservation of Nature and Natural Resources IUCN defines nature-based solutions as: "Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits."[128] Nature-based solutions is an umbrella concept covering a range of ecosystem-related approaches that can complement each other, being implemented alongside other types of interventions.[129] It has been continu-

non-human systems. IPBES, "The Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services: Summary for Policymakers" (IPBES Secretariat, Bonn, Germany: Zenodo, November 25, 2019).

128 Emmanuelle Cohen-Shacham et al., "Nature-Based Solutions to Address Global Societal Challenges" (IUCN, 2016), 1. This report by the IUCN is mainly concerned with conserving natural habitats and finding holistic approaches to benefit the natural environment, biodiversity, and local communities. Case studies demonstrate the application of nature-based solutions, mainly in the rural context of villages, land cultivation, and natural reserves.

129 Cohen-Shacham et al., "Nature-Based Solutions to Address Global Societal Challenges,"

ously refined and more clearly distinguished from other concepts.[130]

The consequences of environmental disasters, such as devastating floods or wildfires, periodically catch wide public attention, especially in cases where large and densely urbanized areas are affected by short-term events.[131] The increasing frequency and intensity of such events and the continuous degradation of ecosystems, more generally, lead to growing awareness among financial institutions and policy-makers for the monetary value of natural environment protection and conservation.[132] Nature-based, ecosystem-related approaches have been identified to provide effective and highly cost-effective solutions.[133] They are more widely promoted, particularly in the context of urban agglomerations, as efficient measures for "urban resiliency," mitigating disaster risk, and preparing cities for climatic change and unexpected weather events. The economic benefits of such approaches have been identified, especially if combined with large infrastructural investments, to help protect real estate and other forms of financial capital. The World Bank, for instance, began to actively promote and increasingly invest in nature-based solutions, particularly in the urban context.[134]

Conserving Indigenous Landscape Wisdom

Environmental conservation generally respects that living systems are self-organizing and self-restoring. It aims to find solutions that avoid human interference with such processes but enhance them instead. A damaged ecosystem can regenerate itself if it has, first, access to the information required for renewal (in short, biodiversity), and second, if that context to retrieve that information (the biophysical environment) has not been altered to a degree where the remaining information becomes meaningless.[135] Indigenous societies traditionally live in close collaboration with their non-human environment. Across generations, they have learned that this deeply rooted, life-sustaining information has to

---

10–24.

130 Emmanuelle Cohen-Shacham et al., "Core Principles for Successfully Implementing and Upscaling Nature-Based Solutions," *Environmental Science & Policy* 98 (August 1, 2019): 20–29.

131 A prominent example is Hurricane Sandy in 2012, which led to iconic images of massive floods and power outages in New York City, causing enormous costs and damages.

132 A study by the World Economy Forum found that "[…] more than half of the world's total GDP – is moderately or highly dependent on nature and its services and is therefore exposed to nature loss." World Economic Forum, "Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy" (Geneva: World Economic Forum, 2020), 8.

133 Christopher M. Raymond et al., "A Framework for Assessing and Implementing the Co-Benefits of Nature-Based Solutions in Urban Areas," *Environmental Science & Policy* 77 (November 1, 2017): 15–24.

134 The World Bank developed a comprehensive catalog to demonstrate how nature-based solutions can be implemented, particularly in the context of urban agglomerations. The World Bank, "A Catalogue of Nature-Based Solutions for Urban Resilience" (Washington, D.C.: World Bank, 2021).

135 Kay and Schneider, "Embracing Complexity: The Challenge of the Ecosystem Approach," 36.

be respected and sustained. Indigenous cultures hold rich understandings of the unique local characteristics of their habitat in a specific world region and thus preserve a precious wisdom of life forms in deep symbiosis with cycles of nature. In many cases, such rich local wisdom and traditional ecological knowledge have been able to sustain human societies over millennia, resisting environmental crises and extreme conditions. Indigenous life forms do not only continue to serve their own and often isolated cultures but bear the potential to influence innovative technologies to craft universal modes of societal development that are sustainable, adaptable, and resilient.[136]

Today, Indigenous communities around the world are not only important sources of knowledge to inspire modern development, but in many cases, they actively provide crucial services to sustain global biodiversity.[137] And they are crucial stakeholders in conservation plans as reserve managers of more than forty percent of the terrestrial protected areas.[138] However, in many cases, they are exposed to conflicting geo-political interests with short-term economic gains, particularly by extraction industries, whose interests are often prioritized over Indigenous rights.[139] It is crucial to recognize and learn from Indigenous peoples' deep-rooted landscape wisdom, traditional ecological practices, art, and technologies, invite them to find innovative collaboration, and benefit from their knowledge to find sustainable and balanced future life forms.[140]

Conserving Half of the Earth for Nature

Given the alarming numbers of global ecosystem degradation, biodiversity loss, and environmental disasters, the proposals for conservation projects are increasingly ambitious, bold, and large in scale. Most prominent might be the Half Earth project[141] by the biologist E. O. Wilson, which suggests that half of

136 Julia Watson coined the term *Lo-TEK* to promote different forms of—often perceived "primitive"—traditional ecological knowledge as valuable and urgently needed technological "wisdom" to effectively respond to uncertain futures of global environmental transformations, protect extra-human nature, and transform modern civilization. She promotes Indigenous knowledge to inform a "new mythology of technology" that counters the predominant belief in scientific knowledge rooted in the European Enlightenment. Julia Watson, *Lo–TEK. Design by Radical Indigenism* (Taschen, 2020), 16–27.

137 While Indigenous communities comprise just four percent of the global population, they are stewards of up to eighty percent of the planet's biodiversity. Claudia Sobrevila, "The Role of Indigenous Peoples in Biodiversity Conservation: The Natural but Often Forgotten Partners," Working Paper (Washington, D.C: World Bank Group, May 1, 2008), xii, xvi.

138 Stephen T. Garnett et al., "A Spatial Overview of the Global Importance of Indigenous Lands for Conservation," *Nature Sustainability* 1, no. 7 (July 2018): 369–74.

139 Harvard Law Review, "The Double Life of International Law: Indigenous Peoples and Extractive Industries," *Harvard Law Review* 129, no. 6 (2016): 1755–78.

140 Learning from Indigenous communities was a major focus in the book *Landscape Approach,* developed parallel to this thesis. Several chapters present cases of traditional ecological knowledge that is applied to craft productive landscapes and ways of collaboration with Indigenous communities. Zander et al., *Landscape Approach*.

141 Edward O. Wilson, *Half-Earth: Our Planet's Fight for Life* (New York: Liveright, 2016); See

the Earth's surface should be protected as a natural reserve to preserve global biodiversity. Such provocative proposals give an idea of what it will take to scale up conservation measures across national boundaries, effectively interconnect natural habitats, and protect biodiversity at global scales. While such proposals may seem idealistic, they are not utopian. They can become feasible with large economic investments, strong international cooperation, intergovernmental coordination, and robust legal frameworks.[142]

However, there seems to be a major flaw in such ideas of land conservation to protect the world's biodiversity: Ironically, it displays an epistemological divide between humans and nature that are conceptually separated from each other. It suggests a world where people continue to thrive in one half of the world while nature is flourishing in the protected other half. And two other misconceptions in global conservation proposals such as the Half Earth project can be identified: First, significantly scaling up the protection of land for biodiversity conservation would lead to higher competition with land uses for settlements and high-yield agriculture, especially in a world of continuously growing human populations, which are already today facing severe challenges of food security.[143] So far, most of the Earth's terrestrial protected area has been allocated in regions where this competition is relatively low, in areas that are arid, cold, steep, inaccessible, and not well suited for intensive human use, and, therefore, relatively simple to protect.[144] In order to be effective, natural conservation should be about the quality of conservation rather than the quantity. Since the vast majority of the terrestrial Earth's surface has already been altered significantly by human use, only a tiny fraction of the world consists of untouched wildlife, questioning the attitude of demarcating land to protect a seemingly non-human preserve.

Second, the concept of conserving "nature" on half of the planet's surface suggests a world that is static. But planetary environmental transformations—

---

also the initiative's website https://www.half-earthproject.org. In addition, see the *Nature Needs Half* project, an international coalition of scientists, conservationists, nonprofits, and public officials, co-founded by the Canadian conservationist Harvey Locke in 2009, which proposes to protect 50% of the planet by 2030. Harvey Locke, "Nature Needs Half: A Necessary and Hopeful New Agenda for Protected Areas," *Parks* 19 (November 5, 2013): 13–22; Eric Dinerstein et al., "An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm," *BioScience* 67, no. 6 (June 1, 2017): 534–45. Find the *Nature Needs Half* website here: https://natureneedshalf.org/.

142 The European *Nature 2000* network serves as a successful example: It is the world's largest coordinated system of protected areas, covering around 18% of the total land area of the European Union—a world region that is comparably densely urbanized and far-developed. Thomas Campagnaro et al., "Half Earth or Whole Earth: What Can Natura 2000 Teach Us?," *BioScience* 69, no. 2 (February 1, 2019): 117–24.

143 Zia Mehrabi, Erle C. Ellis, and Navin Ramankutty, "The Challenge of Feeding the World While Conserving Half the Planet," *Nature Sustainability* 1, no. 8 (August 2018): 409–12.

144 Stuart L. Pimm, Clinton N. Jenkins, and Binbin V. Li, "How to Protect Half of Earth to Ensure it Protects Sufficient Biodiversity," *Science Advances* 4, no. 8 (2018): eaat2616.

particularly those caused by anthropogenic activities such as global warming—create constant spatial shifts of both human and non-human habitats.[145] These transformations require people, flora, and fauna to move freely across continents, making planning for habitat connectivity crucial to allow all life forms to adapt to changing circumstances. Even areas that are intensely urbanized or cultivated have high potential for the protection and improvement of biodiversity, such as through sustainable farming practices or the integration of green infrastructures across dense urban agglomerations. Notably, the most significant potential for biodiversity conservation per land unit is found within the shared, semi-used, hybrid landscapes covering more than half of today's terrestrial surface. They can be transformed into diversified areas with high biodiversity values through extensive forestry, grazing, and other low-intensity land uses.[146]

***

Conservation needs to happen where it is most effective. And measures must be implemented across the entire planet, not just in one half. Long-term sustainability cannot be achieved by following a conservationist approach that separates the Earth into a used, human, and a protected, non-human world. Instead, conservation must bring these two worlds together to find life forms with productive interconnectivity as fundamental parts. In chapter six, bold projects for large-scale restoration and conservation will be critically discussed in the context of contemporary China and the Hexi Corridor. While this thesis is not able to illustrate how the Landscape Approach can be translated into spatial concepts for integrated sustainable development, it is ultimately its ambition to inform systematic planning and design practices that improve conditions for both humans and non-humans alike and where conservation is not a conceptual and spatial externality, but instead integrated across all scales, from the local to the global.

Nature-based solutions thereby serve as practical strategies to break these ambitions down into effective, site-specific interventions. The indigenous knowledge embedded in the individual place provides enormous potential that needs to be respected and taken advantage of. And, in the context of the Anthropocene, the notion of conserving half of the Earth for nature expresses the necessary ambition and scope the Landscape Approach promotes.

145 See, for instance, Abrahm Lustgarten, "How Russia Wins the Climate Crisis," *The New York Times*, December 16, 2020, sec. Magazine. The article describes how formerly non-arable, large-scale regions in Eastern Russia are becoming suitable grounds for cultivating high-yield crops due to climatic change, attracting Russian, Chinese, and Mongolian farmers.

146 Erle C. Ellis, "To Conserve Nature in the Anthropocene, Half Earth Is Not Nearly Enough," *One Earth* 1, no. 2 (October 25, 2019): 163–67.

Facilitating Urban Transformations

In the urban realm, landscape approaches are less concerned with conservation, natural resource management, and sustainable development. What they share with strategies discussed so far is that they are led by the specific geomorphological conditions of a place and informed by the broad context at the scale of the region or watershed. By the 1980s, building on the work of McHarg, Kevin Lynch, and others, there was a significant body of knowledge on urban nature to build upon.[147] Anne Whiston Spirn criticized McHarg's work for being overly concerned with land conservation and essentially places that should *not* be built,[148] not able to expand his practice from the domain of planning into that of design.[149] Theories and systematic, ecological methods of designing with nature in the urban context were defined, such as in Spirn's The Granite Garden or Michael Hough's City Form and Natural Process.[150] Throughout the 1990s, different attempts to build cities in more ecological, green, and sustainable ways were formulated.[151]

Landscape Urbanism

Starting in the late 1990s, based on a thorough investigation of the meaning of landscape, a group of architects and landscape architects, mainly from the U.S., advocated for a "recovering of landscape." They promoted landscape as a productive medium for the revitalization and development of cities, particularly in the context of post-industrial decentralization and the restructuring of a globalized market economy.[152] These shifts in the socio-economic organization transformed cities as many industrial and logistic sites were abandoned and left as large, contaminated sites and inner-city brownfields. In the late twentieth century, this offered opportunities for cities to be restructured, rethought, and redesigned. Landscape urbanism promoted designed landscape systems to re-

147 Anne Whiston Spirn, "Ecological Urbanism: A Framework for the Design of Resilient Cities," in *The Ecological Design and Planning Reader*, ed. Forster O. Ndubisi (Washington, DC: Island Press/Center for Resource Economics, 2014), 558–59.

148 Spirn, "Ian McHarg, Landscape Architecture, and Environmentalism: Ideas and Methods in Context," 102.

149 Ibid., 110.

150 Anne W. Spirn, *The Granite Garden: Urban Nature and Human Design* (New York: Basic Books, 1985); Michael Hough, *City Form and Natural Process: Towards a New Urban Vernacular*, (New York: Van Nostrand Reinhold Company, 1984).

151 See, for instance, John Tillman Lyle, *Regenerative Design for Sustainable Development*, (New York, NY: Wiley, 1994); Frederick R. Steiner, *The Living Landscape: An Ecological Approach to Landscape Planning*, (Washington, DC: Island Press, 2008[1990]).

152 Charles Waldheim traces the beginning of landscape urbanism to postmodern critiques of modernist architecture and planning, reacting to economic shifts from an industrial, Fordist economy to a diversification of consumer markets. Starting in the 1960s, these socio-economic shifts had slowly begun to dramatically transform the characteristics of urban centers in the U.S. and Europe with complex conditions that urban design and architecture failed to respond to effectively. Charles Waldheim, *Landscape as Urbanism: A General Theory* (Princeton, NJ; Oxford: Princeton University Press, 2016), 13–19.

vitalize such conditions of urban restructuring and spatial decentralization.[153]

While landscape urbanism and environmental planning share the same roots in the tradition of scientific and systematic McHargian analysis, the outcome in landscape urbanism is a cultural product that evolves from urban and architecture theory, operates at the scale of an architectural intervention, and is the result of urban restructuring. As Waldheim describes, McHarg's approach came to be perceived as anti-urban, depended on a robust welfare state, and thus reached a dead end under political shifts and new planning mechanisms favoring a neoliberal, post-industrial, globalized economy. Landscape urbanism was, therefore, intended to respond to positivist, rational environmental planning approaches of the 1960s and '70s and as a reaction to a changing political climate.[154]

Landscape urbanism established new sets of drawings and diagrammatic representations of ecological processes and interrelationships. These new visual expressions articulated landscape as a large-scale, dynamic, and performative medium that can be translated into spatial concepts to design and develop urban form, reacting to a broad context of socio-environmental complexities. This new landscape reading and thinking was informed by concepts from ecology, as well as urban, architecture, and landscape theory. Landscape urbanism as a design culture added nuance to landscape architecture and planning fields and caught the attention of other design disciplines.

Urban ecology also began in the 1990s but is rooted in a more traditional idea of ecology, evolving from science-based research and operating at larger scales in metropolitan regions.[155] In the 2000s, ecology continued to be promoted as a concept for the design of cities, further blurring disciplinary boundaries[156] and shifting towards a cultural term integrated into people's daily lives and across design practices.[157]

***

153 The concept of landscape urbanism was developed and documented through several publications and iconic projects from competitions for large-scale brownfield sites in urban agglomerations. See, for instance, Corner, *Recovering Landscape*; Julia Czerniak, ed., *Case: Downsview Park Toronto* (Munich: Prestel, 2001); Charles Waldheim, ed., *The Landscape Urbanism Reader*, (New York: Princeton Architectural Press, 2006).

154 Waldheim, *Landscape as Urbanism*, 50–53.

155 Frederick Steiner, "Landscape Ecological Urbanism: Origins and Trajectories" 100, no. 4 (2011): 333–37.

156 Steiner and Palazzo promoted urban ecology to be included as a basic component of urban design. Danilo Palazzo, *Urban Ecological Design: A Process for Regenerative Places*, (Washington, DC: Island Press, 2011). Urban Ecological Design was coined as one in a series of new frameworks for urbanism in the early 2000s, questioning the distinction between the disciplines of landscape architecture and urban design, which both claim to work at the interface of architecture and urban planning, are both concerned with the shaping of space between buildings, and both aim to guide the development of the city.

157 Mohsen Mostafavi and Gareth Doherty, eds., *Ecological Urbanism* (Zurich: Lars Muller Publishers, 2010).

Whether these approaches in the urban realm were called landscape urbanism, ecological urbanism, or urban ecological design, they share the goal of working with the biophysical and sensitive qualities of non-human life—plants, soil, water, animals, microbes, sunlight, rain, wind, color, smell—to craft landscape systems that inform the way the built environment is organized. The Landscape Approach rejects an urban-rural divide and proposes continually working across territorial scales where all spatial typologies are integrated. Concepts that specifically focus on cities are thus equally relevant as those that tend to focus on rural environments in remote locations. The ultimate goal is to find solutions that translate a broad context comprising complex socio-environmental issues into landscape systems that integrate spatial interventions in specific locations.

Landscape Infrastructure

In a world where urbanization is "the predominant process in contemporary spatial culture,"[158] spatial decentralization, materials of extraction, energy, consumption, disposal, contaminated sites, and resources all proliferate across the globe. In such a context, ecology as an intellectual framework continues to be reinterpreted. In contrast to the strong legacy of technocratic urban planning and civil engineering that dominated the built environment in the twentieth century and produced rigid and standardized forms, landscape was coined as a medium to find adaptive, flexible solutions in the form of productive systems. It was promoted to revitalize and sustain urban, socio-economic life, not as hard and grey infrastructure made of steel and concrete in the form of aging pipes, dams, tunnels, and bridges, but as expansive fields of resources, agents, and services, that are effectively coupling technological and biophysical processes.[159] This concept of landscape infrastructure suggests finding solutions that integrate "deterritorialized" landscapes as well, which lie far "beyond the footprints and grey zones of cities, across different regions and extents, reaching different altitudes and extents."[160]

---

158 Pierre Bélanger, *Landscape as Infrastructure: A Base Primer* (Abingdon, Oxon.; New York, NY: Routledge, 2016), 18.

159 Pierre Bélanger, "Landscape As Infrastructure," *Landscape Journal* 28, no. 1 (January 1, 2009): 79–95; Bélanger, *Landscape as Infrastructure*, 28–77. "Urban" in this context is understood as a ubiquitous condition being part of processes of Lefebvrian planetary urbanization.

160 Bélanger, *Landscape as Infrastructure*, 45. Pierre Bélanger discusses an alternative understanding of infrastructures as "a sophisticated operating system for urban regions where the complex agency of living systems and dynamic processes can be deployed through long-range, large-scale strategies." It suggests prioritizing long-term resource management over short-term mobilization of capital and the "commonwealth of public systems over the uncoordinated guise of self-interests." It should operate across scales and multiple timespans and consider common ecological and economic objectives developed by flexible public-private practices instead of specialized siloes. Bélanger, *Landscape as Infrastructure* 149; 152. In this book, Bélanger discusses this concept in the context of processes of urbanization that reach across regions across jurisdictional boundaries, including flows and networks of water, waste, food, mobility, and

***

Nature-based solutions, ecological, and blue-green infrastructures aim to build "soft" and cost-efficient infrastructures in the urban context. They expand landscape networks to the scale of the urban region, integrate biotic resources as active agents, connect hydrological functions with vegetation systems, and create ecologies that can serve as adaptable and resilient structures. They address urban ills such as flooding, heat, contamination, water, and air pollution while increasing biodiversity and providing socio-economic benefits.[161]

Site, Locality, and Place: Deep Structure and the Inner Logic of Lived Landscapes

Each place holds a deeply rooted, local wisdom generated over long periods. First, through biotic and abiotic processes of non-human nature, and second, through the human inhabitants and users of that place, their spatial practices, technologies, and techniques of belaboring, shaping, and working with the land, as well as through their knowledge, stories, and cultural customs. One key argument of this thesis is that a spatial design intervention in an individual place is most meaningful for human and non-human users if grounded in the inner logic of its broad geographic context. Landscape thinking allows to read a place as a collectively produced cultural formation and to work across scales, connecting that locally specific socio-environmental formation to its broad regional or even planetary context.

Anne Whiston Spirn describes how the visible forms of landscapes are the sum of all the social and environmental processes that have continually formed them "in response to natural processes and changing human purposes." However, Spirn states, there is "a more enduring structure […] to which all organisms within that landscape respond. Deep structure expresses a particular place's fundamental climatic, geomorphic, and biotic processes. Deep structure is the product of these processes operating and interacting across vast scales of time at the scale of large regions and at the microscale." The deep structure is formed by geological and climatic factors which "yield landscape structure with distinctive spatial, physical, and temporal characteristics," expressed physiographically through patterns of landforms, the course of waterbodies, trough

energy, remote sites of contamination, and informal markets.

161 Many books presenting best practices around these terms have been published, as well as many successful precedents of built projects across the world. Chinese landscape architect Kongjian Yu helped to establish a design culture, planning frameworks, and the implementation of legal policies at the highest government level in China. See the article "Ecological Infrastructure as a Systematic Approach to Water Issues," which summarizes the establishment of the "Sponge City" concept in China and presents a regional planning framework and its implementation through built projects in the case of Guangzhou. Hexing Chang and Dong Wang, "Ecological Infrastructure as a Systematic Approach to Water Issues," in *Landscape Approach: From Local Communities to Territorial Systems*, ed. Hannes Zander et al. (Applied Research & Design, 2022), 67–77.

people, plants and other species, and the communities they create.[162]

Spirn's concept of deep structure provides a way to distinguish between landscape structures formed over very long timescales from those in which change is manifested over a much shorter time span. The concept of deep structure focuses on "the fundamental underlying ecological and geological phenomena that ultimately control the dynamic surface activity." Although the deep structure may sometimes be less visible than the physical patterns of human action on the surface of a landscape, it "forms the larger context—both physical and temporal—within which surface structure evolves" and, ultimately, "the foundation for human life and action."[163]

That deep structure persists and "remains crucial for the history and future of a place." It gives reason to a locality and explains why it was inhabited, cultivated, and developed in a certain way. Therefore, Spirn describes how it is crucial to design with sensitivity for this underlying inner logic of a place and region. Designing "in agreement with the deep structure of a region, rather than counter to it, is essential to fostering resilient […] form."[164] Investigating and understanding a place's inner logic or deep structure is essential before investments are made for a spatial intervention in a place. Spirn warns us that "[d]eep structure can be masked, but it cannot be erased. When surface structure obscures or opposes deep structure, it will require additional energy, materials, and information to sustain. […] If these resources cease to be applied, the deep structure will reassert itself."[165] This fundamental understanding of the inner logic of a regional ecosystem and what it means if humans work against it over long periods will be demonstrated in chapter two, describing the inner ecological logic of the Hexi Corridor at a watershed scale. In the fifth chapter, the case of Lanzhou New Area provides an exceptionally stark example of a systematic neglect of and work against a region's "deep structure."

John T. Lyle coined "human ecosystems" as intentionally designed ecologies that "include as subjects of design not only the visible form of the landscape but its inner workings, the systems that motivate and maintain it." He argues that by learning from the self-organizing capabilities of non-human ecosystems and drawing upon the principles by which they work, humans can craft "rich, diverse, productive landscapes that will serve the purposes of both people and nature."[166] Lyle describes an inner "ecosystematic order [that] lies within and informs the landscape we see." And this order scales up "to the regional

162 Anne Whiston Spirn, "Deep Structure: On Process, Form, and Design in the Urban Landscape," ed. T.M. Kristensen et al. (City and Nature: Changing Relations in Time and Space, Odense (Denmark): Humanistisk Forskningsraad, 1993), 9–16.

163 Spirn, "Deep Structure," 10.

164 Spirn, "Ecological Urbanism: A Framework for the Design of Resilient Cities," 564.

165 Spirn, "Deep Structure," 10.

166 John Tillman Lyle, *Design for Human Ecosystems: Landscape, Land Use, and Natural Resources* (Washington, D.C: Island Press, 1985), 1–16.

and eventually global scale. If we can observe that order at every scale and work with it, we can hope to bring our perceptions into congruence with nature's order."[167] Lyle uses a similar terminology as Spirn when he describes that a designed human ecosystem that embodies this inner, ecological logic "has deep form because underlying its surface and giving it deeper substance is this cohesive fundamental order." This deep form is "shaped by the interactions of inner ecological process and human vision, which can make the underlying order visible and meaningful in human terms." And he says that such deep form "stands in contrast to shallow form, which has only the surface perceptual order and lacks the solidity of coherent process beneath the surface."[168]

Aesthetics matter, not just at the human scale of carefully designed operations and tangible materiality but also at the larger scale of an operational landscape system. Crafted landscapes are visual expressions of complex socio-environmental entanglements that reach from the sub-microscopic scale of individual organisms to the human scale of the ordinary, daily life, from the local to the regional, and often beyond, to the continental and global scale. A designed landscape formation can mediate such complex processes, making them visible and perceptible. Landscapes can thus bring a society into a shared experience of human-environmental interdependence. Thereby, different aesthetic expressions have different meanings for this shared visual experience and identity. Gobster et al. call the direct landscape experience the "human perceptible realm." They argue that the aesthetics of designed ecologies at the landscape scale—whether designed intentionally or not—are crucial for people to develop shared values and a sense of care.[169]

Spirn and Lyle emphasize in their writing what this holistic ecosystem thinking means for the design and specific outcome, the deeper form of a site.[170] Kongjian Yu has referred to both these references of "deep structure" and "deep form" by Spirn and Lyle to develop his own design approach, informed by peasants who have learned to work effectively with the cycles of extra-human nature by using simple but highly effective technologies to overcome environmental extremes such as drought, flooding, or soil erosion. In long processes of trial and error, peasants have developed efficient and productive landscape typologies. Yu calls this creation of sustainable life forms, producing

167 John Tillman Lyle, "Can Floating Seeds Make Deep Forms?," *Landscape Journal* 10, no. 1 (1991): 39. For a description of the different levels of ecosystematic order, see Lyle, *Design for Human Ecosystems*, 194–263.

168 Lyle, "Can Floating Seeds Make Deep Forms?," 39–40.

169 Paul H. Gobster et al., "The Shared Landscape: What Does Aesthetics Have to Do with Ecology?," *Landscape Ecology* 22, no. 7 (August 1, 2007): 959–72.

170 Spirn and Lyle both follow the strong legacy of regional planners like Geddes and McHarg. However, in addition to integrating ecological science in their work at the macro scale, they integrate ecological thinking in new design approaches to intervene at the micro-scale to create places that—as Lyle says— "serve the purposes of both people and nature." Lyle, "Can Floating Seeds Make Deep Forms?," 39.

spatial formations that are both productive and beautiful, and are developed through environmental constraints, the "art of survival." In the contemporary context of urbanization and environmental degradation, where collective survival has again become vital, he argues for a "negative approach" in planning that respects and protects vital environmental ecosystems.[171]

***

While this thesis does not discuss the actual design of spatial interventions, it aligns with the above landscape approaches concerned with the individual site. It equally argues for learning from a place's deep and broad context and its users. It promotes simultaneous work across scales, studying the inner logic of a region and the specific local wisdom of a site to eventually find more socially and environmentally just and sustainable design solutions. It is the medium of landscape, its multi-scalar, multi-temporal, and multi-disciplinary characteristics, that serves as the productive framework to cultivate the sensitivity to holistically approach and eventually intervene in individual places.

1.6 Framing a Landscape Approach in the Age of the Anthropocene

The Anthropocene has been introduced in the introductory chapter as a productive context for framing the Landscape Approach. The Anthropocene forces us to question our relationship to extra-human nature. It makes us realize that human activities have significantly altered the vast majority of the terrestrial biosphere, entails an Earth System of growing instability and uncertainty, and is radically interdisciplinary as it affects humanity as a whole. The Landscape Approach argues that in the complex and multidimensional context of the Anthropocene, landscape as an idea, as a culture of thinking, and as a medium of anticipatory design finds itself in an opportune position.

As framed in this chapter, landscape sits at the productive intersection between arts and sciences. Landscape is the physical medium and the spatial entity through which socio-environmental relationships are expressed and become tangible. And landscape as a design practice is based on a strong legacy and rich record of design and planning disciplines that offer models for the anticipatory design of such socio-environmental ecosystems.

Approach, the term's second word, suggests a movement in a certain direction, yet without necessarily getting there. Approach means to take a broad and

171 Kongjian Yu and Mary Padua, eds., *The Art of Survival: Recovering Landscape Architecture* (Victoria, Australia: Images Publishing Group Pty Ltd, 2006). Informed by the "art of survival," environmental constraints, and limitations, Yu defined a "peasant's approach." Kongjian Yu, "Creating Deep Forms in Urban Nature: The Peasant's Approach to Urban Design," in *Nature and Cities: The Ecological Imperative in Urban Design and Planning*, ed. Frederick R. Steiner, George F. Thompson, and Armando Carbonell (Cambridge, Massachusetts: Lincoln Institute of Land Policy, 2016), 95–117.

holistic view from a certain starting point and then consider multiple alternative pathways to achieve desired goals, taking different interests and land uses into account, as well as different spatial and temporal scales of multidisciplinary action.[172] Landscape serves as the common ground through which this multidimensional negotiation can happen. The conception of landscape facilitates, frames, and moderates these processes over space and time. In this sense, approach means that the different pathways are the goal rather than one specific endpoint. Along the way, multiple forms of collaborative action can unfold.

The Landscape Approach is intended to strategically address pressing environmental and socio-economic issues the world is facing in the age of the Anthropocene. In a disciplinary discourse, it argues that landscape has to be thought and practiced in scalar, disciplinary, and thematic contexts that lie far outside the traditional scope of landscape practices. Such ambitious claims have to be addressed through new models of practice, with new interdisciplinary configurations, and including new sets of questions.

In the following, the Landscape Approach is framed across seven propositions based on the extensive literature review in this chapter:

1. See the World as a Web of Socio-Environmental Entanglements

One fundamental cause of environmental challenges linked to the human-induced degradation of natural resources is a worldview that sees humans as separate from extra-human nature. As modern societies have developed, particularly at an accelerated pace since the mid-twentieth century, progress happened through exploitative regimes of extractive industrialization and sprawling urbanization that are seemingly able to completely ignore and decouple from the underlying hydrological flows, the topography, and the natural forces that have been shaping the environment for eons. With the increasing intensity of humans' impact on the Earth System, we began to realize the limitations of such regimes. Today, we must recognize that these enormous waves of modern industrial development have not just created places and conditions that are inhospitable for many non-human species but, in many cases, also no longer livable for people.

The Landscape Approach is based on a worldview that sees people as deeply entangled with and dependent on non-human life. It follows the notion of the world as a web of life co-produced through processes of environment-making over long periods by humans and non-humans alike. If we are able to develop a holistic understanding of socio-environmental problems, the Landscape Approach also suggests establishing such an understanding to anticipate socio-environmental solutions.

172 For a similar description of the term 'approach,' see Minang et al., *Climate-Smart Landscapes: Multifunctionality in Practice*, 5–13.

Seeing the world as a web of socio-environmental entanglements is productive in three ways: First, it allows to read and understand a geographic context—whether it is an entire region, a landscape entity, or an individual site—in a holistic and non-anthropocentric way as part of a multidimensional web of life. Second, the Landscape Approach aims to analytically unravel such complex entanglements. At the same time, it seeks to strategically weave assemblages of humans and non-humans, society, and extra-human nature together into dynamic and performative configurations through spatial planning and design. And third, such a holistic reading can avoid traditional forms of nature preservation that view nature as something external that needs to be protected and where humans have to be kept out. Instead, the Landscape Approach aims to inform and lead to productive entanglements where humans and the extra-human environment thrive and mutually benefit.

2. Embrace Complexity: Think Through Multidimensional Systems Instead of Linear Processes

The growth of capitalist accumulation, the division of labor, industrial processes of production, standardized networks of trade, and global institutional organization led to forms of economic and disciplinary specialization. A culture in favor of specialists generally has an aversion to generalist approaches. It tends to request clear and measurable data outputs that are quantitatively predictable by simulation models, following scientific methods of basic, universal laws. However, in the age of the Anthropocene, we operate in an increasingly complex environment and need to tackle issues that are ill-defined, interconnected, multi-dimensional, messy, and massive in spatial and temporal scales, creating "wicked" problems.[173] Such a context requires new frameworks that do not solely operate in constellations with a clear client and task, a clear set of problems, and according to models of efficient project management following linear, scientific models of problem-solving. Particularly in geographic contexts that are informally organized, that don't follow traditional planning schemes, but are often in urgent need of sensitive design solutions, it is essential to work along frameworks that allow for flexibility, that can adapt to changing circumstances, and don't pursue solutions with a single goal or predefined outcome.

Scientific methods tend to create abstract conditions of consistent reproducibility that simplify processes to the point where they become controllable and predictable. This abstraction of the context aims for an efficient solving of the defined problem. Instead, the Landscape Approach suggests to embrace complexity[174] and to rethink existing models of how social, economic, and po-

173 Horst W. J. Rittel and Melvin M. Webber, "Dilemmas in a General Theory of Planning," *Policy Sciences* 4, no. 2 (June 1, 1973): 155–69; Peter J. Balint et al., *Wicked Environmental Problems: Managing Uncertainty and Conflict* (Washington, DC: Island Press, 2011).

174 This idea of embracing instead of shying away from complexities is also the title of a previously cited article by Kay and Schneider promoting a holistic ecosystem approach. Kay and

litical systems are organized. Of course, it doesn't neglect science and technology's qualities and enormous achievements. However, it aims to provide holistic perspectives that expand specialized expertise, technology, and practices to broader disciplinary concerns, scales, and timeframes.

As discussed in the sixth chapter and the case of afforestation initiatives along the Hexi Corridor, specialists may be well equipped to understand a site-specific condition: A soil scientist may know the soil's specific type, pH value, and potential desertification processes; a botanist may know which plants grow best under these conditions, provide the best services for soil stabilization, and perform with the most efficient water regime. However, all such conditions never happen in an isolated manner. Instead, there are humans involved, political interests, power structures, and complex socio-environmental relationships. Every place results from a long history of human-environmental co-production, patterns of habitation, and cultivation. Each place is connected to large-scale environmental, social, political, and economic processes involving different actors, individuals, and agents. Every situation is thus, from an ecological point of view, inherently dynamic and, to a certain degree, unstable and unpredictable. The Landscape Approach believes in the role of generalists in complex environments, promoting collaboration across disciplinary boundaries, seeking holistic perspectives, and context-specific concepts that operate across different spatial and temporal scales.

3. Recognize Limitations of Spatial Classifications and Typologies

In the dynamic Earth System of the Anthropocene under a dominating regime of planetary urbanization, the classification of places into general typologies, such as "urban," "rural," or "wilderness," are no longer productive. They suggest an order of the Earth that divides geographic space into firm conditions that follow dualist readings. Yet, our time's spatial, biophysical, and socio-political realities have become much more diffuse than what such simplified classifications convey. New models and theories are required to describe these realities—particularly of the 'non-city.' "Urban" agglomerations need to be conceptually connected to larger-scale processes of territorial and, ultimately, global reorganization. "Rural" landscapes need to be connected to territorial systems that are integral parts of a worldwide urban fabric, including the ruins of degraded landscapes it produces, which are, in many cases, contaminated and socio-politically contested. Environmental protection should not exclusively focus on keeping seemingly untouched "wilderness" free from human interference but protect, restore, and maintain ecosystems wherever they are most valuable. The Landscape Approach proposes to ignore any restricting, dualist models of spatial order such as urban, rural, or the many terms that try to de-

Schneider, "Embracing Complexity: The Challenge of the Ecosystem Approach."

scribe the in-between. It aims to work across such boundaries and steer holistic strategies that can facilitate healthy and productive habitats, informed by the scale of watersheds.

4. Work Across Scales: Follow the Specificity of Individual Places and the Logic of Territorial Systems

Landscape operates across scales, connecting an individual microorganism, species, or site to ever-larger interconnected systems. Landscapes, as socio-environmental artifacts that are constantly produced and re-produced over time, add up to territorial systems. In a globalized world economy, these territorial systems are connected to national, continental, and even planetary forces and interdependencies. Ecological theory allows to understand these multi-scalar configurations as open systems that are, to a certain degree, unstable and unpredictable, dynamically adapting to short-term disruptions and long-term transformations.

The Landscape Approach proposes to use landscape's qualities of trans-scalar and socio-environmental connectivity as an analytical lens to identify different hierarchies, typologies, and entities as part of comprehensive systems. Holistic landscape thinking is simultaneously context-specific and longitudinal over scales, incorporating multiple spatial and temporal dynamics. This can reveal the inner logic of a geographic entity, offering a framework to steer and coordinate development in individual places, communities, and habitats while, at the same time, grounding them in the ecological context they are connected to. This context is informed simultaneously by social, political, and economic in addition to environmental systems and interrelationships.

While tackling local challenges, the Landscape Approach aims to respond to large-scale, regional, and even planetary forces of transformation. Changing climates, for instance, play out at the scale of world regions, yet they impact and are experienced in individual places of everyday life. A multi-dimensional approach that simultaneously intervenes in different locations helps to react to failure and learn from success. Instead of a presumably ideal scenario of an isolated intervention, the Landscape Approach aims to provide a comprehensive, guiding framework as a collective way of thinking to coordinate different, site-specific strategies, allowing for a series of multiple projects at different scales to be implemented simultaneously. Instead of pursuing rigid plans to control an entire region and achieve a predefined outcome, the Landscape Approach promotes long-term engagement to incrementally develop large-scale visions.

5. Use the Medium of Landscape as a Strategic and Anticipatory Design Agency

The Landscape Approach aims to help translate the understanding of a place's entanglement with broad socio-environmental systems into spatial interven-

tions. It suggests using theories from ecological science and practices from design and planning to strategically couple social and environmental systems. This coupling is a creative act of design that creates a spatial expression with sensitivity for the specific place. Landscape thus becomes an agency to envision potential futures and spatially organize different biotic and abiotic systems as an active shaper of space. The Landscape Approach looks at a geographic context "from afar" as well as back in time. In addition, it anticipates dynamic transformation processes in specific locations, preparing the ground for future growth and development. The Landscape Approach is positive in nature. It wants to heal, restore, and protect; prepare, guide, and improve. Visualizing such potential futures is crucial to give form to an overall system and individual sites within, to create visions, and to communicate them to different stakeholders. While the regional or even planetary context is necessary to understand the complexities and develop a sensitivity for the individual place, it is the "middle ground" at the scale of the cultural landscape formation where the landscape agency becomes specific, is physically manifested, and where spatial interventions are realized.

6. Facilitate a Common Ground for Mutual Collaboration as Well as Individual, Activist Intervention

The Landscape Approach aims to lead to desired solutions that are socially and environmentally just and sustainable. However, complex geographies are highly dynamic and entail a certain degree of unpredictability. Multiple potential outcomes also mean multiple potential paths to getting there, determined by various competing actors. The planning and designing of spatial interventions at a landscape scale is never a zero-sum game. It requires negotiation among different stakeholders, representing the interests of all actors—humans and non-humans alike.

The Landscape Approach facilitates a broad and inclusive dialogue among different actors. Landscape can thereby serve as a common ground to bring actors with different interests and sets of expertise together, both as a spatial vision and guiding framework, as well as a culture of thinking. As a guiding framework, it can visualize competing demands, develop different scenarios, and provide a forum to negotiate over spatial concepts. As a culture of thinking, it can act as a mediator for various professionals, facilitating a discourse where farsighted negotiation can happen and help to find widely accepted solutions.[175]

175 These ideas have been tested through the independent think-tank International Landscape Collaborative (ILC), which aims to provide a platform for professionals working with and through landscape. Based on the Landscape Approach as a guiding principle, the group seeks to broaden the scope of landscape to engage with other disciplines. The ILC began to contextualize this approach through case studies of projects in diverse geographic and cultural contexts, deepening the understanding of landscapes and the diverse cultures that co-produce and depend on them, particularly in contexts where planned infrastructural systems are not

In increasingly complex socio-environmental constellations, new models of practice are required with new sets of professional alliances. The Landscape Approach suggests integrating local communities while expanding the disciplinary scope to governance and policy. New forms of collaboration require active engagement, seeking opportunities that are usually not commissioned by one specific client or municipality.[176]

7. Find Effective Solutions that Benefit Both Human Societies and Extra-Human Nature

The Landscape Approach is led by a strong belief in extra-human nature and its astonishing ability to replenish natural resources and restore ecosystems that can be highly productive for humans. The Landscape Approach promotes dynamic, diverse, rich, and robust forms of life that take advantage of the highly effective attributes of non-human agents. It suggests strategically weaving social and environmental processes together into large-scale systems that work in favor of both human societies and extra-human nature. In this endeavor, there is often no need to develop costly and material-intensive technologies. Instead, nature-based solutions that respect and work in close collaboration with the extra-human environment are often fairly simple and highly effective: They work with land, water, soil, vegetation, and multi-species systems. Even some highly degraded ecosystems can be astonishingly fast and effective in recovering themselves.

The Landscape Approach aims to provide a theoretical framework and establish a culture of thought that can add to the successful practices of integrative land management and resource conservation. Landscape can productively connect ecosystems across scales and envision future development. This can offer pathways to identify areas to be protected from human interventions

---

yet codified or consolidated. The parallel reading of landscape issues across different world geographies allows to reveal similarities but also distinct differences between various cultural contexts, nurturing cross-cultural exchange of ideas. The ILC aims to give a voice to marginalized groups, such as Indigenous communities, that would otherwise go unnoticed. See Zander et al., *Landscape Approach*; Sciaraffia et al., *From the South*.

176 Kate Orff has demonstrated such active engagements with different sites and communities through her work. She calls for designers to become activist leaders that "expand a traditional service-based discipline by bridging the physical and the social." She suggests that tangible, accessible projects can effectively serve as a platform to engage with collaborators and local citizens as stewards of current and future landscapes. Instead of tackling the complex and overwhelmingly large socio-political context, she promotes landscape as a "visible and manageable record of actions from which we can both scale up to the level of city and regional policy, or down to the level of the organism." Fostering education and stewardship allows to tie together large-scale infrastructural interventions with multiple small actions by community members. Dispersed but coordinated, such local and community-based actions can be a source of positivist hope in a complex and often grim socio-political environment. Kate Orff, *Toward an Urban Ecology* (New York, New York: The Monacelli Press, 2016), 14. See particularly chapters "Introduction" (p.7–16), and "Engage" (141–148).

and places that can be used more effectively. To effectively tackle global environmental issues, the Landscape Approach suggests expanding the scope of working with socio-environmental systems to the scale of watersheds and even entire world regions.

1.7 The Landscape Approach as Research Framework

The Landscape Approach builds upon existing literature and methodologies. It is, therefore, nothing radically new. Also, it does not propose one singular method to be applied in different contexts. Instead, it synthesizes theories and practices from successful alternative landscape approaches into a new theoretical reading in the context of global, interdependent issues of environmental degradation and social inequalities. The Landscape Approach as a culture of thinking informed the reading of the Hexi Corridor case study and provided a mode of working across time and space that guided my research throughout the project.

A Culture of Thinking

The Landscape Approach provides a holistic framework that operates across multiple spatial and temporal scales as well as different disciplinary dimensions. It offers a culture of thinking to understand individual sites as integral parts of a broader geographic context co-produced by social and environmental actors and processes. This thinking steers the work of muddling through a thick reading of that socio-environmental context, leading to a comprehensive understanding of its conflicts and challenges, which the Landscape Approach ultimately aims to tackle. The framework consists of four main dimensions: the operational landscape, the individual site, the territorial system, and the planetary context. [Fig. 1.7]

Operational Landscape

Landscape, as a culturally produced, physical artifact, serves as the middleground where invisible social and environmental forces overlap and intertwine. It is in this middle ground where they become visible as socio-environmental entanglements that are physically expressed through the land, the built environment, and its users. This physical landscape formation results from interdependent—and often conflictive—human (social) and extra-human (environmental) processes. It is referred to as operational landscape because it is an explicitly cultural formation, a physically and mentally constructed system with a collective, cultural meaning that provides certain functions and services for a society.

Individual Site

The operational landscape contains individual sites that generate the larger unit's distinct character. At the scale of the individual site, design becomes operational. Design is here understood as both activity and spatial product: It is the conscious and creative act of shaping space by coupling social and environmental processes to provide a specific function for a particular group of users in one specific place. This activity leads to a spatial, physical outcome with a distinct aesthetic expression. It includes different compositions of materials, technologies, people, and non-human species as active, interacting agents.

Territorial System

An operational landscape is part of a larger territorial system. The extent of a territorial system is defined, on the one hand, by the underlying structure of environmental systems and processes. This includes the geomorphological formation defining geographic units such as a watershed, a valley, or a river delta; the type of rock and soil that allow for a certain kind of habitation, flora, and fauna; as well as natural ecosystems such as waterbodies. On the other hand, the territorial system is defined by its socio-political organization, demarcated through jurisdictional boundaries and cultural practices. It is manifested through infrastructures that connect individual sites and operational landscapes across a territory, such as roads and railways. These social formations either strengthen or, in many cases, neglect the underlying environmental structure and superimpose a socially constructed regime that is driven by geopolitical and economic interests, forces of resource extraction, production, and capital accumulation. The territorial system includes both the human and extra-human realms, plus the constructed socio-environmental systems where the two intersect. Territorial systems are the domain of planning, meaning the organization and coordination of different stakeholders and processes rather than the design of individual places. The territorial system is connected to the larger context of inter-regional, national, or even planetary processes.

Planetary Context

The planetary context is the entire whole that Lovelock and Margulis would call *Gaia*. It is the overarching realm of which everything else is part of, which often seems far detached and forgotten but which increasingly often creeps into our awareness when exceptional, sudden disruptions or systemic consequences of global environmental crises become noticeable. Humanity and all other life forms depend on environmental systems, resources, and processes that are interconnected in a web that reaches far beyond the scale we usually relate to and seem to be directly affected by. Ultimately, it consists of all different spheres of the world, including climatic, biological, oceanic, and tectonic forces. These global environmental systems are coupled with social systems. In many cases, they are abstract, such as political or economic institutions, ac-

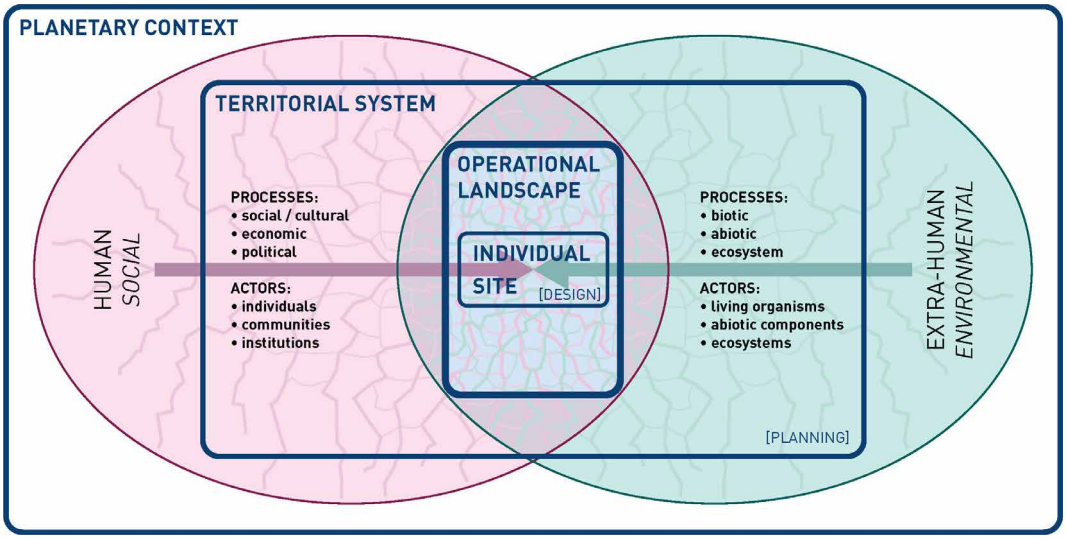


Fig. 1.7: The Landscape Approach as a conceptual framework for modes of working across multiple scales and socio-environmental systems.

tors, and boundaries through which they are regulated. However, they also include physical formations such as planetary shipping routes across land and sea, intercontinental pipelines and submarine cables, and even extraterrestrial satellites. Through these socially constructed systems, essentially every individual and every site is connected to forces and interdependencies of a much larger extent, which, in some cases, reach all the way up to planetary scales.

A Mode of Working

The Landscape Approach suggests working through these four dimensions, whereas the operational landscape serves as the common ground of multi-disciplinary dialogue, negotiation, and intervention.

Starting from the Individual Place

J.B. Jackson wrote that every landscape contains elements that we are unable to explain. However, every landscape, "no matter how exotic, also contains elements which we at once recognize and understand."[177] The trained eye can, therefore, read and understand a lot of information about—or rather through—a landscape by being in a place, observing the constructed system and processes, and identifying specific patterns. Why does a place appear in a certain way? What has led to its unique spatial formation? What are the invisible forces that have shaped the land and built environment in a specific locality? Starting from the phenomenological experience of the particular, tactile, and physically

177 Jackson, *Discovering the Vernacular Landscape*, 11.

constructed place, different socio-environmental layers can begin to be traced and unraveled.

Reading an Operational Landscape Formation

'These social and environmental layers, physically manifested in an individual place, are woven together, creating larger landscape formations. Understood as "synthetic space" that has been collectively created as an operational landscape to serve a community, the landscape formation serves as a medium that can be systematically read to understand how it operates, how it is controlled, maintained, and regulated, and how it is affected by external forces. For example, in the case of an agricultural landscape in the arid Hexi Corridor, this reading would identify peasant collectives, their settlements and living conditions, the farming regime and technology they use to cultivate the land, the products they grow, how they are harvested, processed, and sold, the political organization of the community, regulations of access to land and water, economic benefits and constraints, socio-economic challenges, issues of education and health. In addition, environmental systems would be examined, such as the quality and availability of water resources, soil conditions, ecosystem health and performance, and challenges such as droughts, desertification, salinization, and erosion. Such a comprehensive reading of a large operational landscape formation, including individual people, society, and the extra-human environment, allows to identify systemic problems, conflicts, and challenges resulting from socio-environmental entanglements. To a certain extent, and despite a holistic attitude that aims to consider social, political, economic, and environmental aspects alike, a landscape reading remains inevitably subjective as every observer sees a landscape through different eyes, identifies a different meaning, led by one's own values and interpretation, giving agency to the individual but calling for interdisciplinary collaboration.[178]

Expanding to the Territorial Context

From the socio-environmental system of a landscape formation, the scope is extended to the scale of a territorial context. In parallel to the study of secondary literature about the socio-political organization across different thematic, spatial, and temporal scales, as well as the cartographic mapping of how the territory is spatially organized, multidimensional stories of individual sites and landscape formations allow the creation of a thick reading and broad understanding of a complex, large-scale geographic context. This territorial reading truly works across scales: from the microscopic soil condition or the individual person to a government's distant geopolitical ambitions or a world region's shifting weather patterns. This multiscalar geographic understanding reveals forces of a superordinate, socio-political regime, its territorial conception, am-

178 Meinig, "The Beholding Eye: Ten Versions of the Same Scene."

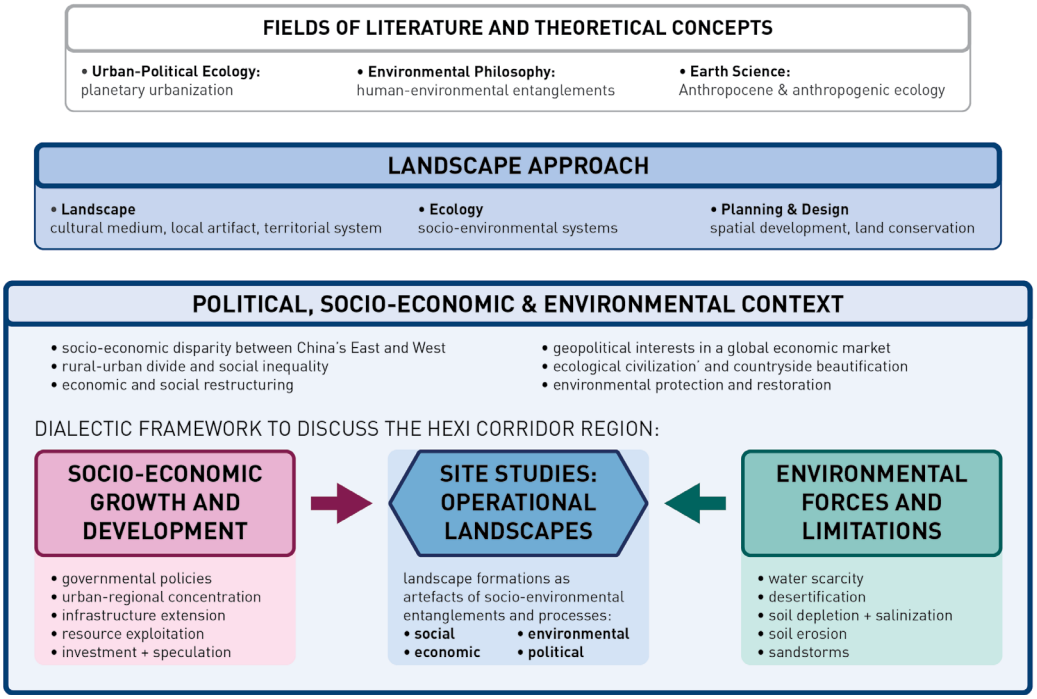


Fig. 1.8: Research structure: General concepts to position the thesis; fields of literature for developing the Landscape Approach; and a dialectic framework for discussing the Hexi Corridor case study region within China's unique socio-environmental conditions.

bitions, and strategies that operate far beyond the individual place but directly affect the land, people, and ecosystems in particular localities. The simultaneous insider and outsider perspective, which is deeply embedded in the landscape idea, concerned with specific characteristics of the individual site and the complex interrelationships of the territorial system, is a key part of the Landscape Approach.

Understanding Landscape through Dialectic Relationships

The cause of many of the problems identified at the scale of the landscape system and more comprehensively understood through a territorial study is the paradox between ambitions for socio-economic growth and development on the one hand and fundamental environmental limitations on the other. This paradox, inherent to any form of societal development, is at the core of the research framework. It frames a dialectic reading that leads through the geographic study across scales. In the context of the arid and sensitive Hexi Corridor, spatial interventions, policies, and development strategies, driven by geopolitical interests and socio-economic aspirations, are juxtaposed with the fundamental environmental limitations the region is facing. These opposing

forces are first analyzed in an isolated manner to then study how they interact and depend on each other. Politically, the culture of externalizing nature for it to be forcefully appropriated and reorganized is a recurrent theme throughout the territorial reading of the Hexi Corridor. Over time, the acceleration of destructive land use regimes, resource consumption, and pollution has led to growing environmental degradation. The method of understanding a geographic context through the dialectic reading of the reciprocal relationship between forces of social and environmental systems derives from ecological science, particularly the concepts of Social-Ecological Systems and Anthropo-ecosystems. [Fig. 1.8]

Envision Interventions at Watershed Scales

The comprehensive understanding of a broad geographic context develops a sensitivity for the operational landscape system and the specific conditions in individual places. Informed by ecological concepts, the Landscape Approach suggests translating this multidimensional understanding of complex interconnections between human and extra-human nature into anticipatory, spatial planning and design solutions. These solutions operate simultaneously on different scales, varying from short-term, small interventions, crafting individual places, to long-term strategies of large-scale land development and restoration. Given the severity of socio-environmental crises that have consequences of increasing magnitude, the Landscape Approach aims to help develop visions that are not only informed by the geographic unit of watersheds but also see it as a scale for intervention. The landscape thereby serves as the productive middleground where the different social and environmental systems can be entangled to visualize such interventions, which can then be discussed and negotiated by interdisciplinary teams of stakeholders and experts.

***

The Landscape Approach, both as a culture of thinking and as a mode of working, is applied to the Hexi Corridor in the following chapters. First, the case study region is studied at a territorial scale through a dialectic reading. In a historical narrative across different timescales, plans for socio-economic growth and development are juxtaposed with environmental forces and limitations the region is facing. At the core of this study are selected sites of operational landscape systems where all these different forces intersect in complex processes of socio-environmental co-production, creating cultural formations as the physical expression of a socio-political regime.

This multi-dimensional reading of the Hexi Corridor is informed by a political, socio-economic, and environmental narrative: Across different historical periods, it positions the case study region in northwestern China within the broader context of the nation, particularly in relation to centers of political power and ambitious plans of development, to urban regions as the main drivers of economic growth and extended urbanization, but also within the coun-

try's strong geographic disparities, facing different sets of socio-environmental challenges. The Landscape Approach informs this geographic reading of the Hexi Corridor as a theoretical framework based on a selection of multidisciplinary concepts. While the notion of envisioning potential futures is a crucial part of the Landscape Approach's ultimate ambition to inform and lead to actual spatial interventions, this thesis does not seek to demonstrate it in a geographic context.

2. Hexi Corridor

A Geographic Portrait and the Establishment of an Arid Frontier

Minqin County

Together with my driver, my guide Du Rong, and her cousin Wang Dingluyao who joined us for the day, we drove from the ancient city of Wuwei in northeastern direction down along the Shiyang River watershed. This part of Wuwei is Minqin County. Over the past decades, it has become known as one of China's most severely desertified regions and one of the main source regions of sandstorms. Only around six percent of the land across the county is suitable for agriculture. The lower reaches of the Shiyang River are surrounded on three sides by the Tengger and Badain Jaran Deserts. The Minqin oasis is, therefore, vital as it acts as a green barrier to prevent the convergence of the two deserts. Restrictions on the irrigation of land and the introduction of water-saving modes of agriculture have helped to cease desertification in past years.[1] We passed the large Hongyashan Reservoir—apparently Asia's largest desert reservoir.[2] It was built in 1965 to supply a growing population with water and enable land reclamation and farming in the region. It was extended in the past years to catch more seasonal melting water. The reservoir aims to prevent spring floods and, instead, hold back water to make it available for land cultivation in a controlled manner throughout the year.[3] [Fig. 2.1]

We continued to drive further downstream through the northern section of the oasis, where we had lunch in Minqin Town, the county seat, which was surprisingly lush with many street trees providing shade. Driving further north after lunch, the oasis became an increasingly narrow strip along the Shiyang River. In fact, since we had

1 Xiaolin Zhu et al., "Monitoring Interannual Dynamics of Desertification in Minqin County, China, Using Dense Landsat Time Series," *International Journal of Digital Earth* 13, no. 8 (August 2, 2020): 886–98.

2 Yao Lan, "Asia's Largest Desert Reservoir Hongyashan to Be Expanded," Ecns.cn (China News Service), March 4, 2016.

3 Xian Xue et al., "Policies, Land Use, and Water Resource Management in an Arid Oasis Ecosystem," *Environmental Management* 55, no. 5 (May 1, 2015): 1043.

Fig. 2.1: The Hongyashan Reservoir in Minqin County has been built to hold back the limited water sources and allow for a controlled supply of farms in the lower, exposed reaches of the Shiyang River watershed; September 2019.

passed the reservoir in the morning, the river was no longer present as an open stream but split up into many small channels, distributing water across the agricultural fields. The surrounding desert became increasingly apparent with unvegetated, degraded land and sand dunes, sometimes on both sides of the road. Road traffic, houses, population, agricultural activities, and vegetation all seemed to fade out the further down the oasis we drove. Eventually, following the moving blue dot on my phone, I navigated our driver along narrow paths across agricultural fields until we reached the very end of the oasis.

Here, the irrigated land ended abruptly, forming a hard edge and straight line. Further north, the vast sandy desert opened up with scattered, xerophytic shrubs that faded out into sand dunes of increasingly large size. Mr. Zhang, the owner of the nearby farm at the most exposed northern edge of the oasis, invited us into his house. While he served us fresh Bailan melons, he told us about his childhood memories of how he and his friends used to play in gardens and small shacks several hundred meters further north, where today only large sand dunes remain. His family had moved to Minqin County from a small town in Shaanxi around 1960, during the years of

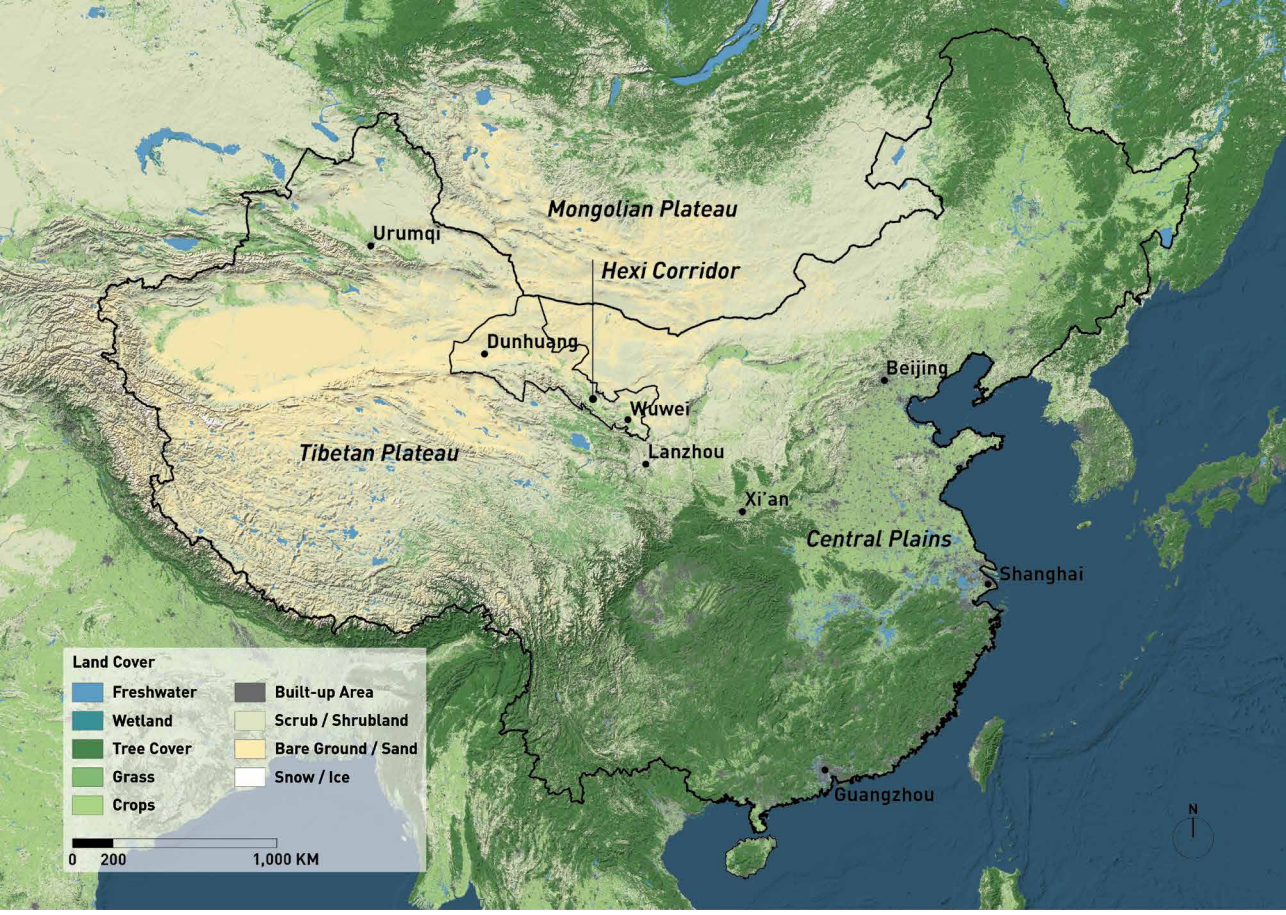


Fig. 2.2: The Hexi Corridor's location in China's interior, spanning from Wuwei to Dunhuang. The remote sensing satellite data shows the contrasting geographic conditions between the country's humid southeastern and arid northwestern half.

the Great Leap Forward. As far as he could remember, desertification and sandstorms had never been an issue until the 1970s. Since then, he said, agriculture had become increasingly challenging. Most of the other families had moved away, and almost half of the remaining people would work elsewhere for most of the year. He told us that his family mainly grew melon, corn, and sunflower seeds. And thanks to the supplies of the reservoir, there had always been sufficient water supply to irrigate the fields. Sandstorms were troublesome, he said, yet they had become less frequent in recent years. Some time ago, a local government agency had begun to recruit farmers from his village during the spring season to help plant trees in large-scale plantations to combat the storms.

The Hexi Corridor is a highly complex and ecologically very sensitive region. Water availability is the decisive factor for the stability and functioning of all its habitats. It is crucial to understand the strong interdependency between different localities across the watershed, spanning from the water source in the high

altitudes of the Qilian Mountains, across the upper and middle reaches where most of the human activities are concentrated, and all the way to the very arid lower reaches as a continuous system. An intervention in one place thus has immediate consequences for other places further downstream.

Because of their relative linearity, with a clear start and endpoint, the Hexi Corridor's watersheds are an interesting case study to understand the territorial transformation of ecosystems through anthropogenic interventions over long periods. Villagers at the very bottom of the watershed, such as the farmer Zhang, who continues cultivating his land despite environmental and economic challenges, are directly affected by changing development patterns and demographics happening much further upstream. Land cultivation sustains the vegetation cover, protects land from degradation, and is thus crucial for the entire region. However, in such an unstable environment at the low end of the watershed, farmer families can only continue to cultivate their land with the support of local governments that provide water resources and implement policies to restrict the excessive use of water.

Because of challenging climatic conditions, human habitation of the region entailed inherent conflicts with its persistent, fundamental environmental limitations throughout history. Not surprisingly, the rural parts along the Hexi Corridor are today amongst the socio-economically weakest regions in China. Historically, the Hexi Corridor has always depended on strong support from the central government. This leads to another dimension that is crucial to contextualize the Hexi Corridor within China across this and the following chapters: The Hexi Corridor sits at the intersection between the country's humid, coastal southeast and its dry interior northwest. Its geography can be understood as the arid frontier that bridges between the prosperous and densely urbanized Chinese heartland, driven by the country's large urban agglomerations along the southeastern coast, and the vast and sparsely settled regions across the arid Tibetan Plateau and northwestern steppes. Due to radically different geographic conditions, China is thus characterized by strong divides between the southeast and northwest. [Fig. 2.2]

The Hexi Corridor has been widely researched by natural scientists because of its unique geomorphological features, its complex ecosystem dynamics, and its important role in the ecological security of Gansu province, China, and even northern Asia. Because of its cultural and historical significance, the region has been studied by historians, anthropologists, and archeologists since the early expeditions of European explorers such as Sven Hedin and Aurel Stein in the late nineteenth and early twentieth centuries. However, very few studies provide a comprehensive description of the Hexi Corridor as a historic, socio-environmental account spanning different disciplines and including both social and natural sciences. Thus, this thesis aims to demonstrate, with the Hexi Corridor as a case and using the Landscape Approach as an intellectual framework, how such a multi-dimensional reading can provide a holistic understanding of

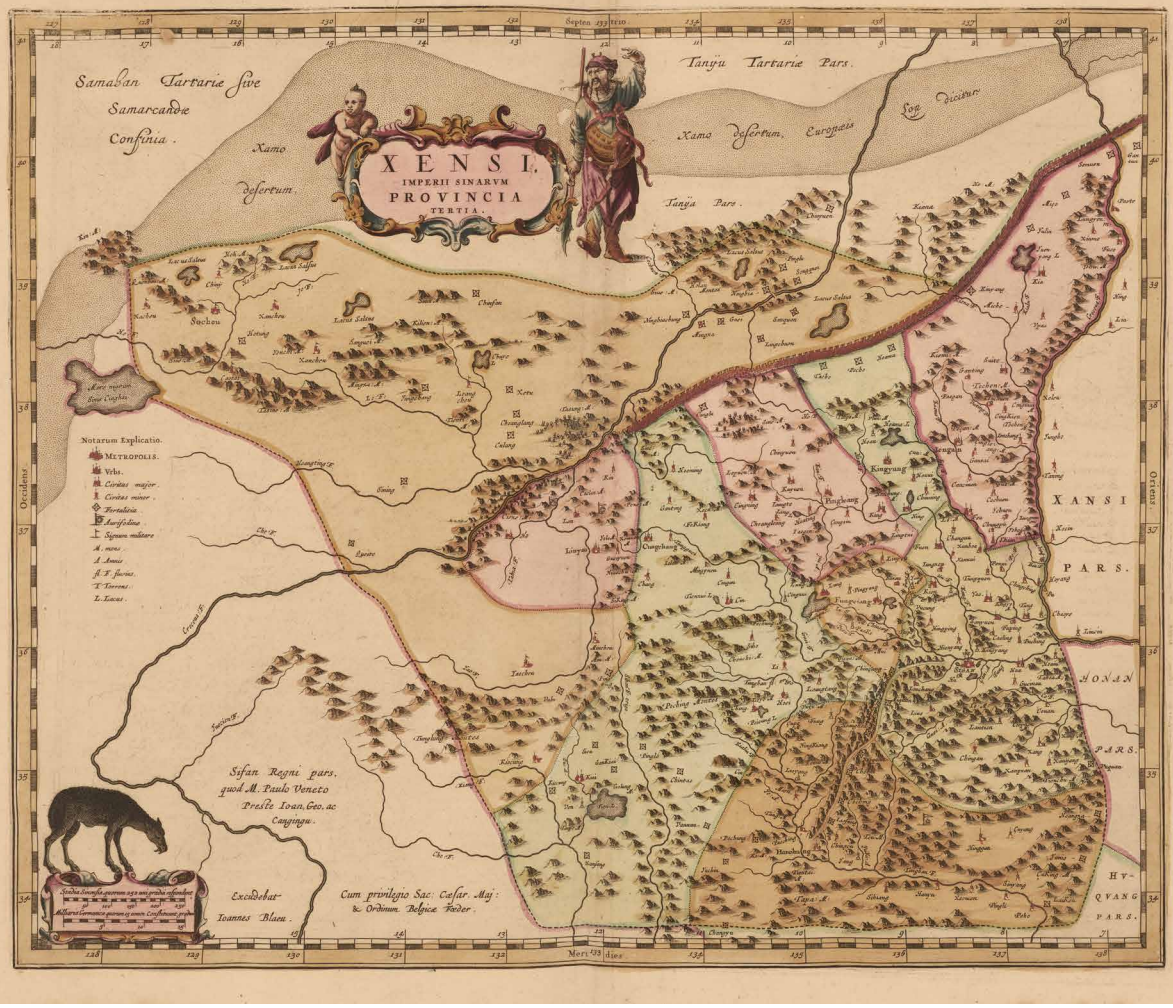


Fig. 2.3: Historic map drawn by the Dutch cartographer Joan Blaeu at the beginning of the Qing dynasty in 1665 showing the Hexi Corridor from Wuwei (*Leangcheu*) to Jiuquan (*Socheu*) in China's far northwest, beyond the Yellow River and beyond the defense line of the Great Wall. Everything north of the Hexi region is illustrated as an undefined desert wasteland (*Xamo*).

a region and its socio-environmental challenges.

In the first part, this chapter provides a geographic overview of the Hexi Corridor in the context of China's macro-regions. The second part describes the emergence of a specific Chinese identity and cultural relationship to extra-human nature during the period of early pre-imperial state formation. This is essential to understand the establishment of the Hexi Corridor as a strategically crucial frontier demarcating China's heartland from its northwestern neighbors and, later, how the transfer of this socio-environmental regime from China's heartland radically transformed the Hexi region.

Between China's Arid Northwestern Mountains and Humid Southeastern Plains

河西 (HeXi) means "west of the river." River refers to the Yellow River, the origin of Chinese civilization, which has emerged along its banks in Central China. As its name suggests, since the beginning of imperial Chinese nation-building, the Hexi region has been perceived as the arid frontier beyond the Great River, forming the northwestern extension of what is understood as the nation's heartland, China Proper.[4] [Fig. 2.3] The Yellow River, together with one of the other major river systems in China, the Yangtze, originates in the high altitudes of the Tibetan Plateau and flows in eastern direction down into the vast, fertile plains of Central China and, eventually, through large river deltas into the sea.[5] The flow direction of these massive watersheds marks the general geography of China, sloping down from west to east and toward the Pacific Ocean. Over millions of years, the uplift of the Himalayan Mountains led to climatic differences and weather patterns that created a rich diversity of geographic regions across Asia with very high biodiversity—particularly in the case of China's landmass due to its wide range of horizontal as well as topographical coordinates.

Generally, China can be divided into a fertile, coastal southeast with a subtropical, humid monsoon climate and a mountainous northwest, with arid, temperate regions in the rain shadow of the Tibetan Plateau. While China's northwest accounts for half of the total landmass, it contains less than twenty percent of the total national water resources.[6] As the regions north of the Tibetan Plateau dried out, they created vast, deserted lands across the Tarim Basin, the Gobi, and dry steppes across the Mongolian Plateau. Annual dry winds

4 China Proper is a Western imperial term of the late 19th century but has earlier Chinese origins: Similar to *ZhongGuo*, it is perceived as the "middle country." China Proper generally refers to the eighteen provinces during the late Qing dynasty that lie between the Pacific coast in the south and east, the Tibetan Plateau in the west, and the Mongolian steppe in the north. They represent the nation's more or less continuous core, where the Chinese civilization developed across the centuries, even though many administrative, cultural, and linguistic shifts occurred over time. The surrounding provinces are the frontier regions, which in ancient China have been perceived as the land of "barbarians" from whom the empire received tributes in times of Chinese ascendency. These frontier regions depended on continuous support from China's central state, were detached in times of declining political power, and have—at least formally—a somewhat autonomous status until today. With its northwestern extension of the Hexi Corridor, Gansu province is considered part of China Proper despite its peripheral location. See Thomas R. Tregear, *A Geography of China* (New Brunswick, N.J: Aldine Transaction, 2008), xvi.

5 Other major river systems in China are the Huai River, between the Yellow and Yangtze; the Pearl River, with its western tributary Xi River, originating in Yunnan; as well as the Mekong River, also originating in the Tibetan Plateau but flowing south, eventually into the Vietnamese South China Sea.

6 Xiangzheng Deng and Chunhong Zhao, "Identification of Water Scarcity and Providing Solutions for Adapting to Climate Changes in the Heihe River Basin of China," *Advances in Meteorology* 2015 (June 7, 2015): e279173, 1.

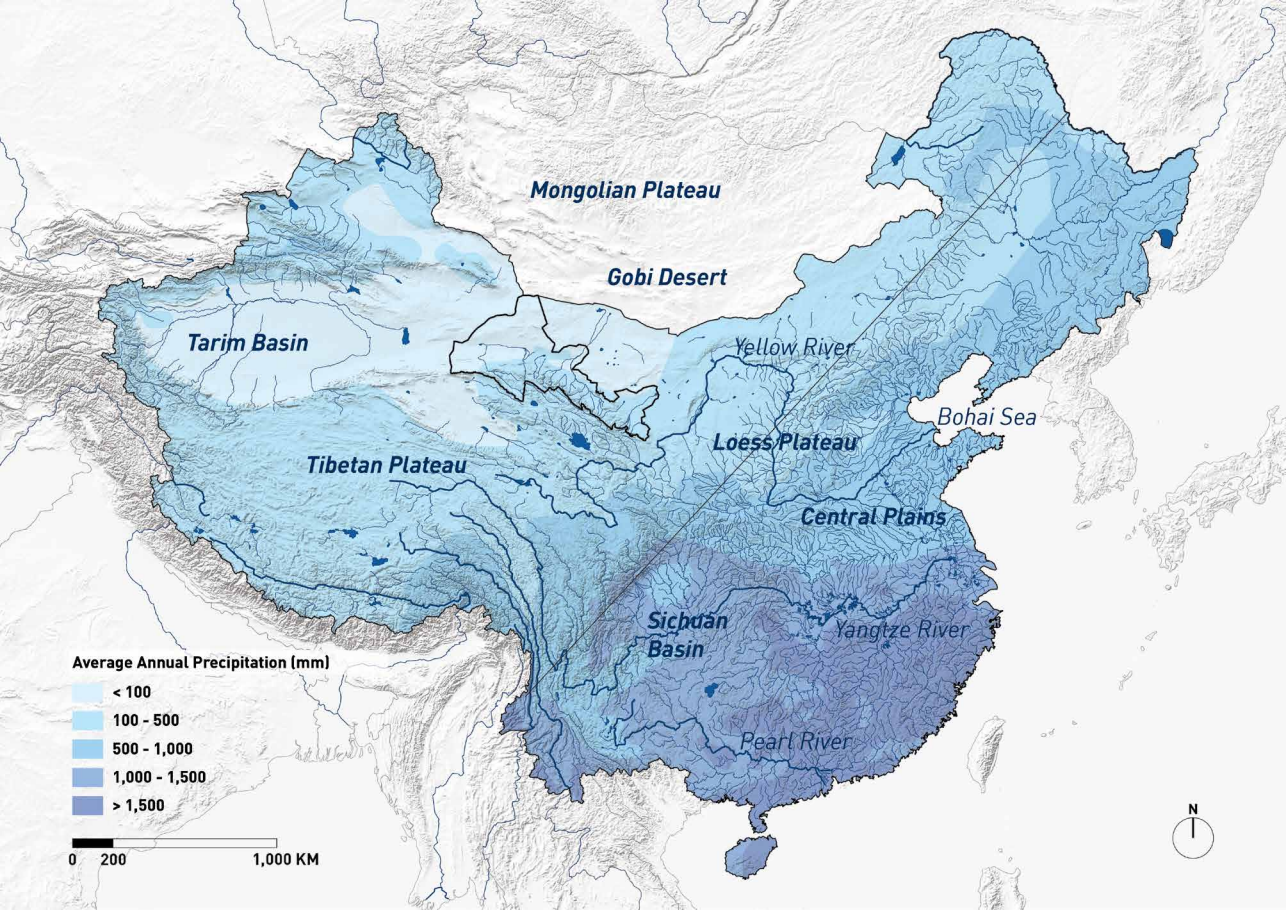


Fig. 2.4: Map of China showing a strong climatic difference and availability of water between the country's humid southeast and arid northwest. Shown are the topography, water bodies, and average annual precipitation.

picked up huge quantities of dust from these large arid regions and deposited them further south, forming the Loess Plateau, which ranges across much of northern and northwestern China. Over millions of years, this loess eroded into the Yellow River. It was carried down to the east, where it was deposited, forming the northern Chinese plains across today's Hebei, Henan, and Shandong provinces. These vast plains of Central China are covered with fertile soil and provide ideal conditions for agricultural cultivation. Further south, the climate is more humid, and the topography is hillier with steep slopes and densely forested valleys. [Fig. 2.4]

These distinct geographic regions of China with the high Tibetan Plateau in the west, the arid deserts and steppes in its north, the extensive hills of the Loess Plateau in the center, the humid and densely forested hills in the south, and the vast, fertile plains in the east, determine the historical development of China. It is believed it was in the middle reaches of the Yangtze River valley where people began to cultivate land after the last ice age ended around 10,000 years ago.[7] Domesticated, annual forms of wild rice started to be farmed in

7 Liu Dongsheng dates the starting point of the Anthropocene around 10,000 years ago, with the beginning of large-scale farming and logging activities in China and increasing exploi-

wetland cultivations that expanded further down into the Yangtze River delta. In the fertile loess deposits of the Wei River valley, the largest tributary to the Yellow River in today's Gansu and Shaanxi provinces, millet began to be cultivated around 1,000 years later in sparsely forested, savanna-like niches, from where it was spread north and east along the forested valleys of the Yellow River and into the northern Chinese plains.[8] From these early prehistoric beginnings, Chinese civilization began to form as a distinctly agricultural society.[9] This origin of an early sedentary civilization that developed in the Loess Plateau is essential for understanding China's environmental history, including the Hexi Corridor.

***

As this short introduction of China's different geographic macro-regions illustrates, a distinct disparity exists between China's arid northwest and its humid southeast. This disparity is strongly manifested until today in geographic, ethnic, and demographic, but, as we will see in the following chapters, also in political and socio-economic terms. The eastern-western divide frames the geographic context in which the Hexi Corridor is positioned in this thesis within China as an arid frontier that bridges two different spheres. China's history of drastic anthropogenic transformations of the natural environment began in the nation's historic heartland, where early dense societies developed, and was later exported to increasingly remote regions, including the Hexi Corridor. Before this environmental history is told, the Hexi Corridor is introduced as a geographic region.[10]

---

tation of nature for societal development. Dongsheng Liu, "Kaizhan 'Renlei Shi' Huanjing Yanjiu, Zuo Xin Shidai Dixue de Kaita Zhe—Jinian Huang Ji Qing Xiansheng Di Dixue Chuangxin Jingshen 开展"人类世"环境研究, 做新时代地学的开拓者—纪念黄汲清先生的地学创新精神 [Carrying out 'Anthropocene' Environmental Research and Becoming a Pioneer of Geoscience in the New Era]," *Di Si Ji Yanjiu* 第四纪研究 [*Quaternary Sciences]* 24, no. 4 (September 9, 2004): 369–78.

8 Robert B. Marks, *China: An Environmental History*, Second edition (Lanham: Rowman & Littlefield Publishers, 2017), 15–38.

9 China is often referred to as the oldest civilization, spanning over 4,000 years, with written records since the Shang dynasty (1600–1100 BC). Chun-shu Chang distinguishes between a *nation*—a kinship group that shares collective race, value systems, language, political power, territorial boundaries, and a geographic identity and common belonging—and a *state*. A state is defined as a territory with an authoritative political institution that imposes central control over that territory and all its inhabitants, which goes beyond the reach of a kinship relation and shared identities. State formation in China underwent different stages, from a feudal state to a centralized bureaucratic state, an imperial bureaucratic state, and a democratic state. The beginning of an imperial unification of China, which is essential for this chapter, started with the short-lived Qin (221–206 BC) and then during the following Han dynasty. Chunshu Chang, *The Rise of the Chinese Empire: Nation, State, and Imperialism in Early China, ca. 1600 B.C.–A.D. 8* (Ann Arbor: University of Michigan Press, 2007), 14–15.

10 Some insights of the following general geographic summary of the Hexi Corridor have been provided by Zhang Xuebin, assistant professor at Northwestern Normal University in Lanzhou, who introduced the region to me on our joint field trip in October 2019.

The Hexi Corridor as a Multi-Dimensional Ecosystem

The Hexi Corridor is a narrow plain between forty and one hundred kilometers wide, running in northwestern direction between the Tibetan Plateau in the south and the Mongolian Plateau in the north. Geographically, the Hexi Corridor is highly complex due to its location between these different landforms and macro-geographic entities. The only route to connect the geographically isolated Chinese heartland to Central Asia led either through this narrow stretch of the Hexi Corridor to then continue around the Taklamakan Desert in the Tarim Basin or from the Yellow River northwards, around the Gobi Deserts and through the Mongolian steppe.[11] Acting as the eye of a needle and splitting up into several routes at its western end, the passage thus opened the Chinese Plain up to India, Central Asia, and the Mediterranean.

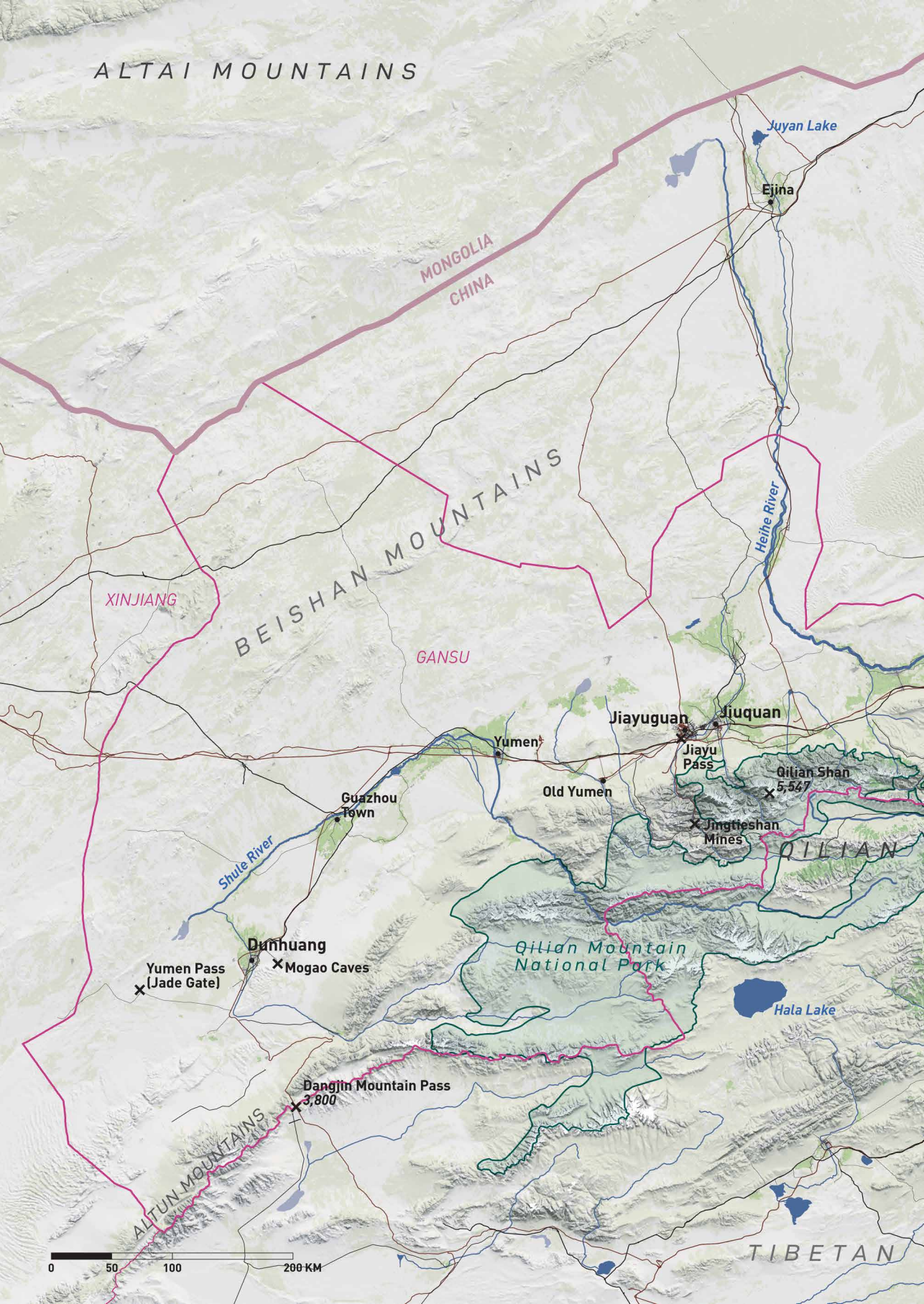
Surrounded by arid steppes and deserts, several large oases lie in the Hexi plain that allow for land cultivation. The oases were first developed as military outposts and later grew into larger towns and cities, forming a cultural corridor connected by important transportation routes. Over the centuries, the Chinese developed trading routes from the historic capital of Chang'an (today Xi'an) upstream along the Yellow River and into the Hexi Corridor toward the west. Its function as an important region for transportation and trade has made the Hexi Corridor a melting pot of cultural exchange and gave China access to knowledge, technologies, and prosperous markets. Surrounded by inhospitable terrain, the narrow Hexi Corridor was a key part, often referred to as the "golden sector,"[12] of the historic Silk Road.

In an early phase of my dissertation project, I discussed my plans to study the Hexi Corridor with Chang Genying, professor of economic geography at Lanzhou University. He argued that the Hexi Corridor should not be studied as one geographic context since its three watersheds must be considered separate entities. Just about three weeks later, after I had returned from a trip traveling along the Hexi Corridor, across all three watersheds, all the way to Dunhuang and back, I met with Li Ding, a professor of human geography in the same College of Earth and Environmental Science at Lanzhou University. He told me that, in his view, it makes perfect sense to study the Hexi Corridor as one geography because of its distinct cultural history and its important role

11 Barry Cunliffe, *By Steppe, Desert, and Ocean: The Birth of Eurasia* (Oxford University Press, 2017), 30–31.

12 Xiaoming Xiao, Zhenguo Li, and Heping Liang, eds., *Gansu: Grottoes on the Ancient Silk Road*, Panoramic China (Beijing: Foreign Language Press, 2006), v.

>> Fig. 2.5 (following spread): Overview of the Hexi Corridor region between the Tibetan and Alxa Plateau. Located northwest beyond the Lanzhou urban region, it stretches across five main cities and oases from Wuwei to Dunhuang, linking to Xinjiang and Central Asia.


ALTAI MOUNTAINS
Juyan Lake
Ejina
MONGOLIA
CHINA
BEISHAN MOUNTAINS
Heihe River
XINJIANG
GANSU
Jiayuguan
Jiuquan
Yumen
Jiayu Pass
Qilian Shan
5,547
Old Yumen
Guazhou Town
Jingtieshan Mines
QILIAN
Shule River
Dunhuang
Qilian Mountain National Park
Yumen Pass (Jade Gate)
Mogao Caves
Hala Lake
Dangjin Mountain Pass
3,800
ALTUN MOUNTAINS
TIBETAN
0
50
100
200 KM


ALXA PLATEAU
INNER MONGOLIA
Badain Jaran Desert
Zhuye Lake
Tengger Desert
Shiyang River
Minqin Town
Hongyashan Reservoir
Jinchang
Hexi Pu
Wuwei
Zhangye
Gulang
WUSHAOLING MOUNTAINS
HELAN MOUNTAINS
YINCHUAN
NINGXIA
Yellow River
Baiyin
Lanzhou New Area
GANSU
LANZHOU
Biandukou Pass
3,680
MOUNTAINS
XINING
Liujiaxia Reservoir
Linxia
Qinghai Lake
QINGHAI
PLATEAU

in China's cultural formation. In order to gain a holistic picture of the region, it needs to be seen as one continuous space that leads from the Chinese heartland all the way to Central Asia and transcends different geomorphological as well as cultural and political boundaries. I followed this second interpretation of the region as a socio-cultural and geopolitical corridor that combines multiple dimensions, including the ecological dynamics of individual watersheds.

The Hexi Corridor stretches from Wuwei at its southeastern end for over one thousand kilometers in northwestern direction, all the way to the famous city of Dunhuang and the Yumen Pass—or Jade Gate—around eighty kilometers to its northwest, which became the westernmost end of the Great Wall during the Han dynasty and marked the far-western entry point into the Chinese empire. In cross-sectional direction, from southwest to northeast, the region can be divided into three main geomorphological parts which help to define its inner logic and geographic formation: First, the tall mountain range of the Qilian Mountains running along the lower end of the Tibetan Plateau and sloping down into the Hexi plain; second, the flat and relatively narrow high plateau in the upper and middle reaches of rivers where large oases with cities, towns, and most of the industries are located, as well as agricultural land and vital infrastructures for transportation, communication, and energy; and third, the lower river reaches in the vast, arid plains of the Alxa Plateau, as well as the Beishan Mountains which mark the northwestern end of the Hexi Corridor.[Fig. 2.5]

Across these different main geographic entities, there are significant differences in terms of climatic conditions and vegetation, ranging from high-elevated glaciers and snowfields, alpine meadows, temperate zones with lush forests and grasslands, to arid steppes with sparse, drought-tolerant vegetation, and sandy deserts. While the Hexi Corridor region is discussed through this cross-section from south to north, there are also climatic differences from east to west with sometimes converse trajectories regarding glacial mass balance, streamflow, and precipitation.[13] Given the relatively stable weather conditions, the socio-environmental relationships and evolution across each of the three main geographic entities can be scientifically explained through the three dimensions: land, vegetation, and water.[14] Land needs to be understood in terms of its mechanic and chemical composition; vegetation is crucial in terms of the species and land cover, determining the ability to stabilize the ground; and water is the decisive factor for all forms of life in terms of its availability and quality above and below ground.

This cross-sectional portrait of the Hexi Corridor follows the inner logic of

13 G. Wang et al., "Environmental Degradation in the Hexi Corridor Region of China Over the Last 50 Years and Comprehensive Mitigation and Rehabilitation Strategies," *Environmental Geology* 44, no. 1 (May 1, 2003): 70.

14 These three dimensions include more detailed aspects such as nutrients, landforms, fauna, etc. Wang et al., "Environmental Degradation in the Hexi Corridor Region," 69.

Fig. 2.6: The Qilian Mountains run along the southern end of the Hexi Corridor. They are the region's lifeblood, supplying it with vital water sources from precipitation, snowmelt, and glaciers throughout the year. Tributary of the Heihe River southeast of Zhangye flowing into the plain with the construction site of a new highway connecting to Xining; October 2019.

the flow of water across the geographic unit of a watershed as a diagrammatic transect from the southern high-elevated source in the Qilian Mountains to the low-lying and arid northern end of the Hexi Corridor. This cohesive and dynamic system is visualized in Poster B. The diagrammatic drawing is a central piece of the thesis: It is a visual representation of the multidimensional geographic reading that the Landscape Approach describes in chapter one. It visualizes how the different dimensions of social (economic, political, cultural) and environmental processes are closely entangled in complex and interrelating socio-environmental systems across the territorial context of the Heihe River watershed. It demonstrates that landscape serves as a mode of analytical, systematic thinking and a form of visual abstraction and representation that allows to read complex ecologies across scales. The drawing informs the following paragraphs and parts of the following chapters. [Poster B]

Qilian Mountains

The Qilian Mountains form a high mountain chain at the northern end of the Tibetan Plateau. When the Himalayas were formed over millions of years, the Qilian Mountains were lifted at their end. Seven massive folds reach around

850 kilometers in length and are about 80 – 240 kilometers wide. Starting from the Wushaoling Mountains at their eastern end, they run in northwestern direction and terminate with the Dangjin Mountain pass southwest of Dunhuang.

The Wushaoling Mountains form a sharp geographic divide that defines the southeastern beginning of the Hexi Corridor: South of the Wushouling Mountains is the wide southeastern half of Gansu province. It is referred to as *HeDong*, "east of the river," as opposed to *HeXi*, "west of the river." *HeDong* stretches across the western end of the Loess Plateau and receives increasing annual precipitation in southern and eastern directions. Around one hundred kilometers south of the Wushouling mountain range lies Gansu's province capital, Lanzhou, located in a valley along the banks of the Yellow River.

The Wushaoling Mountains create an important hydrological barrier, demarcating the Yellow River watershed. All the water south of this mountain range is part of the Yellow River basin, flows towards the east and eventually into the Bohai Sea. In contrast, the river systems north of the Wushaoling Mountains are *endorheic*. This means they are inland rivers that do not end in a sea but instead flow into the deserts of the Gobi, where they drain out or end in terminal basins in the interior.[15] The Wushouling Mountains, therefore, create a strong hydrological divide between these endorheic and exoreic watersheds, but also a climatic divide between the temperate Loess Plateau of southeastern Gansu and the arid Mongolian steppe. Today, tunnels for roads and railways cross this mountain barrier for a fast link between Gansu's southeastern and northwestern half. The town Gulang at the foot of the Wushaoling Mountains creates the southeastern entry point into the Hexi Corridor.

Most of the peaks of the Qilian Mountains are 3,000 – 3,500 meters in elevation, with the highest peak, Daxueshan, reaching over 5,600 meters above sea level. The mountain range is vital for the ecological stability of the entire region. It is the primary source of water and features a wide range of ecosystems with very high biodiversity. The high mountains range across a diverse altitudinal spectrum of ecological zones: They reach from a glacier and permanent snow-covered zone, usually above 4500 meters, an alpine cushion plant zone (between around 4,000 – 4,500 meters), an alpine meadow zone (3,800 – 4,000 meters), an alpine shrub meadow zone (3,400 – 3,800 meters), a forest grassland zone (2,800 – 3,400 meters), a grassland zone (2,200 – 2,800 meters), and a steppe desert zone at the foot of the mountains.[16] [Fig. 2.6]

15 This is the case for almost all river systems in northwestern China and Central Asia. Niels Thevs et al., "Study Areas: The Heihe River Basin and Wuliangsuhai Lake at the Hetao Irrigation District," in *Sustainable Water Management and Wetland Restoration Strategies in Northern China*, ed. Giuseppe Tommaso Cirella and Stefan Zerbe (Bolzano: Bozen Bolzano University Press, 2014), 30.

16 Zhengyi Yao et al., "Alpine Grassland Degradation in the Qilian Mountains, China — A Case Study in Damaying Grassland," *CATENA* 137 (February 1, 2016): 494–500.

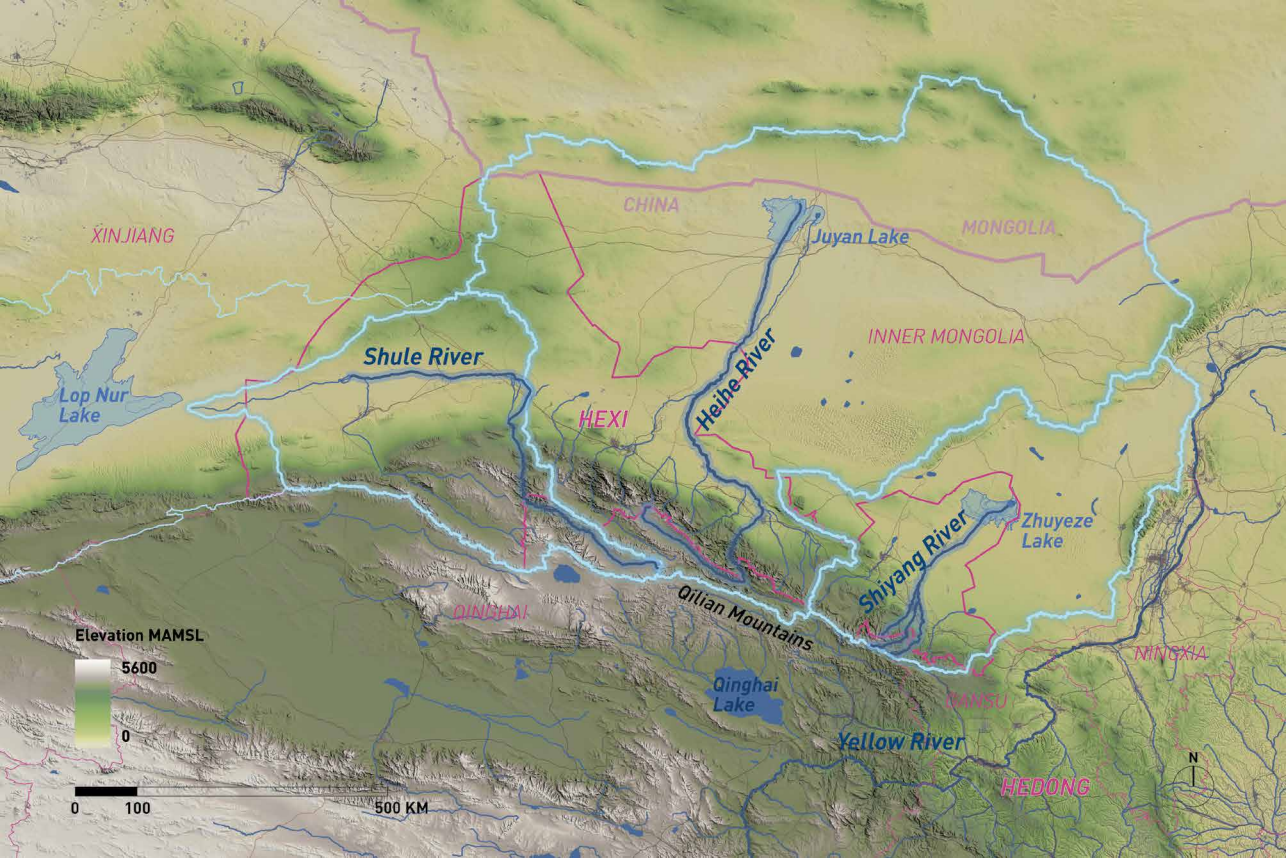


Fig. 2.7: The Hexi Corridor's three watersheds of the Shiyang, Heihe, and Shule River systems. They all originate in the Qilian Mountains. In the past, they formed massive wetlands and terminal lakes in each basin's lower reaches, shown here at their maximal extent of the current interglacial period.

The Qilian Mountains have an alpine climate with much higher humidity than the surrounding lower-elevated areas. As warm and wet air flows from the Pacific Ocean and the humid monsoon regions in south-eastern China into the Himalayas, the high mountain valleys of the Qilian Mountains then block saturated clouds that reach the end of the dry Tibetan Plateau. There, they release rainfall, primarily between April and September.[17] Precipitation across the vast mountain chain varies greatly. It decreases from the southeast, with over eight hundred millimeters of annual rainfall, to around four hundred millimeters in the center, and usually less than 100 mm at its northwestern end. Therefore, the high mountain peaks and highlands are covered in snow and ice, forming more than 2,600 glaciers.[18] The glaciers, snowfields, permafrost, and vegetated mountain slopes are vital for water storage and serve as a constant

17 Qingyu Guan et al., "Greening and Browning of the Hexi Corridor in Northwest China: Spatial Patterns and Responses to Climatic Variability and Anthropogenic Drivers," *Remote Sensing* 10, no. 8 (August 2018): 1270.

18 Quntao Duan et al., "Mapping and Evaluating Human Pressure Changes in the Qilian Mountains," *Remote Sensing* 13, no. 12 (January 2021): 2400. A large portion of that massive amount of ice and water is part of watersheds that do not flow into Gansu and the Hexi Corridor but remain in Qinghai on the southwestern side of the Qilian Mountains.

source of freshwater throughout the year, sustaining the ecosystems in the dry Hexi plain further downstream.

While most of the monsoon rainfall already gets released in the Himalayas before the clouds reach the northern end of the Tibetan Plateau, these last tall mountains create an additional, strong climatic divide: It is the beginning of the arid steppes and deserts of Mongolia and Central Asia. The Hexi Corridor and all the areas beyond that lie in the rain shadow of the high mountain chain receive significantly less precipitation.[19] Rainfall across the Hexi region drops to virtually zero at its northern end. In contrast to the Qilian Mountains, the lower mountains of the Alashan High Plateau are characterized by a very arid climate and release barely any water into the plain. The Qilian Mountains are thus vital to the functioning of the Hexi Corridor's complex ecosystems and the entire region's ecological stability. Rainfall and melting water from high peaks and valleys form large streams across three watersheds that bring water into the plain: The *ShiyangHe* watershed in the east, including the city of Wuwei; the *HeiHe* watershed in the center, including the cities of Zhangye, Jiuquan, and Jiayuguan; and the *ShuleHe* watershed with rivers flowing north and west, including the city of Dunhuang. Each of the main rivers has several tributaries, creating a surface runoff water system that is hundreds of kilometers long. These closed hydrological systems have thus a clear starting point in the high mountains and an endpoint in large river basins in the low reaches of the Hexi Corridor, where they form either terminal lakes and salt marshes or seep into the ground, evaporate, and vanish in the vast desert plains.[20] [Fig. 2.7]

Dense forests, forest grasslands, and alpine shrub meadow belts are critical zones for accumulating water as they collect and store water underground.[21] The quality of the available water resources is generally good, and the glaziers usually sustain a stable supply of melting water throughout the year. Across the northern slopes of the Qilian Mountains that lead into the Hexi Corridor, the runoff water flows through alluvial plains and emerges again further downhill in the form of natural springs before it flows into the main rivers and the Hexi Plain.[22] [Fig. 2.8]

---

19 The mean annual precipitation in the Hexi Corridor is only 111mm per year, ranging from 353mm in the south to 15mm in the north. Guan et al., "Greening and Browning of the Hexi Corridor in Northwest China," 3.

20 Thevs et al., "Study Areas: The Heihe River Basin and Wuliangsuhai Lake at the Hetao Irrigation District," 29.

21 They consist of tall arbor forests (*Picea crassifolia* and *Sabina chinensis*), shrub forest belts (*Salix alpina*, *Caragana sagittata, Rhododendron ssp*.), and areas of grassland vegetation, especially on the shady slopes. Bingcheng Li, *Hexi zoulang lishi shiqi shamohua yanjiu* 河西走廊历史时期沙漠化研究 *[Desertification History Along the Hexi Corridor]* (Beijing: Kexue chuban she 科学出版社 [Science Press Ltd.], 2003), 165–66.

22 Li, *Desertification History Along the Hexi Corridor*, 7.

>> Fig. 2.8: Map of the Shiyang watershed, illustrating the transition from high altitudinal mountain valleys in the upper, cultivated foothills in the middle, and dry plains in the lower reaches, determined by water availability.


Zhuye Lake
Badain Jaran Desert
Mr. Zhang's Farm
1175 m
Tengger Desert
Shiyang River
INNER MONGOLIA
Minqin Town
GANSU
Wind & Solar Power Plants
Hongyashan Reservoir
Solar Power Plants
Jinchang
Jinchang Mines
Hexi Pu
Wuwei
Yongchang Town
Gulang
Wushaoling Train Tunnel
WUSHAOLING MOUNTAINS
QILIAN MOUNTAINS
4840 m
LOWER REACHES
1,175–1,500 m
MIDDLE REACHES
1,500–2,200 m
UPPER REACHES
2,200–4,840 m
0
25
50
100 KM

Upper and Middle Reaches

Along the foot of the Qilian Mountains in the southwest and confined by the lower mountain ranges of the Alashan (Alxa) Plateau on the northeastern side lies the Hexi Corridor, stretching across more than eight hundred kilometers. It is a relatively flat and narrow plateau with an altitude between 1,000 and 2,200 meters above sea level. During the Pleistocene, the plateau was lifted, first covered with glaciers, which were then replaced with freshwater lakes. As the climate became more arid, these lakes became salty, dried out, and formed sand-gravel deserts, creating a high alpine desert.[23] Over time, this high plateau was filled with thick deposits of diluvial and alluvial material since the Cenozoic Era. While the three watersheds all have slightly different characteristics, they follow a general logic that is defined by the flow of water: Along the foot of the Qilian Mountains, the ground consists mainly of thick layers of gravel and sand that have been washed down from the mountains and have been deposited in different belts along the mountain foot according to the mechanic sorting of alluvial flows: First, larger stones and sediments are deposited in the slope accumulation zone at the foot of the mountain ranges, further below are alluvial fans consisting of smaller gravel, and the finest sediments are deposited in the lower-elevation alluvial zone. While the areas in the foothills along the Qilian Mountain are composed of loess ridge landforms and alluvial fans, the areas at the northeastern end consist of gravel deserts with eroded, barren land and residual hills.[24] Fig. [Fig. 2.9]

As the large river systems constantly bring water from the Qilian Mountains into the Hexi plain, several oases have formed with fertile soils. They were either created naturally in river deltas or extended through irrigation systems that transferred water from rivers, springs, and wells into alluvial plains. Over long periods, barren desert ground could be turned into additional fertile soil. Layers with up to 2.5 meters of hummus and high-value subsoils have been formed by accumulating organic material on top of the original desert ground.[25] Despite the dry climate,[26] thanks to these soil conditions in certain locations,

23 National Research Council, *Grasslands and Grassland Sciences in Northern China* (Washington, D.C: The National Academies Press, 1992), 21.

24 Chuanglin Fang, *Zhongguo Xibu Shengtai Jingji Zoulang* 中国西部生态经济走廊 *[Western Chinese Ecological Economic Corridor]* (Beijing: Shangwu yin shu 商务印书 [Commercial Press], 2004), 2.

25 Li, *Desertification History Along the Hexi Corridor*, 9.

26 According to the Koeppen climate classification, the region belongs to a Cold Desert Climate (Koeppen BWk) zone that is temperate continental, arid, not as hot in summers as Hot Desert Climate zones but can get cold in winters with temperatures far below freezing point. Hylke E. Beck et al., "Present and Future Köppen-Geiger Climate Classification Maps at 1-Km Resolution," *Scientific Data* 5, no. 1 (October 30, 2018): 180214. The precipitation north of the Qilian Mountains ranges from 50 to 200mm. The average annual temperature across the Hexi Corridor is around 5–10 degrees Celsius, ranging from -16 in January to 27 degrees Celsius in July. Evaporation rates average 2,000 millimeters annually, far exceeding precipitation. Lanying Han et al., "Desertification Assessments in the Hexi Corridor of Northern China's Gansu

Fig. 2.9: Wide riverbed in the upper reaches of the Heihe River during the dry autumn months; Zhangye, October 2019.

the Hexi Corridor offers ideal opportunities for agriculture and husbandry. With its good soil, flat terrain, high rates of sunshine hours, solar radiation and photosynthesis, and large temperature differences between day and night, it is even known as the "grain belt of the northwest."[27] However, the evaporation is multiple times higher than the precipitation. Therefore, all places along the Hexi Corridor depend on runoff water from the Qilian Mountains and have a high net loss of rainwater supply.[28] Most available water in each of the watersheds is used for irrigation, primarily in the middle reaches.[29] Today, the oases account for only around five percent of the Hexi Corridor's land surface and

Province by Remote Sensing," *Natural Hazards* 75, no. 3 (February 1, 2015): 2718.

27 The Hexi Corridor is an important agricultural region and was declared one of the ten Commodity Grain Bases of China with national significance in the 1950s. National Research Council, *Grasslands and Grassland Sciences in Northern China*, 21.

28 National Research Council, *Grasslands and Grassland Sciences in Northern China*, 21.

29 In the Heihe River watershed, agricultural water usage accounts for 95% of the total water use, primarily for irrigation, whereas 84% of the total water consumption occurs in the middle reaches. Deng and Zhao, "Identification of Water Scarcity and Providing Solutions for Adapting to Climate Changes in the Heihe River Basin of China," 4; In the Shiyang River watershed, the water consumption for agricultural production is almost 80%. Xue et al., "Policies, Land Use, and Water Resource Management in an Arid Oasis Ecosystem," 1038.

Fig. 2.10: Agricultural landscape with tree groves outside Wuwei in the region's east (top). Grape vines and rows of wind-breaking poplar and willow trees in Dunhuang in the Hexi Corridor's far west (bottom); October 2019.

are surrounded by barren land and deserts of the Gobi.[30] In the oases, villages, towns, and cities were developed. The total population in the Hexi Corridor

30 The oases across the three watersheds are different in size due to different soil and water resources: In the Heihe River watershed, they account for 47%; in the Shiyang River watershed for 40%; and in the Shule River watershed for 13% of the total fertile oasis area, according to satellite landcover data. Yaowen Xie et al., "Spatio-Temporal Changes of Oases in the Hexi Corridor Over the Past 30 Years," *Sustainability* 10, no. 12 (December 2018): 4489.

adds up to almost 4.5 million people today,[31] whereas more than ninety-five percent of them live in the oases.[32] Transportation infrastructures connect the major oasis towns and cities and form an important passageway, sharing a short border with Mongolia in the north and leading to Xinjiang at its northwestern end, where the corridor opens into the vast Tarim Basin—one of the driest regions in the world.

Because of differences in topography and water supply, the vegetation changes from temperate forests and grasslands at the foot of the Qilian Mountains to steppe-like vegetation, including low shrubs, perennial herbs, and grasses; and desert vegetation with xerophytic shrubs and semi-shrubs further downstream.[33] Trees and shrubs grow along the rivers, such as poplar, willow, and Elaeagnus; grasses, reeds, and aquatic plants. In longitudinal direction, the vegetation across the Hexi plain differs as well: While the eastern area contains predominantly grasslands and cultivated plants in the large oases, the more arid western part is dominated by meadows.[34] The cultivated plants in the oases are mostly non-native crops and fruits such as corn and rapeseed in the eastern and central parts or grapes in the west. Wheat and cotton are also grown. Greenhouses are widespread for the production of vegetables. Meadows are cultivated for herds of cattle, sheep, and goats. [Fig. 2.10]

Lower Reaches

The vast Alxa (also Alashan) Plateau forms the northeastern boundary of the Hexi Corridor, from where it extends all the way to the Chinese-Mongolian border. The plateau is around 1,000 -1,500 meters above sea level and is characterized by arid deserts, desert steppes, barren rock, and moving sand dunes. Lower-lying depression zones in the Alxa Plateau, creating inland basins, form the end of the Shiyang and Heihe River watersheds.[35]

In the endorheic water systems of the Hexi Corridor, the availability of water decreases toward the end of the watershed. Since streams in the Hexi Corridor are only fed by mountain water and flow relatively slowly through large gravel deposits, they constantly lose water into groundwater aquifers or

31 In 2021, the total population of Gansu was 24.9 million; 17.5% of them (4.36 million) live across the Hexi Corridor, yet the Hexi Corridor accounts for 60% of Gansu's landmass. Survey Office of National Bureau of Statistics in Gansu, "Gansu Development Yearbook 2022," electric version (Lanzhou: Gansu Provincial Bureau of Statistics, 2022); For the landmass of each prefecture city, see City Population, "China: Gansu - Prefectures, Cities, Districts and Counties," Agglomerations of the World, accessed September 22, 2022.

32 Yong Zhong Su et al., "Ecological Effects of Desertification Control and Desertified Land Reclamation in an Oasis–Desert Ecotone in an Arid Region: A Case Study in Hexi Corridor, Northwest China," *Ecological Engineering* 29, no. 2 (February 1, 2007): 118.

33 Li, *Desertification History Along the Hexi Corridor*, 10.

34 Guan et al., "Greening and Browning of the Hexi Corridor in Northwest China," 3.

35 The Shule River watershed ends in the Changmabao Basin of the Kumtag Desert, at the northwestern end of the Hexi Corridor, but follows similar ecosystem patterns.

Fig. 2.11: Small village unit at the very northern end of the Shiyang River watershed in Minqin County, with farmer Zhang's house second on the front left. Looking back south from the open desert above sand dunes; September 2019.

through evaporation.[36] In the lower reaches, the annual precipitation decreases to virtually zero while the evaporation rates increase.[37] In addition, strong winds prevail, generally blowing from northwestern direction, particularly in the dry months of winter and spring, exacerbating droughts and causing sandstorms.[38]

The lower reaches consist today of highly degraded, sensitive ecosystems prone to soil and water salinization, desertification, and are a major source area for sandstorms. Most sites consist of scattered landscapes with small sand dunes. In some places, a high groundwater table persists, allowing sparse vegetation to grow and even agricultural activities in some pockets. Only relatively small, isolated terminal lakes and marshes remained, which are only temporarily recharged with river runoff. Around these bodies of water, reeds and aquatic

36 Thevs et al., "Study Areas: The Heihe River Basin and Wuliangsuhai Lake at the Hetao Irrigation District," 29–30.

37 At the northern end of the Heihe River watershed, for instance, precipitation is less than 50mm, and evaporation can reach 3,755 millimeters. Aifang Cheng et al., "Recent Changes in Precipitation Extremes in the Heihe River Basin, Northwest China," *Advances in Atmospheric Sciences* 32, no. 10 (October 1, 2015): 1393.

38 Zhicong Yin et al., "Why Super Sandstorm 2021 in North China?," *National Science Review* 9, no. 3 (March 1, 2022): nwab165.

plants can be found. However, for the most part, these basins are large, degraded pans of sediment deposits with high salt concentrations. The vegetation is very sparse and consists of xerophytic shrubs and semi-shrubs that are tolerant to droughts and sand burial and are crucial to stabilizing ecosystems that have already experienced high degrees of degradation.[39] [Fig. 2.11]

As this geographic portrait shows, the fragile Hexi Corridor region needs to be understood as a cohesive ecosystem shaped by the logic of the topography, the flow of water, and the characteristics of the soil, flora, and fauna. Over long periods, this ecosystem—or rather, the three ecosystems of the three watersheds—have been transformed: first, by changing climates, and second, by human interventions.

Socio-Environmental Regime Shifts and the Formation of an Arid Frontier

One central theme in this thesis is the particular forms of interaction between a specific socio-environmental regime and extra-human nature to understand how individual sites, operational landscape formations, and territorial systems are created. Such a socio-environmental regime is specific to a geographic and historical context. The anthropogenic transformation of the Hexi Corridor at a territorial scale began with the imperial expansion of the early Han dynasty in the late second century BC. Before that period of strategic development, intensive human activities in the Hexi region remained small and isolated.

Pre-Imperial Habitation in the Hexi Corridor

The earliest human activities in the Hexi Corridor date back to the Neolithic Majiayao culture over 5,000 years ago when people settled in the eastern part of the region during a period of particularly favorable weather conditions.[40] The Hexi Corridor has been identified as a key region for early cultural continental exchange between eastern and western Eurasia. Archeological evidence showed the first forms of agriculture in the region around 4,800 years ago by societies who had immigrated from the western Loess Plateau and cultivated East Asian millet. Around 4,000 years ago, during a first peak of prosperity, Bronze Age communities introduced wheat and barley from Southwest Asia and new land cultivation technologies. Activities were also extended to the western half of the Hexi Corridor.[41] These agricultural activities had increas-

39 Xinrong Li et al., "Patterns of Shrub Species Richness and Abundance in Relation to Environmental Factors on the Alxa Plateau: Prerequisites for Conserving Shrub Diversity in Extreme Arid Desert Regions," *Science in China, Series D: Earth Sciences* 52 (May 1, 2009): 678.

40 Liu Yang et al., "Climate Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years," *Acta Geologica Sinica - English Edition* 94, no. 3 (2020): 616.

41 Guanghui Dong et al., "Prehistoric Trans-Continental Cultural Exchange in the Hexi Corridor, Northwest China," *The Holocene* 28, no. 4 (April 1, 2018): 621–22; Yang et al., "Climate

ingly strong yet isolated impacts on the natural environment: Pollen samples show first an expansion of intensive agricultural activities around 4,000 years ago; second, a subsequent decline around two centuries later, as well as first signs of land degradation and shifts from grassland to desert shrubland vegetation; and third, around 3,500 – 3,400 years ago, a sudden termination of intensive land cultivation in the Hexi region. Land degradation, the decline of agricultural practices, the abandonment of settlements, and the shift to pastoral societies during that period coincide with an increasing climate aridity.[42] This illustrates that habitation and land cultivation patterns happened in relation to changing climatic conditions.

As an example of the strong anthropogenic impact that human activities could have on ecosystems already during prehistoric times serves the case of early smelting activities in one particular location in the lower reaches of the Heihe River around 1900 BC that caused large-scale deforestation as well as increased erosion and land degradation.[43] However, populations along the Hexi Corridor were relatively small in prehistoric times. As intensive human interventions into the extra-human environment happened only in areas where sufficient water was available, human activities did not transform ecosystems at regional scales.

The Formation of a Specific Chinese Identity and Attitude to Extra-Human Nature

The systematic, territorial colonization and spatial reorganization of the Hexi Corridor required a radical shift of the socio-environmental regime. As the next chapter will discuss, this happened through the transfer of a particular Central Chinese culture across geographic boundaries to the remote Hexi region with the beginning of imperial China's expansion during the early Han dynasty, introducing radically different forms of land use according to specific patterns of an agrarian, Central Chinese mentality. Since then, with growing populations and consumption of natural resources, the Hexi Corridor's sensitive environment started a long-term degradation process.

Territorial anthropogenic land transformations leading to environmental degradation have happened in many world regions and often in similar patterns as the introductory discussion on the Anthropocene has mentioned. The emergence of the landscape idea during the early Italian Renaissance describes

Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years," 615–16.

42 Xinying Zhou et al., "Land Degradation During the Bronze Age in Hexi Corridor (Gansu, China)," *Quaternary International*, Holocene Vegetation Dynamics and Human Impact: Agricultural Activities and Rice Cultivation in East Asia II, 254 (March 16, 2012): 42, 47.

43 Xiaoqiang Li et al., "The Impact of Early Smelting on the Environment of Huoshiliang in Hexi Corridor, NW China, as Recorded by Fossil Charcoal and Chemical Elements," *Palaeogeography, Palaeoclimatology, Palaeoecology* 305, no. 1 (May 15, 2011): 329–36.

a historical regime shift and the consequences for the society and extra-human environment across a territorial scale. Other radical socio-environmental transformations happened, for instance, with the systematic appropriation of territories in the New World during European colonialism.

The cultural attitude toward extra-human nature that was established as part of a specific Chinese identity was strongly influenced by the macro-geographic differences between the fertile plains of Central China and its northwestern frontier in the Mongolian steppe, demarcating a Chinese interior and a hostile, barbarian exterior. Already early in pre-imperial history, the anthropogenic environmental transformation of China's heartland in the fertile Central Plains reached large scales and high intensities. The historian Mark Elvin states that in the late eighteenth century, the continuous pressure of intensive land use in China's agricultural core over the millennia had become more intense than in any other world region.[44] While a thorough discussion about the formation of a specific Chinese mentality regarding the human-environmental relationship would go far beyond the scope of this thesis, some characteristics are briefly described below. They are crucial to understanding what enabled Han Chinese nation-building and territorial expansion into the northwestern frontier regions discussed in the next chapter.

Chinese Characteristics of Environmental Transformation

One characteristic in China's environmental history that is still apparent today is the aim to impose uniformity throughout the empire. It began with the unification of warring states to create one centralized Chinese empire during the short-lived Qin dynasty. The central state pursued a homogenization and standardization of the language, currency, and bureaucratic organization. Efforts for a centralization of the political state were followed in the early Han, particularly since the reign of the seventh Emperor Wu (*Han Wudi*, reign: 141–87 BC), leading to the monopolization of products such as salt and iron and extensive land ownership by the state.[45] This trend then continued over the centuries. As the environmental historian Robert B. Marks says, "In a nutshell, China's environmental history is a story of the simplification of environments, peoples, and institutions." Natural diversity was reduced through agriculture and farming, ethnic diversity disappeared as Han Chinese proliferated, and an increasingly dominating centralized state replaced the diversity of societal

44 Some refer to England and the Netherlands as the regions with the most intense forms of historic environmental transformation. Elvin argues that first, China required a continuously strong hydraulic control over centuries that was much greater than in Europe; second, Chinese farming and the maintenance of fertile soil was much more intensive per land unit than most European farming; and third, the use of manure as fertilizer was more comprehensive, applied to every crop, not just the important ones. Mark Elvin, *The Retreat of the Elephants: An Environmental History of China* (Yale University Press, 2004), 460–71.

45 Chang, *The Rise of the Chinese Empire: Ca. 1600 B.C.–A.D. 8*, 43–64. As discussed below, it was also during Emperor Wu's reign when the Hexi Corridor's military occupation succeeded.

organizations.[46]

Already in pre-imperial times, geographically specific attributes of the socio-environmental relationship crystallized. One such feature has its roots in early Neolithic cultures. It is the high efficiency of agricultural production, leading to a distinct identity of an agrarian society. This happened not just early in time, 9500 to 8800 years ago[47]—as mentioned, first in the Yangtze River valley and, around a millennium later, further north—but also in an exceptionally intense fashion. It was in the Central Plains where the highest surplus per farm could be produced, enabling a certain degree of the social division of labor, leaps in technological development, and where the largest agglomerations of villages could be developed. Between 2400 and 1000 BC, the first Chinese states emerged with a distinct culture identified as the beginning of Chinese history.[48]

Particular to this environmental history is that these first Chinese states could sustain societies that were relatively early in time, already very large in scale.[49] Based on the intense competition for land and territorial power, the historian Mark Elvin provides helpful explanations to better understand why the tremendous environmental transformation and homogenization across today's China happened in a certain way—particularly across its fertile and once densely forested eastern half—and if there were interactions between humans and their natural environment that were "recognizably Chinese."[50] While Elvin concludes that such a generalization would be very difficult to make, especially considering cultural ideas and ideologies that were often contradictory over the millennia,[51] he points out several cultural and socio-political patterns across Chinese history. Many characteristics of the human-nature relationship that began to emerge during the early formation of China as a nation can be identi-

46 Marks, *China: An Environmental History*, 7.

47 Ibid., 31.

48 Three states—the Xia, Shang, and Zhou—were competing over territorial power in the north of today's China. They developed mutually, or in parallel, as China's first agricultural states with warring elites. Marks, *China: An Environmental History*, 43–45.

49 Elvin, *The Retreat of the Elephants*, 88.

50 The discourse about the relationship of humans to nature in the context of Chinese literature and culture is very complex and ambivalent, and a thorough review of literature on this issue would go beyond the scope of this thesis. The Chinese meaning of "nature" itself already strongly differs from the English language and Western understandings. Human's perception of nature has changed throughout Chinese history. It derives from different schools of thought, religious beliefs, and cultural values. As in Western culture, it is contradictory in its search for harmony, on the one hand, theorized in concepts such as *fengshui* and expressed in a rich record of often romanticizing visual representations, and, simultaneously, the aim to shape and control the extra-human environment. See, for instance, Hans Ulrich Vogel and Günter Dux, eds., *Concepts of Nature: A Chinese-European Cross-Cultural Perspective* (Leiden, The Netherlands; Boston: Brill, 2010). See particularly "Overview" (p.1–55) and "Introduction" (56–101) by Mark Elvin, "The Myriad Things" (516–525) by Wolfgang Kubin, and "On the Relationship Between Man and Nature in China" (526–542) by Helwig Schmidt-Glintzer.

51 Elvin, *The Retreat of the Elephants*, 471.

fied in later historical periods and until today. They help theorize and better understand China's environmental history and, for this thesis's purpose, the formation of the Hexi Corridor.

Cultural Social Darwinism

Elvin calls the first characteristic of Chinese environment-making "cultural social Darwinism:" In the context of an increasingly densely cultivated Chinese heartland, it describes the military advantage of cultures that actively exploited nature over those that did not. He describes the initial trigger for large-scale environmental destruction in China as a struggle of high territorial competition for resources. Demographic, social, and economic pressures led to technological innovation and increasingly productive land-use systems.[52] In addition, it created early forms of feudal "states" and a hostile environment of constant conflicts and wars. The aim to achieve military superiority led to a concentration of power and accelerated the intensification of production and strict socio-political control. Already in pre-imperial China, this concentration of people and resources produced large cities and a decoupling of the ruling "urban" elite from the non-human, natural world, reducing the awareness and sensitivity to environmental issues in the decision-making process. What Elvin calls the "matrix of power" was at the core of this new socio-environmental regime, describing a state machinery of high social discipline and strict territorial organization that tended to exploit—and eventually destroy—the natural environment.[53]

The systematic exploitation of resources was thus a state necessity. Notably, in early imperial China, the boundaries between society and the military were often fluid: Agricultural and infrastructural projects were commanded and overseen by the military, and troops were an integral part of the necessary labor together with peasants, for instance for land reclamation or the construction of water infrastructures. The political logic was one of state-driven economic development. In the political state thinking, planning infrastructural projects such as for irrigation or food supply was directly connected to military logistics and driven by geopolitical interests.[54] This emerging interlinkage of military power, economic development, and high pressure on natural resources in early Chinese states followed patterns of territorial organization that continued across centuries and, as discussed in the next chapter, was a crucial element in establishing the Hexi Corridor.

52 Ibid., 85–91. This position aligns with Boserup's Land-Use Intensification Theory introduced in the first chapter as part of the discussion around anthropogenic ecology.

53 Ibid., 92–101

54 Ibid., 101–110.

Dual System Between Centralized Power and Distributed Innovation

A second important characteristic of the state apparatus that informed a distinctly Chinese form of development is, in similar form, relevant until today: The imperial Chinese state simultaneously operated on two levels. On the one hand, they were massive in scale and controlled by the central state, such as large-scale water control systems. On the other hand, small-grained units were privately owned, such as individual peasant family farms or workshops. These highly disaggregated small units were simultaneously controlled and free. They usually operated in a state of innovative, commercial competition, far removed from the state monopoly. However, if necessary, they could be coordinated administratively or commercially to form enormous modular aggregates. Elvin believes this combination of small unit initiative and simultaneous coordinated aggregation produced a sustained thoroughness of environmental exploitation.[55] This dual system of strong political power that is centralized by the state (typically in urban centers) and, simultaneously, the freedom and innovative capacity of small, localized units (typically located in rural environments) aligns with patterns of urbanization and economic development in modern China's history, expressing a distinct urban-rural divide among the society.[56]

The Great Deforestation

One other main characteristic of China's environmental history is the radical deforestation at massive scales. Forests must have covered most of today's Chinese heartland. Yet, as early as the sixth century BC, wood had already become a scarce commodity along China's northeastern coast.[57] Large-scale deforestation was driven by the need for space for land cultivation and for timber as the main resource for construction, heating, and cooking.[58] In addition, the beginning of metal production during the bronze age marked China's first large-scale production industry, which required large quantities of energy in the form

55 Ibid., 110–114.

56 Chapter four will further discuss the duality between spatial-political concentration and distribution. It has been identified as a driver of rapid economic and urban growth following the PRC's period of market liberalization in the 1980s.

57 Elvin, *The Retreat of the Elephants*, 45.

58 In *The Retreat of the Elephants*, Elvin identifies interesting cultural attitudes towards trees and forests throughout historical texts. He illustrates a distinct hostility to forests and an "enthusiasm for destruction" (p.42) as the precondition for creating a civilized world and a kind of shared identity during the Zhou dynasty. While individual trees were appreciated for their aesthetic and productive qualities in classic Chinese texts, such as plum and cherry trees, they were also seen as a resource and often "not much more than firewood waiting to be burnt." (47) Forests however, had almost exclusively a negative connotation as a wilderness with economic value to be harvested. Elvin states that this same attitude to natural resources was still apparent much later with the commodification of nature once premodern economic growth had reached a point where money could be securely invested at interest: "A resource, such as a tree, which was not utilized economically appeared as an income foregone." (xviii)

of firewood and produced new tools, enabling more intense modes of production and extraction.[59] Increasing demands for resources extended large-scale logging into remote and mountainous regions. Severe wood shortages became evident starting in the eleventh century and particularly during a phase of stark population growth during the Qing dynasty in the eighteenth and nineteenth centuries, affecting virtually every region across China. The main environmental effects of deforestation were erosion through wind and water, large sediment deposits, floods, and the loss of habitats, leading to decreased biodiversity.[60] As discussed in the next chapter, large-scale deforestation was also one of the main causes of environmental degradation along the Hexi Corridor.

Chinese Sedentary Farmers and Northern Pastoral Herders

The macro-geographic differences across today's Chinese territory produced societies that followed different forms of environmental adaptation. The arid Eurasian steppe provided habitats for an abundance of grazing animal herds roaming across vast grasslands. In this environment, the transition from an agriculture-based to a pastoral-based economy occurred at the end of the second millennium BC. Culturally, the societies in the steppes and deserts of northern China gradually detached from the civilization of the Central Plains. They developed different tools and spatial practices; they emphasized breeding over farming and domesticated herds of cattle, sheep, and horses. Pastoral horse-riding tribes began to emerge as powerful warrior states around the eighth century BC along China's northern frontier. A distinct northern culture emerged—not as a single society but as different communities.[61]

A Chinese Interior and a Barbarian Exterior

While the Chinese began to develop a distinct identity of an agricultural civilization organized in increasingly large settlements, the pastoral, nomadic societies further north and northwest followed different cultural patterns, which started to define an increasingly sharp frontier.[62] The concept of a culturally

59 Already between 1500 and 500 BC, the metal production industry grew astonishingly large with far-reaching consequences for the natural environment. Marks, *China: An Environmental History*, 45–58. Metal production increased quickly thanks to abundant copper and tin deposits and ample supplies of cheap labor. The quantities of logging for metal industries increased later with the production of iron, adding additional environmental pressure. Donald Wagner states that the limiting resource in pre-modern iron production was wood, not ore. Donald B. Wagner, *Iron and Steel in Ancient China* (Leiden, Netherlands; New York: Brill, 1996), 258.

60 Elvin, *The Retreat of the Elephants*, 22–39.

61 Nicola Di Cosmo, "The Northern Frontier in Pre–Imperial China," in *The Cambridge History of Ancient China: From the Origins of Civilization to 221 BC*, ed. Edward L. Shaughnessy and Michael Loewe (Cambridge: Cambridge University Press, 1999), 885–92.

62 During the Shang period, two cultural complexes with distinctly different characteristics between the Chinese Central Plain and the northern nomads emerged. The use of the horse

divergent interior and exterior was already established earlier during the Warring States period. The conception of the "Central Plains" (*Zhongyuan*) as the heartland of the Chinese civilization and *Zhongguo* as the central states' "middle country" aimed to distinguish a civilized inside from foreign and hostile barbarian tribes on the outside. It was an attempt to define two homogenous units on both sides, which were, in fact, highly diverse, not yet institutionalized, and in constant transformation.[63]

The Great Wall—which had already started to being constructed in pre-imperial times and became a unified fortification system during the Qin and early Han—can be understood as the material manifestation of this long process of cultural differentiation.[64] During the Warring States period, while China was in a turbulent process of state formation, the pastoral Xiongnu people established a confederate empire across the East Asian, Manchurian, and Mongolian steppe by the turn of the second century BC.[65] During the Qin dynasty (221–206 BC), the Xiongnu—but the northern tribes in general—were regarded as a contrasting counterpart to China's cultural identity that began to be defined.[66] Once the Chinese empire was unified again after the end of

for hunting, herding, migration, and warfare by cavalries was traditionally absent in Chinese culture. Yet, it was a crucial element in developing the Northern Complex and its later encounters and relationship with the Chinese. Di Cosmo, "The Northern Frontier in Pre–Imperial China," 893–96. While the northern steppe societies can be defined as a pastoral northern complex that had established by the end of the Shang period, it was not one homogenous society but more nuanced with cultural differences and hybrid lifestyles between nomadic and agricultural. There was also not a complete separation between different tribes but, instead, cultural exchange, trade, and parallel evolutions occurred across the centuries. Nicola Di Cosmo, *Ancient China and Its Enemies: The Rise of Nomadic Power in East Asian History* (Cambridge, UK; New York: Cambridge University Press, 2004), 44–59.

63 Zhaoguang Ge, "The 'Interior' and the 'Exterior' in Historical China: A Re-Clarification of the Concepts of 'China' and the 'Periphery,'" *Chinese Studies in History* 51, no. 1 (January 2, 2018): 4–28.

64 Di Cosmo, "The Northern Frontier in Pre–Imperial China," 886; Di Cosmo, *Ancient China and Its Enemies*, 138–52. As we will see in the next chapter, the material-intensive construction of the wall also had significant environmental impacts.

65 The Xiongnu confederate empire was officially established with the beginning of the reign of a new leader in 209 BC. In the years before, the Qin had attacked their northern neighbors, causing political struggle and reorganization among the different tribes across the northern steppe. The Xiongnu emerged as the leading party from this turmoil and consolidated their power during the civil war in China following the death of the First Qin Emperor (210–202 BC). Di Cosmo, "The Northern Frontier in Pre–Imperial China," 965–66. The Xiongnu formed as a confederate multi-ethnic state based on a tributary system with no proper civil institutions but with a centralization of political power and a military aristocracy. The empire was very large in size, stretching from Western Manchuria across Mongolia and Southern Siberia, all the way to the Tarim Basin, East Kazakhstan, and East Kyrgyzstan. It was predominantly nomadic, practiced some degree of farming, was engaged in trade in networks across Inner Asia, and achieved a surplus by profitable tributary treaties with their neighbors and herding practices, particularly of horses, which the Chinese highly valued. Di Cosmo, *Ancient China and Its Enemies*, 167–90.

66 Di Cosmo, "The Northern Frontier in Pre–Imperial China," 886.

the Qin, the early rulers of the Western Han dynasty (202 BC – 9 AD) realized that the Xiongnu had politically, militarily, and culturally become a severe and hostile antagonist.[67] At the time, the Xiongnu empire had dispelled the other nomadic tribes on the Mongolian steppe further to the west. It had an estimated total population of one to 1.3 million people. Around one hundred thousand lived in the Hexi region, which was governed by two minor kings.[68]

***

The context-specific relationship a society develops in relation to its extra-human environment is a recurring theme of the thesis. It argues that a geographic context that has been shaped and organized by humans over long periods can be read as a physical expression of this relationship. It is understood as a spatial manifestation of how a society has adapted to specific local conditions. This aligns with the conception of landscape as introduced in the first chapter. Each human-shaped geography, therefore, includes cultural realities, a society's attitudes, values, preferences, perceptions, and identities. And these cultural characteristics derive from a long history of a geographic context's socio-environmental formation.

The anthropologist Dee Mack Williams studied contemporary pastoral Mongolian herding communities. He describes how the Mongolian perception of the vast grasslands strongly differs from Han Chinese until today. When discussing the political ecology of a geography, he argues that cultural are just as important as material realities.[69] As presented in the following chapter, the contrast of socio-environmental organization between the newly formed Han dynasty and their northern Xiongnu neighbors is instrumental to understanding the formation of the Hexi Corridor and the continuous degradation and collapse of ecosystems over time, as well as many of the structural challenges which the region is facing today.

67 Di Cosmo, *Ancient China and Its Enemies*, 190–92.

68 Chang, *The Rise of the Chinese Empire: Ca. 1600 B.C.–A.D. 8*, 4–5.

69 For instance, Williams explains that all words in Chinese describing the different ecological zones of the northern steppe are negative and hostile. While for the Han, the language to describe resource utilization in the steppe is positive (*kai huang*, "to open up wasteland"), Mongol herders traditionally viewed the same activities in strongly negative terms. Similarly, as a powerful element of Han Chinese civilization, the wall has always been treated as a despised symbol by Mongols, for whom openness, mobility, and mutability are vital. Dee Mack Williams, *Beyond Great Walls: Environment, Identity, and Development on the Chinese Grasslands of Inner Mongolia*, (Stanford, CA: Stanford University Press, 2002), 61–79.

3. The Hexi Corridor's Longue Durée of Socio-Environmental Co-Production

Following the Landscape Approach research framework, the Hexi Corridor is portrayed in this chapter as a historical reading across multiple spatial and temporal dimensions. Like any other cultural world region, the Hexi Corridor has been spatially reshaped and reorganized over centuries through human activities such as the cultivation of land and the consumption of natural resources. In this chapter, the region is described in a dialectic narrative between, on the one hand, geopolitical interests and ambitions for social and economic growth and, on the other hand, environmental threats and fundamental limitations.

Such tensions between societal development and environmental limitations are particularly strong in a region characterized by water scarcity and a highly sensitive natural environment. As this chapter will describe, the radical shift of the socio-environmental regime from nomadic to sedentary land uses, accompanied by rapid population growth and increasing consumption of natural resources, began to dramatically transform the fragile ecosystems of the arid steppe environment. Ecosystems along the Hexi Corridor continued to decay over the centuries in terms of biodiversity, complexity, ecological resilience, and stability. Environmental degradation along the Hexi Corridor did by no means follow a linear trajectory throughout history. Instead, the ecosystem dynamics altered over the centuries depending on changing climatic conditions and shifting socio-political and demographic systems across rising and falling dynasties, including periods of war and political unrest, changing cultural institutions, technological innovations, economic crises, and prosperity, and growing and shrinking populations.[1]

Jason Moore's narrative of contemporary socio-environmental issues as the result of a "co-production" of human and extra-human nature over long periods of time is instrumental for the historical portrait of the Hexi Corridor region. In his work, Moore emphasizes the inseparable interconnectivity of humans and their natural environment and understands human and extra-human nature as deeply entangled. Following Moore's narrative, a regional context, such as the Hexi Corridor, has not been created by humans that shaped nature as an external force. Instead, it is the highly dynamic result of complex, socio-

1 Yang et al., "Climate Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years."

environmental processes as part of this symbiotic co-production that unfold over very long periods.[2] This longue durée of socio-environmental interrelationships, which led to severe degradation of ecosystems at watershed scales, provides the broad and long-term context for discussing today's conditions along the Hexi Corridor region.

Moore's concept of socio-environmental co-production informs the narrative on the Hexi Corridor's multi-dimensional formation and helps frame the challenges the region is facing today. One key period in this longue durée of the region's socio-environmental history is the beginning of systematic colonization during the early Han dynasty in the second century BC after the Chinese empire had been established as a somewhat unified and homogenous nation. The forced relocation of large numbers of people from the Chinese heartland in the fertile Central Plains to the arid, northwestern region, together with their growing non-native practices of land cultivation, introduced a fundamental change of the land use regime. This period of systematic colonization through the expansion of the early Chinese empire into the region is thus identified as the starting point of an over 2,000-year-long history of environmental transformation.

Colonization During the Early Han Dynasty: Transfer of Land Use Regimes and the Creation of a New Frontier

The territorial expansion of the early Han empire, especially during the reign of the seventh Emperor Wu, was a turning point in Chinese history: Aiming to become a dominating force in Asia, China emerged for the first time as an imperialist power. This imperial expansion transformed the extent of the Chinese empire, its racial-ethnic composition, its political culture, and its self-conception as a nation forever.[3] Emperor Wu launched the greatest expansion movement in Chinese history. Chinese troops conquered territories far outside the traditional Chinese sphere, such as in today's Gansu, Qinghai, Inner Mongolia, Sichuan, and Yunnan provinces, but also outside of modern China, such as in Vietnam and the Korean Peninsula, the Mongolian steppe, and Central Asia.[4] In the northwest, the Yellow River had defined China's border until then. In the search for potential foreign allies, the Han learned about other sedentary,

2 In his work, Moore argues that the emergence of early capitalism and global colonial expansion in the long 16th century of the Western European context must be understood as a critical moment in time that marks the beginning of human-induced transformations of the world's ecology, leading to the global environmental crises we experience today. He stresses the importance of human-environmental interconnections and their processes of co-production over long periods rather than individual historical events. Moore, *Capitalism in the Web of Life*."

3 Chang, *The Rise of the Chinese Empire: Ca. 1600 B.C.–A.D. 8*, 9–10.

4 Ibid., 67–68.

well-developed cultures, particularly in Central Asia. It later led to a worldview of international relations with China as the Middle Kingdom at the center, to which other nations were seen as subordinate and tributary. The Western Han's imperial expansion allowed the establishment of a large empire of one state under authoritarian rule and a centralized bureaucracy.[5] While the expansion fostered the strong centralization of state power in China, it simultaneously paved the way for future multinational networks of commercial and cultural exchange and a productive cross-fertilization with other nations.

New Perceptions of and Relations to Extra-Human Nature

From the very onset, the northwestern expansion and colonization of land far outside the Chinese heartland entailed fundamental conflicts and challenges that continued to be present and exacerbated throughout history. It marks not only the beginning of a territorial expansion but also the cultural expansion of a Chinese identity, perceptions of and relations to the extra-human environment that were transferred from the fertile Central Plains into the geographically very different northwestern steppes. The frontier region's systematic occupation and spatial reorganization began to dramatically transform the environment at growing scales.

Parallels can be read to the beginning of Western European imperialism in the long sixteenth century and the establishment of a capitalist system.[6] There are, of course, significant differences between Chinese imperialism during the early Han dynasty and European colonialism during the early Renaissance. In Europe, more than one and a half millennium later, colonialism was led by the systematic appropriation of far-detached territories for the extraction of value and the commodification of nature. State-financed, but increasingly also private corporations aimed to establish and control networks of trade and accumulation across trans-continental, global scales, which required the necessary technologies and a new geographic understanding of the world. Early Han imperialism was led by the interests of the central government and financed by

5 The far-western border during the Western Han in the Tarim Basin marked the limits of western expansion for almost all future dynasties due to geographic, economic, and cultural constraints. The two exceptions are the Mongol Yuan dynasty, which conquered China from the West, and the Tang dynasty, which established an administrative protectorate system over regions even further west. However, the Tang never managed to fully control these far-western regions. Chang, *The Rise of the Chinese Empire: Ca. 1600 B.C.–A.D. 8*, 264–65.

6 Jason Moore emphasizes the rise of a capitalist civilization after 1450, strategies of global conquest, endless commodification, and relentless rationalization, which brought an epochal shift in the scale, speed, and scope of land transformation, which he identifies as the origin of today's global environmental crises. He opposes the widespread perception of humans as separate from nature, acting upon it as an external force. His concept of the *Capitalocene* prioritizes the socio-political relations of power, capital, and nature—the relations *between* humans—as opposed to isolated historical events or technological innovations. Moore, "The Capitalocene, Part I;" Moore, *Capitalism in the Web of Life*, particularly chapter 7, "Anthropocene or Capitalocene?: On the Nature and Origins of Our Ecological Crisis."

the central state with the primary goal of national defense. Instead of detached colonies, early Chinese imperialism meant the expansion of the Central Chinese core as a continuous empire with a state-controlled trading network. Imperial Chinese nation-building was always defined by the spatial boundaries of its immediate frontiers. These frontier regions often defined the national goals, as well as the cultural identity of the Chinese empire, through the dynamic interplay between the subjugation and political control of the periphery and the conquest and colonization of the border regimes.[7]

While there are fundamental differences between China's early imperial expansion during the Western Han and the emergence of European colonialism in the long sixteenth century, they share the notion of radical socio-environmental regime shifts that allowed to reconceptualize, conquer, and spatially transform territorial space, according to new patterns of environment-making. Jason Moore argues to focus on the socio-environmental *relations* that produce certain outcomes rather than the consequences themselves.[8] His narrative of socio-environmental co-production allows to identify specific periods of such regime shifts as the origin of contemporary issues and challenges.

First Western Exploration and Growing Ambitions of Imperial Expansion

In 138 BC, the court official Zhang Qian was famously dispatched to travel westward as an envoy in a diplomatic mission to find alliances against the Xiongnu empire, namely the Yuezhi (Kushans) who had previously inhabited the Hexi Corridor and had been forced by the rise of the Xiongnu to settle further west in today's Uzbekistan. Zhang's mission was the first written attempt of the Chinese to expand their diplomatic relations, trading routes, and political influence outwards to the Western Regions beyond the Xiongnu state.[9] At the time, the Xiongnu were superior to early Han China in their flexible warfare with large and mobile cavalry raids. After a series of defeated attacks and counterattacks, the Han were forced to accept a humiliating tributary treaty. They

7 Chang, *The Rise of the Chinese Empire: Ca. 1600 B.C.–A.D. 8*, 212–13. In recent years, since the early 21st century, particularly during Xi Jinping's presidency and in the course of the Belt and Road Initiative, some describe Chinese foreign policy as imperialist or colonialist in a global context. Jeffrey Reeves, "Imperialism and the Middle Kingdom: The Xi Jinping Administration's Peripheral Diplomacy with Developing States," *Third World Quarterly* 39, no. 5 (May 4, 2018): 976–98; Jamil Anderlini, "China Is at Risk of Becoming a Colonialist Power," *Financial Times*, September 19, 2018, sec. Belt and Road Initiative; Ryan Cooper, "The Looming Threat of Chinese Imperialism," *The Week*, March 29, 2018. Some of these shifting geopolitical ambitions will be further discussed in chapters five and six. China, meanwhile, continues to claim that it had "never bullied, oppressed, or subjugated the people of any other country, and [it] never will." Xinhua News Agency, "Xi Says Chinese People Will Never Allow Foreign Bullying, Oppressing, or Subjugating," *China Daily*, July 1, 2021.

8 Moore, *Capitalism in the Web of Life*, 169–92.

9 Valerie Hansen, *The Silk Road: A New History* (New York: Oxford University Press, 2012), 14; 32–33.

Fig. 3.1: The Hexi Corridor played a critical strategic role in the early Han dynasty's campaigns to secure its northwestern borders and expand its influence towards Central Asia.

agreed to send a yearly tribute of goods and accept a marriage alliance. Despite these agreements, the Xiongnu continued threatening the Chinese with raids across the northern and north-western borders. This led to a shift from a strategy of peace through kinship to a more aggressive stance and the improvement of the Chinese military forces, including a large cavalry under Emperor Wu.[10]

While the Yuezhi showed no interest in cooperation against the Xiongnu, thanks to Zhang's journey to the West, from which he returned around 126 BC, the Han learned about the existence of several Central Asian states further west beyond the Xiongnu and active trading networks across these regions. As a result of this new worldview, and for the first time in history, the Han gained interest in expanding their territory toward Central Asia. In 121 BC, after many failed attempts, the Han finally succeeded in a large raid and were able to

10 Cunliffe, *By Steppe, Desert, and Ocean*, 270–71. This narrative is controversial: While in the Chinese narrative, it is the hostile Xiongnu tribes that attacked the Chinese states from the north, the historian Nicola Di Cosmo states that it was instead the northern Chinese that advanced against their northern neighbors. Military conflicts happened thus in reaction to Chinese aggression by nomadic states to reclaim their land. Di Cosmo argues that the nomads did not need access to Chinese agriculture and had no structural need to raid China as they were part of active trade networks with other societies. In contrast, the Chinese required horses and grasslands for pasture. Di Cosmo, *Ancient China and Its Enemies*, 156–57.

rush into the Hexi Corridor and all the way to today's city of Dunhuang at its western end. By 110 BC, the Xiongnu were defeated from the Hexi region and had retreated to the northern steppes.[11] [Fig. 3.1]

Early Han Colonization and its Patterns of Territorial Reorganization

Emperor Wu understood the effective pastoral organization of the Xiongnu in the geographic context of the vast grasslands. He recognized that in order to secure the northwestern border, it was not sufficient to simply defeat the Xiongnu. Instead, and this is fundamental for the narrative of this thesis, his plan was to eradicate them by forcefully transforming their steppe habitat and livelihood into a sedentary, agricultural ecosystem according to Chinese characteristics.[12] This systematic colonization and strategic environment-making across the newly occupied territories also included the forced relocation and settlement of large numbers of people.[13] A major challenge in this western extension was the logistical support of the remote, newly occupied regions with resources from the Chinese heartland. The Han, therefore, constructed defense lines and beacon towers for communication and supply along the frontier to continuously push further west. Eventually, the Han established a continuous defense infrastructure from east to west, demarcating the empire's northern border, including large-scale agricultural production.[14] These Han outposts were farming colonies managed by military troops who were also engaged in land cultivation and the construction of water irrigation systems. The military-agrarian settlements had multiple functions: First, to prevent the Xiongnu from gaining access to agricultural products; second, to provide logistic support for further Chinese expansion toward the west; and third, to protect and facilitate trade along this new corridor that began to be established.[15]

As mentioned in the previous chapter, the general trend of institutional homogenization that came along with the unification of China into a single em-

11 Chunshu Chang, *The Rise of the Chinese Empire: Frontier, Immigration, and Empire in Han China, 130 B.C.–A.D.157* (Ann Arbor: University of Michigan Press, 2007), 5–6.

12 Marks, *China: An Environmental History*, 89.

13 The Han sent around 600,000 garrison soldiers together with farming officials to the Hexi Corridor and its surrounding regions for both protection and land cultivation. Chang, *The Rise of the Chinese Empire: 130 B.C.–A.D.157*, 8.

14 This colonization scheme of military-agricultural colonies followed a general pattern (*tuntian*) that was adopted by later dynasties: In addition to their strategic importance, the location of military outposts was selected based on the availability of water resources and arable land to be able to function in a self-sustaining manner. Watch towers were constructed at certain repeated distances, developed into larger fortresses, or into regional commanderies, according to an administrative hierarchy. Four commanderies were established along the Hexi Corridor between 111 and 72 BC, which still exist under the same name today (in the order of their historical establishment): Jiuquan, Zhangye, Dunhuang, and Wuwei. Chang, *The Rise of the Chinese Empire: 130 B.C.–A.D.157*, 9–14.

15 Chang, *The Rise of the Chinese Empire: Ca. 1600 B.C.–A.D. 8*, 203.

pire, and which had already started during the Qin dynasty, was also a process of homogenization of people's relationship to their environment: The extension of agricultural practices into the Hexi region followed the notion of taming uncultivated land. This represented the victory of a civilized, agrarian society over a barbarian, nomadic one.[16] The colonization of the Hexi region and the integration of new territories into the Han empire defined a new Chinese frontier. Within these boundaries, the Han pursued an assimilation of both the people and the environment to establish a society that essentially functioned in the same manner as in the interior. However, the frontier regions were less dynamic, governed more rigidly, and under stricter political and military control.[17]

As the Han military moved beyond the Hexi Corridor into alien territory further west, they attempted to establish peaceful relationships with native societies. The Han implemented military and commercial control mechanisms but maintained the far-western regions as independent protectorates. In the political organization of this "outer empire," the Han followed a model of decreasing political control from the center outwards.[18] Together with economic reforms and state consolidation in the late second century BC, the frontier was expanded all the way into the Tarim Basin in today's Xinjiang, where colonial outposts served as exclaves with strong Chinese influence to keep control over the western regions, which were organized as protectorate states. This allowed to secure the Chinese heartland and offered new opportunities for trade and access to knowledge and material resources.[19] In addition, the colonization of new territories in the far-western steppe—including the Hexi Corridor—was used to relocate economically repressed, dislocated, and undesirable populations. This allowed to ease the economic pressure and political instability in some areas of Central China, particularly in the aftermath of natural disasters and poor harvests.[20]

In contrast to European colonialism, the Chinese had no strong desire for the land itself when colonizing the arid northwestern territories. While some believe that the Chinese were seeking new markets for outlets of surplus materials such as silk, access to foreign luxury goods that were in increasing demand, or the expansion of farmland and horse breeding grounds across fertile oases,[21]

16 Ibid., 211–13.

17 Ibid., 246–47.

18 The outer empire consisted of external colonies, which varied in size and character and were somewhat independent yet subordinate and tributary. Protectorates beyond the Han borders accepted suzerainty, were under military Han protection and obligation, but enjoyed political autonomy and partial sovereignty. Further outside in the periphery lay states that had been conquered by the Han but were not directly part of the colonial network. Chang, *The Rise of the Chinese Empire: Ca. 1600 B.C.–A.D. 8*, 258–60.

19 Cunliffe, *By Steppe, Desert, and Ocean*, 270–75; Di Cosmo, *Ancient China and Its Enemies*, 273–74.

20 Chang, *The Rise of the Chinese Empire: Ca. 1600 B.C.–A.D. 8*, 212.

21 Di Cosmo, *Ancient China and Its Enemies*, 247–48.

the primary interests in the northwestern expansion was clearly geopolitical: The Han realized that a stable border in the north would promise peace in the rest of the empire. In this endeavor, they followed a strategy that aimed to isolate the Xiongnu from their allies they depended on for trade and continuous tributary supplies—most notably the Qiang that inhabited the Tibetan Plateau along the southern end of the Hexi Corridor and periodically sparked military disputes.[22] Essentially, the colonization and control of the Hexi Plain allowed the Han to drive a wedge into the Xiongnu territories and cut them off from supplies of their allies further south.

While China did benefit from access to foreign goods and knowledge, Valerie Hansen points out that there were no ambitions of an exploration and trading network further west into Central Asia. The trading connections through the Hexi Corridor were primarily strategic as a means to cherish good relations with their western partners, bypassing the Xiongnu as their constant enemy. Trade didn't happen spontaneously but was carefully planned and executed by official envoys. Private businesses might only have occurred marginally, and there was never a mention of territories further west than the Kushan.[23]

Western Regions's Dependency on the Central State

While the early Han campaigns toward the west and Central Asia were successful, they came at a very high cost and economic sacrifice for the Chinese heartland. From its onset, the new settlements were not self-sufficient. Their development had to be financed by the central government, which was forced to increase taxes and monopolize certain products and industries to acquire more revenue.[24] These economic and institutional reforms towards state centralization, as well as the practice of massive national debt, continued through later periods.[25] As we will see in the following chapters, this dependency of northwestern regions (including the Hexi Corridor) on support from the central state created a strong legacy still present today.

At the end of the last century BC, the western extension had reached its limits and full expansion. The fully developed Han empire at that time was similar in its spatial expansion to modern China. This first period of imperial expansion thus defined the nation's future history, ecology, and cultural identity. The massive, geographically, ethnically, and culturally diverse empire was maintained and consolidated with military power, including a massive and

22 Ibid., 249–51.

23 The Kushan empire was formed in today's Afghanistan, Pakistan, and northern India by the Yuezhi, who had previously inhabited the Hexi region from where they had been expelled by the Xiongnu. Hansen, *The Silk Road*, 18.

24 The military campaigns and colonization of northwestern regions during the reign of Emperor Wu put enormous economic strain on the empire as their costs were several times higher than the total annual revenue. Chang, *The Rise of the Chinese Empire: Ca. 1600 B.C.–A.D. 8*, 246.

25 Chang, *The Rise of the Chinese Empire: Ca. 1600 B.C.–A.D. 8*, 252–53.

costly frontier system. However, it faced—and still faces today—inherent tensions and regional disparities that the central court and bureaucracy tried to balance.[26] Eventually, this first period of territorial expansion exhausted China's economic resources and workforce, destabilized the Western Han empire, and led to its decline.[27] Throughout the history of the following dynasties, the Chinese empire contracted and expanded. While the Hexi Corridor remained a constant part of China's territory throughout most of the nation's long history, the protectorates west of the Hexi Corridor and many other frontier regions were not part of the empire when Central China was weak. Yet, in times of territorial expansion when China was strong and unified, former Chinese outposts in the far west were reactivated along two routes leading north and south around the Tarim Basin.[28]

***

Three things should be highlighted in the history of western expansion during the early Han regarding the Hexi Corridor as they seem to be present until today: First, its significance for the central government primarily for strategic, geopolitical reasons rather than for its land value. Second, the logistic challenges to supply and sustain this remote and arid region depended, from the onset, on support from the Chinese heartland—even though its cities became very prosperous and more autonomous during certain periods. Third, while the Hexi Corridor started to be integrated into China's empire as a narrow stretch and, essentially, as the western extension of the Central Plains, the vast surrounding territories kept a somewhat independent status while being controlled by imperial rule. Even though many ethnic minorities still live along the Hexi Corridor today,[29] this socio-political function as a corridor dominated by Han Chinese within ethnically diverse autonomous regions is an important legacy from that period. In addition, many of the environmental problems that have their origin in the period of early Han imperial colonization have long become concerns far beyond the scale of isolated localities. The degradation of ecosystems has grown to watershed scales, affecting the entire world region and China as a nation. The over 2,000-year-long fluctuating history of environmental degradation will be discussed next.

---

26 Ibid., 265–66.

27 Ibid., 67–69.

28 Di Cosmo, *Ancient China and Its Enemies,* 236–52; Chang, *The Rise of the Chinese Empire: Ca. 1600 B.C.–A.D. 8*, 212–13; see also chapter 5, "The Han March to Inner Asia," (p.215–37) for the colonization of regions further west beyond the Hexi Corridor.

29 Gansu's population is made up of 45 different ethnic groups. Xiao, Li, and Liang, *Gansu: Grottoes on the Ancient Silk Road*, v. In 2020, 10.62% of the province's population belonged to ethnic minorities. Survey Office of National Bureau of Statistics in Gansu, "Gansu Development Yearbook 2022." Specific numbers for the ethnicity in individual municipalities along the Hexi region could not be found.

An Over 2,000-Year-Long History of Environmental Transformation

The beginning of China's imperial expansion into peripheral, foreign regions is not only a pivotal moment in the history of Chinese nation-building but also in the history of the Hexi Corridor's spatial reconception and physical transformation. As described, a radically different socio-environmental regime was introduced to the region, including different worldviews, attitudes to extra-human nature, forms of settlements and construction, and new ways of using, organizing, and belaboring the ground. This radical regime change began to alter ecosystems in their morphological and species composition.

Across the different centuries and dynasties that followed, the Hexi Corridor was continuously reshaped by complex processes of socio-environmental co-production, leading either to periods of environmental degradation or rehabilitation. As mentioned, these interrelationships of social and environmental forces did not happen as linear processes but in fluctuating cycles following different timelines and intensities. Until the late Ming dynasty (late sixteenth to mid-seventeenth century), population numbers across the Hexi Corridor remained relatively low. There seems to be a consensus that until the population density reached a certain threshold during the early Qing dynasty around three hundred years ago, large-scale desertification and severe land degradation were not primarily influenced by demographic numbers but by changing climatic conditions, which were the more decisive factors.[30] For instance, there are signs that significant desertification occurred during the Wei dynasty (sixth century AD) despite very low population numbers of just around 25,000 in the Hexi region at the time, but as the result of exceptionally dry climatic conditions.[31] As population numbers continued to grow over the past three centuries, human activities gradually replaced climatic conditions as the main factor causing the degradation of land and collapse of ecosystems at increasing scales.[32] [Poster A]

Before the Han Chinese colonized the Hexi Corridor, the region was inhabited by nomadic tribes. Construction and agriculture were limited, and sparse populations had little impact on extra-human nature. These nomadic societies lived in the oases mainly from hunting and gathering. They used the vast grasslands for herding and depended on a balanced and functioning environment. The oases, surrounded by steppes and deserts, created diverse eco-

30 Wang et al., "Historical Desertification Process in Hexi Corridor, China;" Li, *Desertification History Along the Hexi Corridor*; Linhai Yang et al., "Historical Settlement Abandonment in the Middle Hexi Corridor Linked to Human-Induced Desertification," *Palaeogeography, Palaeoclimatology, Palaeoecology* 545 (May 1, 2020): 109634.

31 Wang et al., "Historical Desertification Process in Hexi Corridor, China," 249–50.

32 In the early Qing dynasty, the population density exceeded a critical stage with a water usage rate of over 40%, causing high pressure on the extra-human environment. Wang et al., "Historical Desertification Process in Hexi Corridor, China," 249.

systems with high biodiversity. The river bends in the oases were full of water. In the low-lying basins, the large streams supplied hundreds of lakes, marshes, and wetlands with water. Across the oases grew abundant broad-leaved forests (*Populus euphratica),* reeds, shrubs, and grasses. Also, the fauna was rich with deer, camels, horses, wolves, herons, and many other wild animals.[33]

As described, the shift from a nomadic to a sedentary society through China's western extension from the heartland introduced radically different land use regimes into the region.[34] With the region's colonization for geopolitical objectives, the Hexi Corridor was fundamentally reconceived as a strategic territory. It began to be systematically reorganized and spatially reconstructed according to the patterns of Han colonization. As hundreds of thousands of troops, workers, and families were relocated to occupy and cultivate this new northwestern frontier region, the sudden population growth brought a sharp increase in the consumption of natural resources.[35] The construction of a new network of military outposts, farming settlements, and material-intensive fortification structures required large amounts of wood, leading to the deforestation of large portions of the trees growing in the oases. In addition, wood and grass were used as fuel and to feed growing herds of cattle and horses.[36] Agriculture in the Hexi region's arid environment requires land irrigation. Therefore, water bodies were filled in and drained for land reclamation, and rivers and creeks were diverted and channelized, fundamentally altering the natural hydrological system.[37] In parallel to new spatial practices of land use, Han Chinese also

33 Li, *Desertification History Along the Hexi Corridor*, 140–42.

34 A nomadic regime depends directly on the existing grassland and allows it to recover by seasonal migration. Overgrazing is thus usually not a problem, and the soil structure is not destroyed by plowing and loosening the ground on a large scale. A sedentary lifestyle with intensive agriculture eradicates the natural grass cover and requires the land to be constantly maintained, plowed, fertilized, and irrigated, making it vulnerable to wind erosion. Li, *Desertification History Along the Hexi Corridor*, 148.

35 The population peaked during the first phase of colonization at the end of the Western Han (2 AD) at around 370,000. This number most likely never exceeded until the late Ming dynasty in the 16th century, when it began to grow rapidly. Yang et al., "Historical Settlement Abandonment in the Middle Hexi Corridor Linked to Human-Induced Desertification," 5–6.

36 The breeding of horses and cattle had added a new dimension to Chinese agriculture. China had, for the most part, existed without large-scale pastures for grazing until the Western Han recognized the need to build up a strong cavalry, given the superiority of the mounted Xiongnu tribes. Therefore, they began to breed large numbers of horses across vast grasslands along the northern frontier, eventually enabling them to defeat the Xiongnu and control the vast territory of grassland steppes. Marks, *China: An Environmental History*, 89.

37 Decreasing water supply transformed the soil and species composition. Sinking groundwater that became increasingly intermittent and unstable allowed only certain species to continue to grow. Tamarisk shrubs (*Tamarix chinensis*), with their strong, tillering roots, became the dominating species in many areas. Other species, such as poplar trees (*Populus euphratica*), which are less robust and susceptible to periods of drought and low groundwater tables, disappeared. Riverbeds that dried out turned into habitats for xerophytes, such as nitre (*Nitraria tangutorum*). While deserts could be turned into farmland through land irrigation, these areas were also most vulnerable in times of water shortage and were often exposed to wind erosion.

introduced non-native crops, herbs, and fruit plants from the Central Plains to the region, as well as invasive species that transformed plant communities.[38]

The Tang dynasty (618–907) brought a second peak of transregional exchange and introduced non-native plants, animals, technologies, and cultures to the Hexi region. The rapidly growing population and land reclamation during the Ming (1368–1644) and Qing (1644–1912) dynasties coincided with a climatically cold and dry period, also referred to as the Little Ice Age (1400–1900). This disconnect between climate and population numbers illustrates that even though climatic change is an important factor affecting social development, it is not necessarily the most decisive. While the diversification of species, agricultural practices, and technologies over the centuries led to an intensification of land use, it also increased human resilience to climatic change and environmental disasters.[39]

The Watershed as the Spatial Unit and Inherent Logic of Landscape Thinking

The following describes the complex, socio-environmental processes that reshaped the Hexi Corridor over the centuries. In many cases, radical shifts along the remote northwestern frontier were caused by changing political and socioeconomic regimes in the Chinese heartland. As it has been discussed, the Hexi Corridor consists of a series of sensitive, interdependent ecosystems. Through the reciprocity of interlinked ecosystems, anthropogenic interventions at one end can have far-reaching consequences at another. And if such interventions grow in scale and intensity over long periods, it can lead to an imbalance of the entire interrelated system, consisting of human beings, natural resources, and environmental processes. This can then cause severe environmental and socioeconomic degradation across the whole watershed.

Li, *Desertification History Along the Hexi Corridor*, 146–47; 152–53.

38 The Han introduced more than twenty non-native crops and vegetable species that were domesticated in the Hexi Corridor, such as millet, wheat, barley, sorghum, and soybeans; onion, ginger, pepper, and grapevine. Yang et al., "Climate Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years." Thanks to author Shi Zhilin for sharing a detailed table of historically domesticated species in the Hexi Corridor. The physiology of native species differs from non-native, cultivated ones: While non-native plants generally have a larger ecological range, they are much less capable of adapting to the arid steppe's specific, harsh conditions. Native species are mostly perennial and have a higher ability for reproduction and regeneration. They are better at conserving water and soil, thus more easily resisting wind erosion and droughts. Therefore, a shift to non-native, in many cases, annual species makes ecosystems more fragile and more dependent on a stable water supply. Li, *Desertification History Along the Hexi Corridor*, 144–46.

39 International trade via the overland and maritime Silk Roads across continents facilitated such innovations. For instance, during the Ming and Qing, traditional crops such as wheat, millet, and beans were replaced with high-yielding and robust American crops such as corn and potatoes. Yang et al., "Climate Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years," 619.

This historical narrative illustrates how changing social formations affected the vitality and stability of the region over the longue durée. Moreover, it points to the origin of environmental challenges that characterize the region until today. Located in an arid transitional zone, the Hexi Corridor is very sensitive to climatic change. Water is the region's lifeblood, linking environmental with social systems and environmental stability with economic prosperity.[40] The Hexi Corridor is highly water-stressed as the utilization ratio of the available water resources exceeds the annual recharge.[41] Following the previous chapter, the narrative is structured geographically along the logic of the watershed from the water source in the Qilian Mountains; to the fertile upper and middle reaches; and all the way to the arid plains in the river system's lower reaches. The primary literature source for this socio-environmental history of the Hexi Corridor is an extensive, multi-disciplinary record about the long-term processes of environmental degradation and desertification across the Hexi Corridor by Li Bingcheng, which the text has already referred to several times.[42] Posters B and C provide a comprehensive diagrammatic representation of the different forces and entangled processes across the Hexi Corridor's watersheds.

The Qilian Mountains as the Source of Water

Water from the Qilian Mountains is the source of virtually all life along the Hexi Corridor. [Fig. 3.2] The mountains' ecological stability is crucial for the entire region. Before large-scale development began in the Hexi Corridor, the Qilian Mountains were inhabited by small numbers of herding communities, which had only a small impact on the functioning of natural ecosystems. However, throughout imperial Chinese history, interesting examples show how balanced ecosystems in the mountains were affected and disturbed by changing

40 89% of the available surface runoff derives from precipitation and 11% from melting water. Changing precipitation patterns have thus a direct impact on the ability of water and the potential for land cultivation in the Hexi plain. Yang et al., "Climate Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years," 616.

41 In 2003, the overall utilization rate of water resources in the Hexi Corridor reached 102%: In the Shiyang River watershed, the ratio was 154%; in the Heihe River watershed, 112%; and in the Shule River watershed, 76%—much higher than the internationally recognized alarm threshold of 40%. Most areas are, therefore, forced to overexploit the limited groundwater sources. Chao Bao and Chuanglin Fang, "Water Resources Constraint Force on Urbanization in Water Deficient Regions: A Case Study of the Hexi Corridor, Arid Area of NW China," *Ecological Economics* 62, no. 3 (May 15, 2007): 510–11.

42 Li, *Desertification History Along the Hexi Corridor*. Several scholars I talked to in spring 2019 recommended this book as a thorough and unique, multi-dimensional description of the complex socio-environmental processes that led to the long-term degradation and desertification of the Hexi region. The book was published in 2003 in the course of Jiang Zemin's Great Western Development Strategy and the "grand vision of reunifying China, including the northwestern territories" (p. i). The book is a prime source to understand many of today`s socio-environmental challenges that the region is facing. While there are many publications of natural scientific studies on the Hexi Corridor, very few other studies could be found that provide a comprehensive environmental historical narrative of the region.

populations and socio-political and cultural activities in the surrounding plains.

With the beginning of large-scale immigration during the Western Han, the foothills and mountain valleys, with their lush meadows and rich freshwater sources, were used for herding cattle and sheep, food production, and grass mowing. As wood became less available over time in the increasingly deforested oases of the Hexi Plain, people turned to the Qilian Mountains with its abundant forests of spruce, pine, and juniper trees. Timber and firewood started to be harvested from increasingly high altitudes. Already during the Western Han dynasty, records documented large quantities of timber from the mountains. Even the far-distant ancient city of Jincheng (today's Lanzhou) depended on supply from the Qilian Mountains, showing the lack of wood in the greater region. Also, the first records of policies banning logging, hunting, and habitat destruction stem from this early period.[43]

During the prosperous Tang dynasty, the population and land cultivation grew rapidly across the Hexi Corridor. Canals were built to direct water from the foothills and higher up in the mountains to agricultural fields in the lower plains, which required large amounts of timber. The city of Dunhuang became a central hub along the Silk Roads and a major religious center. Buddhist temples grew in large numbers across the whole Hexi region. Dunhuang's Mogao Caves alone counted over 1,000 grottoes at that time. These places of worship required large amounts of wood for construction but also for firewood and pressing oil for lamps. The deforestation it caused and all other construction activities must have been significant, as many records of that time report,[44] serving as examples of the far-reaching consequences such cultural activities could have on the environment.

Increased deforestation on the mountain slopes led to higher soil erosion and devastating floods.[45] The increasing environmental degradation raised concerns among monks and local governments who implemented policies and institutions to protect and manage forests and grasslands in the mountains.[46] Concerns about habitat destruction across the Qilian Mountains continued in later periods, such as the Qing dynasty (1644–1911), when strict laws and regulations were introduced to prohibit felling and regulate forest management.[47]

In addition, the Qilian Mountains were a refuge for people from the Hexi Corridor but also from Central China in times of war and turmoil. Conflicts such as during the Sixteen Kingdoms period (304–439) periodically led to strong increases in human populations in certain localities, putting pressure on mountainous ecosystems. Many forests were then cleared—often with practic-

43 Li, *Desertification History Along the Hexi Corridor*, 167–69.
44 Ibid., 170–75.
45 Ibid., 175.
46 Ibid., 156–158, 174–76.
47 Ibid., 180.

Fig. 3.2: Pastures and snow-covered peaks at Biandukou Pass at over 3,600 meters elevation crossing from Zhangye in the Hexi Corridor to Xining in Qinghai province; October 2019.

es of large-scale burning—for land cultivation and animal husbandry.[48] With a strong population growth in the late Ming dynasty, pressure on the Qilian Mountains as a source of wood and for agricultural development increased once more. Deforestation along the foothills, in addition to dry climates and droughts, turned formerly dense forests into dry and barren land with loose soils and high erosion rates.[49]

Increasing activities in the Qilian Mountains damaged vital habitats for the water regime's conservation, regulation, and stability, which always had direct impacts on the ecosystems further downstream throughout history. Today, only a small portion of the land suitable for forest growth is covered with trees. Logging, overgrazing, cropland misuse, and the unregulated collection of plants for fuel and herbal medicine have been the main reasons for land degradation in the Qilian Mountains. In modern China, mining, transportation infrastructures, and, more recently, a growing tourism industry pose additional pressure

48 Ibid., 170, 180. During the wars after the end of the Qing dynasty and later during the turmoil of the Great Leap Forward and Cultural Revolution, the number of people who fled to the Qilian Mountains strongly increased periodically. However, no numbers or details about refugees during that time could be found. Ibid., 181.

49 Ibid., 177.

on the sensitive alpine ecosystems.[50]

The soil on the northern mountain slopes is generally already relatively thin. Removing vegetation cover further reduces the soil thickness, as well as its nutrient and organic matter content, leading to increased erosion and land degradation. Plowed land conserves much less water than soil covered with trees, shrubs, or grassland. Herding, which causes densification of the earth, and the reduction of organic matter on bare ground reduce the soil's water storage capacity even further.[51] Dense forests also provide shade, protecting the winter snow from melting, stabilizing, and retraining it on steep slopes. In cases where ground and tree cover are destroyed, water seeps directly into the ground while snow melts quickly and gets washed away. Instead of a steady flow of melting water across the spring and summer, this leads to more substantial and frequent floods, causing intense erosion and destructive mudflows.[52]

High Land Use Intensity in the Upper and Middle Reaches

As part of the Hexi Corridor's systematic colonization during the Western Han, several hundred thousand people were moved to the new frontier.[53] The destruction of desert vegetation began primarily along the edges of the oases. Wood was used for firewood and construction; shrubs and grasses were harvested to feed livestock. Garrison soldiers were ordered to engage in clearing, collecting, and transporting vegetation in large quantities.[54] As described, one key component of the Western Han's colonization was the establishment of a remarkable, dense web of roads and watchtowers for communication and transportation, as well as massive fortification structures to protect the newly occupied territories from the defeated northern Xiongnu neighbors. Chunshu Chang provides a detailed account of this system, particularly on the construction of the northernmost outpost in the Juyan oasis. Buildings, watchtowers, and defense walls were built with stamped clay bricks and rammed earth walls that were reinforced with wooden branches, reeds, and grasses.[55] These construction activities required huge amounts of vegetation that were cut over a relatively short amount of time along rivers and across the oases.

50 Duan et al., "Mapping and Evaluating Human Pressure Changes in the Qilian Mountains," 1–13.

51 Yao et al., "Alpine Grassland Degradation in the Qilian Mountains, China — A Case Study in Damaying Grassland," 494–500.

52 Li, *Desertification History Along the Hexi Corridor*, 178–79.

53 It included military troops, forced, and voluntary migrants who were offered free land and government support, yet under a strict regime of military control and the duty to remain in the assigned location. Chang, *The Rise of the Chinese Empire: 130 B.C.–A.D.157*, 15–16.

54 Western Han records meticulously document hundreds of troops engaged in cultivation and thousands of bundles of wood, reed, and grass used for fuel and construction. In some cases, there were plantations for the production of organic fuel. Li, *Desertification History Along the Hexi Corridor*, 149–52.

55 Chang, *The Rise of the Chinese Empire: 130 B.C.–A.D.157*, 91–99.

In times of peace, the cutting, collecting, and transporting of wood—which was also used in large quantities for beacon fires—was often the main duty of garrison soldiers.[56]

As farming intensified and extended across the oases, the natural water regime was increasingly altered by surface runoff that was diverted through a system of irrigation channels. Already during the Han dynasty, but exacerbated in the Tang, Ming, and Qing, less water was available further downstream, and certain areas in the lower reaches experienced seasonal water shortages or were even cut off from water supply.[57] After the collapse of the Han dynasty, the transfer of people from the Chinese heartland to the northwestern frontier came to an end. The population, at least in the eastern part of the Hexi Corridor, sharply decreased, and human activities were reduced. This allowed destructed ecosystems to recover to a certain degree. However, it was not only the influence from the eastern Chinese heartland that caused political collapses or enabled economic prosperity in the Hexi region. For instance, while the fall of the Han dynasty was followed by political fragmentation, socio-economic decline, and rebellious turmoil across the Central Chinese Plains during the Wei-Jin period (220–317 AD), the area around Wuwei, which had so far been the cultural and political center of the Hexi region, collapsed. But simultaneously, the western part of the Hexi Corridor with the cities of Jiuquan and Dunhuang, which had been mere military outposts during the Han, emerged as an independent and prosperous region. Its military colonies were reorganized into farming communities, facilitating trade and cross-cultural interaction with Central Asia.[58]

Coinciding with a warm and humid climate, the Tang dynasty brought growing numbers of people, farming activities, and economic revitalization to the region. The consumption of natural resources, deforestation, and mechanical land use by herding and intensive land cultivation increased. After years of conflicts and changing administrations, garrison soldiers were once again forced into the region to secure, organize, and manage the land according to similar patterns as during the Han, yet with more sophisticated technologies for construction and agriculture.[59] Overall, environmental degradation during the Tang dynasty remained relatively isolated as sufficient water resources were available. At the height of the Tang, before 755, the Hexi Corridor saw one of its most prosperous periods as a rich agricultural region with a robust and feudal trade economy, international connectivity, cultural exchange, and technological innovation.[60]

---

56 Li, *Desertification History Along the Hexi Corridor*, 152–53.

57 Ibid., 237, 251.

58 Heather Clydesdale, "Rethinking China's Frontier: Archaeological Finds Show the Hexi Corridor's Rapid Emergence as a Regional Power," *Humanities* 7, no. 3 (September 2018): 63, p.5.

59 Marks, *China: An Environmental History*, 90.

60 Hansen, *The Silk Road*, 237.

Mild climatic conditions made the high-latitudinal frontier regions suitable for agricultural production and attracted many farmers to settle and engage in land cultivation, increasing the competition among nomadic societies. With the beginning of the An Lushan Rebellion (755–763 AD), the Tang government cut off subsidy payments to its allied western states. The Tubo broke in from the Tibetan Plateau and gradually occupied the Hexi Corridor. The Silk Road economy collapsed, and most troops retreated from the region.[61] The An Lushan Rebellion can be traced back to specific socio-environmental constellations in the course of an unusually arid climate: While the high alpine territory of the Tubo benefitted from higher yields due to milder temperatures, regions in lower altitudes experienced several years of droughts that had negative impacts on agricultural production, leading to food shortages, increased territorial competition, and aggression. Settlements and cultivated fields were abandoned, the population decreased, and most areas shifted from a feudal-agricultural into a nomadic regime.[62] The arable land, however, did not recover by the shift back to an extensive land use regime. On the contrary, the sudden end of maintenance and irrigation turned fertile fields into barren soil, making them vulnerable to erosion and desertification.[63] For several hundred years, the Hexi region was basically detached from China's central government control. During the Song dynasty (960–1279), the Hexi Corridor was detached from central China and controlled by the Western Xia until it was conquered and integrated into the Yuan dynasty (1271–1368). The Western Xia and the Yuan both fostered agricultural production and advanced farming technologies in the region.[64]

During the Ming dynasty (1368–1644), the increasing demand for natural resources led to the loss and overuse of grasslands on large scales. The available farmlands could no longer sustain a growing population, forcing people to find food and fuel in increasingly remote areas. Turf was harvested as fuel, destroying the soil composition and accelerating desertification. Territorial expansion led to conflicts and land disputes.[65] Court documents from the early Qing dynasty discuss attempts for the illegal use of water sources,[66] disputes around water access, particularly between communities further up and downstream of watersheds, and the implementation of increasingly strict policies and regulations.[67]

The alternating shift from land reclamation, irrigation, and intensive agri-

61 Yang et al., "Climate Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years," 620.
62 Ibid.," 620.
63 Wang et al., "Historical Desertification Process in Hexi Corridor, China," 248.
64 Yang et al., "Climate Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years," 620.
65 Li, *Desertification History Along the Hexi Corridor*, 162.
66 Ibid., 282.
67 Ibid., 230–35.

culture to abandonment and back to an extensification of the land use regime is characteristic of the Hexi Corridor's long-term environmental history. However, land that had once been reclaimed and cultivated and later experienced a period of degradation and desertification became very difficult to reactivate as productive agricultural land. While it was somewhat feasible in conditions of abundant water supply in upper river reaches, it was almost impossible in the lower end of watersheds unless the groundwater remained high.[68] In many cases, the shift from intensive farming to extensive animal husbandry even exacerbated processes of land degradation as herds of livestock tended to destroy irrigation canals and trample barren ground, which was then exposed to wind erosion.[69] In addition, soil that was no longer covered with vegetation—particularly in areas along rivers—got washed away, silted up irrigation channels, created destructive mudflows, and caused large sediment deposits further downstream, which could then be picked up by winds.[70]

The transition zone between the oases and the open desert is particularly crucial to stabilizing a sensitive oasis ecosystem. These transition zones can be up to ten kilometers wide, and their soil is usually very low in organic matter.[71] While the groundwater level in these areas is not as good as inside the oasis, it is usually still relatively high, allowing xerophytic shrubs and grasses to grow (*Tamarix ramosissima, Nitraria tangutorum, Artemisia ordosica*). These plants fix loose sand, and even if the vegetation cover is sparse, it shields the farmlands inside the oasis from erosion and sandstorms.[72] In past centuries, despite their ecological importance, these shrubs surrounding the oases were often cut first and harvested for firewood, animal feed, fertilizer, and construction material. The cleared areas were then used for grazing or to extend irrigated fields. In times of ecological decline, this land in the transition zones was generally very vulnerable to water shortages and often had to be abandoned first. This is because once the irrigation regime inside the oases was interrupted, the transition zones received less seepage water and quickly dried out.[73]

In modern history, since the 1950s, the oases have grown significantly in size. Large areas of grassland, shrubland, and desert were reclaimed and turned into farmland.[74] In the 1950s, The Chinese government declared the Hexi Cor-

68 Yang et al., "Historical Settlement Abandonment in the Middle Hexi Corridor Linked to Human-Induced Desertification," 7–9.

69 Li, *Desertification History Along the Hexi Corridor*, 262.

70 Ibid., 264–65.

71 Su et al., "Ecological Effects of Desertification Control and Desertified Land Reclamation in an Oasis–Desert Ecotone in an Arid Region," 118.

72 One Tamarix shrub (*Tamarix chinensis*) alone can fix up to 25m3 of sand. Li, *Desertification History Along the Hexi Corridor*, 149.

73 Ibid., 237–38.

74 Qiang Bie and Yaowen Xie, "The Constraints and Driving Forces of Oasis Development in Arid Region: A Case Study of the Hexi Corridor in Northwest China," *Scientific Reports* 10, no. 1 (October 19, 2020): 17708, 5.

Fig. 3.3: Network of channels and groundwater wells used to irrigate farm fields; Wuwei, September 2019.

ridor one of ten national Commodity Grain Bases. Grain production became the ultimate incentive, and peasants were, once more, encouraged to open up wastelands and grasslands for land cultivation.[75] In the course of the region's gradual industrialization, reservoirs were built to control the water flow and supply a growing population with water for land cultivation. Concrete channels were built to prevent water from infiltrating into the ground, increasingly engineering the already strongly modified hydrological system and further reducing the aquifer recharge. In addition, thousands of wells were drilled to tap into the groundwater sources, including deep wells with depths of several hundred meters. In the late 1970s, policies were implemented to liberalize agricultural production, further promoting land reclamation in the Hexi Corridor. Simultaneously, the awareness of severe land degradation and desertification grew. Strict policies and restoration campaigns began to be implemented with the help of the central government.[76] [Fig. 3.3]

75 Together with the large number of people who were encouraged or forced to move to the arid northwest, the number of grazing animals also multiplied, which had devastating consequences for the land. National Research Council, *Grasslands and Grassland Sciences in Northern China*, 31–32. As discussed in the next chapter, many socio-political campaigns dramatically harmed the natural environment. They promoted agricultural production and sent thousands of people to remote regions to reclaim land for farming.

76 Xue et al., "Policies, Land Use, and Water Resource Management in an Arid Oasis Ecosys-

In the late 1980s, the overall desertification in the Hexi Corridor could be stabilized.[77] However, there were stark differences across the three watersheds and within each oasis, simultaneously shrinking at one end and expanding at another,[78] and depending on local geomorphological conditions such as slope, sun exposure, and soil composition.[79] Across the thirty years between 1984–2014, fifty percent of the total oasis area was affected by such change, illustrating the degree of highly dynamic transformation.[80] Across the Hexi region, precipitation, temperatures, and runoff from the Qilian Mountains have all moderately increased since the late 1980s. Spring precipitation is thereby particularly important for vegetation growth and has increased significantly in northwestern China in general[81] and the Hexi region in particular.[82]

Precipitation is generally the most significant factor for vegetation growth: First, in the Qilian Mountains, particularly in the western part, where more rainfall contributed to the growth of the sensitive alpine grassland, and second, in the arid plains, where higher precipitation rates led to more runoff water available for irrigation. The temperature has a less significant effect but can contribute to stronger vegetation growth in temperate and irrigated environments. Despite abundant rainfall, it started to show negative effects on forest vegetation in the eastern section of the Qilian Mountains.[83] Global climatic change has likely caused higher temperatures and larger quantities of runoff from the Qilian Mountains due to faster glacier melting rates.[84] The larger availability of water resources from higher precipitation rates and melting water helps mitigate desertification. However, in the long term, higher temperatures will lead to a rising snowline, shrinking glaciers, and less evenly distributed annual melting water.

---

tem," 1043–46.

77 Bie and Xie, "The Constraints and Driving Forces of Oasis Development in Arid Region."

78 Zhu et al., "Monitoring Interannual Dynamics of Desertification in Minqin County, China, Using Dense Landsat Time Series;" Xie et al., "Spatio-Temporal Changes of Oases in the Hexi Corridor Over the Past 30 Years;" Xiuxia Zhang and Yaowen Xie, "Detecting Historical Vegetation Changes in the Dunhuang Oasis Protected Area Using Landsat Images," *Sustainability* 9, no. 10 (October 2017): 1780.

79 Bie and Xie, "The Constraints and Driving Forces of Oasis Development in Arid Region," 3–5.

80 Overall, the oasis area in the Hexi Corridor between 1986 and 2014 has grown by almost 40%. 27% of the total oasis land experienced expansion, mainly in middle reaches and due to farmland reclamation. Meanwhile, 12% experienced shrinkage, mainly in the lower reaches and because of desertification or the abandonment of cultivated land. Xie et al., "Spatio-Temporal Changes of Oases in the Hexi Corridor Over the Past 30 Years," 11, 15.

81 Xunming Wang et al., "Desertification in China: An Assessment," *Earth-Science Reviews* 88, no. 3 (June 1, 2008): 188–206.

82 A change to a warm-wet period, starting in the late 1970s, led to higher precipitation rates in the Qilian Mountains and the Hexi Corridor due to changing patterns in large-scale atmospheric circulations. Cheng et al., "Recent Changes in Precipitation Extremes in the Heihe River Basin, Northwest China," 1400.

83 Guan et al., "Greening and Browning of the Hexi Corridor in Northwest China," 13.

84 Xie et al., "Spatio-Temporal Changes of Oases in the Hexi Corridor Over the Past 30 Years," 14.

Deteriorating Land in the Lower Reaches

The areas at the bottom end of the Hexi Corridor's watersheds underwent the most substantial transformation over time. In all three watersheds, vast lakes, salty wetlands, and marshes once filled the low-lying basins in endorheic depression zones. Reacting to both climatic change and human activities further upstream, they expanded and shrank over the centuries. The endorheic lakes were filled by floods during spring and winter and dried out in periods of droughts. The former extent of the lakes and water systems in the lower reaches can be estimated from satellite images and archeological shorelines, showing that the water level in these basins used to be much higher.[85] [Fig. 3.4]

The terminal lake of the Heihe River watershed, the Juyan Lake, located far north of Zhangye in Inner Mongolia, had once reached over 4,300 square kilometers in prehistoric times.[86] The grassland in the basin served as productive pasture grounds for nomadic Mongolian tribes[87] and was developed into an important military garrison during the early Han dynasty.[88] The Han began to turn the areas of retracting lakes into farmland. The oases could thus be significantly expanded, using land that had once been covered by water and marshes. However, as the groundwater sank due to drier climates and increasingly intensive water use further upstream, these areas dried out and degraded.[89] Because of the area's harsh climatic conditions with high evaporation rates and strong winds, people have always struggled with land cultivation for centuries. In some cases, land was reclaimed, cultivated, abandoned, and several centuries later cultivated and abandoned again.[90] Today, most of the terminal lakes have vanished completely. Togther with the water and marshlands, valuable habitats for plant and animal species have disappeared.[91] But even until not too long ago, large lakes still existed: The West Juyan Lake dried out in 1961, while its eastern counterpart was still over thirty-five square kilometers large in 1958,

85 The main bodies of water were the Zhuye Lake in the Shiyang River watershed in the east, the Juyuan Lake in the Heihe River watershed in the center, the Huahai Lake, as well as the famous Lop Nur Lake in the far west of the Shule River watershed. At some point, these lakes covered thousands of square kilometers. Naiang Wang et al., "High Lake Levels on Alxa Plateau During the Late Quaternary," *Chinese Science Bulletin* 56, no. 17 (June 1, 2011): 1799–1808; Wang et al., "Historical Desertification Process in Hexi Corridor, China."

86 Wang et al., "Historical Desertification Process in Hexi Corridor, China," 246.

87 Thevs et al., "Study Areas: The Heihe River Basin and Wuliangsuhai Lake at the Hetao Irrigation District," 31.

88 Chang, *The Rise of the Chinese Empire: 130 B.C.–A.D.157*.

89 Wang et al., "Historical Desertification Process in Hexi Corridor, China," 188–206.

90 Archeological studies show that the northern part of the Juyan oasis, for instance, was used by prehistoric, nomadic cultures, as well as cultivated and inhabited during the early Han, Western Xia, and Yuan dynasties, with long periods in between where the land was abandoned and deserted. In each case, desertification processes must have begun immediately after the land was abandoned and no longer irrigated. Li, *Desertification History Along the Hexi Corridor*, 242f.

91 Wang et al., "Environmental Degradation in the Hexi Corridor Region," 70–74.

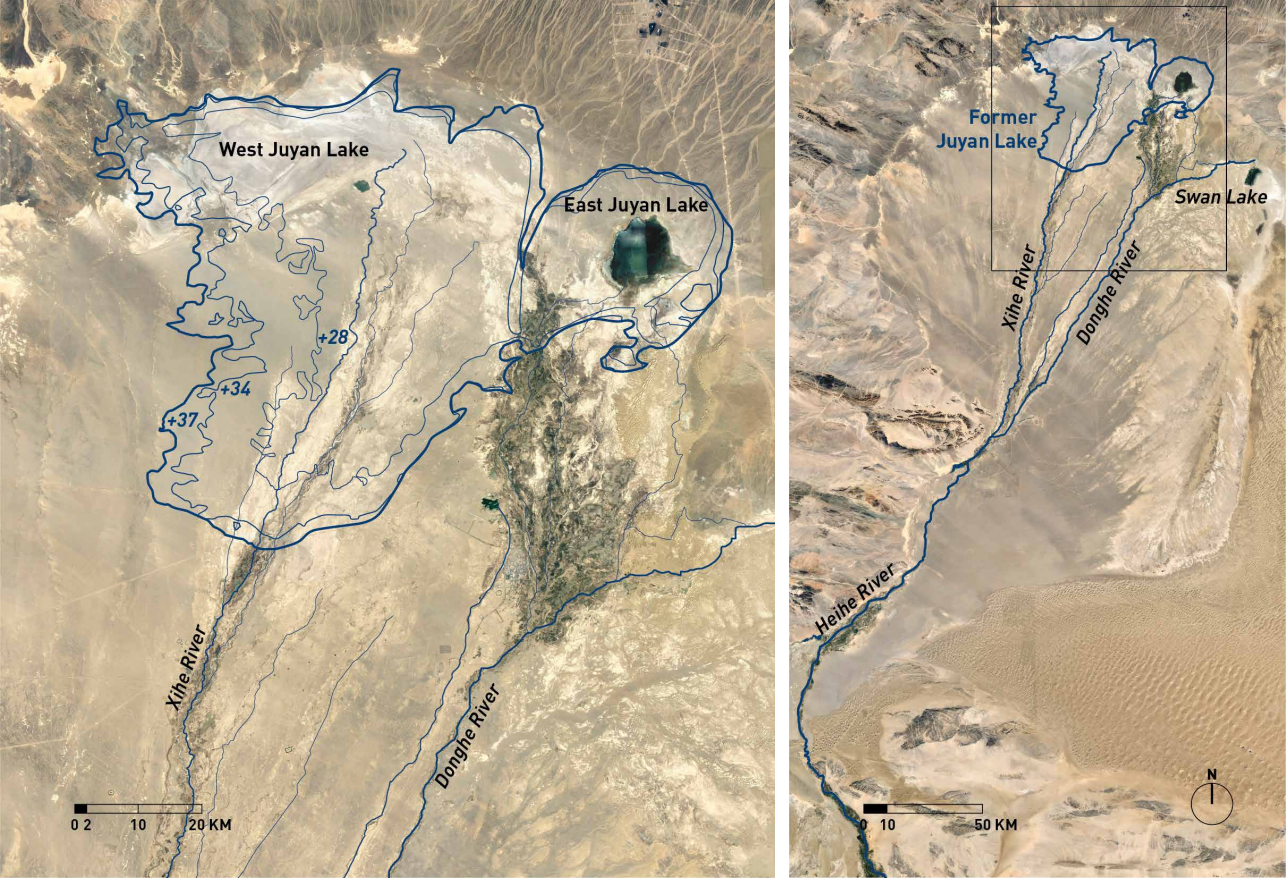


Fig. 3.4: The Juyan Lake at the end of the Heihe River watershed formed a massive body of water in prehistoric times, up to 37 meters above today's basin floor. The Juyan East Lake has reappeared in recent years.

shrank to 23.6 square kilometers, and dried out completely in the 1990s.[92]

Throughout Chinese history, the military always had a strong presence along the Hexi Corridor. To protect the northern edge of the frontier, military outposts had to be constructed in areas at the very end of the watershed, which were most arid and sensitive. Therefore, land reclamation and agriculture were promoted for territorial reasons on land that could not sustain intensive cultivation in the long term. It often degraded soon after and had to be abandoned.[93] In addition to the space and natural resources required to supply troops and the construction of material-intensive defense infrastructures, military actions, in some cases, intentionally destroyed ecosystems as a form of warfare. Such efforts, aiming for a short-term military goal, could have long-term environmental consequences: One tactic was burning grassland beyond the northern border to prevent rivaling tribes from grazing their kettle there. This practice was particularly destructive and accelerated desertification in the

92 Thevs et al., "Study Areas: The Heihe River Basin and Wuliangsuhai Lake at the Hetao Irrigation District," 31. Apparently, the Eastern Lake could be restored to some degree in recent years, and even the West Lake is periodically filled with water again.

93 Li, *Desertification History Along the Hexi Corridor*, 292.

arid transition zone at the edge of oases.[94] Another tactic was to cut off lower-lying settlements and agricultural land from water supply by diverting water or destroying irrigation infrastructures further upstream. In one case in the Heihe River basin during the late Yuan dynasty, it might have contributed to large-scale abandonment and degradation of cultivated land.[95] In contrast, water was, in other cases, diverted to flood land and create marshes as a form of military defense, which is assumed to have fundamentally transformed the Juyan oasis.[96]

In the Ming and Qing dynasties, the political situation was relatively stable. As the population density, as well as the competition for land and natural resources, were growing around the mid-Ming dynasty, irrigated farmlands were extended significantly. Formerly abandoned, desertified areas were tried to be reclaimed. In the Shiyang watershed, farmlands in the lower reaches no longer received sufficient water supply to sustain a functioning irrigation system once the growing population had passed a certain threshold of forty percent water utilization. Human activities gradually replaced environmental conditions as the decisive factor for ecological stability. Many farming settlements, particularly in the lower reaches, had to be abandoned, and villagers moved away to extend farmlands further upstream, which only exacerbated the water shortage in the lower-lying areas.[97] This development continued in modern China's history as the environmental relationships between the upper and lower reaches were increasingly brought out of balance. Even though the runoff from the Qilian Mountains has generally increased in recent decades, water availability in the lower reaches decreased across all three watersheds, leading to dropping groundwater tables. The irrigation from natural springs thus became increasingly challenging, and the irrigation was replaced with water sources from wells that were drilled deeper and deeper over the years.[98]

***

In the remote and arid region of the Hexi Corridor, sedentary habitation and land cultivation have always been challenging and often in conflict with the sensitive environment. The rising and falling populations and the shrinking and expanding oases along the region over the millennia tell a story of conflicting interests between ambitions for socio-economic growth and development and the conditions and processes of extra-human nature.

94 Ibid., 160.

95 Ibid., 286–88.

96 Ibid., 208.

97 The population in the upper and middle reaches of the Shiyang River watershed never exceeded 50,000 before the late Ming dynasty. It is estimated that the total water consumption at that rate remained below 20%. However, as the population sharply jumped to 730,000 in the mid-Qing dynasty, the total utilization rate accounted for 53%, with devastating consequences for the ecosystems in the lower reaches. Wang et al., "Historical Desertification Process in Hexi Corridor, China," 249–250.

98 Wang et al., "Environmental Degradation in the Hexi Corridor Region," 252.

Fig. 3.5: Apocalyptic scenes in Gansu's capital, Lanzhou, during a major sandstorm event in March 2021.

The imperial expansion of the Chinese empire into the region and the following systematic colonization introduced a fundamentally new relationship to and mental conception of the natural environment. Since this socio-environmental regime shift in the late second century BC, ecosystems began to be altered by human activities at increasingly large dimensions and intensities. While these ecosystem transformations remained relatively local and were primarily dominated by changing climatic conditions, since the early Qing dynasty, humans have become the dominating force in this process of socio-environmental co-production.

The sensitive Hexi Corridor's environmental history illustrates complex processes of socio-environmental entanglements. The history illustrates how social development is fundamentally dependent on and interrelated with environmental conditions, the resiliency of ecosystems, and their capacity to provide and restore sufficient resources. Many of the socio-environmental challenges the region faces today are consequences of this long history of environment-making. This history provides a broad context to better understand specific conflictive conditions as results of systematic imbalances and flaws.

Ecological Processes and Challenges the Hexi Corridor is Facing Today

Lanzhou

In March 2021, I received apocalyptic pictures from friends in Lanzhou, which was hit by a major sandstorm. [Fig. 3.5] In the photos, the whole city seemed to be immersed in yellow color. Roads and buildings were engulfed in a blurry veil of dust, white pairs of car headlights gleaming in the background, pedestrians and cyclists struggling through the streets, their faces ducked away and covered with white face masks. That month, two consecutive dust storms, separat-

ed by only one week, spread across China, accumulating their highest concentration of dust near the Bohai Sea. They led to air pollution reaching record highs and, in some places, visibility dropped to just a few hundred meters. Airports were temporarily closed, businesses stopped, and public life disappeared from cities, which seemed to turn into vacant ghost towns. The storms, which reached a massive height of up to eight kilometers, have been the worst sandstorms in China in over a decade.[99] They affected distant regions, including Korea and Japan, eighteen of China's provinces across forty percent of the country's land area, and the capital of Beijing, where it led to sensational media reports.[100]

Large-scale sandstorms are singular events that periodically strike people's minds in coastal first-tier cities like Beijing or Tianjin. They are the consequences of long-term processes of socio-environmental co-production that have been transforming China for centuries. These processes, which caused massive land degradation, become visible and tangible in such rare moments and bring the seemingly detached, sparsely populated regions in northwestern China to public attention. For a short moment, they may raise awareness about the far-remote, rural hinterlands that cities depend upon but are usually ignored by the broad public, taking their stable existence and functioning for granted.

The historic transformation of the Hexi Corridor ecosystem at the scale of three watersheds, from the water source in the Qilian Mountains to the dry and degraded terminal basins, is tremendously complex. In the following, some major ecological—socio-environmental—processes are discussed in more detail. The description mainly focuses on the most recent and well-documented period of modern China that brought vigorous spatial transformations to the region from the early 1950s until today. Processes of desertification, groundwater depletion, sandstorms, and ecological migration are briefly described. All

99 The two major historic sandstorm events on March 15–20 and 27–29 were almost the worst in over two decades, second only to a storm in March 2010. They had been caused by exceptionally strong northwesterly winds on the Mongolian Plateau, combined with climatic anomalies leading to early melting of spring snow, decreased precipitation, and drier and barer soil surface than usual. The PM10 concentration reached unprecedented and extremely hazardous levels, in some cases beyond the maximum monitoring threshold, 222 times higher than the air quality guidelines set by the World Health Organization. Sandstorms are a global issue, with Northeastern Asia accounting for 40% of global dust loads, primarily originating from northern China. Ke Gui et al., "Record-Breaking Dust Loading During Two Mega Dust Storm Events Over Northern China in March 2021: Aerosol Optical and Radiative Properties and Meteorological Drivers," *Atmospheric Chemistry and Physics* 22, no. 12 (June 17, 2022): 7911–12.

100 "Apocalyptic Skies as Beijing Hit by Worst Sandstorm in a Decade," *BBC News*, March 15, 2021, sec. China; Helen Sullivan and Michael Standaert, "Sandstorms Turn Sun Blue and Sky Yellow in Beijing," *The Guardian*, March 29, 2021, sec. Environment.

these processes pose severe challenges to the Hexi region of today and appear in similar forms across many other world regions. The annotated transect drawing that diagrammatically cuts through an oasis, the dynamic transition zone, terminal lakes, marshes, and salt pans illustrates some of these complex socio-environmental entanglements. [Poster C] The illustration can be read as a detailed section of the much larger watershed drawing (Poster B), which shows the Jinta Oasis in the low-lying, northern end of the Heihe River watershed.

Desertification

"Desertification is the persistent or irreversible reduction in the capacity of ecosystems to supply ecosystem services for several decades (soil, vegetation, and water) in drylands."[101] There are several other definitions for desertification. It is caused by a highly complex interaction of climatic change and human activities.[102] To understand and potentially mitigate desertification, it is crucial to study both these dimensions simultaneously and understand ecosystems holistically at watershed scales.[103]

In arid northwestern China, desertification means land degradation, resulting in a loss of vegetation cover and erosion. In addition to the biomass above and below ground, desertification negatively influences the composition and chemical properties of the soil, affecting the productivity of vegetation growth.[104] Eventually, wind erosion is the primary process of desertification as a geomorphological force, either eroding or depositing fine sand particles.[105] In short, desertification happens if vegetation is lost, the soil composition is disturbed, and the ground is exposed to wind, which blows the degraded soil away.

The loss of vegetation cover can have several causes. One is land reclamation for agriculture. As described, non-native plants create ecosystems that are much less resistant to arid and harsh climatic conditions. However, replacing

101 Rocio Becerril-Piña and Carlos Alberto Mastachi-Loza, "Desertification: Causes and Countermeasures," in *Life on Land*, ed. Walter Leal Filho et al. (Cham: Springer International Publishing, 2019), 1.

102 Across contemporary northwestern China, in almost 80% of the cases, anthropogenic activities are the dominant factor leading to desertification. The main environmental factors are water availability and soil moisture; the main anthropogenic factors are overgrazing and farmland reclamation. Qi Feng et al., "What Has Caused Desertification in China?," *Scientific Reports* 5, no. 1 (November 3, 2015): 15998, 4–6.

103 Becerril-Piña et al. divide the causes of desertification into direct factors (irrigation, deforestation, overgrazing, etc.) and indirect factors (population growth, urbanization, politics, etc.). Becerril-Piña and Mastachi-Loza, "Desertification: Causes and Countermeasures." To comprehensively understand desertification processes, it is necessary to study both these types of factors and the multi-dimensional ecosystems they co-produce.

104 This is described in the case of a study in Ningxia province. Zhuangsheng Tang et al., "Effect of Desertification on Productivity in a Desert Steppe," *Scientific Reports* 6, no. 1 (June 14, 2016): 27839.

105 Fine sand particles have a higher water and nutrient storage capacity, which gets lost by erosion and coarsening of the soil. Sand dune deposits then harm vegetation growth. Ibid., 4–5.

Fig. 3.6: Agricultural land loss due to desertification processes in Gulang County, south of Wuwei. The Tengger Desert opens east of the road, while on the western side, irrigation stabilizes the ground and allows for crop production; September 2019.

native vegetation with non-native crops alone does not lead to desertification as long as the ground is constantly irrigated and cultivated with a sustainable farming regime, keeping the soil fertile. Desertification of farmland begins if the ground is overcultivated, depleted, or abandoned without implementing effective measures to protect it. And even abandoned farmland does not necessarily lead to desertification as long as the groundwater table remains high.[106] Other causes, as described throughout the Hexi Corridor's environmental history, are the active destruction of native vegetation through felling, cutting, and overgrazing, which is particularly harmful in the protective transition zone along the oasis edge and at the water source in the Qilian Mountains. Mechanical destruction of the soil through overuse, particularly of animal herds, is another reason that can lead to desertification. Land degradation caused by overgrazing has thus become a major concern across the Hexi region,[107] and

106 Yiyuan Li and M. Shao, "Change of Soil Physical Properties Under Long-Term Natural Vegetation Restoration in the Loess Plateau of China," *Journal of Arid Environments* 64, no. 1 (January 1, 2006): 77–96.

107 Between 1950 and 2000, the overgrazing rate of grasslands in the Hexi Corridor region reached over 69%, leading to the degradation of over 46% of grassland. Wang et al., "Environmental Degradation in the Hexi Corridor Region," 73.

desertification a severe environmental issue. The highest rates of desertification occurred during the 1970s and 1980s. Since the 1990s, it could be stabilized in most places or even began to be reversed. However, the region is still highly degraded and water-stressed today. Desertified land accounted for over seventy-six percent of the Hexi Corridor's total land area in 2010.[108] [Fig. 3.6]

As mentioned, human factors have become the main cause of desertification processes in the Hexi Corridor. This includes rapid population growth, per capita income, natural resource consumption, industrialization, urbanization, and policies promoting land reclamation and farming.[109] In contrast, it was also anthropogenic actions that initiated reversing trends of desertification rates in recent decades. Policy incentives that ban uncoordinated land reclamation and foster water-saving agricultural practices have been successful measures,[110] along with restoration programs that actively combat desertification.[111] However, all efforts aiming for a more sustainable water regime or the restoration of ecosystems are confronted with the contradiction between environmental protection and socioeconomic development.

Groundwater Depletion

In many regions across the Hexi Corridor, extracting groundwater is the only available irrigation method. Over the past decades, groundwater has been pumped to the surface in large quantities and used for flood irrigation. It has led to sinking groundwater tables, which reduced the overall water supply, drying out natural vegetation and planted shelter forests. While high salinity levels are common in the watersheds' lower reaches, characterized by high evaporation and very low precipitation rates, this practice has led to an unnaturally strong mineralization of the aquifer.[112]

Dryland salinization is not only a problem for the deterioration of water sources but also for the fertility of the ground as high mineral concentrations

108 Han et al., "Desertification Assessments in the Hexi Corridor of Northern China's Gansu Province by Remote Sensing," 2722.

109 Xie et al., "Spatio-Temporal Changes of Oases in the Hexi Corridor Over the Past 30 Years," 14–15.

110 Xue et al., "Policies, Land Use, and Water Resource Management in an Arid Oasis Ecosystem;" Hui Xu et al., "The Role of Water Users Associations in Integrated Water Resource Management of Zhangye City in Heihe River Basin, China," 2014, 304–24.

111 To combat land degradation and desertification, particularly in China's arid and fragile northwest, the Chinese government enacted the Law of Combating Desertification (2002), approved the National Plan for Combating Desertification (2005), and launched large-scale initiatives for the restoration of habitats, including The Three North Shelter Forest program (1978), Beijing and Tianjin Sandstorm Source Treatment Project (2001–2010), Returning Farmlands to Forest Project (2003), Returning Grazing Land to Grassland (2003), and the Grain for Green program (1999). Feng Wang et al., "Combating Desertification in China: Past, Present and Future," *Land Use Policy* 31 (March 1, 2013): 311–13; Xie et al., "Spatio-Temporal Changes of Oases in the Hexi Corridor Over the Past 30 Years."

112 Wang et al., "Environmental Degradation in the Hexi Corridor Region," 71–72.

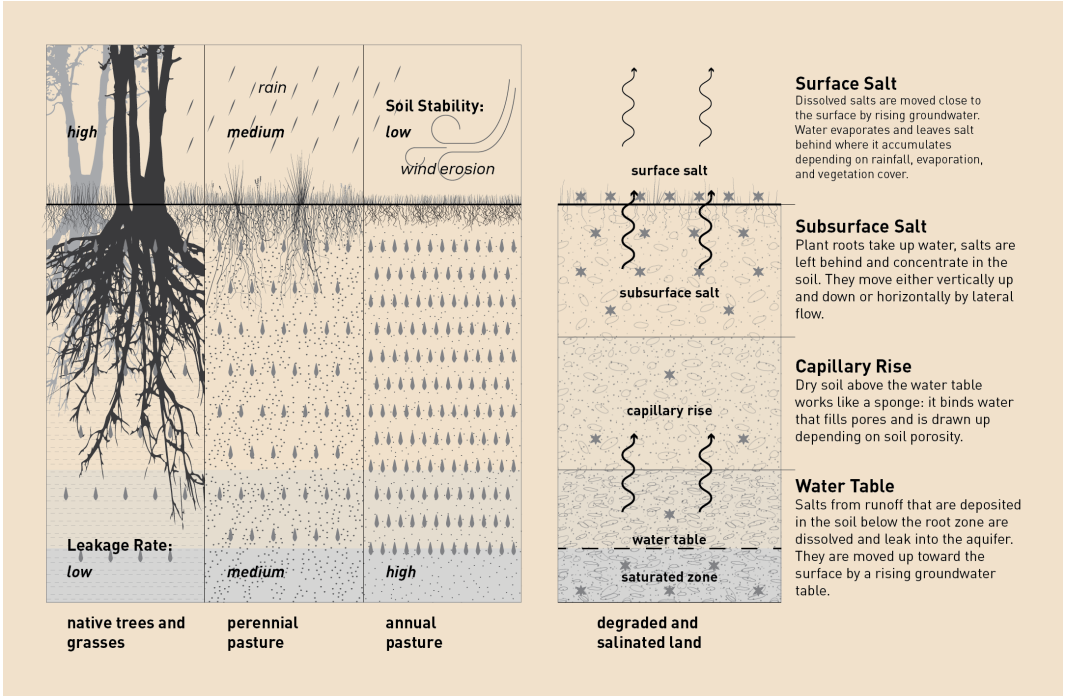


Fig. 3.7: Landscape reading across scales: Specific conditions in individual places leading to land degradation at territorial scales. Erosion and leakage comparison (left), soil salinization (right).

accumulate in the topsoil through irrigation and evaporation.[113] In low-lying basins at the lower end of watersheds, the groundwater table is typically relatively high. The high evaporation rates in these areas naturally lead to an accumulation of salt minerals (primarily sodium chloride) in the upper soil layers, mainly since there is very little precipitation that could help dilute the high concentration. [Fig. 3.7] This creates situations where insufficient clean surface water is available for drinking and irrigation while the groundwater, wells, and topsoil are all depleted.[114] Several terminal basins in the Hexi Corridor have

113 Naturally, salt is an inherent component of ecosystems, deriving from marine deposits from former oceans, weathering rock, or transported by wind and rain. While salt is captured by deep root systems of native vegetation, it leaks into the aquifer in places of barren ground or cultivated land with shallow-rooted, annual plants—particularly in cases of coarse soils, which are prevalent in the Hexi region. It is then brought to the topsoil through evaporation in areas where the groundwater table is close to the surface. Fereidoun Ghassemi, A. J. Jakeman, and H. A. Nix, *Salinisation of Land and Water Resources: Human Causes, Extent, Management and Case Studies* (Wallingford, UK: CAB International, 1995), 31–35.

114 J. Nikolaus Callow, Matthew R. Hipsey, and Ryan I. J. Vogwill, "Surface Water as a Cause of Land Degradation from Dryland Salinity," *Hydrology and Earth System Sciences* 24, no. 2 (February 17, 2020): 717–34. Globally, 20% of irrigated land is affected by saline soil, while in arid and semi-arid regions (such as the Hexi Corridor's lower reaches), it is even 30–40%. Jianguo Li et al., "Soil Salinization Research in China: Advances and Prospects," *Journal of Geographical Sciences* 24, no. 5 (October 1, 2014): 943–44. High salt concentrations impede plants from extracting water, are toxic, disturb plants' metabolism, and reduce their ability to

thus become salty lakes, marshes, and vast salt pans. In some cases, such as the Yabrai Salt Lake, there are large deposits of minerals used for industrial salt extraction. In addition, surface water pollution has increased, particularly in the middle reaches where human activities are most intense. The contamination derives primarily from fertilizer runoff, but in urbanized regions, it also comes from the solid and chemical waste of industrial and domestic activities, which usually remain in the soil or seep into the aquifer.[115]

Sandstorms

Conditions that are most conducive to sandstorms are found on loose and scattered land with little or no vegetation and shelter, particularly when cold surface temperatures and frozen soil are followed by an exceptionally dry and warm period, loosening up and drying the top layer. Soil is then picked up by strong winds, typically in winter and spring.[116] In the Hexi region, such conditions can be found across the Hexi plain, particularly in the northern ends of the Hexi Corridor's watersheds, where evaporation rates are highest. Reclaimed land that has degraded and desertified, naturally barren, sandy areas, as well as bare and abandoned farmlands, plus the vast depression zones of former lakes where large amounts of fine particles have been deposited, are prone to sandstorms. In 2000, seventy-five percent of the Hexi Corridor was identified as potential source area for sandstorms.[117] Throughout history, sandstorms have been a recurring and destructive threat to people. Particularly in periods of droughts, sudden and unsustainable land reclamation, or abandonment of cultivated land, there were more frequent records of sandstorm events. They can lead to sudden topsoil loss, reduce land fertility, and cause desertification. Sandstorms lead to bad air conditions that are hazardous to public health. They can destroy buildings, remove vegetation, and silt up irrigation systems. They cover infrastructures and cultivated land with thick layers of sand deposits, negatively affect production, cause economic losses, and force people to abandon their homes and farmlands.[118]

Ecological Migration

The abandonment of land and the migration of communities due to environmental issues have always existed in the sensitive environment of the Hexi Corridor. What is referred to as *environmental refugees* since the United Na-

take up nutrients, allowing only salt-tolerant plants to grow. Ibid., 945–47.

115 Wang et al., "Environmental Degradation in the Hexi Corridor Region," 71–72. Xue et al., "Policies, Land Use, and Water Resource Management in an Arid Oasis Ecosystem," 1043–49.

116 Yin et al., "Why Super Sandstorm 2021 in North China?," 1–2.

117 C. Z. Yan et al., "Estimation of Areas of Sand and Dust Emission in the Hexi Corridor from a Land Cover Database: An Approach That Combines Remote Sensing with GIS," *Environmental Geology* 57, no. 3 (April 1, 2009): 709.

118 Ibid.; Li, *Desertification History Along the Hexi Corridor*, 250.

tions Environment Program coined the term in 1985, has become a rising global concern, particularly in the context of climatic change, sea level rise, and increasing land degradation across entire regions. However, it is often difficult to differentiate between economic and environmental factors as, in most cases, these two dimensions are closely entangled.[119]

As the Hexi Corridor's long socio-environmental history has shown, the Hexi Corridor has always provided a challenging environment for sedentary habitation, intensive land use, and agricultural production. With growing populations and resource consumption, the reclamation of barren ground, the forced habitation of highly arid environments in the lower river reaches, and the dependency on irrigation despite limited water resources had created ecologically very fragile conditions. Living and farming at the edges of natural oases created sensitive, arid frontiers. They were exposed to constant fluctuations determined by ecosystem limitations and the availability of natural resources.[120] Throughout history, geopolitically strategic settlements in the Hexi region, particularly those at the northern end of the oases, depended on governmental support, providing subsidies, protective policies, and infrastructures for ample resource supply. They were thus ecological but also political frontiers that were highly dynamic and shifted across the centuries.

Whenever the productivity of these human-constructed ecosystems fell below a certain threshold and when they were no longer able to sustain the communities that depended on them, it led to environmentally induced migrations. People were forced to abandon their degraded farmlands and move elsewhere, where more fertile land was available. While the ultimate cause for such migration movements is environmental—such as desertification, water depletion, or sandstorms, as introduced above—the origins of these issues are often human-induced, such as the misuse of land, overpopulation, and the exploitation of limited resources. [Fig. 3.8]

***

119 Norman Myers, "Environmental Refugees: A Growing Phenomenon of the 21st Century," *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences* 357, no. 1420 (April 29, 2002): 609–12. The UN defined environmental refugees as "people who have been forced to leave their traditional habitat, temporarily or permanently, because of a marked environmental disruption […] that jeopardized their existence and/or seriously affected the quality of their life," whereby environmental disruptions are understood as "changes in the ecosystem [that are] unsuitable to support human life." The term includes people who are forced to move because of large-scale environmental transformations such as the construction of dams. Essam El-Hinnawi, "Environmental Refugees" (Nairobi, Kenya: United Nations Environment Programme, 1985), 4.

120 Sustaining a population in arid and water-stressed environments becomes exponentially more difficult. For grasslands and animal husbandry, decreasing soil productivity means a decreasing yield per area and, therefore, a higher demand for land. National Research Council, *Grasslands and Grassland Sciences in Northern China*, 47–49.

Fig. 3.8: Abandoned rammed earth houses surrounded by corn fields in the oasis transition zone with limited water resources north of Wuwei; September 2019.

Many of the challenges the Hexi Corridor faces today derive from the long-term history of socio-environmental co-production and the systematic transformation of the natural environment at a territorial scale, often in stark contrast to the ecosystems' inner logic and capacities. The region's colonization during the early Han dynasty has been identified as the starting point of this history. In the early 1950s, heavy industrialization was introduced into the Hexi region and brought an enormous acceleration of social-environmental transformation. The beginning of the PRC and the central government's ambitious project of nation-building marks a second key moment in the Hexi Corridor's longue durée of socio-environmental co-production. The region started to be systematically reorganized for the production, extraction, and transportation of resources. Another three to four decades later, China began to be gradually integrated into the global market economy and its dominating Western capitalist regime. This period of accelerated socio-environmental transformation through the industrialization and territorialization of the Hexi Corridor in the second half of the twentieth century is discussed in the following chapter.

4. The Territorialization of the Hexi Corridor

State-Led Nation-Building and Persistent Ambitions of Economic Growth

The previous chapter described how the extra-human nature along the Hexi Corridor has been fundamentally transformed since the beginning of Han colonization and the introduction of radically different land use regimes. This chapter discusses how the Hexi Corridor has been socially produced—or *territorialized*—through political and economic institutions, policies, and flows of capital, labor, and material resources since the introduction of heavy industrialization in the early 1950s. Since then, the Chinese central government has intended to lift western regions in recurring attempts to balance the increasing demographic and economic disparities between the country`s West and East, as well as rural and urban populations, across several shifts of different political campaigns. In the context of inherent geographic and social disparities in China, remote areas such as the Hexi Corridor serve as source regions of material extraction to sustain rapidly urbanizing and modernizing agglomerations, particularly along China`s southeastern coast. The case of the Hexi Corridor illustrates how the physical formation of a territory in one geography is driven by the interests of political and economic actors in another.

Building on the long-term environmental-historic context of the region, which has been provided above, this chapter discusses how modern China`s state apparatus, since the beginning of the PRC, has turned the region into a strategically crucial industrial corridor. It illustrates how invisible forces of a specific socio-political regime have shaped not only individual places but also the entire Hexi Corridor as a territorial system.

Theories of Territorialization and the Production of Nature

The introduction of industrial modes of production in the early 1950s, accompanied by heavy infrastructures, led to a territorial reconfiguration of the Hexi region. Building upon literature from critical geography and urban political ecology, the chapter illustrates that the Hexi territory is not an arbitrary by-product of the PRC's changing socio-political system over the decades. Instead, this chapter argues, it has been actively *produced*—or co-produced together with the extra-human environment—according to specific patterns that are inherent to processes of state centralization, planned economy, resource extraction, and capital accumulation. This reading of the Hexi Corridor is informed by the concept of *territorialization*, the understanding of territory not as a gen-

eral geographic entity but as a "historically specific political form" of socially "produced space."[1] This concept, which derives from Henri Lefebvre`s spatialization of political theory, understands a territory as the socially produced outcome of a "state[`s] spatial strategies," including the state`s "administration, repression, domination, and centralized power."[2] As George Lin points out, the state-society relation in pre-socialist China was relatively relaxed. Therefore, the cultural shift the PRC introduced was particularly strong as it replaced this state-society relation with one characterized by a repressive state, tightly controlling the society for ideological and strategic considerations.[3]

The timeline of major investment projects in the Hexi Corridor across the past seven decades since the beginning of the PRC illustrates how invisible forces of a changing socio-political apparatus shape the physical environment of a region over time, affecting individual places and people. Across these different phases, the central government's political concerns and priorities have shifted, and its state power has been distributed unevenly in geographic terms. The Hexi Corridor has been reshaped by massive works of infrastructure for transporting people and materials, such as highways, railway links, and pipelines. New, nationally significant industries have been created by moving materials and labor to strategic localities, such as in the case of the two major mining cities of Jinchang and Jiayuguan, located in the western Hexi Corridor, where iron ore and rare earths had been found in the late 1950s and which began to supply manufacturing industries across the country. As major industrial hubs of raw material production, these cities continued to benefit from massive investments, including the period of All Front Open policies in the 1990s, when many other places in the Hexi region started a socio-economic decline.

The development of modern China's West has primarily been concerned with investments into heavy industries and infrastructures as a means of material extraction and primary production. For the most part, the focus has been laid on selected localities as urban centers of industrial production, such as in

1 Neil Brenner and Stuart Elden, "Henri Lefebvre on State, Space, Territory," *International Political Sociology* 3, no. 4 (December 1, 2009): 363. Brenner and Elden's—and Lefebvre's, whom they refer to—"historically specific form of political-economic space" is associated with the modern state and capitalism. In the case of China, the transition to a state market economy integrated into the capitalist global economy was strongly rejected in the Maoist years and only began with market liberalizations during the period of Reform and Opening-Up. However, even though the industries that reshaped and reorganized the Hexi Corridor were mostly state-owned enterprises, the concept of territorialization is still valid, particularly for the early phases of the PRC's "nationalization," as they were characterized by material extraction in one place for the accumulation of capital in another.

2 Brenner and Elden, "Henri Lefebvre on State, Space, Territory," 359. As Brenner and Elden point out, in *The Production of Space*, Lefebvre also relates the political form of state territory to the project of "nationalization," which is relevant to note in the case of the PRC's nation-building.

3 George C. S. Lin, "Chinese Urbanism in Question: State, Society, and the Reproduction of Urban Spaces," *Urban Geography* 28 (February 1, 2007): 13–14.

the case of Gansu's capital, Lanzhou, which has been turned into a major regional urban-industrial hub starting in the early 1950s. However, such urbanization processes have always depended on the extraction of natural resources from their rural hinterland. Industrial Chinese cities thus need to be seen in close relationship and interdependence with remote locations of extraction and production. Literature on urban political ecology helps to understand this process of a "production of nature" as the relationships of urban centers to their surrounding territory and how the latter is systematically organized to sustain urbanization, including the socio-environmental inequalities these extractive processes entail. In the case of China, this production of nature operates both between a city and its rural hinterland (such as between the city of Lanzhou and sites of extraction along the Hexi Corridor), as well as between the coastal regions of rapid urban growth in the southeast and the nation's interior northwest.[4]

In the tradition of scholars who added a geographical dimension to Marxist theory (the geography of politics or the politics of geography),[5] Neil Smith describes that this notion of spatial, *uneven development* is not the result of a society that accidentally fails to develop evenly. Instead, in a capitalist regime, space is socially produced, mediating capitalism's inherent contradictions and instabilities. The resulting uneven development is the systematic geographical expression of the contradictions inherent to the modes of capitalist accumulation and production. This is based on the tendency of capital towards the differentiation and simultaneous equalization of the conditions of production: Capital is continually invested in the built environment in order to produce surplus value, but equally, it is continuously withdrawn from the built environment so that it can move elsewhere and take advantage of higher profit rates. Capital aims to be bound immobile, yet, with equal necessity, circulate as a value. The

4 The "production of nature" is simply a philosophical extension of the capitalist production of space if we accept that nature is not separated from but, instead, an integral part of society. Smith, *Uneven Development*, 49–91. For Smith, the production of nature has become universal and extended to a planetary context where "no part of the earth[…] is immune from transformation by capital"(p.79), and the ultimate "goal of capital […] is the production of nature at a global scale."(87)
Literature from Urban Political Ecology discusses the "urbanization of nature" as the metabolic integration of ecological processes and materials of extra-human nature into urban growth and transformation processes. See, for instance, Erik Swyngedouw, "The City as a Hybrid: On Nature, Society and Cyborg Urbanization," *Capitalism Nature Socialism* 7, no. 2 (June 1, 1996): 65–80; Erik Swyngedouw and Nikolas C Heynen, "Urban Political Ecology, Justice and the Politics of Scale," *Antipode* 35, no. 5 (2003): 898–918; Roger Keil, "Urban Political Ecology 1," *Urban Geography* 24, no. 8 (December 1, 2003): 723–38; Matthew Gandy, "Cyborg Urbanization: Complexity and Monstrosity in the Contemporary City," *International Journal of Urban and Regional Research* 29, no. 1 (2005): 26–49; Nik Heynen, Maria Kaika, and Erik Swyngedouw, eds., *In the Nature of Cities: Urban Political Ecology and the Politics of Urban Metabolism* (London: Routledge, 2005).

5 Castells, *The Urban Question: A Marxist Approach*; Lefebvre, *The Production of Space*; Harvey, *The Limits to Capital*.

geographic results of these contradictions are the development at one pole and the underdevelopment at another.[6]

China's political-economic system is different from the dominating, Western capitalist market economy. Quite the contrary, during Maoist communism, there was virtually no privatization. It was the strong and repressive, centralized state apparatus that was in control of capital investment and accumulation, spatially reorganizing geographic space at territorial scales. While state-led campaigns in Maoist times were led by egalitarian goals and geographic balancing, the policy reforms during the period of Reform and Opening-Up, market liberalizations, and increasing integration of China into the global market began to be driven by high competition, and rapid economic growth as the ultimate goal. In this new China of a socialist market economy, "state capitalism," or "neoliberalism with 'Chinese characteristics,'"[7] the inequalities between different regions across the country dramatically intensified. In a dynamic environment of decentralized development, *urbanization*—the conversion of agricultural into urban land and the "fixing" of capital in the built environment—became the ultimate aspiration, explicit mandate, and key strategy of governments across the administrative apparatus. In their pursuit of economic growth, local administrations utilized land accumulation to legitimize their political power, actively promoting urban development.[8]

Following the multi-dimensional "landscape reading" across scales and disciplines which has been introduced in chapter one, this chapter illustrates how specific sites have been physically shaped over time through different agencies (from central governmental institutions to local communities and individuals), their interrelationship with land, and the extra-human environment. As

6 Smith, *Uneven Development*, 135–153.

7 Gittings uses the term "state capitalism" but also describes the limitations of that terminology. John Gittings, *The Changing Face of China: From Mao to Market*, 1 edition (Oxford; New York: Oxford University Press, 2006), 2–5. David Harvey uses "neoliberalism with 'Chinese characteristics,'" referring to Deng Xiaoping's famous term 'socialism with Chinese characteristics,' to describe the transformation of China's economy, starting in the late 1970s, following similar characteristics as the neoliberal shift to a deregulated, privatized, free-market economy in the West. David Harvey, *A Brief History of Neoliberalism* (Oxford University Press, 2005), 120–151. Yasheng Huang discusses a "capitalism with Chinese characteristics." Yasheng Huang, *Capitalism with Chinese Characteristics: Entrepreneurship and the State* (New York: Cambridge University Press, 2008). McMahon coined the term "crony capitalism" to describe how contemporary China has, at first sight, all mechanisms of a free-market capitalist system; however, how the presence of the government remains ubiquitous as Beijing retains strong control through state-owned enterprises, market monopolies, selective subsidies, at times intervenes in informal and opaque manner, and executes social repression. Dinny McMahon, *China's Great Wall of Debt: Shadow Banks, Ghost Cities, Massive Loans, and the End of the Chinese Miracle* (Boston: Harper Business, 2018), 6–9.

8 You-Tien Hsing developed the theory of an "urbanization of the local state" that follows the concept of urbanization as a territorial project and active force that shapes the power process of the local state in post-reform China. You-Tien Hsing, *The Great Urban Transformation: Politics of Land and Property in China* (Oxford: Oxford University Press, 2010).

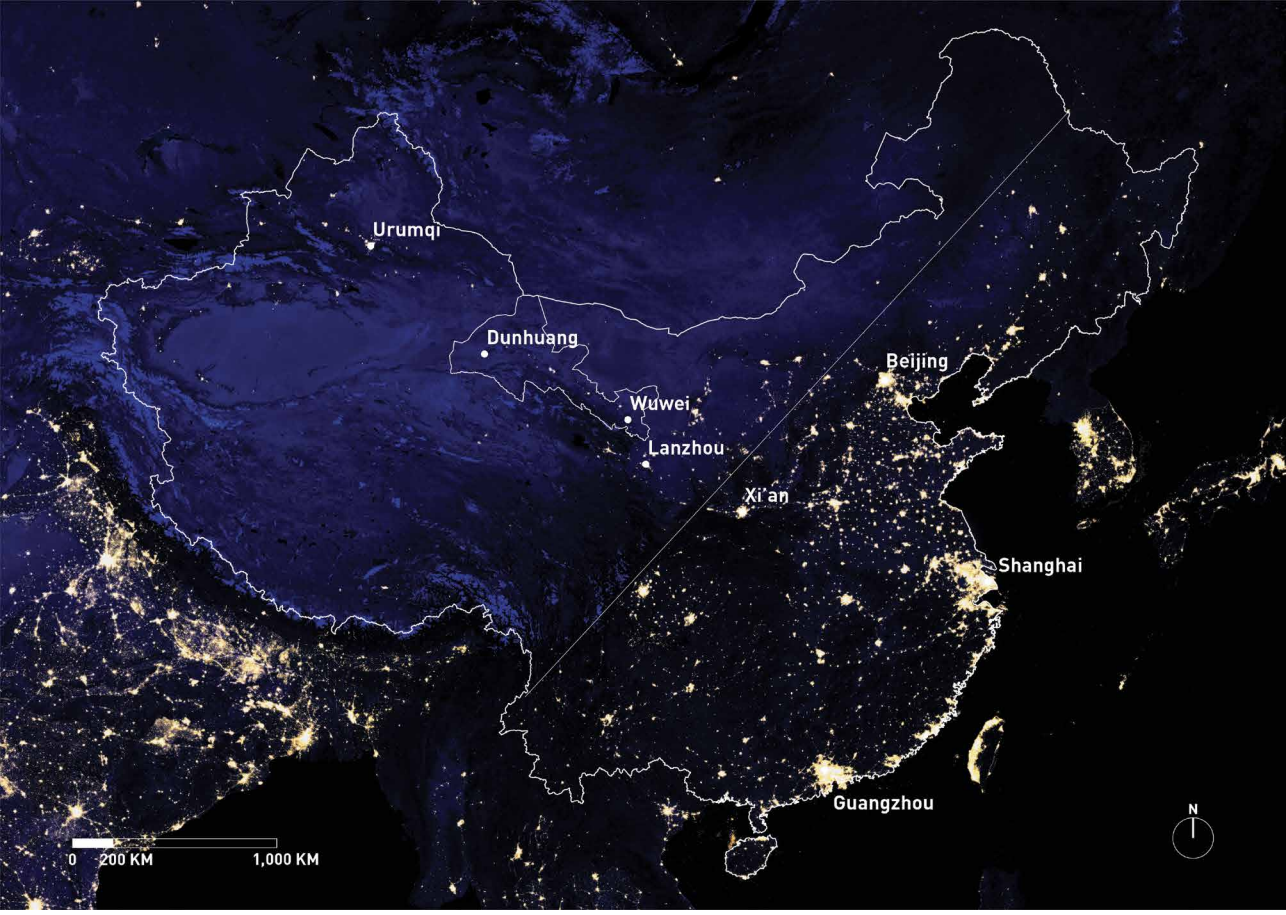


Fig. 4.1: Night view showing unequal urbanization across China with massive agglomerations along the south-eastern coast and a sparsely developed northwestern interior.

demonstrated in the following, this territorial landscape reading is intended to provide a thick and multidimensional understanding of a geographic context, including the invisible forces of different actors and their often divergent interests that physically reshape and reorganize it. In a territorial study, this connection of specific localities to the overarching socio-environmental regime aims to better understand the spatial conditions of individual places, including the people and non-human agents that inhabit them.

The Hexi Corridor's Socio-Economic Challenges in the Context of China`s Eastern-Western as well as Rural-Urban Divide

China is a nation of strong divides: As discussed in chapter two, there is first a strong geomorphological disparity between the vast, humid, and fertile, low-lying plains in the country`s coastal southeast and the arid, high plateaus across the interior northwest. These varying environmental conditions are coupled with strong demographic differences between densely settled, enormous agglomerations in the east and sparsely developed regions in the west. While

China`s large urban centers have developed along the southeastern coast, particularly in the three major river deltas of the Yellow, Yangtze, and Pearl River, as well as in the fertile southern interior, the northwest is primarily characterized by lower-tier cities and rural hinterlands. Modern cities in the east, such as Shanghai, Beijing, or Shenzhen, with over ten or even over twenty million residents, have become global centers of commerce and trade and are home to some of the world`s largest companies in finance, high-tech, and industrial production. In contrast, the interior is dominated by structurally weak regions of agricultural production or post-industrial decay, such as in China's northeastern provinces.[9] [Fig. 4.1]

Eastern-Western Divides

The Hu Huanyong Line, a famous concept by the population geographer Hu Huanyong from 1935, divided China with an imaginary diagonal line from Heihe in northeastern Heilongjiang to Tengchong in southwestern Yunnan into an eastern and western half. The line divides China into a densely populated southeastern and a sparsely populated northwestern half. Surprisingly, the ratio of population and area on each side of this line is still almost identical today as it was back in the 1930s,[10] despite the costly state-led campaigns to lift up the western regions, which will be introduced in the following. The Hexi Corridor can be seen as a transition zone of decreasing population density in which China's densely urbanized east is fading out towards the west. [Fig. 4.2]

In this context, it is interesting that China's political centers historically moved from west to east along the Yellow River basin (Xianyang, Xi'an, Luoyang, Kaifeng, and via Nanjing and Hangzhou to Beijing). As the geographers Li Xiaojian et al. describe, the Chinese nation has developed from the interior with its cultural origins in the Loess Plateau of today's Shaanxi province, from where it gradually shifted towards the eastern coast. It was a slow shift of state power and economic development to the coastal and central-southern regions. The Yangtze River then replaced the Yellow River over time as the main economic region.[11] As the authors point out, different mentalities started

9 Mun Young Cho, for instance, discusses in an anthropological study how dismantling industrial state-owned enterprises and the social apparatus in the 1990s has produced massive unemployment and poverty in the context of a residential area in the outskirts of Harbin, capital of northeastern Heilongjiang. Mun Young Cho, *The Specter of "the People": Urban Poverty in Northeast China*, (Ithaca: Cornell University Press, 2013). Similar conditions can be observed across northeastern China's 'rustbelt' and other regions in the interior that have previously been heavily industrialized by the central state, including places along the Hexi Corridor, as described later.

10 Mingxing Chen et al., "Population Distribution and Urbanization on Both Sides of the Hu Huanyong Line: Answering the Premier's Question," *Journal of Geographical Sciences* 26, no. 11 (November 1, 2016): 1593–1610. Thanks to Prof. Liu Jian for making me aware of the concept of the Hu Huanyong Line. (Conversation at Tsinghua University, March 15, 2019).

11 Xiaojian Li, Yue-man Yeung, and Jiajun Qiao, "Historical Legacy and Future Challenges," in *Developing China's West: A Critical Path to Balanced National Development*, ed. Yue-man Yeung

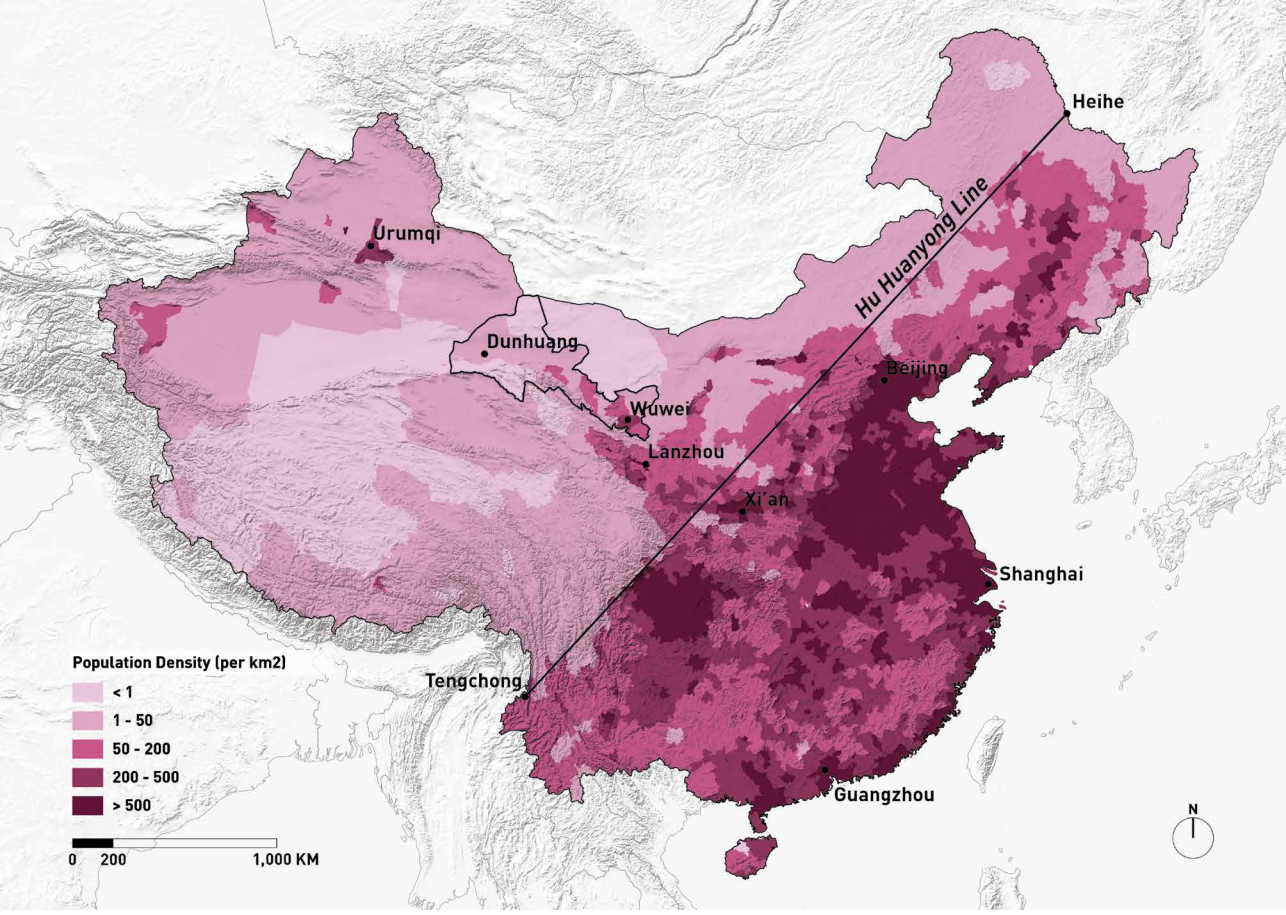


Fig. 4.2: Demographic map of China showing population density per county in 2015 and the Hu Huanyong Line between the border cities Heihe and Tengchong. The Hexi Corridor is located where China's densely populated heartland along the Upper Yellow River is fading out towards the northwest.

to develop through this economic and political shift in China's West and East. This continued the nation's long history of formation that began already in pre-imperial times, as discussed in the second chapter. As we have seen, development in the West has always depended on state sponsorship, such as costly irrigation systems for agriculture. In addition, state initiatives forcefully transferred (often undesirable) citizens, encouraging them to reclaim and cultivate land in western areas. Western Chinese societies are thus, to a large degree, the result of state intervention. Environmentally, the western regions are generally less suitable for habitation, and large-scale development has always put pressure on the environment. In contrast, development in eastern China was much more driven by local forces and economic innovation, while state intervention was less appreciated.[12]

The Hexi Corridor finds itself in an interesting but challenging location in this eastern-western divide of unequal geographic and socio-economic conditions. Originating from the first period of imperial expansion during the early

and Shen Jianfa (Hong Kong: Chinese University Press, 2004), 28–29.

12 Li, Yeung, and Qiao, "Historical Legacy and Future Challenges," 33–35.

Fig. 4.3: Map of China from 1912 at the end of the Qing dynasty showing China Proper extending northwest along the Hexi Corridor into the nation's autonomous territories.

Han dynasty, it has since functioned as a territorial extension of China's heartland towards the west, like a northwestern appendix surrounded by vast and ethnically different autonomous regions. [Fig. 4.3] [Fig. 4.4] Gansu province, with the Hexi Corridor in its northwest, is particularly affected by these eastern-western divides. The landlocked province, sharing only a small and rather insignificant border with Mongolia, is today at the very bottom of the list of Chinese provinces in terms of the per capita gross regional product (GRP)—an expression of its difficult geographic location and environmental challenges.[13]

13 The Gansu-wide GDP per capita accounts for only 35,995 RMB, while the national average is 72,000 RMB. "China Statistical Yearbook 2021," National Bureau of Statistics of China, 2022. While the Hexi region is, by far, not the poorest area within Gansu, 63.3% of all Chinese counties that were considered poor in 2018 were located in Gansu province (375 out of 592). Yazhuo Zheng and Kent Deng, "Typical Cases in Northwest China," in *State Failure and Distorted Urbanisation in Post-Mao's China, 1993–2012*, ed. Yazhuo Zheng and Kent Deng, Palgrave Studies in Economic History (Cham: Springer International Publishing, 2018), 27. The poorest regions are in the south of Gansu, dominated by ethnic minorities, such as the Gannan Tibetan or the Linxia Hui Autonomous Prefectures. Liyan Xu et al., "Economic Geography Analysis of Gansu Province: Analytical Report in Support of Project Design of Gansu Revitalization and Innovation Project (GRIP)" (Beijing: The World Bank, 2018), 20–22.

Rural-Urban Divides

In addition to the strong geographic and demographic divides between China's East and West, the country is characterized by a pronounced socio-economic divide between its rural and urban populations. Social inequalities between these two spheres are not only manifested in different numbers of economic development and productivity but also in different qualities of public services such as health and education.[14] Despite the rapid growth of massive urban regions China has experienced over the past several decades and their prominent coverage in mass media, the level of urbanization in China is still far behind most industrialized countries: Over 500 million people (around thirty-six percent of the population) are still living in areas that are considered as rural.[15] While villages located in proximity to urban centers enjoy advantages to accumulate capital, such as providing housing for migrant workers, villages and towns in more remote locations, on the other hand, usually face difficulties in attracting business opportunities, investments for real estate, or land conversions.[16] Despite remarkable economic growth numbers over previous decades, leading to a growing middle class and rich elite, a large portion of the rural population still lags behind in basic education levels and public health conditions, far below most middle-income countries.[17]

---

14 One central aspect of these inequalities is the household registration system *hukou*. It is crucial to understand many dimensions of China's complex rural-urban relationship: The *hukou* system was established in the late 1950s as an attempt to control the influx of peasants into cities but also because of the realization that China's urban-based industrial revolution could be accomplished only by the extraction of a surplus from grain production and the mass mobilization of labor for capital projects. Initially, the system divided the society into agricultural and non-agricultural citizens—or a privileged urban minority and an exploited rural majority. The system is linked to social policies and provides urban residents with non-agricultural *hukou* benefits and access to urban infrastructures, such as subsidized education and healthcare, not available to their agricultural counterparts. The separation into agricultural and non-agricultural has been weakened, and restrictions have been loosened since the end of the Maoist era and in recent years. However, the *hukou* system still forces rural residents seeking job opportunities in fast-growing urban centers to live as floating population in cities, often with limited legal status and bad reputation, not eligible to benefit from public institutions, social security, and vulnerable to exploitation. See, for instance, John Friedmann, *China's Urban Transition* (Minneapolis: University of Minnesota Press, 2005), 57–76.

15 This number is by residence, not by household resident status, but does, naturally, not include non-registered citizens. "China Statistical Yearbook 2021."

16 Hsing, *The Great Urban Transformation*, 185–88.

17 Scott Rozelle and Natalie Hell describe how China has failed to invest in its people. The country is strongly lagging in human capital, leading to a divided nation with a large part of the society being highly disadvantaged and usually remaining "invisible." Scott Rozelle and Natalie Hell, *Invisible China: How the Urban–Rural Divide Threatens China's Rise* (Chicago; London: University of Chicago Press, 2020). As demographics show, the majority of China's future labor force will grow up in the countryside. Around two-thirds of the current population are rural *hukou* holders with a higher children per capita rate than its urban counterpart. More importantly, over 70% of China's children are growing up outside cities in systems that lag far behind in education and public health levels. In addition to an economy that has begun to cool down significantly over the past decade, this presents a grim prospect for China's future

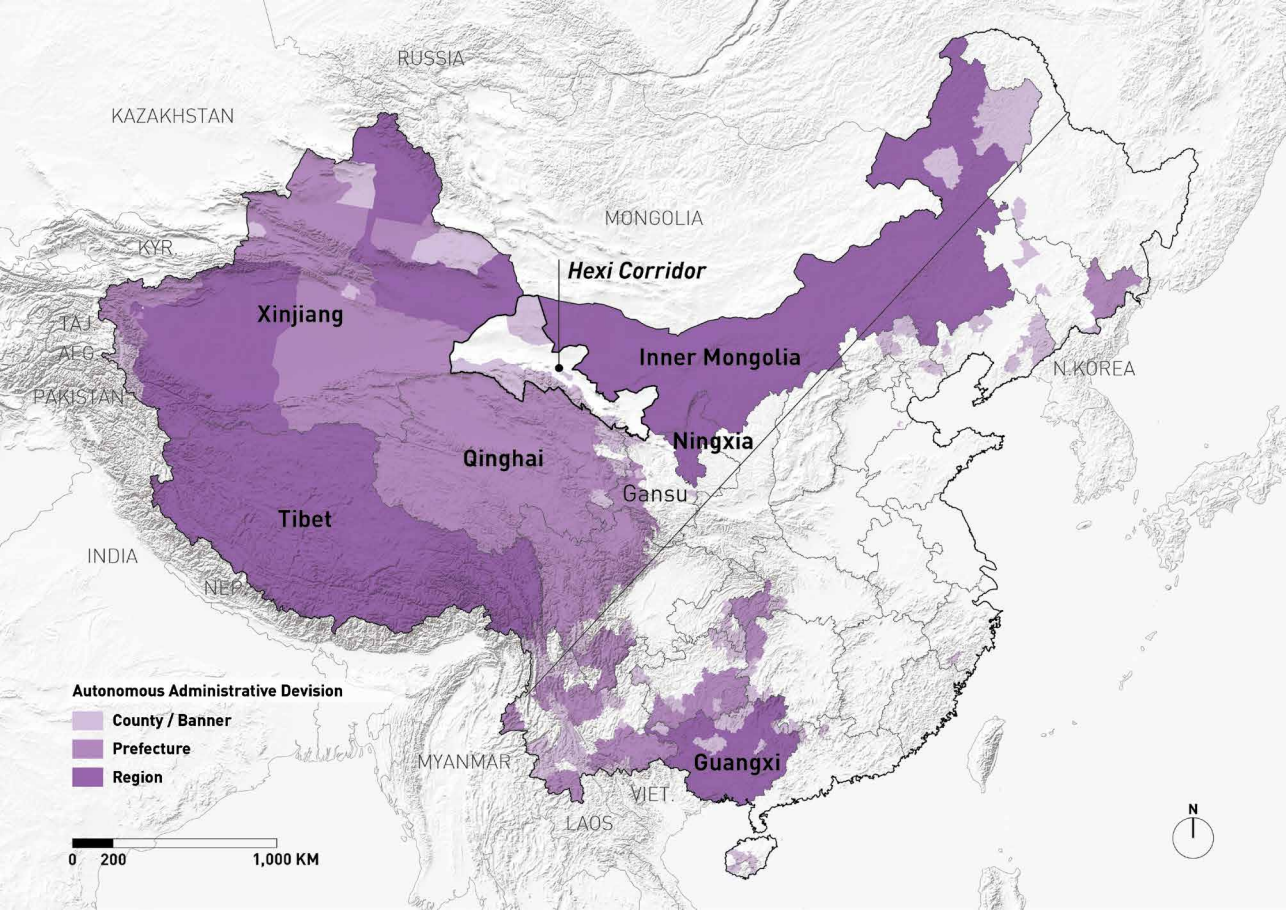


Fig. 4.4: Map of China's autonomous administrative divisions showing the Hexi Corridor as a political and ethnic extension of China's heartland reaching towards the northwest.

Another characteristic that is crucial to understanding the rural-urban relationship in China is that modern, Western industrialization in today's second-largest economy did not start before the arrival of Western colonial states in coastal cities as well as Japan in the northeast and in the rest of the country not in large scale until the beginning of post-war, Soviet-Maoist industrialization in the 1950s, as it will be discussed further below. In that period of early communist state formation, the former imperial structure of villages, ruled by family lineages and bound the individual peasant to a village, was reorganized into farming collectives.[18]

The rural-urban relationship in China has often been contradictory. The countryside underwent dramatic transformations during the Maoist era: it was used in different forms as a metaphor for utopian narratives and has been the locus of destructive social campaigns and socio-economic experimentation.[19]

unless the country is able to radically shift this imbalance (p.7–10).

18 For the spatial and social structure of villages in imperial China and their transformation during the period of Maoist collectivization, see Ronald G. Knapp, ed., *Chinese Landscapes: The Village as Place* (Honolulu: University of Hawaii Press, 1992).

19 The relationship between urban and rural China has been—and still is until today—con-

However, economic investments and development have primarily focused on urban centers and, particularly with the beginning of the period of Reform and Opening-Up, rural-urban disparities became more pronounced. Gansu is one of the rural regions in China where the urban-rural and modern-traditional differences are particularly strong. As mentioned, Gansu's GDP per capita is the lowest across all of China's provinces. Particularly for a rural population in a region such as the arid Hexi Corridor with its harsh climatic conditions, productive land cultivation is generally challenging. Poverty alleviation has thus been one of the central government's primary concerns, including campaigns for modernization and "townization" of the countryside, in parallel to a continuing shift of rural populations into existing urban areas.[20]

tradictory. R.J.R. Kirkby describes how, already in the mid-19th century, China developed a pronounced anti-urban attitude: First, as a reaction to the Opium Wars and foreign incursion, as well as the USA's later intervention in support of the Kuomintang. Later, the Communist Party movement, with its predominantly peasant members, followed an anti-urban or pro-ruralist attitude. After 1949, the PRC developed a contradictory attitude which, on the one hand, continued to promote such positions, on the other hand, followed an urban-industrial model according to the Soviet Union. While Maoist China promoted social campaigns favoring the countryside, in the post-Mao era, China shifted to pragmatic politics in clear favor of cities. In contrast, the countryside became a dynamic area of economic experimentation. R. J. R Kirkby, *Urbanisation in China: Town and Country in a Developing Economy 1949–2000 AD* (London: Croom Helm, 1985), 1–18. The Maoist rural-urban divide was based on the unequal concept of the countryside acting as a supplier of the city with grains, manifested in the *hukou* household registration system and organized clearly in favor of the urban population. During the famine of the Great Leap Forward, this regime was ramped up with unequal prioritization and treatment, expressed in grain rations favoring cities. Frank Dikötter, *Mao's Great Famine: The History of China's Most Devastating Catastrophe, 1958–62* (London: Bloomsbury Paperbacks, 2017), 133–34; 231.

20 In February 2021, the PRC declared that it had achieved the "final victory in the fight against poverty" and had lifted the remaining roughly one hundred million poor above the poverty line by the end of 2020, precisely as promised eight years earlier, and despite the global Covid pandemic. "Poverty Alleviation: China's Experience and Contribution" (Beijing: The State Council Information Office of the People's Republic of China, April 2021). However, very little information was provided about how these numbers had been calculated. Previously, Chinese leaders had defined poverty far below the World Bank's threshold for middle-income countries like China. Lily Kuo, "China Claims to Have Eliminated Poverty, but the Figures Mask Harsh Challenges," *The Washington Post*, February 25, 2022. Rozelle and Hell identify the primary cause of poverty as the lack of human capital in rural areas, lagging far behind in basic education, something the campaign has not effectively addressed. Rozelle and Hell, *Invisible China*. For China's plans of "townization," see, for instance, Peter G. Rowe and Har Ye Kan, "China's Townization Plan and Its Implications," in *Common Frameworks: Rethinking the Developmental City in China*, ed. Christopher C. M. Lee (Cambridge, MA: Harvard Graduate School of Design, 2016), 242–47. The authors describe how villages are transformed into towns that include, in many cases, urban centers of radically different spatial forms, aiming to foster socio-economic intensity.

Five Phases of State Development in China's West Since the Founding of the PRC

The history of the Hexi Corridor's colonization by the Western Han has demonstrated how a new geographic perception of the region could be translated into spatial strategies for the reorganization and physical transformation of the environment. It has been framed as a historical paradigm shift to a new socio-environmental regime. This allows to contextualize and better understand the origins of inherent structural challenges the region faces today. This chapter argues that another such paradigm shift can be identified in the early 1950s with the beginning of the People's Republic of China and the introduction of heavy industrialization. It marks the starting point of a new period of acceleration in the long-term process of socio-environmental transformation—or co-production—resulting in an exacerbation of environmental problems. This process was, again, by no means linear but highly erratic.

In 1949, after years of tremendous turmoil, destruction, and radical societal change, China embarked on a disruptive process of redefining and reorganizing its nation. In this process of post-war nation-building, the central government soon turned its focus to the country's western regions. It continued to do so across different periods of changing political agendas. Initially, the primary reasons were the pronounced deficits of the structurally weak and sparsely populated regions in the country`s interior in terms of economic production compared to the country's coastal southeast. It led to the realization that national modernization was only feasible if these inherent socio-economic imbalances could be eased.[21]

Since the founding of the PRC in 1949, several phases of state-led campaigns and policy initiatives can be identified that tried to bring investments and economic production to the West, aiming to lift regions that were lagging behind in terms of economic prosperity, basic civic infrastructures of transportation, education, and public health, as well as environmental stability. However, what is essential across all these different phases is the perception of the country's interior northwest as a source region for the extraction of materials to supply distant urban centers of capital accumulation in the country`s prosperous east. The landlocked hinterland, far inland from China's southeastern coast, continuously provided extractive materials such as coal, oil, iron, rare earths, and—in recent years—renewable energies, which are transferred from northwestern regions to the east.

Yue-man Yeung divides China's western development since the early 1950s and the First Five-Year Plan of the PRC into four phases: First, a phase that

21 Yue-man Yeung, "Introduction," in *Developing China's West: A Critical Path to Balanced National Development*, ed. Yue-man Yeung and Shen Jianfa (Hong Kong: Chinese University Press, 2004), 5–17.

aimed to concentrate industrial production in remote locations close to the source of raw materials from 1953 to 1957; second, a phase of industrial distribution because of national defense and security concerns from 1965 to 1975; third, a shift in regional development policies from the interior to eastern coastal regions with economic reforms beginning in the late 1970s and promoting economic opening across all fronts in 1992; and fourth, a shift back to more egalitarian modes of regional development with the "Open Up the West" initiative of balanced western development in 1999.[22]

The following account of this territorial reorganization process across different periods of state-led campaigns includes short vignettes with descriptions of specific localities. Some of the places have been visited on two field trips in the spring and fall of 2019; others are described based on secondary literature. The texts aim to add a tangible, on-the-ground dimension, illustrating how individual sites have been physically shaped and transformed by the invisible forces of socio-environmental entanglements that operate on territorial, national, or even planetary scales. Such entanglements result from different actors' often divergent social, economic, and political interests, including individuals, communities, institutions, and the central state. Individual localities can thus be understood as the physical expression of a socio-political state apparatus and its interaction with land, space, and processes of the extra-human environment.[23]

First Five-Year Plan and Industrialization According to Soviet Models (1953–1957)

In 1949, the PRC's new Maoist state began a modernization and nation-building process. Despite a contested relationship with the Soviet Union from the onset, China`s governmental apparatus was constructed according to the model of its large northern neighbor and communist ally.[24] The first years after

22 Ibid., 12. Other authors in the edited volume divide the time of Chinese nation-building since 1949 into slightly different phases. Generally, they all follow campaigns of state development that shifted their focus between the western interior and the eastern coast, between balanced, national development and market liberalization.

23 This notion of a specific socio-political context shaping individual places not only aligns with the concept of territorialization as introduced above but also with the understanding of *landscape* as a cultural medium and physical expression of a society, as outlined in chapter one.

24 Hundreds of Chinese personnel were sent to the Soviet Union to learn how to run a one-party state while well-paid Soviet troops and experts were invited to China to guide the new PRC on building its military, infrastructures, and industries. For the organization of the CCP following a Soviet political model and its strong heritage until today, see Richard McGregor, *The Party: The Secret World of China's Communist Rulers* (New York: Harper Perennial, 2012), 12f.; On the tensions between early communist China and Soviet Russia, see Frank Dikötter, *The Tragedy of Liberation: A History of the Chinese Revolution 1945–1957* (London: Bloomsbury Paperbacks, 2017), 120–27. The Soviet Union benefitted not only geopolitically from the communist alliance with China but also from large payments, export revenues, and access to Chinese sites of resource extraction. Baichun Zhang, Jiuchun Zhang, and Fang Yao, "Technology

the devastating wars were characterized by a constant fear of a potential foreign invasion, particularly from the defeated Republic of China across the Taiwan Strait. The Maoist regime thus regarded the eastern coast as an unfavorable area for industrial development. Such national defense concerns were one main reason to shift the focus toward the western interior. Another reason was an imbalance in terms of per capita economic production: industries at the time were primarily concentrated in cities along the southeastern coast, accounting for around seventy percent of the industrial assets and output. Consequently, most of the central government`s investments into state-owned enterprises shifted to the interior, where they continued targeting cities, towns, and large-scale infrastructures far off the coast until the mid-1970s.[25]

The first wave of national development in China's modernization process was built upon a Soviet model of heavy industrialization: At the core of the First Five-Year Plan of China`s planned economy (1953–1957) were 156 Soviet-aided "key projects" to build up China's industrial and national defense sectors. Most of them were located in urban locations, and seventy-nine percent in the interior. Eight projects were located in Gansu province, where they turned the capital city, Lanzhou, into a major industrial hub.[26] A large-scale Urban Construction Plan for Lanzhou's development had already been drafted in 1951. A revised version of the plan, following a top-down national, Soviet-aided direction, strongly favored industrial development over agriculture. The plan's urban layout was organized around key industrial areas, and its implementation turned Lanzhou from a consumer- into a production city. This complete revision of Lanzhou's urban development plan marks a shift in China away from European and North American urban planning schemes that had been consulted previously toward a Soviet model. It aimed to serve a greater goal of national construction, led by top-down modes of industrialization and urbanization.[27] In the case of Lanzhou, the main drivers of capital investment

---

Transfer from the Soviet Union to the People's Republic of China: 1949–1966," *Comparative Technology Transfer and Society* 4, no. 2 (2006), 117f.

25 Between 1953–1975, around 55% of national investments were distributed to western regions (only around 40% to coastal areas), marking the peak of western development in the 20th century. Li, Yeung, and Qiao, "Historical Legacy and Future Challenges," 36.

26 Yimin He and Mingchang Zhou, "The 156 Projects and New China's Industrial and Urban Development," in *Selected Essays on the History of Contemporary China*, ed. Xingxing Zhang, vol. 1, Historical Studies of Contemporary China (Brill, 2015), 56–59. Zheng and Deng count 16 large, heavy-industry projects of this period of industrialization that were allocated to Gansu. Zheng and Deng, "Typical Cases in Northwest China," 33. No official and complete list of the "156 projects" exists. 139 projects involving Soviet technology transfer were signed off and approved. Bo Li and Michela Giorcelli, "Technology Transfer and Early Industrial Development: The Case of the Sino-Soviet Alliance," *Centre for Economic Policy Research (CEPR)*, January 10, 2022. For a comprehensive list compiling different sources and counting 150 projects, see "156 Xiang zhongdian gongcheng 156项重点工程 [156 Key Projects]," Wikipedia, April 30, 2022.

27 Xianglong Tang et al., "From Continuation to Evolution: Historic Review and Value Enlight-

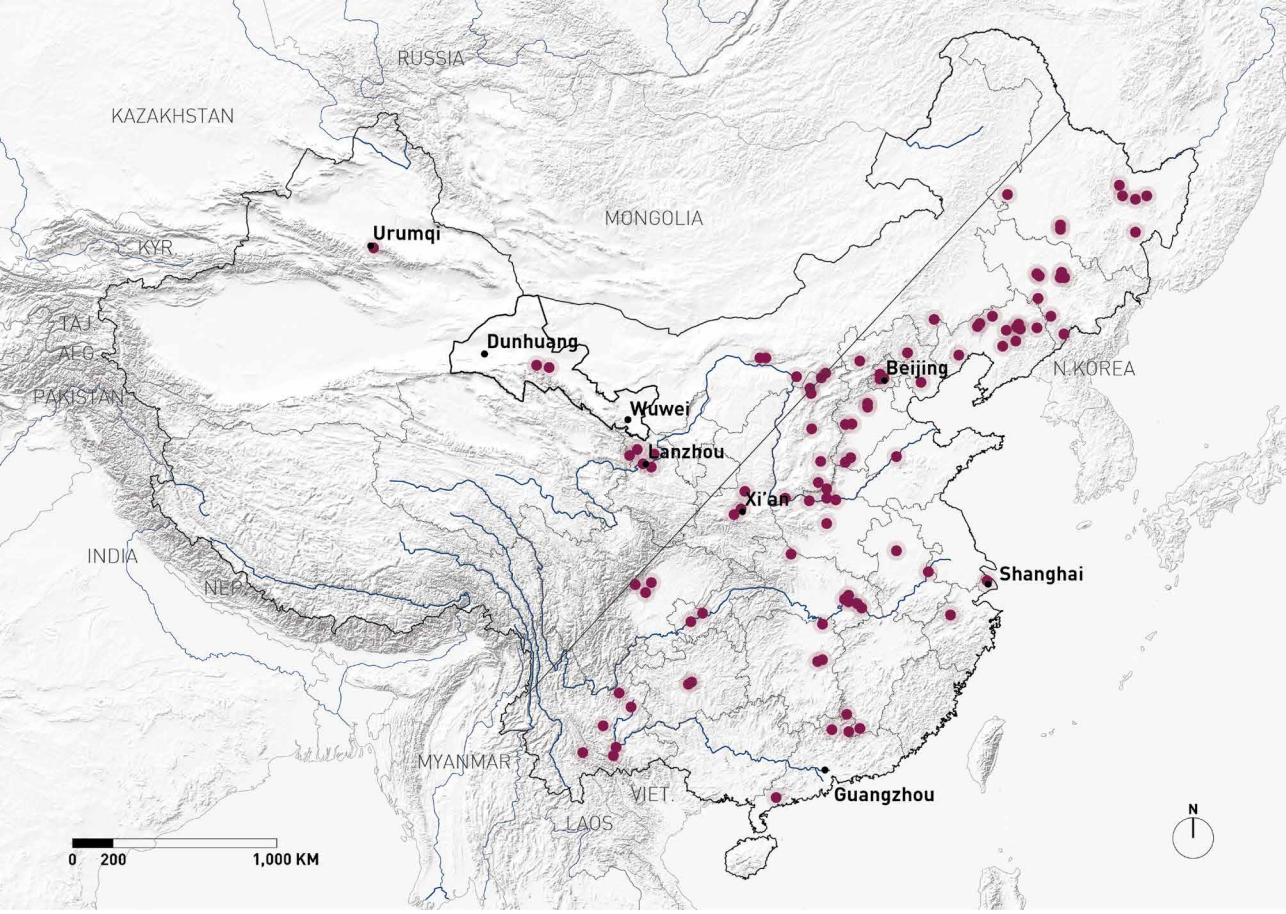


Fig. 4.5: Purple dots representing the 139 Soviet-aided projects approved from the "156 projects" during the PRC's first phase of post-war industrialization. The majority of the projects were located along the Yellow River, including Lanzhou as a major industrial hub, and in China's northeast.

and urban development were industries of non-ferrous metals, heavy machinery, and petrochemicals, with the Lanzhou Oil Refinery and Lanzhou Petrochemical Company as key enterprises.[28] Later, in the Second Five-Year Plan, the Soviet Union supported industrial projects in even larger numbers.[29] [Fig. 4.5] [Poster D]

Soviet-led modernization was built on cities as centers of industrial production. It focused on the reconstruction of provincial capitals (such as Lanzhou), as well as strategically important second and third-tier cities, as described below in the case of the Hexi Corridor. The country's urban population rose rapidly as rural migrants moved into cities and industrial areas. However, according to concepts of urban metabolism and the production of nature, the

enment of the Lanzhou Urban Construction Plan," *China City Planning Review* 27, no. 04 (2018): 69–75.

28 Both the Lanzhou refinery and the Lanzhou Petrochemical Company were part of the "156 key projects." Both still exist today and belong to PetroChina, a branch of China National Petroleum Corporation, one of the country's largest state-owned enterprises.

29 Zhang, Zhang, and Yao, "Technology Transfer from the Soviet Union." 114–15.

emerging, new industrial centers, such as the case of Lanzhou, need to be seen in close relationship and interdependency with productive hinterlands they depended on, including remote locations of extraction and production.

Yumen

Yumen is located in the far-western part of the Hexi Corridor.[30] The city serves as a prominent example to illustrate the integration of remote locations of resource extraction into the process of nation-building, including the state-driven construction of the industrial province capital, Lanzhou. In 1939, during the Second Sino-Japanese War, when petrol had become scarce, the Nationalist and Communist governments began a joint mission to drill for oil in Yumen. Production increased in the following years, attracting workers and businesses to this remote region.[31] The Yumen Oilfields became China's first modern site of oil extraction. It grew to the largest and most productive source of crude oil, producing more than half of the country's total at its peak in 1959 and supplying the oil industry across China with expertise and trained labor.[32] The emerging nodes of industrial production and resource extraction across China started to be connected through transportation infrastructures, which are at the core of any territorialization project.

A central piece during the early Maoist era was the Lanzhou-Xinjiang Railway, constructed between 1952 and 1962 and finally opened in 1966.[33] The construction was celebrated as a prime modernization project and used for socialist state propaganda.[34] China's longest railway line allowed to travel all the way from east to west across the country. Its main purpose, however, must have been to connect Urumqi, the capital of Xinjiang province—one of China's major source regions of raw materials—to the industrial city of Lanzhou, Central China, and coastal cities.

The remote oilfields in Yumen directly supplied the oil refinery and manufacturing industry in Lanzhou some 800 kilometers fur-

30 I was neither able to visit Yumen nor New Yumen, which will be discussed later. The description is based on secondary literature.

31 Mao Huahe, *The Ebb and Flow of Chinese Petroleum: A Story Told by a Witness*, Ideas, History, and Modern China (Leiden, Boston: BRILL, 2019), 16–22.

32 Ibid., 40.

33 "Lanzhou–Xinjiang Railway," Wikipedia, January 5, 2022.

34 The railway included a tunnel through the Wushaoling Mountains as a gateway into the Hexi Corridor. The tunnel was one of China's most significant construction projects at the time. It was celebrated as a national accomplishment through propaganda projects such as the 1965 film "Blossom of Malan Flowers," which heroically portrays the story of Hu Youmei, supposedly the first and exceptionally distinguished female bulldozer driver in the country. "Ma Lan Hua Kai 马兰花开 [Malan Flower Blossom]," Baidu Encyclopedia, April 19, 2022.

ther east, but also industrial bases in Shanxi and Sichuan province. First, the crude oil was trucked via roads that had been constructed with the beginning of oil drilling in Yumen. In 1956, the railway was extended to a new transfer station in Yumen that was built by Lanzhou Petrochemical. This allowed exporting the crude oil directly by train from its source. It also enabled the connection of Yumen to a broader network of resource management and distribution, including stations in Gulang (Qinghai province), Tianshui (Eastern Gansu), and Baoji (Shaanxi).[35] Eventually, in 2007, a pipeline was opened to transfer crude oil from the Tarim Basin in Xinjiang province–beyond the western end of the Hexi Corridor–all the way to Lanzhou. The Shanshan-Lanzhou oil pipeline allowed to connect other source regions, such as Yumen, but also oil fields in Kazakhstan, to the Chinese market.[36]

"Third Front" and Territorial Distribution (1964–1972)

The second phase of western development continued the egalitarian approach to strengthen China's interior. By the early 1960s, the international political climate had significantly worsened. The relationship with the Soviet Union continued to deteriorate, and most cooperation projects were terminated,[37] forcing China to import urgently needed technologies from elsewhere.[38] The risk of a major geopolitical conflict during the Cold War and the fear of an atomic strike led China to a much more pessimistic assessment of the geopolitical situation. National defense and security matters, which had already been a significant concern in the first phase of western development, became more urgent.[39] China shifted the national development strategy from urban

35 Yaqin Du, "Xibei xiaoshou yu men fen gongsi 70 nian fazhan ceji 西北销售玉门分公司70年发展侧记 [70 Years of Development of Yumen Branch of [Petro China's] Northwest Sales]," *Shiyou shang bao* 石油商报 *[Petroleum Business Daily]*, December 21, 2021.

36 Boyu Wang and Congru Xiong, "Gouzhu Zhongguo Nengyuan Xin Ganxian 构筑中国能源新干线 [Building a New Energy Line in China]," *Jingji Canguan Bao* 经济参观报 *[Economic Information Daily]*, August 29, 2007.

37 Already in the late 1950s, the Sino-Soviet relationship began to worsen. In 1958, the Soviet Union began to reduce its assistance until, in the 1960s, the collaboration ended, and Soviet experts were expelled from China. Zhang, Zhang, and Yao, "Technology Transfer from the Soviet Union," 145–49.

38 Xiaojuan Jiang, "China's Seven Decades of Opening-Up: Empowering Growth and Reforms," *China Economist (Beijing, China)* 16, no. 4 (2021): 13–29.

39 In addition to a changing situation of foreign relations, Barry Naughton points out that China's economy also had to recover from the devastating years of the Great Leap Forward. While advisors presented plans to focus on establishing a stable economy to ensure basic needs of food and clothing to the population, it was Mao who preferred a politics of "austerity socialism" with fewer grain imports and more spending on heavy industries, and an "emergency response" to external threats instead of cohesive plans of inland development. Barry Naughton, "Industrial Policy during the Cultural Revolution: Military Preparation, Decentralization, and Leaps Forward," in *New Perspectives on the Cultural Revolution*, ed. Christine P. W. Wong, Da-

centers as industrial hubs toward a spatial distribution of essential industries. In 1964, the central government decided that the concentration of factories in large cities was no longer favorable. Instead, major enterprises should be relocated to the interior west to build a strategic rear.[40] Starting in 1964, a series of major investment campaigns began as part of this strategy. The share of national capital that was allocated to western provinces in the Third Five-Year Plan (1966–1970) more than doubled compared to the First Five-Year Plan.[41] The second significant strategy concerning regional development was to create independent regional clusters of economic cooperation in manufacturing and agriculture. While the initiative worked primarily as a centrally-directed investment program, it introduced political decentralization and local government autonomy to a certain degree.[42] The plan was to disperse industrial construction across the interior "Third Front,"[43] and concentrate it locally. The location of new industrial factories followed the principle of "close to the mountains, dispersed, and hidden in the caves."[44] In this process, each of the selected interior provinces was ordered to develop its own industries, especially for the production of military equipment. Some industries were built from scratch, particularly in the machinery and chemical sector, while others were relocated from coastal areas to the interior. Guo Jie points out that this strategy of regionalization and direct investments into local bases of development and social reorganization was a way for the central government to infiltrate its interests into local socio-economic spheres. It is part of the state's territorial-

vid Zweig, and William A. Joseph (Cambridge, MA: Harvard University Asia Center, 1991), 156–57.

40 Guo Jie lists fourteen major enterprises relocated from mostly eastern and coastal cities to Lanzhou between 1964 and 1970. Lanzhou continued to be one of the major national industrial bases and benefitted greatly from central state subsidies. However, Lanzhou's development always prioritized national interests over local concerns with social, economic, and geographic conditions. Jie Guo, "Industrial Restructuring and Urban Spaces Transformation in Lanzhou City, With Focus on Its Transition Periods," in *Urban Governance, Spatial Planning, and Economic Development in the 21th Century China*, ed. Hans Gebhardt (Zurich: Lit Verlag, 2018), 95–122.

41 In total, China's west received 66.8% of total state investments during the period of the Third Front, while the coastal city of Shanghai, for instance, only received 3.6%. Jie Fan, "Western Development Policy: Changes, Effects and Evaluation," in *Developing China's West: A Critical Path to Balanced National Development*, ed. Yue-man Yeung and Shen Jianfa (Hong Kong: Chinese University Press, 2004), 86.

42 Eventually, this led to the central state apparatus's loss of control over the economy, especially toward the end of the Cultural Revolution (1966–1976). Naughton, "Industrial Policy during the Cultural Revolution," 155; 164–66.

43 The "Third Front" was a military metaphor. The first front referred to the coastal regions, vulnerable to attack; the second front to regions that were more inland but exposed to bombing raids in a military conflict; the third front to secure base areas nestled in remote mountainous regions of inland China. See Naughton, "Industrial Policy during the Cultural Revolution," 158.

44 In some cases, this slogan was translated literally, and out of the fear of airstrikes, several major factories were built in caves. Fan, "Western Development Policy," 85–86.

ization project that legitimizes national accumulation strategies and allows the central state to consolidate its political authority.[45]

In China's process of modernization and nation-building, the demand for energy and raw materials, such as coal, oil, and steel, grew constantly. In 1955, a nationwide search for iron ore was launched. Iron was found inside the Qilian Mountains, at over 2,600 meters elevation, along the Beida River, around fifty kilometers southwest of Jiuquan.[46] The Jingtieshan Mines started to operate in 1958 with the opening of the Jiuquan Iron and Steel Group and its factories that were built around twenty kilometers west of the historic city of Jiuquan.[47] For the Hexi Corridor, the Third Front period of national development was particularly significant. In 1965, Jiayuguan was formally established around the Jiuquan steel factories as an independent prefectural-level city.[48] It was developed in the 1960s as a critical national industrial base for large-scale steel production. In 1965, a railway started to operate that transferred mine workers to the Jingtieshan mines and the extracted iron ore in reverse direction, out of the narrow mountain valleys and along the Beida River to the steel plants in Jiayuguan.[49]

The bulk of national Third Front investments went to the interior southwest (Sichuan, Guizhou, and Yunnan).[50] Many manufacturing and machinery enterprises were relocated to the northwest in the early 1970s, including Gansu, Ningxia, and eastern Qinghai. However, little is known about Third Front projects in China, which remained a state secret. This was particularly the case for Gansu, which was developed as the center of China's nuclear and aerospace industries. Specific data about most of the projects was, therefore, regarded as classified information.[51] The work on a massive hydropower plant in Gansu had already begun during the First Five-Year Plan in 1958. The Liujiaxia Reservoir on the upper Yellow River southwest of Lanzhou was one of the PRC's main

45 Guo, "Industrial Restructuring and Urban Spaces Transformation in Lanzhou City," 108.

46 Over time, other resource sites in the same region were found, as well as other minerals in addition to iron ore, which together form the Jingtieshan Mining Field. "Gansu Jing Tie Shan Tie Kuang 甘肃镜铁山铁矿[Gansu Jingtieshan Iron Mine]," Baidu Encyclopedia, accessed July 27, 2022.

47 While the work on the steel plant in Jiuquan had begun during the Great Leap Forward in the late 1950s, construction was abandoned, and the work did not resume until 1965 during the Third Front initiative. Naughton, "Industrial Policy during the Cultural Revolution," 160.

48 The city was first part of Jiuquan but became an independent prefecture-level city in 1965, named after the famous Jiayu Pass nearby, the westernmost fortress gate of the Great Wall during the Ming dynasty. "Jiayuguan Gaikuang 嘉峪关概况 [Overview of Jiayuguan]," Jiayuguan shi renmin zhengfu 嘉峪关市人民政府 [Jiayuguan Municipal People's Government], April 17, 2023.

49 "Jiajing Railway," Wikipedia, January 22, 2022.

50 For these regions in the southwest, state investments more than doubled to 23% of the national total during 1965–1971. Naughton, "Industrial Policy during the Cultural Revolution," 161.

51 Ibid., 160–61.

hydroelectric projects in the 1950s. During the Third Front, it was expanded and connected to the energy-intensive nuclear and non-ferrous industries in Lanzhou.[52]

Jiayuguan

When I visited Jiayuguan in the fall of 2019, I was impressed by the degree of industrial decay and urban poverty I encountered. A large portion of the city was occupied by sites of industrial production, especially by the large compound of the Jiuquan Iron & Steel Group. Large straight roads led through the vast, walled plots of land from which smoking blast furnaces, chimneys, and massive cooling towers protruded. It was a cold, hazy day, aggravating the bad air condition and wrapping everything in dense smog. Together with my guide, Du Rong, we strolled through dusty blue-collar working settlements and a wet market in one of the street lanes adjacent to large sites of heavy industrial production. According to a resident we met, the apartments used to provide high-standard housing until around twenty years ago. Today, they are mostly in poor condition but still in high demand, particularly for young families, because of a nearby school.

A driver of a motorized three-wheel rickshaw later drove us across the large logistic sites and industrial compounds, intersected by rail tracks, pipelines, and overhead power lines. Whenever our driver dropped us off and we were able to pass through an open gateway, we seemed to enter the informal part of the city. While we tried to avoid the grim-looking, straying dogs, we sporadically met individuals who appeared from closed doors or behind street corners. On one of the sites, former manufacturing shops were being rented out as apartment homes. In front of the converted entrance doors were parked bicycles and wheelbarrows, stored tools and construction material, coops for chickens and bunnies, and laundry hanging on clotheslines. A young mother we wanted to talk to hastily fobbed us off and pulled her daughter into their home. An older woman, her face wrapped in a thick scarf, turned away after a short conversation and was unwilling to answer further questions. But she briefly told

52 The Liujiaxia Reservoir was part of a major mission by the central government, declared in 1955, to build 46 hydroelectric dams along the Yellow River. The Liujiaxia Reservoir was China's largest hydropower facility at its completion in 1969 and until the early 1980s. Its primary purpose was the power generation for vital industries in the industrial hubs of Lanzhou and Baiyin. Located within Linxia Hui Autonomous Prefecture, its construction included flooding large agricultural land, displacing thousands of farmer families, and leaving them with far too little or virtually no compensation payments. The large reservoir is also crucial for seasonal flood control and irrigation. Jun Jing, *The Temple of Memories: History, Power, and Morality in a Chinese Village* (Stanford, CA: Stanford University Press, 1996), 71–73.

Fig. 4.6: Decaying and mostly abandoned factory compound in Jiayuguan with some of the sheds and houses still being occupied; October 2019.

us that the owner of the stacks had started to rent them out around thirty years ago for today's rent of 300 yuan (around 45 USD), mostly low-wage families and laborers who work in the city. [Fig. 4.6]

Our rickshaw driver, an older man with an old-fashioned red helmet and a shabby, dark blue down jacket, moaned about his troublesome life and requested extra money for all his waiting time while we explored the area. He told us how he had moved to Jiayuguan with his family from a small village in Shaanxi when he was about ten years old during the years of the Cultural Revolution. Later, he lost his job in one of the steel factories because of a delinquency he did not want to specify further and would, therefore, only receive a tiny pension. In a surprisingly open manner, he confided to us about how he had started to drink and how his wife had left him; how he had been working as a rikshaw driver for the past twenty years and how he would live all by himself adjacent to a factory, not far from his previous working place.

We entered another site that was used as a parking ground for truck drivers as part of a large industrial park. In the front, close to the road, a cheap-looking, four-story motel was followed by small manufacturing shops and street food stalls. The walls were full of graffiti

Fig. 4.7: Impressions from Jiayuguan (from top left, clockwise): View inside a steel factory compound; Wet market surrounded by blue-collar housing; Shelter home and recycling site of dismantled trucks; Housing adjacent to smokestacks and cooling towers; October 2019.

and posters with phone numbers of various businesses. In the part further in the back, the site turned into a "vehicle cemetery" where rusty trucks had been left behind. As we were climbing across massive mounds of metal scraps, decayed driving cabs, pulled-out seats, motors, and gas tanks, we met a man who had built a small shack in the middle of this waste deposit. He sorted the trucks into smaller portions, laid them out in long rows, and then dismantled everything into small pieces, which he would sell for, as he said, around two yuan (30 cents) per kilogram. [Fig. 4.7]

As Jiayuguan had been turned into an industrial hub of national significance during the Third Front period, it had been established as a locality for purely industrial-economic reasons in the dry plain north of the Beida River valley at the source of iron ore extraction. It is by far the smallest city jurisdiction in the Hexi Corridor and consists of only one administrative unit plus five townships. From its population of around 250,000, more than ninety-three percent are urban residents. Therefore, it is not surprising that it is also the wealthiest of the five prefectures in the Hexi Corridor, with the largest gross regional product (GRP) per capita.[53]

53 The city's GDP per capita accounts for 112,219 RMP (around 16,700 USD). See "National

The short impressions from my visit to Jiayuguan may offer a small peak into the urban decay and informality that must be present in many other industrial cities that were developed during the period of state-led Maoist industrialization. Many industries are no longer competitive in today's market economy. While these cities used to be major employment hubs in their respective region and the new home for many dislocated individuals and families during the years of the Cultural Revolution, markets have shifted in past decades, and many jobs have disappeared, forcing people to reorient themselves. Vast sites of heavy infrastructure have either been transformed into new uses or are crumbling away, leaving a depressing scenery of post-industrial urban backyards. As many of the urban welfare services had been dismantled during China's years of economic liberalization, unemployed and retired blue-collar workers are left in often peculiar situations. This period of Reform and Opening-Up will be discussed later. Before, the legacy of policies and practices during the Maoist era from 1949 to 1976 is described. While China's Communist Party has undergone a drastic transformation since then, in the one-party state, the political foundation is still the same at its core. Many characteristics of China's political, cultural, and economic system established in almost three decades of Maoist nation-building remain relevant today.

The Legacy of Policies and Practices During the Maoist Era (1949–1976)

The period between 1949 and 1972 was led by egalitarian goals. It successfully balanced geographic inequalities in China's economy to a certain degree. It opened the interior to coastal areas and connected different regions among each other. However, there was a lack of an overall plan: The industry-based economic development in the first phase focused on urban centers but came at the cost of local agriculture. In the second phase of the Third Front, large amounts of central government investments went into new and relocated industries. At the same time, however, many state-driven projects for which investments had been made in the first phase had not yet reached full operation. Instead, they started to slow down, and many were eventually aborted. In addition, some enterprises no longer functioned profitably once they were relocated to western localities. In short, the excessive decentralization of industries resulted in an enormous waste of resources. Furthermore, many large-scale manufacturing plants remained isolated and did not contribute to the regional economy overall.[54]

Accounts" in Survey Office of National Bureau of Statistics in Gansu, "Gansu Development Yearbook 2020." Jiayuguan's GDP per capita is relatively high, even in national comparison. Compared with China's provinces (not cities), only three have a higher GDP per capita (Beijing, Shanghai, Jiangsu), while the provincial national average is 70,892 RMB, with Gansu's only accounting for 32,995 RMB. "National Accounts" in "China Statistical Yearbook 2021."

54 Fan, "Western Development Policy," 87.

The decentralization of governmental power led to divergent interests and a lack of coordination. The localization of seemingly independent industrial systems resulted in inefficient duplication of services. The construction of Third Front projects in intentionally remote locations and rugged terrain was much more costly and time-consuming compared to central areas close to urban centers and transportation infrastructures. In most cases, the projects were executed with great haste, and the preparatory work was either inadequate or nonexistent, causing additional costs and inefficiencies. As a good example, the Jiuquan steel plant in Jiayuguan took not only very long to be completed but could not operate at full capacity for a long time because of significant planning flaws.[55] The decentralized development of massive Third Front projects that were pursued simultaneously resulted in resource shortages and enormous volumes of material, money, and labor tied in construction sites, which, in many cases, eventually remained uncompleted.[56] In addition, factories in remote, mountainous locations often could not efficiently transfer their material output into economically productive and well-connected plains.[57]

While the Third Front cannot be directly compared to contemporary China's territorial planning strategies, issues of lack of coordination, wasted resources, and logistic inefficiency are crucial to recognizing parallels to tremendously resource-intensive urbanization projects from the past two decades, as discussed in the following chapter.

Regional development policies in the first phases of Maoist national development could ease economic disparities between China's coastal east and western interior to a certain degree. However, the rural-urban divide continued to exacerbate. Large investments into centers of industrial production attracted increasing numbers of rural peasants moving as migrant workers into cities.[58] Another legacy of the Third Front's concept of placing major industries in mountain valleys can be illustrated with the case of Lanzhou: The city—which has grown to a regional industrial hub with a population of almost three

55 The construction of the Jiayuguan mill had already begun in 1958. It was halted during the crises of the Great Leap Forward before a top-priority order was given in 1965 to construct a prime steel factory. However, the locality was not well chosen as the steel mill struggled with iron ore supplies of minor quality, therefore producing quantities of steel that were not anywhere near commensurate with the enormous investments. In total, the design was changed six times, and despite more than a billion yuan in investment, the plant produced steel only twenty-seven years after construction had started. Barry Naughton called the project the "most colossal failure in the Third Front construction." Barry Naughton, "The Third Front: Defence Industrialization in the Chinese Interior," *The China Quarterly*, no. 115 (1988), 377.

56 Naughton, "Industrial Policy during the Cultural Revolution," 169.

57 Ibid., 179.

58 Massive industrialization and recruitment of rural labor caused an explosion of urban populations between the early 1950s and early 1960s. The uncontrolled urban inflow of job-seeking labor led the central government to implement the *hukou* household registration system in 1957. Kam Wing Chan, *Cities with Invisible Walls: Reinterpreting Urbanization in Post-1949 China* (Hong Kong; New York: Oxford University Press, 1994), 33–41.

million in the city proper today[59]—is located in a narrow valley. It, therefore, faces severe spatial constraints for urban development, as will be discussed in more detail later. Lanzhou is also a prime example of a city with extreme air pollution rates due to heavy industrialization in narrow valleys.[60] In addition, by decentralizing industries, transportation infrastructures had to be built in untouched mountain regions that would have been bypassed under other circumstances. This extended and accelerated the human footprint into remote locations, which came at an unnecessarily high environmental price with devastating consequences until today.[61]

Consequences for People, Communities, and the Extra-Human Environment

The governance and planning culture during the Maoist era caused tremendous social and environmental harm and destruction. Conflicts between ambitions for economic growth and the inherent limitations of local ecosystems became exceptionally apparent. The period is an impressive account of a systematic disregard of the individual person's as well as extra-human nature's values and needs. While political narratives glorified peasants, the traditional wisdom of farmers who had developed highly efficient methods of continuous land cultivation over millennia was completely disregarded. In addition, modern science was neglected as well. In *Mao's War Against Nature,* Judith Saphiro describes how militarized language and rhetoric were used to promote the aggressive exploitation of nature. She identifies a clear connection between the abuse of people and the abuse of extra-human nature, how establishing a certain social value system had direct consequences for the environment. The period is a stark example of a world conception that makes an explicit distinction between humans and nature, enabling forceful interventions into the extra-human environment. As Shapiro describes, throughout Maoist attempts of sociopolitical restructuring and nation-building, campaigns were launched to "conquer na-

59 The four inner-city districts Chengguan, Qilihe, Xigu, and Anning added up to 2.87 million in 2019. See "Population" in Survey Office of National Bureau of Statistics in Gansu, "Gansu Development Yearbook 2020."

60 Already in the late 1950s, the pollution in Lanzhou must have been exceptionally bad. The amount of chemical waste that was discharged from the new factories into runoff water was enormous. Lanzhou was the first city along the Yellow River that reached pollution levels eight times above what the Ministry of Hygiene allowed at the time. Dikötter, *Mao's Great Famine*, 185. This legacy of the Third Front continued in the post-Mao era: Lanzhou used to consistently rank in the top ten of China's cities with the worst air pollution since the central government began to release an air pollution index for major cities in 2003. However, in 2011, the local government implemented effective measures that helped to improve the air quality substantially. Yaqun Zhang et al., "Air Quality in Lanzhou, a Major Industrial City in China: Characteristics of Air Pollution and Review of Existing Evidence from Air Pollution and Health Studies," *Water, Air, and Soil Pollution* 225, no. 11 (2014): 15.

61 Judith Shapiro, *Mao's War Against Nature: Politics and the Environment in Revolutionary China* (Cambridge: Cambridge University Press, 2001), 158.

ture," to wage a "war against nature," or to "wipe out" species. These campaigns were characterized by political repression, utopian urgency, dogmatic formalism, and forced displacement of people. They aimed to translate idealistic socio-political conceptions from rhetoric metaphors and state propaganda into physical reality, manifesting them in the built environment. Campaigns were characterized by an intensification of land use, massive destruction of wildlife, extraction of resources, and disposal of industrial waste, often illustrating an extreme lack of understanding of ecosystem thinking and the laws of nature.[62]

Examples of this hostile attitude to extra-human nature are massive hydroelectric constructions such as the Liujiaxia Reservoir, which often led to an enormous waste of materials and devastating hydrological consequences. Forests were cut at massive scales, radically reducing biodiversity in favor of grain production during the Great Leap Forward. Short-sighted campaigns often resulted in bizarre and absurd orders, such as during the famous Four Pests campaign.[63] The emblematic assault against sparrows is just one example of the failure of the Great Leap Forward, which ended in "the greatest human-created famine in history."[64] Other examples include agricultural practices of deep plowing and close cropping. They completely contradicted the sustainable practices peasants had developed over millennia, yet they were enforced by radicalized cadres in a militarized fashion.[65] In the "educated youth" or "up to the mountains, down to the countryside" campaign, millions of youths were sent to the countryside to open up and cultivate wasteland, in most cases resulting in massive environmental destruction.[66] As mentioned, industries were relocated to remote regions during the Third Front for purely ideological reasons with mostly adverse consequences. During the Cultural Revolution, uniform and often absurd agricultural models following the Dazhai model were dictated

62 Shapiro, *Mao's War Against Nature.*

63 Starting in 1958, the masses were mobilized nationwide to hunt down millions of sparrows perceived as grain predators. This had, not surprisingly, the converse effect of a devastating surge of insects, leading to shortfalls in crop harvests. Dikötter, *Mao's Great Famine*, 186–88.

64 Frank Dikötter calculates that at least 45 million people died of premature death during the famine of 1958 and 1962. Dikötter, *Mao's Great Famine*, 333.

65 Deep plowing believed deeper planting would lead to stronger roots and taller stalks. Farmers across the country were forced to dig absurdly deep furrows from forty centimeters to one meter or even three meters in depth, which was done in many cases day and night with bare hands—the deeper, the better. Farmers dug through the earth all the way to the bedrock, destroying the topsoil of millions of hectares of farmland. In a similar fashion, absurd amounts of fertilizer were applied, polluting the soil, excessive concentrations of seeds were applied, and close cropping was suggested to plant shoots as closely together as possible. These practices negatively affected the yield and often harmed the environment in the long term—yet they were enforced for ideological reasons, and resistance was suppressed with social terror. Dikötter, *Mao's Great Famine*, 38–40.

66 The campaign also targeted people who were perceived as a threat to social order, such as criminals and refugees, but also intellectuals, including some of the most capable scientists, physicists, and engineers, who were displaced to unproductively work out in the 'wasteland,' systematically diminishing human capital. Frank Dikötter, *The Cultural Revolution: A People's History, 1962–1976* (Bloomsbury Press, 2017), 200–05.

across the country, regardless of specific local conditions.[67] These examples of disregarding the inner logic of a geographic context, such as hydrology across a watershed or traditional socio-environmental landscape systems, are mentioned here because they fundamentally contradict the culture of thought the Landscape Approach aims to establish.

In parallel to the Great Acceleration in the Western world, the Maoist era intensified land use and accelerated China's environmental degradation—albeit mostly on a technologically different level. There is a strong legacy from China's early communist period that continued in the post-Mao era and, to some degree, is still present today. For instance, the realization of massive-scale infrastructural projects such as the South to North Water Transfer Project, which began to be constructed in 2003 and literally works against the forces of nature at a national scale, moving water across watersheds from the humid south to the water-stressed north.[68] To a certain degree, characteristics of the Maoist regime, such as social repression, taming nature, and strongly anthropocentric attitudes, seem to be still ubiquitous today. Disruptive socio-environmental processes of the Maoist era played out on top of a long history of human-caused environmental transformation. "Mao's war against nature," plus the four decades of rapid economic growth and urbanization that followed, had dramatic consequences for the built environment, which today appears in large parts tremendously degraded and pushed into strong uniformity.[69] Shapiro argues that China will continue to struggle to achieve a sustainable relationship with the natural world if it does not confront its Maoist legacy.[70]

---

67 Land was forcefully transformed and cultivated in ways that blindly adhered to predetermined models and what was propagated as best practices. The results of the attempts to "conquer nature" were not only unproductive but harmful to the environment. For instance, terraced fields following the Dazhai model appeared in the most unlikely places. Uniformity was imposed across the country. Neither climate nor topography mattered: Lakes were filled in, forests were cleared, deserts reclaimed, and even hills were built on flat plains to be then terraced like in Dazhai. Shapiro, *Mao's War Against Nature*, 98–114; Dikötter, *The Cultural Revolution,* 228–31.

68 Michael Webber, Britt Crow-Miller, and Sarah Rogers, "The South–North Water Transfer Project: Remaking the Geography of China," *Regional Studies* 51, no. 3 (March 4, 2017): 370–82; Sarah Rogers et al., "An Integrated Assessment of China's South–North Water Transfer Project," *Geographical Research* 58, no. 1 (2020): 49–63. The concept of diverting water from China's humid south to the arid north dates back to the early 1950s and was an idea of Mao Zedong himself. Wong, "Plan for China's Water Crisis Spurs Concern," *The New York Times*, June 1, 2011, sec. World.

69 Maoist collectivization campaigns and communist utopianism have been highly destructive and have impoverished China to a large degree from its rich cultural heritage and diversity. Dikötter states that "the Great Leap Forward constitutes, by far, the greatest demolition of property in human history." Private houses were destroyed, but also buildings of worship, historical monuments, and cultural landscapes were replaced with uniform collective infrastructures, sites of industrial production, and monumental, Soviet-style representation. Dikötter, *Mao's Great Famine*, 163–173. The systematic and large-scale destruction of all signs of the "imperialist old world" continued during the Cultural Revolution. Social structures and the moral fabric were gradually eroded, eradicating moral values and uncountable objects and sites of cultural heritage. Dikötter, *The Cultural Revolution*, 83–93.

70 Shapiro, *Mao's War Against Nature*, 212–15.

Policy Reforms, Slow Market Liberalization, and All Front Open Policy (1978 / 1992)

The period of policy reforms and economic liberalization following the Maoist era marks another regime change that radically restructured the PRC. It led to fundamental transformations that are critical to understanding contemporary China. In the following, a historical account describes such shifts, particularly focusing on new policies in relation to land and urban development. This illustrates a changing socio-political apparatus's far-reaching spatial, social, economic, and environmental consequences.

In 1976, China faced a situation of an enormous labor force while being short on capital and technology.[71] Therefore, it began to slowly open the Chinese market to foreign and ideologically hostile nations, importing essential technologies from Japan and the West.[72] In terms of national development, this meant a shift away from the western interior towards the southeastern coastal cities where foreign equipment and technologies were introduced starting in 1973.[73]

Slow Market Liberalization, 1978

After the end of the Maoist era, China started to openly discuss policies of market liberalization. They began to be slowly incorporated in parallel to continuous measures of authoritarian, centralized state control. The new leadership argued that individual and local initiatives had to be unleashed in order to increase productivity and stimulate economic growth. While egalitarianism as a long-term goal was not abandoned, it was evident that this market liberalization would lead to social inequalities. Deng Xiaoping focused on "four modernizations" in agriculture, industry, defense, plus science and technology to stimulate competition among state-owned firms, sparking innovation and growth. This economic reorganization happened in parallel with shifts to neoliberal market solutions in Great Britain and the United States. However, in contrast, China managed to construct a form of state-manipulated market economy, which David Harvey called "neoliberalism with Chinese characteristics."[74]

Economic policies were liberalized, radically breaking with the previous Maoist agenda of balanced development. Responsibilities and decision-making powers were decentralized, allowing provincial and local governments to decide on direct investments. In addition to these domestic policy shifts toward more market liberalization, China began to be slowly opened to the outside

71 China accounted for over twenty-two percent of the global workforce but only two percent of total world investment volume. Jiang, "China's Seven-Decades of Opening-Up," 13–29.

72 Gittings, *The Changing Face of China*, 100.

73 Fan, "Western Development Policy," 87.

74 China avoided to taking a "shock therapy path" of instant privatization, allowed experimentation only in limited, selected areas, kept control over state-owned enterprises. Harvey, *A Brief History of Neoliberalism*, 120–23.

world, integrated into an increasingly globalized market economy, and welcoming foreign investments.[75]

In 1980, four coastal harbors were selected as authorized "special economic zones." These special economic zones attracted outside investment, knowledge, and innovation, drove national modernization, and acted as laboratories to test out China's contained version of a capitalist market economy.[76] The private sector was permitted at first only in small-scale production, trade, and service activities, but policy limitations were gradually relaxed. Market liberalization and economic decentralization resulted in a spectacular economic acceleration, starting from a comparably low level in the 1980s and boosted by China's new urban engines of growth and innovation along its eastern coast. At the same time, however, it also led to a gradual dismantling of the welfare state, increasing political tensions with growing demands for social freedom.[77] For remote industrial cities in China's interior, such as in the case of Yumen, this combination of decreasing economic attention, growing competition, lack of business innovation, and dismantling of the welfare state dramatically affected the workforce and local economies.

All Front Open Policy, 1992

In 1992, the late Deng Xiaoping inspected the coastal cities which had been opened up over the previous decade[78] and then announced the All Front Open policy, extending the successfully tested policies to the rest of the country, aiming to open up the country's west to outside investments and domestic, eastern-western cooperation.[79] [Fig. 4.8] In addition, a wave of massive investments

75 Fan, "Western Development Policy," 87–88.

76 Interestingly, China did not open up to the world's market through its front gate but rather through the "nation's back door" in China's Guangdong province and its Cantonese "subnation," followed by other 'open coastal cities' four years later. Thomas J Campanella, *The Concrete Dragon: China's Urban Revolution and What It Means for the World* (New York: Princeton Architectural Press, 2008), 27–34.

77 Gittings describes the years of economic but also social liberalization leading up to the Tiananmen crackdown in 1989, which marked a brutal reassessment of the freewheeling 1980s, making clear that Chinese "neoliberalization" was not to be accompanied by any progress in the fields of human, civil, or democratic rights. Gittings, *The Changing Face of China*, 187–222. After 1989, state control and political authority were reinforced, while, simultaneously, the economic market was further liberalized and integrated into the global arena. The post-1989 years brought a return to strict, central state planning, CCP ownership and control, political authority, and social repression. At the same time, however, it led to a redefinition of communist leadership ("new conservatives") that radically dismantled traditional party structures, old, and non-profitable SOEs ("iron rice bowl"), laying off millions of workers. McGregor, *The Party*, 41f.

78 For a vivid account of Deng's 1992 visit to Shenzhen and the tremendous urban transformation that was unleashed through the opening of coastal Special Economic Zones, see Campanella, *The Concrete Dragon*, 37–55.

79 All province capitals (excluding Lhasa) as well as other strategic cities were selected. Ten out of thirteen of these additional cities were located in western regions and received the same policy

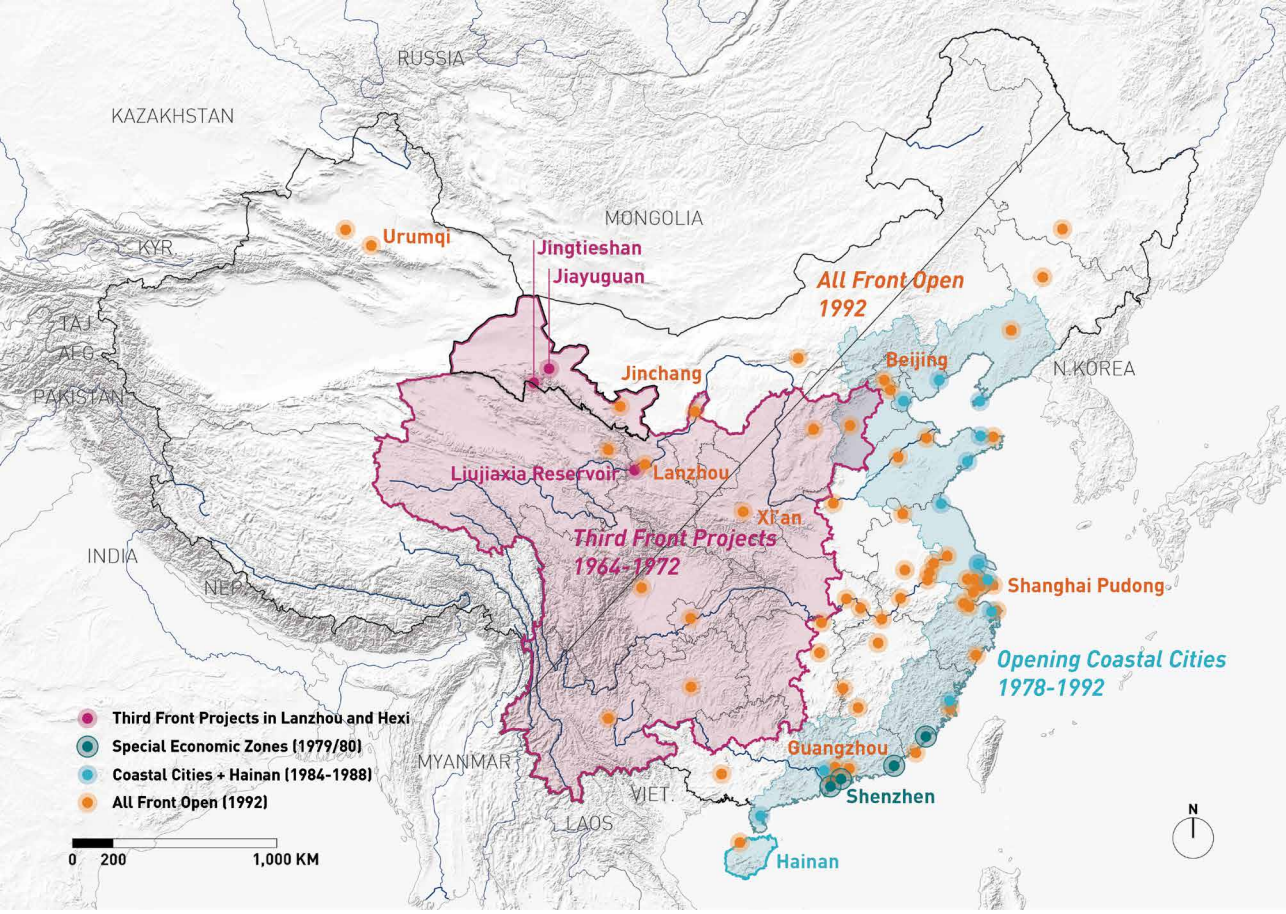


Fig. 4.8: Changing development policies shifted the focus and investments from a territorial distribution in the interior during the "Third Front" to a concentration in strategic, coastal cities during the first phase of Reform and Opening, to a nationwide implementation of development zones with All Front Open policies.

into large infrastructure projects was launched, mostly in heavy industries, including energy, extraction, and large-scale production of raw materials. This included selected state-owned companies in the Hexi region, such as the mining industries in Jiayuguan and Jinchang. This push to a country-wide acceleration of market liberalization was led by pragmatic ambitions to achieve economic growth at any price with the idea that by allowing "one group of people to get rich first," the entire society would benefit from the accumulated wealth later.[80] [Fig. 4.9]

benefits as their coastal first-generation counterparts. Fan, "Western Development Policy," 93.

80 Deng had used the phrase 'getting rich first' already earlier on several occasions. The first time at a party conference in 1978 promoting reforms and pointing out that while it would increase inequalities and might include other risks, it would pay off in the long run. Ezra F. Vogel, *Deng Xiaoping and the Transformation of China* (Cambridge, MA; London: Harvard University Press, 2011) 242–44. While the period of Reform and Opening-Up was first characterized by a stark shift away from the interior, it can still be understood as a holistic approach, led by the idea of letting some regions get rich first to benefit then the rest of the country, including, particularly, the structurally weak interior. Ibid. 669–75; Gittings, *The Changing Face of China*, 251–55.

Fig. 4.9: Jinchang City as an example of a destination in the remote interior that received massive investments in the course of the All Front Open policies to expand its nickel and copper extraction industries; October 2019.

Accelerated Rates of Urban and Economic Growth

In many regards, China's case of rapid social transformation is unique, particularly because of the dominant role of the communist one-party state.[81] However, China was not isolated. Its policy shifts and successful growth need to be understood in the global context of a world economy that simultaneously underwent significant transformations, moving toward a more flexible organization based on multi-layered, global production chains that integrated low-wage, developing countries. This allowed China to become the prime manufacturer in this new international division of labor.[82]

81 John Friedmann argues that China's urban transition can therefore not be fitted into one grand theory, whether into the narrative of modernization, globalization, urbanization, or national integration. Friedmann, *China's Urban Transition*, xiv-xvii.

82 This integration of China was also enabled by the simultaneous collapse of the Soviet Union as a common enemy for competing Western powers, leading to a decline of the U.S. hegemony and a more open attitude toward socialist states. This "world-system explanation" is used by the sociologists Alvin So and Yin-Wah Chu to discuss reasons for China's achievement of remarkable, continuous economic growth and the successful transition from a backward socialist state in the 1970s to a global economic powerhouse of today. They eventually end up with a more state-centered explanation of "state neoliberalism." Alvin Y. So and Yin-Wah Chu, *The*

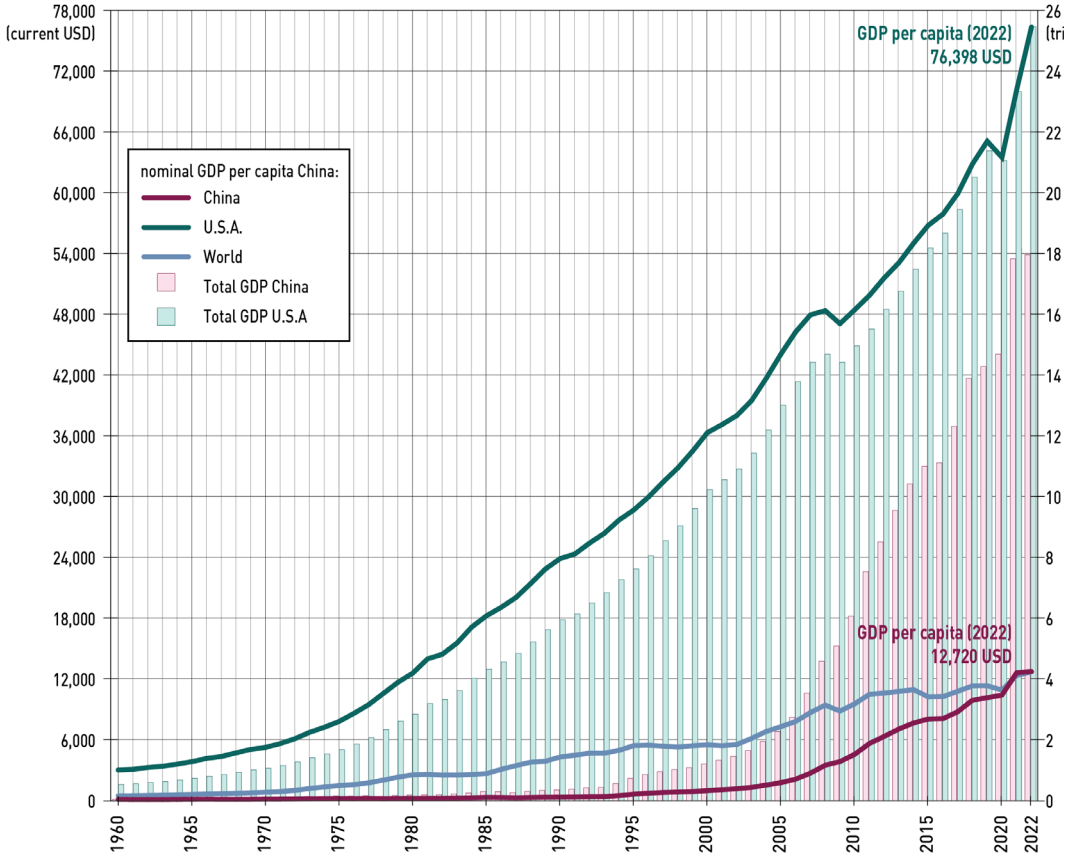


Fig. 4.10: China's economic growth from 1960 – 2022 shows the nation as the second largest economy in the world, yet with a GDP per capita that is still at a relatively low level, just above the world's average.

The reform period from the late 1970s to the late 1990s favored certain localities and introduced mechanisms of a competitive market economy between state-owned and private firms, following patterns of unbalanced development. This enabled an acceleration of economic growth and material production, accompanied by an unprecedented urbanization of society. However, this transition significantly widened the economic gaps between the eastern, central, and western regions. It worsened financial conditions in backward areas, leaving them with a shortage of capital for the construction of basic infrastructures and industries, as well as cultural, educational, and public health facilities.[83] Not only globally but also domestically, the rapid economic and urban development of one region was sustained by the extraction of resources and labor in another.

Global Rise of China (Cambridge, UK: Polity Press, 2016), 1–26; 56–85.

83 Fan, "Western Development Policy," 90–91.

In China, it was, to a large degree, the rural society as a cheap labor force, as well as the extraction of energy and resources in the interior that enabled the tremendous growth of urban regions along the southeastern coast. Two curves are essential to illustrate the socioeconomic shifts that transformed China during this period of policy reforms: The first is China's GDP, which grew at rapid rates of repeatedly over ten percent after 1978.[84] However, while China is today the second largest economy in the world, the GDP per capita rate is still at a comparably low level, just around the same as the world's average.[85] [Fig. 4.10] The second curve is the population growth and the shift from rural to urban residents.[86] China's rapid transformation from a predominantly agrarian society well into the 1970s to an increasingly urbanized country of today has happened at an unprecedented speed and scale of urban development.[87] [Fig. 4.11] This shift from a rural to an urban society is first a spatial movement of people from rural to urban areas; second, a transformation of rural villages into cities and urban conditions; and third, the shift of low-skilled to high-skilled workers, including the transformation of traditional agricultural to modern industrial technologies, and the opportunity to improve the living status from one generation to the next.

This socio-economic transformation in China was able—as it is often stated—to lift millions of people out of poverty. It promises better life conditions for the individual, generates human capital, and accelerates investment, consumption, and global competitiveness. However, the aspirations of modern, urban lifestyles in shiny coastal cities contrast with an aging rural population, shrinking farmlands, and environmental degradation, as exemplified in the Hexi Corridor's rural parts. Today, China is one of the world's most unequal societies, with a small elite owning most of the country's wealth and income.[88] [Fig. 4.12] These differences are particularly pronounced between

84 The average GDP growth from 1978 until 2011, when the rate started to slow down until today, was exactly 10%. Calculated from "GDP Growth (Annual %) - China," The World Bank Data, accessed June 22, 2022.

85 According to World Bank data, the Chinese GDP per capita in 2022 was 12,700 USD. The world's average that year was around 12,600 USD. "GDP per Capita (Current US$) - United States, China, World," World Bank Open Data, 2023. China provides slightly smaller numbers, remaining below the world's average, with around 11,300 USD (80,976 RMB) in 2021. "China Statistical Yearbook 2022."

86 China's society grew from 962 million in 1978 to over 1.4 billion today. In the same period, the ratio of rural residents shrank from 82% in 1978 to 36% in 2011. "China Statistical Yearbook 2021."

87 You-Tien Hsing points out that China has developed at a scale and speed that is unprecedented compared to other nations such as Great Britain, The United States, and Japan, which have all experienced rapid industrialization and urbanization. China's urbanization level increased from 10.6% in 1949 to 49.9% in 2010. The increase of its urban population from 20%–40% occurred in the span of just 22 years, while it took 120 years in Britain (1720 – 1840), 40 years in the United States (1860 – 1900), and 30 years in Japan (1925 – 1955) to achieve the same. Hsing, *The Great Urban Transformation*, 2.

88 The country's top one percent owns over 32% of the pre-tax personal wealth and receives

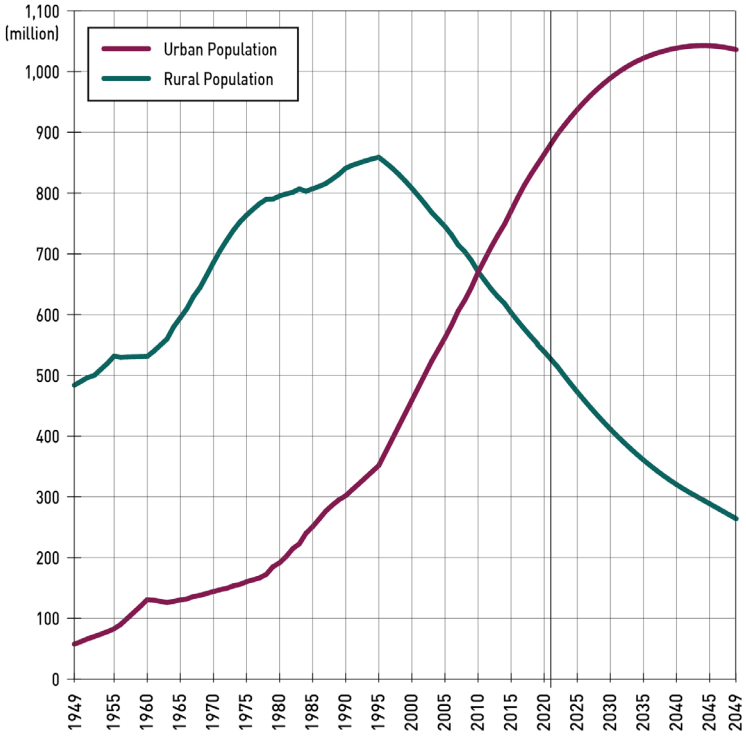


Fig. 4.11: China's Rural and Urban Population 1949–2049: China experienced rapid shifts from rural to urban populations over the past decades. However, almost five hundred million Chinese still live in places classified as rural today.

rural and urban populations. The rural-urban income gap is usually even more pronounced in the interior western provinces. Gansu, thereby, has the largest urban-rural income gap across all provinces.[89] The deep-rooted causes—the socio-environmental co-production—of such inequalities, including the contrasts between first-tier, global centers and remote, rural, and degraded regions, is the subject of this chapter and is at the core of this thesis.

almost 16% of the pre-tax national income, while the bottom fifty percent owns only 6.2% of personal wealth and receives 13.7% of the income. "China," World Inequality Database, accessed July 26, 2023. In 2021, Beijing overtook New York as the city with the most billionaires, and China accounts for four (or even five, if Hong Kong is included) of the top ten cities in that list. John Hyatt, "Beijing Overtakes New York City as City with Most Billionaires: Forbes 2021 List," *Forbes*, April 6, 2021, sec. Billionaires.

89 Ping Zhang et al., "Spatial Pattern and Driving Mechanism of Urban–Rural Income Gap in Gansu Province of China," *Land* 10 (September 23, 2021): 1002. This study focuses specifically on drivers of the income gap between rural and urban residents, not across the whole society.

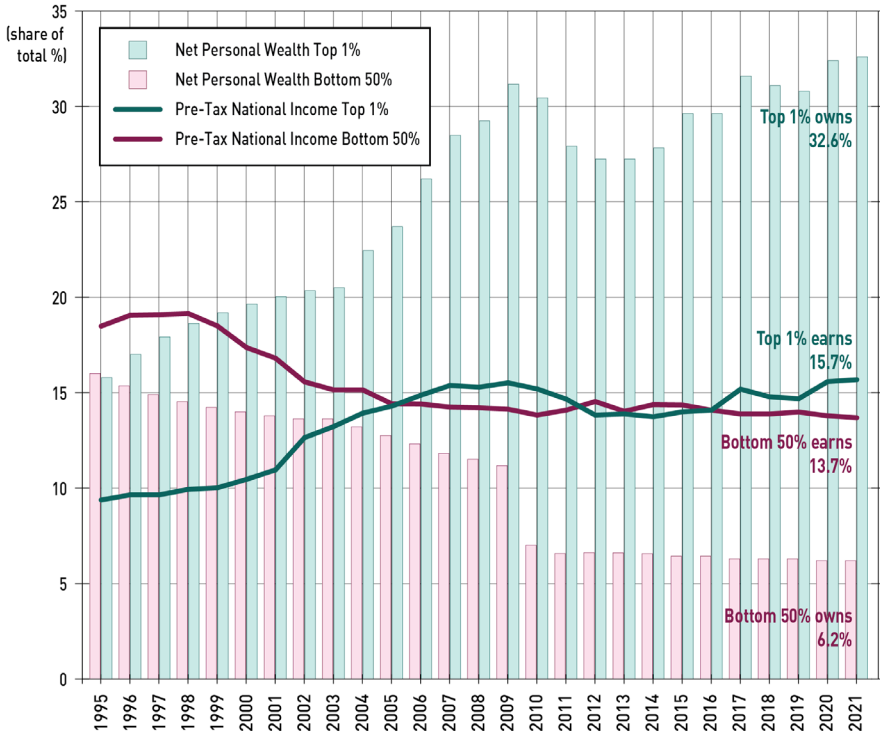


Fig. 4.12: Economic Inequality in China 1995 – 2021: China is today one of the world's most unequal societies, with a small elite owning the majority of the country's wealth and income.

Socio-Political Shifts and Land Transformation in Rural China

Land in China is inherently political. When the PRC was established, private property ownership and means of production were eliminated. In the monopolized, centrally planned economy that was set up, all land belongs to the state, with the only exception of rural land owned by village collectives.[90] This separation of ownership is at the core of all dimensions of land development in China. In this system, the only way to make additional land accessible for development is to shift it from its status as rural land designated for agricultural production to the urban state sector through state expropriation. This conflict is crucial to understanding the specific cases of land development in Lanzhou New Area presented in the next chapter.

90 Land was distinguished in three ways: First, between urban and rural land, whereas the former refers to land in cities, county seats, designated towns, and industrial and mining areas, and the latter to village land. Second, it was distinguished between state- and collective-owned land. And third, all land was classified in three ways according to its designated use, either as construction land, agricultural land, or unused land. In addition, the state owned all natural resources such as water, forests, grassland, etc., unlike it can be proven otherwise by village collectives. George C. S. Lin, *Developing China: Land, Politics and Social Conditions*, Routledge Contemporary China Series (New York: Routledge, 2009), 71–105.

While adhering to the socialist principles of public and collective ownership, responding to the growing demand for land development during the era of Reform and Opening-Up, the land market was liberalized to attract investments and increase efficiency and agricultural productivity. With a growing interest in profitable land conversion into urban land uses, this ambiguous and conflictive land tenure system became a major cause of black markets, corruption, and social discontent.[91] Starting in the late 1970s, land policy reforms led to an often contested socio-political restructuring of rural China. Two significant policy changes are briefly presented below to illustrate their far-reaching consequences for society and the built environment.

The countryside was decollectivized, allowing the individual peasants increasing degrees of autonomy and engage in non-agricultural activities. This led to an ambiguous secondary land market in which collective rural land was exchanged for more efficient consolidation and subcontracted to outsiders[92] and to Township and Village Enterprises (TVE) as new forms of innovative, highly dynamic, and competitive businesses.[93] A second major policy shift with far-reaching impacts on the built environment was the establishment of a land leasehold market in 1988. It allowed urban land use rights to be leased out at a profit for a fixed period of time. Through these market-oriented policy reforms, land has been commodified in both cities and the countryside; however, it has not been privatized in either category.[94] Land thus became the dominating fac-

91 Lin, *Developing China*, 92–94.

92 The Agricultural Production Responsibility System was formally introduced in 1982. It allowed agricultural land to be contracted to individual farm households, shifting decision-making power from rural collectives to individuals and breaking with the communist system of state-planned production and distribution. Farmers were allowed to retain their surplus output for their own consumption or to sell it at a market price. While the land was still not technically owned by individual farming households, it essentially installed a tenant system in which the village collective acted as the landlord and individual farmers as tenants. Vogel, *Deng Xiaoping and the Transformation of China*, 445–47.

93 Township and Village Enterprises (TVE) replaced the former system of village collectives and led to dynamic and competitive clusters of non-agricultural businesses with an innovative entrepreneurial spirit. Industrialized areas in southeastern China, particularly in the Yangtze and Pearl River Deltas, were particularly receptive to this new socio-economic organization. The spatial transformation (urbanization) of the countryside happened mostly illegally, based on a secondary black market for the conversion of rural land. In coastal Jiangsu province, for instance, local governments encouraged all forms of agricultural land conversion in this secondary market. Lin, *Developing China*, 81. In contrast, western regions continued to strongly depend on state-owned enterprises with generally underdeveloped markets and only a few TVE. Chaolin Gu, Shen Jianfa, and Taofang Yu, "Urban and Regional Development," in *Developing China's West: A Critical Path to Balanced National Development*, ed. Yue-man Yeung and Shen Jianfa (Hong Kong: Chinese University Press, 2004), 180–81.

94 The Chinese state is organized in a territorial hierarchy of different administrative levels (simplified: 1. central state, 2. province, 3. municipality, 4. county, 5. township, 6. village), which are constantly competing with each other. The legally responsible authority in this competition is often highly ambiguous. A homeowner can own a house, yet not the land underneath, for which the owner only has use rights. Village governments are under particularly strong pres-

tor in politics of accumulation and distribution. This situation led to massive urban expansion and increasing land values in the 1990s and a pronounced intra-state competition for land between the central and local government bodies. You-Tien Hsing described these processes as a highly dynamic "territorialization of the state" or a "politicization of place." In this competitive territorialization process, land accumulation and urbanization became the key mechanisms of local state-building at territorial scales on all levels of governance across the "urban core," "urban fringe," and "rural fringe."[95] As the examples from western development strategies have shown, territorialization and decentralization processes in the Maoist era happened according to top-down plans and in a rather contained spatial organization. In contrast, the Reform and Opening-Up period introduced a more relaxed and flexible society-state relationship that allowed forms of urbanism to grow more spontaneously, with a more unequal and heterogeneous society.[96]

Floating Populations and Rural Hollowing

The policy reforms and liberalizations have been truly transformative for rural China and the nation as a whole. Rural residents have performed astonishing entrepreneurial innovation and growth rates, increased agricultural yields, and highly productive businesses.[97] Economically, the urbanization of rural China did lead to increasing incomes, especially until the mid-1980s. However, in the longer run, businesses in the countryside could not keep up with the growth of urban incomes, and the rural-urban disparity increased.[98] Beginning in the

---

sure as they have the least political power but are in control over land with the potential for profitable conversion into urban land use and development. Peter Ho understands this legal indeterminacy as a "deliberate institutional ambiguity" that allows the state government to react to changing situations. Peter Ho, "Who Owns China's Land? Policies, Property Rights and Deliberate Institutional Ambiguity," *The China Quarterly* 166 (2001): 394–421.

95 Hsing, *The Great Urban Transformation*. As an ultimate legal framework in the competition for land, the Property Rights Law allows the state to requisition land if it is for the "purpose of public interest." Essentially, this gives the state ultimate power over any land and has often been used for land grabs. Ibid. 95, 116–117. The practice of relocating rural residents is discussed in the next chapter as part of Lanzhou New Area's development.

96 Particularly, the countryside's spatial transformation—driven by the innovation and dynamism of the TVE—happened more spontaneously than planned during that period. Lin, *Developing China*, 17.

97 Yasheng Huang points out rural China's innovative entrepreneurial potential. He argues that China succeeded when- and wherever private ownership could emerge from the bottom-up and stagnated where private entrepreneurship was suppressed. This marks a strong contrast between the market-driven rural China vis-à-vis the state-led urban China. Huang, *Capitalism with Chinese Characteristics*.

98 Many TVE grew into major regional economic players, changing their ownership from township or village into shareholding or private companies, financed by state banks or foreign investments, and even entering competition with State Owned Enterprises (SOE). However, most TVE began to collapse in the mid-1990s due to increasingly competitive markets for low-end products and their lack of scale economies. The manufacturing sector spilled over and back into SOE, which had been liberalized in the meantime, and shifted from the countryside

mid-1980s, due to widening economic disparity between provinces and enabled by relaxing policies, tens of millions of rural residents moved from the countryside into fast-growing urban centers, their suburbs, and the rural and semi-rural areas surrounding them. While this movement of labor from the countryside to cities played out locally, it also happened over very far distances between different provinces and macro-regions, such as from the northwestern interior to the southeastern coast. As a low-wage workforce, these "floating populations" enabled the fast rise of China's economy and the spatial growth of its urban development. Because of the *hukou* household registration system, there is still a persistent social inequality between urban and rural residents. It forces many rural residents to live in a volatile manner, in illegality, and vulnerable to exploitation.[99] Migrant workers who left poor regions seeking job opportunities in far-distant and more prosperous places have started in many villages a process of "rural hollowing:" Often, only elderly people and their grandchildren remain in the villages. Many properties are also left shuttered and vacant for long periods of time and often begin to decay. While rural hollowing is a global phenomenon, it is particularly pronounced and widespread in China with its strong legal and economic inequalities between urban and rural residents.[100] Both the structural and social conditions of hollowing villages could be observed on field trips throughout the rural Hexi Corridor, outside industrial cities such as Jinchang, or in remote areas with heavy land degradation, such as Wuwei's Minqin County. [Fig. 4.13]

back into urban centers. Harvey, *A Brief History of Neoliberalism*, 126–30.

99 In the official census, floating population refers to people who lived in places other than their household registration for six months or more. This means—as the name suggests—they are not migrants, but they are also not permanent residents. At least in theory, they remain bound to their place of origin. The official number of floating populations in the 2020 national population census was over 375 million, with over 125 million living outside their native province. "Communiqué of the Seventh National Population Census (No. 7)," National Bureau of Statistics of China, May 11, 2021. "Floaters" account for a considerable share of the total population in many cities. They also have consequences for the spatial configuration of cities, often leading to a dynamic urban-rural interaction, as many migrant workers find housing in the rural periphery of cities. On floating populations in China and their relation to changing state policies, see Dorothy J. Solinger, *Contesting Citizenship in Urban China: Peasant Migrants, the State, and the Logic of the Market* (Berkeley, CA: University of California Press, 1999). For a vivid anthropologic account of migrant workers employed in factories, construction, and service industries during the period of rapid economic growth in the early 2000s, see Leslie T. Chang, *Factory Girls: From Village to City in a Changing China* (New York: Spiegel & Grau, 2009).

100 Yansui Liu et al., "The Process and Driving Forces of Rural Hollowing in China Under Rapid Urbanization," *Journal of Geographical Sciences* 20, no. 6 (December 1, 2010): 876–88.

The Hexi Corridor in the Context of Market Liberalization and Rural Transformation

New Yumen

Yumen has been mentioned earlier in this chapter to illustrate the production of space during the first phase of modern China's development based on Soviet industrialization. The city in the Hexi Corridor's far northwest also serves as a good example of the decline of many local industries over time. During the third phase of national development with its market liberalization policies, the city of Yumen, which had grown to around 130,000 residents at its peak, started a period of economic and demographic collapse. Policy shifts forced Yumen to compete with other bases of oil extraction, such as the famous Daqing oil fields in Heilongjiang or the growing oil industry in Xinjiang's Tarim Basin. These alternative sources of crude oil soon surpassed Yumen in terms of production quantities and national significance. Many workers in Yumen were laid off and moved to these other regions where the China National Petroleum Corporation was opening up new oil fields.[101] Thousands of residents started to leave the decaying industrial city. Today, Yumen is a dusty ghost town with abandoned buildings and less than 20,000 residents. The state has largely withdrawn from the former national base of energy extraction. Schools and hospitals have been shut down, and empty building blocks were fenced off.[102] Recently, there have been plans to revitalize decaying "resource cities" such as Yumen, but it seems to be a mostly hopeless undertaking. Meanwhile, around eighty kilometers northwest of the old oilfields, New Yumen has been built. Most of the residents from the old town started to be relocated to the new location in 2003. Today, New Yumen is a bustling provincial town where most people are employed in the burgeoning regional wind energy sector. Energy is again the driver of prosperity, yet this time stemming from renewable sources of wind and sun. However, in 2021, the new town struggled to fill all its new houses and tried to attract future residents with free schooling and public health services.[103]

101 Allen Wan, Karoline Kan, and Adam Majendie, "How to Turn an Oil Boomtown Into an Oasis of Renewable Energy," *Bloomberg News*, May 17, 2021.

102 Unfortunately, I was not able to visit Yumen myself. In 2019, *Sixth Tone* provided an interesting account with impressive visual material about the city's history and contemporary conditions: Walsh, "Red, Dead, Renewed." In 2021, *Bloomberg* reported in an illustrated story on Yumen's recent shift to renewable energies: Wan, Kan, and Majendie, "How to Turn an Oil Boomtown Into an Oasis of Renewable Energy."

103 Wan, Kan, and Majendie, "How to Turn an Oil Boomtown Into an Oasis of Renewable Energy."

Fig. 4.13: Vacant and decaying homes in mostly empty villages. Rural hollowing in Hexi Pu, Jinchang, October 2019.

In the the Hexi Corridor, the period of Reform and Opening-Up led to the decay of many local industries and the urban clusters that had been developed around them. Simultaneously, also the rural parts of the Hexi region have experienced only little investments.[104] This had cultural, institutional, and geo-

104 Gansu's small and medium-sized enterprises are poorly developing, even compared to other

graphic reasons:

As mentioned, regions in western China have traditionally developed a culture that strongly differs from the country's coastal southeast. It is characterized by a strong dependency on the state and much less by an innovative and entrepreneurial mentality. In modern times, Gansu was generally a poor, remote region without sophisticated economic or commercial activities until investments in heavy industrialization projects in the early 1950s. When privately owned businesses finally entered the province in the 1990s, they suffered from a poorly developed market environment and a lack of human capital resources.[105] Generally, across all western regions, SOE have always been strongly present and in control over most significant land development. State control and the implementation of policies are generally executed much stricter.[106] Until today, Gansu province and the Hexi Corridor lag behind in basic infrastructure.[107] Urban development is mainly restricted to the oases, which are thus rather isolated and not strongly interconnected. The harsh environmental conditions add an additional layer of complexity and disadvantage compared to more fertile and environmentally less hazardous regions.

Despite its long tradition as a significant zone for food production, the agricultural sector in the Hexi Corridor is generally weak and overstaffed compared to the national average.[108] In recent years, however, the Hexi Corridor, with its extensive open plains and high number of sunshine hours, has become a strategic region for new forms of agricultural production, such as modern greenhouses with water-efficient drip irrigation facilities, fields of center pivot irrigation, as well as the integration of technologies such a solar and wind power plants. Some of these new business opportunities will be discussed in chapter six.

Regional Compensation and Paired Development

Despite a general trend toward economic liberalization emphasizing coastal regions, the national government did introduce policies that actively tried to curb the growing geographic disparity during the period of Reform and Opening-Up. Already in 1980, the central government had introduced a policy of "regional compensation," aiming to allocate direct subsidies to economically declining regions, particularly those with high populations of ethnic minori-

---

northwestern provinces. Until today, investments in TVE in western Chinese regions have been so low that they are considered insignificant, primarily because of a weak rate of development. Xincai Gao et al., "Financial Support and Growth of Township and Village Enterprises in China: Fresh Evidence From Regional Analyses," *SAGE Open* 9, no. 2 (April 1, 2019), 9.

105 Xu et al., "Economic Geography Analysis of Gansu Province," 26.

106 Lin, "Chinese Urbanism in Question," 17. As a geopolitically strategic region with a large sector of national defense and aerospace, the strong presence of the central state is presumably even more pronounced in the Hexi Corridor than elsewhere.

107 Xu et al., "Economic Geography Analysis of Gansu Province," 20, 29.

108 Ibid., 24–25.

ties, in an attempt at poverty alleviation and social cohesion. The Hexi Corridor was one of the few selected regions that benefited from these state subsidies.[109] During the Sixth Five-Year Plan in the early 1980s, the central government introduced a policy that fostered technological and economic cooperation between different regions. It focused particularly on the investment in projects of national importance, including the steel production industry in Jiayuguan. In addition, it fostered the transfer of energy and raw materials from structurally declining sites of extraction and primary production in the western interior to growing coastal cities in the east, with capital flowing in reverse direction.[110] The All Front Open campaign from 1992 was an additional attempt to curb growing geographic disparities.

Another strategy to curb uneven development was the concept of "paired development," introduced in 1994. It paired a more developed province or city—usually in a coastal region—with a structurally weak province, an autonomous region, or a city in the interior to pursue long-term cooperative development for their mutual benefit. In addition, individual enterprises in the coastal east were encouraged to actively seek investments and development opportunities in the west.[111]

Great Western Development Strategy (1999)

By the late 1990s, the growing inequalities in China, amplified by the years of policy reforms, market liberalization, and urbanization, had become alarmingly strong. In addition to economic productivity and the built environment, the differences had intensified in terms of social parameters, such as education and public health, creating completely contrasting life realities among Chinese citizens. This notion of uneven development caused a general public skepticism about the promised principle of "common wealth"—a situation that threatened social stability and thus raised concerns about national security. Additional problems included over-production in some sectors, insufficient effective demand, continuous loss of cultivable land, and environmental degradation, particularly across western regions.[112] According to the central government's narrative, the coastal development had reached a certain stage of maturity. Jiang Zemin, therefore, announced a "second situation" that—once more—included a shift to the interior west.[113]

To tackle all the above issues while simultaneously further promoting eco-

109 In 1983, the central government established a special "Three West" construction fund through which a few selected regions (including the Hexi Corridor) received substantial funds for economic construction over three consecutive years. Fan, "Western Development Policy," 89–90.

110 Ibid., 89.

111 This mode of paired development generally continued the transfer of resources and capital between the western interior and the eastern coast. However, in most cases, the policy only benefitted individual localities rather than a broader region. Yeung, "Introduction," 19.

112 Fan, "Western Development Policy," 89–90.

113 Yeung, "Introduction," 16.

nomic growth and urbanization across the country, the Great Western Development, or "Open up the West" Strategy (西部大开发 *Xibu da kaifa*) was introduced in 1999 with a specific focus on the western regions.[114] As in previous state-led campaigns, large-scale infrastructure projects were identified as the most effective driver. As part of the strategy, the central government launched thirty-six key construction projects along three infrastructure corridors in the western regions, mainly in the transportation and energy sectors, including the West-East Natural Gas Transmission, the West-East Electricity Transmission, large-scale road, and railway, but also tourism, and agriculture projects.[115] It also introduced policies in favor of western regions, easing the transfer of funds and loans through state-owned enterprises and stimulating institutional, eastern-western cooperation.[116]

In the Hexi region, projects included the West-East Gas Pipeline project and the West-East Power Transmission project. In addition, investments were made in crude and refined oil pipelines. All these projects took advantage of the Hexi Corridor's geography and its traditional function as a strategic link between Central China and the country's vast and resource-rich northwestern regions. Construction on the Lanzhou-Xinjiang highspeed railway began in 2009, connecting the capital cities Lanzhou and Xining and from there through the Hexi Corridor with Urumqi.[117] While the campaign's infrastructure projects were not explicitly discussed in an international scope, they did anticipate the connection of domestic Chinese economic corridors to Central Asia and Europe, such as in the case of the Euro-Asian Continental Bridge railway project.[118]

Persistent Structural Challenges

While the central government continuously aimed to lift the western interior through state-led programs since the beginning of the PRC, in reality, the western regions suffered from policies that were detrimental to such campaigns: Throughout modern Chinese history, "scissor price" policies allowed goods from western regions to be sold at an artificially low price which caused

114 The financial crisis in East Asia in the late 1990s and the upcoming entry to the WTO (2001) may have been two other reasons for the campaign's launch, which hoped to attract foreign investments to the western regions. Heike Holbig, "The Emergence of the Campaign to Open Up the West: Ideological Formation, Central Decision-Making and the Role of the Provinces," in *China's Campaign to "Open up the West": National, Provincial and Local Perspectives*, ed. David S. G. Goodman, The China Quarterly (Cambridge; New York: Cambridge University Press, 2004), 341–44.

115 Yue-man Yeung, Fengjun Jin, and Guang Zeng, "Infrastructure and the New Economy," in *Developing China's West: A Critical Path to Balanced National Development*, ed. Yue-man Yeung and Shen Jianfa (Hong Kong: Chinese University Press, 2004), 107–31.

116 Fan, "Western Development Policy," 95–99.

117 "Lanzhou–Xinjiang High-Speed Railway," Wikipedia, January 26, 2023.

118 Gu, Shen, and Yu, "Urban and Regional Development," 202.

the west to be drained from its rich natural resources at the benefit of the coastal regions. This is an apparent conflict with the narrative of balanced development that propagated policy incentives in favor of China`s western regions, helping them to attract investments from outside as compensation for their geographic disadvantages.[119] Therefore, one of the primary objectives of the Great Western Development Strategy was to attract foreign investment to the interior by creating more stable economic conditions through infrastructure construction. To some degree, the campaign was successful as foreign investments in China's western provinces did increase in the early 2000s. However, that growth was fueled mainly by relocated, high-pollutant, and energy-dependent industries such as metallurgy and chemicals, which were no longer tolerated in coastal first-tier cities.[120] In addition, not all western regions benefitted equally from these incentives, as many policies were not tailored to the specific economic characteristics of the western regions.[121]

Like other state-led campaigns before, such as the Third Front, the Great Western Development Strategy remained a vague construct of isolated projects, soft policies, and diverse agendas rather than a coherent program. According to David Goodman, not one single policy document summarized the initiative as a whole.[122] Due to this ambiguity and the lack of a cohesive plan, the interpretation and implementation of the strategy remained mostly up to local governments. Different local agendas and interests led to intense competition between provinces and a process of bargaining for state investments. Despite the narrative of a grand vision bringing development to the country's west, the local, socio-institutional context was often ignored. Eventually, the ambiguous campaign left local governments leeway for decision-making.[123] The strategy of attracting foreign investment through massive-scale infrastructure projects might also have had the opposite effect: As Tim Oakes argues, consolidating provincial governments and strengthening central control over local economies eroded the trust in local stakeholders and discouraged foreign investors.[124]

Another dimension of the 1999 development strategy, similar to previous territorialization campaigns, was a socio-political one: In addition to regional

119 Yeung, "Introduction," 18.

120 Zheng and Deng, "Typical Cases in Northwest China," 31.

121 Fan, "Western Development Policy," 100–102.

122 David S. G. Goodman, "The Campaign to 'Open up the West': National, Provincial-Level and Local Perspectives," in *China's Campaign to "Open up the West": National, Provincial and Local Perspectives*, The China Quarterly (Cambridge; New York: Cambridge University Press, 2004), 319.

123 Holbig, "The Emergence of the Campaign to Open Up the West," 336.

124 Tim Oakes discusses this discouragement of foreign investors due to the centralization of state power in the case of the West-East Electricity Transfer project in Guizhou. Tim Oakes, "Building a Southern Dynamo: Guizhou and State Power," in *China's Campaign to "Open up the West": National, Provincial and Local Perspectives*, ed. David S. G. Goodman, The China Quarterly (Cambridge; New York: Cambridge University Press, 2004), 483–87.

economic inequalities, concerns about cultural and ethnic diversity and potential social unrest were equally important. The campaign can be understood as an act of integration and nation-building. Tendencies can be identified toward processes of standardization and homogenization through specific urbanization measures as well as increasing movements of nationalism in the early 2000s, seeking social assimilation. David Goodman calls this tendency an "internal colonialism" of strengthening the society's core and securing ethnically diverse border areas.[125]

***

This chapter presented the history of modern China's nation-building and the territorialization of the Hexi Corridor in the second half of the twentieth century, across the periods of Maoist industrialization, followed by the years of liberalization, market opening, and rapid urbanization. It intended to show how national shifts in policy-making and the implementation of territorial development strategies affect individual places and people while reshaping entire territories. The persistent problems of an unevenly developed country and the ambition to lift structurally weak regions in western China continue to be a significant challenge today. One key element of the Great Western Development Strategy at the turn of the century was the use of large-scale, heavy infrastructure projects as a catalyst for regional economic development. This approach resembles many of the strategies established at the beginning of the current leadership around Xi Jinping.

The following chapter discusses the most recent period of nation-building with the Belt and Road Initiative, first announced in 2013 as its core development campaign and declared as one of the top priorities of the central government's agenda. It continues previous campaigns and policies, building on their strong legacy. Goals for developing the interior western regions articulated in the "Go West" campaign are expanded beyond China's borders to a strategy of global market integration in the context of the country's long-term vision of national prosperity and rejuvenation. The Belt and Road Initiative elevates the territorialization of the Hexi Corridor to a new planetary scope. This most recent phase of western development will be discussed in the next chapter.

125 David S. G. Goodman, "The Campaign to 'Open up the West': National, Provincial-Level and Local Perspectives," ed. David S. G. Goodman, *The China Quarterly*, no. 178 (2004): 324–430.

5. Belts, Roads, and Cities in a New World Order

In the Anthropocene narrative, laid out in the introduction, this chapter follows the notion of planetary urbanization. The concept of planetary urbanization expands modes of rapid urban and infrastructural growth, happening in an increasingly globalized market economy, to a planetary scope. In this process of tremendous expansion, territorial aspirations of development and geopolitical control are manifested in specific places where they reshape local landscapes and ecologies. This local concentration in the context of a planetary expansion will be illustrated with the case of Lanzhou New Area as an example of a strategic but speculative urban development project.

The Belt and Road Initiative and National Rejuvenation

In 2013, the newly elected President Xi Jinping laid out his vision for a "New Silk Road." First, in September, on a visit to Kazakhstan ("Silk Road Economic Belt"), and in October in Indonesia ("21st Century Maritime Silk Road"). It extended previous state-led campaigns of infrastructural development, such as the Great Western Development Strategy, to a multi-national, global vision of interconnectivity. Moreover, it represents China's transformation from a regional to a leading global power. The massive development campaign was later referred to as One Belt One Road (一带一路 *Yidai yilu*) and as Belt and Road Initiative (BRI) for an international audience.

Policies and campaigns connected to the BRI suggest a new geopolitical order. From its onset, the BRI was propagated in the context of a "national rejuvenation," suggesting to restore what has been lost: a world order with Beijing at its core. This refers to a world before Western hegemony and is thus a combination of the old and the new.[1] Both the concept of a new overland Silk Road and maritime shipping routes made reference to China's legendary past as the leading "middle kingdom."[2] Experts discuss different scenarios of the potential

1 The goal of a national rejuvenation has been propagated by every Chinese leader since Sun Yat-sen. Under the current government, however, it has become a guiding philosophy. Tom Miller, *China's Asian Dream: Empire Building Along the New Silk Road* (London: Zed Books, 2019), 8.

2 The "Silk Road economic belt" refers to the historic Silk Road connecting China with Central

success and longevity of the BRI.[3] Domestically, the initiative is among the top priorities of Xi's presidency and intended to contribute to his historical legacy.[4] However, whichever form the BRI eventually takes, it will likely contribute to the geopolitical reordering of the world. Moreover, it will physically reshape individual places and entire ecological regions. Most strikingly are cases where this happens through entirely new cities seemingly being built from scratch in strategic locations along these new routes, such as Lanzhou New Area. As I observed on my trips to Lanzhou and the Hexi region, BRI-branded projects have direct consequences for individual places, are reshaping localities, and affect the living conditions of its residents.

Elizabeth Economy describes how this state-led campaign of new Belts

---

Asia, beginning with the western extension during the early Han. The "maritime Silk Road" refers to Chinese shipping routes during the Song dynasty and particularly to the legendary expeditions of Zheng He, who established maritime trading routes from China to Southeast Asia during the Ming. Tai Wei Lim, Henry Chan, and Katherine Tseng, *China's One Belt One Road Initiative* (London; New Jersey: Imperial College Press, 2016), 49. Notably, the historical Silk Road was a vast network of smaller routes rather than one road, with goods traded organically over countless short stations rather than long distances. It functioned as a bottom-up system rather than a top-down, state-controlled infrastructure. Like the new BRI, the historical Silk Road has always been a metaphor more than an actual road. In *The Silk Road,* Valerie Hansen points out that the historical Silk Road was one of the "least traveled trading routes in human history" (p.235), and travel was "painfully slow." The historic Silk Road was commercially far less significant than what many of the contemporary narratives try to convey. As a vital cultural artery, however, it did change world history and was essential in spreading cultures along the routes where settlements and trading hubs were developed (9–10).

3 China's state-led campaigns tend to follow a narrative characterized by a seemingly inevitable implicitness, communicated through long-term visions of Five-Year Plans and often much longer time frames. The "Chinese Dream" of national rejuvenation has been set at a target date of 2049 when China suggests being a dominating world power. In this scenario, based on economic wealth, technological superiority, and held together by hard infrastructures, China acts as the head of a modern tribute system with literally all roads leading to Beijing. Yiwei Wang, *Belt and Road Initiative: What Will China Offer the World in Its Rise* (Beijing: New World Press, 2016), 16–20. At the same time, China's state-led campaigns are also highly dynamic and ambiguous, leaving a lot of room for interpretation, adjustment, and modes of implementation up to local governments. Bruno Maçães sketches out four radically different potential scenarios for the future of the BRI, including domination, integration, a clash between two opposing poles, and a complete fracture. Bruno Maçães, *Belt and Road: A Chinese World Order* (London: C Hurst & Co Publishers Ltd, 2018). Some Western scholars, such as Jonathan Hillman, are consistently pessimistic about the long-term success of the BRI, see it as a display of the same mistakes previous great powers have made, and as a highly destructive force for the world, particularly for developing countries. Jonathan E. Hillman, *The Emperor's New Road: China and the Project of the Century* (New Haven, CT; London: Yale University Press, 2020), 7–15. Throughout the book, Hillman portrays many places outside of China, discusses how they are negatively affected by BRI projects, and how the initiative is built on shaky grounds.

4 Xue Li, head of the Department of International Strategy at the CASS Institute of World Economics and Politics, cited in Elizabeth C. Economy, *The Third Revolution: Xi Jinping and the New Chinese State* (New York, NY: Oxford University Press, 2018), 194. The BRI has been propagated as a vital part of the current party's leadership and was included in the Party's Constitution in 2017. Therefore, it seems that it can no longer be abandoned. Maçães, *Belt and Road*, 43, 164.

and Roads must be understood in the context of global, geopolitical shifts. After China's WTO entry in 2001, it sought integration into the world market, growing its reputation as a reliable and peaceful partner. A significant shift occurred during the 2008 financial crisis: While the US struggled to climb out of recession and Europe had to overcome its debt crisis, China stepped in to save the global market with enormous state-bank loans to stimulate global resource trade. Domestically, the massive growth of material-intensive urban infrastructures was used as a catalyst to boost GDP growth rates. Consequently, China's pace of construction peaked in this post-2008 period.[5] Building on intentions that had already been formulated by the previous administration, this led to new ambitions of China to regain its "rightful place" as a leader on the global stage, capable of proactively shaping international norms and institutions and introducing a radical shift in foreign policy away from the previous commitment of maintaining a low profile in international affairs.[6]

China seeks to communicate the BRI not as a solely Chinese undertaking but as an initiative of mutual trust and collaboration, inviting all countries to join the campaign in a "win-win cooperation." However, in reality, it is very much a Chinese-led project: The initial group of countries along the new Silk Roads accounted for sixty-three percent of the world's population but only twenty-nine of the global economic output, whereas China added up to more than half of the group's total GDP.[7] Most countries that joined the BRI are underfunded and in desperate need of infrastructure.[8] They welcome China's ability to offer loans, as well as expertise, raw materials, and labor through state-owned enterprises.[9]

---

5 This frenzy of infrastructure construction led to several cases of financial investments that were highly speculative and seemed absurd, as in the famous case of "China's largest ghost city," Ordos, in Inner Mongolia. For the case of the new city of Ordos, see Zheng and Deng, "Typical Cases in Northwest China," 44–54. For a more positive perspective on Ordos, Wade Shepard, *Ghost Cities of China: The Story of Cities Without People in the World's Most Populated Country* (London: Zed Books, 2015), 67–73.

6 Economy, *The Third Revolution,* 5–12, 190–200.

7 Wang, *Belt and Road Initiative*, 4; Miller, *China's Asian Dream*, 33–34.

8 The infrastructure needs of the Asia-Pacific region, which the New Silk Road aims to connect, exceed 8 trillion USD. Asia Securities Industry & Financial Markets Association, cited in Economy, *The Third Revolution*, 196.

9 China founded a set of institutional and financial infrastructures to realize the BRI: The Asia Infrastructure Investment Bank (AIIB) was founded in 2014, is headquartered in Beijing, and considers the BRI one of its investment priorities. The Silk Road Fund, founded in 2014, is funded by state financial institutions and directly finances BRI projects. In addition, China's giant state banks play a dominant role in funding BRI projects by providing loans to partner states. Foreign direct investment and concessional loans thus make up the vast majority of BRI financing. These financial institutions offer an alternative to established institutions such as the Western-dominated World Bank or the Japanese-dominated Asia Development Bank. In contrast, China aims to offer efficient solutions not hampered by moral obligations or economic preconditions, combined with soft-power engagement. With this new "infrastructure diplomacy," China approaches its strategic partners across the world, promising tremendous

Fig. 5.1: Xinhua's 2013 map of China's Belt and Road Initiative showing an overland "Silk Road Economic Belt" and a "21st-Century Maritime Silk Road."

The BRI can be understood as a spatial expression of this new geopolitical self-conception, both as an abstract construct on the world map and as concrete projects on the ground. It is a domestic vision to connect China's matured urban regions and economic centers along the southeastern coast to the interior and western regions. At the same time, it is bound up with China's new international ambitions that connect the Chinese market with strategic partners across the globe. In the early 2000s, China began to face production overcapacity, particularly of raw materials produced by state-owned enterprises.[10] Given

investments and infrastructures. In exchange for economic incentives, the delivery of roads, ports, and power lines, China expects its partners to respect its core interests and provide access to local markets. Mações, *Belt and Road*, 46–50, 172–73; Miller, *China's Asian Dream*, 36–43. In many cases, this resulted in a "debt trap" and forced partnering countries to concede political or real estate concessions to China, such as in the widely-published case of Sri Lanka's Colombo Port City. Ibid., 191–95.

10 China entered what is known as the "middle-income trap" of a labor shortage in a saturated market that leads to increasing wages. The domestic market then becomes less capable of competing in an international, standardized, low-value market. At the same time, due to the lack of expertise, it cannot yet compete with high-value production. The period of rapid economic growth, enabled by Deng's reforms and market liberalizations and based on the production of low-value goods for a world market, ended. Rozelle and Hell, *Invisible China*, 18–28; Mações, *Belt and Road*, 75–77.

increasing domestic wages and costs of production, many manufacturing enterprises began to be moved from coastal, first-tier cities toward the west, but also abroad, mainly to places in Southeast Asia. The central government repeatedly urged industries to transfer their manufacturing inland to western regions and outsource businesses domestically.[11] This notion of "going west" continues the Great Western Development Strategy to integrate the less-developed interior regions, where labor wages and policy restrictions are still lower, into domestic production chains.[12]

A Process Rather than a Project

"More than a project or an initiative, the Belt and Road is a movement or a process. The map comes first, it is an expression of power and influence. The story will follow. Wherever it finds a vacuum or an area of little resistance, it moves in."[13] The BRI remains a vague idea, captured through a metaphor rather than an exact description. There has never been a geographically accurate concept published. Several unofficial maps circulate, trying to interpret what has been communicated by the Chinese central state apparatus.[14] The most commonly known and widely used map was published in 2013 by Xinhua, China's official news agency.[15] However, the map's specific spatial meaning remains opaque and confusing. For instance, one of the bold lines on the map suggests a link from Xi'an across Lanzhou, the Hexi Corridor, to Central Asia. It is unclear whether such lines represent a railway line, a road, or something less material, such as political influence or power. [Fig. 5.1]

11 Ye Zhang, "Nation Aims to Retain Processing Trade by Using Favorable Policies," *Global Times*, May 17, 2016; Duncan Hewitt, "China Promotes Policies to Urge Manufacturers in Expensive Coastal Regions to Move Inland Rather Than Abroad," *International Business Times*, May 18, 2016, sec. Business; Alexander Chipman Koty, "New China Guidelines Aim to Transfer Manufacturing to Inland Regions," *China Briefing News*, February 22, 2022.

12 In 2020, given uncertainties related to the COVID pandemic, responding to an economic slowdown, and aiming for a further decoupling from the U.S., China looked once more toward its western regions and announced a new "Go West" plan. It aimed to incorporate the country's interior more strongly into the Belt and Road Initiative, combining domestic with foreign strategies. Frank Tang, "China Launches New Go West Development Drive to Counter Post-Coronavirus Geopolitical Risks," *South China Morning Post*, June 22, 2020.

13 Maçães, *Belt and Road*, 6.

14 Institutions, both in China and abroad, have developed their own interpretations and world maps of the BRI. See, for instance, the Reconnecting Asia project by the Washington D.C.-based think-tank Center For Strategic and International Studies (CSIS) that monitors projects along the Belt and Road in an online world map. CSIS Center for Strategic and International Studies, "Reconnecting Asia Project Database," Reconnecting Asia, May 14, 2021.

15 It could not be verified if the figure shown in the thesis was indeed the first, original Xinhua version of the map. Surprisingly, it does not comply with China's strict policies of today on the cartographic representation of national borders. The map was found in several documents, with Xinhua cited as primary source. In later maps by PRC's official news outlets, several more ports and cities have been added to depict more detailed versions of the BRI roadmap, for instance, in a 2016 People's Daily article. See Xiaochun Ma, "Chronology of China's Belt and Road Initiative," *People's Daily Online*, June 24, 2016.

Internally, there must be a list of key projects intended to be realized.[16] However, the process of expanding this list and fleshing out actual projects seems to be highly dynamic. I only realized how vague the Belt and Road Initiative must be when Liu Bo, a post-doctoral researcher at Lanzhou University, told me that no individual projects of the BRI were publicly available and how local governments as well as scholars and analysts like himself were trying to define what the overall strategy could mean for specific regions, such as, in his case, of Gansu and the Hexi Corridor. The initiative thus operates across different levels of governance, whereas the central government's plans remain highly ambiguous, leaving a lot of room for interpretation. Provincial and local governments thus anticipate future investments, trying to tap into new financial sources and hoping to benefit from large, state-funded infrastructural projects.[17]

A Territorial Rather than a Linear Approach

According to Bruno Maçães, China's interest in the Belt and Road is not so much in transportation infrastructures such as transcontinental railway links, even though they serve well as marketing opportunities. The real interest, he states, lies in the prospect of regional economic integration through industrial parks and massive ports. These hubs receive investments for construction and renovation and become catalysts for the development of territorial, interconnected systems of transport, logistics, energy, and digital infrastructure. This allows to gradually create free-trade zones, industrial clusters, and eventually entire economic corridors, including construction, logistics, energy, manufacturing, agriculture, and tourism. The concept of such economic corridors focuses primarily on connectivity. However, it is not primarily the linear connections between two endpoints, but rather, it considers the entire space in between to create territorial economic prosperity. For the new overland Silk Road, the term "belt" is, therefore, more appropriate than "road," which is used for the anticipated maritime shipping routes. Essentially, the Belt and Road thus envisions the fragmentation of production processes across entire regions to create specialized territories of production.[18]

16 Chinese media reported in 2015 that there were over 900 major projects planned as part of the BRI. Maçães, *Belt and Road*, 191. However, some of these projects had begun planning and construction before the BRI was first announced.

17 Lanzhou University, October 15, 2019. Liu Bo works at the Silk Road Economic Belt Construction Research Center (兰州大学丝绸之路经济带建设研究中心 *Lanzhou daxue sichou zhi lu jingji dai jianshe yanjiu zhongxin*) at the Lanzhou University, School of Economics.

18 Maçães, *Belt and Road*, 51–53. Throughout the Fourteenth Five-Year Plan of Gansu Province, the "New Silk Road" is mentioned in connection with economic and technological development for the region. National Development and Reform Commission, "Gansu sheng guomin jingji he shehui fazhan di shisi ge wu nian guihua he er ling sanwu nian yuanjing mubiao gangyao 甘肃省国民经济和社会发展第十四个五年规划和二〇三五年远景目标纲要 [The 14th Five-Year Plan of National Economic and Social Development of Gansu Prov-

Fig. 5.2: New Areas as attempts to attract new and innovative businesses with cheap land and tax incentives can be found outside each of the main prefecture-level cities. New Area outside of Zhangye, October 2019.

While the notion of developing industrial regions resembles previous strategies such as the Third Front, it no longer focuses on heavy industries but, instead, operates across all sectors and national borders. With the Belt and Road Initiative, a new world map appeared. With Beijing at its core, it depicts Lanzhou as a centrally located, strategically important regional hub connected to the Hexi region as a crucial transportation corridor. The Lanzhou-Hexi "belt" thus tries to position itself as a central economic corridor.[19]

During my visits to the region, references to the Belt and Road Initiative were noticeable on many occasions, whether on large signs above the gates of special economic zones or in the name of university research centers. The

ince Outline of Planning and Vision for 2035]" (Zhonghua renmin gongheguo guojia fazhan he gaige weiyuanhui 中华人民共和国国家发展和改革委员会 [National Development and Reform Commission of the PRC], February 2021). New technologies, innovation, and modernization are mentioned frequently (e.g., p.22). Specific competitive clusters of innovative industries should be developed (26–30). "Green development," "low-carbon development," and "circular development," as well as the development of townships into regional centers as a "link between cities and villages," are also mentioned throughout.

19 Gansu is promoted as both domestic and international centerpiece for the circulation and transfer of materials, with Lanzhou at its core and the Hexi Corridor as one of several critical logistic chains. See National Development and Reform Commission, "The 14th Five-Year Plan of Gansu Province," 34–36.

goal of developing an industrial corridor that consists of fragmented production processes aligns with industrial parks, referred to as New Area, that have emerged outside of every city. These zones of production and commerce in the urban periphery try to attract enterprises with policy and tax incentives. They are symmetrically laid out with a massive grid of roads and vast rectangular plots of land, which so far mostly remained vacant. [Fig. 5.2] I visited such sites outside Wuwei, Jinchang, Zhangye, and Jiuquan. Provincial and local governments across Gansu are explicitly seeking to attract "high-end," "green," and "innovative" industries to transform traditional forms of production and "transition from basic raw materials to a significant province of new materials."[20] However, when I visited the New Areas, it appeared that almost all of the few existing businesses were from heavy manufacturing, chemical, and fossil-fuel-intensive industries. It seems it must be very challenging for local governments to convince the desired, innovative companies to open branches in the remote, dusty hinterland outside of the Hexi Corridor's prefecture-level cities.

A Strategy of City Clusters

In 2016, China announced the concept of city clusters as a national, guiding framework of regional urban planning. It intends to steer the country's development around nineteen large urban regions—in some cases with over one hundred million people—rather than individual cities. [Fig. 5.3] These urban clusters should act as major economic regions to boost national development and accommodate the country's continuous urbanization and societal modernization process. They should help to achieve more efficiency, higher productivity, and faster economic growth. In addition, they are intended to relieve pressure from first-tier cities and instead move people and institutions into secondary or tertiary cities within the respective region.[21]

---

20 Yufang Zhang, "Gansu Xing Renmin Zhengfu Guanyu Yinfa Gansu Sheng 'Shisiwu' Tuijin Nongye Nongcun Xiandaihua Guihua de Tongzhi 甘肃省人民政府关于印发甘肃省‘十四五’推进农业农村现代化规划的通知_政府文件_中国甘肃网 [Notice of the People's Government of Gansu Province on Printing and Distributing Gansu Province's '14th Five-Year Plan' to Promote the Modernization of Agriculture and Rural Areas]" (Lanzhou: Sheng zhengfu bangong ting 省政府办公厅 [(Gansu) Provincial Governmnet Office], February 18, 2022). Aligning with Belt and Road principles laid out above, Gansu should be developed in "industrial clusters," with economically specialized counties and townships that are developed in "patches," "across counties and belts," and in "clusters and chains," based on modern agricultural practices as the primary industry (chapter 4.2). The local "industrial parks" are conceived as intensely developed zones with "large-scale processing and innovative technology," to form "clusters" of entire "industry chains" that integrate and facilitate agricultural modernization, including production, processing, and logistics (chapter 4.3).

21 Stephen P. Groff and Stefan Rau, "China's City Clusters: Pioneering Future Mega-Urban Governance," *American Affairs* 3, no. 2 (2019): 134–50; Mark Preen, "China's City Clusters: The Plan to Develop 19 Super-Regions," *China Briefing News*, August 14, 2018; The Economist, "A Tale of 19 Mega Cities: China is Trying to Turn Itself Into a Country of 19 Super-Regions," *The Economist*, June 23, 2018.

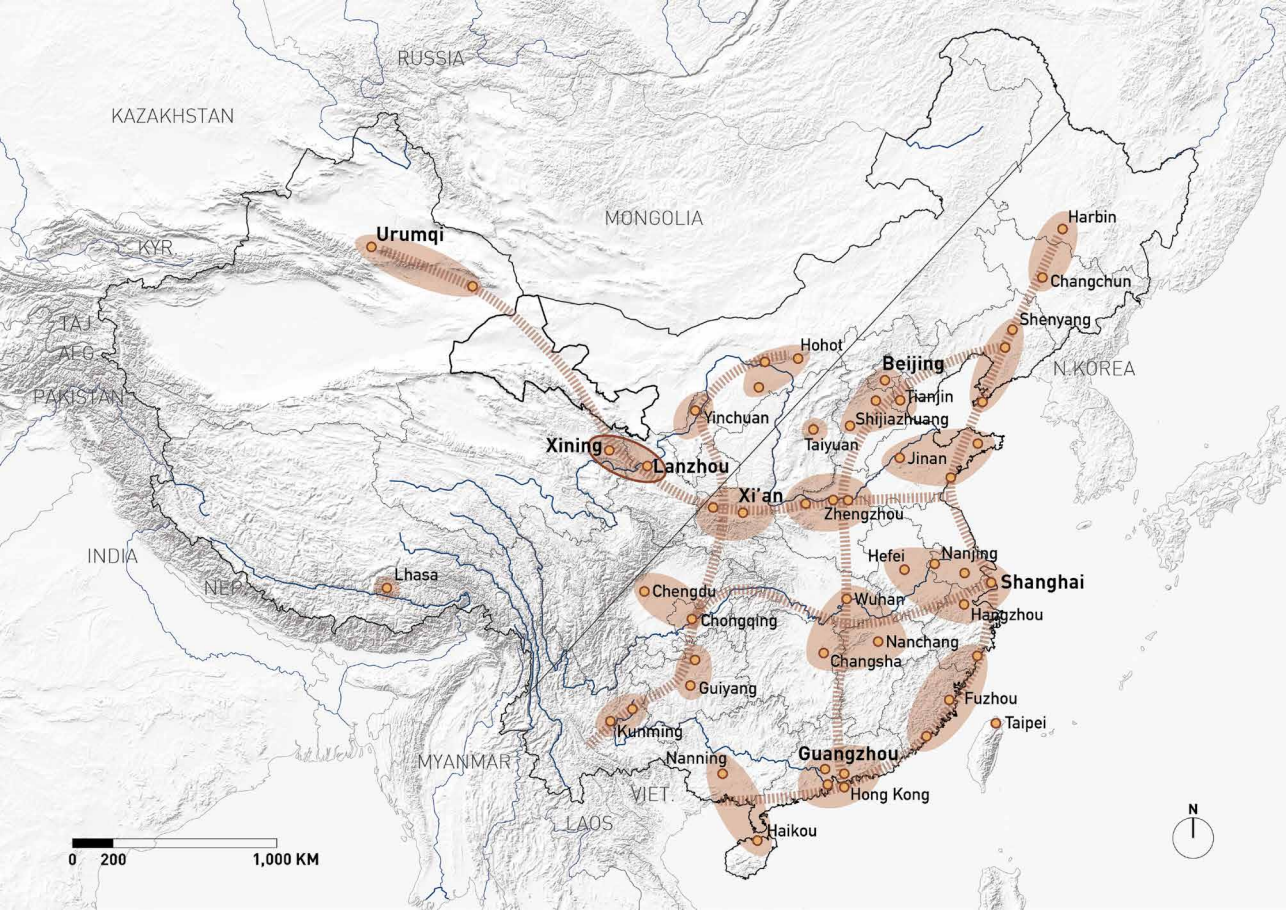


Fig. 5.3: Map showing the central government's concept of city clusters from 2016, planning to create large urban regions around the provincial capitals that are woven together through a network of interregional corridors, including other major cities. The concept strengthens the southeastern coast with China's main agglomerations across the three major river deltas. The Hexi Corridor is, once more, located at the northwestern edge of this urban web, linking from the Lanzhou-Xining Urban Cluster to Xinjiang's capital, Urumqi.

According to this strategy, the two metropolitan areas of Lanzhou and Xining—the capital of Qinghai province, located around 200 km west of Lanzhou—form the *LanXi* (Lanzhou-Xining) City Cluster. The cities of Baiyin and Lanzhou New Area are also included, adding up to around twelve million people today. With coordinated planning strategies until 2035, the Lan-Xi City Cluster is planned to be developed into a modern, economically productive, and competitive metropolitan region across municipal and provincial boundaries. This aims to foster local industries, target new economic opportunities, and increase the overall living standard and economic output.[22] City clusters align

22 "Lanzhou—Xining Chengshi Qun Fazhan Guihua 兰州—西宁城市群发展规划 [Lanzhou–Xining City Cluster Development Plan]" (Chinese National Development and Reform Commission and Ministry of Housing and Urban-Rural Development, 2018). The Lanzhou–Xining City Cluster (depending on the source, including Ningxia's capital Yinchuan) was announced as the first city cluster in China's western regions. Development goals for the Lan-Xi urban cluster are also promoted in Gansu's latest provincial Five-Year Plan with a strong emphasis on "green" development, ecological security, recycling, and low-carbon industries.

with the Belt and Road's vision of achieving higher degrees of connectivity and developing economic corridors rather than isolated nodes. Bruno Maçães states that the BRI development plans are not about individual infrastructures or companies. It is not the individual region but the overall economy that matters. "It's about ecosystems: collections of companies, workers, and consumers—clusters of culture, social life, and economic activity."[23]

Benefits and Challenges for the Hexi Corridor

For a remote region, such as the Hexi Corridor, the concept of productive economic ecosystems is challenging: While the city of Lanzhou has traditionally always served as a regional economic hub and can benefit from developments associated with the BRI, it is difficult for a remote, structurally weak, and environmentally degraded region to attract investment. It is often emphasized how important the strategic location of the Hexi Corridor is as a key section in the overland route to Central Asia and Europe, often referring to the Historic Silk Road.[24] However, the challenge for a linear transportation corridor such as the Hexi region is to find ways to absorb revenue rather than act as a mere transit zone. Already in the early 2000s, regional development strategies along such transportation corridors were discussed: A "nodes and axes-based development model" was regarded as particularly useful for less developed western regions. According to this model, the two capitals of Xi'an and Lanzhou (as well as smaller provincial cities) should be developed as "nodes" along these major transportation links. These nodes should then be developed into "lines" and further into "areas," eventually forming a Euro-Asian continental belt of one hundred to one hundred fifty kilometers width in which industries and cities should be concentrated.[25] As I was told, one potential advantage of improved logistics and transportation infrastructures in the Hexi region is that companies can benefit from lower shipment costs. For instance, wine produced in Jiuquan no longer needs to be transported all the way to the east coast to be then shipped to Central Asia. Instead, it can be exported directly westwards via one of the northwestern border regions.[26] In this example, a remote agricultural

National Development and Reform Commission, "The 14th Five-Year Plan of Gansu Province," chapter 34, 66–69.

23 Maçães, *Belt and Road*, 151.

24 The term "Silk Road"— often associated with colorful myths—is a relatively recent invention coined in 1877 by the German geographer Ferdinand von Richthofen. Interestingly, in the context of the Belt and Road, he was surveying and mapping northwestern China to develop a potential railroad link from the seaport in Germany's concession Qingdao to Inner Asian coal fields and all the way to Germany. Hansen, *The Silk Road.*, 6–8. This Sino-German land route has become a reality more than a century later: Several trans-continental transportation links have been established connecting China with Russia, Central Asia, and Europe. The New Eurasian Land Bridge is a railway link that reaches from Jiangsu's coastal city of Lianyungang via the Hexi Corridor and Central Asia, all the way to the port port city of Duisburg in western Germany.

25 Gu, Shen, and Yu, "Urban and Regional Development," 202.

26 Liu Bo, Lanzhou University, School of Economics, October 15, 2019. Liu provided the exam-

region such as Jiuquan's vineyards can be integrated into a transportation belt and linked to urban nodes of economic prosperity across national and continental boundaries.

According to Li Ding, professor of human geography at Lanzhou University, the legacy of state-owned enterprises that receive direct funding from the central state is still very present in the Hexi region. Such enterprises that have been identified as being nationally significant tend to be detached from the province and contribute little to the overall productivity of the region. The BRI might exacerbate this spatial fragmentation and economic disparities as it will likely increase the competition among different counties and economic actors. According to Li, Gansu—China's province with the smallest per capita economic output—is economically the central government's lowest priority and, therefore, likely last in receiving attention and instructions. It remains thus often up to local governments or individual companies to reform, invent, and adapt to new markets and technologies. However, as mentioned, a culture of creative innovation, which this kind of economic adaptation would require, is not particularly strong in Gansu due to the traditional dependency on support from the central state.[27]

Despite its ambitions of creating economically prosperous urban clusters, Gansu's official narrative describes it as a predominantly rural province. In what seems to be a more pragmatic approach, the province's strategy remains to create first, the modernization of the agricultural sector and second, a "rural modernization," referring to a general improvement of living conditions and poverty alleviation through more efficient and sustainable farming practices, technological progress, and restructuring local governance at the village level. Opportunities are seen in the growing tourism industry, in water-efficient forms of agriculture, as well as renewable energies, which have the potential to become the region's primary industry.[28] Some of these new economic opportunities and how they are reshaping the Hexi region are discussed in the next chapter.

---

ple of Jiuquan wine. However, it does not seem to be among the most crucial goods exported from the Hexi Corridor region.

27 Li Ding, Lanzhou University, College of Earth and Environmental Sciences, October 16, 2019.

28 Zhang, "Notice of the People's Government of Gansu Province." Along the Hexi Corridor, this rural modernization should be achieved through water-saving and high-efficiency practices of modern agriculture as the primary mode of economic development. The Hexi Corridor should become an "export base for agricultural products with One Belt One Road characteristics" (chapter 4.1). Modern modes of animal husbandry and the dairy industry are explicitly mentioned for the Hexi Corridor region, as well as the production of vegetables and fruits with greenhouses and other efficient irrigation technologies, including innovative products such as rare crops, herbs, medicine, and aquaculture fish farms (chapter 4.2). Rural industries should be built through *townization*: the construction of modern "industrialized" and "urbanized" towns where primary production is integrated into larger production and processing chains. Selected villages should be promoted as "leisure agriculture" bases around scenic spots and transportation lines (chapter 4.6).

Uneven Development

In his theory of uneven development, Neil Smith described the tendency of capital to constantly seek underdeveloped regions in a "seesaw movement:" While capitalist accumulation is a constant process of concentration and centralization to maximize profits, at the same time, there is a counteracting tendency of a continuous process of decentralization and differentiation. Capital moves where profit rates promise to be the highest. As fixed capital, employment, and wages rise in one area that has been maturely developed, capital thus seeks to move away to underdeveloped areas with contrary conditions. This seesaw movement creates highly dynamic geographies and mosaics of contradictory conditions inherent to capitalist modes of production.[29] In the case of China, while competition among businesses is fostered, this movement of capital is moderated to a certain degree, especially in the case of state-owned enterprises, but also with strict policy regulations.

As Bruno Maçães explains, in a globalized world economy where goods are produced in an international division of labor, the challenge for an individual country is no longer to secure access to commodity markets and produce single products that can successfully be exported. Instead, the goal is to build and control highly efficient global value chains while occupying its top segment. According to Maçães, the BRI is a strategy intended to allow China to reconstruct global value chains in a way that most productively integrates its domestic industrial market. One of China's main economic ambitions with the BRI is thus to move away from its function as a global producer of low-value goods and toward higher-value products integrated into a global supply chain with China at its core and in control. Such a restructured, global network of production and trade that is tailored according to China's interests allows, depending on China's needs, the creation of new opportunities for the export of raw materials and domestically produced goods or, conversely, to secure raw materials from abroad for its own industry. In an "international capacity cooperation," China aims to take advantage of the differences in stages of economic development across geographies: While many countries along the Belt and Road are underdeveloped and have insufficient funds, China can facilitate markets that allow them to either supply raw materials to the bottom of the chain or move up to the middle, while China occupies the top, controlling both the most lucrative segments of production and organizing the whole.[30] This global narrative expands the notion of uneven development, which has been discussed domestically between China's coastal and interior regions, to a planetary dimension across national and continental boundaries.

29 Smith, *Uneven Development,* 196–199.

30 Maçães, *Belt and Road*, 73–84, 97–104. For the "Made in China 2025" strategy, which seeks to replace China's status as the world's producer of low-value goods and a "manufacturer of quantity to one of quality," including innovation-driven development, smart and green technologies, see Sylvia Xihui Liu, "Innovation Design: Made in China 2025," *Design Management Review* 27, no. 1 (2016): 52–58.

The Belt and Road Initiative in the Context of Planetary Urbanization

Ultimately, it seems, the Belt and Road Initiative aims for a trans-continental network regulated by a Chinese-dominated institutional apparatus of territorial presence and control. What is conveyed as a global masterplan connects individual places through a web of enormous flows of capital, information, materials, and labor. Nodes and lines, clusters, belts, and roads on the world map are spatially manifested in strategically selected locations through massive infrastructural projects. Places of material extraction and primary production, linear infrastructures of transportation and communication, ports of logistics and trade, and new urban nodes of socio-economic concentration are intended to act as catalysts to stimulate consumption.

During Maoist nation-building, urbanization followed the traditional concept of a city as the spatial manifestation of industrial production. With the beginning of market liberalizations and the de-collectivization of the countryside, the strong urban-rural divide began to be spatially dissolved. Urbanization became the ultimate goal of local-state building, moving non-urban residents as a workforce from villages into rapidly growing cities despite legal ambiguities and inequalities. Territorial urbanization seemed to no longer describe a spatial condition or geographic unit. Instead, it became an all-encompassing process of societal transformation that is ubiquitous, shapeless, and intangible. It includes new forms of urbanism and housing typologies, accelerated material consumption by the individual, "urban" technologies, and "urban" lifestyles.

According to Lefebvre's model of urbanization, China shifted from the agrarian toward the urban. After passing the stage of the traditional industrial city, the society has entered a "critical zone" on its way to complete urbanization. In the case of contemporary China, this critical zone is characterized by a globalized market economy "with Chinese characteristics." Lefebvre argues that the ultimate goal of the capitalist state is to achieve, through a trend of generalization, a condition of an urban society that is fully integrated into the bureaucratic apparatus of "controlled consumption."[31] This notion of controlled consumption resembles China's state apparatus aiming to control and stimulate the consumption of space, as well as commercial goods, while simultaneously executing strong social repression.

The Belt and Road Initiative expands intensified and dynamic networks of material consumption and capital accumulation to a global context, accelerating the process of planetary urbanization. The concept of complete, planetary urbanization frames the third stage in the thesis' long-term narrative of the Hexi Corridor. The concept helps to perceive spaces that "lie far beyond the traditional city"—territories of extraction, production, communication, and

31 Lefebvre, *The Urban Revolution*, particularly chapter 1, "From the City to Urban Society," 1–22.

Fig. 5.4: View over the construction site of a plaza with a vast, open plain in the background created by flattening hills and removing villages and farmlands; March 2019.

capital accumulation—as "integral parts of the worldwide urban fabric."[32] This planetary urban fabric is manifested in urban nodes and linear transportation links but also in remote places, such as some of the localities discussed in the Hexi Corridor's geographic context.

The following part of the chapter presents Lanzhou New Area as a case of spatial intensification within the global urban fabric and within the vision of the Belt and Road Initiative. The new city is an iconic manifestation of a central state-led culture of top-down planning, disregarding specific local characteristics and the individual citizen. However, Lanzhou New Area, as an early project of the BRI, also stands for a recent period in which the limits of endless growth in China started becoming increasingly apparent.

32 Brenner and Schmid, "Planetary Urbanisation," 12.

Lanzhou New Area and the Limits of Endless Growth

Lanzhou New Area

On a visit to Lanzhou New Area in the spring of 2019, the new city appeared as a mostly vacant ghost town, dotted with innumerable red and yellow tower cranes looming into the sky. The population must have been only a fraction of the around 300,000 residents, which was the official population number at the time. As I was walking around the central district of the future city, a lone group of public service workers—their faces wrapped in white cloths to be protected from the sun—were watering dusty shrubs that had been meticulously cut in straight rows along the empty, over-dimensioned, six- to eight-lane roads. The civic plaza adjacent to the artificial central lake, with a vast, flat surface of concrete paving and fields of plastic flowers decorating the sandy planting beds, was completely empty on that late April morning. Metal fences and large plastic sculptures with banners from the past New Year festivities were still in place, the tall light poles with vertical sails offering only little shade. The large concrete water pools were empty, revealing waterpipes and spotlights installed on the ground to orchestrate a play of water, light, and music, intended to create an experience described as "entering a fairyland" at the time of its opening.[33]

Large black windows gaped into the concrete slab buildings of a residential compound nearby, an open glass door opening the view into the unfinished construction site on the ground floor. Bright posters advertised vacant office space for rent across tall glass façades while the construction of many half-completed tower blocks seemed to have been put on hold some time ago. The hollow silence was only interrupted periodically by cars that were passing by or the distant chatter of service workers—a stark contrast to the usually bustling life of Chinese streetscapes such as on Peili Square in Lanzhou, where my driver had picked me up just a few hours earlier that morning. As I was later standing on the long stairs in front of a massive new sports stadium, I looked out south over an empty lake that had been carved out in the shape of a waterdrop and the abandoned construction site of an extensive concrete plaza where once large groups of people should gather, and activities should be held—a vast, open plain was opening up in the background, demarcating the temporary limit of

33 China.org.cn, "Wonderful Musical Fountain in Lanzhou New Area," This is Lanzhou, June 18, 2014.

urban growth. The flat, sandy terrain had replaced the original topography and was a reminder of the hundreds of silty hills that had been flattened to create space for a bright future of modern development. It all seemed like the surreal scenery of a city that had begun to be erected but was somehow frozen in time halfway. [Fig. 5.4]

A New City as Urban Relief

The old city of Lanzhou is located in a valley stretched along the Yellow River and locked between mountains on both sides, leaving virtually no space for additional urban development. As mentioned, this topographic condition causes air pollution that has reached very high levels.[34] Driven by the imperative of GDP growth, the local government constantly seeks to create additional space for urban development as the primary mode of generating revenue. In many places, the tall hillsides have been scraped off in a desperate attempt to create space for urban growth. For larger-scale development, the city tried to build a new "East District" in 2000 in Yuzhong County, east of the city. Some years later, it also sought to incorporate the mining city of Baiyin, located around 60 kilometers further northwest, into its jurisdiction. However, both projects were unsuccessful and only led to intra-governmental competition and disruptions.[35]

In 2009, a state-led initiative aimed to accelerate socio-economic development in Gansu. In 2010, the central government announced plans to develop a "New District" (新区 *XinQu*),[36] also referred to as New Area. Administratively, the new development was set as a state-level New Area, the first of its kind in northwestern China after three coastal cities and Liangjiang New Area in Chongqing.[37] The construction of Lanzhou New Area was then approved by the State Council in 2012 as a "pilot zone for the nation's economic restructuring" to accelerate economic growth in the western regions.[38] [Fig. 5.5]

34 According to a report by the World Health Organization, Lanzhou was the city with the worst air pollution in 2011, caused by high-emission industries, sandstorms, and traffic within the narrow valley—7.5 times the recommended healthy index by the WHO. However, as mentioned in the previous chapter, the situation has significantly improved. Lan Jin et al., "Ambient Air Pollution and Congenital Heart Defects in Lanzhou, China," *Environmental Research Letters* 10, no. 7 (July 2015), 2.

35 Zheng and Deng, "Typical Cases in Northwest China," 36–37.

36 State-level New Areas are not clearly defined. They are special economic development zones approved by the central government. While these special economic development zones are administratively part of cities, they are referred to as "national-level" or "state-level" as they are monitored and granted privileges directly by the Central State Council. These privileges are meant to encourage and attract new developments (particularly foreign direct investment) to speed up the city's and region's economies. Tao Liu, "Guojia ji xinqu de lilun, shijian ji qi weilai yanjiu fangxiang 国家级新区的理论、实践及其未来研究方向 [Theory, Practice and Future Research Direction of National New Areas]," *Chengshi guancha* 城市观察 *[Urban Insight]*, no. 4 (2015): 67–93.

37 Yinan Zhao and Chaohua Xue, "New State-Level Zone to Boost Western Growth," *China Daily*, September 8, 2012.

38 Ibid.

Fig. 5.5: A masterplan of Lanzhou New Area in the city's planning bureau showroom shows the spatial layout of different land uses and institutions: The center contains government buildings and civic infrastructures for culture and leisure. It is surrounded by zones for trade and logistics, education, industries and manufacturing, the airport in the west, and petrochemical industries in the far northwest. In addition, there are zones for environmental protection and innovative agriculture in the north and south.

Lanzhou New Area continues previous plans of the "Open Up the West" initiative from 1999. It is *the* main project in relation to the Belt and Road Initiative in Gansu province and the central state's continuous efforts of regional development. Located around fifty kilometers north of the historic city of Lanzhou, the New Area is intended to become a regional base of logistics, manufacturing, and trade, with the Lanzhou Zhongchuan International Airport being extended to a major air hub in northwestern China.[Fig. 5.6] In an attempt to increase domestic demand and boost economic growth, Lanzhou New Area was promised to be an urban transformation "equivalent to Pudong in Shanghai"—"a golden opportunity that no one wants to miss."[39] A promotion video from 2012 seems to visualize the dream of urbanity, economic prosperity, and the conquest of the region's hilly desert. Emblematically, the film starts with a fly-through of clouds, a thunderstorm, and a drop of rain that transforms a grey plane into a green model landscape. Martial sounds of

39 Yuan Gao, "Go-West Project Dusts Itself Off in Arid Plateau," *Chinadaily*, November 19, 2012.

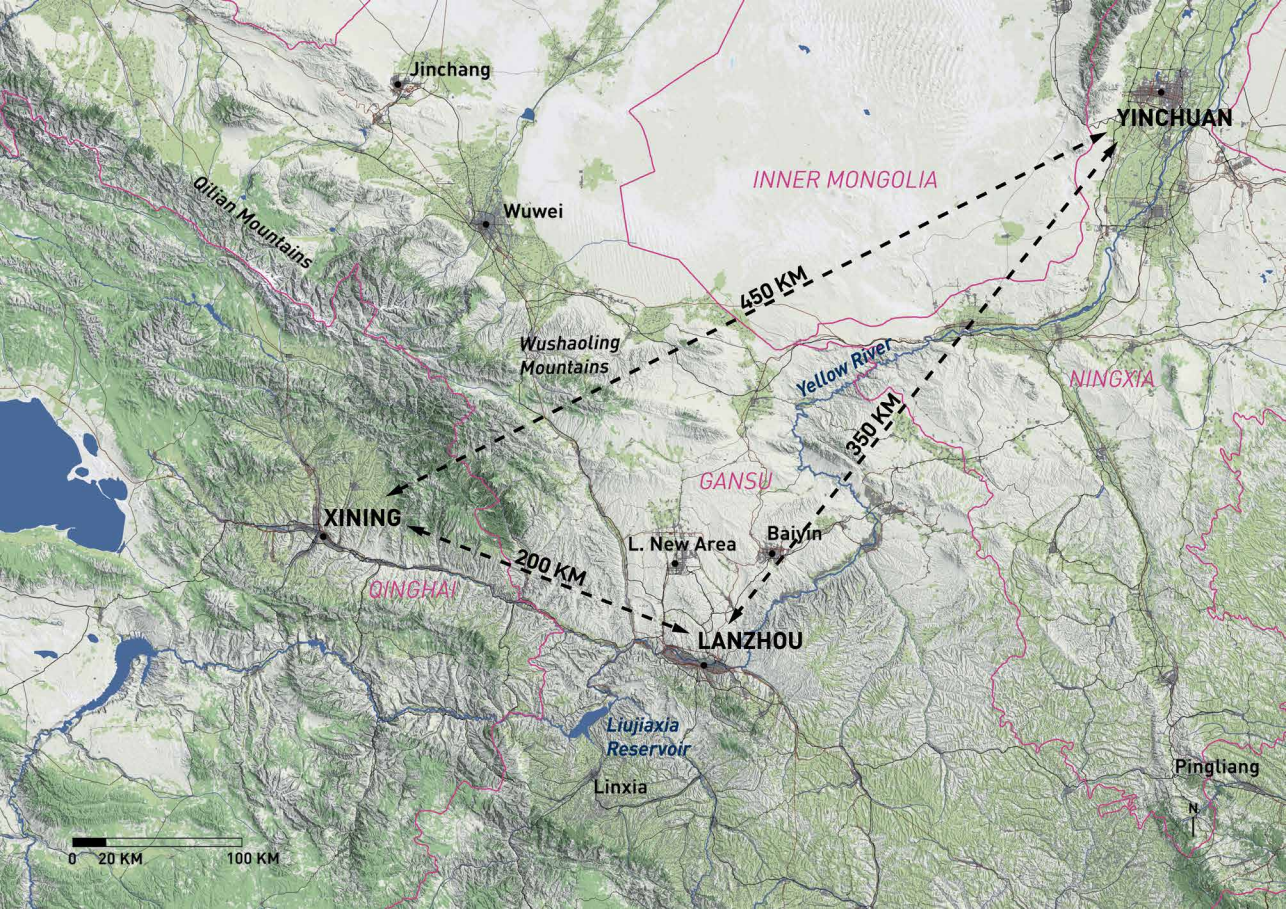


Fig. 5.6: A regional map showing the extent of the Lanzhou-Xining City Cluster at the intersection of Qinghai, Gansu, Ningxia, and Inner Mongolia, and at the gateway to the Hexi Corridor, spanning across large, rural areas and elevation differences.

music lead through the animation, showing a mix of heavy industries, bustling trade, and large-scale civic infrastructures that are emerging from the dusty ground. The many tall tower buildings and busy roads are surrounded by lush green spaces, large bodies of water, wetlands, and forests. Water fountains are dancing on the city's main plaza, and white yachts are cruising across the central lake. An elevated train line and modern streetscapes with busy sidewalks show scenes of a shiny urban life during day and night. A large stadium filled with cheering spectators finally fades into a grand firework. What remains is a bright, modern skyline and a new, large urban node that shines in the dark, arid northwest of China's country map.[40] [Fig. 5.7]

Institutional Planning and Funding Mechanisms

Lanzhou New Area is a culmination of several planning strategies across different levels of governance in a collaboration between planning bureaus of China's central and Gansu's provincial governments. In addition to start-up

40 *Lanzhou New District [Promotion Video]*. (2012, December 8). YouTube.

Fig. 5.7: A 2012 promotion film visualizes Lanzhou New Area as a bustling new metropolis with symbols of urbanity and economic prosperity.

funds that arrived directly from the Central State Council in Beijing, projects are financed by the local administration under the direct control of the Lanzhou municipal government, by loans from various state-owned financial institutions, and state-owned enterprises, primarily of Lanzhou's petrochemical industries, which act as major investors and project developers.[41] The new city north of Lanzhou thus derives from the pragmatic need for additional space for the province capital's urban development. As a centerpiece of the Belt and Road Initiative, it continues the goals of the previous "Open Up the West" initiative. It is the result of risky finance mechanisms based on speculation and debt. In this process, massive works of infrastructure and rapid urbanization are seen as effective vehicles in local government's endless pursuit of growth and accumulation.[42]

41 Much of the information about Lanzhou New Area has been gathered on field trips in April and October of 2019, talking to faculty at Lanzhou University, Lanzhou City University, and Northwestern Normal University, as well as on a private tour with three members from the local government and planning bureau who showed me core investment projects in Lanzhou New Area and gave me a tour through the local government's information center on April 25, 2019.

42 For the mechanisms of endless urban growth and opaque constructs of financial debt, see McMahon, *China's Great Wall of Debt*, particularly chapter 3, "Ghost Cities," (p.49–73) that presents several almost identical cases of other ghost cities which have been built across China in recent years. See also Hsing, *The Great Urban Transformation*, who describes how state-

Fig. 5.8: Impressions from Lanzhou New Area: Empty residential towers with advertisement banners for lease; plastic flowers as attempts to bring life and color to the city's central public plaza.

Over-dimensioned roads fully equipped with lighting, security cameras and decorated with pruned shrubs for a future city; towers under construction in the city center; March 2019.

By relocating institutions, labor, and large, space-consuming, and polluting industrial production sites from the old city of Lanzhou, the New Area serves as a strategic urban node to relieve the dense and mountain-locked province capital from future densification. Instead, it promises to make space for profitable new real estate projects downtown. As mentioned, Lanzhou New Area is a strategic node in a triangle with the neighboring capital cities of Xining in Qinghai and Yinchuan in Ningxia. The greater Lanzhou city cluster should help to boost the entire region and alleviate poverty and economic decline across structurally weak hinterlands, such as the Hexi Corridor. The Lanzhou New Area Free Trade Zone was approved by the State Council in 2014, aiming to serve as a geographically advantageous trade and transfer hub in the center of the Lanzhou-Yinchuan-Xining region and linking China to Central Asia and Europe according to the concept of the overland Eurasian Continental Bridge.[43] [Poster D]

Finding the Most Suitable Site

For the construction of the new city, a relatively flat plain in the Qinwangchuan Valley within the hilly environment of the region was selected. Several towns, villages, agricultural fields, and the Lanzhou Zhongchuan International Airport were already located there.[44] In the arid environment of Gansu, water availability was one of the main criteria in the selection process. Since the mid-1990s, the completed Datong River To Qinwangchuan Region Water Transferring Irrigation Project has been diverting water from the Datong River in the mountainous Gansu-Qinghai border region to the east into the Qinwangchaun basin to enable land cultivation there.[45] The availability of wa-

owned enterprises act as "secondary developers" in an "intra-state competition," for example, by replacing inner-city industrial campuses in prime locations with highly profitable real estate projects, particularly in chapter 2 on "socialist land masters" (33–59). The same mechanism happened in the case of Lanzhou Petrochemical Company, which moved several large-scale and polluting production facilities to the Lanzhou New Area and replaced industrial sites in downtown Lanzhou with highly profitable residential projects.

43 China Daily, "Lanzhou New Area Free Trade Zone," Provincial Government Portal, Lanzhou, Gansu, April 12, 2021.

44 The airport began to be expanded in 2010, coinciding with the decision to build Lanzhou New Area. The New Area encompasses six villages and towns. See China City Planning Review, "State Council Approves Lanzhou New District as the Fifth National New District," *China City Planning Review* 21, no. 4 (2012). Some of the settlements have been incorporated into the development. Some have strongly benefited from the New Area and started massive redevelopment projects, such as in the case of Zhongchuan town next to the International Airport. Others, such as Qinchuanzhen at the northern end of the New Area, lie now adjacent to cleared plots of land and are intersected with massive road infrastructures designated for future urban growth, remaining, for now, as typical, small provincial Chinese towns.

45 The water diversion project was the world's largest at the time and was partially funded by the World Bank. It started in 1976, was postponed until the 1980s, and finally opened in 1994. Until 2015, it was further extended. The project allows water transfer through tunnels and aqueducts over several hundred kilometers of canals and includes several dams and

ter resources, along with an existing railway link, the airport, and the relative proximity to Lanzhou, led to the selection of the plain as the ideal site for constructing the satellite city. The New Area was intended to be developed until 2030 with ambitious goals of economic growth, an anticipated population of over 600,000 in 2020, and eventually reaching over one million in 2030.[46] [Fig. 5.8]

Preparing the Ground

Lanzhou New Area was announced to be built seemingly from scratch across over eight hundred square kilometers, based on a blueprint masterplan with a new grid of large roads, absorbing many of the existing towns and agricultural fields, and including new features such as an artificial lake in the central district.[47] In order to lay out the new city, the plan included the destruction of existing villages and the relocation of its farming households, leveling hundreds of hills in what was being billed as "the largest mountain-moving project in Chinese history."[48] The flattening of hills is a common practice across Chi-

---

reservoirs. It allowed the irrigation and cultivation of land in the Qinwangchuan valley and its construction involved the forceful relocation of tens of thousands of farmers. "Yin Da Ru Qin Gongcheng 引大入秦工程 [Introducing the Da into Qin Project]," Baidu Encyclopedia, February 1, 2022.

46 The GDP was expected to reach 50 billion yuan (around 7.3 billion USD) in 2015 and 100 billion (14.5 billion USD) in 2020. Yan Mo, "Lanzhou Xinqu—Zhonggong Yuanlao Song Ping de Yuyan 兰州新区—中共元老宋平的预言 [Lanzhou New District: The Prophecy of Song Ping, the Veteran of the Communist Party]," Weixin Official Accounts Platform, July 4, 2017. The Gansu governor even expected a GDP of 270 billion (39 billion USD) by 2030. Zhao and Xue, "New State-Level Zone to Boost Western Growth;".

47 Little consideration of the geographic context is noticeable other than the integration of the existing airport and highways, as well as some farmlands and ecological zones that were kept as protected areas unsuitable for development. The city is designed in an efficient manner with a separation of uses and on a flattened terrain. The master plan encompasses an area of 34 square kilometers in the urban core and 806 square kilometers in total [roughly 13.6 times Manhattan's land area]. The master plan was developed in 2010 by Shenzhen Leo Planning and Design Consulting Co., Ltd., a planning bureau headquartered in Shenzhen and listed on the Shenzhen Stock Exchange. The company has conducted planning projects in over 100 cities across China. In recent years, it has exported its expertise and planning schemes abroad, including projects in Nigeria, Pakistan, and Malaysia. Leo Action Planning, "Company Profile," Lei ao xingdong guihua 蕾奥行动规划 [Leo Action Planning], accessed August 29, 2022. The Lanzhou New Area master plan is listed as one of their showcase projects and was awarded with a first prize of the Guangdong Province Excellent Urban and Rural Planning and Design Award. Leo Action Planning, "Lanzhou New District Master Plan Solicitation," Lei ao xingdong guihua 蕾奥行动规划 [Leo Action Planning], accessed August 29, 2022.

48 One of China's largest construction firms, China Pacific Construction Group, was commissioned to spend around 2.5 billion USD to flatten around 700 hills and prepare a flat terrain for the New Area's development. Kaiman, "China to Flatten 700 Mountains for New Metropolis in the Desert." Wade Shepard mentions even 3.65 billion USD for the costs of flattening the hundreds of mountains across an area of 25 square kilometers with over 3,000 excavators and dump trucks that were, therefore, unleashed. Shepard, *Ghost Cities of China*, 35. The China Pacific Construction Group claims to have been involved in the construction of

na's Loess Plateau and northern steppe regions. It is emblematic of planning schemes that disregard existing socio-environmental patterns and explicitly work *against* them instead of being informed by them.[49] The massive efforts of flattening hundreds of hills across the future city were temporarily halted in 2013 when severe issues of air pollution associated with the development project became apparent. The pending environmental assessment was never completed, and construction works resumed four weeks later as contractor's and local government's costs mounted.[50]

Land leasing deals are the primary source of revenue for local governments in China. Accumulating land and preparing it in a functional and efficient manner to then offer it on the market is thus one of their main concerns. In the case of Lanzhou New Area, the plan was to lease out all eight hundred square kilometers of land to the private sector in exchange for a sheer unlimited source of income.[51] In addition to flattening the terrain, the existing transportation network was, therefore, improved with new highway and railway links, and a massive network of several hundred kilometers of roads was constructed across the plain[52] to make land accessible and connect the New Area with Lan-

over 1,000 cities and 3,000 industrial parks, listing Lanzhou New Area as one of their prime projects. Interestingly, the company moved its headquarters to Urumqi in Xinjiang, according to its website, in order to get more strongly involved in the building of the Belt and Road Initiative and expand to an international market. China Pacific Construction Group, "Group Profile," Taipingyang jianshe 太平洋建设 [Pacific Construction], accessed August 26, 2022.

49 Hills are flattened, and ravines are filled in to offer developers cleared land for efficient, master plan development, often—as in the case of Lanzhou New Area—followed by unexpected ground deformations. See Yi He et al., "TS-InSAR Analysis for Monitoring Ground Deformation in Lanzhou New District, the Loess Plateau of China, From 2017 to 2019," *Advances in Space Research* 67, no. 4 (February 15, 2021): 1267–83. Another drastic example, following very similar patterns, is the construction of the new district of Yan'an in Shaanxi province. Chuanhao Pu et al., "Characterizing the Topographic Changes and Land Subsidence Associated with the Mountain Excavation and City Construction on the Chinese Loess Plateau," *Remote Sensing* 13, no. 8 (January 2021): 1556. See also Peiyue Li, Hui Qian, and Jianhua Wu, "Environment: Accelerate Research on Land Creation," *Nature* 510, no. 7503 (June 2014): 29–31, who argue that much more research is needed to understand the full picture of such drastic interventions into natural ecosystems. Air and water pollution, the loss of vegetation and biodiversity, increasing soil erosion, landslides, and flooding caused by such large-scale land deformations can lead to very costly and long-term problems that contradict the promises of urban and economic growth.

50 Li, Qian, and Wu, "Environment."

51 Zheng and Deng, "Typical Cases in Northwest China," 39. Most of the developers in Lanzhou New Area are, in fact, operated by state-owned enterprises, while the number of private developers remains very small, as will be discussed later.

52 This aligns with many other new development areas I have come across in China, such as the new economic zones in the Hexi Corridor. The practice of construction "in advance" leads to completely underused road infrastructures of four, six, or even eight lanes with empty plots of land on both sides and, in many cases, equipped with lighting, surveillance cameras, and decorated with pruned and irrigated planting, ending abruptly at some point, waiting for the anticipated urban development. Tom Phillips mentions "more than 400 miles of roads" (around 650 kilometers) that have been constructed in Lanzhou New Area. Tom Phillips, "China Goes

zhou and the greater region, such as Wuwei and the Hexi Corridor.[53] [Fig. 5.9] Across the flat terrain and gridded framework of roads, hundreds of high-rise towers soon started to be constructed by real estate developers with different uses and public infrastructures distributed among them.

The anticipated revenue did not work out as planned for the local government. According to what is referred to as *san tong yi ping*, local governments not just clear and flatten land but connect it to basic utilities, including water and electricity, and a road network in order to lease it out.[54] Of course, this preparation work is costly. At an estimated fifty RMB per square meter, the preparation work of the total eight hundred square kilometers creates costs of forty billion RMB (around 5.8 billion USD). In addition, costs incurred for the compensation of tens of thousands of relocated villagers. As Zheng and Deng point out, in 2012, the total government revenue of the New Area was only 2.4 billion RMB, a mere six percent of the land preparation costs. However, the enormous debts necessary to finance the massive construction were transferred to private contractors who continued erecting infrastructures such as roads and trains—most of them barely used or not operating regularly due to a lack of passenger demand. In 2016, the real estate bubble in Lanzhou New Area burst, with new apartments losing ninety-four percent of their value compared with the previous year. To continue construction, the local government continued to pump more money in, acquiring six million square meters of apartment blocks at a cost of twenty-four billion RMB.[55]

Attracting Capital and People

According to Chinese state media, the story reads much rosier: In 2012, as construction was just about to kick off, Lanzhou New Area had already attracted around ninety major projects and investments of over seventy billion RMB, according to a *China Daily* article.[56] In order for the new city to function self-sufficiently, to stimulate economic growth, and to attract investors, several industrial parks were built or relocated to the new city. A key project is the Lanzhou New Area Free Trade Park, which opened in 2015 with a comprehensive bonded area for customs clearance of cargo to be shipped out of the country. The strategy that was announced to populate the Free Trade Park included private businesses from various high-tech industries, including electronics, machinery, biomedicine, and agriculture. According to the official narrative, such businesses would be attracted by promising lower labor costs

West: A Ghost City in the Sand Comes to Life," *The Guardian*, March 21, 2017, sec. Cities.

53 Zhao and Xue, "New State-Level Zone to Boost Western Growth."

54 三通一平 (*San tong yi ping*) literally means "three through" (connecting land through water, electricity, and road infrastructures), "one flattening." Thanks to Prof. Wang Zhifang for making me aware of this policy of land preparation. Beijing University, March 13, 2019.

55 Zheng and Deng, "Typical Cases in Northwest China," 39–44.

56 Zhao and Xue, "New State-Level Zone to Boost Western Growth."

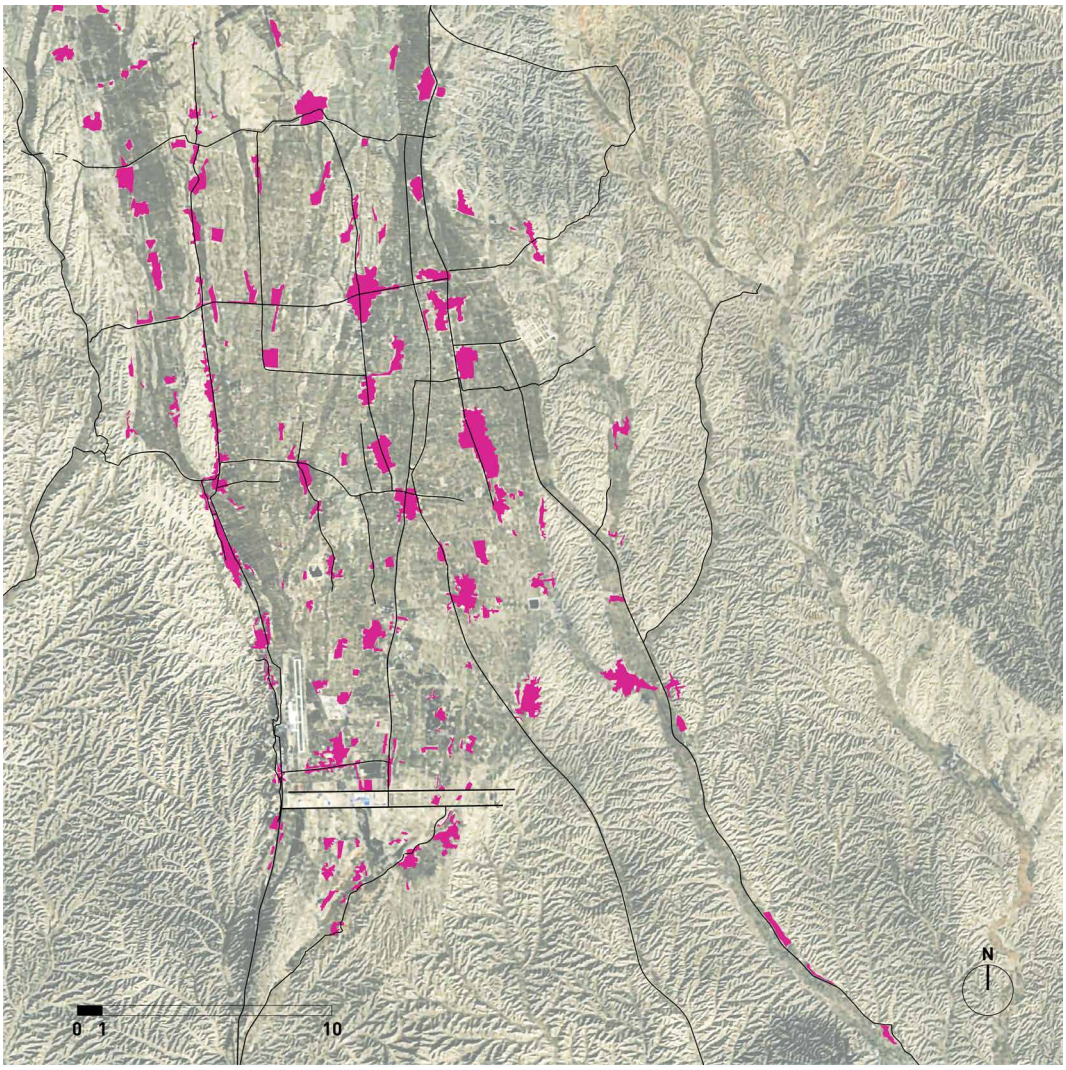
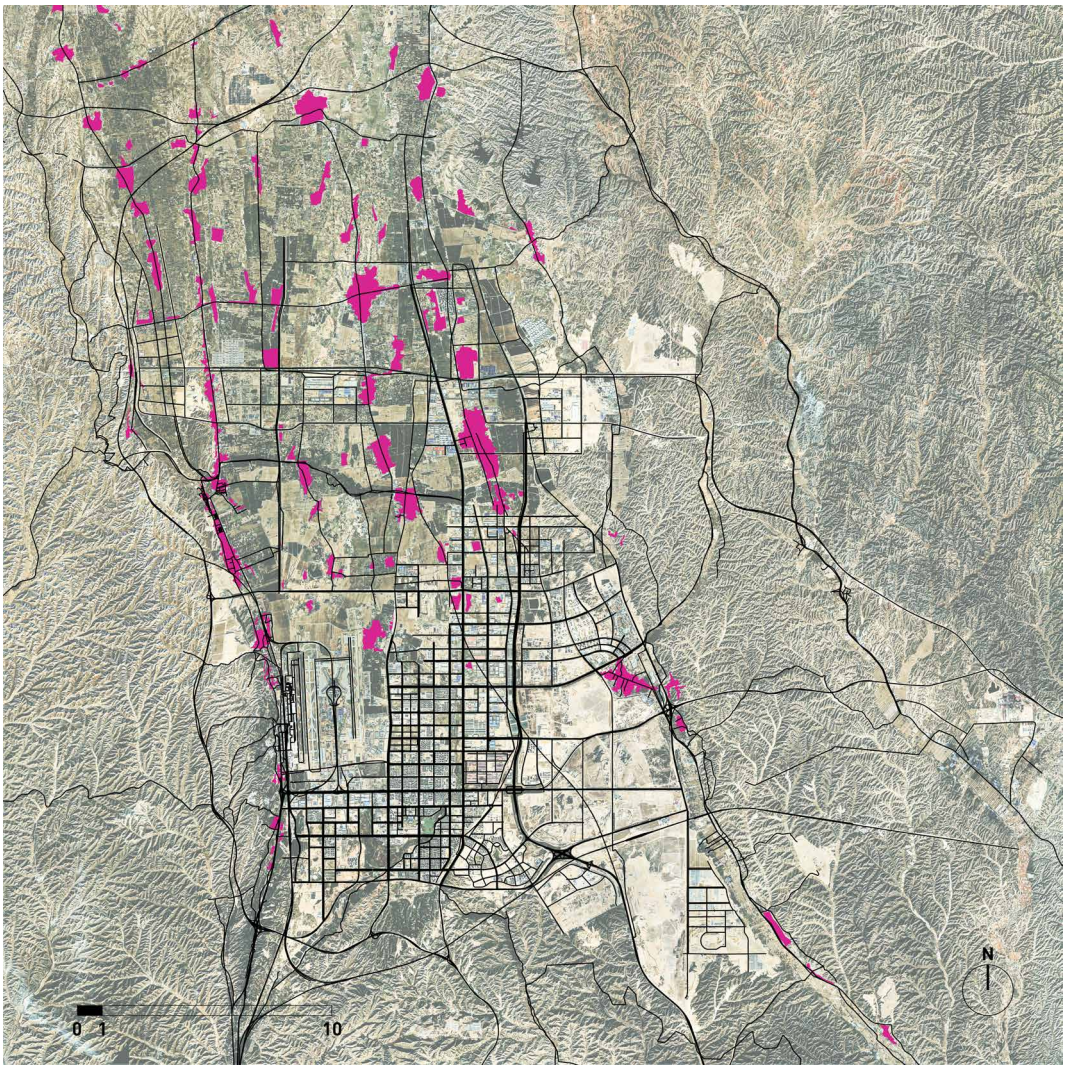


Fig. 5.9: Satellite images from 2011 (above) and 2023 (opposite) show the intense impact of Lanzhou New Area's construction on the existing environment. Villages and towns are highlighted in color, and the transportation network is shown in black. Demolition and construction had already started in 2011 along the central west-east axis.

compared to higher-tier cities in the country's east,[57] explicitly turning away from previous phases of western development characterized by few, large state-owned enterprises that relocated heavy industrial plants to western provinces. However, many traditional, highly polluting, and somewhat redundant factories moved in instead during the first years, such as steel and cement producers.

In addition to subsidies, infrastructure investments, and tax incentives by the central and local governments, as well as state-owned enterprises that acted

57 Ibid.



as the main investors of the project, several other strategies were pursued to lure residents and businesses to the New Area in order to activate the local economy and civic life: Developers offered cheap leases to business owners and up to three years of free rent to residents.[58] Another strategy was to move departments and personnel from Lanzhou city's municipal government to new government buildings in the New Area. Employees were granted full board and a daily travel allowance. However, after just two years, most departments ordered their employees back to Lanzhou as the costs for daily commute turned out to be too high. Most employees had kept a second home in Lanzhou and traveled daily to work in the New Area without contributing to the local community.[59]

58 Mo, "Lanzhou New District."
59 Zheng and Deng, "Typical Cases in Northwest China," 41.

Exemplarily, once my private afternoon tour through the urban planning exhibition hall in the New Area's government seat had ended, the young tour guide asked us for a ride back to the city, and we dropped her off at an intersection in downtown Lanzhou.

In a more desperate approach to attracting residents, a group of "refugees" from Zhouqu, a town in the Tibetan Autonomous Prefecture of Gannan that was heavily destroyed by a mudslide in 2010, were invited to settle in Lanzhou New Area. Therefore, a boarding school and a resettlement compound were established for several thousand people. However, because of a lack of job opportunities, many chose not to stay in their new homes, sold or rented out their apartments, and preferred to return to their hometown and continue farming their land.[60] The strategy of relocating villagers affected by natural disasters continued and was even anchored in a provincial government policy in 2020. That year, villagers from Longnan—like Zhouqu, located in the impoverished and ethnically diverse south of Gansu—were affected by heavy flooding and landslides. It was therefore decided to promote the relocation of the entire community "to fundamentally solve the problem of people's living safety" as "the village site is unsuitable for living, the reconstruction cost is too high, and the production and life are inconvenient."[61]

Another strategy that aimed to stimulate Lanzhou New Area is a common practice in new cities across China: the relocation of schools and universities to create a local population of students, teachers, staff, and related businesses.[62] In addition to industries, businesses, and leisure, the Xicha Park in the southeast of Lanzhou New Area should integrate education, research, sports, and culture. The scale of development is enormous, anticipating an ambitious number of residents. As I learned on my tour in 2019, eleven colleges and universities were planned across sixteen square kilometers, well connected to Lanzhou and other places across the province, including Baiyin and Jingtai County in the north. The Gansu Radio and Television University alone was planned to accommodate 151,600 people across its seven different colleges. The Lanzhou Modern Vocational College campus will eventually consist of several schools across 106 single buildings, built with an investment of five billion RMB. In 2017, it welcomed 37,000 students and teachers in the first batch of its operation, according to my tour guide. An indoor stadium was under construction, which swallowed an investment of over 750 million RMB and, once completed, should

60 Mo, "Lanzhou New District."

61 Yuhao Zhong, "Lanzhou Xinqu Jinnian Yi Shixian 10 Wan Ji Renkou Zengzhang, Ling You Sheng Nei Yimin Zhengce Jiachi 兰州新区今年已实现10万级人口增长，另有省内移民政策加持 [Lanzhou New District Has Achieved a Population Growth of 100,000 This Year and Is Also Supported by the Provincial Immigration Policy]," *Pengpai Xinwen* 澎湃新闻 *[The Paper]*, December 18, 2020.

62 Wade Shepard describes the relocation of educational institutions as a common strategy employed in new cities all over China. Shepard, *Ghost Cities of China*, 76–77.

Fig. 5.10: College campus building with scraped-off hills in the background on one of the school campuses in Lanzhou New Area's education zone; March 2019.

provide almost ten thousand seats for student basketball and volleyball competitions. Despite all these ambitious numbers and grand planning schemes, when I was shown across the different university campuses, they seemed almost completely vacant. Large, newly finished university buildings in bright, pastel colors were arranged with generous open spaces in between. Empty windows and seemingly untouched balconies covered the facades of modern dormitory complexes. Only very few students walked along the concrete-paved paths that led through brown lawns with many small, pruned, and leafless trees that had been recently planted, their trunks painted in white and staked with leaning poles. [Fig. 5.10]

To attract visitors and to express the flair of a buzzing destination—and as it has been done in many other urban development projects across China—several theme and amusement parks have been built in Lanzhou New Area. The "Great Wall Film Studio" hosts giant replicas of Chinese and overseas tourist attractions, including the Forbidden City, the Temple of Heaven, the Daming Palace, the Athenian Parthenon, and the Great Sphinx of Egypt. The "West China Dinosaur Park" includes a large waterpark with pools, beaches, and waterslides, a dinosaur garden, and a theme hotel, as well as a children's park with entertainers disguised as Western clowns, tropical indigenous war-

Fig. 5.11: The Rainbow Village in Lanzhou New Area is the city's showcase relocation project where farmer families from dismantled villages are offered new housing; March 2019.

riors, or Brazilian samba dancers.[63] A wetland park with large artificial lakes and grasslands opened in 2018 at the bottom end of the plain; the irrigated fairways of an 18-hole golf course lie further south, surrounded by hills.

Relocating Residents

In the process of clearing the land for the construction of the New Area, many villages have been dismantled, their surrounding farmlands cleared and flattened, and the villagers moved to new residential towers. As it is common in such forced relocations in China, the farmers are compensated for their property and offered to buy new housing.[64] In the case of Lanzhou New Area,

63 I did not have a chance to visit these entertainment sites, but they are documented in numerous blog posts and articles.

64 As discussed, all land in China belongs either to the state or to farming collectives as a legacy of Maoist policies. Legal land rights in China are highly ambiguous, particularly regarding collectively owned land and the relationship between a built property and the land it is standing on. While land has not been privatized and can still not be legally leased or sold in the case of rural land, it has become commodified since the 1990s, and its accumulation has become the key strategy of local state leaders. Township party branches often interfere in village collectives through interest alliances. In addition, the Property Rights Law stipulates a vague policy of

several resettlement housing projects were built for this purpose. The largest and most successful is the Rainbow City Community, which is presented to foreign visitors as a prime example of resettlement programs. On my private tour, I have been shown community spaces, classrooms, and other facilities with elderly residents participating in indoor entertainment programs and families sitting in outdoor open spaces decorated with large and colorful propaganda banners. [Fig. 5.11]

Shanzidun Village

In strong contrast to this ostensibly happy community life, and just a few hours before my curated afternoon tour, I had visited a dismantled village in the eastern part of the New Area. Our driver had dropped me off on one of the wide roads at the eastern end of the New Area's ongoing development, together with my guide, Du Rong, and Zhang Shuping, my translator for the day. We walked around a metal fence that was covered with large, faded posters showing scenes of a shiny city and slogans about a bright urban future. Behind the fence, the view opened up across a vast field of debris. It was a scene that did not come as a surprise and that I have encountered many times in the periphery of China's fast-growing cities. We scrambled across mounds of bricks and gravel, overviewing a vast area of several village units that had been bulldozed almost entirely. Only a few of the one-story courtyard buildings were still in place, together with some leafless trees. In the background toward the east, piles of the destroyed village houses covered the slopes all the way up to the horizon, where excavators were scraping off and flattening hilltops. Toward the north, behind the masking fence surrounding the demolition area, half-finished concrete slab buildings of a new university campus were growing, crisscrossed with dozens of cranes. [Fig. 5.12]

"public interest" that allows authorities to claim land use rights from individuals and collectives in the interest of projects considered necessary for the greater good. Since the 2000s, land grabs and forced eviction have become the primary cause of peasant protests, mainly due to disproportionate compensation payments. So-called "nail houses" of residents that defy the local government's intentions and hold out in their homes of an otherwise demolished village have become emblematic of such protests. In most cases, they are attempts for higher compensation payments rather than for the protection of the property. For the complex and dynamic land market in China, see Lin, *Developing China*; Hsing, *The Great Urban Transformation*; Peter Ho, *Institutions in Transition: Land Ownership, Property Rights and Social Conflict in China*, (Oxford; New York: Oxford University Press, 2005). For the policy of "public interest," see "Database of Laws and Regulations" (The National People's Congress of the People's Republic of China), accessed June 7, 2022. Article 42 in the chapter "Property Law of the People's Republic of China" states: "For public interests, land owned by the collectives, and the houses and other immovables of units and individuals may be expropriated within the limits of power and in compliance with the procedures provided for by law."

Fig. 5.12: Shanzidun Village in the southeast of the New Area has been completely dismantled and turned into a vast field of debris. In the background on the left are construction sites of new buildings, while on the right, excavators are scraping off hills to create flat ground for development; March 2019.

Suddenly, we were standing in front of an older man slowly approaching us through his home's entrance, consisting of old wooden doors and planks that had been cobbled together to close the missing wall of the small remains of his courtyard house. Staring into the empty space beside us, he said he was one of the very few residents still staying behind in their village homes. The bald man told us that he was almost entirely blind and that almost all other villagers had left before large bulldozers showed up one day and smashed all the houses apart. His neighbors' attached house had also been removed, leaving him with only a small fraction of the courtyard home and some partially collapsed walls. He told us how he used to farm and how their village unit's soil quality and water supply had been sufficient to grow crops. Now, where most of his neighbors had left, his daughter would come regularly to look after him. The man seemed desperate and said he was undecided whether or not he should accept the compensation the local government had offered him. Maybe he also did not have the courage to move away from his land and intimate home to start a new life in one of the modern high-rise residential blocks in the New District. However, his situation of holding out in his house had likely only been a matter of weeks. Soon after my visit, his protest must have ended, and the final clearing of the

remaining houses and all the debris must have begun, completing the conversion of the village land into an object of capital investment and speculation for future urban growth.[65] [Fig. 5.13]

We continued to wander around the piles of bricks, plaster, and corrugated iron sheets, following the rattling sound of a pocket radio. The sound led us to another resident who had stayed behind: A single, middle-aged man confidently sitting in front of his house. He wore a straw hat, sunglasses, and gloves, sawing a long log that he had stabilized on a reversed stool into pieces. The wooden entrance to his home was studded with golden sheets and decorated with red and pink Chinese fortune couplets. Looking up at Zhang Shuping with the bright sun on his face, and without paying any attention to me, he hastily told her about his disappointment with the New Area's government. They had offered him an unsatisfying compensation for his property, he said. However, he had only received less than twenty percent of it so far. He complained about how they would have changed their policy, first promising to pay each farmer by area of land to now only paying a fixed compensation per person. Also, the prospect of switching his household registration from the village to an urban one in the New Area did not seem attractive to him. He said changing his *hukou* would not make a significant difference and was similar in terms of public services offered, continuing to pay only fifty percent of his medical costs. Before we left, he repeated that he would stay back and watch over his house, being aware that he would have to move eventually but trying to negotiate a higher compensation. Behind him, a crutch was leaned against the wall marked with several large numbers authorities had sprayed on.

A Success Story or a Complete Failure?

The rapid development of China's new urban centers is usually told as success stories: seemingly planned from scratch, they have turned wasteland into shiny modern cities. However, the famous cases of Shenzhen and Pudong, which are often referred to, have remained exceptions rather than the rule.[66] Neverthe-

65 Satellite images from fall 2022 revealed that the area had been completely cleared and leveled. However, no roads or buildings had been constructed yet, and the area remained empty.

66 While these two examples have been successful in terms of urban and economic growth, Juan Du provides an alternative reading of the Shenzhen case: It opposes the often-cited misconception of "a small fishing village" that was, almost overnight, turned into a shiny beacon of modern China. Du reveals that the city has not been heroically built from scratch through a successful political campaign. Instead, it is rooted in a rich history, multilayered social fabric, and complex ecology that existed long before the alleged miracle of Deng's declaration as a special economic zone. Du points out how the city continues to bear an often neglected, distinct local character and cultural-historic value. Juan Du, *The Shenzhen Experiment: The Story of China's Instant City*, (Cambridge, Massachusetts: Harvard University Press, 2020).

less, the same narrative of rapid urban and economic growth continues to be used in the case of Lanzhou New Area.[67] Similar models of urban stimulus are replicated across the country, mostly neglecting local characteristics of the existing socio-environmental conditions. Such development projects are built on optimism, hope, and speculation. In 2012, it was announced that by 2030, one million people would be living in Lanzhou New Area. Along the same note, in 2012, Lanzhou's mayor stated optimistically that the available talent in Gansu's capital of Lanzhou would be able to meet the demands of the new city,[68] despite the fact that Gansu has always struggled with human capital.

It is now around ten years since the construction of the new city began. Based on the English version of the official Lanzhou government website, where reports about openings of new institutions, infrastructures, and progress of economic growth have regularly been reported, the enthusiasm about the New District seems to have calmed down, with the last blog entry being from September 2018.[69] In contrast, on the Chinese version of the website, the New Area continues to be praised for its successful growth.[70]

Already in 2016, just a few years after the beginning of construction, a real estate analyst concluded that the Lanzhou New Area project had been "very unsuccessful," according to a Washington Post report.[71] In contrast, a Guardian article published less than one year later reported about progress and that the New District would slowly come to life. The Rainbow City Community is described in that article as the "busiest part of Lanzhou New Area."[72] However, as mentioned above, I experienced the neighborhood as relatively calm and only partially inhabited during my visit in 2019. The cautious optimism of residents quoted in the article must be seen in the context of what their life realities had been before. Many farmers lived in rudimentary housing conditions before they moved to the modern tower blocks. Their houses are now gone, and the land they used to cultivate has been cleared. As residents of the new housing

67 Like Shenzhen, Lanzhou New Area was also not built from scratch but was home to thousands of villagers who used to cultivate the plain. The Qinwangchuan Plain has a long history as a once-fertile grassland used for grazing by Mongolian tribes. It became an arid and troublesome dryland over the centuries and, according to a legend, was successfully turned into arable land during the mid-Qing dynasty with astonishing agricultural practices that were later replicated across central Gansu. Lanzhou New District Party Working Committee, "Qinwangchuan de Chuanshuo 秦王川的传说 [The Legend of Qinwangchuan]," Lanzhou xinqu menhu wangzhan 兰州新区门户网站 [Lanzhou New Area Web Portal], May 16, 2022.

68 Gao, "Go-West Project Dusts Itself Off in Arid Plateau."

69 China.org.cn, "New Area," This is Lanzhou, September 10, 2018.

70 Lanzhou xinqu dang gong wei bangongshi 兰州新区党工委办公室 [Lanzhou New Area Party Working Committee Office], "Lanzhou Xinqu Gaikuang 兰州新区概况 [Overview of Lanzhou New Area]," Lanzhou xinqu menhu wangzhan 兰州新区门户网站 [Lanzhou New Area Web Portal], April 26, 2022.

71 Simon Denyer, "Along the New Silk Road, a City Built on Sand Is a Monument to China's Problems," *The Washington Post*, May 29, 2016.

72 Phillips, "China Goes West."

Fig. 5.13: A "nail house" in Shanzidun Village that had remained partially destructed with one elderly resident who continued negotiating compensation while the surrounding buildings had been dismantled and almost all neighbors had left; March 2019.

compounds to which they have been relocated, they contribute a large share of the New Area's number of permanent residents.

In 2019, Lanzhou New Area was formally established as a county-level division. In this process, three townships were separated from their respective counties and integrated into the new municipality. One of them is Zhongchuan, which had previously demolished its original town plus several adjacent villages to provide space for the airport expansion, relocating many residents to the new city. This administrative integration of the three towns helped increase the official population number by over 100,000 in just one year.[73] The official total population in 2020 was 288,200, including the newly integrated towns and villages and holders of a household registration elsewhere.[74] It is hard to say how many residents actually live in the new city of Lanzhou New Area today. The number in the 2020 census might be lower than in the years before due to the COVID-19 pandemic. The official numbers clearly state that the anticipated population of 600,000 for the year 2020 was not reached by far. The

73 Zhong, "Lanzhou New District Has Achieved a Population Growth of 100,000."

74 The official population in 2020 was 288,200, while the number of residents who were *hukou* holders from elsewhere was 188,827. Zhongguo tongji chuban she youxian gongsi 中国统计出版社有限公司 [China Statistics Press Co., Ltd.], "2021 Lanzhou Tongji Nianjian 兰州统计年鉴 [Lanzhou Statistical Yearbook 2021]" (Beijing: Zhongguo tongji chuban she 中国统计出版社 [China Statistics Press], October 2021), 93–97.

estimate is also difficult considering the many non-Lanzhou New Area *hukou* holders. In 2020, their number was around 190,000—two-thirds of the total population.[75] These residents are considered as "floating population," maintaining a somewhat temporary status, observing progress and what direction the new city will take.

Local Perspectives

In September 2022, my guide, Du Rong, introduced me to a businessman from Baiyin who works in the energy and mining sector.[76] Mr. Deng has been involved in businesses in Lanzhou New Area since its beginning in 2012 and also bought property in the new city as a speculative investment. One major problem he identified is the frequent changes in government leadership, which is, however, not exceptional but a common practice in China's political system. Mr. Deng said that in the past years, each provincial leader sought to initiate rapid growth in Lanzhou New Area, allocating strong financial and institutional support from the provincial government and aiming to use the development project as a springboard for promotion. Short leadership intervals were problematic as with each change of office, previous development strategies were neglected or reversed. New leaders introduced direction shifts chaotically, such as repeatedly selecting different industrial sectors to supply with generous subsidies, leading to failed and sometimes counterproductive investments. The resulting loss of state-owned assets continues to be a severe problem, and, as Deng suspected, it is highly possible that corruption is its main cause.

According to Mr. Deng's assessment, the New Area's development model follows a piecemeal strategy of separate districts (such as the education district that has been mentioned), which are all governed by a separate ministry within the government, each following different political goals and authorities. Instead of being led by a free market, the development is strongly interlinked with these different institutional bodies. In order to accelerate growth, they have all set up different state-owned enterprises as desired economic drivers of their respective districts. Because of massive investment campaigns, all these state-owned enterprises are in high debt. In the private sector, only very few companies were able to operate successfully in the past years, and many of them were from industries with a high degree of mechanization, creating only few jobs and not contributing significantly to the overall development of the New

75 From the 188,827 non-Lanzhou New Area *hukou* holders, 87% (163,470) had their household registration from elsewhere in Gansu, and only 13% (25,357) were from a municipality outside Gansu province. Ibid., 97.

76 Although the interviewee agreed to be mentioned by his name, given some controversial critical comments he made during the online interview, I decided not to disclose his identity. In the following, he is therefore referred to as Mr. Deng. While by September 2022, he had not visited the New Area since the outbreak of the COVID-19 pandemic, Deng has been following the city's development closely and has constantly been in contact with permanent residents.

Fig. 5.14: Detail of an urban design model in Lanzhou New Area's planning bureau exhibition hall showing the urban core with wide roads, public parks, business and residential buildings; March 2019.

Area. Mr. Deng stated that growth is driven, for the most part, by very few key enterprises, which are almost exclusively state-owned, such as Lanzhou Petrochemical. Only a few businesses from outside Gansu or from abroad could be established successfully. Not surprisingly, the many educational institutions seem to contribute most to the desired urbanity and civic life today. However, they are also present due to government policies and large subsidies rather than economic market reasons.

Another problem that Deng identified is that the number of available apartments and office space is far beyond the actual demand, with a large majority remaining vacant until today. While many people bought apartments in the first years for speculation, they had never moved in. Mr. Deng also never lived in his New Area apartment. Overall, Deng said, the area of urban development seems completely over-dimensioned. While he estimated that around 300,000 permanent residents might live in the New District, they are distributed across a vast perimeter. Most of them live in relatively small clusters (such as in Rainbow City), which might generate pockets of some degree of density, yet they are completely separated from each other. In another interesting observation, Mr. Deng pointed out that the education level of Lanzhou New Area's residents is generally very low. Only few of them went through higher education, while many are landless farmers who have been relocated into modern resi-

dential blocks. Summing up, Mr. Deng thus described Lanzhou New Area as a "phony fat creature" (假的胖子 *Jia de pangzi*): While the city appears large, it is hollow, its competitiveness remains very low, and the debt ratio must be enormous. Given the massive investments that have been made over the past decade, the project has likely become too big to fail. Yet, Deng believed that it remains an option that the entire development project could fail completely, especially considering the presumably exorbitant high debt rate.

The Limits of Endless Growth

With a 2020 GDP of 23.5 billion RMB, the ambitious economic goals of achieving fifty billion in 2015 and over one hundred billion in 2020 have remained mere rhetoric.[77] Based on my visit in the spring of 2019, there was very little public life, and most buildings and civic infrastructures seemed completely underused. As we drove through neighborhoods of newly constructed tower blocks, most appeared only partially used, vacant, or their construction had been halted halfway. While I have not been able to return to Lanzhou New Area, it seems clear that the city is far away from the bustling urban life that has initially been promoted and the shiny city that is visualized in the large exhibition hall of the local government's planning bureau. [Fig. 5.14] The material and capital investments that have been made are enormous. The transformation of vast areas of land and topography against the forces of wind and water is irreparable and will literally leave a human footprint that will likely outlive humanity. The long-term overall gain and financial return on these massive efforts and investments remain highly questionable. The initial emphasis on heavy industries as the primary driver of urban growth seems to repeat mistakes from previous phases of state-led development and does not align with the goals that the provincial government has formulated. Also, the desperate attempts to attract investments and create a wishful urbanity with seemingly universal strategies, such as through cultural destinations in the form of mediocre theme parks or oversized and chronically underused civic infrastructures like grand plazas and stadiums, were so far unable to generate the anticipated outcome. Under pressure to meet economic targets and follow grand visions such as the Belt and Road Initiative, it seems difficult for local leaders to abandon previous models and develop innovative, alternative strategies while facing the threats of increasing debt, slowing growth numbers, and environmental limitations.

In his 2015 book, Wayne Shepard paints a much more optimistic picture than most Western media that reported on China's "ghost cities." For him, these places of rapid urban development are just "a temporary phenomenon." In the book, he points out that urban life needs time to grow. Moreover, he believes that, while maybe not all of these city projects will succeed, many will

77 Zhongguo tongji chuban she youxian gongsi 中国统计出版社有限公司 [China Statistics Press Co., Ltd.], "Lanzhou Statistical Yearbook 2021," 73.

have positive effects in the long term.[78] However, today's China is different from almost ten years ago when Shepard's book was published and Lanzhou New Area's development started. China's industrial and urban growth have been tremendously capital and material intensive. Over the past seven decades, this has caused devastating environmental consequences. The awareness of the urgent need to limit land consumption and the destruction of natural resources has become much more present in political decision-making since then. Several policies and guidelines have been put in place to restrict extended urbanization.[79]

As China's demographics shift towards a shrinking population[80] and rural-to-urban migration rates decrease, the seemingly never-ending demand for housing property has begun to cool down. In many regards, urbanization, as the ultimate driver of endless growth, has reached its limits. Chinese real estate development companies have all made the same bet on inexorably rising property prices. They accumulated massive amounts of land—often overpaid at auctions—and took on as many real estate risks as possible, accelerating overproduction. They now all face the same issue of prices that stop rising, which, therefore, immediately becomes a systemic problem. A troubling property sector has been one of the primary reasons for downward trends in China's economy in recent years and a severe problem for central and local governments.[81] It

78 Shepard, *Ghost Cities of China*, 200–205.

79 Initiated by the State Council, "Ecological Red Lines" to protect the environment from intensified resource exploitation have been implemented. The next chapter will discuss this policy and general political shifts toward environmental awareness.

80 In a brief side note, the Chinese National Bureau of Statistics reported that in 2022, China's population dropped for the first time in over six decades [since the catastrophic years of the Great Leap Forward in 1961]. National Bureau of Statistics of China, "National Economy Withstood Pressure and Reached a New Level in 2022," accessed September 17, 2023.

81 China's latest property market crisis began in the fall of 2021, sparked by the downgrading, delisting, and eventual debt default of one of China's largest property developers, Evergrande. Prominent developer companies like Evergrande or Kaisa were in enormous debt, no longer able to pay bonds, and unable to build the apartments they had been paid for. In response, the central state began to curb the trend of highly speculative and risky real estate development practices in 2020 by placing caps on developers' borrowing, signaling that these companies were facing increased financial tension, which led to a further decline. To avoid the risk of a collapsing market, as well as social protests and unrest, the central government has in the past always been willing to intervene and eventually bail out failed actors. The central government would have the financial institutions and policy tools to resolve the real estate debt crisis also this time. It has to mediate moral hazards, unreasonable speculation, and excessive growth rates to prevent a complete collapse of the property market, a spillover into the banking sector, and a tip of the economy into a financial crisis. Cao Li and Rebecca Feng, "The Bursting Chinese Housing Bubble Compounds Beijing's Economic Woes," *The Wall Street Journal*, August 11, 2022, sec. World; Martin Farrer, "Evergrande: 'Everyone Bet on Inexorably Rising Chinese Property Prices,'" *The Guardian*, December 31, 2021, sec. Business; Bert Hofman, "How China Can Overcome Its Property Crisis," *OMFIF* (blog), August 1, 2022. In spring 2023, the property market crisis continued to struggle with additional, prominent cases of bankruptcy, while national economy growth rates remained even below cautious estimates, and the central

seems that China's global geopolitical ambitions initially expressed in the Belt and Road Initiative are no longer primarily about heavy infrastructures and excessive growth. Instead, China seeks to achieve a dominating role in the envisioned planetary network of trade and transportation by shifting institutions away from Western domination and increasingly establishing Chinese values, technologies, and policies.

Positioning Lanzhou New Area in a Territorial Context and the Hexi Corridor

This chapter illustrates that urban growth and economic prosperity cannot be forcefully created anywhere. The case of Lanzhou New Area shows that it is very challenging to develop a singular urban-economic node in a structurally weak region like Gansu despite its location near the province's capital. A city cannot not be conceptualized as an isolated peak of prosperity. Instead, it requires a solid geographic and cultural foundation—a functioning territorial system—with continuous flows of capital, labor, knowledge, and innovation, as well as socio-environmental conditions able to offer efficient transportation corridors, vital ecosystems, and material resources. While the plan to create prosperous economic belts rather than isolated locations seems reasonable, it is a highly resource-intensive strategy.

The struggles of turning Lanzhou New Area into the desired modern and prosperous city illustrate several key issues development projects face in China's northwest interior. First, as mentioned and throughout their long history, China's northwestern regions notoriously lack innovation and socio-economic dynamism and heavily depend on central government support.[82] Second, while certain individual localities and industries were able to benefit from state investments over the past seven decades, they have largely remained isolated and were not able to have a significant impact on the economic growth of their surrounding.[83] Third, China's northwest has always been a region of the extraction of resources but also of human capital. Despite significant investments, Gansu province continues struggling to attract talented personnel, competing with eastern first- and second-tier cities offering far more attractive job opportunities, education, and general life quality.[84] On top of these socio-economic challenges, and despite somewhat successful initiatives to curb and even reverse environmental degradation in recent years, the region remains characterized by limited natural resources, water stress, harsh climates, land loss due to processes

government resisted bailing out privately owned developer companies.

82 Li, Yeung, and Qiao, "Historical Legacy and Future Challenges," 34.

83 Yeung, "Introduction," 19.

84 Peijun Shi, Xuemin Liu, and Minghuan Yang, "Education and Skill Training," in *Developing China's West: A Critical Path to Balanced National Development*, ed. Yue-man Yeung and Shen Jianfa (Hong Kong: Chinese University Press, 2004), 134–44.

of desertification and salinization, as well as devastating sandstorms.

The ambitious goal of developing Lanzhou New Area into an urban node with one million residents by 2030 raises the question of where all these people are expected to come from. Many villagers who cultivated the Qinwangchuan Valley before construction began have been moved in situ from their land into new apartment blocks. The examples of relocating "refugees" from remote villages in Gansu's poor and ethnically diverse south illustrate that the provincial government seeks to use Lanzhou New Area to solve issues of poverty and spatial and ethnic seclusion by promoting concentration in cities and assimilation in modern, "urban" lifestyles. In addition to peasants who are relocated to become urban residents, Lanzhou New Area can also serve as a catalyst of modernization for villagers who remain in their rural households: In Xicha Village on the northeastern edge of Lanzhou New Area, I met Mr. Xu and his family who lived in a newly built, rural courtyard house. As they told me, they had recently moved to Xicha, together with several neighboring families from their village in central Shanxi, in exchange for new land they were offered near the new city of Lanzhou New Area. They said they were pleased with their new living conditions and explained that they would no longer have to work in agriculture. Instead, they leased out their new land for a small price while Mr. Xu found a job in a furniture production company in the New Area. While Xu's family has moved from outside Gansu, most new residents are likely from the Lanzhou-Baiyin urban region or elsewhere in the province, and some may come from places along the Hexi Corridor.

Lanzhou New Area lies outside the Hexi Corridor, around 140 kilometers southeast of its starting point, Gulang, on the opposite side of the Wushaoling Mountains. However, the Hexi Corridor can be understood as part of the rural-dominated hinterland that helps sustain and strategically connect the new urban node of Lanzhou New Area. Around half of the over twenty-six million people who live across the Hexi Corridor are non-urban *hukou* holders. Of course, Lanzhou New Area and the greater Lan-Xi City Cluster are not meant to be filled explicitly with people from the Hexi region. However, as discussed, many places across the Hexi Corridor face challenges of declining industries and environmental degradation.

While the urban experiment of Lanzhou New Area is itself built on land that once hosted fertile ecosystems and has been transformed by environmental degradation, it is presented in this thesis as a modern, urban countermodel to remote regions like the Hexi Corridor, deriving from top-down territorial planning strategies. One ambition of China's latest territorialization plans seems to be the integration of rural-dominated hinterlands into schemes of urban-economic clusters intended for people from structurally weak areas to find new job opportunities, adopt modern lifestyles in urban environments, and accelerate individual consumption.

Fig. 5.15: Hundreds of mountains are being flattened to create space for urban development, radically transforming the existing topography, soil structure, and hydrologic processes.

The Foolish Old Man Who Removed the Mountains

To shift the focus at the end of this chapter back toward environmental issues, some desperate attempts to extend the city of Lanzhou despite geographic limitations are highlighted: Before the decision was made to construct Lanzhou New Area fifty kilometers north and detached from the capital, other strategies were pursued to create new space for urban expansion. In the Daqingshan Project in 1997, a 1,689-meter-high peak was planned to be removed to create extra land that could be leased out to developers and as an attempt to improve the city's air quality. Once half of the mountain had been scraped off, the project was terminated as it ran out of money. In addition, it was discovered that the mountain removal had no measurable impact on the air circulation that could help dissolve smog. Later, the city filled in a river and tried to lease out the reclaimed land, only to discover that the soil and subterranean water had turned saline and that the aquifer and the city's drinking water supply were at risk. A few years later, Lanzhou's city government started another attempt to expand land for development. It began to flatten an area of forty-one square kilometers of hills only to, again, stop halfway for reasons that were never released.[85]

The famous Daoist parable of *The Foolish Old Man Who Removed the Mountains* tells the story of an old man who decides to remove two mountain peaks obstructing the way to his house, bucket by bucket. In Mao's re-interpretation

85 Shepard, *Ghost Cities of China*, 34.

of the story in a memorable speech from 1945, the two mountains were described as symbols of the twin evils of feudalism and imperialism. And the story was turned into a call for collective action as the foolish old man's faith and perseverance heroically convince his skeptical village neighbors, and eventually, the joined force of many hands accomplishes the seemingly impossible undertaking of removing the mountains. Mao's speech became one of the key texts in the Little Red Book, and it is commonly still referred to today. In his opening speech on the Three Gorges Dam in 1997, Jiang Zemin also famously referred to the myth of the Foolish Old Man to express how Chinese have been able to "conquer nature" since ancient times.[86]

The notion of overcoming the forces of nature through megaprojects and drastic interventions into the natural environment seems to remain present in the rhetoric and certain actions of local governments, the central state, and contemporary culture in general. It is manifested in the massive-scale flattening of mountain tops, as in the case of Lanzhou's desperate attempts to create space for urban development. [Fig. 5.15] Such disruptive interventions can be seen as expressions of a culture that is characterized by a strong dualist divide between human and extra-human nature. The territorialization of an entire world region, as in the case of the Hexi Corridor over the past seven decades or, on a more local scale, in the case of Lanzhou New Area over the past years, follows similar patterns of spatial production. They require a socio-political system informed by such a human-nature divide and driven by strong ambi-

86 Shapiro, *Mao's War Against Nature*. For the remarkable rhetoric on the Three Gorges Dam as a symbol of the conquest of nature, see 102–105; for Jiang's reference to the *Foolish Old Man*, see 205.

tions of material extraction, industrial production, urbanization, and economic growth.

In projects of rapid development, such as Lanzhou New Area, three attributes are particularly striking: First, seemingly best practices are implemented according to a blueprint masterplan with very little attention to the specific, local characteristics, leading to a standardized spatial expression as in the form of roads and buildings. Second, the complex and sensitive cycles of the underlying socio-environmental formation—the inner logic of an ecological system that has been co-produced by cycles of human and extra-human nature—are, to a large extent, not only ignored but dismantled and erased: Water is imported across natural boundaries of watersheds, mountaintops are leveled, ravines are filled in, cultivated lands and farming settlements are bulldozed, peasant families are displaced and relocated. Third, the project is not developed as a gradual process of slow but steady growth. Instead, in many regards, the final vision of the full-grown city across over eight hundred square kilometers is taken as a starting point: all the land is cleared and leveled before there is demand, infrastructures are dimensioned according to bloated population estimates, civic infrastructures are built for an ideal but highly uncertain future scenario.

***

In the most recent phase of the Hexi Corridor's history of territorialization, the region has been integrated into strategies encompassing much larger scales and magnitude. China's development is no longer about growing individual cities of intensive industrial production or remote places of resource extraction necessary to sustain these urban centers. Instead, national development is perceived as territorial city clusters connected through productive belts of massive infrastructures and dynamic socio-economic activity. With growing ambitions to establish China as a leading power of prosperity, geopolitical strength, and autonomy, domestic development plans are connected to a global network of nodes, belts, and roads; ports, trading corridors, and shipping routes.

This expansion across continental boundaries has far-reaching consequences for local ecosystems, natural resources, and communities. Lanzhou New Area is presented as a case of rapid development in a strategic location as part of such territorial planning strategies. Its modes of construction and administration happen along patterns of the socio-political apparatus these strategies derive from. In many cases, the translation of abstract planning strategies into spatial interventions that are reshaping the ground is informed by a strong human-nature divide and a misconception and neglect of specific local conditions, preventing place-sensitive and sustainable solutions.

6. Green Growth and Territorial Restoration

Paradoxes Between Economic Development and Environmental Limitations

The Hexi Corridor region has been described over the last chapters in a broad, interdisciplinary narrative: a dense reading of its long history of socio-environmental co-production, as well as changing cultural, political, and economic forces of modern China's nation-building over the past seven decades. This revealed some of the complex socio-environmental processes that have led to the specific conditions that can be observed today. Driven by aspirations for urban-economic growth, particularly since the late 1970s, this socio-environmental development has radically transformed society and caused tremendous ecological degradation.

In recent years, following other nations and multilateral organizations that began to discuss environmental issues more prominently, China's central government has introduced shifts in its political rhetoric and prioritization. While the previous chapters have described what has led to today's situation, this chapter discusses contemporary China's reactions and attitudes to addressing its environmental challenges. The heavily degraded and sensitive Hexi Corridor serves again as a specific case study within China's unique socio-political organization. However, in the age of the Anthropocene that forms the overarching planetary context for this thesis, the case demonstrates challenges many other world regions need to grapple with, as well as conflictive potential responses in the form of policies and technological and spatial interventions.

Environmental Challenges of Growing Magnitude

The story of China's impressive economic growth and modernization since the late 1970s has been told numerous times: hundreds of millions of people were lifted out of poverty as China has grown to a global superpower. However, as this thesis shows, this success story of tremendous development came at a very high price for people and the environment. As China embarked on a rapid transformation process with radical reforms in the post-Mao period, economic growth became the ultimate incentive. As discussed, territorial urbanization served as an effective catalyst to foster growth across all administrative levels. In this hasty process of rapid growth, local governments established a culture of polluting first and cleaning up later. Consequently, the loss of land due to urbanization, pollution, and degradation and the depletion of natural resources and biodiversity accelerated heavily. Water resources across the country have

deteriorated dramatically since the 1980s.[1] Chinese citizens began to suffer from tremendous air pollution, leading to respiratory diseases, such as in the case of Lanzhou, which, as mentioned in chapter four, became one of the cities with the worst air quality in the 2000s.[2] The country has seen dramatic rates of arable land loss with severe consequences for the nation's food security.[3] Landscape fragmentation has been another major issue, leading to dramatic biodiversity losses.[4] While the territorial degradation of natural resources has harmful consequences for the health and livelihood of Chinese people, it also began to have increasingly negative effects on economic production. Degraded environments directly affect China's economic productivity, cause enormous costs, and harm the nation's reputation.[5] In addition, issues related to environmental pollution became the main cause of public protests in the country.[6]

The nation's appetite for energy and raw material commodities to sustain its growth of an increasingly developed, prosperous society has surged tremendously.[7] Of course, China cannot supply this resource demand domestically but depends on a planetary network connecting territories of extraction, production, logistic infrastructures, transportation, and military control. With its large population of 1.4 billion, China has long arrived as a significant player in the Anthropocene. It is a decisive factor in how the world is "used" today and how the Earth System is being transformed. As China has become *the* major force behind many of the world's socio-environmental challenges, such as climatic change, ozone depletion, biodiversity loss, and world food security, Judith Shapiro pointed out, already more than twenty years ago, that no real solution to these global problems is possible without the involvement of China.[8]

---

1 In 2016, the Ministry of Water Resources estimated that eighty percent of all groundwater in China's major river basins was unsafe for human contact, with nearly half of the wells tested being contaminated at the highest grade. Jing Li, "80 Per Cent of Groundwater in China's Major River Basins Is Unsafe for Humans, Study Reveals," *South China Morning Post*, April 11, 2016, sec. News.

2 Zhang et al., "Air Quality in Lanzhou, a Major Industrial City in China."

3 Christina Larson, "Losing Arable Land, China Faces Stark Choice: Adapt or Go Hungry," *Science* 339, no. 6120 (February 8, 2013): 644–45; Kaifang Shi et al., "Urban Expansion and Agricultural Land Loss in China: A Multiscale Perspective," *Sustainability* 8, no. 8 (August 11, 2016): 1–16; Shuping Niu et al., "Farming the World: China's Epic Race to Avoid a Food Crisis," *Bloomberg News*, May 22, 2017.

4 Jiajia Liu et al., "Forest Fragmentation in China and Its Effect on Biodiversity," *Biological Reviews* 94, no. 5 (2019): 1636–57; Taian Li et al., "Fragmentation of China's Landscape by Roads and Urban Areas," *Landscape Ecology* 25, no. 6 (July 1, 2010): 839–53.

5 Economy, *The Third Revolution*, 158–60.

6 "Chinese Anger Over Pollution Becomes Main Cause of Social Unrest," *Bloomberg News*, March 6, 2013.

7 For example, during 2016–2017, China's industries consumed 59% of the world's total supply of cement, 56% of nickel, 50% of coal, 50% of copper, 50% of steel, and 47% of aluminum. Meanwhile, Chinese citizens consumed 47% of the world's pork, 31% of rice, and 23% of corn. Jeff Desjardins, "China's Staggering Demand for Commodities," Visual Capitalist, March 2, 2018.

8 Shapiro, *Mao's War Against Nature*, xi.

While economic growth has been propagated as the ultimate goal across China's administrative hierarchy for decades, given the tremendous environmental problems the country is facing, the central government has shifted the political discourse in recent years, much more vocally emphasizing environmental priorities and ecological stability. As outlined in the introduction, the paradox between economic growth and environmental stability is at the core of the thesis' research framework. In the following, the chapter presents some of China's strategies that aim to navigate between these two conflictive ambitions of sustaining growth while protecting and restoring natural resources. With the Hexi Corridor providing specific cases, the second half of the chapter contextualizes and critically discusses territorial projects of "green growth" and environmental restoration. They unfold in an often controversial manner and contradict the values that the Landscape Approach has set out in many regards.

Shifting Political Narratives Towards an Ecological Civilization

Attempts to shift society into ostensibly sustainable futures while continuing to expand the economy and built environment are not unique to China. This chapter is also not meant as a mere critique of China's ambitions to shift policies toward "green" development. In fact, many of the intentions defined in the latest Five-Year Plan send positive and progressive signs, such as a departure from modes of development that are purely fixated on GDP growth and, instead, are more strongly concerned with public health and environmental stability. However, a narrative that directly couples environmental protection with the nation's rapid economic growth and prosperity seems contradictory.

The Hexi Corridor is today an environmentally highly degraded region. Simultaneously, it is home to many communities that lag far behind in basic development, human capital, public health, and economic income. China's unique socio-political organization and the Hexi Corridor's interesting geographic position within that offer a productive context to discuss the conflictive relationship between ambitions for economic growth vis-à-vis a sensitive environment with fundamental limitations—a paradox many other nations grapple with as well. In 2007, during the most rapid development period under Hu Jintao's leadership, "ecological civilization" became an explicit goal of the Chinese Communist Party, eventually written into the PRC's constitution in 2018. It is a popular concept among China's state apparatus as it nicely fits in the Marxist historical narrative of society that is undergoing several stages of development: transforming from an agrarian to an industrial civilization under Mao, to a material civilization under Deng, and finally to an ecological civilization, culminating in the propagated Chinese Dream of a great rejuvenation as

a leading global superpower.[9] Fitting in this timeline of a nation on its way to reaching a stage of full, superior development by 2049, China promised in 2014 to reach its peak carbon emissions by 2030, and in 2020, pledged to achieve carbon neutrality by 2060.[10]

The dilemma between stimulating growth and protecting life-essential but increasingly depleted natural resources became more prominent around the beginning of the current leadership of Xi Jinping in the early 2010s. This derived not only from domestic concerns but also from the international scientific and political discourse that shifted more strongly to environmental concerns. Several policies were introduced in China to curb environmental destruction: In 2013, a new system for the assessment of cadres was institutionalized, evaluating local officials no longer almost exclusively based on economic performance and GDP growth but also on how effectively environmental protection was advanced.[11] The same year, former Premier Li Keqiang called for a "war on pollution," noting that the environment had sent a "red light warning" against the country's economic development model.[12] The "Ecological Red Lines" policy was formally implemented in 2015 to protect natural resources nationwide from destruction in certain zones.[13] To tackle global environmental threats effectively, the environmental ministry was reorganized in 2018 and installed directly under the State Council. This reform brought more responsibilities and empowerment for government bodies concerned with protecting natural resources and introduced a series of experimental policy reforms.[14]

Political Centralization and Authoritarian Environmentalism

What is notable in China's authoritarian system of governance is that the political priority shifts toward environmental protection were accompanied by a

9 Yifei Li and Judith Shapiro, *China Goes Green: Coercive Environmentalism for a Troubled Planet* (Cambridge, UK; Medford, MA: Polity, 2020), 6.

10 Steven Lee Myers, "China's Pledge to Be Carbon Neutral by 2060: What It Means," *The New York Times*, September 23, 2020, sec. World.

11 Susanne Weigelin-Schwiedrzik, "Doing Things With Numbers: Chinese Approaches to the Anthropocene," *International Communication of Chinese Culture* 5, no. 1 (May 1, 2018): 17–37.

12 Economy, *The Third Revolution*, 162.

13 Initiated by the State Council in 2010, the Ministry of Environmental Protection formally implemented the "Ecological Red Lines" in 2015, aiming to protect the environment from intensified resource exploitation and enforcing strict protection over certain zones nationwide by 2020. Yang Bai et al., "New Ecological Redline Policy (ERP) to Secure Ecosystem Services in China," *Land Use Policy* 55 (September 1, 2016): 348–51. In 2014, the rapid rates of land loss and urban expansion were curbed with "Land Saving and Intensive Utilization Rules" implemented by the Ministry of Land and Resources, aiming for fixed development targets and slower growth rates. Yansui Liu, Jintao Li, and Yuanyuan Yang, "Strategic Adjustment of Land Use Policy Under the Economic Transformation," *Land Use Policy* 74 (May 1, 2018): 5–14.

14 Li and Shapiro, *China Goes Green*, 2.

stronger centralization of political power and homogenization. China's central state aims to control environmentalist efforts, which resulted in top-down governmental tools with the ostensible goal of environmental protection. Despite earnest environmental concerns, the control of the public society remains the central state's primary concern. Mistrust and fear from public participation, civil society organizations, or democratic processes do not spare public efforts for environmental protection. Therefore, China's environmental movement can be understood as—what Li and Shapiro call—an "authoritarian" or "coercive environmentalism." It includes political campaigns as a means of "green control" of society, surveillance, crackdowns of undesired institutions, the "green grabbing" of resources, land dispossession, or relocation of communities under a supposedly environmental framework. The authors argue that under such an authoritarian regime, and despite widespread awareness of environmental challenges, robust environmental action through individual and grassroots citizen action is unlikely to evolve.[15]

Target-Setting and Scientific Engineering Solutions

In this effort to execute efficient measures to protect the environment without giving up political control, Chinese governments turned to an approach of target-setting. Targets have proven to be an effective tool to govern through a centralized system. The PRC, with its Five-Year Plans of a planned economy, has always operated with this technique—in many cases with negative consequences, such as during Maoist campaigns, as discussed in chapter four. Since nature restoration emerged in China as a critical concern on the political agenda in the 1990s, the familiar target-setting tool was also applied to achieve environmental goals. In the context of China's hierarchical state bureaucracy that is dominated by cadres with backgrounds in engineering and science, environmental problems are believed to belong within the purview of engineers and scientists. Cadres are evaluated and promoted according to various metrics in favor of "scientific" approaches and quantifiable, data-based assessments.[16] The concept of a Green GDP (or Gross Ecosystem Product) quantifies GDP growth by including the value of ecosystem services in a monetary metric.[17]

15 Ibid., 203–04.

16 Ibid., 56–65.

17 Based on a National Ecosystem Assessment published in 2015, Ouyang et al. have developed a Gross Ecosystem Product that summarizes the value of ecosystem services in a single monetary metric. While this holistic, spatially explicit quantification of ecosystem services—including values for production, health, retention, restoration, and risk prevention—is very complex, the GEP provides one overall monetary measure to quantify the contribution of ecosystem flows for society. The GEP can help decision-makers to evaluate and plan investments. The model is at an early stage of development but is actively worked on by Chinese governments at different levels. Zhiyun Ouyang et al., "Using Gross Ecosystem Product (GEP) to Value Nature in Decision Making," *Proceedings of the National Academy of Sciences* 117, no. 25 (June 23, 2020): 14593–601. While China has experimented with the concept of Green GDP since

This focus on "green" targets resulted in incentives to reach quantifiable targets such as air, water, or soil quality. This practice influences environmental protection and restoration projects, as discussed later in this chapter: In the case of territorial restoration initiatives, the top-down approach concerned with scaling up measures to reach quantifiable targets has often been counterproductive and even exacerbated environmental devastation.

Changing the Forces of Weather

China's technocratically oriented governmental bodies seem to be receptive to the engineering of ecosystems, actively working against the forces of nature. To illustrate this ecomodernist culture, an ongoing weather-making project serves as a particularly strong example. It seeks to alter natural cycles across the Tibetan Plateau to enforce certain desired rainfall patterns. With its glaciers and vast amounts of water runoff, the Tibetan Plateau was introduced earlier in this thesis as the lifeblood of the Hexi Corridor and the origin of several major river systems in China. Asia's largest freshwater reserve is, therefore, vital for all of China. As mentioned, the high-altitudinal region has experienced an unusually strong melting of glaciers in recent years, reducing the water availability for millions of people further downstream. Across the Tibetan Plateau, including the Qilian Mountains and Hexi Corridor, a spectacular project has thus begun implementing technology at massive scales with the vision of modifying weather patterns across an entire world region. In a tremendous undertaking already proposed in 2016, tens of thousands of fuel-burning chambers are being installed across the Tibetan Plateau. They burn solid fuel to produce silver iodide particles, which winds lift into the clouds where they are supposed to generate rainfall—so the theory goes.[18] This geoengineering project applies cloud-seeding technology at an unprecedented scale. It stands in a long legacy of Chinese plans of environment-making, from Maoist campaigns to contemporary projects such as the South-to-North Water Transfer Project. It can be read as a stark expression of an anthropogenic world.

Green Growth "With Chinese Characteristics for a New Era"

In recent years, China has made enormous efforts to change its reputation from the world's biggest polluter to a champion in mitigating global environmental crises, particularly emphasizing the "green" technology industry. China has

---

the late 1970s and has slowly implemented it as pilot projects in certain places, it seems to have not fully taken off. Weigelin-Schwiedrzik, "Doing Things with Numbers."

18 The cutting-edge project is being developed by the state as a highly sensitive matter, using military rocket engine technology. In addition, the project uses planes, drones, and artillery and is monitored by satellites. Stephen Chen, "China's Building a Rain-Making Network Three Times the Size of Spain," *South China Morning Post*, March 26, 2018; Jingna Ma and Yimeng Zhao, "Rain-Making Drone Takes Maiden Flight," *China Daily*, January 8, 2021.

grown to the dominating power of the solar panel supply chain,[19] has become, by far, the leading nation in the production of wind energy,[20] and has become, fueled by generous government support, the world's largest manufacturer and buyer of electric vehicles.[21] In October 2021, the United Nations Biodiversity Conference was held in Kunming, Yunnan. The final declaration titled "Ecological Civilization: Building a Shared Future for All Life on Earth" listed laudable ambitions around "living in harmony with nature," including the need for "integrated action" and "ecosystem-based approaches."[22] At the same conference, Xi Jinping presented plans for massive investments into renewable energies, including the construction of the world's largest solar and wind farms.[23] Hence, China's approach to living in harmony with nature is built upon large-scale technological solutions. If China wants to reach its ambitious targets of carbon neutrality—which requires a shift away from coal as, by far, the biggest energy source today[24]—technological solutions are essential. And to be fair, China simultaneously set other goals of non-technological solutions and committed to massive financial investments in measures such as large-scale land protection.[25] However, a closer look at the Fourteenth Five-Year Plan from 2021 clearly shows that top-down measures and technological solutions dominate the agenda.

19 In 2021, China controlled 84% of the global solar panel manufacturing market with at least 75% for every component necessary for production, dwarfing all other producing nations and significantly helping to lower production costs as the world's leading exporter. Niccolo Conte, "Visualizing China's Dominance in the Solar Panel Supply Chain," Visual Capitalist, August 30, 2022.

20 In 2021, China produced almost 40% of the world's total wind energy. IRENA et al., "Renewable Energy Statistics 2022" (Abu Dhabi: IRENA, The International Renewable Energy Agency, 2022).

21 Christian Shepherd and Lyric Li, "Cutthroat Competition, State Support Power China's Electric Car Revolution," *The Washington Post*, December 25, 2022.

22 Conference of the Parties to the Convention on Biological Diversity, "Kunming Declaration: 'Ecological Civilization: Building a Shared Future for All Life on Earth'" (Kunming: UN Environmental Programme, October 13, 2021).

23 The solar and wind energy project was announced to be expanded to reach a capacity of 400 gigawatts: one single project with a renewable energy capacity of almost twice the United States' currently installed total and almost 70% of Europe's. Very few details have been revealed about the project, and its feasibility to be realized remains unclear. "China Announces Largest Renewable Project Ever," *Mr. Sustainability* (blog), October 18, 2021. In reality, and as observed in the Hexi Corridor, it is presumably intended as many, much smaller projects with multiple stakeholders involved rather than one giant undertaking.

24 The share of energy from coal sources is decreasing but still amounts to over 50% of the total consumption. Hannah Ritchie and Max Roser, "China: Energy Country Profile," *Our World in Data*, October 27, 2022

25 For instance, Xi announced a fund to protect biodiversity worldwide and promoted China's national park system, covering nearly 30% of the terrestrial area. Jun Mai and Echo Xie, "COP15: China's Xi Pledges US$232m for New Fund to Protect Biodiversity," *South China Morning Post*, October 12, 2021, sec. News.

It defines a roadmap on how to grow economic and spatial development at a fast speed while simultaneously shifting to a mode of "green growth" that is environmentally less destructive and allows to target ambitious goals such as decreasing carbon emissions.[26] China's ambition of doubling the national GDP by 2035 remains a prominent goal in the latest Five-Year Plan. The document, therefore, exemplifies the conflicts that nations aiming to transform their society through such "green development" strategies will face in the coming decades, struggling with the paradoxes between economic growth and environmental limitations.

The fourteenth provincial Five-Year Plans were released in early 2021, laying out short-term goals and ambitions for the year 2035. The Five-Year Plan of Gansu—as mentioned, the country's least economically productive province per capita—anticipated many plans regarding environmental protection and renewable energies that were later announced at the Kunming conference to an international audience. In Gansu's roadmap, very little specific information can be found about how to achieve a "green transformation. Yet, there is a strong presence of terms like "large-scale development," "regional growth," "mining resources," and "technology."[27] While industries are supposed to be transformed and modernized, leading enterprises such as the petrochemical industry and non-ferrous metallurgy should be strengthened, explicitly "increasing the demand for traditional industrial bases," fostering traditional enterprises such as Jiuquan Steel or the Lanzhou Petrochemical companies.[28] Chapter twelve lays out concepts to build a green comprehensive energy base. It focuses strongly on applying "new" technologies, such as photovoltaic, wind, and energy storage facilities. At the same time, investments into coal, oil, and mining areas should be intensified significantly, yet integrated in a "green, clean, and efficient" fashion.[29] What has been discussed in this thesis throughout the previous chapters, providing a geographic paradigm to contextualize the Hexi Corridor case study, also plays out in Gansu's latest Five Year Plan: The controversial eastern-western and urban-rural divides remain ubiquitously present. The vast northwestern regions are turned into strategic zones for harnessing hydropower, wind, and solar energy to fuel the future nation.

The following part of this chapter introduces several dimensions of how space is reorganized and spatially transformed in the Hexi region in response to environmental challenges, including the shift toward green technologies following an agenda of "green growth." It continues the thesis' framework, aiming

26 Asian Development Bank, "Observations and Suggestions: The 14th Five-Year Plan of the People's Republic of China – Fostering High-Quality Development" (Manila, Philippines: Asian Development Bank, 2021).

27 National Development and Reform Commission, "The 14th Five-Year Plan of Gansu Province," 8–10.

28 Ibid., 22–23.

29 Ibid., 28–30.

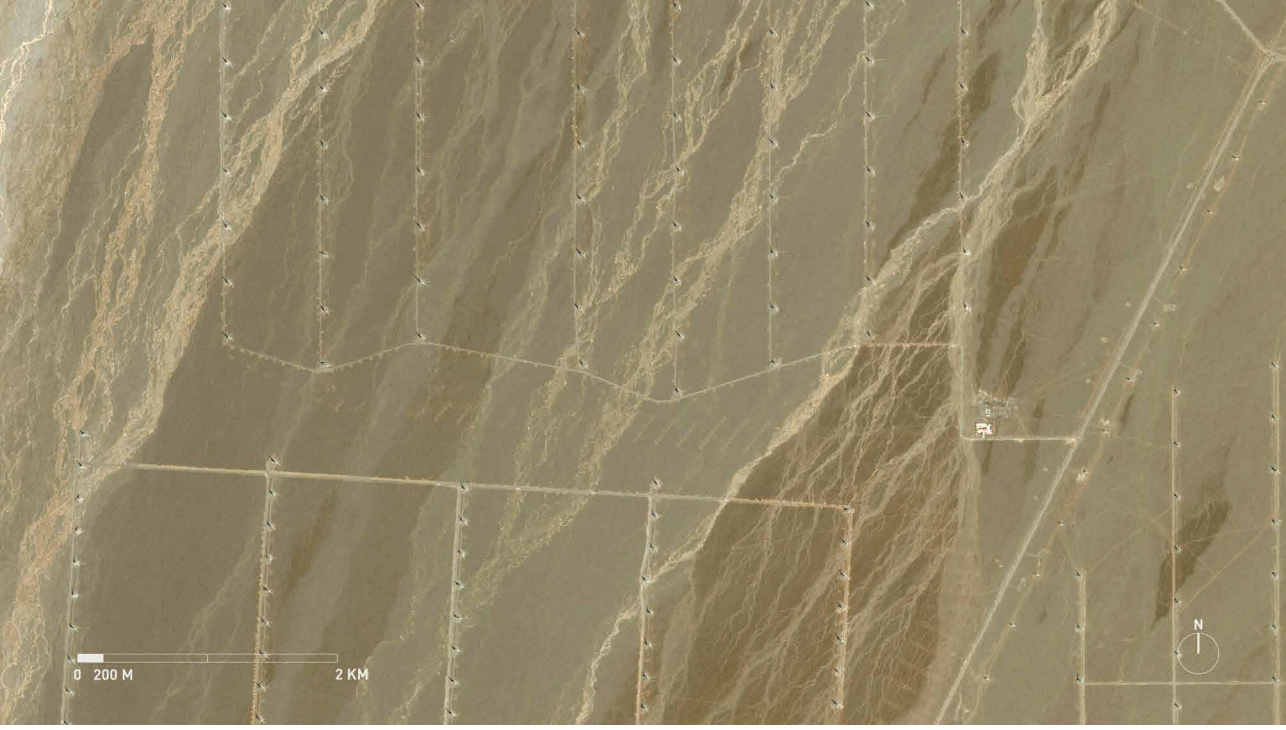


Fig. 6.1: Wind power farms at massive scales create novel landscapes of energy production, carving new traces onto the land in Guazhou County, Jiuquan, 2023.

to illustrate how a specific socio-political organization—or socio-environmental regime—actively produces space. This creates new landscape typologies of energy production, land cultivation, conservation, and restoration, introducing new sets of legal frameworks, spatial practices, aesthetics, ecologies, and socio-economic patterns.

New Landscapes of Energy Production

Guazhou County, Jiuquan

I woke up in the early morning in the dark coach of a sleeper train on the way to the far-western city of Dunhuang at the edge of the Taklamakan Desert. My head felt heavy, hung over from the never-ending drinking games the night before. I had been invited to a garden barbeque party in Wuwei by my local host's family before they had dropped me off at the train station together with my guide. The sky was slowly brightening behind the window shades. As I peeked out, I could see endless rows of wind turbines passing by, forming a dense web of slowly moving giants that stood pitch black before the dawning, dark blue sky. A sea of innumerable small red lights illuminated the top of the poles. I watched this silent spectacle with my forehead pressed against the cold glass window as the train rumbled through the desert.

When I later managed to get out of my bunk bed, the black giants

Fig. 6.2: The over two hundred-meter tall towers of the salt-molten power plant west of Dunhuang remain detached from the city and inaccessible to the public. Still, they can be seen from afar across the area as silent, glowing flagships alluding to a bright future of energy shifts; Dunhuang, October 2019.

had gone. All the shades had been rolled up, and bright light was shining in. A scenery of yellow, flat, and endless desert extended to the horizon on both sides of the train, which seemed to be floating through complete emptiness on its way to the Dunhuang oasis.

Gansu province, and particularly the northwestern parts of the Hexi Corridor, with its vast areas of undeveloped land, arid climate, strong winds, and intense sunshine hours, is among the prime source regions to produce renewable energy. After periods of territorial transformation through the introduction of heavy industries and transportation infrastructures, which included, as discussed, destructive and heavily polluting side effects, the Hexi Corridor became, once more, a prime target for the extraction of resources to supply the dense agglomerations and large economies along the country's southeastern coast.[30] Landscapes of energy production increasingly characterize large areas along the Hexi Corridor in the form of massive-scale wind and solar farms.

30 Chapter 21 in Gansu's 14th Provincial Five-Year Plan discusses how a more robust energy network can be built with a large-scale transmission project to transfer energy across regional grids from Gansu to Hunan, eventually reaching coastal Zhejiang and Shandong provinces. This shows how the Hexi region plays a crucial role as a transportation corridor between China's west and east. Simultaneously, projects for the transportation of coal to Sichuan and Chongqing via railways from coal bases in Mongolia, as well as pipelines for natural gas and refined oil, continue to be promoted. National Development and Reform Commission, "The 14th Five-Year Plan of Gansu Province," 46.

In the northwestern Chinese deserts, billions of dollars have been invested in constructing the world's largest wind power plants over the past years.[31] In the case of New Yumen, the notion of "green growth" is particularly emblematic: The new city was built as a new satellite town to replace the crumbling, old city of Yumen that once stood for China's successful industrialization as the modern center of oil extraction. New Yumen is surrounded by expanding fields of wind turbines and solar panels, fueling the new city with new life and aspirations. On satellite images, these fields of turbines can be seen as endless rows of dots that are evenly lined up along straight maintenance tracks, forming grids extending across square kilometers of grey desert land. [Fig. 6.1]

Solar farms are distributed across the whole Hexi Region, many as comparably small and isolated parks for local supply. But also large clusters with massive investments are growing in different locations, such as south of Jiuquan or further north in Jinta County.[32] West outside of Dunhuang, China's first large-scale molten salt tower thermal power station has been built, creating a giant footprint with over 12,000 mirrors that are arranged in a concentric circle and heat molten salt on top of a 260-meter high tower,[33] shining like a hyper-bright torch or a beacon tower as a new icon that can be seen from afar, everywhere in and around Dunhuang. [Fig. 6.2]

In the massive-scale wind and solar farms along the Hexi Corridor, energy is produced in the seemingly empty desert to be exported to urban agglomerations and industrial production sites elsewhere. Given the region's favorable conditions for producing renewable energy, the two main limitations are the

31 The Jiuquan Wind Power Base consists of several massive energy production sites. It was approved by the government in 2008 and is constantly being extended. One large cluster of turbines is growing along the foothills of the Beishan mountains in Guazhou County, located in the windy northwest of the Hexi Corridor. As mentioned in chapter four, a second major field is located further east, close to New Yumen. Many different agencies and developers participate in constructing and operating these massive wind farms. Reuters, "China Starts Building First 10-GW Mega Wind Farm," *Reuters*, August 8, 2009, sec. Green Business News; Javier C. Hernández, "It Can Power a Small Nation. But This Wind Farm in China Is Mostly Idle," *The New York Times*, January 15, 2017, sec. World; Shengpeng Xu, "The 14th Five-Year Plan for Energy in Gansu Province Has Been Released!," *Seetao*, February 18, 2022.

32 Project design documents published by the United Nations Climate Change, Clean Development Mechanism provide details about the project's size, capacity, funding models, and involved stakeholders, as in the case of the Jinta solar power plant. CDM Executive Board, "Project Design Document Form for CDM Project Activities - Gansu Jinta Solar Power Generation Project" (UN Climate Change, Clean Development Mechanism, December 12, 2012).

33 The power station was completed in 2018. Before completion, a second, smaller plant of the same technology had already started construction next to it. Yiran Zheng and Jingna Ma, "Molten Salt Solar Power Station Largest of Its Kind," *China Daily*, January 8, 2019; Kuei Lang and Conor Salcetti, "The World is Watching! China Builds Its First Hundred-Megawatt Molten Salt Solar Thermal Power Plant," *Advantech*, March 20, 2019; Xinhua, "Super Mirror Power Plant in Gansu, NW China," *XinhuaNet*, March 1, 2021. I was not allowed to access the power stations and watch them up close, nor to fly my drone anywhere in Dunhuang.

transmission grid's capacity and energy storage facilities. Both are constantly being expanded to allow for the distribution of growing amounts of renewable energy across the country. Because of these limitations, many power plants cannot operate at full capacity, and Gansu's renewable energy plants experience huge underutilization rates.[34]

The benefits of these new landscapes of energy production for the local population seem limited. As I flew my drone above a village east of Jiuquan, a villager rushed toward me and my guide to find out what we were doing. While I was trying to capture the fields of solar panels, he told Du Rong that since the solar panels were constructed beyond the village farmlands, across the street and train tracks, no peasants had received direct compensation for the affected land. According to the farmer, the growing solar farm is operated by a non-specified company under the control of the township government rather than the village committee. He said that workers recruited from elsewhere had installed the solar panels without knowing more about their exact number or origin. Even though solar panels mushroomed in a large field right across his village, with several of the high-voltage powerlines crossing above the farmlands, he did not seem to see much of a connection to this new landscape of energy production nor to my questions about land ownership and the operating company. [Fig. 6.3]

Such power plants seem completely detached from their surrounding context, and there must be barely any interaction between the workers on the solar farm and the local peasant communities. I could see no people or activities on any of the growing fields of solar panels. Only a small parking lot with barrack quarters in their center hinted at some form of human presence. While such power plants offer temporary job opportunities during construction and local governments may benefit from tax revenues, once completed, their operation only requires a small number of high-skilled personnel. Seemingly self-operating landscapes of energy production occupy enormous land areas without being rooted in the fabric of the local landscape, creating new aesthetics and identities for the region. Gansu's wind turbines have become iconic symbols of progress and modern innovation in movies and images documenting the Hexi Corridor.[35]

Changing Patterns of Land Cultivation

Similar to the transformation of the energy sector, the modernization of China's agriculture is one of the most complex challenges the country is facing. The

34 Ersheng Pan et al., "The State Grid Corporation of China's Practice and Outlook for Promoting New Energy Development," *Energy Conversion and Economics* 1, no. 2 (2020): 71–80.

35 For instance, the popular, ten-part historical documentary series *Hexi Corridor* prominently shows sceneries of wind turbines in the theme video clip at the beginning and end of each episode. *Hexi Zoulang* 河西走廊 [English title: *Hexi Corridor: China's Wild West*], produced by the CCTV Propaganda Department in collaboration with the Gansu Provincial PRC's Party Committee, first aired in March 2015.

Fig. 6.3: Solar farms mushroom across the Hexi Corridor. A field of solar panels across the train line from a village east of Jiuquan (top) and more isolated fields southeast of Hexi Pu, Jinchang.

Fig. 6.4: The aesthetic of traditional villages and cultures creates strong contrasts to novel landscapes of energy and food production. A village during corn harvest north of Jiuquan, October 2019.

amount of arable land in China is very limited and has been in intense competition with urbanization and land conversion processes in recent decades.[36] Because of the legacy of Maoist land collectivization, rural China is predominantly characterized by traditional forms of cultivation that are, compared to other industrial countries, to a large extent, still organized in plot sizes that are very small, often barely large enough to sustain a household.[37] Given China's tremendous shortage of arable land for domestic food production and its weak agricultural productivity, the central state has pushed for reforms in the agricultural sector, beginning with de-collectivization policies in the post-Mao era. While the population officially employed in agriculture is still very high, accounting for around one-quarter of the country's total, China's small-scale, subsistence household farms have rapidly declined since the 1990s and are being increasingly replaced with large-scale, mechanized operations.[38] In recent years, state media repeatedly announced that China plans to pour hundreds of

36 Sijing Ye et al., "Spatial Pattern of Arable Land-Use Intensity in China," *Land Use Policy* 99 (December 1, 2020): 104845.

37 Niu et al., "Farming the World: China's Epic Race to Avoid a Food Crisis."

38 Fangbin Qiao, "Increasing Wage, Mechanization, and Agriculture Production in China," *China Economic Review* 46 (December 1, 2017): 249–60.

millions of yuan into agricultural infrastructures and subsidies to create new, "modern" farms.[39] In the Hexi Corridor, which offers ideal climatic conditions for agricultural production but faces severe water shortages, a strong focus has been put on technological innovation for more efficient and productive farming processes, mainly through water-saving technologies.[40]

Most areas I visited outside the Hexi Corridor's main cities are dominated by traditional forms of agriculture with high inputs of manual labor, such as for wheat and corn production. [Fig. 6.4] But in recent years, alternative forms of irrigation and land cultivation have been implemented in growing numbers.

Ganzhou District, Zhangye

During my days in Zhangye and Jinchang, I was accompanied by Zhang Xuebin, assistant professor in environmental planning at Northeastern Normal University in Lanzhou. He studies the Hexi Corridor in his work and joined me for a few days of my trip. South of Zhangye, we visited two new greenhouse projects. Greenhouses were introduced in China on a large scale in the early 1980s and can be found throughout the Hexi Corridor as detached structures built from rammed earth and bricks covered with plastic foil.[41] Many modern greenhouse facilities have been built in recent years. On both sites we visited, steel structures had been constructed with high-tech drip-irrigation technology, covering a continuous area and allowing for efficient, large-scale production of vegetables and fruits under ideal conditions. In the first case, in close proximity to the city of Zhangye, it was a relatively small operation with greenhouses built by a village collective in the center of their farmlands. An elderly farmer showed us around the facility. He told us that the greenhouses had been subsidized by the local Zhangye city district government

39 Houkai Wei and Kai Cui, "Agricultural Modernization on Horizon," *China Daily*, March 18, 2021; Xinhua, "China to Invest $450B Modernizing Agriculture by 2020," *China Daily*, September 19, 2016.

40 The economist Liu Bo told me that modern modes of land cultivation, including greenhouses and water-saving technologies, were becoming the most significant potential for local economies in the Hexi Corridor. While such facilities were still expensive, he said they would become more affordable over time and offer farmers profitable business opportunities, especially in combination with land consolidation and larger plot sizes. New investments could also become accessible through the BRI, which might help introduce water-efficient technologies on a large scale to increase land productivity along the region significantly. Lanzhou University, School of Economics, October 15, 2019. Also, more integrated solutions have been introduced, such as improved irrigation management regimes through Water User Associations, allocating water more responsibly, and policy reforms for water protection and rationalization. Xu et al., "The Role of Water Users Associations in Integrated Water Resource Management of Zhangye City in Heihe River Basin, China."

41 Niek Botden et al., *Greenhouse Horticulture in China: Situation & Prospects* (Wageningen: Horticulture Production Chains Group, 2004), 15–18.

as part of a rural development initiative, replacing former corn fields for which the respective farmers had been compensated. The facility was collectively owned and operated by the village, which pays those working in the greenhouse.

The second greenhouse we visited gave a completely different impression: It was a much larger facility located further southeast, covering a large land area. Narrow alleys divided the different sections of greenhouses. As we walked around the muggy fields underneath the plastic covers, we met the director, who was inspecting the operation together with the young manager of the facility. He told us that he was part of a larger group of investors who had leased out uncultivated, deserted land from the local township. He was from a farmer family in southeastern Gansu and had been able to acquire cheap land here. In addition to the initial costs for construction, he said that costs for water and fertilizer would be the main expense. He did not mention the few migrant workers employed to operate the farm. While the investor talked to Zhang Xuebin about the type of vegetables they were growing, I took another walk around the facility. I observed one lone woman working deep inside a vast field of lettuce, bent over, harvesting, wrapped in a raincoat from top to toe, gloves, a camouflage cap, and a scarf around her head, only leaving her eyes uncovered. A male worker drove a three-wheeled truck up and down the alleys to collect the piled vegetables. Outside the facility, in a small grove of poplar trees next to the main road, two tents served as office space and recreation area for the workers. [Fig. 6.5]

Minle County, Zhangye

As we continued our drive further south, we reached an area I had previously noticed on satellite images appearing unfamiliar to me in the context of China: Large, green circles stood out from the bright, sandy background. Center-pivot irrigation—initially invented in the early 1950s in the Midwest of the United States, where it has shaped entire regions of agricultural land—had been introduced for efficient land cultivation. However, in the Hexi Corridor region, this technology remains relatively rare according to satellite images, with only small clusters outside of Zhangye, Jinchang, as well as in Jinta County at the far-northern, hyper-arid end of the Beida River watershed. The site we visited south of Zhangye used the water-efficient technology to cultivate alfalfa as forage for an adjacent dairy farm containing stable barns for several thousand cattle. Such industrial livestock farms are common in many other parts of the world, including parts of China, but seem still rare in the Hexi region. [Fig. 6.6]

Yongchang County, Jinchang

A few days later, we visited a second farm that had introduced center-pivot irrigation technology on the next stop, further east, in Jinchang. Following the large green circles on the navigation app brought us to a remote valley, a short drive along dirt roads off the highway. As we learned from one of the workers, the farm was owned by an entrepreneur from Southern China who had leased the land from the local township. As he was distributing corn cobs across the hard compressed soil for drying, he told us that all the employees working on the farm would come from rural Guangxi and from a village in far-eastern Heilongjiang. They would spend most of the year on the property as seasonal workers, mainly growing corn and sunflowers. He told us that the center-pivot system had not been used in over a year. When I later searched for the latest satellite images of the place in the fall of 2022, the green circles had disappeared while the land was still being cultivated, yet without center pivot irrigation.[42]

In parallel to energy production on massive scales, these examples from my research trip to the region show that the Hexi Corridor is also being transformed through novel forms of land cultivation. As mentioned, China's agriculture is highly inefficient today. Innovations in the agricultural sector are, therefore, vital. Given China's investments in robotics, big data, artificial intelligence, and agricultural technologies, trends point toward land consolidation, forming more extensive and efficient farmlands, and replacing manual labor through mechanization and automation. No doubt, technology in land cultivation and food production offers many advantages. It can help reduce water consumption and the amount of fertilizer, increase land productivity and crop efficiency. Particularly in a water-stressed region like the Hexi Corridor, technological innovations are thus critical to help balance and restore degraded ecosystems. However, changing land use regimes alter the spatial formation of rural Chinese landscapes, including their social and cultural fabric. The relationship of farmers to their land radically changes once farms are organized as large-scale private enterprises that are designed for mass production and belabored by decreasing numbers of workers who tend to be recruited as temporary migrant workers from far-distant places. In addition to such social shifts, like in the case of large-scale renewable energy power plants, rural China's agricultural transformations introduce radically new aesthetics and identities.

42 I was not able to find out why center-pivot irrigation seems to have never taken off in the Hexi Corridor. With its vast, flat land resources, dry climate, high sunshine hours, and solar radiation rates, it seems to provide good conditions. The technology has famously been implemented on large scales in other arid world regions, such as Saudi Arabia or Southern California.

Fig. 6.5: Modern greenhouses with drip irrigation technology introduce different forms of land management and landowner-labor relations, as photographed around Zhangye in October 2019. A: New greenhouses are integrated into a village, owned and farmed collectively, and have replaced cornfields. B: A farmer of the collective in conversation with my guide, Zhang Xuebin, explaining the new facility's irrigation and planting regime in its first year of operation. C & D: A large greenhouse farm on degraded land in a remote location outside of Zhangye, owned by a group of external investors. E: Tents adjacent to the greenhouses serving as office space and recreation area. F: A migrant worker harvesting underneath the plastic roof cover.

Fig. 6.6: New forms of land cultivation through center pivot irrigation. The fields produce alfalfa as forage for a large-scale dairy farm with several thousand cattle.

China's new production landscapes send promising signs but also raise questions: The modernization of the agriculture sector aims to produce more efficiently, save resources, and minimize fertilizer use. In addition, what seems more important for investors is that it saves costs and labor. However, one question is what should happen to China's large yet shrinking rural population once farms are largely automated and renewable energy plants have been built. Two aspects that have been mentioned in chapter four are important to point out again in this socio-economic discussion of this latest phase of transformation along the Hexi Corridor: First, Scott Rozelle's notion of an "invisible China" that provides the majority of China's future workforce but lags far behind in education and public health due to systemic, urban-rural inequalities.[43] And second, Yasheng Huang's observation of rural China's strong entrepreneurial dynamic and potential for innovation through bottom-up and individual-driven initiatives.[44] From these two observations, it seems evident that in the complex and challenging process of rural China's transformation, the central state needs to invest strongly in human capital, trying to balance the stark rural-urban differences. At the same time, rural China's villagers need to be able to keep a sense of private ownership and belonging, as well as the regulatory freedom to drive innovative solutions through bottom-up initiatives that are rooted in a place and community.

Environmental Protection, Conservation, and National Parks

Qilian Mountains

From Zhangye, we drove southeast along the G227 highway. The section between Zhangye and the Qilian Mountains, with its alleys of willow and poplar trees and vast fields of rapeseed that extend on both sides of the highway along the foothills, is known as one of the most scenic routes in China, particularly in the summer months when the rapes are blooming in intense yellow. Our guide and driver for the day was Guo Dong, a researcher at the Chinese Academy of Sciences, based at a research station outside of Zhangye that monitors the ecological transformation of the Qilian Mountains.[45] He drove us first up to the Biandukou Pass, bordering Qinghai province at over 3,600-meter elevation, historically serving as an important link for

43 Rozelle and Hell, *Invisible China*.

44 Huang, *Capitalism with Chinese Characteristics*.

45 Guo Dong monitors snow cover in the Heihe River watershed and researches remote sensing techniques to improve their accuracy. He works at the Heihe Remote Sensing Experimental Research Station, Chinese Academy of Sciences, Zhangye.

Fig. 6.7: Field trip to the Qilian Mountains in October 2019: A: Snow-covered peaks, steep slopes, and rivers on the way to the Biandaku Pass. B: Bare, steep hillsides with marks of slope failure landslides in the core zone of the Qilian Mountain National Park. C: Replanted patches of forests around one of the reservoirs and former hydroelectric power plant. D: Protected grassland and recultivated, dense forest along a riverbed in the core zone of the National Park.

trade and transportation between Zhangye and Qinghai's capital, Xining.

The long, curvy drive through steep mountain valleys followed the water to its source, passing small villages, brown pastures, and wild streams to snow-covered mountain peaks. The sensitive, high-altitude region faces land use conflicts with farmers using the steep mountain slopes for herding. Many of the slopes have been deforested and remain almost bare with little grassy vegetation, rugged by the marks of sheet and gully erosion that have removed the thin soil layers from the bedrock. In some places, forests have been replanted for soil protection, appearing as unnatural, dense patches of monoculture trees with hard, straight edges. As I was told, afforestation across the steep valleys of the Qilian Mountains is also conducted with seed bombs that are dropped from airplanes. In both cases, it is primarily native spruce trees (*Picea crassifolia*) that have been used to regrow a tree cover across the steep flanks to help stabilize the ground.

Later in the day, we drove back from the Hexi plain into a different valley further west. Already at the valley's mouth at the foot of the mountains, we passed a gateway to the Qilian Mountains National Park, established to protect the vital ecosystem services the mountains provide for the whole region, and particularly for the Hexi Corridor. We continued to drive along a tributary of the Heihe River, coming across remote farms and small villages, sometimes stopping to let a herd of sheep cross the road. As we continued to drive up the steep and increasingly narrow road, we arrived at a second checkpoint, located at a sharp turn below the tall dam of a reservoir. This was the gate to the protected core area of the newly established National Park. Guo Dong had to show his credentials, and as we continued driving up the road, he told me once more that I was no longer allowed to use my camera to take photographs. Only cellphone pictures were permitted inside the core zone.

We stopped at the reservoir, filled with clean and high-quality drinking water and protected by green fences. Further up, at the end of an access road, we parked the car next to barren, yellow grasslands, a dry, rocky riverbed, and bare, partially eroded hillsides, of which some were covered with afforested patches of trees. [Fig. 6.7] As I was walking around, I noticed a ranger in camouflage military clothing approaching us. Immediately after our arrival, he must have started walking down from the outpost I could see further uphill. As he came closer, he friendly asked what we were doing and began chatting with our researcher guide. However, this encounter showed how strictly protected the core zone of the Park must be.

The Qilian Mountains National Park was approved by the Central Government and State Council in 2017 as one of ten pilot projects of China's National Park System. [Fig. 6.8] Already in 1988, a smaller and more scattered area had been established as the locally administered Qilian Mountains Nature Reserve. However, despite the urgency of increasing environmental degradation in the late 1980s, its implementation in the following decades was not able to significantly reduce human activities, which continued to grow both inside and outside its boundaries.[46] In the poor Qilian Mountains region of rural Gansu and Qinghai province, a persistent conflict remained between the urge for economic development and local governments' enforcement of environmental protection policies. Logging became an important industry in the 1960s, followed by mining, which continued to operate inside the park until 2018. The abundant water resources in the Qilian Mountains have been used

46 Shicheng Li et al., "Effectiveness of the Qilian Mountain Nature Reserve of China in Reducing Human Impacts," *Land* 11, no. 7 (July 2022): 1071, 6.

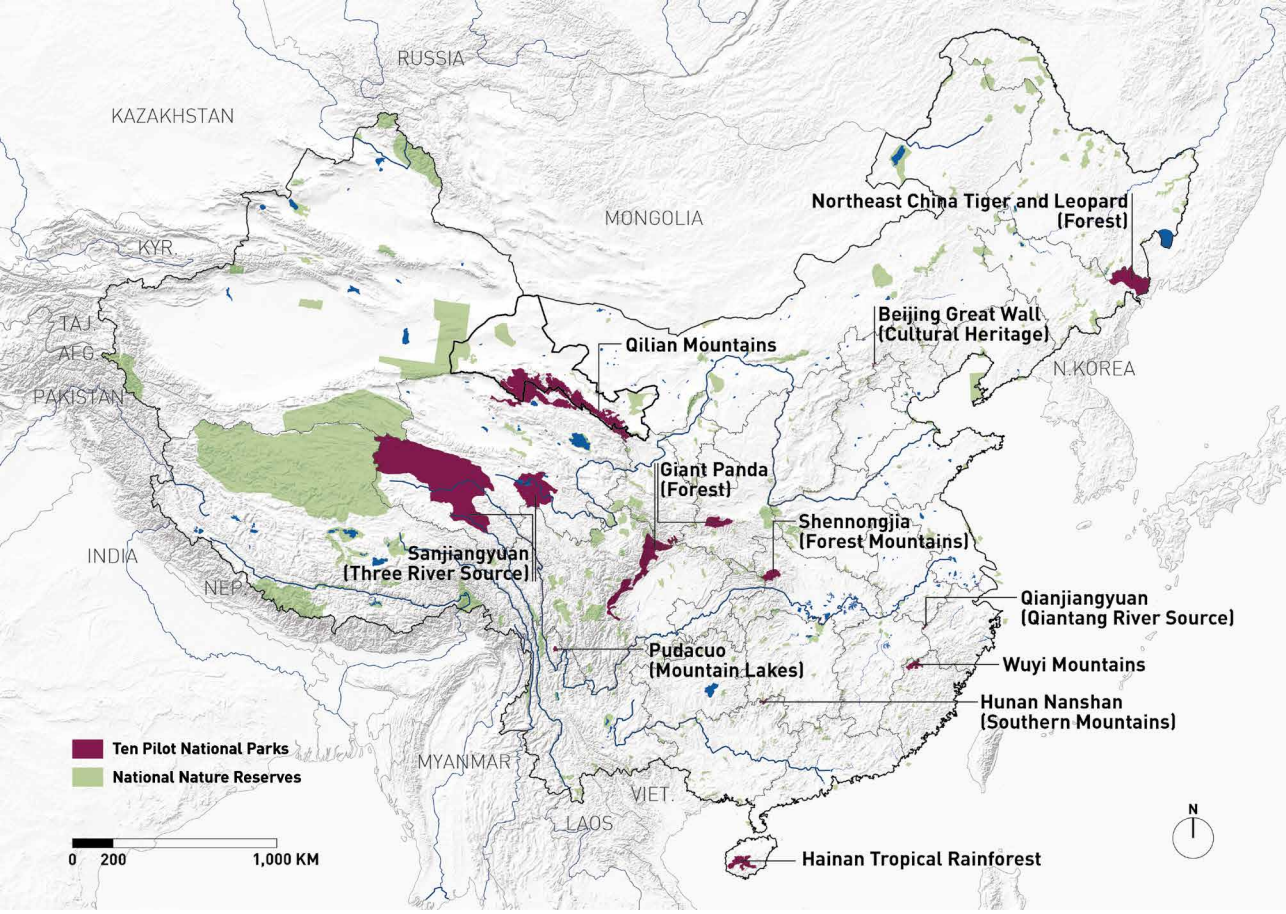


Fig. 6.8: Map showing China's nationally protected areas with the ten National Park pilot projects from 2018. They represent iconic preservation targets and strongly vary in character and size, ranging from the 363,000 km2 large Sangjiangyuan, high up in the Tibetan Plateau, to the 60 km2 small Great Wall National Park, surrounding the busy tourist destination north of Beijing.

for hydroelectricity for many years. Over forty now abandoned power stations are located inside the protected area of the Nature Reserve, previously causing downstream water shortages and environmental harm. Livestock rapidly increased since the 1980s, leading to severe grassland degradation. In addition, the number of cultivated croplands and roads grew across the reserve, and illegal farming and mining activities were widespread.[47]

The Qilian Mountain National Park integrated the territory of the 1988 Nature Reserve and doubled in size, now encompassing an area of 52,000 square kilometers and spanning across the provincial border of Qinghai and Gansu provinces. [Fig. 6.9] Plans for establishing a National Park system derived from increasingly urgent environmental degradation in the 2000s, including dramatic biodiversity loss and a growing public awareness of such issues. In the case of the Qilian Mountain National Park, the objective was to strictly protect land, preventing further vegetation loss. Other issues included the deteriora-

47 Gonghan Sheng et al., "Moving Toward a Greener China: Is China's National Park Pilot Program a Solution?," *Land* 9, no. 12 (December 2020): 489.

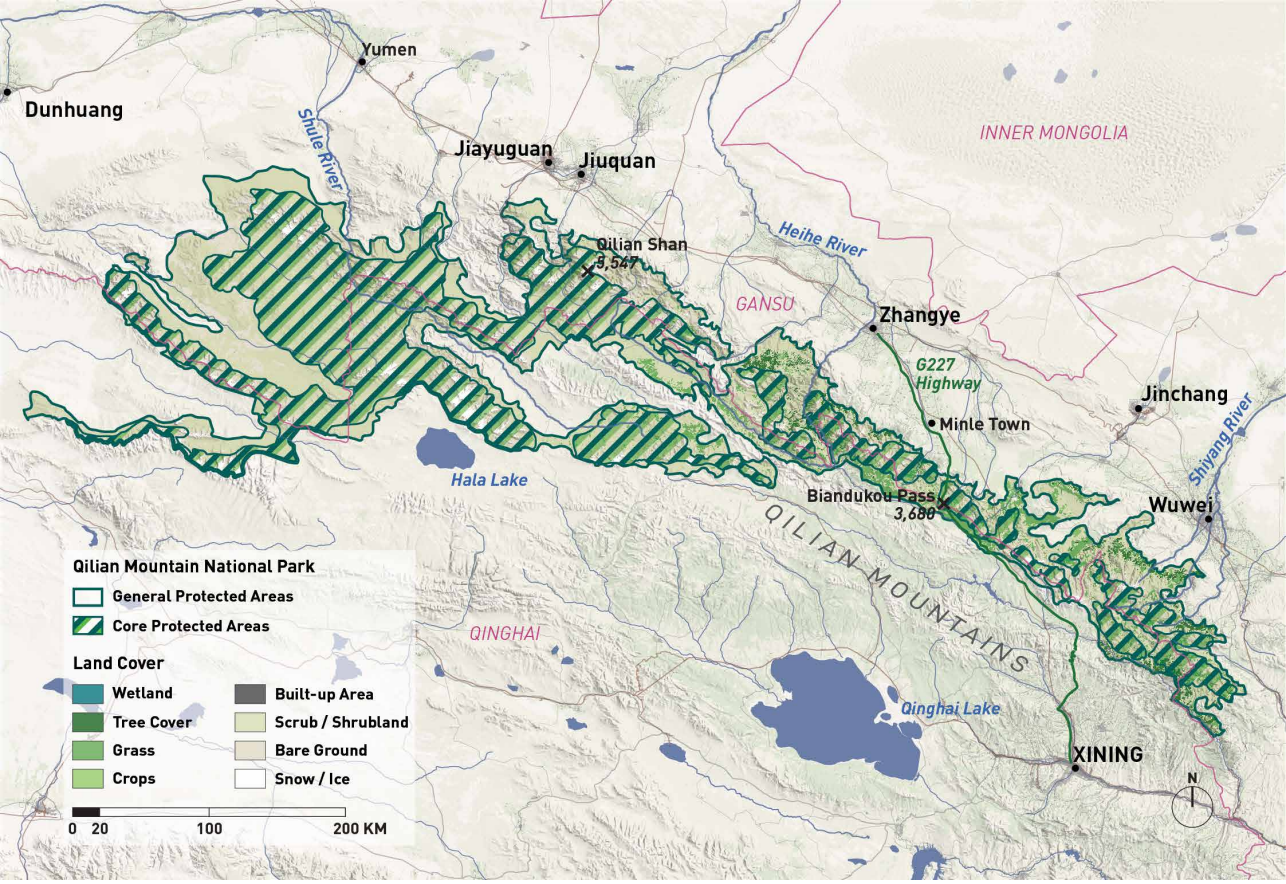


Fig. 6.9: The Qilian Mountains National Park with the boundaries of the surrounding, generally protected mixed-use areas, and the strictly protected core zones. The park stretches almost across the entire Qilian Mountains chain. Vegetation cover is sparse and primarily located in the more humid southeastern part of the park.

tion of water, soil, and vital habitats.[48] Many locally governed protected areas in China turned out to be completely ineffective in protecting natural habitats.[49] The main causes for the ineffective implementation of preservation measures were the divergent interests of the central state, local governments, and communities. In many cases, parks served as drivers for a nature-based tourism and recreation industry, often leading local governments to prioritize these new market opportunities over social and environmental considerations.[50] In addition, the administrative and institutional structure between stakeholders was often uncoordinated, conflictive, and inconsistent. Thus, the central state urged a centralization of governance with standardized management and a strict, top-down enforcement of policies. Plans to establish centrally governed National Parks began to be realized in 2013. Eventually, ten Pilot National Parks were officially established by 2018, building on previous, locally governed Nature Reserves distributed across the country and accounting for a total of three per-

48 Sheng et al., "Moving Toward a Greener China," 8.

49 Guangyu Wang et al., "National Park Development in China: Conservation or Commercialization?," *AMBIO* 41, no. 3 (May 1, 2012): 248.

50 Wang et al., "National Park Development in China," 252–54.

cent of China's land area.[51]

As one of these ten pilot parks, the Qilian Mountains National Park was put under a comprehensive management organization under the direct control of the State Council's National Park Administration (National Forestry and Grassland Administration) and reaching down to provincial and local agencies.[52] The main goal of the newly established park is the protection of the Qilian Mountains as a strategic environmental security barrier and a major water source, sustaining a vast territory with millions of livelihoods. With the centralized National Park system, strict monitoring and protection policies were implemented, mining and hydropower rights were withdrawn, and people living in the park's core zones—considered "ecological migrants"—were relocated.[53] Since the implementation of the Qilian Mountains National Park, communities outside the core zones but inside the park boundaries have adapted in different forms to the new policies.[54]

In addition to the National Park, several other protected areas have been established across the Hexi Corridor region, including natural reserves, national desert, wetland, forest, mining, and geo parks, aiming to improve the region's overall ecological stability. However, at least the two parks I visited outside of Zhangye and Dunhuang have become hotspots of mass tourism. Their contribution to the region's environmental stability seems questionable.[55]

Longer-term improvement trends are significantly affected by changing climate and weather patterns in addition to land protection. Already since 2001, studies have shown that there has been a slow but steady increase in vegetation cover across the area of the Qilian Mountains Nature Reserve. However, most of this vegetation growth has likely been enabled by rising temperatures and precipitation.[56] As Guo Dong told me, their research station has been observ-

51 Xiaoping Tang, "The Establishment of National Park System: A New Milestone for the Field of Nature Conservation in China," *International Journal of Geoheritage and Parks*, China's National Park System, 8, no. 4 (December 1, 2020): 196.

52 Kun Yan and Ying Ding, "The Overview of the Progress of Qilian Mountain National Park System Pilot Area," *International Journal of Geoheritage and Parks*, China's National Park System, 8, no. 4 (December 1, 2020): 211; Tang, "The Establishment of National Park System," 199–200.

53 Yan and Ding, "The Overview of the Progress of Qilian Mountain National Park System Pilot Area," 212–214.

54 Jing Li et al., "Local Residents' Social-Ecological Adaptability of the Qilian Mountain National Park Pilot, Northwestern China," *Land* 11, no. 5 (May 2022): 742.

55 The Zhangye National Geopark is located west of Zhangye. The Mingshashan National Protected Area is located just south of Dunhuang City. These parks are accompanied by a full palette of vast parking lots, restaurants, souvenir shops, and wide roads for tourist buses leading through the park. In the case of Mingshashan, the scenery includes long lines of hundreds of camels offering rides, the constant whirring of helicopter flights, Jeep and motor scooter cruises through the sand dunes, and artificial wetlands with planted grasses as scenic background for photoshoots.

56 Between 1985 and 2019, both the temperature and the precipitation have significantly increased in the region of the former Nature Reserve and today's National Park, which corre-

ing a decreasing snow cover in recent years across the alpine zones of the Heihe River watershed due to rising temperatures, which they explain with effects of global warming.

***

From the literature on preservation measures regarding China's National Park system, it seems to be critical that the parks operate simultaneously top-down, through overseeing and coordinating agencies, and bottom-up, informed by the specific place: Strict control mechanisms that enforce stakeholders to adhere to protection policies and resist the temptation of short-term revenue gains are equally crucial as productive relationships that are built with local communities, benefitting from their deep knowledge and expertise of local conditions, and engaging them as stewards of natural resources in the processes of management and maintenance of the protected land.[57] However, an assessment of how the National Park policy frameworks have been set up in China's top-down, hierarchical—or, as Li and Shapiro would say, authoritarian—governance system identified only limited space for bottom-up approaches in the park management. The integration of non-governmental organizations cannot lead to truly participatory and inclusive modes of land conservation. Instead, the new policies reaffirm the trend of China's increasing withdrawal from such practices and a stronger concern with political centralization, leaving very little room for public participation in the planning and management process and likely leading to adverse effects on conservation goals.[58]

Projects of Territorial Land Restoration

Ant Forest

The bright waiting room of the Jinchang train station was flooded with light, reflecting on the white, shiny floor. Zhang Xuebin and I were over an hour early for our train back to Lanzhou. The large hall under the high ceilings of Jinchang station, located in the industrial satellite Hexi Pu, around twenty kilometers southwest of the city, was unusually empty on that Sunday afternoon. While we were sitting on the long rows of chairs, Zhang Xuebin was typing on his phone. As he would do several times a day, he checked on the status of his Ant Forest app. He told me it was the first thing he would do every morning. He enjoyed harvesting the green energy points that helped him

lates with the effects of global warming. Xiang Gao et al., "Vegetation Responses to Climate Change in the Qilian Mountain Nature Reserve, Northwest China," *Global Ecology and Conservation* 28 (August 1, 2021): e01698, 5–9.

57 Sheng et al., "Moving Toward a Greener China," 14–18.

58 Ju-Han Zoe Wang, "National Parks in China: Parks for People or for the Nation?," *Land Use Policy* 81 (February 1, 2019): 825–33.

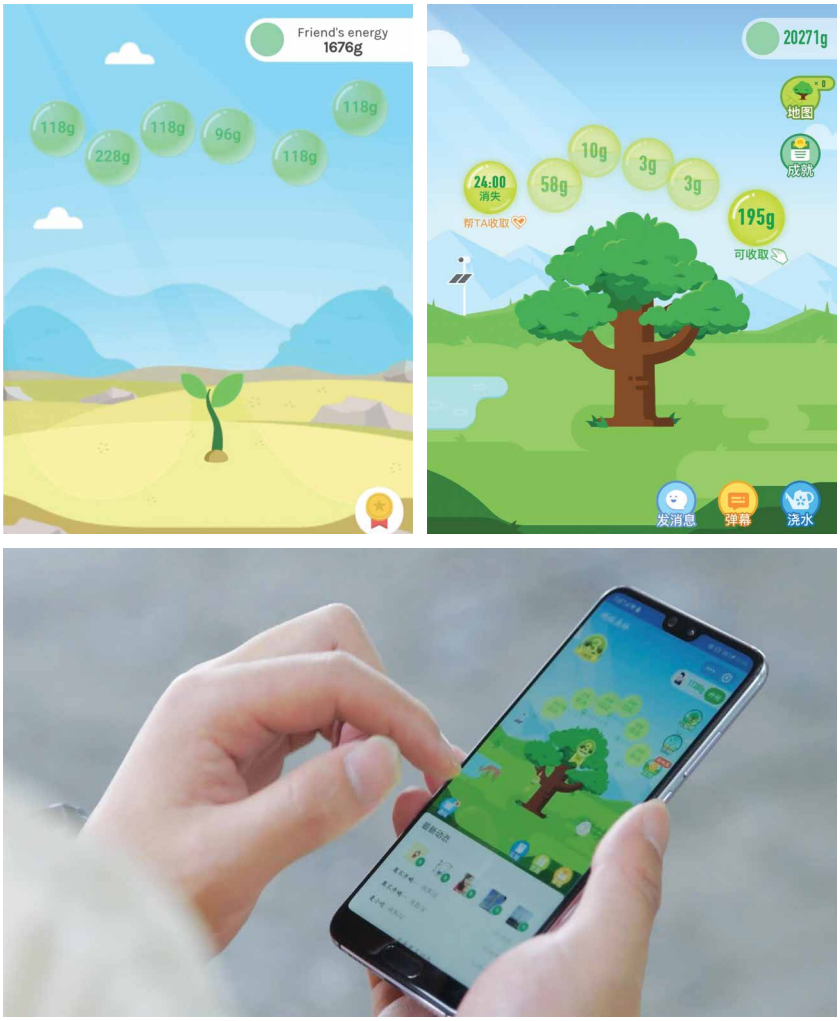


Fig. 6.10: The Ant Forest app allows Alipay users to virtually plant trees and turn deserts into forests by harvesting credit points earned through the consumption of selected services with electronic payment.

grow virtual trees, adding leaves and branches each time he would achieve a certain threshold. He told me his ambition was to raise his trees large and strong, enjoying the reward of watching his little grove expand overtime on the lush, green lawn with high peaked mountain tops and a bright blue sky in the background. [Fig. 6.10]

Ant Forest is a program launched in 2016 and built into Alipay, a so-called super app. Alipay combines everyday cellphone payments and bank account management with dozens of lifestyle services such as online shopping, food

orders, insurance selections, or car hires. Ant Forest has been developed by Ant Group, an affiliate of the giant conglomerate Alibaba. Its goal is to encourage Alipay users to engage in activities and consume services with low-carbon emissions, tracking their everyday behavior and payments for products and services provided by Ant Forest's brand partners. Green energy points reward the bus ride, the vegetarian meal without plastic packaging, or the paperless bill payment as opposed to more carbon-intensive alternatives. And these green energy points can then be used to grow virtual trees in the app. What is visualized as virtual trees in the Ant Forest interface is promised to become reality, transforming the supposedly avoided emissions of Ant Forest's over 600 million users into physical trees. This is done through afforestation projects in deserted regions of China's northwest, including Gansu, Inner Mongolia, Qinghai, and Shanxi, sponsored by Alibaba's Ant Group and its philanthropic NGO partners. By August 2021, the planting of more than 326 million trees had been financed this way.[59] As Ant Forest has been very popular among its users, environmental projects were expanded to land conservation and coastal ecosystem restoration programs.[60]

Ant Forest has been highly successful and claims to have achieved goals such as reducing carbon emissions. The company was recognized as a *Champion of the Earth* by the United Nations Environment Programme for its innovations towards reaching the UN's Sustainable Development Goals. It also claims to have changed consumer behavior, encouraged greener lifestyles, and evoked the powerful capabilities of technology to tackle global environmental crises.[61] Generally, there is nothing wrong with attempts to sensitize consumers to environmental issues and encourage people to help address them. The importance of the individual should not be underestimated in the urgent matter of global environmental crises. Maybe the everyday tools of the cellphone and mobile payment apps and the playful virtual interface of an app like Ant Forest are indeed effective media to do so. However, there are certain dimensions of such an approach that seem highly contradictory and potentially even counterproductive:

Most of the Ant Forest users who engage in the virtual plantation of trees have never been in one of the remote areas where the actual trees are planted. Mentally and spatially, they are completely detached from the places, specific conditions, and life realities immediately affected by land degradation, water shortage, droughts, and sandstorms. This mental detachment reinforces the uneven conditions of a mostly urban, developed part of the country that is sustained by resources and energy from its distant, rural interior. In the Ant For-

59 Business Wire, "Over 600 Million People Planted More Than 326 Million Trees via Alipay Ant Forest in Five Years," *Business Wire*, August 25, 2021.

60 Business Wire, "Over 600 Million People Planted More Than 326 Million Trees."

61 UN Environment Programme, "Chinese Initiative Ant Forest Wins UN Champions of the Earth Award," UN Environment, September 19, 2019.

est's narrative, such remote, seemingly empty, deserted regions now serve as the realm to solve abstract environmental problems that, as the app users are told, will threaten humanity. This manifests the notion of an externalization of problems and their burdensome mitigation. The app presumably allows to tackle the evil of a degraded world through the cheerful activity of engaging with Ant Forest, which directly rewards consumer decisions with the indulgence of moral points. Among the Ant Forest partners participating in the project's carbon offset programs are famous global luxury brands and companies that do not seem to have integrated environmental ambitions in their mass-produced, disposable products. Nevertheless, they have committed to offset their carbon emissions, thereby acquitting themselves of the environmental harm they cause. Meanwhile, the millions of planted trees create monocultural landscapes across massive scales in some remote, dusty locations, resembling the sceneries of industrial parks for energy production with its unnumerable wind turbines and solar panels. These novel, industrial landscapes presumably allow to achieve restoration goals not through abstinence or constraints but through the consumption of services, modern lifestyles, and "green growth."

Monoculture Forests as a Green Great Wall

As described in chapter two, deforestation on a massive scale has characterized China's history over millennia.[62] Particularly in highly vulnerable environments, land degradation began to increasingly threaten China's stable growth and development as a nation. While the Qilian Mountains National Park is an attempt to protect and conserve vital habitats and freshwater reserves at the watershed's source, large-scale land afforestation projects focus on the heavily degraded land at their end.

Three Norths Shelter Forest Program

Already in the 1950s, and in a more intensified fashion starting in the 1960s, plantations of forest shelterbelts in deserted areas began to be planted. However, these early attempts had limited impacts due to a lack of a scientific understanding of the complex local conditions and the larger ecological context. In 1978, in parallel with newly defined policies for economic reforms and market opening aiming to stimulate national economic growth, the Chinese central government decided to start a tremendous, coordinated afforestation project called the Three Norths Shelter Forest Program TNSFP (三北防护林

62 Assessing forest loss in areas with at least 50% tree cover, it is estimated that around 59–67% of Chinese forests have been lost historically. The loss of natural forest habitats is even much higher as about one-third of today's tree cover in China are plantations. Of course, intensive deforestation has happened in other world regions as well. Scholars estimate that 42–51% of the total planetary forest tree cover has historically been lost. Antje Ahrends et al., "China's Fight to Halt Tree Cover Loss," *Proceedings of the Royal Society B: Biological Sciences* 284, no. 1854 (May 3, 2017): 3–7.

Fig. 6.11: Map of the Three North Shelter Forest Program spanning thirteen provinces in Northern China, including the national central cities of Beijing and Tianjin.

工程 *Sanbei Fanghulin Gongcheng*). The initiative spans all of northern China's thirteen provinces, including the province-level municipalities of Beijing and Tianjin. [Fig. 6.11] As chapter two has discussed, land degradation is a highly complex process, causing harmful consequences that affect local communities, as well as the country's overall ecological stability. In the case of major sandstorms, these consequences become directly noticeable for large portions of the national population. The program's primary goals aim to combat continuous desertification processes, control devastating dust storms, and conserve biodiversity, but also to supply the demand for timber.[63]

The ambition to expand local projects to a territorial context to tackle problems of a degraded planet across watershed scales aligns with some of the Landscape Approach's ambitions. The TNSFP follows one grand and bold vision of territorial land restoration to heal an entire world region. However, it is not implemented as one project.[64] While the overall plan of the TNSFP consists of highly dynamic processes, including numerous top-down as well as

63 Ahrends et al., "China's Fight to Halt Tree Cover Loss," 2.

64 In addition to the TNSFP, other initiatives have been implemented, including the Beijing-Tianjin Sand Source Control Program (afforestation), the Natural Forest Conservation Program (logging bans), and the Grain to Green program (conversion of farmland into grassland and forests and receiving the largest economic investments from the Chinese central government, involving millions of households). Quanfu Niu et al., "Ecological Engineering Projects Increased Vegetation Cover, Production, and Biomass in Semiarid and Subhumid Northern China," *Land Degradation & Development* 30, no. 13 (2019): 1621.

bottom-up initiatives,[65] it is outlined as a master plan with a timeline composed of eight periods of engineering campaigns and with the familiar completion date of 2050. The bold vision follows clear goals of increasing the quantifiable tree cover in the dedicated regions, aiming to raise it from less than five percent in 1978 to fifteen percent by 2050.[66] The entire area of the TNSFP master plan is divided into six shelter belts with different functions, such as soil stabilization, water conservation, agricultural land protection, and commercial forests, subdivided into smaller functional regions. Naturally, the restoration measures showed different grades of efficacy across the regions, with more successful results in semi-humid and humid areas, such as the Qilian Mountains.[67]

Trees are the key measure to achieve these goals and are planted in enormous numbers. Every year since the early 1990s, ten thousands of square kilometers have been turned into tree plantations.[68] Different strategies were developed to effectively combat desertification and sandstorms with trees: Linear sand breaks of just about ten to fifty meters in width are planted in the periphery of oases, mostly with fast-growing species of poplar (*Populus gansuensis*) and oleaster (*Elaeagnus angustifolia*) to provide shelter from wind and sand deposits. In addition, larger forest grids of several hundred meters are planted inside the oases, consisting primarily of poplar, oleaster, willow (*Salix matsudana*), and elm (*Ulmus pumila*) trees. In another strategy, different vegetation types are planted on mobile dunes, trying to stabilize them with straw and reed barriers, as well as desert shrubs. In addition, grassland conservation belts

65 On a visit to the Gansu Desert Control Research Institute in Lanzhou in fall 2019, I was told that there are two implementation mechanisms in a combination of top-down and bottom-up planning: First, through large-scale initiatives such as the TNSFP that are initiated directly by the central government and which allocate money to selected local governments or institutions on the county level, where local projects are designed, organized, and implemented. And second, by local counties or cities that apply for federal or, in some cases, non-governmental funding to finance local conservation or restoration programs. Local initiatives are carried out by a combination of institutions, such as the local forestry, agriculture, land resource, and water resource bureaus, together with township governments. The funding comes mainly from the National Development and Reform Commission (which is a macroeconomic management agency concerned with economic growth and social development). Gansu Desert Control Research Institute, Lanzhou, October 17, 2019.

66 Xiaowei Wang et al., "Has the Three Norths Forest Shelterbelt Program Solved the Desertification and Dust Storm Problems in Arid and Semiarid China?," *Journal of Arid Environments* 74, no. 1 (January 1, 2010): 13.

67 Bingwen Qiu et al., "Assessing the Three-North Shelter Forest Program in China by a Novel Framework for Characterizing Vegetation Changes," *ISPRS Journal of Photogrammetry and Remote Sensing* 133 (November 1, 2017): 82–86.

68 The TNSFP alone accounts for the planting of billions of trees to create a shelterbelt across an area of around 4,500 kilometers in length. The Chinese government claims that by 2019, over 66 billion trees had been planted as part of the TNSFP. Mark Zastrow, "China's Tree-Planting Drive Could Falter in a Warming World," *Nature* 573, no. 7775 (September 23, 2019): 474–75. In order to achieve these numbers, China is investing enormous resources. In the first decade of the 21st century, the spending accounted for over 100 billion USD for China's six key forestry programs. Ahrends et al., "China's Fight to Halt Tree Cover Loss," 1–2.

are defined to protect the sensitive zone along the oases' edges. Together, such mosaics of different measures form a protection system as a buffering strip that is usually several kilometers wide.[69] [Fig. 6.12]

While studies based on satellite data are never entirely accurate, many have found a significant increase in tree cover and densities over the past five decades across regions where projects as part of the TNSFP have been rolled out.[70] In the Hexi Corridor region, the reasons for tree cover growth have been identified as increasing rainfall, effective bans on grazing and farming in specific vulnerable locations, and multiple projects actively working on land conservation and restoration.[71] Enhanced vegetation cover can help combat land loss caused by desertification, it helps to store carbon both in biomass and in the soil, locally cool down surface temperatures, and it can thus positively affect the overall regional environment.[72] Studies suggest that the results of successful afforestation also had positive effects on the per capita GDP, as well as education levels around forestry and forest management.[73]

Growing Numbers Rather Than Quality

In a much-noticed 2019 article, NASA researchers announced that satellite studies had shown a worldwide increase of five percent in foliage production since the year 2000, having made the world "greener" over the past twenty years. Much of this success was dedicated to China's tree plantation efforts. However, as the study shows, another significant contribution in addition to tree planting was the intensification of agriculture, for instance, with more effective irrigation systems in India, the second biggest contributor to the overall increase.[74] While such global numbers seem promising, it is important to note that while a tree plantation in the Gobi or an irrigated cropland in India contributes to this statistic, it can never replace a lush Amazonian rainforest.

---

69 Su et al., "Ecological Effects of Desertification Control and Desertified Land Reclamation in an Oasis–Desert Ecotone in an Arid Region," 118–119.

70 Niu et al., "Ecological Engineering Projects Increased Vegetation Cover;" Yao Zhang et al., "Multiple Afforestation Programs Accelerate the Greenness in the 'Three North' Region of China from 1982 to 2013," *Ecological Indicators* 61 (February 1, 2016): 404–12. Such studies use remote sensing technology, mostly the Normalized Difference Vegetation Index NDVI, to quantify before/after vegetation cover and density. Trees with small crowns, particularly narrow shelterbelts, and shrubs (potentially equally effective as trees) can thereby not always be captured, and plantations that often have little biodiversity benefits can usually not be distinguished. Ahrends et al., "China's Fight to Halt Tree Cover Loss."

71 Since 1984, an official desertification monitoring program has been carried out across China every five years, primarily based on remote sensing data. According to this national monitoring campaign, the overall desertification rate could be stabilized around 2000 and reversed for the first time in 2014. Gansu Desert Control Research Institute, Lanzhou, October 17, 2019.

72 Zhang et al., "Multiple Afforestation Programs Accelerate the Greenness," 405.

73 Chao Wang et al., "Factors Contributing to Efficient Forest Production in the Region of the Three-North Shelter Forest Program, China," *Sustainability* 12, no. 1 (January 2020): 302.

74 Chi Chen et al., "China and India Lead in Greening of the World Through Land-Use Management," *Nature Sustainability* 2, no. 2 (February 2019): 122–29.

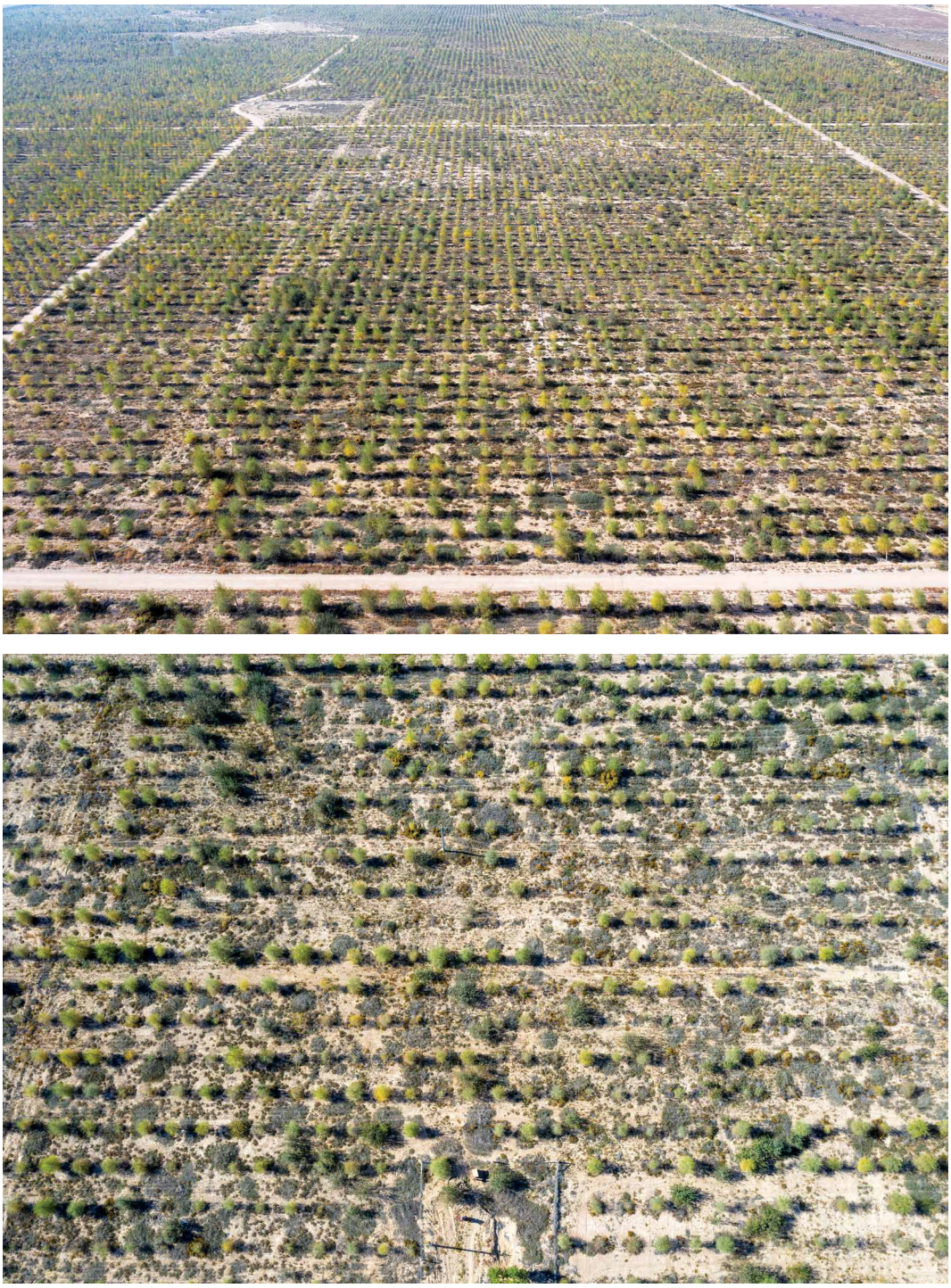


Fig. 6.12: A tree plantation in the northern transition zone of Wuwei Oasis (Eleagnus angustifolia), September 2019.

Almost all of the methods to assess global vegetation growth depend on remote sensing data. Monitoring assessments are primarily concerned with numbers, such as the area of land that appears as vegetation cover on a satellite image or the reported number of trees that have been planted. However, as the Landscape Approach suggests, it is essential to focus on the *quality* of local conditions rather than the quantity of overall measures. Something as complex as greening an arid region with soils that have been heavily degraded over very long periods also requires long-term engagement to let ecosystems grow back over time.

As Li and Shapiro point out, tree-planting initiatives are integrated into the overall apparatus of Chinese state planning. At different levels of government, targets of tree plantations are stipulated, both in national and local Five-Year Plans, and also spatially defined in development plans as shades of green, covering areas of farmlands, villages, or deserted lands. This pronounced concern with quantities has led many local afforestation campaigns to focus on monoculture plantations. Dictated by short terms of office, such plantations enable local officials to effectively reach quantitative targets and allow efficient monitoring and evaluation.[75]

The engineered landscapes these monocultures produce can be read as a physical expression of China's coercive, top-down planning culture and as a spatial manifestation of the attitude of linear, efficient problem-solving. As the Ant Forest initiative has shown, large-scale plantations in northwestern China exhibit a notion of externalization. They usually remain detached from their place-specific context. Land is appropriated to implement a set of seemingly best-practice solutions, in the case of afforestation campaigns with often non-native but fast-growing tree species, according to an abstract, overall vision that is quantified in target numbers. In many cases, studies found significant differences between reported and actually planted areas.[76] An *Economist* article from 2019 describes how millions of workers had been recruited to realize plantation campaigns in northwestern China. In addition to impressive growth rates, the article suggests another reason that makes plantation campaigns popular among local officials might be that they offer a simple way of providing jobs to an impoverished local population.[77]

As scholars at the Desert Control Research Institute told me, much progress has been made in recent years in terms of planting strategies, the selection of species, and the combination of different types of vegetation.[78] However, it is evident that site-specific solutions that cannot be simply scaled up in seemingly endless numbers require more time, labor, and expertise to be thoroughly

75 Li and Shapiro, *China Goes Green*, 78–84.

76 Ahrends et al., "China's Fight to Halt Tree Cover Loss," 5–6.

77 " China's Desert-Taming 'Green Great Wall' Is Not as Great as It Sounds," *The Economist*, May 18, 2019.

78 Gansu Desert Control Research Institute, Lanzhou, October 17, 2019.

designed and implemented. Other scholars are more skeptical about the efficacy of large-scale plantations in general: In arid and semi-arid regions, the overall survival rate of planted trees until the early 2000s turned out to be only around fifteen percent. By then, more than half (around fifty-two percent) of the TNSFP's land area showed no vegetation trend at all.[79] Some scholars argued that the correlation between mass tree plantations and decreasing desertification rates remained unclear. According to them, there is also no clear evidence that the lower frequency of sandstorms is happening due to territorial tree plantations, as they began a declining trend already before the large-scale afforestation programs started on large scales.[80] Therefore, the success of massive tree plantation campaigns in northwestern China—also commonly referred to as the Green Great Wall—might be overrated.

China's shelterbelt plantations have been criticized by scholars for their ecological deficiencies and, in many cases, even for being counterproductive. One major problem of large-scale monoculture plantations has been that they led to sharp increases in water consumption and dropping aquifers, pumping up groundwater and increasing evapotranspiration, especially in arid areas in the lower river reaches with already very limited water resources. This could be observed particularly in cases where fast-growing species with deep-reaching root systems had been used, such as poplar trees. In some areas, it has led to severe water shortages, the loss of ground cover due to shading and dried-up soil, increased erosion, and sandstorm frequencies.[81] In addition, many scholars pointed out that monocultures are more vulnerable and susceptible to diseases[82] and show higher risks of wildfires.[83] [Fig. 6.13]

***

To some degree, mass tree plantations can have positive environmental effects, help restore and stabilize soil, capture water and carbon dioxide, and serve as a practical starting point for a longer-term restoration of valuable ecosystems. However, they must be examined critically and understood in a multi-dimensional context, including socio-political dimensions. Territorial afforestation projects have become very popular across different world regions, such as in the case of the 10-Billion Tree Tsunami, a nationwide initiative launched 2018 in Pakistan, or the African Great Green Wall, a cross-continental plantation project in the Sahel. Many companies, including some from fossil fuel industries,

79 Qiu et al., "Assessing the Three-North Shelter Forest Program in China by a Novel Framework for Characterizing Vegetation Changes," 82.

80 Wang et al., "Has the Three Norths Forest Shelterbelt Program Solved the Desertification and Dust Storm Problems?," 15–16.

81 Feng et al., "What Has Caused Desertification in China?," 6.

82 A poplar beetle outbreak in the 1980s in Ningxia, for instance, affected around 90% of all trees, totaling about eighty million trees that had to be cut. Ahrends et al., "China's Fight to Halt Tree Cover Loss," 8.

83 Gansu Desert Control Research Institute, Lanzhou, October 17, 2019.

Fig. 6.13: Tree plantations at different stages of maturity: A: Young saplings (Eleagnus angustifolia) with stakes and drop irrigation south of Wuwei. B&C: Dense grids of poplar trees (Populus euphratica) in Minqin County, Wuwei, and the northeastern transition zone of Zhangye oasis. D: Plantations of different species at different stages of maturity next to the Hongyashan Reservoir, Wuwei.

announced their engagement in such tree plantation campaigns and are publicly chasing numbers of carbon offset programs.[84] While mass plantations have employed millions of workers with low-wage jobs, they have, in some cases, served as lucrative businesses and brought fortune to very few.[85] As discussed, tree plantations can have negative effects on local ecosystems. They can even compete with native vegetation and traditional forms of agriculture, forcefully dislocate local communities, damage biodiversity, and destroy livelihoods.[86]

Desertification happens through highly complex processes with different characteristics, depending on the specific site conditions. The mass plantations of trees in sensitive and vulnerable environments do not seem to serve as a uni-

84 Adam Welz, "Are Huge Tree Planting Projects More Hype Than Solution?," *Yale Environment 360*, April 8, 2021; Vince Beiser, "China's Green Great Wall Is on the Front Line of Its Fight Against Desertification, But Is It Sustainable?," *South China Morning Post*, December 15, 2018.

85 Beiser, "China's Green Great Wall Is on the Front Line of Its Fight Against Desertification, But Is It Sustainable?"

86 Adam Welz, "Are Huge Tree Planting Projects More Hype Than Solution?," *Yale Environment 360*, April 8, 2021; Beiser, "China's Green Great Wall Is on the Front Line of Its Fight Against Desertification, But Is It Sustainable?"

versally applicable solution to restoring degraded drylands. In contrast, while the Landscapes Approach promotes visions that are led by grand schemes of bold and ambitious visions across watershed scales, it argues that robust and top-down planning needs to happen in parallel to practices that literally function from the bottom-up, from the *land*, and the very specific conditions on the ground. This requires a strong sensitivity for the individual place and a deep engagement with the communities that have been using and shaping it over long periods—including both humans and non-humans. These local communities—or ecologies—can serve as strong allies, able to translate an overall concept into productive, well-crafted systems on the ground. Genuine and long-term participation is necessary to allow local stakeholders to develop a sense of ownership and the liberty to create a strong agency. Such practices cannot be driven solely according to natural scientific knowledge and implemented by a technocratic political apparatus concerned with clear, short-term, and quantitative targets. Instead, it requires interdisciplinary teams that work towards integrative, holistic, multidimensional systems for long-term rehabilitation.

Contradiction of Environmental Protection and Territorial Development

In recent years, China has often been celebrated as the world's leader in renewable energy production. However, "green" goals and environmentally good intentions bear conflicts and are often not as favorable as they might seem. Dammed reservoirs generate renewable power but may cause enormous harm with dramatic consequences for habitats, people, and ecosystems, as in the case of the Liujiaxia reservoir in Gansu, presented in chapter four. National parks set aside land for conservation but may forcefully relocate local populations and induce mass tourism. The mass plantation of monoculture forests increases tree canopy coverage but can exacerbate ecological degradation in already vulnerable areas. Therefore, environmental governance happens in the context of a constant tradeoff between different interests of the central state, local governments, and local communities between economic growth and development as well as environmental protection.

Tremendous social and economic shifts that are necessary to achieve China's ambitious targets of carbon neutrality and territorial environmental protection are happening in a particularly challenging context: The nation is the world's biggest polluter, faces shortages of highly limited and degraded natural resources, has the world's second-largest, yet aging population with a shrinking labor force, and a large portion that is lagging far behind in development and living standard. On a planetary scale, China's plans for the Belt and Road Initiative are discussed in parallel with its vision of developing domestically towards an Ecological Civilization, revealing fundamental contradictions between BRI-related efforts and the rhetoric of decarbonization. Projects associ-

ated with the BRI follow geopolitical interests and patterns of market-driven, planetary urbanization. They include a massive global expansion of mining operations, construction, and transportation activities. While the BRI is often branded as the Green Silk Road, in reality, as many cases in past years have shown, it acts as a powerful catalyst that boosts environmental degradation and carbon emissions, fostering the construction of heavy infrastructures leading through some of the world's most environmentally vulnerable regions.[87] In many cases, Chinese funds for large-scale development projects in partnering countries require much lower regulation standards for environmental safeguard and biodiversity mitigation measures than what is usually coupled with Western funding sources. This promises efficient and straightforward implementation as Chinese funds usually only need to comply with the host country's social and environmental regulations.[88]

In the long run, social prosperity fundamentally depends on a healthy extra-human environment. As the above examples of policies, such as the Ecological Red Lines or strictly protected National Parks, have illustrated, China has begun implementing bold territorial environmental protection measures to sustain future growth and development. Projects such as the Qilian National Park or the Three North Shelter Forest Program operate at scales far beyond what landscape design and planning projects are usually accustomed to. As the Landscape Approach argues, in the age of the Anthropocene and in light of the urgent and existential socio-environmental challenges this human epoch has created, such projects are necessary to restore ecosystems across watershed scales. While these projects have been successful to some degree, their modes of implementation illustrate fundamental conflicts, flaws, and misconceptions. For instance, while the literature on effective restoration confirms how crucial public engagement and the expertise and stewardship of local communities are, state-led initiatives in China are often characterized by social repression and a strong mistrust in the individual citizen and public engagement practices. Of course, such conflicts appear not only in the context of China's political system, but they illustrate general tensions between ambitions for stable growth rates and environmental limitations.

87 John Vidal, "Are China's Pledges to Green Its Belt and Road Initiative the Real Deal?," *Ensia*, September 20, 2022.

88 Divya Narain et al., "Best-Practice Biodiversity Safeguards for Belt and Road Initiative's Financiers," *Nature Sustainability* 3, no. 8 (August 2020): 650–57. Li and Shapiro critically evaluate the BRI and reveal stark contradictions in the official Chinese narrative. However, they end with a spark of hope, pointing out an enormous potential if China commits to environmentally compatible policies domestically and abroad. Li and Shapiro, *China Goes Green*, 115–48. The central government's announcement at a UN General Assembly in September 2021 to ban any future funding of coal-powered power plants abroad—one of the main points of international criticism—was a sign of such commitments. However, its implementation requires thorough observation. Lili Pike, "China's Promise to Stop Building Coal Plants Overseas Is Full of Caveats and Loopholes," *Grid News*, April 28, 2022.

The Appeal of Authoritarian Environmentalism

The Anthropocene implies a high degree of urgency. Many describe how global environmental crises have already reached dramatic tipping points with potentially existential threats to humanity. There seems to remain no time for cumbersome multilateral negotiations, long rounds of consultations, and political compromises. Interest groups constantly express their frustration with governmental decisions, which they see as not doing justice to the grim realities the world is facing. In this context, authoritarian, pragmatic, top-down decision-making seems appealing to achieve fast, radical, and effective results. In many cases, Chinese governments have demonstrated that they can respond to environmental issues in a very effective manner.[89] However, as this chapter illustrates, such technocratic approaches have serious downsides, limitations, and risks. They tend to be discriminatory, create injustice and are often even counterproductive. Authoritarian environmentalism can also be used as a popular narrative to foster "green growth" of material-intensive technologies. Moreover, as discussed in chapter five, negative effects can be extended across continental boundaries as economic growth is based on planetary networks of extractive forces and infrastructures encompassing remote territories that lie far outside centers of public attention and often remain invisible.[90]

***

The Landscape Approach, framed at the conflictive intersection between socio-economic growth and environmental degradation and informed by concepts from ecological science, provides a culture of thought used in the following paragraphs to critically reflect on strategies, measures, and cultural attitudes presented above.

First, "green growth"—if that is not an oxymoron in itself—cannot be driven primarily by interests of economic revenue. To deserve its name, the term's main incentive needs to be the protection and restoration of ecosystems, which can act as a framework guiding development and defining its limitations. By definition, growth consumes space and material resources. It can thus only happen in a "green," environmentally sustainable way if it is integrated into stable ecosystems that may be dynamic and temporarily declining but, overall,

89 A prominent example at the time I was living in Beijing was the often-mentioned "APEC blue," referring to the two weeks of transient blue skies during the 2014 APEC summit. Beijing's authorities implemented strict policies during the period the summit was held, such as shutting down strongly polluting factories surrounding the city, restrictions on using motorized vehicles, and mandatory holidays for certain state-owned enterprises. Such strong measures are often motivated by short-term events and global publicity, while, in the long run, environmental benefits tend to be weighed up with social and economic consequences. However, in cases of urban air pollution, such as in Beijing or, as mentioned, in Lanzhou, substantial improvements could be achieved in recent years.

90 Some thoughts and terms presented here are informed by Li and Shapiro, *China Goes Green*, 185–205.

do not degrade beyond what they are able to restore. Green growth should be understood as investments in the long-term stability of ecosystems. Their careful management can then potentially offer economic benefits in the long run.

Second, pursuing predetermined, quantifiable goals does not necessarily lead to desired outcomes. Target-setting is not unique to China, nor to authoritarian regimes.[91] While it seems attractive and convincing to "scientifically" measure the abstract yield of material and financial investments with precise numbers, in environmental protection and restoration projects, it is crucial to shift the focus on quality rather than quantity, as examples from northern China's afforestation campaigns illustrate. The qualitative functioning of entire ecosystems must be the primary concern rather than the quantitative growth rates of one isolated part. This requires a holistic understanding and assessment of the whole system's performance.

Third, artificial technology can help mitigate the harmful consequences of socio-environmental processes or gain time to achieve socio-political shifts and innovations. However, novel technologies usually depend on highly material-intensive applications and must be scaled up in high quantities in order to be effective. Material resources required for their production, such as rare earths, are essentially limited and usually become more costly, complex, and environmentally destructive to extract with increasing volumes. As the example of the weather-making project in the Tibetan Plateau has shown, forcefully engineering the Earth System to act in humans' favor may seem appealing. However, it seems evident that something as massive and powerful as weather patterns has to be understood holistically. If rain is induced in one region, it begins to be lacking in another. Potential benefits for people at one end may have devastating consequences for people and ecosystems at another. Cycles of nature can, therefore, only be manipulated to a certain degree. Plans of massive geoengineering interventions need to be informed by an understanding of the Earth System as a cohesive organism that is essentially limited in its material capacities.

91 In global environmental governance, target-setting is also increasingly common, for example, in the case of UN Sustainable Development Goals or in carbon emission offsets and compensation programs that are calculated based on certain numbers of planted trees or produced amounts of renewable energy.

Conclusion

Landscape as a Culture of Thought for a Degraded Planet

Up to forty percent of the total terrestrial land area has experienced various degrees of human-induced land degradation.[1] Largely, this happened in drylands with similar geographic conditions as the Hexi Corridor and due to similar desertification processes.[2] In contrast, many of the world's fastest-growing urban agglomerations, housing hundreds of millions of people combined, are located in regions that are already highly water-stressed.[3] These figures illustrate some of the contradictions of anthropogenic development across the world, requiring massive economic investments and societal sacrifices despite inevitable future environmental limitations and conflicts.

The Hexi Corridor has undergone dramatic environmental degradation processes in parallel to climatic change and the acceleration of human activities over long periods of time. While the case is unique in the historical context of China's imperial expansion and its geopolitical function as a frontier region bridging different climatic and cultural geographies, many other world regions experienced similar ecological transformation processes due to uncoordinated and irresponsible land uses. In the context of the Anthropocene, where the consequences of such transformations have become planetary concerns, the Hexi Corridor stands for a globalized society that has to grapple with the multiple socio-environmental crises of a degraded planet.

This concluding chapter refers back to the many strands of thought that are woven together into a cohesive narrative across the thesis. It demonstrates the holistic mode of reading a geographic context, which the Landscape Approach argues for. It aims to understand the complex history of socio-environmental co-production across vast temporal and spatial dimensions, resulting in spe-

1 Global assessments of human-induced land degradation vary between twenty and forty percent. This number includes "green" land, which is intensely farmed and/or deforested and has lost its natural productivity. H. K. Gibbs and J. M. Salmon, "Mapping the World's Degraded Lands," *Applied Geography* 57 (February 1, 2015): 12–21; United Nations Convention to Combat Desertification, "The Global Land Outlook: Second Edition" (Bonn: UNCCD, 2022), xvi.

2 Nearly 40% of the global terrestrial surface is classified as drylands where desertification can occur. And 10–20% of them are estimated to have been degraded. Becerril-Piña and Mastachi-Loza, "Desertification: Causes and Countermeasures," 2.

3 Robert I. McDonald et al., "Water on an Urban Planet: Urbanization and the Reach of Urban Water Infrastructure," *Global Environmental Change* 27 (July 1, 2014): 100–102.

cific conditions of individual sites that can be observed and experienced today. Demonstrated with the case of the Hexi Corridor, this systematic mode of reading can position seemingly isolated problems in a broad and multidimensional context and thus help identify their often deeply-rooted causes. As a culture of thought, it can inform other geographic contexts and be applied across scales.

As mentioned in the introduction chapter, such a multidimensional study is not an attempt to draw a complete picture. Instead, it is a subjective narrative curated by the author, based on the Landscape Approach as a methodological framework. Instead of pretending to provide clear and simple answers, such a geographic study aims to raise questions, point out contradictions and conflicting interdependencies, and identify potentials for collaborative intervention. In this concluding chapter, the thesis and the specific case of the Hexi Corridor are connected to general concerns around a future anthropogenic world that will require new theoretical concepts and modes of practice. It is organized along the five research themes that were introduced in the introduction and led through this thesis. It briefly summarizes 1) how each theme has been discussed in the thesis, 2) the major findings this has led to, and 3) additional layers of research for potential future discussions.

1. Individual Place: The production of places along the Hexi Corridor through invisible forces of a specific socio-environmental regime

1) The qualitative conditions of a unique place, the phenomenological experience of observing and documenting its specific characteristics, is at the core of the systematic geographical investigation this thesis promotes. While the study expands to broad, multidimensional interdependencies, it is the individual inhabitants of a particular locality that are essentially the primary concern. As a systematic mode of working, the thesis promotes a parallel reading of the conditions on the ground and, simultaneously, of secondary sources describing the socio-environmental formation of a much larger context, which includes political, economic, cultural, and environmental forces in relation to land and extra-human nature across multiple temporal and spatial scales. The first research theme is thus concerned with the question of how and why individual places and their specific conditions are produced.

2) One major finding of the research has been revealed through the long-term history of environmental degradation along the Hexi Corridor: In many cases, local ecosystems collapsed because of irresponsible human activities that were enforced through non-native land use regimes often following geopolitical or economic ambitions, despite apparent socio-environmental challenges and limitations. While in pre-modern history, many of these actions may have happened due to the incomprehension of their complex ecological correlations (even though in many cases the consequences were perfectly understood, as

chapter three has shown), today, harmful effects that can be experienced in individual places are tolerated or even encouraged by the socio-political system they are embedded in.

In the thesis' research framework, individual sites as part of a landscape formation sit at the center, between the forces of socio-economic growth and development on one side and the forces of environmental processes and limitations on the other. It is at the scale of the individual site where the complex interactions between these divergent forces become tangible and directly affect its inhabitants. The thesis argues that the specific characteristics of a particular locality can be understood as the spatial manifestation of the socio-environmental regime's invisible forces. Site conditions can, therefore, be read in relation to their overarching multidimensional context. And the constant reflection between these two realms allows to identify the broader causes of conflicts, inherent contradictions, and multiscalar interdependencies.

3) The notion of a broad, socio-environmental regime that creates specific site conditions is informed by the concept of the social production of space, arguing that space is the result of the means of production in the particular organization of a society. Land transformation, therefore, happens according to patterns of the socio-environmental regime, meaning the ways in which a society is organized in relation to extra-human nature. In today's globalized world, this regime is dominated by a market economy of high economic competition and surplus production, essentially encompassing the entire planet. It includes inherent contradictions that lead to the depletion of resources and the degradation of ecosystems in specific locations. In the form of environmental crises such as human-induced climatic change with irregular and extreme droughts and floods, the far-reaching consequences of these systemic fractures become evident in increasing frequency and intensity.

As the second chapter has described, starting from a very long environmental historical timeframe and following the concept of the Early Anthropocene, human societies have significantly transformed their immediate environments to be controlled, made productive, and sustain their needs since the beginning of large-scale land cultivation. As human societies have developed, they have seemingly *naturally* shaped their environment with an increasingly strong environmental impact. However, the concept of the production of space emphasizes that the built environment and its specific site conditions have not been created naturally but according to a socio-political system, its political and economic intentions, ambitions, and power structures.

This notion of intentionality is also important to highlight in the context of the Anthropocene. While Erle Ellis' theory of an anthroecology has been essential for the framing of the Landscape Approach—particularly for its narrative of ecosystems as products of sociocultural production over long time frames—it entails one major contradiction: Ellis states that human societies are integrated into ecological systems and shape them "in much the same way

as climate systems."[4] But as the public ethicist Clive Hamilton points out, the Anthropocene does exactly *not* happen through a gradual process that is naturally unfolding. The critical point for Hamilton is that the Anthropocene as a geological epoch is not defined by biogeological processes that just happened, like tectonic or climatic transformations at the macro-scale. In contrast, it is determined by the consequences, whether intended or not, that derive from *decisions* made by human minds. This anthropogenic force of nature not just appeared over time because humans exist but because of "human volition."[5]

With all the progress in Earth science and increasingly accurate models projecting future scenarios, we understand perfectly well what the potential consequences of human activities and the transformation of individual places are. Hamilton points out that contemporary societies choose—or allow—to transform their environment in irresponsible ways despite this knowledge. In the age of the Anthropocene, the description of individual places should, therefore, be informed by this notion of intentionality—and accountability as well. Space is consciously organized and shaped in certain ways despite the often harmful and well-known consequences.

2. Territorial Context: The territorialization of the Hexi Corridor as a strategic spatial formation

1) The second theme is also concerned with the invisible forces of a socio-environmental regime. However, it expands the focus from individual places to the question of how entire territorial formations are produced. As chapters three to six have discussed, territorialization happens first, mentally, as the reconception of that territory (plus its representation and quantification), and second, physically, as its spatial reorganization. In this process, seemingly isolated, individual places that have been produced locally are turned into a strategic territorial formation, following the geopolitical ambitions of the socio-political apparatus that controls the land.

This territorialization process is illustrated in the thesis with the specific case of the Hexi Corridor across different timescales: Beginning with the first colonial expansion of the Han empire into its arid and remote northwestern frontier region in chapter three; continuing with state-led strategies of nation-building after the founding of the PRC based on heavy industrialization and social campaigns in chapter four; recent strategies to stimulate growth through heavy infrastructures and speculative modes of urbanization that are extended to planetary scales in chapter five; and ending with contemporary responses to environmental threats through large-scale technological applications led by contradictory visions of green growth and ecological civilization in chapter six.

4 Ellis, "Ecology in an Anthropogenic Biosphere," 317.

5 Hamilton explicitly criticizes Ellis for his positivist attitude that regards the Anthropocene as a "human-directed opportunity." Hamilton, *Defiant Earth*, 1–35.

With this narrative of a territorialization of the Hexi Corridor across different timeframes, the concept of the production of space is extended from the individual place to the production of a territory. Flows of capital, labor, and material goods have been traced in connection to environmental systems across watersheds, forming complex assemblages at a territorial scale. This allowed the identification of different agents, their interrelationships, and often divergent interests.

2) The territorial analysis of the Hexi Corridor's historical formation shows that the region has served China's heartland throughout history as a strategic frontier, expanding the empire towards the northwest and Central Asia, pushing like a wedge into vast, geographically harsh, and ethnically different autonomous regions. The Hexi Corridor has, therefore, always been strongly dependent on the central government, either being strengthened or weakened, spatially expanding or subtracting, depending on the political stability in the empire's core. It has been created and sustained with strong support and control from outside as knowledge, technologies, labor, non-native species, land use regimes, and cultural attitudes toward nature were transferred from Central China. They have radically reshaped the Hexi Corridor region, transformed ecosystems at territorial scales, and led to gradual environmental degradation.

While the Hexi region has been developed with support from the heartland, it has, in reverse, always served as a strategic territory for material extraction to sustain populations and economies of increasingly large agglomerations in eastern China. The production of renewable energies across massive scales in the arid northwestern steppes is just the latest case in this process of material extraction. The transfer of materials, energy, and labor from China's western interior to the country's southeastern coast has led to socio-economic imbalances and inequalities, which the central state has responded to with different campaigns over time. As this thesis argues, today's structural challenges and socio-environmental problems in the Hexi region are not just a consequence of a modern human society acting upon nature as an external force. Instead, it is essential to study the region's socio-environmental co-production that happened over long periods and intensified with the advent of modern technologies.

3) Driven by capitalist modes of economic growth and global integration, humans have created a world that makes physical places more easily accessible through an increasingly dense and extended transportation network spanning across the entire planet. This has created conditions through which we are also virtually much more strongly connected to the world as it allows us to acquire daily-life products that depend on complex, global commodity chains and incorporate tremendous quantities of materials. Today's anthropogenic world system allows a growing middle class to visit virtually any place on Earth for mere recreation purposes and to casually consume commodities, such as electronic devices, cosmetic products, fashion accessories, or foods, whose produc-

tion requires enormous amounts of resources and can have devastating social as well as environmental consequences.

As the thesis discusses, the collective, global force of territorial formations of extraction, consumption, and trade has destroyed habitats and degraded large fractions of the Earth System. This planetary implication of territorialization processes is a key argument of the thesis: Individual sites cannot be understood as isolated cases that are being created arbitrarily. Instead, they need to be seen as integral parts of complex socio-environmental entanglements organized in strategic, territorial formations and connected to regional, national, and even planetary contexts. These multidimensional systems operate in dynamic processes of spatial expansion, seeking endless material extraction and overproduction. They include conflictive patterns that tend to create uneven conditions and inequalities, resulting in resource depletion and harmful social and environmental consequences. To identify the roots of these conflicts and multidimensional issues, it is necessary to expand the conception of individual sites to territorial systems and from contemporary conditions to long-term processes of socio-environmental co-production.

3. Landscape Reading: Landscape as a holistic, multidimensional concept to read a geographic context across spatial, temporal, and disciplinary boundaries

1) As discussed in the first chapter, landscape is understood as a cultural artifact, a physical formation collectively shaped by its users, which can be read as the physical expression of a society's organization. It forms a dynamic socio-environmental system, including reciprocal relationships among social, economic, political, and environmental dimensions. The physical landscape formation thus becomes a medium through which these different dimensions can be read and better understood.

As the thesis illustrates with the case of the Hexi Corridor, the mode of *reading landscape* allows to systematically analyze a geographic context across scales. Throughout chapters two to six, descriptions of seemingly isolated local conditions were connected to their broad, multidimensional context. Simultaneously, landscape thinking allows to connect complex socio-environmental processes operating at territorial scales to particular places, adding specificity and tangible quality to abstract, invisible forces. While individual places have been visited to study and document their qualitative conditions, the territorial context was constructed analytically by assembling and visualizing multiple data sets. Different sites and place typologies were described and, led by the logic of ecological science at the scale of watersheds, systematically organized, put in order, and spatial sequence.

These systems of spatial operations and dynamic ecological processes across scales were diagrammatically visualized in poster drawings. The abstract visual representations add an additional dimension to understanding the specific con-

ditions along the Hexi Corridor. In addition, they also serve as general schemes that can be applied to similar geographic constellations. The posters emphasize the conception of landscape as a mode of multidimensional reading. They consist of different layers of information that are combined and overlaid, including text, drawings, and diagrams of large-scale processes and local operations. Similar to what the Landscape Approach describes, the posters cannot be read solely from afar or from too close up. They must be physically unfolded and read by zooming in and out, muddling through the different themes that cross time and space, are interrelated, and create an organic whole.

2) The Hexi Corridor, in the context of China's imperial history and current political organization, is a unique case in many ways. In order to understand the region's socio-environmental co-production, it was necessary to study specific environmental processes in northwestern China as well as patterns of China's political apparatus, shifting governance, planning strategies, development projects, and policies across long periods. However, the systematic landscape reading defined in the first chapter as Landscape Approach is considered a methodological framework that can also be applied to other geographic contexts. The Hexi Corridor shares many characteristics and challenges with arid environments elsewhere. Similarly, processes of anthropogenic transformation have reshaped other world regions, resulting in environmental degradation across territorial scales. Such processes illustrate conflicts between ambitions for economic growth and development on the one hand and fundamental environmental limitations on the other. This paradox that sits at the core of the Landscape Approach framework is a universal conflict embedded in any form of societal development, yet expressed in different degrees depending on the respective socio-environmental regime.

This thesis is a hybrid. It aims to study a geographic context across multiple dimensions. This has, of course, disciplinary and methodological limitations. For a thorough economic, political, historical, or environmental study, different data sets and methods would have needed to be applied. For instance, the scientific analysis of economic data and fieldwork interviews would be required to assess the success of policies related to the Belt and Road Initiative and their impact on the case study region. Both were not possible due to disciplinary and logistic limitations. The thesis argues that the simultaneity of different thematic perspectives that are overlaid, combined, and connected, together with a sensitivity to specific site conditions, can offer new insights and a holistic understanding of a region that could not be achieved from the perspective of disciplinary silos.

3) The narrative of the Anthropocene describes global conditions that are increasingly dynamic, unpredictable, and unlivable, characterized by a growing loss of living systems that sustain us and devastating environmental events that threaten us. While we are just beginning to grasp the far-reaching consequences of what the accumulated human-induced environmental degradation will

mean for the Earth, its ecosystems, other species, and our own, the thesis argues that we need to learn to think holistically, understanding both human and extra-human systems as well as their complex interrelationships across large scales, and across long time frames. The thesis argues that landscape can serve as a medium to better understand, express, and communicate these tremendous complexities and their particular consequences for individual places.

In addition to the conceptual qualities of landscape that allow to read and analyze a geographic context, a physical landscape formation is an operational system. It has been collectively created to provide certain functions and services. It offers a productive middle ground between the scale of the individual locality and the overall territorial context as the realm where the invisible social and environmental forces overlap and intertwine. They become visible as socio-environmental entanglements that are physically expressed through the land, the built environment, and its interacting users. At the intersection between arts and sciences, landscape is an active medium to organize and create space. It is about imagining and anticipating potential futures as a discipline of planning and design. Therefore, the multidisciplinary practice of landscape creation is always present in the thesis' landscape-informed narrative. While the project is analytical and refrains from proposing spatial interventions in the form of maps or planning schemes, it is concerned with identifying particular conflicts and problems. Throughout the thesis, the research critically discusses past and current practices and projects that have been implemented. The work aims to allude to alternative futures and potential solutions, which, in the context of the Anthropocene, need to operate at increasingly large magnitudes.

4. Spatial Intervention: A Landscape Approach to restore degraded land across watershed scales

1) Informed by concepts from ecological science, the Landscape Approach provides an intellectual framework to systematically read a geographic context across scales. However, referring to design and planning disciplines in the first chapter, it promotes landscape also as a spatial design practice. As the description of the Hexi Corridor has shown exemplarily, the socio-environmental challenges entire world regions are facing have become tremendously large and complex. Therefore, the thesis argues that landscape, like most other design disciplines, has to grapple with and address such growing complexities. In the context of land degradation across watershed scales, it is necessary to find modes of working that allow to holistically repair ecosystems and restore their capacity to provide life-essential services.

In chapter six, ongoing projects of territorial land conservation, restoration, and ecosystem engineering along the Hexi region were critically discussed, including National Parks to preserve land, large-scale afforestations trying to restore soil and vegetation that have long been lost, and a weather-making project that seeks to actively modify patterns of precipitation. These initiatives

Fig. 7.1: North of Jiuquan, a landscape has been created combining heavy engineering with traditional land uses and nature-based solutions. The dynamic, small-grained, and multilayered ecosystem provides rich habitats, integrating various waterbodies, wetlands, and vegetation patterns, as well as housing, tourism, farming, livestock, and fishing; October, 2019. (above and following pages)

have been selected to highlight the bold ambitions and large scales necessary to develop interventions that can effectively address global challenges of the Anthropocene. However, discussed in the unique context of China's political system, fundamental flaws and contradictions were identified in all these cases. Alternatively, the thesis proposes an approach that strategically translates coupled human and non-human systems into spatial interventions operating across scales.

2) Applied in chapter three, the Landscape Approach framework allowed to comprehensively understand individual sites as being part of and dependent on a larger geographic organization, expressed through the water flow, soil composition, vegetation patterns, or the formation of cultural landscapes. This ecological analysis revealed how the watershed acts as the geographic unit in this territorial ecosystem thinking. Each such unit is highly dynamic, exposed to external forces such as changing climates and weather patterns, but also to shifts in the socio-political organization.

The long-term historical narrative of the Hexi Corridor's socio-environmental co-production has revealed that the inner logic of ecosystems across watershed scales has been disturbed whenever the modes of land use and development did not happen in its agreement, but instead were driven by geopolitical interests, ambitions of economic growth, socio-political control, or by disregard. Throughout history, the Hexi Corridor has not been transformed

linearly but, instead, in a highly fluctuating manner, depending on shifting anthropogenic and environmental forces. First, this transformation happened as local and rather isolated events, and later, across regional scales. While ecosystems in the arid Hexi Corridor, characterized by strongly limited water resources, react very sensitively to external forces, they have also shown, throughout history, that they can be highly robust, resilient, and restorative. However, the capacity to recover has fundamental limitations and is only possible as long as individual parameters, such as groundwater availability, remain within certain thresholds.

The excessive use and depletion of resources can shift systems to a point where they become highly vulnerable and unstable. Consequently, once the population density and land use intensity had reached a certain level during the early Qing dynasty around three hundred years ago, anthropogenic forces became the decisive factor for ecosystem transformation in the Hexi Corridor region, and land degradation and resource depletion increased exponentially. Therefore, the thesis suggests developing spatial practices that can mitigate the adverse effects of human activities, repair broken fluxes and beneficial interrelationships in socio-environmental systems, and expand the restorative qualities of ecosystems from the scale of the place to watersheds and entire world regions.

3) As mentioned, this thesis does not demonstrate how the Landscape Approach can be translated into such planning concepts and spatial interventions. Instead, it provides a culture of thinking that seeks to inform territorial-scale projects. This is an obvious limitation and may question some of the bold claims made throughout the thesis. However, the thesis speculates how landscape-

informed practices could be realized and what their political, methodological, and practical implications would be.

The term restoration suggests that a certain state from the past should be restored. The successful restoration of ecosystems that once existed along the Hexi region but disappeared long ago, such as wetlands, forests, and grasslands, would require tremendous efforts and most likely take centuries. Ecological conditions from a time when only small numbers of nomadic societies inhabited the region will most likely not return in the human epoch of world history. But such a utopian, backward-looking vision should also not be the pursued goal of territorial restoration efforts. Instead, the Landscape Approach proposes strategically working with landscape as an active, dynamic, and anticipatory medium of collective, balanced future development that benefits humans while allowing the extra-human environment time and space to heal.[6]

Such restorative territorial development requires holistic thinking and models of practice that can effectively intervene at watershed scales. But unlike some of the projects presented in the previous chapter, such bold visions simultaneously need to develop a strong sensitivity for the *place*. They need to genuinely engage with the specific conditions in individual localities and learn from the deep knowledge of local communities. This means that they operate as

6 This aligns with the UN Environmental Programme that defines land restoration as coordinated activities that avoid, reduce, and reverse land degradation with the explicit objective of meeting human needs and improving biosphere stewardship. The UNEP called for a "Decade of Ecosystem Restoration" with ambitious goals of land restoration projects worldwide, emphasizing both the urgent need and the vast scale of such strategies. United Nations Environment Programme, "Becoming #GenerationRestoration: Ecosystem Restoration for People, Nature and Climate." (Nairobi: UNEP, 2021).

territorial systems, aiming to mitigate the adverse consequences of the current regime according to long-term goals. At the same time, they are grounded in specific places, proposing interventions to restore, protect, and create productive landscape formations that promise to result in effective and short-term change. Such holistic, large-scale landscape strategies include cities, towns, villages, farmlands, sites of extraction, and natural habitats.

Creating productive environments for human and non-human actors requires a robust institutional and legal framework to restrict development and protect land in some areas while promoting and fostering growth and interventions in others. While such strategies are abstract and diagrammatic, they become spatial once applied in an accurate scale. They aim to give degraded ecosystems space and time to recover. With specific, nature-based interventions, robust and resilient conditions can be established, which allow ecosystems to replenish vital resources. In this process, humans are not considered as a harmful external force. Instead, they play an integral role in restoration and sustainable development and can benefit from socio-economic opportunities. The thesis promotes landscape-informed strategies that engage with multiple stakeholders, inviting them to participate in decision-making and implementation processes that offer immediate, mutual benefits. [Fig. 7.1]

Instead of uniform, one-dimensional solutions that may seem to promise fast results, the thesis argues that it is necessary to embrace reciprocal processes over long periods. In most cases, working towards integrated landscape approaches does not require costly and material-intensive technologies. Solutions that respect, work with, and benefit from the productive qualities extra-human nature can offer are often relatively simple and highly effective. They work with

land, water, soil, vegetation, and multi-species systems. Degraded, extra-human ecosystems can be astonishingly fast and effective in recovering and restoring themselves. In many cases, it is even sufficient to give these systems time and space to heal and recover from human-induced destruction. As the thesis argues, landscape as a cultural medium has the potential to mediate the persistent contradictions between ambitions for socio-economic growth and fundamental environmental limitations.

To illustrate what kind of projects the translation of the Landscape Approach into spatial interventions could lead to, one famous case of territorial land restoration is briefly introduced below. It followed similar strategies to those mentioned above and created a socio-environmental system that proved to be highly productive for human societies and extra-human nature.

The Case of China's Loess Plateau

As described in the second chapter, China's Loess Plateau has experienced soil erosion over centuries due to massive deforestation. This has led to huge amounts of sediments constantly being carried eastwards by the Yellow River and its tributaries. Unsustainable farming practices, in combination with population pressure across the Loess Plateau, resulted not only in severe land degradation, erosion, and downstream flooding but also widespread poverty. Financed mainly by the World Bank's International Development Association IDA, an ambitious initiative named China's Loess Plateau Watershed Rehabilitation Project was launched in 1994 and completed in 2002. The project's primary goals were the reduction of erosion, sustainable crop production on high-yielding farmlands, and alleviating poverty in the region. The project be-

came one of the world's largest and most successful water and soil conservancy projects.

First, it was achieved by implementing strict land tenure policies, which reorganized land ownership and restricted intensive grazing. Second, nature-based solutions, implemented as a fine-meshed system of ecological engineering in combination with land use practices, including strategic terracing, irrigation, small-scale dams, and plantations of site-specific vegetation patterns, proved to be highly effective. These relatively quick and cost-effective measures allowed to stabilize land and the production of fuel, timber, and fodder with socio-economic benefits. Around one thousand small watersheds provided the planning framework and served as the unit for implementation.

Political commitment and strong leadership have played a vital role in this case. Another aspect that seems particularly important is that the initiative has been primarily driven by the logic of ecosystems instead of ambitions for economic growth. The project illustrates the effectiveness of a holistic approach led by a robust and overall vision based on a thorough understanding of the broad context. Simultaneously, however, it was strongly informed by the specific site conditions and the inclusive participation of local agencies. It combined clear, long-term goals of one guiding regional planning framework carried out by political institutions together with ecological planners and designers. They enforced strict policies while steering multiple small-scale interventions implemented together with local communities and private agencies, offering them short-term benefits. The project effectively intervened at a tremendous scale of 35,000 square kilometers across various land uses, hundreds of townships, and villages. Project stakeholders mentioned the strong participation of local communities as one of the main reasons for the project's success and the land contracting system that incentivized locals to care for their contracted land.[7]

The project aligns in many respects with the Landscape Approach. Therefore, it serves as a successful example of territorial restoration across a region that has experienced severe land degradation for centuries. The project achieved astonishing results through cohesive strategies crafting socio-environmental systems. Of course, this very short summary of the Loess Plateau project is not intended to provide a complete picture of the many complexities such an

7 Shaojun Chen et al., "The Loess Plateau Watershed Rehabilitation Project" (Shanghai: International Bank for Reconstruction and Development / The World Bank, 2004). The two documentaries *Hope in a Changing Climate* (2009) and *The Lessons of the Loess Plateau* (2010) by the ecologist John D. Liu provide more insights into the successful project implementation. *Hope in a Changing Climate*, Documentary (Environmental Education Media Project, 2009); *The Lessons of the Loess Plateau*, Documentary (Environmental Education Media Project, 2010). Li and Shapiro describe how later attempts to scale up and replicate the reforestation strategies were unsuccessful. In contrast to the World Bank project, local officials sought high-density planting of fast-growing trees to achieve fast results. This essentially exceeded the region's ecological capacities and overwhelmed local water sources, reducing soil moisture levels and could not sustain vegetation growth. Li and Shapiro, *China Goes Green*, 84–87.

extensive restoration initiative entails. However, it aims to showcase the feasibility of strategies the Landscape Approach promotes to restore degraded environments and benefit both human and extra-human nature, restoring weak and unsustainable ecosystems and offering socio-economic opportunities for dwindled local economies. This helps to imagine what large-scale restoration could mean in the endeavor of healing a degraded world.

5. Culture of Thought: The multidimensional narrative of the Hexi Corridor as a case to establish a new landscape-informed culture in an anthropogenic world

1) The thesis develops a structured, holistic narrative of the Hexi Corridor as an exemplary case of an anthropogenic world that has been heavily transformed and degraded through anthropogenic activities. This research approach promoting a culture of thought and a way of seeing the world is considered a major contribution of the thesis. It showcases how different sets of information can be combined and put in a systematic order and how a complex geographic context can be productively discussed across disciplinary boundaries.

The Hexi Corridor spans over one thousand kilometers, from high, ice-covered mountain peaks to deserted salt pans. It is home to millions of residents living in different life realities across multiple cities, towns, and villages. The thesis's narrative of the Hexi Corridor spans millennia and enormous spatial scales. It is informed by a discussion of ecologically scientific processes that unfold across watersheds, and it is connected to socio-political interests within China and the entire world. This systematic expansion—in terms of scale, time, themes, and disciplines—aims to extend a multidimensional discourse to new sets of questions, challenges, and practices that will become necessary to be addressed in a future anthropogenic world.

2) The introductory chapter presented literature from two epistemological camps discussing the Anthropocene. On the one hand, natural scientists understand the Earth System through scientific models of quantitative measurements and projections. With a strong belief in science and technology, they tend to propose solutions that seek pragmatic solutions to complex problems, actively intervening in planetary ecosystems to transform them to function in favor of human needs. On the other hand, scholars from humanities see the Earth System as a multidimensional system in which humans are deeply entangled with and dependent on their extra-human environment. They tend to favor long-term solutions through holistic, systemic change. The Landscape Approach is informed by both these different ways of seeing the world.

3) As a conclusion at the end of this thesis, the two positions, coined as positivist ecomodernism and posthumanist nihilism, are first characterized to then frame landscape as a culture of thought to respond to the socio-environmental challenges of the Anthropocene.

Positivist Ecomodernism

In their famous 2007 publication, Paul Crutzen and his co-authors describe humans' future role in the Anthropocene age as "stewards of the Earth System."[8] I sympathize with this metaphor that defines humans' future role as cautious agents who collectively protect and care for the world's valuable ecosystems. However, the authors' perspectives reveal a strong confidence in human creation, in science, engineering, and technology, which this thesis is skeptical of.

Paul Crutzen won a Nobel Prize in 1995 for his work on atmospheric ozone depletion. The global response to the worldwide threat of a decomposing ozone layer included banning and phasing out chlorofluorocarbons (CFCs). This turned out to be highly effective and serves as an example of what Earth science can achieve if translated into effective global agreements and policies. Ironically, it was a ban on technology, rather than its application, that effectively helped to mitigate a global environmental threat. The rapid worldwide immunization campaigns launched in record time in response to the COVID-19 pandemic may serve as another impressive example of how effective science, technology, and its worldwide distribution can be in protecting humanity. However, in this second case, the technological solution only addresses the consequence and not the cause of the problem.

Ecomodernists propose to tackle global environmental issues with great optimism into solutions that follow scientific logic and the application of technology on massive scales. Geo-engineering strategies suggest actively intervening in the natural cycles of the Earth System in order to manipulate it for the better. The weather-making project in the Tibetan Plateau has been mentioned as an example. Not only are the consequences of some of these engineering interventions highly controversial and bear significant risks of unexpected side effects,[9] but such technological solutions are promoted with the promise to quickly fix ecosystems that human activities have disrupted over long periods of time.

While such proposals should be appreciated for their optimistic attitude,

8 Steffen, Crutzen, and McNeill, "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature," 5.

9 Another prominent example is the controversial method of stratospheric aerosol injection, which proposes to release precursor gases into the stratosphere, intended to then lead to the formation of aerosols and produce a global dimming effect: more sunlight is reflected back into space, while less sunlight reaches the Earth's surface, reducing the effects of global climatic change—so at least the theory goes. Initially suggested in 1974, the concept achieved wide attention through publications by scientists such as atmospheric chemist Paul Crutzen in 2006 and climate scientist Tom Wigley in the same year. It could reduce global warming and cool climates, including all its benefits. But it could likely also produce regional droughts and ozone depletion, reduce available sunlight for solar power, make skies less blue, and present many other potential risks, as well as ethical and moral issues. In addition, it would do nothing to stop ocean acidification and wouldn't address many other consequences of climatic change. Alan Robock et al., "Benefits, Risks, and Costs of Stratospheric Geoengineering," *Geophysical Research Letters* 36, no. 19 (2009), 2.

their strong belief in human resilience and the long-term livability of the world, they are also an expression of what has been identified as the fundamental cause of most human-induced environmental problems: a dualist worldview that sees humans as separate from nature and a false belief in humanity's superiority that is presumed to be able to control and master the Earth System. These ideas of technological fixes promote one-dimensional and single-disciplinary modes of efficient problem-solving instead of the courage to collectively work toward integrated, systemic solutions. They stand in the tradition of a strong belief in science, technology, and large-scale industries deriving from competitive, capitalist modes of production. Essentially, such approaches suggest finding solutions that can fix a problem, such as global warming, without having to fundamentally question the causes and the overarching socio-environmental regime.

The notion of "green" growth has been discussed in the previous chapter in the context of China. It follows a similar logic of scaling up technological interventions. Such solutions often depend on the application of massive amounts of synthetic materials and material-intensive components. However, their production requires natural resources that are essentially limited. If scaled up to numbers that can effectively address the planetary environmental problems they promise to tackle, their production demands enormous material and energy inputs.[10] Many of such "green" technological solutions have been very

10 A prominent example is lithium-ion batteries, which are promoted to help achieve a transition away from fossil fuels. In parallel to the global energy demand, the demand for such batteries is also growing at around 24% annually over the past few years. Major battery manufacturers are thus willing to invest over 50 billion USD in the coming years to increase capacities. Peter Greim, A. A. Solomon, and Christian Breyer, "Assessment of Lithium Criticality in the Global Energy Transition and Addressing Policy Gaps in Transportation," *Nature Communications* 11, no. 1 (September 11, 2020), 2. However, the production of lithium—which does not exist as a pure element in nature but has to be extracted from ionic compounds such as oxides or chlorides—is labor- and resource-intensive, has negative social and environmental implications, depends on resources that are limited in total global accessibility, and stored in deposits that are unequally distributed across the Earth. The extraction becomes increasingly expensive, geopolitically contested, and environmentally harmful over time. In addition to lithium, such batteries require additional raw materials, such as cobalt, with their controversial extraction methods; plus, they don't have a particularly long lifespan and are costly and energy-intensive to recycle. United Nations, "Commodities at a Glance: Special Issue on Strategic Battery Raw Materials" (Geneva: United Nations Conference on Trade and Development, 2020); Datu Buyung Agusdinata et al., "Socio-Environmental Impacts of Lithium Mineral Extraction: Towards a Research Agenda," *Environmental Research Letters* 13, no. 12 (November 2018): 123001. While progress in material efficiency, recycling, and potentially new extraction sources, such as seawater, will likely improve, it is questionable if lithium batteries will meet the growing future demand and become the leading new technology to achieve the global goals they are promoted for. The International Energy Agency aptly noticed in May 2021 that the industrial conversion to electricity-fueled vehicles marks a "shift from a fuel-intensive to a material-intensive energy system." Davide Castelvecchi, "Electric Cars and Batteries: How Will the World Produce Enough?," *Nature* 596, no. 7872 (August 17, 2021): 336. Lithium-ion batteries are just one example of a technological solution that seems politically attractive and

successful in receiving public investment and raising venture capital from private investors.[11] In stark contrast, investments in nature-based solutions are multiple times smaller, even though an urgent need has been identified, and the main share comes from the public sector.[12]

***

Of course, this thesis does not deny the benefits and capability of technological solutions. It also opposes dystopian, fatalistic worldviews and a conservative skepticism toward technological progress. It is aware of the urgency and need for fast and radical solutions. However, it aims to point out the limitations of human creation and its potentially destructive consequences. And it argues to radically rethink current socio-environmental regimes rather than investing massive resources into seemingly well-suited technological solutions that essentially aim to continue the status quo under a new guise. Instead of an ecomodernist attitude, seemingly following unrestricted confidence in science, the thesis argues for a much more holistic approach, led by an understanding of the Earth as a multidimensional world ecology.

Posthumanist Nihilism

In strong opposition to such positivist beliefs in human exceptionalism are scholars from posthumanist philosophy. Their understanding of the Earth System as a cohesive whole in which humans are deeply entangled with extra-human nature has informed this thesis. Posthumanist narratives provide much more humble and grounded perspectives of human's position in the world.

---

suitable in the current debate around global environmental issues. However, it aims to sustain a continuous growth culture based on large-scale natural resource extraction. At the same time, it fundamentally depends on a few single materials with limited global availability and destructive environmental implications. It avoids fundamentally questioning the conflicts of this exploitative regime.

11 Investments in "clean" low-carbon assets—including renewable energies, non-fossil fuel transportation, energy storage, carbon capture, hydrogen, and electric heat—increased to over 500 billion USD in 2020. See Veronika Henze, "Energy Transition Investment Hit $500 Billion in 2020 – For First Time," *BloombergNEF* (blog), January 19, 2021. In 2020, investments in renewable energies reached over 320 billion USD. By far, the private sector provided the main share of global capital investments (86% between 2013–2018, while only 14% of direct investments were from public funding sources). See International Renewable Energy Agency, "World Energy Transitions Outlook: 1.5°C Pathway" (Abu Dhabi: International Renewable Energy Agency, 2021), 48–53.

12 The investments in 2020 into nature-based solutions have been estimated at 133 billion USD. 86% of the funding in 2020 has been received from public investment—exactly the opposite ratio to private funding into renewable energy technologies. To effectively tackle the planetary environmental crises and to reach its goals in mitigating climate change, biodiversity loss, and land degradation, the UN Environment Programme suggests that these investments need to at least triple in real terms by 2030 and increase four-fold by 2050. This adds up to a future annual investment rate of 536 billion USD. See Ivo Mulder and Aurelia Blin, "State of Finance for Nature: Tripling Investments in Nature-Based Solutions by 2030" (Nairobi: United Nations Environment Programme, 2021).

They emphasize our strong dependency on non-human agents, providing us with basic, life-essential needs. They understand the world as a self-regulating system of reciprocal webs of dynamic relationships that would also perfectly thrive without humans.

Posthumanist positions provide a radicality that allows to productively rethink the role of humans in relation to extra-human nature. Modern technologies have demonstrated that they can function as tremendously destructive force. Therefore, this thesis argues that scientific knowledge and modern technologies should not be regarded as the sole source of remedy. It rejects euphoric positivism and the confident belief in human superiority, modernity, and technology. Instead, it argues that traditional land uses, the deep wisdom of indigenous practices, and the deep understanding of specific site conditions should be equally considered in defining approaches to future challenges.

In the Anthropocene, many of the wicked problems that the world is facing have become so tremendously big and complex that they cannot even be formulated as *one* problem anymore. And thus, there cannot be *one* solution to resolve these issues. While there is an urgent need for fast and radical changes, we need to realize, unfortunately, that there is no easy fix to overcome the complex problems the Anthropocene has produced. Instead, the thesis argues, we need to learn to embrace these complexities and develop the willingness to muddle through their multidimensional context in order to reveal and understand individual conditions holistically.

In this process, the posthumanist flattening of hierarchies that integrates humans in a dynamic web of multi-agent interdependencies helps develop such holistic thinking and radically connect social and environmental systems. However, the perception of humans as "earthlings," equal to spiders, worms, or mushrooms, does not provide productive answers to the urgent crises of the Anthropocene. It deprives humans of necessary plans for action in the context of severe challenges. Humans are exceptional. A denial of that fact would be cynical. As the Anthropocene tells us, the way humans have consumed and depleted natural resources over generations in often irresponsible practices has proven to be potentially highly destructive, leading to unintended consequences such as climatic change, species extinction, and resource depletion. This extraordinary force of collective human behavior has transformed the Earth System to the point that it can even threaten our own human existence. But humans are also extraordinary as a species in that we have started to recognize these devastating forces and to understand the complex consequences in their planetary totality. Therefore, in a more hopeful manner, human exceptionalism means that humans have the potential to act and intentionally design environments in ways that no longer destroy ecosystems but can sustain and repair them.

***

In many cases, the ability to act is a question of collective values, political will, and priorities.[13] The Landscape Approach framework is informed by posthumanist thought but is built on theory from ecological science. Understanding ecosystems' systematic functioning and ability to operate as resilient and sustainable organisms where human societies can be productively integrated reveals their immense value. This value is material as ecosystems provide life-sustaining resources of water, air, and soil. It is equally about ethical values in collectively defining new cultural practices. But it is also about economic values and the price tag given to natural resources. Multiple aspects must be considered to define a shared understanding and agreement of widely accepted values. The thesis, therefore, promotes ecology as a multidimensional concept that is social, economic, political, and environmental. It argues that such a broad understanding of ecology is necessary to create new forms of spatial-material as well as socio-political organization.

Landscape Culture: Humans as Stewards of the Earth

The Anthropocene as a planetary paradigm puts us into a new relationship with extra-human nature: It suggests that humanity has become more powerful than ever before as we not only shape our immediate environments but have begun to collectively transform the Earth System as a whole. At the same time, however, the Anthropocene also means that we have never been more vulnerable, as we have altered the functioning of the Earth to a degree that makes a growing number of world regions less livable and less resilient, leading to higher degrees of instability. This has created a contradictory situation of human superiority with a stronger separation from extra-human nature and, simultaneously, a fundamental dependency on the Earth System.[14] Informed by Earth science, the Anthropocene makes us understand the world as one cohesive system in which we are deeply integrated. This coherent system has been severely harmed through particular forms of globalized, socio-environmental organization manifested through environmental degradation and its far-reaching consequences for societies.

Socio-environmental crises should be understood as signs that humanity needs to seriously grapple with questions of repair and restoration. Not just

13 According to *Bloomberg*, UN scientists estimated that the total cost to stop the rise of greenhouse gases over the next 20 years would be around 300 billion USD. The article argues that in comparison, and as an example of priority setting, this sum accounts for the world's military spending every 60 days in 2018, putting potential expenses for massive environmental restoration into perspective. Adam Majendie and Pratik Parija, "How to Halt Global Warming for $300 Billion," *Bloomberg News*, October 23, 2019.

14 Throughout *Defiant Earth,* Clive Hamilton points to this "double truth" of humanity in the Anthropocene that makes us "more powerful than ever yet confirms our ultimate inseparability from the forces of the natural world we inhabit." Humans are also more vulnerable and endangered than ever by being exposed to an increasingly unstable and inhabitable world. Hamilton, *Defiant Earth*, 52.

the apparent foreground of human activities should be addressed through local and isolated interventions or through the one-dimensional fixing of problems. Instead, humans need to address the broad and complex background in long-term processes of healing as a society. In addition to environmental restoration, this healing process includes social and economic issues, injustice, inequality, and social degradation. It requires a holistic worldview that embraces the complexities of an environment where human and non-human life not just co-exist but are closely intertwined and can mutually benefit in collaborative, interdependent relationships.

In the multidimensional Landscape Approach framework introduced at the end of the first chapter, *land* is placed at the core. Land that has been shaped, in some cases over very long timeframes, through the interaction of people and their extra-human environment into landscape formations. But, in addition to these cultural dimensions, land is also relevant as a dynamic system of non-human organisms, chemical processes of decomposition, and reproduction. The restoration of degraded ecosystems, including wetlands, forests, steppes, and croplands, has an enormous potential to provide vital services that help tackle some of the tremendous multidimensional problems of our time, such as climatic change. Land can convert carbon into biomass and store it in the soil, water, and vegetation, helping to stabilize emissions. In addition, landscape formations consisting of healthy, balanced ecosystems can offer habitats for all live forms to thrive.

Thankfully, technological innovation is happening at a fast speed. It enables us to live healthy, modern lives today and is required to keep the Earth livable for future generations. Significantly reducing global carbon emissions, for instance, requires alternative technologies like the solar power plants that are growing across the Hexi Corridor. However, the Landscape Approach suggests that solutions to global environmental issues should not be considered at the scale of a solar panel or a lithium battery. Instead, it promotes site-specific concepts that work with local communities, land, soil, water, vegetation, and non-human species. They follow the logic and scale of ecosystems but expand them to a broad context. Led by a holistic approach, they should aim for landscapes that are similarly productive but where technological solutions are integrated into diverse and multilayered landscape formations. This can produce landscape formations that grow out of the place's history and are innovative, meaningful, beautiful, locally specific, and beneficial for humans and non-humans alike.

***

Like the ecomodernists Paul Crutzen and his co-authors, Ian McHarg used the term "steward" to describe a desired future role for humankind. But McHarg emphasized that by taking agency as a steward of the Earth, we need to "design with nature."[15] Today, this notion of designing with nature seems to

15 McHarg uses the term "steward" throughout *Design with Nature*. In the introduction chapter,

have become more relevant than ever. The Landscape Approach follows the same ambition that suggests strategically working with extra-human nature as a powerful ally. It is not about conserving or restoring a pristine ideal of untouched natural habitats. Instead, it suggests working with landscape as a cultural medium that includes modern societies. It takes advantage of technological innovation but equally consults the long-lasting wisdom of traditional practices.

In a world with increasingly blurred boundaries between social and environmental systems, landscape serves as a productive medium at the intersection of arts and sciences. The simultaneous insider and outsider perspectives that the conception of landscape entails allow us to think in an integrated, subordinate manner, being part of a network of socio-environmental entanglements while, at the same time, acting with strong agency from the superior position of a visionary designer and creator. The Landscape Approach proposes to work with landscape as an anticipatory, creative, and ambitious practice of physical creation.

With the advent of the Anthropocene, the logic of ecosystems has been redefined: Ecology, which operates at the local and regional scale, is increasingly dominated by the global context. Essentially, all the "wicked" problems in the Anthropocene are global, connected through a dense web entangling human and non-human processes. They cannot be understood as spatially isolated, recent phenomena. Instead, to understand and potentially tackle their cause, they need to be grounded in a context that spans large spatial and temporal scales. While environmental degradation and processes such as desertification can be experienced in individual places and at the scale of the region, what is ultimately at stake is the Earth System in its totality.

This forces us to take stronger responsibility for the world we are creating, working as stewards with care for long-term stability rather than short-term gains. Intellectually, we thus have to expand the landscape practice and the concern for stable ecologies from the place and the region to world regions and, ultimately, the entire planet. At the same time, however, in a world of anthropogenic, planetary transformation, we cannot disregard the importance of the individual person, place, and unique site formation. The specific locality is necessary to mediate between all different dimensions and—in most cases, unconsciously—to connect the individual to the larger context, creating collective awareness, sensitivity, and the intention to act.[16]

---

he says, "Man must become the steward of the biosphere. To do this, he must design with nature." McHarg, *Design with Nature*, 5.

16 The narrative of the Landscape Approach suggests a pragmatic middle ground that doesn't follow a euphoric confidence in modern technology nor remains paralyzed and struck in awe in view of the tremendous complexity. This narrative is similar to others: Clive Hamilton develops a framework of a "new anthropocentrism." However, in contrast to the Landscape Approach that follows Jason Moore's concept of socio-environmental co-production as a criti-

The Anthropocene is an anthropocentric concept that puts humans at the center. It is also profoundly optimistic because it implies that debates over the Anthropocene's exact starting point are just defining the beginning of a human future that will persist for thousands of years to come. It can be productive to recall the incomprehensibly long timespan of Earth's history in which humanity's temporary presence is irrelevant, putting human-centered narratives in another perspective. However, before we imagine a very distant, post-human future in an ecological time frame, it seems more productive to acknowledge the struggles to sustain balanced lifeforms in the current state of the Earth. Within just a few generations, the Earth System has been disturbed to a degree that already makes it uninhabitable for societies in many world regions. While the Anthropocene might be a renunciation of the logic of previous geological epochs, it is evident that human activities are not "normal" but unprecedented. Never before has a single multi-cellular species transformed the Earth System to such an extent and in such a short timeframe. Therefore, many of the human-caused environmental transformations we see today are not "natural" at all.[17]

The narrative of the Hexi Corridor's human-induced transformation over the longue-durée serves as an example of the Earth System's accelerated anthropogenic transformation. In this narrative, many different time scales can be followed: Whether it is the moment of the first introduction of systematic and large-scale agriculture in the region during the Neolithic Revolution, almost 5,000 years ago; the socio-political dimension of territorial formation, beginning with the first colonial expansion of Han Chinese in the year 121 BC; the region's industrialization to turn it into a territory of extraction and production in the course of nation-building, starting in the early 1950s; the urban explosion beginning in the post-Mao years of Reform and Opening-Up, and the global integration into a network of planetary urbanization; or, more recently, attempts to protect the region from continuous degradation, restore ecosys-

---

cal strategy, Hamilton doesn't regard such coupling of geological history with social history as valid or productive and explicitly disregards it. See Hamilton, *Defiant Earth* 87-97. Dirk Sijmons follows Hamilton's analysis in his development of a future landscape practice, which he calls "Anthropocentrism 2.0," ending with a similar conclusion and arguing for the need of a new landscape practice to actively shape the planet for the better. In his narrative, he describes the need for a strong consideration of the individual site and the strategic work with productive systems of extra-human nature. Dirk Sijmons, "In the Anthropocene, Site Matters in Four Ways," in *Site Matters: Strategies for Uncertainty Through Planning and Design*, ed. Andrea Kahn and Carol J. Burns, 2nd edition (London: Routledge, 2020), 110–30.

17 For instance, today's CO2 concentration level in the atmosphere reached a stark increase that is clearly caused by human action over just the past 150 years and has not existed for more than around the last 3 million years. Nicola Jones, "How the World Passed a Carbon Threshold and Why It Matters," *Yale Environment 360*, January 26, 2017. Despite less global mobility and activity in 2020, the global carbon dioxide and methane levels continued to increase. NOAA National Oceanic and Atmospheric Administration, "Despite Pandemic Shutdowns, Carbon Dioxide and Methane Surged in 2020," NOAA Research News, April 7, 2021.

tems, and lead the nation into a "green" future of prosperity; for this thesis, the question when to set the precise beginning of the region's anthropogenic history is not relevant. What the thesis emphasizes is how the transformation and degradation of an entire world region follow the intentions and values of a socio-environmental regime.

What is necessary is a collective understanding of the sincerity and urgency of Earth's condition and a culture that aims to heal and carefully develop socio-environmental systems that are productive for humans and non-humans alike. The Landscape Approach aims to contribute to a future of collaborative and interdisciplinary work. It hopes to help establish a culture that approaches the complex challenges of our time with a holistic reading of the broad context in which these issues are embedded across multiple dimensions of time and scale. And, given the urgency to act, it hopes to inform new forms of practice that can effectively address planetary challenges.

Figure References

All figures by Hannes Zander, if not cited otherwise below. Maps and illustrations generated with information cited below. Photos in Lanzhou New Area were taken in March 2019. Pictures of places along the Hexi Corridor are from field trips in September and October 2019.

1.3 Von Humboldt, Alexander. "Idealer Durchschnitt von der Bildung der Erdrinde [Ideal Cross Section of the Earth Crust's Creation]." In *Berghaus' Physikalischer Atlas*, 95–126. Gotha: Justus Perthes, 1845. Public Domain. Digitally retouched reproduction of the original https://commons.wikimedia.org/wiki/File:Alexander_von_Humboldt_-_Diagram_of_a_cross-section_of_the_earth%27s_crust_-_rectified.jpg.

1.4 Redrawn from Redman, Grove, and Kuby, "Integrating Social Science into the Long-Term Ecological Research (LTER) Network," 164.

1.5 Redrawn from Ellis, "Ecology in an Anthropogenic Biosphere," 304.

2.2 Sentinel-2 land cover data from Impact Observatory, 2021; Esri, FAO, NOAA, USGS based on the dataset produced for the Dynamic World Project by National Geographic Society in partnership with Google and the World Resources Institute, available under a Creative Commons BY-4.0 license, https://www.arcgis.com/apps/instant/media/index.html?appid=fc92d38533d440078f17678ebc20e8e2.

2.3 Blaeu, Joan. "Xensi." Atlas Map, 48 x 40cm. Atlas Maior Sive Cosmographia Blaviana, Qua Solvm, Salvm, Coelvm, Accvratissime Describvntvr. Amsterdam, 1665. National Library of Scotland. Courtesy of David Rumsey Map Collection, David Rumsey Map Center, Stanford Libraries. https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~282866~90054372:Xensi%25E2%2580%25A6?sort=Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No&qvq=q:xensi;sort:Pub_List_No_InitialSort%2CPub_Date%2CPub_List_No%2CSeries_No;lc:RUMSEY~8~1&mi=0&trs=2. Colors, brightness, and contrasts modified by Hannes Zander.

2.4 Shaded Relief from Natural Earth, https://www.naturalearthdata.com/downloads/10m-raster-data/10m-shaded-relief/. Waterbodies from Efrain Maps, https://www.efrainmaps.es/english-version/free-downloads/china/. Annual Average Precipitation reproduced based on Mak, Alan. "China Average Annual Precipitation." Wikipedia, June 20, 2011, https://commons.wikimedia.org/wiki/File:China_average_annual_precipitation_(en).png.

2.5 Hillshade from Natural Earth. Transportation layers from OpenStreetMap, 2021, https://www.openstreetmap.org. Waterbodies from Efrain Maps and OpenStreetMap. Land use from Impact Observatory, 2021; Esri, FAO, NOAA, USGS. Qilian Mountain National Park from the Chinese Academy of Sciences. "Quanguo ziran baohu qu bianjie shuju 全国自然保护区边界数据 [Boundary Data of National Nature Reserves]." Resource and Environment Science and Data Center. Accessed October 10, 2022. https://www.resdc.cn/data.aspx?DATAID=272.

2.7 Hillshade and elevation data from Natural Earth. Transportation layers from OpenStreetMap, 2021. Waterbodies from Efrain Maps. Extent of the former Zhuyeze Lake (Shiyang River basin) from Fan, Yuxin, Zhenjun Li, Guangliang Yang, Shuangwen Yi, Qingsong Zhang, Wenhao Liu, and Xuesong Mou. "Sedimentary Evidence and Luminescence and ESR Dating of Early Pleistocene High Lake Levels of Megalake Tengger, Northwestern China." *Journal of Quaternary Science* 35, no. 8 (2020): 994–1006. https://doi.org/10.1002/jqs.3246. Extent of the former Juyan Lake (Heihe River basin) from Jin, Ming, Guoqiang Li, Fangliang Li, Yanwu Duan, Lijuan Wen, Haitao Wei, Liping Yang, Yuxin Fan, and Fahu Chen. "Holocene Shorelines and Lake Evolution in Juyanze Basin, Southern Mongolian Plateau, Revealed by Luminescence Dating." *The Holocene* 25, no. 12 (December 1, 2015): 1898–1911. https://doi.org/10.1177/0959683615591349. Extent of former Lop Nur Lake (Shule River basin) from Shao, Yun, Huaze Gong, Charles Elachi, Brian Brisco, Jiaqi Liu, Xuncheng Xia, Huadong Guo, et al. "The Lake-Level Changes of Lop Nur Over the Past 2000 Years and Its Linkage to the Decline of the Ancient Loulan Kingdom." *Journal of Hydrology: Regional Studies* 40 (April 1, 2022): 101002. https://doi.org/10.1016/j.ejrh.2022.101002.

2.8 Hillshade and elevation data from Natural Earth. Transportation layers from OpenStreetMap, 2021. Waterbodies from Efrain Maps and OpenStreetMap. Land use from Impact Observatory, 2021; Esri, FAO, NOAA, USGS.

3.1 Map redrawn from SY, *Map Showing the Expansion of Han Dynasty in 2nd Century BC*, July 10, 2017, https://commons.wikimedia.org/wiki/File:Han_Expansion.png, Creative Commons license.

3.4 Background satellite image from Google Earth; Landsat/Copernicus, CNES/Airbus, Maxar Technologies, 2023. Outlines of the former lake shorelines at 37, 34, and 28 meters above today's basin floor from Jin et al., "Holocene Shorelines and Lake Evolution in Juyanze Basin, Southern Mongolian Plateau, Revealed by Luminescence Dating."

3.5 Photographs courtesy of Kan Yanlong.

3.7 Drawing redrawn and expanded from Deb Slinger and Kathy Tenison,

eds., *Salinity Glove Box Guide: NSW Murray & Murrumbidgee Catchments* (Wagga Wagga, N.S.W: NSW Department of Primary Industries, 2007), cited in Cynthia Podmore, "Dryland Salinity: Causes and Impacts" (Orange, NSW: New South Wales Government Department of Primary Industries, October 2009), 2-3.

4.1 Satellite night view data by NASA Earth Observatory, 2016. "Earth at Night." 500 Meter Resolution – 2016 Color. NASA Earth Observatory, April 12, 2017. https://earthobservatory.nasa.gov/features/NightLights/page3.php.

4.2 Map recreated based on Li, Minmin, Biao He, Renzhong Guo, You Li, Yu Chen, and Yong Fan. "Study on Population Distribution Pattern at the County Level of China." *Sustainability* 10, no. 10 (October 2018): 3598. Administrative Boundaries (2018) from Esri, Michael Bauer Research GmbH, National Bureau of Statistics of China, https://www.arcgis.com/home/item.html?id=c9c26d32bdec4beea7589e303bb06a85. No comparable study from a more recent date could be found. There are slight inconsistencies in cases where county boundaries have changed between 2015 and 2018.

4.3 Bartholomew, John George. "Map of China and Its Territories." 55 x 40 cm. Washington, D.C.: National Geographic Society, Edinburgh Geographical Institute, 1912. Map reproduction courtesy of the Norman B. Leventhal Map & Education Center at the Boston Public Library. https://collections.leventhalmap.org/search/commonwealth:x633f939c#image Brightness, contrast, and colors edited by Hannes Zander.

4.4 Administrative Boundaries (2018) from Esri, Michael Bauer Research GmbH, National Bureau of Statistics of China; Autonomous Administrative Divisions of China from ASDFGH, Wikipedia, 2011. https://en.wikipedia.org/w/index.php?title=Autonomous_administrative_divisions_of_China&oldid=1158393638. Creative Commons license.

4.5 Map recreated from Li, Bo, and Michela Giorcelli. "Technology Transfer and Early Industrial Development: The Case of the Sino-Soviet Alliance." *Centre for Economic Policy Research (CEPR)*, January 10, 2022. https://cepr.org/voxeu/columns/technology-transfer-and-early-industrial-development-case-sino-soviet-alliance.

4.8 Area of Third Front projects reproduced from Huang, Zhangkai, Lixing Li, Guangrong Ma, and Lixin Colin Xu. "Hayek, Local Information, and Commanding Heights: Decentralizing State-Owned Enterprises in China." *American Economic Review* 107, no. 8 (August 2017): 2455–78; Barry Naughton, "The Third Front: Defence Industrialization in the Chinese Interior," *The China Quarterly*, no. 115 (1988): 351–86. Special Economic Zones SEZ and Economic and Technological Development Zones ETDZ 1979 – 2010 from Zeng, Douglas Zhihua. "China's Spe-

cial Economic Zones and Industrial Clusters: Success and Challenges." Cambridge, MA: Lincoln Institute of Land Policy, 2012. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.lincolninst.edu/sites/default/files/pubfiles/2261_1600_Zeng_WP13DZ1.pdf.

4.10 **T**he World Bank. "GDP (Current US$);" "GDP per Capita (Current US$);" Accessed July 26, 2023. https://data.worldbank.org/

4.11 Years 1949–2021: National Bureau of Statistics of China. "China Statistical Yearbook 2022," 2023. http://www.stats.gov.cn/sj/ndsj/2022/indexeh.htm. 2022 – 2049: The World Bank Data. "Population Estimates and Projections." Accessed July 27, 2023. https://databank.worldbank.org/source/population-estimates-and-projections#. Note: Population after 1981 classified by residence (instead of household registration). Figures from 1982, 1990, 2000, and 2010 are from census year estimates; all other years are calculated population estimates.

4.12 World Inequality Database. "China." Accessed July 26, 2023. https://wid.world/country/china/.

5.1 Map reproduced from Xinhua New Agency, 2013. Found in several secondary sources, for instance, in "Development Corridors: China," *Development Corridors Partnership* (blog), accessed August 11, 2022, https://developmentcorridors.org/china/.

5.3 Map recreated according to the "Urban Group Spatial Distribution Diagram" from The 13th Five-Year Plan for National Economic and Social Development, National Development and Reform Commission. Beijing, 2016. Edition 8, Chapter 33, Section 1.

5.6 Transportation infrastructures from OpenStreetMap, 2021. Land use from Impact Observatory, 2021; Esri, FAO, NOAA, USGS. Shaded Relief from Natural Earth. Waterbodies from Efrain Maps.

5.7 Video stills from *Lanzhou New Area [Promotion Video]*. YouTube, 2012. https://www.youtube.com/watch?v=kF1l6P-W0Hs.

5.9 Satellite images from Google Earth; Landsat/Copernicus, 2011, CNES/Airbus, Maxar Technologies, 2023. Road network and villages from OpenStreetMap, 2021.

5.15 Satellite images from Google Earth; Maxar Technologies, 2022.

6.1 Satellite image from Google Earth; CNES/Airbus, 2023.

6.8 National Nature Reserves and National Parks boundaries from the Chinese Academy of Sciences.

6.9 Hillshade from Natural Earth. Transportation layers from OpenStreetMap, 2021. Waterbodies from Efrain Maps and OpenStreetMap. Land use from Impact Observatory, 2021; Esri, FAO, NOAA, USGS. Qilian Mountains National Park boundaries from the Chinese Academy of Sciences.

6.10 Video still from UN Environmental Programme video *Champion of the Earth 2019 – Ant Forest*. YouTube, 2019. https://www.youtube.com/watch?v=ZHHlWUPoppM. Screenshots from the Ant Forest app.

6.11 Perimeter of the areas officially part of the Three North Shelter Forest Program from Shao Quanqin, Shuchao Liu, Jia Ning, Guobo Liu, Fan Yang, Xiongyi Zhang, Linan Niu, Haibo Huang, Jiangwen Fan, and Jiyuan Liu. "Assessment of Ecological Benefits of Key National Ecological Projects in China in 2000-2019 Using Remote Sensing." *Acta Geographica Sinica*, 2022, 77(9): 2133–53. Hillshade from Natural Earth. Waterbodies from Efrain Maps and OpenStreetMap. Land use from Impact Observatory, 2021; Esri, FAO, NOAA, USGS. Naming and location of deserts from Yanli Lyu et al., "Desertification and Blown Sand Disaster in China," *Journal of Agricultural Science and Technology A* 6 (December 28, 2016): 363–71.

Poster Illustrations

A: Timeline 3000 BC – 2020 AD

The timeline depicts individual trajectories of different parameters and their interdependencies across a 5,000-year-long historical timeline. Cultural, political, economic, and environmental systems have been selected to illustrate this long-term history of socio-environmental co-production. Climatic factors (temperature and precipitation) were the dominant forces until the early Qing dynasty, around 1700, when the human forces of a growing population, sustained by technological progress, became dominant. This long-term historical development is discussed mainly in chapters three and four.

Literature Sources

GDP Growth:

Yaowen Xie, Hong Zhao, and Guisheng Wang, "Spatio-Temporal Changes in Oases in the Heihe River Basin of China: 1963–2013," *Écoscience* 22, no. 1 (January 2, 2015): 33–46. (Heihe Watershed)

Survey Office of National Bureau of Statistics in Gansu, "Gansu Development Yearbook 2022," electric version (Lanzhou: Gansu Provincial Bureau of Statistics, 2022). (Gansu Province)

Land Cultivation Increase:

Xinyang Yu et al., "Multi-Temporal Arable Land Monitoring in Arid Region of Northwest China Using a New Extraction Index," *Sustainability* 13, no. 9 (January 2021): 5274.

Yaowen Xie, Hong Zhao, and Guisheng Wang, "Spatio-Temporal Changes in Oases in the Heihe River Basin of China: 1963–2013," *Écoscience* 22, no. 1 (January 2, 2015): 33–46. (Increase oases Heihe Basin).

Liu Yang et al., "Climate Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years," *Acta Geologica Sinica - English Edition* 94, no. 3 (2020): 612–23. (Estimate agricultural land 0 – 1900 AD).

Lake Shrinkage:

Wang Naiang et al., "Historical Desertification Process in Hexi Corridor, China," *Chinese Geographical Science* 15, no. 3 (September 20, 2005): 245–53.

Number of Wars per Century:

Liu Yang et al., "Climate Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years," *Acta Geologica Sinica - English Edition* 94, no. 3 (2020): 612–23.

Population:

Linhai Yang et al., "Historical Settlement Abandonment in the Middle Hexi Corridor Linked to Human-Induced Desertification," *Palaeogeography, Palaeoclimatology, Palaeoecology* 545 (May 1, 2020): 109634.

Survey Office of National Bureau of Statistics in Gansu, "Gansu Development Yearbook 2022," electric version (Lanzhou: Gansu Provincial Bureau of Statistics, 2022). (Rural-Urban Population Gansu Province)

Temperature and Precipitation:

Xiujing Meng et al., "Temporal and Spatial Changes of Temperature and Precipitation in Hexi Corridor During 1955–2011," *Journal of Geographical Sciences* 23, no. 4 (August 1, 2013): 653–67.

Yanpeng Li et al., "Relationships Between Climate Change, Agricultural Development, and Social Stability in the Hexi Corridor Over the Last 2000 Years," *Science China Earth Sciences* 62, no. 9 (September 1, 2019): 1453–60.

Liu Yang et al., "Climate Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years," *Acta Geologica Sinica - English Edition* 94, no. 3 (2020): 612–23.

Yang Bao et al., "Evidence for a Late Holocene Warm and Humid Climate Period and Environmental Characteristics in the Arid Zones of Northwest China During 2.2 ~ 1.8 Kyr B.P.," *Journal of Geophysical Research: Atmospheres* 109, no. D2 (2004).

Terminal Lakes:

Wang Naiang et al., "Historical Desertification Process in Hexi Corridor, China," *Chinese Geographical Science* 15, no. 3 (September 20, 2005): 245–53.

Niels Thevs et al., "Study Areas: The Heihe River Basin and Wuliangsuhai Lake at the Hetao Irrigation District," in *Sustainable Water Management and Wetland Restoration Strategies in Northern China*, ed. Giuseppe Tommaso Cirella and Stefan Zerbe (Bolzano: Bozen Bolzano University Press, 2014), 27–37.

Water Salinity:

G. Wang et al., "Environmental Degradation in the Hexi Corridor Region of China Over the Last 50 Years," *Environmental Geology* 44, no. 1 (May 1, 2003): 68–77.

Niels Thevs et al., "Study Areas: The Heihe River Basin and Wuliangsuhai Lake at the Hetao Irrigation District," in *Sustainable Water Management and Wetland Restoration Strategies in Northern China*, ed. Giuseppe Tommaso Cirella and Stefan Zerbe (Bolzano: Bozen Bolzano University Press, 2014), 27–37.

Water Usage Rate Shiyang Watershed:

Wang Naiang et al., "Historical Desertification Process in Hexi Corridor, China," *Chinese Geographical Science* 15, no. 3 (September 20, 2005): 245–53.

Chao Bao and Chuanglin Fang, "Water Resources Constraint Force on Urbanization in Water Deficient Regions: A Case Study of the Hexi Corridor, Arid Area of NW China," *Ecological Economics* 62, no. 3 (May 15, 2007): 508–17.

Lizhen Wang et al., "Optimal Water Allocation Based on Water Rights Transaction Models with Administered and Market-Based Systems: A Case Study of Shiyang River Basin, China," *Water* 11, no. 3 (March 2019): 577.

B & C: Transect Hexi Corridor Ecosystem

Posters B and C represent geographic conditions and ecological dynamics across the Hexi Corridor. These processes are discussed mainly in chapters two and three. The diagrammatic transect in poster B shows typical socio-environmental interrelationships in the region's endorheic watersheds. The illustration is geographically based on the Beida and Houhai River Basins as part of the larger Heihe River watershed, reaching from its source in the Qilian Mountains to the desertified salt pans of the former terminal lakes. Poster C shows more detailed processes in the lower reaches of Hexi Corridor watersheds, based on the conditions in the lower end of Jinta Oasis and its transition to the surrounding desert.

Literature Sources

Bao, Chao, and Chuanglin Fang. "Water Resources Constraint Force on Urbanization in Water Deficient Regions: A Case Study of the Hexi Corridor, Arid Area of NW China." *Ecological Economics* 62, no. 3 (May 15, 2007): 508–17.

Bie, Qiang, and Yaowen Xie. "The Constraints and Driving Forces of Oasis Development in Arid Region: A Case Study of the Hexi Corridor in Northwest China." *Scientific Reports* 10, no. 1 (October 19, 2020): 17708.

Cheng, Aifang, Qi Feng, Guobin Fu, Jiankai Zhang, Zongxing Li, Meng Hu, and Gang Wang. "Recent Changes in Precipitation Extremes in the Heihe River Basin, Northwest China." *Advances in Atmospheric Sciences* 32, no. 10 (October 1, 2015): 1391–1406.

Ghassemi, Fereidoun, A. J. Jakeman, and H. A. Nix. *Salinisation of Land and Water Resources: Human Causes, Extent, Management and Case Studies*. Wallingford, UK: CAB International, 1995.

Guan, Qingyu, Liqin Yang, Ninghui Pan, Jinkuo Lin, Chuanqi Xu, Feifei Wang, and Zeyu Liu. "Greening and Browning of the Hexi Corridor in Northwest China: Spatial Patterns and Responses to Climatic Variability and Anthropogenic Drivers." *Remote Sensing* 10, no. 8 (August 2018): 1270.

Li, Bingcheng. *Hexi zoulang lishi shiqi shamohua yanjiu* 河西走廊历史时期沙漠化研究 *[Desertification History Along the Hexi Corridor]*. Beijing: Kexue chuban she 科学出版社 [Science Press Ltd.], 2003.

Li, Jianguo, Lijie Pu, Mingfang Han, Ming Zhu, Runsen Zhang, and Yangzhou Xiang. "Soil Salinization Research in China: Advances and Prospects." *Journal of Geographical Sciences* 24, no. 5 (October 1, 2014): 943–60.

Li, Jing. "80 Per Cent of Groundwater in China's Major River Basins Is Unsafe for Humans, Study Reveals." *South China Morning Post*, April 11, 2016, sec. News. https://www.scmp.com/news/china/policies-politics/article/1935314/80-cent-groundwater-chinas-major-river-basins-unsafe.

Liu, Yansui, Yu Liu, Yangfen Chen, and Hualou Long. "The Process and Driving Forces of Rural Hollowing in China Under Rapid Urbanization." *Jour-*

nal of Geographical Sciences 20, no. 6 (December 1, 2010): 876–88.
National Research Council. *Grasslands and Grassland Sciences in Northern China*. Washington, D.C: The National Academics Press, 1992. https://nap.nationalacademies.org/catalog/1942/grasslands-and-grassland-sciences-in-northern-china.
Su, Yong Zhong, Wen Zhi Zhao, Pei Xi Su, Zhi Hui Zhang, Tao Wang, and Raghuvanshi Ram. "Ecological Effects of Desertification Control and Desertified Land Reclamation in an Oasis–Desert Ecotone in an Arid Region: A Case Study in Hexi Corridor, Northwest China." *Ecological Engineering* 29, no. 2 (February 1, 2007): 117–24.
Wang, G., Y. Ding, Y. Shen, and Y. Lai. "Environmental Degradation in the Hexi Corridor Region of China Over the Last 50 Years and Comprehensive Mitigation and Rehabilitation Strategies." *Environmental Geology* 44, no. 1 (May 1, 2003): 68–77.
Wang, Naiang, Zhuolun Li, Hongyi Cheng, Yu Li, and Yinzhou Huang. "High Lake Levels on Alxa Plateau During the Late Quaternary." *Chinese Science Bulletin* 56, no. 17 (June 1, 2011): 1799–1808.
Wang Naiang, Zhang Chunhui, Li Gang, and Cheng Hongyi. "Historical Desertification Process in Hexi Corridor, China." *Chinese Geographical Science* 15, no. 3 (September 20, 2005): 245–53.
Xue, Xian, Jie Liao, Youtian Hsing, Cuihua Huang, and Famin Liu. "Policies, Land Use, and Water Resource Management in an Arid Oasis Ecosystem." *Environmental Management* 55, no. 5 (May 1, 2015): 1036–51.
Yang, Bao, Chun Qin, Achim Bräuning, Iris Burchardt, and Jingjing Liu. "Rainfall History for the Hexi Corridor in the Arid Northwest China During the Past 620 Years Derived from Tree Rings." *International Journal of Climatology* 31, no. 8 (2011): 1166–76.
Yang, Liu, Zhilin Shi, Shanjia Zhang, and Harry F. Lee. "Climate Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years." *Acta Geologica Sinica - English Edition* 94, no. 3 (2020): 612–23.
Yao, Zhengyi, Cunyu Zhao, Keshuo Yang, Weicheng Liu, Yuan Li, Jiandong You, and Jianhua Xiao. "Alpine Grassland Degradation in the Qilian Mountains, China — A Case Study in Damaying Grassland." *CATENA* 137 (February 1, 2016): 494–500.
Yin, Zhicong, Yu Wan, Yijia Zhang, and Huijun Wang. "Why Super Sandstorm 2021 in North China?" *National Science Review* 9, no. 3 (March 1, 2022): nwab165.
Zhu, Xiaolin, Kwok Huen Leung, Wing Sze Li, and Lek Kin Cheung. "Monitoring Interannual Dynamics of Desertification in Minqin County, China, Using Dense Landsat Time Series." *International Journal of Digital Earth* 13, no. 8 (August 2, 2020): 886–98.

D: Territorialization

The diagram shows different infrastructural development projects along the Hexi region, places in China and abroad they are connected to, different political and economic institutions, and flows of capital, labor, and material resources. While the diagram is, of course, unable to draw a complete picture, the research aimed to identify essential enterprises that have shaped the Hexi Corridor since the beginning of the PRC in 1949. Selected sites, actors, and forces are illustrated in different themes and time periods. It is striking that it is almost exclusively state-owned enterprises that were the main drivers of the Hexi Corridor's modern territorialization. Processes of the Hexi Corridor's territorialization are discussed in chapters four to six.

Literature Sources

1. Du, Yaqin. "Xibei xiaoshou yu men fen gongsi 70 nian fazhan ceji 西北销售玉门分公司70年发展侧记 [70 Years of Development of Yumen Branch of [Petro China's] Northwest Sales]." *Shiyou shang bao* 石油商报 *[Petroleum Business Daily]*, December 21, 2021. http://center.cnpc.com.cn/sysb/system/2021/12/01/030051767.shtml; He, Yimin, and Mingchang Zhou. "The 156 Projects and New China's Industrial and Urban Development." In *Selected Essays on the History of Contemporary China*, edited by Xingxing Zhang, 1:54–70. Historical Studies of Contemporary China. Brill, 2015. https://doi.org/10.1163/9789004292673_004; Huahe, Mao. *The Ebb and Flow of Chinese Petroleum: A Story Told by a Witness*. Ideas, History, and Modern China. Leiden, Boston: BRILL, 2019; Wan, Allen, Karoline Kan, and Adam Majendie. "How to Turn an Oil Boomtown Into an Oasis of Renewable Energy." *Bloomberg News*, May 17, 2021. https://www.bloomberg.com/features/2021-yumen-china-oil-city-renewable-energy/.
2. Wikipedia. "Baiyin Nonferrous," September 14, 2021. https://en.wikipedia.org/w/index.php?title=Baiyin_Nonferrous&oldid=1175367598; Baidu Encyclopedia. "Baiyin Youse Jituan Gufen Youxian Gongsi 白银有色集团股份有限公司_百度百科 [Baiyin Nonferrous Metals Group Co., Ltd.]." Accessed October 10, 2021. https://baike.baidu.com/item/%E7%99%BD%E9%93%B6%E6%9C%89%E8%89%B2%E9%9B%86%E5%9B%A2%E8%82%A1%E4%BB%BD%E6%9C%89%E9%99%90%E5%85%AC%E5%8F%B8/11062848?fr=aladdin.
3. Tian, Zengpeng. "Three Generations of Tunnels Witness the Development of the Railway." Seetao, June 17, 2021. https://www.facebook.com/sharer/sharer.php?u=https%3A%2F%2Fwww.seetao.com%2Fdetails%2F89723.html; Wikipedia. "Lanzhou–Xinjiang Railway," January 5, 2022. https://en.wikipedia.org/w/index.php?title=Lanzhou%E2%80%93Xinjiang_railway&oldid=1063953560; Wikipedia. "Wushaoling Tunnel 乌鞘岭隧道," February 27, 2022. https://zh.wikipedia.org/w/index.php?title=%E4

%B9%8C%E9%9E%98%E5%B2%AD%E9%9A%A7%E9%81%93&oldid=70370559.

4. Huahe, Mao. The Ebb and Flow of Chinese Petroleum: A Story Told by a Witness. Ideas, History, and Modern China. Leiden, Boston: BRILL, 2019, 43-44; OilLink. "Chengwei qinghai youtian de da houfang! Zhe zuo gansu xiaocheng ping shenme? 成为青海油田的大后方！这座甘肃小城凭什么？ [Becoming the Rear of Qinghai Oilfields! Why is this small town in Gansu?]," August 5, 2019. https://zhuanlan.zhihu.com/p/76737163; Baidu Encyclopedia. "Qinghai Youtian青海油田_百度百科 [Qinghai Oilfields]." Accessed October 10, 2021. https://baike.baidu.com/item/%E9%9D%92%E6%B5%B7%E6%B2%B9%E7%94%B0/625524?fr=aladdin.
5. Jing, Jun. The Temple of Memories: History, Power, and Morality in a Chinese Village. Stanford, CA: Stanford University Press, 1996, 71-73; Baidu Encyclopedia. "Liujiaxia Shuiku 刘家峡水库 [Liujiaxia Reservoir]." Accessed October 10, 2021. https://baike.baidu.com/item/%E5%88%98%E5%AE%B6%E5%B3%A1%E6%B0%B4%E5%BA%93?fromModule=lemma_search-box.
6. Du, Yaqin. "Xibei xiaoshou yu men fen gongsi 70 nian fazhan ceji 西北销售玉门分公司70年发展侧记 [70 Years of Development of Yumen Branch of [Petro China's] Northwest Sales]." Shiyou shang bao 石油商报 [Petroleum Business Daily], December 21, 2021.
7. Baidu Encyclopedia. "Zhongguo Shiyou Lanzhou Shihua Gongsi 中国石油兰州石化公司 [PetroChina Lanzhou Petrochemical Company]." Accessed October 10, 2021. https://baike.baidu.com/item/%E4%B8%AD%E5%9B%BD%E7%9F%B3%E6%B2%B9%E5%85%B0%E5%B7%9E%E7%9F%B3%E5%8C%96%E5%85%AC%E5%8F%B8/7653421?fr=aladdin; Zhongguo Shiyou中国石油 [Petro China]. "Lanzhou Shihua兰州石化 [Lanzhou Petrochemical]." Accessed October 10, 2021. http://www.cnpc.com.cn/cnpc/lzsh/sywq_column.shtml.
8. Baidu Encyclopedia. "Gansu Jing Tie Shan Tie Kuang 甘肃镜铁山铁矿 [Gansu Jingtieshan Iron Mine]." Accessed July 27, 2022. https://baike.baidu.com/item/%E7%94%98%E8%82%83%E9%95%9C%E9%93%81%E5%B1%B1%E9%93%81%E7%9F%BF/3037773.
9. JISCO. "The Course of Development." Accessed October 10, 2021. https://jiscojude.com/company/the-course-of-development/; Naughton, Barry. "Industrial Policy during the Cultural Revolution: Military Preparation, Decentralization, and Leaps Forward." In New Perspectives on the Cultural Revolution, edited by Christine P. W. Wong, David Zweig, and William A. Joseph, 153–82. Cambridge, MA: Harvard University Asia Center, 1991. https://doi.org/10.2307/j.ctt1sq5tmt.10; Jiayuguan shi renmin zhengfu 嘉峪关市人民政府 [Jiayuguan Municipal People's Government]. "Jiayuguan Gaikuang 嘉峪关概况 [Overview of Jiayuguan]," April 17, 2022. http://jyg.gov.cn/zjjyg/index.html.
10. Baidu Encyclopedia. "Jiuquan Weixing Fashe Zhong Xin酒泉卫星发射

中心_百度百科 [Jiuquan Satellite Launch Center]." Accessed October 10, 2021. https://baike.baidu.com/item/%E9%85%92%E6%B3%89%E5%8D%AB%E6%98%9F%E5%8F%91%E5%B0%84%E4%B8%AD%E5%BF%83/478228; Wikipedia. "Jiuquan Satellite Launch Center," September 26, 2021. https://en.wikipedia.org/w/index.php?title=Jiuquan_Satellite_Launch_Center&oldid=1177236375.

11. Jinchuan Group. "Our History." Accessed October 10, 2021. http://en.jnmc.com/2022-07/29/c_793221.htm; Baidu Encyclopedia. "Jinchuan Jituan Gufen Youxian Gongsi金川集团股份有限公司_百度百科 [Jinchuan Group Co., Ltd.]." Accessed October 10, 2021. https://baike.baidu.com/item/%E9%87%91%E5%B7%9D%E9%9B%86%E5%9B%A2%E8%82%A1%E4%BB%BD%E6%9C%89%E9%99%90%E5%85%AC%E5%8F%B8/3308470?fr=aladdin&fromtitle=%E9%87%91%E5%B7%9D%E9%9B%86%E5%9B%A2%E6%9C%89%E9%99%90%E5%85%AC%E5%8F%B8&fromid=9440384.
12. Wikiwand. "Jiajing Railway." Accessed October 12, 2021. https://www.wikiwand.com/en/Jiajing_Railway; Baidu Encyclopedia. "Gansu Jing Tie Shan Tie Kuang 甘肃镜铁山铁矿[Gansu Jingtieshan Iron Mine]." Accessed July 27, 2022. https://baike.baidu.com/item/%E7%94%98%E8%82%83%E9%95%9C%E9%93%81%E5%B1%B1%E9%93%81%E7%9F%BF/3037773.
13. Wikipedia. "Lanzhou–Xinjiang Railway," January 5, 2022. https://en.wikipedia.org/w/index.php?title=Lanzhou%E2%80%93Xinjiang_railway&oldid=1063953560.
14. Zhengxie jiayuguan shi weiyuanhui 政协嘉峪关市委员会 [CPPCC Jiayuguan Municipal Committee]. "Jing—Mu Tielu, Women Zai Qidaizhuo! Ji Dai Ren de Mengxiang 镜—木铁路，我们在期待着！几代人的梦想 [Jingmu Railway, We Are Looking Forward to It! The Dream of Generations]," May 2, 2014. https://web.archive.org/web/20140502004809/http:/www.jygzhx.cn/news/yzjy/2009/5/0958135853845.html
15. Naughton, Barry. "Industrial Policy during the Cultural Revolution: Military Preparation, Decentralization, and Leaps Forward." In New Perspectives on the Cultural Revolution, edited by Christine P. W. Wong, David Zweig, and William A. Joseph, 153–82. Cambridge, MA: Harvard University Asia Center, 1991, 160-61.
16. Ahrends, Antje, Peter M. Hollingsworth, Philip Beckschäfer, Huafang Chen, Robert J. Zomer, Lubiao Zhang, Mingcheng Wang, and Jianchu Xu. "China's Fight to Halt Tree Cover Loss." Proceedings of the Royal Society B: Biological Sciences 284, no. 1854 (May 3, 2017): 20162559. https://doi.org/10.1098/rspb.2016.2559; Niu, Quanfu, Xiangming Xiao, Yao Zhang, Yuanwei Qin, Xinghai Dang, Jie Wang, Zhenhua Zou, et al. "Ecological Engineering Projects Increased Vegetation Cover, Production, and Biomass in Semiarid and Subhumid Northern China." *Land Degradation & Development* 30, no. 13 (2019): 1621. https://doi.org/10.1002/ldr.3351.

17. Huahe, Mao. *The Ebb and Flow of Chinese Petroleum: A Story Told by a Witness*. Ideas, History, and Modern China. Leiden, Boston: BRILL, 2019, 261-272; Gu, Yu, and Shaoxiong Sun. "Talimu Youtian: Sanshi Zai Jueqi de Da Youqitian 塔里木油田：三十载崛起的大油气田_滚动新闻_中国政府网 [Tarim Oilfield: A Major Oil and Gas Field That Has Emerged in the Past Thirty Years." Xinhua New Agency, June 1, 2019. https://www.gov.cn/xinwen/2019-06/01/content_5396543.htm.
18. The Getty Conservation Institute. "Mogao Grottoes Visitor Center Opens," Spring 2015. https://www.getty.edu/conservation/publications_resources/newsletters/30_1/gcinews2.html; Wikipedia. "Mogao Caves," October 6, 2021. https://en.wikipedia.org/w/index.php?title=Mogao_Caves&oldid=1178841349; *Pengpai xinwen* 澎湃新闻 *[The Paper]*. "Dunhuang Shi Quanli Tuijin Da Dunhuang Wenhua Luyou Jingji Quan Jianshe敦煌市全力推进大敦煌文化旅游经济圈建设 [Dunhuang City Makes Every Effort to Promote the Construction of the Greater Dunhuang Cultural Tourism Economic Circle]." March 7, 2022, sec. Zhengwu 政务 [Government Affairs]. https://m.thepaper.cn/baijiahao_16996201.
19. Sinochem. "Gansu Weng Fu Huagong Youxian Zeren Gongsi甘肃瓮福化工有限责任公司 [Gansu Wengfu Chemical Co., Ltd.]." Accessed October 13, 2021. https://www.sinochem.com/s/1259-4309-9245.html; Xing, Wentao. "Gansu Nenghua Group and Wengfu Group Signed an Agreement--Seetao." *Seetao*, July 25, 2021. https://www.seetao.com/details/98874.html; Sinofert (Sinochem). "Sinochem Fertilizer Makes Strategic Investment in the Largest Phosphate Fertilizer Company of North," November 5, 2007. http://www.sinofert.com/en/s/5635-15034-47938.html.
20. Baidu Encyclopedia. "Yin Da Ru Qin Gongcheng 引大入秦工程 [Introducing the Da into Qin Project]," February 1, 2022. https://baike.baidu.com/item/%E5%BC%95%E5%A4%A7%E5%85%A5%E7%A7%A6%E5%B7%A5%E7%A8%8B/7307000.
21. Fairley, Peter. "China's Ambitious Plan to Build the World's Biggest Supergrid - IEEE Spectrum." IEEE Spectrum (blog), February 21, 2019. https://spectrum.ieee.org/chinas-ambitious-plan-to-build-the-worlds-biggest-supergrid; Ma, Li. "Inter-Provincial Power Transmission and Its Embodied Carbon Flow in China: Uneven Green Energy Transition Road to East and West." Energies 15, no. 1 (January 2022): 176. https://doi.org/10.3390/en15010176; Wikipedia. "Ultra-High-Voltage Electricity Transmission in China," October 10, 2021. https://en.wikipedia.org/w/index.php?title=Ultra-high-voltage_electricity_transmission_in_China&oldid=1179534344.
22. Zhang, Guojie, Lizhen Dou, and Ying Xu. "Opportunities and Challenges of Natural Gas Development and Utilization in China." Clean Technologies and Environmental Policy 21 (August 1, 2019). https://doi.org/10.1007/s10098-019-01690-4; Wang, Boyu, and Congru Xiong. "Gouzhu Zhongguo Nengyuan Xin Ganxian 构筑中国能源新干线

[Building a New Energy Line in China]." Jingji Canguan Bao 经济参观报 [Economic Information Daily], August 29, 2007. http://www.jjckb.cn/wzpd/2007-08/29/content_63991.htm; Global Energy Monitor Wiki. "West-East Gas Pipeline Project," n.d. https://www.hydrocarbons-technology.com/projects/west-east/; Hydrocarbons Technology. "West-East Gas Pipeline Project." Accessed October 13, 2023. https://www.hydrocarbons-technology.com/projects/west-east/; Times, Global. "China's West-East Gas Transmission Project Kicks Off No. 4 Pipeline Construction." *Global Times*, September 28, 2022, sec. Economy. https://www.globaltimes.cn/page/202209/1276300.shtml.

23. Wikipedia. "Central Asia–China Gas Pipeline," August 15, 2023. https://en.wikipedia.org/w/index.php?title=Central_Asia%E2%80%93China_gas_pipeline&oldid=1170432856.
24. Railway Technology. "Qinghai-Tibet Heavy Rail Line," September 21, 2006. https://www.railway-technology.com/projects/china-tibet/; Tibet Vista. "Qinghai Tibet Railway: How and Why Build Tibet Train?" Accessed October 13, 2021. https://www.tibettravel.org/qinghai-tibet-railway/.
25. Wang, Boyu, and Congru Xiong. "Gouzhu Zhongguo Nengyuan Xin Ganxian 构筑中国能源新干线 [Building a New Energy Line in China]." Jingji Canguan Bao 经济参观报 [Economic Information Daily], August 29, 2007. http://www.jjckb.cn/wzpd/2007-08/29/content_63991.htm.
26. Reuters. "China Starts Building First 10-GW Mega Wind Farm." August 9, 2009, sec. Green Business News. https://www.reuters.com/article/idUSTRE5771IP20090808; Mr. Sustainability. "China Announces Largest Renewable Project Ever," October 18, 2021. https://www.mr-sustainability.com/stories/2021/china-400gw; China Power. "Zai Xibu Jueqi de Zhongguo Luse Nengyuan Zhi Du——Jiuquan Qian Wan Qianwa Ji Fengdian Jidi Jianshe Jishi 在西部崛起的中国绿色能源之都——酒泉千万千瓦级风电基地建设纪实_电力网 [A Record of the Construction of Jiuquan, a 10-Million-Kilowatt Wind Power Base That Is Emerging as China's Green Energy Capital in the West]," August 5, 2021. http://www.chinapower.com.cn/flfd/gnxw/20210807/93343.html; Baidu Encyclopedia. "Gansu Jiuquan Fengdian Jidi 甘肃酒泉风电基地_百度百科 [Gansu Jiuquan Wind Power Base]." Accessed October 13, 2023. https://baike.baidu.com/item/%E7%94%98%E8%82%83%E9%85%92%E6%B3%89%E9%A3%8E%E7%94%B5%E5%9F%BA%E5%9C%B0/10570054.
27. China City Planning Review. "State Council Approves Lanzhou New District as the Fifth National New District." China City Planning Review 21, no. 4 (2012); Wikipedia. "Lanzhou Zhongchuan International Airport," September 29, 2023. https://en.wikipedia.org/w/index.php?title=Lanzhou_Zhongchuan_International_Airport&oldid=1177805237.
28. Pomfret, Richard. "The Eurasian Landbridge and China's Belt and Road Initiative." Centre for Economic Policy Research (CEPR), May 2, 2018. https://cepr.org/voxeu/columns/eurasian-landbridge-and-chinas-belt-

and-road-initiative; Gu, Chaolin, Shen Jianfa, and Taofang Yu. "Urban and Regional Development." In *Developing China's West: A Critical Path to Balanced National Development*, edited by Yue-man Yeung and Shen Jianfa, 202. Hong Kong: Chinese University Press, 2004; Wikipedia. "New Eurasian Land Bridge," July 25, 2023. https://en.wikipedia.org/w/index.php?title=New_Eurasian_Land_Bridge&oldid=1167131288.

29. Zhao, Yinan, and Chaohua Xue. "New State-Level Zone to Boost Western Growth." China Daily, September 8, 2012. http://www.chinadaily.com.cn/china/2012-09/08/content_15744715.htm.
30. CDM Executive Board. "Project Design Document Form for CDM Project Activities - Gansu Jinta Solar Power Generation Project." UN Climate Change, Clean Development Mechanism, December 12, 2012. https://cdm.unfccc.int/UserManagement/FileStorage/QKU3E8B2VAT-9NPL46FDZG075OJYXHW; Asian Development Bank. "Gansu Jinta Concentrated Solar Power Project," April 8, 2013. China, People's Republic of. https://www.adb.org/projects/47006-001/main.
31. Wikipedia. "Lanzhou–Xinjiang High-Speed Railway," January 26, 2023. https://en.wikipedia.org/w/index.php?title=Lanzhou%E2%80%93Xinjiang_high-speed_railway&oldid=1135675832.
32. China Daily. "Lanzhou New Area Free Trade Zone." Provincial Government Portal. Lanzhou, Gansu, April 12, 2021. http://lanzhou.gogansu.com/2021-04/12/c_635448.htm; Lanzhou xinqu shangmao wuliu touzi jituan youxian gongsi 兰州新区商贸物流投资集团有限公司 [Lanzhou New Area Commerce Trade and Logistics Investment Group Co., Ltd.]. "Lanzhou New Area Commerce Trade and Logistics Investment Group Co., Ltd." Accessed October 13, 2021. http://lzxqctlig.com/page/cid/6.html.
33. Xing, Wen, and Weihua Mao. "Key Transportation Link: The G30 Expressway." China Daily, May 4, 2021. https://global.chinadaily.com.cn/a/202105/04/WS6090b356a31024ad0babbe4b.html; Wikipedia. "G30 Lianyungang–Khorgas Expressway." Accessed October 13, 2023. https://en.wikipedia.org/wiki/G30_Lianyungang%E2%80%93Khorgas_Expressway.
34. Zheng, Yiran, and Jingna Ma. "Molten Salt Solar Power Station Largest of Its Kind." China Daily, January 8, 2019. https://www.chinadaily.com.cn/a/201901/08/WS5c3408aba31068606745f714.html; Lang, Kuei, and Conor Salcetti. "The World is Watching! China Builds Its First Hundred-Megawatt Molten Salt Solar Thermal Power Plant." Advantech, March 20, 2019. https://www.advantech.com/th-th/resources/case-study/the-world-is-watching-china-builds-its-first-hundred-megawatt-molten-salt-solar-thermal-power-plant; Xinhua. "Super Mirror Power Plant in Gansu, NW China." *XinhuaNet*, March 1, 2021. http://www.xinhuanet.com/english/2021-03/01/c_139775005.htm.
35. Li, Shicheng, Shan Su, Yanxia Liu, Xuewu Zhou, Quanxin Luo, and Basanta Paudel. "Effectiveness of the Qilian Mountain Nature Reserve of

China in Reducing Human Impacts." Land 11, no. 7 (July 2022): 1071. https://doi.org/10.3390/land11071071.

36. Lanzhou New Area Companies:
    A) Baker Institute. "China's Energy Infrastructure." Interactive Map of China, 2023.https://www.bakerinstitute.org/chinas-energy-infrastructure.
    B) Denyer, Simon. "Along the New Silk Road, a City Built on Sand Is a Monument to China's Problems." The Washington Post, May 29, 2016. https://www.washingtonpost.com/world/asia_pacific/along-the-new-silk-road-a-city-built-on-sand-is-a-monument-to-chinas-problems/2016/05/29/982424c0-1d09-11e6-82c2-a7dcb313287d_story.html.
    C) Gao, Yuan. "Go-West Project Dusts Itself Off in Arid Plateau." Chinadaily, November 19, 2012. www.chinadaily.com.cn/business/2012-11/19/content_15942037.htm.
    D) Gao, "Go-West Project Dusts Itself Off in Arid Plateau."
    E) Gao, "Go-West Project Dusts Itself Off in Arid Plateau."
    F) Gao, "Go-West Project Dusts Itself Off in Arid Plateau."
    G) Kaiman, Jonathan. "China to Flatten 700 Mountains for New Metropolis in the Desert." The Guardian, December 6, 2012, sec. World news. https://www.theguardian.com/world/2012/dec/06/china-flatten-mountain-lanzhou-new-area.
    H) Zhongguo - Lanzhou xinqu 中国 – 兰州新区 [China: Lanzhou New Area]. "Lanzhou Xinqu Gaikuang 兰州新区概况 [Overview of Lanzhou New Area]," May 23, 2022. http://www.lzxq.gov.cn/system/2018/10/25/030000231.shtml.
    I) "Lanzhou Xinqu Gaikuang 兰州新区概况 [Overview of Lanzhou New Area]."
    J) Denyer, "Along the New Silk Road, a City Built on Sand Is a Monument to China's Problems."
    K) Baker Institute, "China's Energy Infrastructure."
    L) Huawei Enterprise. "Lanzhou New Area: A New Smart City." Accessed October 14, 2023. https://e.huawei.com/en/case-studies/industries/2019/201901241112.
    M) Baker Institute, "China's Energy Infrastructure."
    N) He, Yuting. "Concentration of 25 Projects in Lanzhou New District Started." Seetao, July 7, 2021. https://www.facebook.com/sharer/sharer.php?u=https%3A%2F%2Fwww.seetao.com%2Fdetails%2F94515.html.
    O) He, "Concentration of 25 Projects in Lanzhou New District Started."

Bibliography

Agusdinata, Datu Buyung, Wenjuan Liu, Hallie Eakin, and Hugo Romero. "Socio-Environmental Impacts of Lithium Mineral Extraction: Towards a Research Agenda." *Environmental Research Letters* 13, no. 12 (November 2018): 123001. https://doi.org/10.1088/1748-9326/aae9b1.

Ahrends, Antje, Peter M. Hollingsworth, Philip Beckschäfer, Huafang Chen, Robert J. Zomer, Lubiao Zhang, Mingcheng Wang, and Jianchu Xu. "China's Fight to Halt Tree Cover Loss." *Proceedings of the Royal Society B: Biological Sciences* 284, no. 1854 (May 3, 2017): 20162559. https://doi.org/10.1098/rspb.2016.2559.

Anderlini, Jamil. "China Is at Risk of Becoming a Colonialist Power." *Financial Times*, September 19, 2018, sec. Belt and Road Initiative. https://www.ft.com/content/186743b8-bb25-11e8-94b2-17176fbf93f5.

Anthropocene Working Group, AWG. "Working Group on the 'Anthropocene' | Subcommission on Quaternary Stratigraphy," May 21, 2019. http://quaternary.stratigraphy.org/working-groups/anthropocene/.

Arts, Bas, Marleen Buizer, Lummina Horlings, Verina Ingram, Cora van Oosten, and Paul Opdam. "Landscape Approaches: A State-of-the-Art Review." *Annual Review of Environment and Resources* 42, no. 1 (2017): 439–63. https://doi.org/10.1146/annurev-environ-102016-060932.

Asian Development Bank. "Observations and Suggestions: The 14th Five-Year Plan of the People's Republic of China – Fostering High-Quality Development." Manila, Philippines: Asian Development Bank, 2021. https://www.adb.org/sites/default/files/publication/705886/14th-five-year-plan-high-quality-development-prc.pdf.

Bai, Yang, Bo Jiang, Min Wang, Hui Li, Juha M. Alatalo, and Shenfa Huang. "New Ecological Redline Policy (ERP) to Secure Ecosystem Services in China." *Land Use Policy* 55 (September 1, 2016): 348–51. https://doi.org/10.1016/j.landusepol.2015.09.002.

Baidu Encyclopedia. "Gansu Jing Tie Shan Tie Kuang 甘肃镜铁山铁矿 [Gansu Jingtieshan Iron Mine]." Accessed July 27, 2022. https://baike.baidu.com/item/%E7%94%98%E8%82%83%E9%95%9C%E9%93%81%E5%B1%B1%E9%93%81%E7%9F%BF/3037773.

Baidu Encyclopedia. "Ma Lanhua Kai 马兰花开 [Malan Flower Blossom]," April 19, 2022. https://baike.baidu.com/item/%E9%A9%AC%E5%85%B0%E8%8A%B1%E5%BC%80/3550027?fr=aladdin.

Baidu Encyclopedia. "Yin Da Ru Qin Gongcheng 引大入秦工程 [Introducing the Da into Qin Project]," February 1, 2022. https://baike.baidu.com/item/%E5%BC%95%E5%A4%A7%E5%85%A5%E7%A7%A6%E5%B7%

A5%E7%A8%8B/7307000.

Balint, Peter J., Ronald E. Stewart, Anand Desai, and Lawrence C. Walters. *Wicked Environmental Problems: Managing Uncertainty and Conflict*. Washington, DC: Island Press, 2011.

Bao, Chao, and Chuanglin Fang. "Water Resources Constraint Force on Urbanization in Water Deficient Regions: A Case Study of the Hexi Corridor, Arid Area of NW China." *Ecological Economics* 62, no. 3 (May 15, 2007): 508–17. https://doi.org/10.1016/j.ecolecon.2006.07.013.

Barbour, Michael G. "Ecological Fragmentation in the Fifties." In *Uncommon Ground: Rethinking the Human Place in Nature*, edited by William Cronon, 233–55. W. W. Norton & Company, 1996.

Barnosky, Anthony D. "Paleontological Evidence for Defining the Anthropocene." *Geological Society, London, Special Publications* 395, no. 1 (January 1, 2014): 149–65. https://doi.org/10.1144/SP395.6.

BBC News. "Apocalyptic Skies as Beijing Hit by Worst Sandstorm in a Decade." March 15, 2021, sec. China. https://www.bbc.com/news/world-asia-china-56399267.

Becerril-Piña, Rocio, and Carlos Alberto Mastachi-Loza. "Desertification: Causes and Countermeasures." In *Life on Land*, edited by Walter Leal Filho, Anabela Marisa Azul, Luciana Brandli, Pinar Gökcin Özuyar, and Tony Wall, 1–13. Cham: Springer International Publishing, 2019. https://doi.org/10.1007/978-3-319-71065-5_81-1.

Beck, Hylke E., Niklaus E. Zimmermann, Tim R. McVicar, Noemi Vergopolan, Alexis Berg, and Eric F. Wood. "Present and Future Köppen-Geiger Climate Classification Maps at 1-Km Resolution." *Scientific Data* 5, no. 1 (October 30, 2018): 180214. https://doi.org/10.1038/sdata.2018.214.

Beiser, Vince. "China's Green Great Wall Is on the Front Line of Its Fight Against Desertification, But Is It Sustainable?" *South China Morning Post*, December 15, 2018. https://www.scmp.com/magazines/post-magazine/long-reads/article/2177586/chinas-green-great-wall-front-line-its-fight.

Bélanger, Pierre. "Landscape As Infrastructure." *Landscape Journal* 28, no. 1 (January 1, 2009): 79–95. https://doi.org/10.3368/lj.28.1.79.

———. *Landscape as Infrastructure: A Base Primer*. Abingdon, Oxon.; New York, NY: Routledge, 2016.

Bennett, Jane. *Vibrant Matter: A Political Ecology of Things*. Durham: Duke University Press Books, 2010.

Berger, Alan. *Drosscape: Wasting Land in Urban America*. New York: Princeton Architectural Press, 2007.

Berkes, Fikret, and Carl Folke. *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge

University Press, 2000.

Bie, Qiang, and Yaowen Xie. "The Constraints and Driving Forces of Oasis Development in Arid Region: A Case Study of the Hexi Corridor in Northwest China." *Scientific Reports* 10, no. 1 (October 19, 2020): 17708. https://doi.org/10.1038/s41598-020-74930-z.

Bloomberg News. "Chinese Anger Over Pollution Becomes Main Cause of Social Unrest." March 6, 2013. https://www.bloomberg.com/news/articles/2013-03-06/pollution-passes-land-grievances-as-main-spark-of-china-protests.

Botden, Niek, Susana Carvalho, Miguel Costa, E. Heuvelink, Oliver Körner, and Anke van der Ploeg. *Greenhouse Horticulture in China: Situation & Prospects*. Wageningen: Horticulture Production Chains Group, 2004.

Botequilha Leitão, André, and Jack Ahern. "Applying Landscape Ecological Concepts and Metrics in Sustainable Landscape Planning." *Landscape and Urban Planning* 59, no. 2 (April 15, 2002): 65–93. https://doi.org/10.1016/S0169-2046(02)00005-1.

Bounoua, Lahouari, Ruth Defries, GJ Collatz, Piers Sellers, and H Khan. "Effects of Land Cover Conversion on Surface Climate." *Cc* 52 (January 1, 2002): 29. https://doi.org/10.1023/A:1013051420309.

Bramwell, Anna. *Ecology in the 20th Century: A History*. New Haven: Yale University Press, 1989.

Brenner, Neil, ed. *Implosions/Explosions: Towards a Study of Planetary Urbanization*. Berlin: Jovis, 2014.

———. "The Hinterland Urbanised?" *Architectural Design* 86, no. 4 (2016): 118–27. https://doi.org/10.1002/ad.2077.

———. "Theses on Urbanization." *Public Culture* 25, no. 1 (69) (January 1, 2013): 85–114. https://doi.org/10.1215/08992363-1890477.

Brenner, Neil, and Stuart Elden. "Henri Lefebvre on State, Space, Territory." *International Political Sociology* 3, no. 4 (December 1, 2009): 353–77. https://doi.org/10.1111/j.1749-5687.2009.00081.x.

Brenner, Neil, and Christian Schmid. "Planetary Urbanisation." In *Urban Constellations*, edited by Matthew Gandy, 10–13. Jovis, 2011. https://www.research-collection.ethz.ch/handle/20.500.11850/43038.

———. "The 'Urban Age' in Question." *International Journal of Urban and Regional Research* 38, no. 3 (2014): 731–55.

Business Wire. "Over 600 Million People Planted More Than 326 Million Trees via Alipay Ant Forest in Five Years." *Business Wire*, August 25, 2021. https://www.businesswire.com/news/home/20210825005340/en/Over-600-Million-People-Planted-More-Than-326-Million-Trees-via-Alipay-Ant-Forest-in-Five-Years.

Callow, J. Nikolaus, Matthew R. Hipsey, and Ryan I. J. Vogwill. "Surface Water as a Cause of Land Degradation from Dryland Salinity." *Hydrology and Earth System Sciences* 24, no. 2 (February 17, 2020): 717–34. https://doi.org/10.5194/hess-24-717-2020.

Campagnaro, Thomas, Tommaso Sitzia, Peter Bridgewater, Douglas Evans, and Erle C Ellis. "Half Earth or Whole Earth: What Can Natura 2000 Teach Us?" *BioScience* 69, no. 2 (February 1, 2019): 117–24. https://doi.org/10.1093/biosci/biy153.

Campanella, Thomas J. *The Concrete Dragon: China's Urban Revolution and What It Means for the World*. New York: Princeton Architectural Press, 2008.

Capra, Fritjof. *The Turning Point: Science, Society, and the Rising Culture*. London: Flamingo, 1983.

Carson, Rachel. *Silent Spring*. Anniversary edition. Boston: Houghton Mifflin Company, 2002.

Castells, Manuel. *The Urban Question: A Marxist Approach*. Translated by Alan Sheridan. London: Edward-Arnold, 1977.

Castelvecchi, Davide. "Electric Cars and Batteries: How Will the World Produce Enough?" *Nature* 596, no. 7872 (August 17, 2021): 336–39. https://doi.org/10.1038/d41586-021-02222-1.

CDM Executive Board. "Project Design Document Form for CDM Project Activities - Gansu Jinta Solar Power Generation Project." UN Climate Change, Clean Development Mechanism, December 12, 2012. https://cdm.unfccc.int/UserManagement/FileStorage/QKU3E8B2VAT9NPL46FDZG075OJYXHW.

Chan, Kam Wing. *Cities with Invisible Walls: Reinterpreting Urbanization in Post-1949 China*. Hong Kong; New York: Oxford University Press, 1994.

Chang, Chunshu. *The Rise of the Chinese Empire: Frontier, Immigration, and Empire in Han China, 130 B.C.–A.D.157*. Ann Arbor: University of Michigan Press, 2007.

———. *The Rise of the Chinese Empire: Nation, State, and Imperialism in Early China, ca. 1600 B.C.–A.D. 8*. Ann Arbor: University of Michigan Press, 2007.

Chang, Hexing, and Dong Wang. "Ecological Infrastructure as a Systematic Approach to Water Issues." In *Landscape Approach: From Local Communities to Territorial Systems*, edited by Hannes Zander, Shelagh McCartney, Samantha Solano, and Sonja Vangjeli, 67–77. Applied Research & Design, 2022.

Chang, Leslie T. *Factory Girls: From Village to City in a Changing China*. New York: Spiegel & Grau, 2009.

Chen, Chi, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K.

Chaturvedi, Richard Fuchs, et al. "China and India Lead in Greening of the World Through Land-Use Management." *Nature Sustainability* 2, no. 2 (February 2019): 122–29. https://doi.org/10.1038/s41893-019-0220-7.

Chen, Mingxing, Yinghua Gong, Yang Li, Dadao Lu, and Hua Zhang. "Population Distribution and Urbanization on Both Sides of the Hu Huanyong Line: Answering the Premier's Question." *Journal of Geographical Sciences* 26, no. 11 (November 1, 2016): 1593–1610. https://doi.org/10.1007/s11442-016-1346-4.

Chen, Shaojun, Yue Wang, Yijie Wang, Zhen Liu, and Juergen Voegele. "The Loess Plateau Watershed Rehabilitation Project." Shanghai: International Bank for Reconstruction and Development / The World Bank, 2004. https://web.worldbank.org/archive/website00819C/WEB/PDF/CHINA_LO.PDF.

Chen, Stephen. "China's Building a Rain-Making Network Three Times the Size of Spain." *South China Morning Post*, March 26, 2018, sec. News. https://www.scmp.com/news/china/society/article/2138866/china-needs-more-water-so-its-building-rain-making-network-three.

Cheng, Aifang, Qi Feng, Guobin Fu, Jiankai Zhang, Zongxing Li, Meng Hu, and Gang Wang. "Recent Changes in Precipitation Extremes in the Heihe River Basin, Northwest China." *Advances in Atmospheric Sciences* 32, no. 10 (October 1, 2015): 1391–1406. https://doi.org/10.1007/s00376-015-4199-3.

China City Planning Review. "State Council Approves Lanzhou New District as the Fifth National New District." *China City Planning Review* 21, no. 4 (2012).

China Daily. "Lanzhou New Area Free Trade Zone." Provincial Government Portal. Lanzhou, Gansu, April 12, 2021. http://lanzhou.gogansu.com/2021-04/12/c_635448.htm.

China Pacific Construction Group. "Group Profile." Taipingyang jianshe 太平洋建设 [Pacific Construction]. Accessed August 27, 2022. http://www.cpcg.com.cn/en/about/2014-05-28/1401266223d2372.shtml.

China.org.cn. "New Area." This is Lanzhou, September 10, 2018. http://lanzhou.china.org.cn/node_7194623.htm.

———. "Wonderful Musical Fountain in Lanzhou New Area." This is Lanzhou, June 18, 2014. http://lanzhou.china.org.cn/2014-06/18/content_32703768.htm.

Chipman Koty, Alexander. "New China Guidelines Aim to Transfer Manufacturing to Inland Regions." *China Briefing News*, February 22, 2022. https://www.china-briefing.com/news/new-china-guidelines-promote-transfer-of-manufacturing-to-inland-regions/.

Cho, Mun Young. *The Specter of "the People": Urban Poverty in Northeast China*.

Ithaca: Cornell University Press, 2013.

City Population. "China: Gansu - Prefectures, Cities, Districts and Counties." Agglomerations of the World. Accessed September 22, 2022. https://www.citypopulation.de/en/china/gansu/admin/.

Clydesdale, Heather. "Rethinking China's Frontier: Archaeological Finds Show the Hexi Corridor's Rapid Emergence as a Regional Power." *Humanities* 7, no. 3 (September 2018): 63. https://doi.org/10.3390/h7030063.

Cohen-Shacham, Emmanuelle, Angela Andrade, James Dalton, Nigel Dudley, Mike Jones, Chetan Kumar, Stewart Maginnis, et al. "Core Principles for Successfully Implementing and Upscaling Nature-Based Solutions." *Environmental Science & Policy* 98 (August 1, 2019): 20–29. https://doi.org/10.1016/j.envsci.2019.04.014.

Cohen-Shacham, Emmanuelle, C. Janzen, Stewart Maginnis, and Gretchen Walters. "Nature-Based Solutions to Address Global Societal Challenges." IUCN, 2016. https://portals.iucn.org/library/node/46191.

Conference of the Parties to the Convention on Biological Diversity. "Kunming Declaration: 'Ecological Civilization: Building a Shared Future for All Life on Earth.'" Kunming: UN Environmental Programme, October 13, 2021. https://www.cbd.int/doc/c/c2db/972a/fb32e0a277bf1ccfff742be5/cop-15-05-add1-en.pdf.

Conte, Niccolo. "Visualizing China's Dominance in the Solar Panel Supply Chain." Visual Capitalist, August 30, 2022. https://www.visualcapitalist.com/visualizing-chinas-dominance-in-the-solar-panel-supply-chain/.

Cooper, Ryan. "The Looming Threat of Chinese Imperialism." *The Week*, March 29, 2018. https://theweek.com/articles/763786/looming-threat-chinese-imperialism.

Corboz, André. "The Land as Palimpsest." *Diogenes* 31, no. 121 (March 1, 1983): 12–34. https://doi.org/10.1177/039219218303112102.

Corner, James. "Ecology and Landscape as Agents of Creativity." In *Ecological Design and Planning*, edited by George F. Thompson and Frederick Steiner, 80–108. New York: John Wiley & Sons, 1997.

———. "Eidetic Operations and New Landscapes." In *Recovering Landscape: Essays in Contemporary Landscape Theory*, edited by James Corner, 153–69. Princeton Architectural Press, 1999.

———, ed. *Recovering Landscape: Essays in Contemporary Landscape Architecture*. New York: Princeton Architectural Press, 1999.

———. "The Agency of Mapping: Speculation, Critique and Invention." In *Mappings*, edited by Denis Cosgrove, 213–52. London: Reaktion Books, 1999.

Corner, James, Alex S. MacLean, and Denis Cosgrove. *Taking Measures Across*

the American Landscape. New Haven, Conn.: Yale University Press, 1996.

Cosgrove, Denis. "Introduction." In *Mappings*, 1–23. London: Reaktion Books, 1999.

———. "Landscape and Landschaft." *GHI Bulletin* 35, no. Fall 2004 (2004): 57–71.

———. "Prospect, Perspective and the Evolution of the Landscape Idea." *Transactions of the Institute of British Geographers* 10, no. 1 (1985): 45–62. https://doi.org/10.2307/622249.

———. *Social Formation and Symbolic Landscape*. 2nd ed. Madison, WI: University of Wisconsin Press, 1998.

———. *The Palladian Landscape: Geographical Change and Its Cultural Representations in Sixteenth-Century Italy*. First edition. University Park: Penn State University Press, 1993.

Crosby, Alfred W. *Ecological Imperialism*. Cambridge University Press, 1986.

———. *The Columbian Exchange: Biological and Cultural Consequences of 1492*. Greenwood Publishing Company, 1972.

Crutzen, Paul, and Eugene F. Stoermer. "The 'Anthropocene.'" *IGBP Newsletter* 41 (2000): 17–18.

CSIS Center for Strategic and International Studies. "Reconnecting Asia Project Database." Reconnecting Asia, May 14, 2021. https://reconasia.csis.org/reconnecting-asia-map/.

Cunliffe, Barry. *By Steppe, Desert, and Ocean: The Birth of Eurasia*. Oxford: Oxford University Press, 2017.

Czerniak, Julia, ed. *Case: Downsview Park Toronto*. Munich: Prestel, 2001.

"Database of Laws and Regulations." The National People's Congress of the People's Republic of China. Accessed June 7, 2023. http://www.npc.gov.cn/zgrdw/englishnpc/Law/2009-02/20/content_1471118.htm.

Davis, Robert. "Inventing the Present: Historical Roots of the Anthropocene." Edited by David Oldroyd. *Earth Sciences History* 30, no. 1 (December 20, 2011): 63–84. https://doi.org/10.17704/eshi.30.1.p8327x7042g3q989.

Defries, Ruth S., and Cynthia E. Rosenzweig. "Toward a Whole-Landscape Approach for Sustainable Land Use in the Tropics." *Proceedings of the National Academy of Sciences* 107, no. 46 (November 16, 2010): 19627–32. https://doi.org/10.1073/pnas.1011163107.

Deng, Xiangzheng, and Chunhong Zhao. "Identification of Water Scarcity and Providing Solutions for Adapting to Climate Changes in the Heihe River Basin of China." *Advances in Meteorology* 2015 (June 7, 2015): e279173. https://doi.org/10.1155/2015/279173.

Denyer, Simon. "Along the New Silk Road, a City Built on Sand Is a Monument to China's Problems." *The Washington Post*, May 29, 2016. https://

www.washingtonpost.com/world/asia_pacific/along-the-new-silk-road-a-city-built-on-sand-is-a-monument-to-chinas-problems/2016/05/29/982424c0-1d09-11e6-82c2-a7dcb313287d_story.html.

Desjardins, Jeff. "China's Staggering Demand for Commodities." Visual Capitalist, March 2, 2018. https://www.visualcapitalist.com/chinas-staggering-demand-commodities/.

Di Cosmo, Nicola. *Ancient China and Its Enemies: The Rise of Nomadic Power in East Asian History*. Cambridge, UK; New York: Cambridge University Press, 2004.

———. "The Northern Frontier in Pre–Imperial China." In *The Cambridge History of Ancient China: From the Origins of Civilization to 221 BC*, edited by Edward L. Shaughnessy and Michael Loewe, 885–966. Cambridge: Cambridge University Press, 1999. https://doi.org/10.1017/CHOL9780521470308.015.

Dikötter, Frank. *Mao's Great Famine: The History of China's Most Devastating Catastrophe, 1958–62*. London: Bloomsbury Paperbacks, 2017.

———. *The Cultural Revolution: A People's History, 1962–1976*. Bloomsbury Press, 2017.

———. *The Tragedy of Liberation: A History of the Chinese Revolution 1945–1957*. London: Bloomsbury Paperbacks, 2017.

Dinerstein, Eric, David Olson, Anup Joshi, Carly Vynne, Neil D. Burgess, Eric Wikramanayake, Nathan Hahn, et al. "An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm." *BioScience* 67, no. 6 (June 1, 2017): 534–45. https://doi.org/10.1093/biosci/bix014.

Doherty, Gareth, and Charles Waldheim, eds. *Is Landscape... ?: Essays on the Identity of Landscape*. Abingdon; New York: Routledge, 2015.

Dong, Guanghui, Yishi Yang, Xinyi Liu, Haiming Li, Yifu Cui, Hui Wang, Guoke Chen, John Dodson, and Fahu Chen. "Prehistoric Trans-Continental Cultural Exchange in the Hexi Corridor, Northwest China." *The Holocene* 28, no. 4 (April 1, 2018): 621–28. https://doi.org/10.1177/0959683617735585.

Doughty, Christopher E. "Preindustrial Human Impacts on Global and Regional Environment." *Annual Review of Environment and Resources* 38, no. 1 (2013): 503–27. https://doi.org/10.1146/annurev-environ-032012-095147.

Du, Juan. *The Shenzhen Experiment: The Story of China's Instant City*. Cambridge, Massachusetts: Harvard University Press, 2020.

Du, Yaqin. "Xibei xiaoshou yu men fen gongsi 70 nian fazhan ceji 西北销售玉门分公司70年发展侧记 [70 Years of Development of Yumen Branch of [Petro China's] Northwest Sales]." *Shiyou shang bao* 石油商报 *[Petroleum Business Daily]*, December 21, 2021. http://center.cnpc.com.cn/sysb/system/2021/12/01/030051767.shtml.

Duan, Quntao, Lihui Luo, Wenzhi Zhao, Yanli Zhuang, and Fang Liu. "Mapping and Evaluating Human Pressure Changes in the Qilian Mountains." *Remote Sensing* 13, no. 12 (January 2021): 2400. https://doi.org/10.3390/rs13122400.

Economy, Elizabeth C. *The Third Revolution: Xi Jinping and the New Chinese State*. New York, NY: Oxford University Press, 2018.

Elden, Stuart. "Land, Terrain, Territory." *Progress in Human Geography* 34, no. 6 (December 1, 2010): 799–817. https://doi.org/10.1177/0309132510362603.

El-Hinnawi, Essam. "Environmental Refugees." Nairobi, Kenya: United Nations Environment Programme, 1985. https://digitallibrary.un.org/record/121267?ln=en.

Eliot, Charles W. 2nd. "Considerations of Defense and Post-Defense Planning: The Landscape Architect as a Constructive Factor." *Landscape Architecture Magazine* 31, no. 3 (1941): 123–24.

Ellefsen, Karl Otto, and Espen Aukrust Hauglin. "The Imprint of Fisheries on Land: The Logics of Settlement Structure and Place in an Arctic Landscape." *Landscape Architecture*, no. 11 (2022): 91–103.

Ellefsen, Karl Otto, and Tarald Lundevall. *North Atlantic Coast. A Monography of Place*. Oslo: Pax Forlag, 2019.

Ellis, Erle C. "Anthropogenic Transformation of the Terrestrial Biosphere." *Philosophical Transactions: Mathematical, Physical and Engineering Sciences* 369, no. 1938 (2011): 1010–35.

———. "Ecology in an Anthropogenic Biosphere." *Ecological Monographs* 85, no. 3 (2015): 287–331. https://doi.org/10.1890/14-2274.1.

———. "To Conserve Nature in the Anthropocene, Half Earth Is Not Nearly Enough." *One Earth* 1, no. 2 (October 25, 2019): 163–67. https://doi.org/10.1016/j.oneear.2019.10.009.

Ellis, Erle C., Jed O. Kaplan, Dorian Q. Fuller, Steve Vavrus, Kees Klein Goldewijk, and Peter H. Verburg. "Used Planet: A Global History." *Proceedings of the National Academy of Sciences* 110, no. 20 (May 14, 2013): 7978–85. https://doi.org/10.1073/pnas.1217241110.

Ellis, Erle C., and Navin Ramankutty. "Putting People in the Map: Anthropogenic Biomes of the World." *Frontiers in Ecology and the Environment* 6, no. 8 (2008): 439–47. https://doi.org/10.1890/070062.

Elvin, Mark. *The Retreat of the Elephants: An Environmental History of China*. Yale University Press, 2004.

Fan, Jie. "Western Development Policy: Changes, Effects and Evaluation." In *Developing China's West: A Critical Path to Balanced National Development*, edited by Yue-man Yeung and Shen Jianfa, 79–106. Hong Kong: Chinese University Press, 2004.

Fang, Chuanglin. *Zhongguo Xibu Shengtai Jingji Zoulang* 中国西部生态经济走廊 *[Western Chinese Ecological Economic Corridor]*. Beijing: Shangwu yin shu 商务印书 [Commercial Press], 2004.

Farrer, Martin. "Evergrande: 'Everyone Bet on Inexorably Rising Chinese Property Prices.'" *The Guardian*, December 31, 2021, sec. Business. https://www.theguardian.com/business/2021/dec/31/evergrande-chinese-property-sectors-debt-crisis-to-intensify-in-2022.

Feng, Qi, Hua Ma, Xuemei Jiang, Xin Wang, and Shixiong Cao. "What Has Caused Desertification in China?" *Scientific Reports* 5, no. 1 (November 3, 2015): 15998. https://doi.org/10.1038/srep15998.

Food and Agriculture Organization of the United Nations. "Climate Smart Agriculture Sourcebook." Accessed January 25, 2022. https://www.fao.org/climate-smart-agriculture-sourcebook/en/.

Forman, Richard T. T. *Land Mosaics: The Ecology of Landscapes and Regions*. Cambridge: Cambridge University Press, 1995.

Forman, Richard T. T., and Michel Godron. *Landscape Ecology*. New York: Wiley, 1986.

Foster, John Bellamy. "Marx's Theory of Metabolic Rift: Classical Foundations for Environmental Sociology." *American Journal of Sociology* 105, no. 2 (1999): 366–405. https://doi.org/10.1086/210315.

Foster, John Bellamy, and Brett Clark. "Monthly Review: Marxism and the Dialectics of Ecology." *Monthly Review*, October 1, 2016. https://monthlyreview.org/2016/10/01/marxism-and-the-dialectics-of-ecology/.

Friedmann, John. *China's Urban Transition*. Minneapolis: University of Minnesota Press, 2005.

Gandy, Matthew. "Cyborg Urbanization: Complexity and Monstrosity in the Contemporary City." *International Journal of Urban and Regional Research* 29, no. 1 (2005): 26–49. https://doi.org/10.1111/j.1468-2427.2005.00568.x.

Gao, Xiang, Xingxing Huang, Kevin Lo, Qianwen Dang, and Ruiyang Wen. "Vegetation Responses to Climate Change in the Qilian Mountain Nature Reserve, Northwest China." *Global Ecology and Conservation* 28 (August 1, 2021): e01698. https://doi.org/10.1016/j.gecco.2021.e01698.

Gao, Xincai, Zhongyang Ji, Fayyaz Ahmad, and Muhammad Umar Draz. "Financial Support and Growth of Township and Village Enterprises in China: Fresh Evidence From Regional Analyses." *SAGE Open* 9, no. 2 (April 1, 2019): 1–12. https://doi.org/10.1177/2158244019858444.

Gao, Yuan. "Go-West Project Dusts Itself Off in Arid Plateau." *Chinadaily*, November 19, 2012. www.chinadaily.com.cn/business/2012-11/19/content_15942037.htm.

Garnett, Stephen T., Neil D. Burgess, Julia E. Fa, Álvaro Fernández-Llamaz-

ares, Zsolt Molnár, Cathy J. Robinson, James E. M. Watson, et al. "A Spatial Overview of the Global Importance of Indigenous Lands for Conservation." *Nature Sustainability* 1, no. 7 (July 2018): 369–74. https://doi.org/10.1038/s41893-018-0100-6.

Ge, Zhaoguang. "The 'Interior' and the 'Exterior' in Historical China: A Re-Clarification of the Concepts of 'China' and the 'Periphery.'" *Chinese Studies in History* 51, no. 1 (January 2, 2018): 4–28. https://doi.org/10.1080/00094633.2018.1467668.

Geddes, Patrick. "The Study of Cities (1972[1915])." In *The Ecological Design and Planning Reader*, edited by Forster O. Ndubisi, 58–65. Washington, DC: Island Press/Center for Resource Economics, 2014.

Ghassemi, Fereidoun, A. J. Jakeman, and H. A. Nix. *Salinisation of Land and Water Resources: Human Causes, Extent, Management and Case Studies*. Wallingford, UK: CAB International, 1995.

Gibbs, H. K., and J. M. Salmon. "Mapping the World's Degraded Lands." *Applied Geography* 57 (February 1, 2015): 12–21. https://doi.org/10.1016/j.apgeog.2014.11.024.

Gittings, John. *The Changing Face of China: From Mao to Market*. 1 edition. Oxford; New York: Oxford University Press, 2006.

Gobster, Paul H., Joan I. Nassauer, Terry C. Daniel, and Gary Fry. "The Shared Landscape: What Does Aesthetics Have to Do with Ecology?" *Landscape Ecology* 22, no. 7 (August 1, 2007): 959–72. https://doi.org/10.1007/s10980-007-9110-x.

Gombrich, E. H. *Norm and Form: Studies in the Art of the Renaissance*. Chicago: Phaidon Press, 1966.

Goodman, David S. G. "The Campaign to 'Open up the West': National, Provincial-Level and Local Perspectives." In *China's Campaign to "Open up the West": National, Provincial and Local Perspectives*, 317–34. The China Quarterly. Cambridge; New York: Cambridge University Press, 2004.

Gradstein, Felix M., James G. Ogg, Mark D. Schmitz, and Gabi M. Ogg, eds. *The Geological Time Scale 2012*. Boston: Elsevier, 2012. https://doi.org/10.1016/B978-0-444-59425-9.00001-9.

Greim, Peter, A. A. Solomon, and Christian Breyer. "Assessment of Lithium Criticality in the Global Energy Transition and Addressing Policy Gaps in Transportation." *Nature Communications* 11, no. 1 (September 11, 2020): 4570. https://doi.org/10.1038/s41467-020-18402-y.

Groff, Stephen P., and Stefan Rau. "China's City Clusters: Pioneering Future Mega-Urban Governance." *American Affairs* 3, no. 2 (2019): 134–50.

Gu, Chaolin, Shen Jianfa, and Taofang Yu. "Urban and Regional Development." In *Developing China's West: A Critical Path to Balanced National Development*, edited by Yue-man Yeung and Shen Jianfa, 177–212. Hong

Kong: Chinese University Press, 2004.

Guan, Qingyu, Liqin Yang, Ninghui Pan, Jinkuo Lin, Chuanqi Xu, Feifei Wang, and Zeyu Liu. "Greening and Browning of the Hexi Corridor in Northwest China: Spatial Patterns and Responses to Climatic Variability and Anthropogenic Drivers." *Remote Sensing* 10, no. 8 (August 2018): 1270. https://doi.org/10.3390/rs10081270.

Guattari, Félix. *The Three Ecologies*. London: The Athlone Press, 2000.

Gui, Ke, Wenrui Yao, Huizheng Che, Linchang An, Yu Zheng, Lei Li, Hujia Zhao, et al. "Record-Breaking Dust Loading During Two Mega Dust Storm Events Over Northern China in March 2021: Aerosol Optical and Radiative Properties and Meteorological Drivers." *Atmospheric Chemistry and Physics* 22, no. 12 (June 17, 2022): 7905–32. https://doi.org/10.5194/acp-22-7905-2022.

Guo, Jie. "Industrial Restructuring and Urban Spaces Transformation in Lanzhou City, With Focus on Its Transition Periods." In *Urban Governance, Spatial Planning and Economic Development in the 21th Century China*, edited by Hans Gebhardt, 95–122. Zurich: Lit Verlag, 2018.

Hamilton, Clive. *Defiant Earth: The Fate of Humans in the Anthropocene*. Cambridge, UK; Malden, MA: Polity, 2017.

Han, Lanying, Zhengcai Zhang, Qiang Zhang, and Xin Wan. "Desertification Assessments in the Hexi Corridor of Northern China's Gansu Province by Remote Sensing." *Natural Hazards* 75, no. 3 (February 1, 2015): 2715–31. https://doi.org/10.1007/s11069-014-1457-0.

Handl, Günther. "Declaration of the United Nations Conference on the Human Environment (Stockholm Declaration), 1972 and the Rio Declaration on Environment and Development, 1992." United Nations, 2012. https://legal.un.org/avl/pdf/ha/dunche/dunche_e.pdf.

Hansen, Valerie. *The Silk Road: A New History*. New York: Oxford University Press, 2012.

Haraway, Donna J. *Staying with the Trouble: Making Kin in the Chthulucene*. Durham, NC: Duke University Press, 2016.

Harvard Law Review. "The Double Life of International Law: Indigenous Peoples and Extractive Industries." *Harvard Law Review* 129, no. 6 (2016): 1755–78.

Harvey, David. *A Brief History of Neoliberalism*. Oxford University Press, 2005.

———. *The Limits to Capital*. Oxford: Blackwell, 1982.

He, Yi, Youdong Chen, Wenhui Wang, Haowen Yan, Lifeng Zhang, and Tao Liu. "TS-InSAR Analysis for Monitoring Ground Deformation in Lanzhou New District, the Loess Plateau of China, From 2017 to 2019." *Advances in Space Research* 67, no. 4 (February 15, 2021): 1267–83. https://doi.

org/10.1016/j.asr.2020.11.004.

He, Yimin, and Mingchang Zhou. "The 156 Projects and New China's Industrial and Urban Development." In *Selected Essays on the History of Contemporary China*, edited by Xingxing Zhang, 1:54–70. Historical Studies of Contemporary China. Brill, 2015. https://doi.org/10.1163/9789004292673_004.

Henze, Veronika. "Energy Transition Investment Hit $500 Billion in 2020 – For First Time." *BloombergNEF* (blog), January 19, 2021. https://about.bnef.com/blog/energy-transition-investment-hit-500-billion-in-2020-for-first-time/.

Hernández, Javier C. "It Can Power a Small Nation. But This Wind Farm in China Is Mostly Idle." *The New York Times*, January 15, 2017, sec. World. https://www.nytimes.com/2017/01/15/world/asia/china-gansu-wind-farm.html.

Hewitt, Duncan. "China Promotes Policies to Urge Manufacturers in Expensive Coastal Regions to Move Inland Rather Than Abroad." *International Business Times*, May 18, 2016, sec. Business. https://www.ibtimes.com/china-promotes-policies-urge-manufacturers-expensive-coastal-regions-move-inland-2370602.

Heynen, Nik, Maria Kaika, and Erik Swyngedouw, eds. *In the Nature of Cities: Urban Political Ecology and the Politics of Urban Metabolism*. London: Routledge, 2005.

Hight, Christopher. "Designing Ecologies." In *Projective Ecologies*, edited by Chris Reed and Nina-Marie Lister, 84–105. New York: Actar, 2014.

Hillman, Jonathan E. *The Emperor's New Road: China and the Project of the Century*. New Haven, CT; London: Yale University Press, 2020.

Ho, Peter. *Institutions in Transition: Land Ownership, Property Rights and Social Conflict in China*. Oxford; New York: Oxford University Press, 2005.

———. "Who Owns China's Land? Policies, Property Rights and Deliberate Institutional Ambiguity." *The China Quarterly* 166 (2001): 394–421.

Hobbs, Richard J., Salvatore Arico, James Aronson, Jill S. Baron, Peter Bridgewater, Viki A. Cramer, Paul R. Epstein, et al. "Novel Ecosystems: Theoretical and Management Aspects of the New Ecological World Order." *Global Ecology and Biogeography* 15, no. 1 (2006): 1–7. https://doi.org/10.1111/j.1466-822X.2006.00212.x.

Hobbs, Richard J., Eric Higgs, Carol M. Hall, Peter Bridgewater, F. Stuart Chapin, Erle C. Ellis, John J. Ewel, et al. "Managing the Whole Landscape: Historical, Hybrid, and Novel Ecosystems." *Frontiers in Ecology and the Environment* 12, no. 10 (2014): 557–64. https://doi.org/10.1890/130300.

Hofman, Bert. "How China Can Overcome Its Property Crisis." *OMFIF* (blog), August 1, 2022. https://www.omfif.org/2022/08/how-china-can-overcome-its-property-crisis/.

Holbig, Heike. "The Emergence of the Campaign to Open Up the West: Ideological Formation, Central Decision-Making and the Role of the Provinces." In *China's Campaign to "Open up the West": National, Provincial and Local Perspectives*, edited by David S. G. Goodman, 335–57. The China Quarterly. Cambridge; New York: Cambridge University Press, 2004.

Holling, Crawford Stanley. "The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change." In *Sustainable Development of the Biosphere*, 64–103. Cambridge: Cambridge University Press, 1986.

Hope in a Changing Climate. Documentary. Environmental Education Media Project, 2009.

Hough, Michael. *City Form and Natural Process: Towards a New Urban Vernacular*. New York: Van Nostrand Reinhold Company, 1984.

Hsing, You-tien. *The Great Urban Transformation: Politics of Land and Property in China*. Oxford: Oxford University Press, 2010.

Huahe, Mao. *The Ebb and Flow of Chinese Petroleum: A Story Told by a Witness*. Ideas, History, and Modern China. Leiden, Boston: BRILL, 2019.

Huang, Yasheng. *Capitalism with Chinese Characteristics: Entrepreneurship and the State*. New York: Cambridge University Press, 2008. https://doi.org/10.1017/CBO9780511754210.

Hunt, John Dixon. "Picturesque Mirrors and Ruins of the Past." In *Gardens and the Picturesque: Studies in the History of Landscape Architecture*, 171–91. Cambridge, MA: MIT Press, 1992.

Hutton, Jane, ed. *Material Culture: Assembling and Disassembling Landscapes*. Berlin: Jovis Berlin, 2017.

———. *Reciprocal Landscapes: Stories of Material Movements*. London; New York: Routledge, 2020.

Hyatt, John. "Beijing Overtakes New York City as City with Most Billionaires: Forbes 2021 List." *Forbes*, April 6, 2021, sec. Billionaires. https://www.forbes.com/sites/johnhyatt/2021/04/06/worlds-richest-cities-the-top-10-cities-billionaires-call-home/.

Ibañez, Daniel, Jane Hutton, and Kiel Moe, eds. *Wood Urbanism: From the Molecular to the Territorial*. New York; Barcelona: Actar, 2020.

Intergovernmental Panel on Climate Change. *Climate Change and Land: IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*. Cambridge: Cambridge University Press, 2022. https://doi.org/10.1017/9781009157988.

International Renewable Energy Agency. "World Energy Transitions Outlook: 1.5°C Pathway." Abu Dhabi: International Renewable Energy Agency, 2021. https://www.irena.org/publications/2021/Jun/World-Energy-Tran-

sitions-Outlook.

IPBES. "The Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services: Summary for Policymakers." IPBES Secretariat, Bonn, Germany: Zenodo, November 25, 2019. https://doi.org/10.5281/zenodo.3553579.

IRENA, Arvydas Lebedys, Dennis Akande, Nicolas Coënt, Nazik Elhassan, Gerardo Escamilla, Iana Arkhipova, and Adrian Whiteman. "Renewable Energy Statistics 2022." Abu Dhabi: IRENA, The International Renewable Energy Agency, 2022. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Apr/IRENA_RE_Capacity_Statistics_2022.pdf.

Jackson, John Brinckerhoff. *Discovering the Vernacular Landscape*. New Haven: Yale University Press, 1986.

Jiang, Xiaojuan. "China's Seven-Decades of Opening-Up: Empowering Growth and Reforms." *China Economist (Beijing, China)* 16, no. 4 (2021): 13–29. https://doi.org/10.19602/j.chinaeconomist.2021.07.02.

Jiayuguan shi renmin zhengfu 嘉峪关市人民政府 [Jiayuguan Municipal People's Government]. "Jiayuguan Gaikuang 嘉峪关概况 [Overview of Jiayuguan]," April 17, 2023. http://jyg.gov.cn/zjjyg/index.html.

Jin, Lan, Jie Qiu, Yaqun Zhang, Weitao Qiu, Xiaochun He, Yixuan Wang, Qingmei Sun, et al. "Ambient Air Pollution and Congenital Heart Defects in Lanzhou, China." *Environmental Research Letters* 10, no. 7 (July 2015): 074005. https://doi.org/10.1088/1748-9326/10/7/074005.

Jing, Jun. *The Temple of Memories: History, Power, and Morality in a Chinese Village*. Stanford, CA: Stanford University Press, 1996.

Jones, Kate E., Nikkita G. Patel, Marc A. Levy, Adam Storeygard, Deborah Balk, John L. Gittleman, and Peter Daszak. "Global Trends in Emerging Infectious Diseases." *Nature* 451, no. 7181 (February 2008): 990–93. https://doi.org/10.1038/nature06536.

Jones, Nicola. "How the World Passed a Carbon Threshold and Why It Matters." *Yale Environment 360*, January 26, 2017. https://e360.yale.edu/features/how-the-world-passed-a-carbon-threshold-400ppm-and-why-it-matters.

Kaiman, Jonathan. "China to Flatten 700 Mountains for New Metropolis in the Desert." *The Guardian*, December 6, 2012, sec. World news. https://www.theguardian.com/world/2012/dec/06/china-flatten-mountain-lanzhou-new-area.

Kay, James J., and Eric Schneider. "Embracing Complexity: The Challenge of the Ecosystem Approach." *Alternatives Journal* 20, no. 3 (1994): 32–38.

Keil, Roger. "Urban Political Ecology 1." *Urban Geography* 24, no. 8 (December

1, 2003): 723–38. https://doi.org/10.2747/0272-3638.24.8.723.

Kilbourne, William E. "Consumption and the Ecological Crisis: Historical Roots." In *Proceedings of the 1995 World Marketing Congress*, edited by K. Grant and I. Walker, 99–107. Developments in Marketing Science: Proceedings of the Academy of Marketing Science. Cham: Springer International Publishing, 2015. https://doi.org/10.1007/978-3-319-17311-5_17.

Kirkby, R. J. R. *Urbanisation in China: Town and Country in a Developing Economy 1949-2000 AD*. London: Croom Helm, 1985.

Klein, Richard G. "Modern Human Origins." *General Anthropology* 20, no. 1 (2013): 1–4. https://doi.org/10.1111/j.1939-3466.2013.00002.x.

Knapp, Ronald G., ed. *Chinese Landscapes: The Village as Place*. Honolulu: University of Hawaii Press, 1992.

Kuo, Lily. "China Claims to Have Eliminated Poverty, but the Figures Mask Harsh Challenges." *The Washington Post*, February 25, 2022. https://www.washingtonpost.com/world/asia_pacific/china-poverty-economy-growth/2021/02/25/9e92cb18-7722-11eb-9489-8f7dacd51e75_story.html.

Kutschera, U. "The Age of Man: A Father Figure." *Science* 340, no. 6138 (June 14, 2013): 1287–1287. https://doi.org/10.1126/science.340.6138.1287-a.

Kutzbach, John E., W. F. Ruddiman, S. J. Vavrus, and G. Philippon. "Climate Model Simulation of Anthropogenic Influence on Greenhouse-Induced Climate Change (Early Agriculture to Modern): The Role of Ocean Feedbacks." *Climatic Change* 99, no. 3 (April 1, 2010): 351–81. https://doi.org/10.1007/s10584-009-9684-1.

Laland, Kevin N., and Michael J. O'Brien. "Cultural Niche Construction: An Introduction." *Biological Theory* 6, no. 3 (September 1, 2011): 191–202. https://doi.org/10.1007/s13752-012-0026-6.

Lan, Yao. "Asia's Largest Desert Reservoir Hongyashan to Be Expanded." Ecns.cn (China News Service), March 4, 2016. http://www.ecns.cn/hd/2016-03-04/detail-ifytxtex5111948.shtml.

Lang, Kuei, and Conor Salcetti. "The World is Watching! China Builds Its First Hundred-Megawatt Molten Salt Solar Thermal Power Plant." *Advantech*, March 20, 2019. https://www.advantech.com/th-th/resources/case-study/the-world-is-watching-china-builds-its-first-hundred-megawatt-molten-salt-solar-thermal-power-plant.

Lanzhou New Area [Promotion Video]. YouTube, 2012. https://www.youtube.com/watch?v=kF1l6P-W0Hs.

Lanzhou New District Party Working Committee. "Qinwangchuan de Chuanshuo 秦王川的传说 [The Legend of Qinwangchuan]." Lanzhou xinqu menhu wangzhan 兰州新区门户网站 [Lanzhou New Area Web Portal], May 16, 2022. http://www.lzxq.gov.cn/system/2019/06/24/000071436.

shtml.

Lanzhou xinqu dang gong wei bangongshi 兰州新区党工委办公室 [Lanzhou New Area Party Working Committee Office]. "Lanzhou Xinqu Gaikuang 兰州新区概况 [Overview of Lanzhou New Area]." Lanzhou xinqu menhu wangzhan 兰州新区门户网站 [Lanzhou New Area Web Portal], April 26, 2022. http://www.lzxq.gov.cn/system/2018/10/25/030000231.shtml.

"Lanzhou—Xining Chengshi Qun Fazhan Guihua 兰州—西宁城市群发展规划 [Lanzhou - Xining City Cluster Development Plan]." Chinese National Development and Reform Commission and Ministry of Housing and Urban-Rural Development, 2018. http://www.ndrc.gov.cn/zcfb/zcfbghwb/201803/ W020180320368228843033.pdf,.

Larson, Christina. "Losing Arable Land, China Faces Stark Choice: Adapt or Go Hungry." *Science* 339, no. 6120 (February 8, 2013): 644–45. https://doi.org/10.1126/science.339.6120.644.

Lassus, Bernard. *The Landscape Approach*. Philadelphia: University of Pennsylvania Press, 1998.

Latour, Bruno. *We Have Never Been Modern*. Cambridge, Mass: Harvard University Press, 1993.

Lefebvre, Henri. *The Production of Space*. La Production de l'éspace. Oxford: Blackwell, 1991.

———. *The Urban Revolution*. Minneapolis: University of Minnesota Press, 2003.

Leo Action Planning. "Company Profile." Lei ao xingdong guihua 蕾奥行动规划 [Leo Action Planning]. Accessed August 29, 2022. https://www.lay-out.com.cn/about-profile-about.htm.

———. "Lanzhou New District Master Plan Solicitation." Lei ao xingdong guihua 蕾奥行动规划 [Leo Action Planning]. Accessed August 29, 2022. https://www.lay-out.com.cn/projects-i_14322.htm.

Lewis, Simon L., and Mark A. Maslin. "Defining the Anthropocene." *Nature* 519, no. 7542 (March 2015): 171–80. https://doi.org/10.1038/nature14258.

Li, Bingcheng. *Hexi zoulang lishi shiqi shamohua yanjiu* 河西走廊历史时期沙漠化研究 *[Desertification History Along the Hexi Corridor]*. Beijing: Kexue chuban she 科学出版社 [Science Press Ltd.], 2003.

Li, Bo, and Michela Giorcelli. "Technology Transfer and Early Industrial Development: The Case of the Sino-Soviet Alliance." *Centre for Economic Policy Research (CEPR)* (blog), January 10, 2022. https://cepr.org/voxeu/columns/technology-transfer-and-early-industrial-development-case-sino-soviet-alliance.

Li, Cao, and Rebecca Feng. "The Bursting Chinese Housing Bubble Compounds Beijing's Economic Woes." *The Wall Street Journal*, August 11, 2022,

sec. World. https://www.wsj.com/articles/bursting-chinese-housing-bubble-compounds-beijings-economic-woes-11660235003.

Li, Jianguo, Lijie Pu, Mingfang Han, Ming Zhu, Runsen Zhang, and Yangzhou Xiang. "Soil Salinization Research in China: Advances and Prospects." *Journal of Geographical Sciences* 24, no. 5 (October 1, 2014): 943–60. https://doi.org/10.1007/s11442-014-1130-2.

Li, Jing. "80 Per Cent of Groundwater in China's Major River Basins Is Unsafe for Humans, Study Reveals." *South China Morning Post*, April 11, 2016, sec. News. https://www.scmp.com/news/china/policies-politics/article/1935314/80-cent-groundwater-chinas-major-river-basins-unsafe.

Li, Jing, Guoqiang Ma, Jinghua Feng, Liying Guo, and Yinzhou Huang. "Local Residents' Social-Ecological Adaptability of the Qilian Mountain National Park Pilot, Northwestern China." *Land* 11, no. 5 (May 2022): 742. https://doi.org/10.3390/land11050742.

Li, Peiyue, Hui Qian, and Jianhua Wu. "Environment: Accelerate Research on Land Creation." *Nature* 510, no. 7503 (June 2014): 29–31. https://doi.org/10.1038/510029a.

Li, Shicheng, Shan Su, Yanxia Liu, Xuewu Zhou, Quanxin Luo, and Basanta Paudel. "Effectiveness of the Qilian Mountain Nature Reserve of China in Reducing Human Impacts." *Land* 11, no. 7 (July 2022): 1071. https://doi.org/10.3390/land11071071.

Li, Taian, Fraser Shilling, James Thorne, Fengmin Li, Heidi Schott, Ryan Boynton, and Alison M. Berry. "Fragmentation of China's Landscape by Roads and Urban Areas." *Landscape Ecology* 25, no. 6 (July 1, 2010): 839–53. https://doi.org/10.1007/s10980-010-9461-6.

Li, Xiaojian, Yue-man Yeung, and Jiajun Qiao. "Historical Legacy and Future Challenges." In *Developing China's West: A Critical Path to Balanced National Development*, edited by Yue-man Yeung and Shen Jianfa, 27–50. Hong Kong: Chinese University Press, 2004.

Li, Xiaoqiang, Nan Sun, John Dodson, Ming Ji, Keliang Zhao, and Xinying Zhou. "The Impact of Early Smelting on the Environment of Huoshiliang in Hexi Corridor, NW China, as Recorded by Fossil Charcoal and Chemical Elements." *Palaeogeography, Palaeoclimatology, Palaeoecology* 305, no. 1 (May 15, 2011): 329–36. https://doi.org/10.1016/j.palaeo.2011.03.015.

Li, Xinrong, Huijuan Tan, Mingzhu He, Xin-Ping Wang, and XiaoJun Li. "Patterns of Shrub Species Richness and Abundance in Relation to Environmental Factors on the Alxa Plateau: Prerequisites for Conserving Shrub Diversity in Extreme Arid Desert Regions." *Science in China, Series D: Earth Sciences* 52 (May 1, 2009): 669–80. https://doi.org/10.1007/s11430-009-0054-7.

Li, Yifei, and Judith Shapiro. *China Goes Green: Coercive Environmentalism for*

a Troubled Planet. Cambridge, UK; Medford, MA: Polity, 2020.

Li, Yiyuan, and M. Shao. "Change of Soil Physical Properties Under Long-Term Natural Vegetation Restoration in the Loess Plateau of China." *Journal of Arid Environments* 64, no. 1 (January 1, 2006): 77–96. https://doi.org/10.1016/j.jaridenv.2005.04.005.

Lim, Tai Wei, Henry Chan, and Katherine Tseng. *China's One Belt One Road Initiative*. London; New Jersey: Imperial College Press, 2016.

Lin, George C. S. "Chinese Urbanism in Question: State, Society, and the Reproduction of Urban Spaces." *Urban Geography* 28 (February 1, 2007): 7–29. https://doi.org/10.2747/0272-3638.28.1.7.

———. *Developing China: Land, Politics and Social Conditions*. Routledge Contemporary China Series. New York: Routledge, 2009.

Lister, Nina-Marie. "Sustainable Large Parks: Ecological Design or Designer Ecology?" In *Large Parks*, edited by Julia Czerniak and George Hargreaves, 35–57. New York: Princeton Architectural Press, 2007.

Liu, Dongsheng. "Kaizhan 'Renlei Shi' Huanjing Yanjiu, Zuo Xin Shidai Dixue de Kaita Zhe—Jinian Huang Ji Qing Xiansheng Di Dixue Chuangxin Jingshen 开展"人类世"环境研究, 做新时代地学的开拓者—纪念黄汲清先生的地学创新精神 [Carrying out 'Anthropocene' Environmental Research and Becoming a Pioneer of Geoscience in the New Era]." *Di Si Ji Yanjiu* 第四纪研究 *[Quaternary Sciences]* 24, no. 4 (September 9, 2004): 369–78. https://doi.org/10.3321/j.issn:1001-7410.2004.04.001.

Liu, Jiajia, David A. Coomes, Luke Gibson, Guang Hu, Jinliang Liu, Yangqing Luo, Chuping Wu, and Mingjian Yu. "Forest Fragmentation in China and Its Effect on Biodiversity." *Biological Reviews* 94, no. 5 (2019): 1636–57. https://doi.org/10.1111/brv.12519.

Liu, Jianguo, Thomas Dietz, Stephen R. Carpenter, Marina Alberti, Carl Folke, Emilio Moran, Alice N. Pell, et al. "Complexity of Coupled Human and Natural Systems." *Science* 317, no. 5844 (September 14, 2007): 1513–16. https://doi.org/10.1126/science.1144004.

Liu, Jianguo, Thomas Dietz, Stephen R. Carpenter, Carl Folke, Marina Alberti, Charles L. Redman, Stephen H. Schneider, et al. "Coupled Human and Natural Systems." *AMBIO: A Journal of the Human Environment* 36, no. 8 (December 2007): 639–49. https://doi.org/10.1579/0044-7447(2007)36[639:CHANS]2.0.CO;2.

Liu, Sylvia Xihui. "Innovation Design: Made in China 2025." *Design Management Review* 27, no. 1 (2016): 52–58. https://doi.org/10.1111/drev.10349.

Liu, Tao. "Guojia ji xinqu de lilun, shijian ji qi weilai yanjiu fangxiang 国家级新区的理论、实践及其未来研究方向 [Theory, Practice and Future Research Direction of National New Areas]." *Chengshi guancha* 城市观察 *[Urban Insight]*, no. 4 (2015): 67–93. https://doi.org/doi: 0.3969/j.issn.

674-7 78.20 5.04.007.

Liu, Yansui, Jintao Li, and Yuanyuan Yang. "Strategic Adjustment of Land Use Policy Under the Economic Transformation." *Land Use Policy* 74 (May 1, 2018): 5–14. https://doi.org/10.1016/j.landusepol.2017.07.005.

Liu, Yansui, Yu Liu, Yangfen Chen, and Hualou Long. "The Process and Driving Forces of Rural Hollowing in China Under Rapid Urbanization." *Journal of Geographical Sciences* 20, no. 6 (December 1, 2010): 876–88. https://doi.org/10.1007/s11442-010-0817-2.

Locke, Harvey. "Nature Needs Half: A Necessary and Hopeful New Agenda for Protected Areas." *Parks* 19 (November 5, 2013): 13–22. https://doi.org/10.2305/IUCN.CH.2013.PARKS-19-2.HL.en.

Lovelock, James E., and Lynn Margulis. "Atmospheric Homeostasis by and for the Biosphere: The Gaia Hypothesis." *Tellus* 26, no. 1–2 (1974): 2–10. https://doi.org/10.1111/j.2153-3490.1974.tb01946.x.

Luccarelli, Mark. *Lewis Mumford and the Ecological Region: The Politics of Planning*. The Guilford Press, 1997.

Lustgarten, Abrahm. "How Russia Wins the Climate Crisis." *The New York Times*, December 16, 2020, sec. Magazine. https://www.nytimes.com/interactive/2020/12/16/magazine/russia-climate-migration-crisis.html.

Lyle, John Tillman. "Can Floating Seeds Make Deep Forms?" *Landscape Journal* 10, no. 1 (1991): 37–47. https://doi.org/10.3368/lj.10.1.37.

———. *Design for Human Ecosystems: Landscape, Land Use, and Natural Resources*. Washington, D.C: Island Press, 1985.

———. *Regenerative Design for Sustainable Development*. Revised edition. New York, NY: Wiley, 1994.

Ma, Jingna, and Yimeng Zhao. "Rain-Making Drone Takes Maiden Flight." *China Daily*, January 8, 2021. https://enapp.chinadaily.com.cn/a/202101/08/AP5ff7b8f9a310f03332f92efa.html.

Ma, Xiaochun. "Chronology of China's Belt and Road Initiative." *People's Daily Online*, June 24, 2016. http://en.people.cn/n3/2016/0624/c90883-9077342.html.

Maçães, Bruno. *Belt and Road: A Chinese World Order*. London: C Hurst & Co Publishers Ltd, 2018.

MacKaye, Benton. "Regional Planning and Ecology." *Ecological Monographs* 10, no. 3 (1940): 349–53. https://doi.org/10.2307/1948509.

———. *The New Exploration: A Philosophy of Regional Planning [1928]*. Harpers Ferry, W Va: Appalachian Trail Conservancy, 1991.

Mai, Jun, and Echo Xie. "COP15: China's Xi Pledges US$232m for New Fund to Protect Biodiversity." *South China Morning Post*, October 12, 2021, sec. News. https://www.scmp.com/news/china/science/article/3152055/

cop15-chinas-xi-jinping-pledges-us232m-new-fund-protect-world.

Majendie, Adam, and Pratik Parija. "How to Halt Global Warming for $300 Billion." *Bloomberg News*, October 23, 2019. https://www.bloomberg.com/news/articles/2019-10-23/how-to-halt-global-warming-for-300-billion.

Marks, Robert B. *China: An Environmental History*. Second edition. Lanham: Rowman & Littlefield Publishers, 2017.

Mathur, Anuradha, and Dilip Da Cunha. *Mississippi Floods: Designing a Shifting Landscape*. New Haven: Yale University Press, 2001.

McDonald, Robert I., Katherine Weber, Julie Padowski, Martina Flörke, Christof Schneider, Pamela A. Green, Thomas Gleeson, et al. "Water on an Urban Planet: Urbanization and the Reach of Urban Water Infrastructure." *Global Environmental Change* 27 (July 1, 2014): 96–105. https://doi.org/10.1016/j.gloenvcha.2014.04.022.

McGregor, Richard. *The Party: The Secret World of China's Communist Rulers*. New York: Harper Perennial, 2012.

McHarg, Ian L. *Design with Nature*. 1st edition. Garden City, New York: Natural History Press, 1969.

———. "Man and the Environment." In *The Urban Condition: People and Policy in the Metropolis*, edited by Leonard Duhl and John Powell. New York: Basic Books, 1963.

McMahon, Dinny. *China's Great Wall of Debt: Shadow Banks, Ghost Cities, Massive Loans, and the End of the Chinese Miracle*. Boston: Harper Business, 2018.

Meadows, Donella H., Jorgen Randers, Dennis L. Meadows, and William W. Behrens. *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind*. New York: Universe Books, 1972.

Mehrabi, Zia, Erle C. Ellis, and Navin Ramankutty. "The Challenge of Feeding the World While Conserving Half the Planet." *Nature Sustainability* 1, no. 8 (August 2018): 409–12. https://doi.org/10.1038/s41893-018-0119-8.

Meinig, Donald W. "The Beholding Eye: Ten Versions of the Same Scene." In *The Interpretation of Ordinary Landscapes: Geographical Essays*, edited by Donald W. Meinig, 33–48. New York: Oxford University Press, 1979.

Miller, Tom. *China's Asian Dream: Empire Building Along the New Silk Road*. London: Zed Books, 2019.

Minang, Peter. A., Meine van Noordwijk, Olivia E. Freeman, Cheikh Mbow, Jan de Leeuw, and Delia Catacutan, eds. *Climate-Smart Landscapes: Multifunctionality in Practice*. Nairobi, Kenya: World Agroforestry Centre (ICRAF), 2015.

Mo, Yan. "Lanzhou Xinqu—Zhonggong Yuanlao Song Ping de Yuyan 兰州新区—中共元老宋平的预言 [Lanzhou New District—The Prophecy of

Song Ping, the Veteran of the Communist Party]." Weixin Official Accounts Platform, July 4, 2017. http://mp.weixin.qq.com/s?__biz=MzI3NTE2N-jI4Nw==&mid=2670641612&idx=1&sn=9b4941fd132b03079e7fa74a05c85e73&chksm=f1d284ecc6a50dfa2607a441d008ca75fad7d40a09015557f32b6952e3ae3c8f4907e4424366#rd.

Moore, Jason W. "'Amsterdam Is Standing on Norway' Part II: The Global North Atlantic in the Ecological Revolution of the Long Seventeenth Century." *Journal of Agrarian Change* 10, no. 2 (2010): 188–227. https://doi.org/10.1111/j.1471-0366.2009.00262.x.

———. *Capitalism in the Web of Life: Ecology and the Accumulation of Capital*. London: Verso, 2015.

———. "The Capitalocene, Part I: On the Nature and Origins of Our Ecological Crisis." *The Journal of Peasant Studies* 44, no. 3 (May 4, 2017): 594–630. https://doi.org/10.1080/03066150.2016.1235036.

Mostafavi, Mohsen. "Why Ecological Urbanism? Why Now?" In *Ecological Urbanism*, edited by Mohsen Mostafavi and Gareth Doherty, Revised Edition., 12–55. Zurich: Lars Muller Publishers, 2016.

Mostafavi, Mohsen, and Gareth Doherty, eds. *Ecological Urbanism*. Zurich: Lars Muller Publishers, 2010.

Mr. Sustainability. "China Announces Largest Renewable Project Ever," October 18, 2021. https://www.mr-sustainability.com/stories/2021/china-400gw.

Mulder, Ivo, and Aurelia Blin. "State of Finance for Nature: Tripling Investments in Nature-Based Solutions by 2030." Nairobi: United Nations Environment Programme, 2021. https://www.unep.org/resources/state-finance-nature.

Myers, John Peterson, Joshua Reichert, Sandra Postel, Kamaljit Bawa, Les Kaufman, Charles H. Peterson, Stephen Carpenter, et al. *Nature's Services: Societal Dependence on Natural Ecosystems*. Edited by Gretchen Cara Daily. Washington, DC: Island Press, 1997.

Myers, Norman. "Environmental Refugees: A Growing Phenomenon of the 21st Century." *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences* 357, no. 1420 (April 29, 2002): 609–13. https://doi.org/10.1098/rstb.2001.0953.

Myers, Steven Lee. "China's Pledge to Be Carbon Neutral by 2060: What It Means." *The New York Times*, September 23, 2020, sec. World. https://www.nytimes.com/2020/09/23/world/asia/china-climate-change.html.

Narain, Divya, Martine Maron, Hoong Chen Teo, Karen Hussey, and Alex Mark Lechner. "Best-Practice Biodiversity Safeguards for Belt and Road Initiative's Financiers." *Nature Sustainability* 3, no. 8 (August 2020): 650–57. https://doi.org/10.1038/s41893-020-0528-3.

Nassauer, Joan Iverson, and Paul Opdam. "Design in Science: Extending the Landscape Ecology Paradigm." *Landscape Ecology* 23, no. 6 (July 1, 2008): 633–44. https://doi.org/10.1007/s10980-008-9226-7.

National Bureau of Statistics of China. "China Statistical Yearbook 2021," 2022. http://www.stats.gov.cn/sj/ndsj/2021/indexeh.htm.

National Bureau of Statistics of China. "China Statistical Yearbook 2022," 2023. http://www.stats.gov.cn/sj/ndsj/2022/indexeh.htm.

National Bureau of Statistics of China. "Communiqué of the Seventh National Population Census (No. 7)," May 11, 2021. http://www.stats.gov.cn/english/PressRelease/202105/t20210510_1817192.html.

National Bureau of Statistics of China. "National Economy Withstood Pressure and Reached a New Level in 2022." Accessed September 17, 2023. http://www.stats.gov.cn/english/PressRelease/202301/t20230117_1892094.html.

National Development and Reform Commission. "Gansu sheng guomin jingji he shehui fazhan di shisi ge wu nian guihua he er ling sanwu nian yuanjing mubiao gangyao 甘肃省国民经济和社会发展第十四个五年规划和二〇三五年远景目标纲要 [The 14th Five-Year Plan of National Economic and Social Development of Gansu Province Outline of Planning and Vision for 2035]." Zhonghua renmin gongheguo guojia fazhan he gaige weiyuanhui 中华人民共和国国家发展和改革委员会 [National Development and Reform Commission of the PRC], February 2021. https://www.ndrc.gov.cn/fggz/fzzlgh/dffzgh/202105/t20210519_1280212_ext.html.

National Research Council. *Grasslands and Grassland Sciences in Northern China*. Washington, D.C: The National Academies Press, 1992. https://nap.nationalacademies.org/catalog/1942/grasslands-and-grassland-sciences-in-northern-china.

Naughton, Barry. "Industrial Policy during the Cultural Revolution: Military Preparation, Decentralization, and Leaps Forward." In *New Perspectives on the Cultural Revolution*, edited by Christine P. W. Wong, David Zweig, and William A. Joseph, 153–82. Cambridge, MA: Harvard University Asia Center, 1991. https://doi.org/10.2307/j.ctt1sq5tmt.10.

———. "The Third Front: Defence Industrialization in the Chinese Interior." *The China Quarterly*, no. 115 (1988): 351–86.

Newman, Erica A., Maureen C. Kennedy, Donald A. Falk, and Donald McKenzie. "Scaling and Complexity in Landscape Ecology." *Frontiers in Ecology and Evolution* 7 (2019): 293; 1–16. https://doi.org/10.3389/fevo.2019.00293.

Niu, Quanfu, Xiangming Xiao, Yao Zhang, Yuanwei Qin, Xinghai Dang, Jie Wang, Zhenhua Zou, et al. "Ecological Engineering Projects Increased Vegetation Cover, Production, and Biomass in Semiarid and Subhumid

Northern China." *Land Degradation & Development* 30, no. 13 (2019): 1620–31. https://doi.org/10.1002/ldr.3351.

Niu, Shuping, Emma O'Brien, Lulu Yilun Chen, Borges Nhamire, and Christina Larson. "Farming the World: China's Epic Race to Avoid a Food Crisis." *Bloomberg News*, May 22, 2017. https://www.bloomberg.com/graphics/2017-feeding-china/?leadSource=uverify%20wall.

Oakes, Tim. "Building a Southern Dynamo: Guizhou and State Power." In *China's Campaign to "Open up the West": National, Provincial and Local Perspectives*, edited by David S. G. Goodman, 467–87. The China Quarterly. Cambridge; New York: Cambridge University Press, 2004.

Odum, Eugene P. *Fundamentals of Ecology*. Philadelphia: Saunders, 1953.

Olóriz, Clara, ed. *Landscape as Territory: A Cartographic Design Project*. New York, NY: Actar, 2020.

Orff, Kate. *Toward an Urban Ecology*. New York, New York: The Monacelli Press, 2016.

Ouyang, Zhiyun, Changsu Song, Hua Zheng, Stephen Polasky, Yi Xiao, Ian J. Bateman, Jianguo Liu, et al. "Using Gross Ecosystem Product (GEP) to Value Nature in Decision Making." *Proceedings of the National Academy of Sciences* 117, no. 25 (June 23, 2020): 14593–601. https://doi.org/10.1073/pnas.1911439117.

Palazzo, Danilo. *Urban Ecological Design: A Process for Regenerative Places*. Washington, DC: Island Press, 2011.

Pan, Ersheng, Siwei Liu, Jianqin Liu, Qingru Qi, and Zun Guo. "The State Grid Corporation of China's Practice and Outlook for Promoting New Energy Development." *Energy Conversion and Economics* 1, no. 2 (2020): 71–80. https://doi.org/10.1049/enc2.12007.

Parsons, Howard. *Marx and Engels on Ecology*. Westport, Conn: Praeger, 1977.

Phillips, Tom. "China Goes West: A Ghost City in the Sand Comes to Life." *The Guardian*, March 21, 2017, sec. Cities. https://www.theguardian.com/cities/2017/mar/21/china-west-ghost-city-comes-to-life-lanzhou-new-area.

Picon, Antoine. "Constructing Landscape by Engineering Water." In *Landscape Architecture in Mutation: Essays on Urban Landscapes*, edited by Hubertus Adam, Jorg Dettmar, Christoph Girot, Susanne Hauser, Michael Koch, Maya Kohte, Marcel Meili, Antoine Picon, Stefan Rotzler, and Charles Waldheim, 99–115. Zürich: gta Verlag / eth Zürich, 2005.

———. *French Architects and Engineers in the Age of Enlightenment*. Cambridge: Cambridge University Press, 2010.

Pike, Lili. "China's Promise to Stop Building Coal Plants Overseas Is Full of Caveats and Loopholes." *Grid News*, April 28, 2022. https://www.grid.

news/story/global/2022/04/28/chinas-promise-to-stop-building-coal-plants-overseas-is-full-of-caveats-and-loopholes/.

Pimm, Stuart L., Clinton N. Jenkins, and Binbin V. Li. "How to Protect Half of Earth to Ensure It Protects Sufficient Biodiversity." *Science Advances* 4, no. 8 (2018): eaat2616. https://doi.org/10.1126/sciadv.aat2616.

Pongsiri, Montira J., Joe Roman, Vanessa O. Ezenwa, Tony L. Goldberg, Hillel S. Koren, Stephen C. Newbold, Richard S. Ostfeld, Subhrendu K. Pattanayak, and Daniel J. Salkeld. "Biodiversity Loss Affects Global Disease Ecology." *BioScience* 59, no. 11 (December 1, 2009): 945–54. https://doi.org/10.1525/bio.2009.59.11.6.

"Poverty Alleviation: China's Experience and Contribution." Beijing: The State Council Information Office of the People's Republic of China, April 2021. http://www.xinhuanet.com/english/2021-04/06/c_139860414.htm.

Preen, Mark. "China's City Clusters: The Plan to Develop 19 Super-Regions." *China Briefing News*, August 14, 2018. https://www.china-briefing.com/news/chinas-city-clusters-plan-to-transform-into-19-super-regions/.

Pu, Chuanhao, Qiang Xu, Kuanyao Zhao, Yanan Jiang, Lina Hao, Jialiang Liu, Wanlin Chen, and Pinglang Kou. "Characterizing the Topographic Changes and Land Subsidence Associated with the Mountain Excavation and City Construction on the Chinese Loess Plateau." *Remote Sensing* 13, no. 8 (January 2021): 1556. https://doi.org/10.3390/rs13081556.

Pyne, Stephen J. *Vestal Fire: An Environmental History, Told Through Fire, of Europe and Europe's Encounter with the World*. University of Washington Press, 1997.

Qiao, Fangbin. "Increasing Wage, Mechanization, and Agriculture Production in China." *China Economic Review* 46 (December 1, 2017): 249–60. https://doi.org/10.1016/j.chieco.2017.10.002.

Qiu, Bingwen, Gong Chen, Zhenghong Tang, Difei Lu, Zhuangzhuang Wang, and Chongchen Chen. "Assessing the Three-North Shelter Forest Program in China by a Novel Framework for Characterizing Vegetation Changes." *ISPRS Journal of Photogrammetry and Remote Sensing* 133 (November 1, 2017): 75–88. https://doi.org/10.1016/j.isprsjprs.2017.10.003.

Raymond, Christopher M., Niki Frantzeskaki, Nadja Kabisch, Pam Berry, Margaretha Breil, Mihai Razvan Nita, Davide Geneletti, and Carlo Calfapietra. "A Framework for Assessing and Implementing the Co-Benefits of Nature-Based Solutions in Urban Areas." *Environmental Science & Policy* 77 (November 1, 2017): 15–24. https://doi.org/10.1016/j.envsci.2017.07.008.

Redman, Charles L. *Human Impact on Ancient Environments*. University of Arizona Press, 1999.

Redman, Charles L., J. Morgan Grove, and Lauren H. Kuby. "Integrating Social Science into the Long-Term Ecological Research (LTER) Network:

Social Dimensions of Ecological Change and Ecological Dimensions of Social Change." *Ecosystems* 7, no. 2 (March 1, 2004): 161–71. https://doi.org/10.1007/s10021-003-0215-z.

Reed, Chris, and Nina-Marie Lister, eds. *Projective Ecologies*. New York: Actar, 2014.

Reed, James, Liz Deakin, and Terry Sunderland. "What Are 'Integrated Landscape Approaches' and How Effectively Have They Been Implemented in the Tropics: A Systematic Map Protocol." *Environmental Evidence* 4, no. 1 (January 7, 2015): 2. https://doi.org/10.1186/2047-2382-4-2.

Reeves, Jeffrey. "Imperialism and the Middle Kingdom: The Xi Jinping Administration's Peripheral Diplomacy with Developing States." *Third World Quarterly* 39, no. 5 (May 4, 2018): 976–98. https://doi.org/10.1080/01436597.2018.1447376.

Reuters. "China Starts Building First 10-GW Mega Wind Farm." *Reuters*, August 8, 2009, sec. Green Business News. https://www.reuters.com/article/us-china-wind-power-idUSTRE5771IP20090808.

Richardson, Katherine, Will Steffen, Wolfgang Lucht, Jørgen Bendtsen, Sarah E. Cornell, Jonathan F. Donges, Markus Drüke, et al. "Earth Beyond Six of Nine Planetary Boundaries." *Science Advances* 9, no. 37 (September 13, 2023): eadh2458. https://doi.org/10.1126/sciadv.adh2458.

Ritchie, Hannah, and Max Roser. "China: Energy Country Profile." *Our World in Data*, October 27, 2022. https://ourworldindata.org/energy/country/china.

Rittel, Horst W. J., and Melvin M. Webber. "Dilemmas in a General Theory of Planning." *Policy Sciences* 4, no. 2 (June 1, 1973): 155–69. https://doi.org/10.1007/BF01405730.

Robock, Alan, Allison Marquardt, Ben Kravitz, and Georgiy Stenchikov. "Benefits, Risks, and Costs of Stratospheric Geoengineering." *Geophysical Research Letters* 36, no. 19 (2009): 1–9. https://doi.org/10.1029/2009GL039209.

Rockström, Johan, Will Steffen, Kevin Noone, Åsa Persson, F. Stuart III Chapin, Eric Lambin, Timothy Lenton, et al. "Planetary Boundaries: Exploring the Safe Operating Space for Humanity." *Ecology and Society* 14, no. 2 (November 18, 2009). https://doi.org/10.5751/ES-03180-140232.

Rogers, Sarah, Dan Chen, Hong Jiang, Ian Rutherfurd, Mark Wang, Michael Webber, Britt Crow-Miller, et al. "An Integrated Assessment of China's South—North Water Transfer Project." *Geographical Research* 58, no. 1 (2020): 49–63. https://doi.org/10.1111/1745-5871.12361.

Rowe, Peter G., and Har Ye Kan. "China's Townization Plan and Its Implications." In *Common Frameworks: Rethinking the Developmental City in China*, edited by Christopher C. M. Lee, 242–47. Cambridge, MA: Harvard Graduate School of Design, 2016.

Rozelle, Scott, and Natalie Hell. *Invisible China: How the Urban–Rural Divide Threatens China's Rise*. Chicago; London: University of Chicago Press, 2020.

Ruddiman, William F. "The Anthropogenic Greenhouse Era Began Thousands of Years Ago." *Climatic Change* 61, no. 3 (December 1, 2003): 261–93. https://doi.org/10.1023/B:CLIM.0000004577.17928.fa.

Sage, Steven F. *Ancient Sichuan and the Unification of China*. Albany: State University of New York Press, 1992.

Sandom, Christopher, Søren Faurby, Brody Sandel, and Jens-Christian Svenning. "Global Late Quaternary Megafauna Extinctions Linked to Humans, Not Climate Change." *Proceedings of the Royal Society B: Biological Sciences* 281, no. 1787 (July 22, 2014): 1–9. https://doi.org/10.1098/rspb.2013.3254.

Sayer, Jeffrey. "Reconciling Conservation and Development: Are Landscapes the Answer?" *Biotropica* 41, no. 6 (2009): 649–52. https://doi.org/10.1111/j.1744-7429.2009.00575.x.

Sayer, Jeffrey, Terry Sunderland, Jaboury Ghazoul, Jean-Laurent Pfund, Douglas Sheil, Erik Meijaard, Michelle Venter, et al. "Ten Principles for a Landscape Approach to Reconciling Agriculture, Conservation, and Other Competing Land Uses." *Proceedings of the National Academy of Sciences* 110, no. 21 (May 21, 2013): 8349–56. https://doi.org/10.1073/pnas.1210595110.

Schuyler, David. *The New Urban Landscape: The Redefinition of City Form in Nineteenth-Century America*. Baltimore: Johns Hopkins University Press, 1988.

Sciaraffia, Flavio, Sourav Kumar Biswas, Thomas Nideroest, and Hannes Zander, eds. *From the South: Global Perspectives on Landscape and Territory*. Santiago, Chile: Ediciones Universidad del Desarrollo, 2019.

Shapiro, Judith. *Mao's War Against Nature: Politics and the Environment in Revolutionary China*. Cambridge: Cambridge University Press, 2001.

Sheng, Gonghan, Heyuan Chen, Kalifi Ferretti-Gallon, John L. Innes, Zhongjun Wang, Yujun Zhang, and Guangyu Wang. "Moving Toward a Greener China: Is China's National Park Pilot Program a Solution?" *Land* 9, no. 12 (December 2020): 489. https://doi.org/10.3390/land9120489.

Shepard, Wade. *Ghost Cities of China: The Story of Cities Without People in the World's Most Populated Country*. London: Zed Books, 2015.

Shepherd, Christian, and Lyric Li. "Cutthroat Competition, State Support Power China's Electric Car Revolution." *The Washington Post*, December 25, 2022. https://www.washingtonpost.com/world/2022/12/21/china-electric-vehicles-tesla-byd/.

Shi, Kaifang, Yun Chen, Bailang Yu, Tingbao Xu, Linyi Li, Chang Huang, Rui Liu, Zuoqi Chen, and Jianping Wu. "Urban Expansion and Agricultural Land Loss in China: A Multiscale Perspective." *Sustainability* 8, no. 8 (August 11, 2016): 1–16. https://doi.org/10.3390/su8080790.

Shi, Peijun, Xuemin Liu, and Minghuan Yang. "Education and Skill Training." In *Developing China's West: A Critical Path to Balanced National Development*, edited by Yue-man Yeung and Shen Jianfa, 133–51. Hong Kong: Chinese University Press, 2004.

Sijmons, Dirk. "In the Anthropocene, Site Matters in Four Ways." In *Site Matters: Strategies for Uncertainty Through Planning and Design*, edited by Andrea Kahn and Carol J. Burns, 2nd edition., 110–30. London: Routledge, 2020.

Simonson, Wilbur H. "Roadside Planting." *Landscape Architecture* 26, no. 4 (1936): 167–74.

Smith, Neil. *Uneven Development: Nature, Capital, and the Production of Space*. Oxford: Blackwell, 1984.

So, Alvin Y., and Yin-Wah Chu. *The Global Rise of China*. Cambridge, UK: Polity Press, 2016.

Sobrevila, Claudia. "The Role of Indigenous Peoples in Biodiversity Conservation: The Natural but Often Forgotten Partners." Working Paper. Washington, D.C: World Bank Group, May 1, 2008. http://documents.worldbank.org/curated/en/995271468177530126/The-role-of-indigenous-peoples-in-biodiversity-conservation-the-natural-but-often-forgotten-partners.

Solinger, Dorothy J. *Contesting Citizenship in Urban China: Peasant Migrants, the State, and the Logic of the Market*. Berkeley, CA: University of California Press, 1999.

Spencer, Douglas. "Agency and Artifice in the Environment of Neoliberalism." In *Landscape and Agency: Critical Essays*, edited by Ed Wall and Tim Waterman, 177–87. Routledge, 2017.

Spirn, Anne Whiston. "Deep Structure: On Process, Form and Design in the Urban Landscape." edited by T.M. Kristensen, S.E. Larsen, P.G. Moeller, and S.E. Petersen, 9–16. Odense (Denmark): Humanistisk Forskningsraad, 1993.

———. "Ecological Urbanism: A Framework for the Design of Resilient Cities." In *The Ecological Design and Planning Reader*, edited by Forster O. Ndubisi, 557–71. Washington, DC: Island Press/Center for Resource Economics, 2014.

———. "Ian McHarg, Landscape Architecture, and Environmentalism: Ideas and Methods in Context." In *Environmentalism in Landscape Architecture*, edited by Michel Conan, 97–114. Washington, D.C: Dumbarton Oaks Research Library and Collection, 2001.

———. *The Granite Garden: Urban Nature and Human Design*. New York: Basic Books, 1985.

Steffen, Will, Paul J. Crutzen, and John R. McNeill. "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature." *AMBIO: A*

Journal of the Human Environment 36, no. 8 (December 2007): 614–21. https://doi.org/10.1579/0044-7447(2007)36[614:TAAHNO]2.0.CO;2.

Steffen, Will, Jacques Grinevald, Paul Crutzen, and John McNeill. "The Anthropocene: Conceptual and Historical Perspectives." *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 369, no. 1938 (March 13, 2011): 842–67. https://doi.org/10.1098/rsta.2010.0327.

Steiner, Frederick. "Landscape Ecological Urbanism: Origins and Trajectories" 100, no. 4 (2011): 333–37.

Steiner, Frederick R. *The Living Landscape: An Ecological Approach to Landscape Planning*. Washington, DC: Island Press, 2008.

Steinitz, Carl. *A Framework for Geodesign: Changing Geography by Design*. Redlands, Calif: Esri Press, 2012.

———. "A Framework for Theory Applicable to the Education of Landscape Architects (and Other Environmental Design Professionals)." *Landscape Journal* 9, no. 2 (1990): 136–43.

Stilgoe, John R. *Common Landscape of America, 1580-1845*. New Haven: Yale University Press, 1983.

Su, Yong Zhong, Wen Zhi Zhao, Pei Xi Su, Zhi Hui Zhang, Tao Wang, and Raghuvanshi Ram. "Ecological Effects of Desertification Control and Desertified Land Reclamation in an Oasis–Desert Ecotone in an Arid Region: A Case Study in Hexi Corridor, Northwest China." *Ecological Engineering* 29, no. 2 (February 1, 2007): 117–24. https://doi.org/10.1016/j.ecoleng.2005.10.015.

Sullivan, Helen, and Michael Standaert. "Sandstorms Turn Sun Blue and Sky Yellow in Beijing." *The Guardian*, March 29, 2021, sec. Environment. https://www.theguardian.com/environment/2021/mar/29/sandstorms-turn-sun-blue-and-sky-yellow-in-beijing.

Survey Office of National Bureau of Statistics in Gansu. "Gansu Development Yearbook 2020." Lanzhou: Gansu Provincial Bureau of Statistics, 2020. http://tjj.gansu.gov.cn/tjj/tjnj/2020/indexeh.htm.

———. "Gansu Development Yearbook 2022." Electric version. Lanzhou: Gansu Provincial Bureau of Statistics, 2022.

Swyngedouw, Erik. "The City as a Hybrid: On Nature, Society and Cyborg Urbanization." *Capitalism Nature Socialism* 7, no. 2 (June 1, 1996): 65–80. https://doi.org/10.1080/10455759609358679.

Swyngedouw, Erik, and Nikolas C Heynen. "Urban Political Ecology, Justice and the Politics of Scale." *Antipode* 35, no. 5 (2003): 898–918. https://doi.org/10.1111/j.1467-8330.2003.00364.x.

Tang, Xianglong, De Wang, Baihao Li, and Jinxing Liu. "From Continuation

to Evolution: Historic Review and Value Enlightenment of the Lanzhou Urban Construction Plan." *China City Planning Review* 27, no. 04 (2018): 69–75.

Tang, Xiaoping. "The Establishment of National Park System: A New Milestone for the Field of Nature Conservation in China." *International Journal of Geoheritage and Parks*, China's National Park System, 8, no. 4 (December 1, 2020): 195–202. https://doi.org/10.1016/j.ijgeop.2020.11.006.

Tang, Zhuangsheng, Hui An, Lei Deng, Yingying Wang, Guangyu Zhu, and Zhouping Shangguan. "Effect of Desertification on Productivity in a Desert Steppe." *Scientific Reports* 6, no. 1 (June 14, 2016): 27839. https://doi.org/10.1038/srep27839.

Tansley, A. G. "The Use and Abuse of Vegetational Concepts and Terms." *Ecology* 16, no. 3 (1935): 284–307. https://doi.org/10.2307/1930070.

The Economist. "A Tale of 19 Mega Cities: China Is Trying to Turn Itself Into a Country of 19 Super-Regions." *The Economist*, June 23, 2018.

———. "China's Desert-Taming 'Green Great Wall' Is Not as Great as It Sounds." *The Economist*, May 18, 2019. https://www.economist.com/china/2019/05/18/chinas-desert-taming-green-great-wall-is-not-as-great-as-it-sounds.

The Lessons of the Loess Plateau. Documentary. Environmental Education Media Project, 2010.

The World Bank. "A Catalogue of Nature-Based Solutions for Urban Resilience." Washington, D.C.: World Bank, 2021. https://openknowledge.worldbank.org/handle/10986/36507.

The World Bank Data. "GDP Growth (Annual %) - China." Accessed June 22, 2022. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?end=2020&locations=CN&name_desc=false&start=1961&view=chart.

Thevs, Niels, Konrad Ott, Lilin Kerschbaumer, and Ping He. "Study Areas: The Heihe River Basin and Wuliangsuhai Lake at the Hetao Irrigation District." In *Sustainable Water Management and Wetland Restoration Strategies in Northern China*, edited by Giuseppe Tommaso Cirella and Stefan Zerbe, 27–37. Bolzano: Bozen Bolzano University Press, 2014.

Tregear, Thomas R. *A Geography of China*. New Brunswick, N.J: Aldine Transaction, 2008.

Tsing, Anna, Nils Bubandt, Elaine Gan, and Heather Anne Swanson, eds. *Arts of Living on a Damaged Planet: Ghosts and Monsters of the Anthropocene*. Minneapolis: University of Minnesota Press, 2017.

Tsing, Anna Lowenhaupt. *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. Princeton: Princeton University Press, 2015.

Turner, B. L., and Marina Fischer-Kowalski. "Ester Boserup: An Interdisciplinary Visionary Relevant for Sustainability." *Proceedings of the National Academy of Sciences* 107, no. 51 (December 21, 2010): 21963–65. https://doi.org/10.1073/pnas.1013972108.

UN Environment Programme. "Chinese Initiative Ant Forest Wins UN Champions of the Earth Award." UN Environment, September 19, 2019. http://www.unep.org/news-and-stories/press-release/chinese-initiative-ant-forest-wins-un-champions-earth-award.

United Nations. "Commodities at a Glance: Special Issue on Strategic Battery Raw Materials." Geneva: United Nations Conference on Trade and Development, 2020. https://unctad.org/webflyer/commodities-glance-special-issue-strategic-battery-raw-materials.

United Nations Convention to Combat Desertification. "The Global Land Outlook: Second Edition." Bonn: UNCCD, 2022. https://www.unccd.int/resources/global-land-outlook/global-land-outlook-2nd-edition.

United Nations Environment Programme. "Becoming #GenerationRestoration: Ecosystem Restoration for People, Nature and Climate." Nairobi: UNEP, 2021. https://wedocs.unep.org/bitstream/handle/20.500.11822/36251/ERPNC.pdf.

Vidal, John. "Are China's Pledges to Green Its Belt and Road Initiative the Real Deal?" *Ensia*, September 20, 2022. https://ensia.com/features/china-belt-road-initiative-infrastructure-sustainable-silk-road/.

Vigano, Paola. *Territorialism*. Cambridge, Massachusetts: Harvard University Graduate School of Design, 2014.

Vogel, Ezra F. *Deng Xiaoping and the Transformation of China*. Cambridge, MA; London: Harvard University Press, 2011.

Vogel, Hans Ulrich, and Günter Dux, eds. *Concepts of Nature: A Chinese-European Cross-Cultural Perspective*. Leiden, The Netherlands; Boston: Brill, 2010.

Wackernagel, Mathis, and Bert Beyers. *Ecological Footprint: Managing Our Biocapacity Budget*. New Society Publishers, 2019.

Wagner, Donald B. *Iron and Steel in Ancient China*. Leiden, Netherlands; New York: Brill, 1996.

Waldheim, Charles. *Landscape as Urbanism: A General Theory*. Princeton, NJ; Oxford: Princeton University Press, 2016.

———, ed. *The Landscape Urbanism Reader*. New York: Princeton Architectural Press, 2006.

Wall, Ed, and Tim Waterman, eds. *Landscape and Agency: Critical Essays*. London; New York: Routledge, 2017.

Wallemacq, Pascaline, Debarati Guha-Sapir, Denis McClean, CRED, and

UNISDR. *The Human Cost of Weather Related Disasters, 1995 - 2015*, 2015. https://doi.org/10.13140/RG.2.2.17677.33769.

Walsh, Matthew. "Red, Dead, Renewed." *Sixth Tone*, October 29, 2019. https://www.sixthtone.com/news/1004753/https%3A%2F%2Fwww.sixthtone.com%2Fnews%2F1004753%2Fred%252C-dead%252C-renewed.

Wan, Allen, Karoline Kan, and Adam Majendie. "How to Turn an Oil Boomtown Into an Oasis of Renewable Energy." *Bloomberg News*, May 17, 2021. https://www.bloomberg.com/features/2021-yumen-china-oil-city-renewable-energy/.

Wang, Boyu, and Congru Xiong. "Gouzhu Zhongguo Nengyuan Xin Ganxian 构筑中国能源新干线 [Building a New Energy Line in China]." *Jingji Canguan Bao* 经济参观报 *[Economic Information Daily]*, August 29, 2007. http://www.jjckb.cn/wzpd/2007-08/29/content_63991.htm.

Wang, Chao, Xi Chu, Jinyan Zhan, Pei Wang, Fan Zhang, and Zhongling Xin. "Factors Contributing to Efficient Forest Production in the Region of the Three-North Shelter Forest Program, China." *Sustainability* 12, no. 1 (January 2020): 302. https://doi.org/10.3390/su12010302.

Wang, Feng, Xubin Pan, Dongfang Wang, Chongyang Shen, and Qi Lu. "Combating Desertification in China: Past, Present and Future." *Land Use Policy* 31 (March 1, 2013): 311–13. https://doi.org/10.1016/j.landusepol.2012.07.010.

Wang, G., Y. Ding, Y. Shen, and Y. Lai. "Environmental Degradation in the Hexi Corridor Region of China Over the Last 50 Years and Comprehensive Mitigation and Rehabilitation Strategies." *Environmental Geology* 44, no. 1 (May 1, 2003): 68–77. https://doi.org/10.1007/s00254-002-0736-3.

Wang, Guangyu, John L. Innes, Sara W. Wu, Judi Krzyzanowski, Yongyuan Yin, Shuanyou Dai, Xiaoping Zhang, and Sihui Liu. "National Park Development in China: Conservation or Commercialization?" *AMBIO* 41, no. 3 (May 1, 2012): 247–61. https://doi.org/10.1007/s13280-011-0194-9.

Wang, Ju-Han Zoe. "National Parks in China: Parks for People or for the Nation?" *Land Use Policy* 81 (February 1, 2019): 825–33. https://doi.org/10.1016/j.landusepol.2018.10.034.

Wang, Naiang, Zhuolun Li, Hongyi Cheng, Yu Li, and Yinzhou Huang. "High Lake Levels on Alxa Plateau During the Late Quaternary." *Chinese Science Bulletin* 56, no. 17 (June 1, 2011): 1799–1808. https://doi.org/10.1007/s11434-011-4498-8.

Wang Naiang, Zhang Chunhui, Li Gang, and Cheng Hongyi. "Historical Desertification Process in Hexi Corridor, China." *Chinese Geographical Science* 15, no. 3 (September 20, 2005): 245–53.

Wang, Xiaowei, Caixia Zhang, Eerdun Hasi, and Z. B. Dong. "Has the Three Norths Forest Shelterbelt Program Solved the Desertification and Dust

Storm Problems in Arid and Semiarid China?" *Journal of Arid Environments* 74, no. 1 (January 1, 2010): 13–22. https://doi.org/10.1016/j.jaridenv.2009.08.001.

Wang, Xunming, Fahu Chen, Eerdun Hasi, and Jinchang Li. "Desertification in China: An Assessment." *Earth-Science Reviews* 88, no. 3 (June 1, 2008): 188–206. https://doi.org/10.1016/j.earscirev.2008.02.001.

Wang, Yiwei. *Belt and Road Initiative: What Will China Offer the World in Its Rise*. Beijing: New World Press, 2016.

Waters, Colin, Jan Zalasiewicz, Mark Williams, Michael Ellis, and Andrea Snelling. "A Stratigraphical Basis for the Anthropocene?" *Geological Society, London, Special Publications* 395 (May 14, 2014): 1–21. https://doi.org/10.1144/SP395.18.

Watson, Julia. *Lo—TEK. Design by Radical Indigenism*. Taschen, 2020.

Watson, Richard A. "What Moves the Mind: An Excursion in Cartesian Dualism." *American Philosophical Quarterly* 19, no. 1 (1982): 73–81.

Webber, Michael, Britt Crow-Miller, and Sarah Rogers. "The South–North Water Transfer Project: Remaking the Geography of China." *Regional Studies* 51, no. 3 (March 4, 2017): 370–82. https://doi.org/10.1080/00343404.2016.1265647.

Wei, Houkai, and Kai Cui. "Agricultural Modernization on Horizon." *China Daily*, March 18, 2021. //global.chinadaily.com.cn/a/202103/18/WS6052a4c3a31024ad0baafde1.html.

Weigelin-Schwiedrzik, Susanne. "Doing Things With Numbers: Chinese Approaches to the Anthropocene." *International Communication of Chinese Culture* 5, no. 1 (May 1, 2018): 17–37. https://doi.org/10.1007/s40636-018-0115-8.

Welz, Adam. "Are Huge Tree Planting Projects More Hype Than Solution?" *Yale Environment 360*, April 8, 2021. https://e360.yale.edu/features/are-huge-tree-planting-projects-more-hype-than-solution.

White, Lynn. "The Historical Roots of Our Ecologic Crisis." *Science* 155, no. 3767 (March 10, 1967): 1203–7. https://doi.org/10.1126/science.155.3767.1203.

Wikipedia. "156 Xiang zhongdian gongcheng 156项重点工程 [156 Key Projects]," April 30, 2022. https://zh.wikipedia.org/w/index.php?title=156%E9%A1%B9%E9%87%8D%E7%82%B9%E5%B7%A5%E7%A8%8B&oldid=71406000.

Wikipedia. "Jiajing Railway," January 22, 2022. https://en.wikipedia.org/w/index.php?title=Jiajing_Railway&oldid=1067182465.

Wikipedia. "Lanzhou–Xinjiang High-Speed Railway," January 26, 2023. https://en.wikipedia.org/w/index.php?title=Lanzhou%E2%80%93Xinjia

ng_high-speed_railway&oldid=1135675832.

Wikipedia. "Lanzhou-Xinjiang Railway 兰新铁路," December 12, 2022. https://zh.wikipedia.org/w/index.php?title=%E5%85%B0%E6%96%B0%E9%93%81%E8%B7%AF&oldid=75024640.

Wilkinson, Bruce H. "Humans as Geologic Agents: A Deep-Time Perspective." *Geology* 33, no. 3 (March 1, 2005): 161–64. https://doi.org/10.1130/G21108.1.

Wilkinson, David A., Jonathan C. Marshall, Nigel P. French, and David T. S. Hayman. "Habitat Fragmentation, Biodiversity Loss and the Risk of Novel Infectious Disease Emergence." *Journal of The Royal Society Interface* 15, no. 149 (December 21, 2018): 20180403. https://doi.org/10.1098/rsif.2018.0403.

Williams, Dee Mack. *Beyond Great Walls: Environment, Identity, and Development on the Chinese Grasslands of Inner Mongolia*. Stanford, CA: Stanford University Press, 2002.

Willis, A. J. "The Ecosystem: An Evolving Concept Viewed Historically." *Functional Ecology* 11, no. 2 (1997): 268–71. https://doi.org/10.1111/j.1365-2435.1997.00081.x.

Wilson, Edward O. *Half-Earth: Our Planet's Fight for Life*. New York: Liveright, 2016.

Wirth, Louis. "Urbanism as a Way of Life." *American Journal of Sociology* 44, no. 1 (1938): 1–24.

Wong, Edward. "Plan for China's Water Crisis Spurs Concern." *The New York Times*, June 1, 2011, sec. World. https://www.nytimes.com/2011/06/02/world/asia/02water.html.

World Bank Open Data. "GDP per Capita (Current US$) - United States, China, World," 2023. https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=US-CN-1W.

World Economic Forum. "Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy." Geneva: World Economic Forum, 2020. https://www.weforum.org/reports/nature-risk-rising-why-the-crisis-engulfing-nature-matters-for-business-and-the-economy.

World Inequality Database. "China." Accessed July 26, 2023. https://wid.world/country/china/.

Worster, Donald. *Nature's Economy: A History of Ecological Ideas Second Edition*. 2nd edition. Cambridge; New York, NY, USA: Cambridge University Press, 1994.

Wu, Jianguo, and Richard Hobbs. "Landscape Ecology: The State-of-The-Science." In *Key Topics in Landscape Ecology*, edited by Jianguo Wu and Richard J. Hobbs, 271–87. Cambridge Studies in Landscape Ecology.

Cambridge: Cambridge University Press, 2007. https://doi.org/10.1017/CBO9780511618581.016.

Xiao, Xiaoming, Zhenguo Li, and Heping Liang, eds. *Gansu: Grottoes on the Ancient Silk Road*. Panoramic China. Beijing: Foreign Language Press, 2006.

Xie, Yaowen, Qiang Bie, Hui Lu, and Lei He. "Spatio-Temporal Changes of Oases in the Hexi Corridor Over the Past 30 Years." *Sustainability* 10, no. 12 (December 2018): 4489. https://doi.org/10.3390/su10124489.

Xie, Yaowen, Hong Zhao, and Guisheng Wang. "Spatio-Temporal Changes in Oases in the Heihe River Basin of China: 1963–2013." *Écoscience* 22, no. 1 (January 2, 2015): 33–46. https://doi.org/10.1080/11956860.2015.1047140.

Xinhua. "China to Invest $450B Modernizing Agriculture by 2020." *China Daily*, September 19, 2016. https://www.chinadaily.com.cn/business/2016-09/19/content_26828613.htm.

———. "Super Mirror Power Plant in Gansu, NW China." *XinhuaNet*, March 1, 2021. http://www.xinhuanet.com/english/2021-03/01/c_139775005.htm.

Xinhua News Agency. "Xi Says Chinese People Will Never Allow Foreign Bullying, Oppressing, or Subjugating." *China Daily*, July 1, 2021. https://www.chinadaily.com.cn/a/202107/01/WS60dd17cba310efa1bd65f176.html.

Xu, Hui, Lichun Sui, Yuhong Li, and Dawei Zhang. "The Role of Water Users Associations in Integrated Water Resource Management of Zhangye City in Heihe River Basin, China," 304–24, 2014. https://doi.org/10.1201/b17168-17.

Xu, Liyan, Ahmed Eiweida, Yuan Jia, Yuan Xiao, and Hongwei Zhao. "Economic Geography Analysis of Gansu Province: Analytical Report in Support of Project Design of Gansu Revitalization and Innovation Project (GRIP)." Beijing: The World Bank, 2018.

Xu, Shengpeng. "The 14th Five-Year Plan for Energy in Gansu Province Has Been Released!" *Seetao*, February 18, 2022. https://www.seetao.com/details/139415.html.

Xue, Xian, Jie Liao, Youtian Hsing, Cuihua Huang, and Famin Liu. "Policies, Land Use, and Water Resource Management in an Arid Oasis Ecosystem." *Environmental Management* 55, no. 5 (May 1, 2015): 1036–51. https://doi.org/10.1007/s00267-015-0451-y.

Yan, C. Z., Y. M. Zhou, X. Song, and H. C. Duan. "Estimation of Areas of Sand and Dust Emission in the Hexi Corridor from a Land Cover Database: An Approach That Combines Remote Sensing with GIS." *Environmental Geology* 57, no. 3 (April 1, 2009): 707–13. https://doi.org/10.1007/

s00254-008-1349-2.

Yan, Kun, and Ying Ding. "The Overview of the Progress of Qilian Mountain National Park System Pilot Area." *International Journal of Geoheritage and Parks*, China's National Park System, 8, no. 4 (December 1, 2020): 210–14. https://doi.org/10.1016/j.ijgeop.2020.11.008.

Yang, Linhai, Hao Long, Hongyi Cheng, Guangyin Hu, Hanchen Duan, and Hui Zhao. "Historical Settlement Abandonment in the Middle Hexi Corridor Linked to Human-Induced Desertification." *Palaeogeography, Palaeoclimatology, Palaeoecology* 545 (May 1, 2020): 109634. https://doi.org/10.1016/j.palaeo.2020.109634.

Yang, Liu, Zhilin Shi, Shanjia Zhang, and Harry F. Lee. "Climate Change, Geopolitics, and Human Settlements in the Hexi Corridor Over the Last 5,000 Years." *Acta Geologica Sinica - English Edition* 94, no. 3 (2020): 612–23. https://doi.org/10.1111/1755-6724.14529.

Yao, Zhengyi, Cunyu Zhao, Keshuo Yang, Weicheng Liu, Yuan Li, Jiandong You, and Jianhua Xiao. "Alpine Grassland Degradation in the Qilian Mountains, China — A Case Study in Damaying Grassland." *CATENA* 137 (February 1, 2016): 494–500. https://doi.org/10.1016/j.catena.2015.09.021.

Ye, Sijing, Changqing Song, Shi Shen, Peichao Gao, Changxiu Cheng, Feng Cheng, Changjun Wan, and Dehai Zhu. "Spatial Pattern of Arable Land-Use Intensity in China." *Land Use Policy* 99 (December 1, 2020): 104845. https://doi.org/10.1016/j.landusepol.2020.104845.

Yeung, Yue-man. "Introduction." In *Developing China's West: A Critical Path to Balanced National Development*, edited by Yue-man Yeung and Shen Jianfa, 1–26. Hong Kong: Chinese University Press, 2004.

Yeung, Yue-man, Fengjun Jin, and Guang Zeng. "Infrastructure and the New Economy." In *Developing China's West: A Critical Path to Balanced National Development*, edited by Yue-man Yeung and Shen Jianfa, 107–31. Hong Kong: Chinese University Press, 2004.

Yin, Zhicong, Yu Wan, Yijia Zhang, and Huijun Wang. "Why Super Sandstorm 2021 in North China?" *National Science Review* 9, no. 3 (March 1, 2022): nwab165. https://doi.org/10.1093/nsr/nwab165.

Yu, Kongjian. "Creating Deep Forms in Urban Nature: The Peasant's Approach to Urban Design." In *Nature and Cities: The Ecological Imperative in Urban Design and Planning*, edited by Frederick R. Steiner, George F. Thompson, and Armando Carbonell, 95–117. Cambridge, Massachusetts: Lincoln Institute of Land Policy, 2016.

Yu, Kongjian, and Mary Padua, eds. *The Art of Survival: Recovering Landscape Architecture*. Victoria, Australia: Images Publishing Group Pty Ltd, 2006.

Zander, Hannes, Shelagh McCartney, Samantha Solano, and Sonja Vangjeli, eds. *Landscape Approach: From Local Communities to Territorial Systems*. Ap-

plied Research & Design, 2022.

Zastrow, Mark. "China's Tree-Planting Drive Could Falter in a Warming World." *Nature* 573, no. 7775 (September 23, 2019): 474–75. https://doi.org/10.1038/d41586-019-02789-w.

Zeller, Katherine A., Kevin McGarigal, and Andrew R. Whiteley. "Estimating Landscape Resistance to Movement: A Review." *Landscape Ecology* 27, no. 6 (July 1, 2012): 777–97. https://doi.org/10.1007/s10980-012-9737-0.

Zhang, Baichun, Jiuchun Zhang, and Fang Yao. "Technology Transfer from the Soviet Union to the People's Republic of China: 1949-1966." *Comparative Technology Transfer and Society* 4, no. 2 (2006): 105–67. https://doi.org/10.1353/ctt.2006.0024.

Zhang, Ping, Weiwei Li, Kaixu Zhao, and Sidong Zhao. "Spatial Pattern and Driving Mechanism of Urban–Rural Income Gap in Gansu Province of China." *Land* 10 (September 23, 2021): 1002. https://doi.org/10.3390/land10101002.

Zhang, Xiuxia, and Yaowen Xie. "Detecting Historical Vegetation Changes in the Dunhuang Oasis Protected Area Using Landsat Images." *Sustainability* 9, no. 10 (October 2017): 1780. https://doi.org/10.3390/su9101780.

Zhang, Yao, Changhui Peng, Weizhong Li, Liuxi Tian, Qiuan Zhu, Huai Chen, Xiuqin Fang, et al. "Multiple Afforestation Programs Accelerate the Greenness in the 'Three North' Region of China from 1982 to 2013." *Ecological Indicators* 61 (February 1, 2016): 404–12. https://doi.org/10.1016/j.ecolind.2015.09.041.

Zhang, Yaqun, Min Li, Mercedes A. Bravo, Lan Jin, Amruta Nori-Sarma, Yanwen Xu, Donghong Guan, et al. "Air Quality in Lanzhou, a Major Industrial City in China: Characteristics of Air Pollution and Review of Existing Evidence from Air Pollution and Health Studies." *Water, Air, and Soil Pollution* 225, no. 11 (2014): 1–17. https://doi.org/10.1007/s11270-014-2187-3.

Zhang, Ye. "Nation Aims to Retain Processing Trade by Using Favorable Policies." *Global Times*, May 17, 2016. https://www.globaltimes.cn/content/983584.shtml.

Zhang, Yufang. "Gansu Xing Renmin Zhengfu Guanyu Yinfa Gansu Sheng 'Shisiwu' Tuijin Nongye Nongcun Xiandaihua Guihua de Tongzhi 甘肃省人民政府关于印发甘肃省‘十四五’推进农业农村现代化规划的通知_政府文件_中国甘肃网 [Notice of the People's Government of Gansu Province on Printing and Distributing Gansu Province's '14th Five-Year Plan' to Promote the Modernization of Agriculture and Rural Areas]." Lanzhou: Sheng zhengfu bangong ting 省政府办公厅 [(Gansu) Provincial Government Office], February 18, 2022. http://gov.gscn.com.cn/system/2022/03/03/012721548.shtml.

Zhao, Yinan, and Chaohua Xue. "New State-Level Zone to Boost Western

Growth." *China Daily*, September 8, 2012. http://www.chinadaily.com.cn/china/2012-09/08/content_15744715.htm.

Zheng, Yazhuo, and Kent Deng. "Typical Cases in Northwest China." In *State Failure and Distorted Urbanisation in Post-Mao's China, 1993–2012*, edited by Yazhuo Zheng and Kent Deng, 25–64. Palgrave Studies in Economic History. Cham: Springer International Publishing, 2018. https://doi.org/10.1007/978-3-319-92168-6_3.

Zheng, Yiran, and Jingna Ma. "Molten Salt Solar Power Station Largest of Its Kind." *China Daily*, January 8, 2019. https://www.chinadaily.com.cn/a/201901/08/WS5c3408aba31068606745f714.html.

Zhong, Yuhao. "Lanzhou Xinqu Jinnian Yi Shixian 10 Wan Ji Renkou Zengzhang, Ling You Sheng Nei Yimin Zhengce Jiachi 兰州新区今年已实现10万级人口增长，另有省内移民政策加持 [Lanzhou New District Has Achieved a Population Growth of 100,000 This Year and Is Also Supported by the Provincial Immigration Policy]." *Pengpai Xinwen* 澎湃新闻 *[The Paper]*, December 18, 2020. https://www.thepaper.cn/newsDetail_forward_10444130.

Zhongguo tongji chuban she youxian gongsi 中国统计出版社有限公司 [China Statistics Press Co., Ltd.]. "2021 Lanzhou Tongji Nianjian 兰州统计年鉴 [Lanzhou Statistical Yearbook 2021]." Beijing: Zhongguo tongji chuban she 中国统计出版社 [China Statistics Press], October 2021. http://tjj.lanzhou.gov.cn/module/download/downfile.jsp?classid=0&filename=b2930c9ecb9c4c4db6614b894c3332ec.pdf.

Zhou, Xinying, Xiaoqiang Li, John Dodson, Keliang Zhao, Pia Atahan, Nan Sun, and Qing Yang. "Land Degradation During the Bronze Age in Hexi Corridor (Gansu, China)." *Quaternary International*, Holocene Vegetation Dynamics and Human Impact: Agricultural Activities and Rice Cultivation in East Asia II, 254 (March 16, 2012): 42–48. https://doi.org/10.1016/j.quaint.2011.06.046.

Zhu, Xiaolin, Kwok Huen Leung, Wing Sze Li, and Lek Kin Cheung. "Monitoring Interannual Dynamics of Desertification in Minqin County, China, Using Dense Landsat Time Series." *International Journal of Digital Earth* 13, no. 8 (August 2, 2020): 886–98. https://doi.org/10.1080/17538947.2019.1585979.

A: TIMELINE 3000 BC – 2020 AD

3,000 BC — 500 BC

NEOLITHIC CULTURES | XIA | SHANG | ZHOU | QIN / HAN

2800 BC
Neolithic cultures begin to inhabit the region over 5,000 years ago, during a period of favorable climatic conditions. The earliest forms of agriculture are dated to 2800 BC by the Majiayao culture which immigrated from Central China and cultivated East Asian millet.

2000 – 1500 BC
Bronze Age societies introduce crops from Southeast Asia and improve technologies for land cultivation. Agriculture intensifies and expands to the western part of the region until it suddenly terminates around 1500 BC due to changing climates.

800 BC
Pastoral, horse-riding tribes begin to emerge as powerful warrior societies across the northwestern steppe.

250 BC
The Xiongnu establish a confederate empire across the East Asian, Manchurian and Mongolian steppe, and become China's main geopolitical threat and competitor by 200 BC.

214 BC
The Great Wall, a massive defense system, begins to be constructed along China's northwestern border, reaching to Jiuquan and being further extended to Dunhuang.

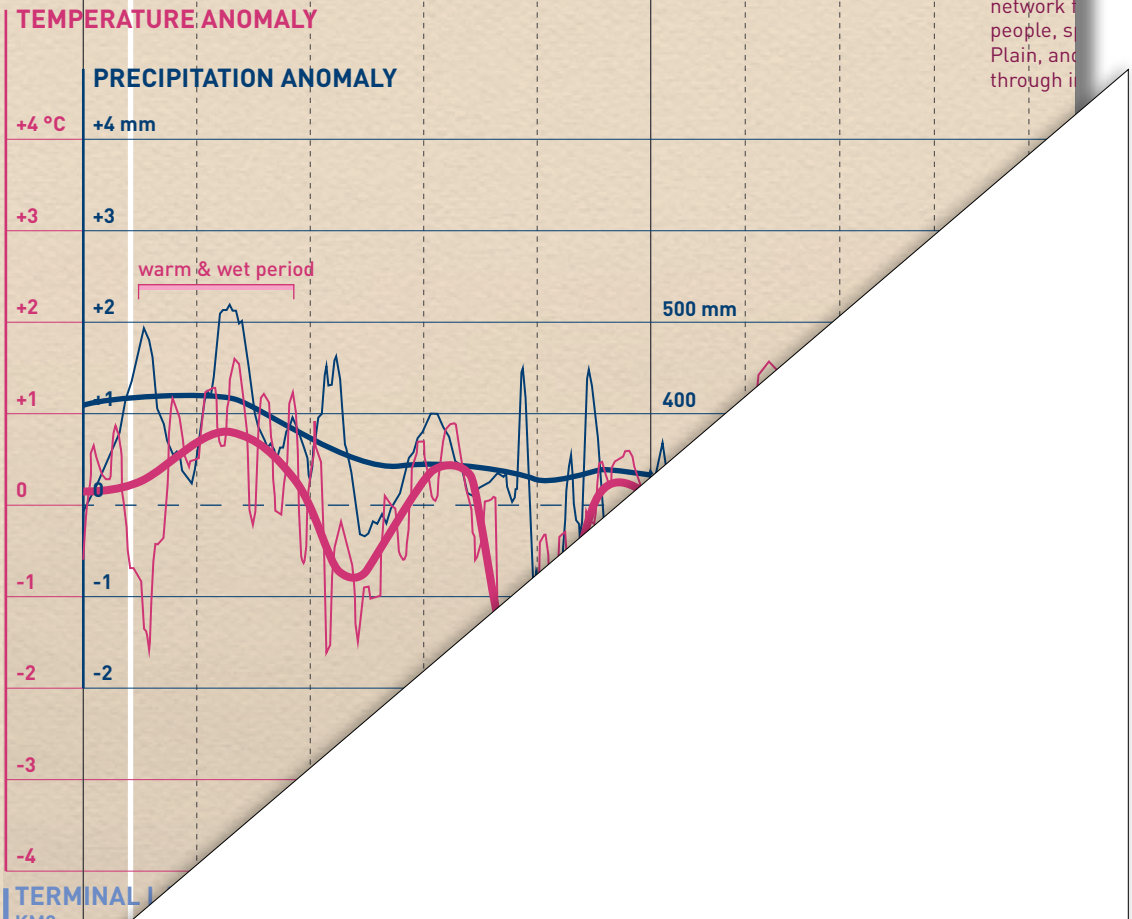
141 – 8
Emperor
political c
launches
campaign
national r
exchange

138 BC
Zhang Qia
the territ
western b
Xiongnu a

121 BC
After mar
Hexi Corr
Dunhuan
systemat
network f
people, s
Plain, and
through i

EARLY ANTHROPOCENE

2800 BC



A: TIMELINE 3000 BC – 2020 AD

3,000 BC | 500 BC | 0 AD | 500 | 1000 | 1500 | 1900 | 1950 | 2000 | 2020

NEOLITHIC CULTURES | XIA | SHANG | ZHOU | QIN / HAN | SIX DYNASTIES | SUI / TANG | FIVE DYNASTIES / SONG | YUAN | MING | QING | REPUBLIC OF CHINA | PEOPLE'S REPUBLIC OF CHINA

2800 BC
Neolithic cultures begin to inhabit the region over 5,000 years ago, during a period of favorable climatic conditions. The earliest forms of agriculture are dated to 2800 BC by the Majiayao culture which immigrated from Central China and cultivated East Asian millet.

2000 – 1500 BC
Bronze Age societies introduce crops from Southeast Asia and improve technologies for land cultivation. Agriculture intensifies and expands to the western part of the region until it suddenly terminates around 1500 BC due to changing climates.

800 BC
Pastoral, horse-riding tribes begin to emerge as powerful warrior societies across the northwestern steppe.

250 BC
The Xiongnu establish a confederate empire across the East Asian, Manchurian and Mongolian steppe, and become China's main geopolitical threat and competitor by 200 BC.

214 BC
The Great Wall, a massive defense system, begins to be constructed along China's northwestern border, reaching to Jiuquan and being further extended to Dunhuang.

141 – 87 BC
Emperor Wu of Han strengthens the efforts of political centralization while simultaneously launches China's largest imperial expansion campaign in history and establishes multinational networks of commercial and cultural exchange.

138 BC
Zhang Qian is dispatched for his mission to explore the territories beyond China's northwestern border, establish alliances against the Xiongnu and potential trading routes.

121 BC
After many failed attempts, the Han conquer the Hexi Corridor region and progress all the way to Dunhuang. Subsequently, the Han begin to systematically transform the Hexi region with a network for defense and logistics, the transfer of people, species, and technologies from the Central Plain, and the large-scale transformation of land through irrigation and cultivation.

220 AD
With the end of the Han dynasty, the transfer of people, capital, and military support come to an end. The population sharply decreases, particularly in the eastern part.

300 AD
While the eastern end of the Hexi Corridor decline and economic centers such as Wuwei collapse, places in the west, namely Jiuquan and Dunhuang, benefit from a new autonomy and develop as prosperous and artistically vibrant places in the century after the end of the Han.

304 – 439
During the Sixteen Kingdoms period of political fragmentation, Buddhism flourishes along the Hexi Corridor, from where scripts and cultures are introduced to Central China. In 366, the first Mogao caves in Dunhuang are built.

581
The Sui dynasty is established and unifies Central China. The Hexi Corridor is unified and revitalized as a crucial zone to reintegrate the Western Regions.

618 – 907
During the Tang dynasty, trading routes to Central Asia are reactivated. The Hexi Corridor becomes the Golden Sector of the Historic Silk Road and flourishes as a prosperous agricultural region with a strong feudal trading economy, cultural exchange, and technological innovation. Dunhuang becomes an increasingly important hub for cultural dissemination.

755 – 763
The An Lushan Rebellion causes massive turmoil across Northern China. The Tang government cuts off subsidy payments to its western allies. Tibetan tribes gradually occupy the Hexi Corridor, which remains out of the central government's control for several centuries, and the Silk Road economy collapses. The period of rebellion coincides with an arid climate and several years of drought.

1226
Genghis Khan attacks the Hexi region; Gansu and Qinghai are ruled by the Mongols thereafter. Liangzhou (Wuwei) becomes an important destination where successful peace negotiations are held in 1247 with Tibetans, integrating Buddhist into Mongolian culture.

1368
The Ming dynasty pulls back from Western Regions in fear of the defeated Mongols. Instead of overland trade in the northwest, they invest in defense walls with the Jiayu Pass (Jiayuguan) as the westernmost gate of the Great Wall, and foster maritime shipping routes to Southeast Asia with Zheng He's first voyages in 1405 – 1409.

1600
In the late Ming dynasty, the rapid population growth leads to increasing environmental degradation while the political situation remains relatively stable throughout the Qing dynasty.

1850 – 1864
The Taiping Rebellion requires the central government's attention. In addition, it is exposed to increasing pressure on all fronts, including Western colonial states and Japan in the east and Russia capturing several of the Western Regions.

1877
The German geologist Ferdinand von Richthofen coins the term "Silk Roads."

1907
The Hungarian-British explorer Aurel Stein travels to Dunhuang and discovers the Diamond Sutra.

1937
The Yumen Oil Fields are opened. The extraction of resources for industrial production becomes a major concern of the Nationalists and, later, the Communists, who defeat the Kuomintang forces from the northwestern provinces in 1949.

1965
The Third Front intends to build massive industrial sites in remote locations. Jiayuguan is established as a prefecture-level city around a major steel plant, which started to be constructed in 1958.

1966
The Lanzhou-Xinjiang Railway starts operation.

1978
Jinchang receives massive investments and becomes one of the world's largest nickel mines. Extraction had begun in 1959, and first productions in 1964.

1990
The first train rolls across the New Eurasian Land Bridge from Lianyungang to Rotterdam.

1999
The Great Western Development Strategy launches massive infrastructural projects, including gas and oil pipelines, power transmission lines, and the Lanzhou-Xinjiang highspeed railway that lead through the Hexi Corridor.

2013
The "New Silk Road," the Belt and Road Initiative, is announced, promising major investments. Lanzhou New Area begins construction as a major regional hub outside the Hexi Corridor.

2021
The 14th Five-Year Plan lays out ambitious plans for environmental protection and restoration. It includes massive investments into renewable energies, including the world's largest solar and wind power plants in the Hexi Corridor.

EARLY ANTHROPOCENE
2800 BC

"ORBIS SPIKE"
1610 (Lewis & Maslin)

STEAM ENGINE
1784 (Crutzen & Stoermer)

GREAT ACCELERATION
1950

TEMPERATURE ANOMALY
+4 °C | +3 | +2 | +1 | 0 | -1 | -2 | -3 | -4

PRECIPITATION ANOMALY
+4 mm | +3 | +2 | +1 | 0 | -1 | -2
500 mm | 400 | 300 | 200 | 100

warm & wet period
cold & dry period
warm & wet period

temperature anomaly (based on water level Qinghai Lake) 3000 BC - 1925 AD

precipitation based on oxygen isotopes in Jiuxian cave 3000 BC - 1925 AD

temperature anomaly (based on multiple paleoclimatic proxies) 0 - 1950 AD / 0 - 2020 AD

net precipitation proxy based on ice core in Qilian Mountains 0 - 1995 AD

Little Ice Age (globally cold and dry conditions)

+9 °C | +7 °C | +5 °C
mean annual temperature 1955 - 2011
increasing temperature
increasing rainfall
200 | 100
mean annual precipitation 1955 - 2011
0 mm

TERMINAL LAKES
KM2
800 | 600 | 400 | 200 | 0

834 km2 ≈180 BC
Juyan Lake (Heihe River)
445 km2 ≈180 BC
Huahai Lake (Shule River)
286 km2 ≈180 BC
Zhuyeze Lake (Shiyang River)

POPULATION
4,000,000 | 3,000,000 | 2,000,000 | 1,000,000 | 0

Abundant water habitats, forests, grasslands, and high biodiversity in the middle and lower reaches offer ideal conditions for husbandry, hunting and small-scale farming.

Populations in small numbers in the eastern part of the Hexi Corridor. No major effects on environment and water resources.

beginning of large-scale land cultivation, 2800 BC

sudden stop of intensive land cultivation, 1500 - 1400 BC

NUMBER OF WARS
2nd cent. BC - 20th cent. AD
25 | 20 | 15 | 10 | 5 | 0
22 wars in 5th cent. AD

WATER USE RATE
PERCENT
150 % | 100 % | 40 % | 0 %

CULTIVATED LAND
KM2
15,000 | 12,000 | 9,000 | 6,000 | 3,000 | 0

Relatively stable and mild climates improve conditions for agriculture in the high-latitude northwestern steppe, leading to increasing population and farming in border regions but also increasing competition and conflicts with nomadic societies.

Introduction of new species from Central China, large-scale application of new technologies for land cultivation and irrigation, increasing water consumption.

Rapid population growth and consumption of natural resources, intensive competition for land, improved technologies for irrigation and land cultivation make human forces become more decisive than environmental.

water usage rate exceeds 100%

water usage rate exceeds critical threshold of 40%

URBAN / RURAL POPULATION
percentage of total population
100% | 80% | 50% | 20% | 0%
Rural Population Gansu Province
Urban Population Gansu Province

Strong population decrease after the collapse of Imperial China due to lacking governance, increasing militarization, and macro-regional conflicts.

Water Use Rate Shiyang River Basin

Agricultural Area (estimate calculation) 0 - 1835 AD

WATER SALINITY
[gL-1]
14 | 12 | 10 | 8 | 6 | 4 | 2

GDP GROWTH
(Billion RMB)
35 | 30 | 25 | 20 | 15 | 10 | 5

Total Population 135 BC - 2020 AD
4.90 Million (2019)

Total GDP Gansu Province 1978 - 2019 (100 Billion RMB)

Total GDP Heihe River Basin 1963 - 2013

Social campaigns transfer people to the region to engage in farming and the construction of heavy infrastructures.

Surface Water Juyan Lake 10.15 gL-1 (1987)

14,950 km2 +140%

Total Oasis Area 1986 - 2014

Salinity Heihe River 1963 - 1987

Cultivated Land 1990 - 2020

50% / 50% (2019)

Ground Water Lower Reaches 6.50 gL-1 (1987)

Total Oasis Area Heihe River Basin 1963 - 2013

7,192 km2 +160%

≈1985: Z. Lake dries out, H. Lake: 3km2

1992: J. Lake dries out

3,000 BC | 500 BC | 0 AD | 500 | 1000 | 1500 | 1900 | 1950 | 2000 | 2020

B: TRANSECT WATERSHED

CLIMATE

QINGHAI-TIBET PLATEAU ALPINE CLIMATE
precipitation: 200-500mm
av. temperature: 0-5°C (2,000-3,000 AMSL)

sustaining over 1,600 glaciers in the Qilian Mountains covering over 1,300 km2 (2005)
feeding 57 inland river systems that flow into the Hexi Corridor

TEMPERATE DESERT CLIMATE
precipitation: around 100-250mm (decreasing towards west and north), av. temperature: 6.6-9.5 °C (140-170 frost-free days)

evaporation: 2,000-3,500mm

precipitation: around 50-150mm (decreasing towards the west)

ARID DESERT CLIMATE
precipitation: extremely low, around 50-150mm, in some areas less than 10mm
evaporation: over 3,000mm

strong seasonal winds in winter and spring (coinciding with dry season)
prevailing wind direction: north-west (towards oases further south)

HABITAT

*** water runoff yield:**

- **> 4,500: GLACIER AND PERMANENT SNOW *34%**
- **4,000 - 4,500: ALPINE CUSHION PLANT**
- ***39%**
- **3,800 - 4,000: ALPINE MEADOW ZONE**
- **main water conservation area**
- **3,400 - 3,800: ALPINE SHRUB MEADOW ZONE *24%**
- **2,800 - 3,400: FOREST GRASSLAND ZONE *1.5%**
- **2,600 - 2,800: GRASSLAND ZONE *1.5%**
- **2,200 - 2,600: DESERT GRASSLAND ZONE**
- **2,000 - 2,200: STEPPE DESERT ZONE**
- **< 2,000: TEMPERATE DESERT ZONE**
- **ARID DESERT ZONE**

VEGETATION

SPARSE VEGETATION
cushion plants such as *Androsace spp.* (>4,500 MSL)

ALPINE SHRUB STEPPE
Salix cupularis, Potentilla fruticosa, Spiraea alpina, and Caragana jubata (3,200-4,500 MSL)

TALL ARBOR FORESTS
Sabina chinensis, Picea crassifolia
Juniperus przewalskii (2,600 - 3,500 MSL)
Salix alpina, Caragana sagittata, Rhododendron ssp.

ALPINE MEADOW STEPPE
Polygonum viviparum, Kobresia myosuroides, Carex tristachya (2,900-3,200 MSL)

ALPINE STEPPE
Artemisia splendens, Stipa capillata, Artemisia abrotanum, Agropyron cristatum, Leymus secalinus, Roegneria kamoji, Elymus dahuricus, Poa annua, Festuca rubra, Carex tristachya (2,600-2,900 MSL)

TEMPERATE STEPPE
Artemisia abrotanum, Achnatherum splendens, Stipa capillata (2,500-2,700 MSL)

OASIS VEGETATION
Elaeagnus angustifolia (mostly disappeared), Populus euphratica

Chenopodium album, Malvaceae, Artemisia ordesica, Achnatherum splendens, Typha angustifolia, Potamogeton ssp.

domesticated and cultivated plants

TEMPERATE DESERT VEGETATION
xerophytic and super-xerophytic shrubs and semi-shrubs

Artemisia ordesica, Calligonum mongolicum, Nitraria tangutorum,Tamarix ramosissima

Allium fistulosum, Ephedra ssp., Reaumuria songarica, Stipa ssp.

xerophytic and super-xerophytic shrubs and semi-shrubs

Tamarix chinensis, Tamarix ramosissima*

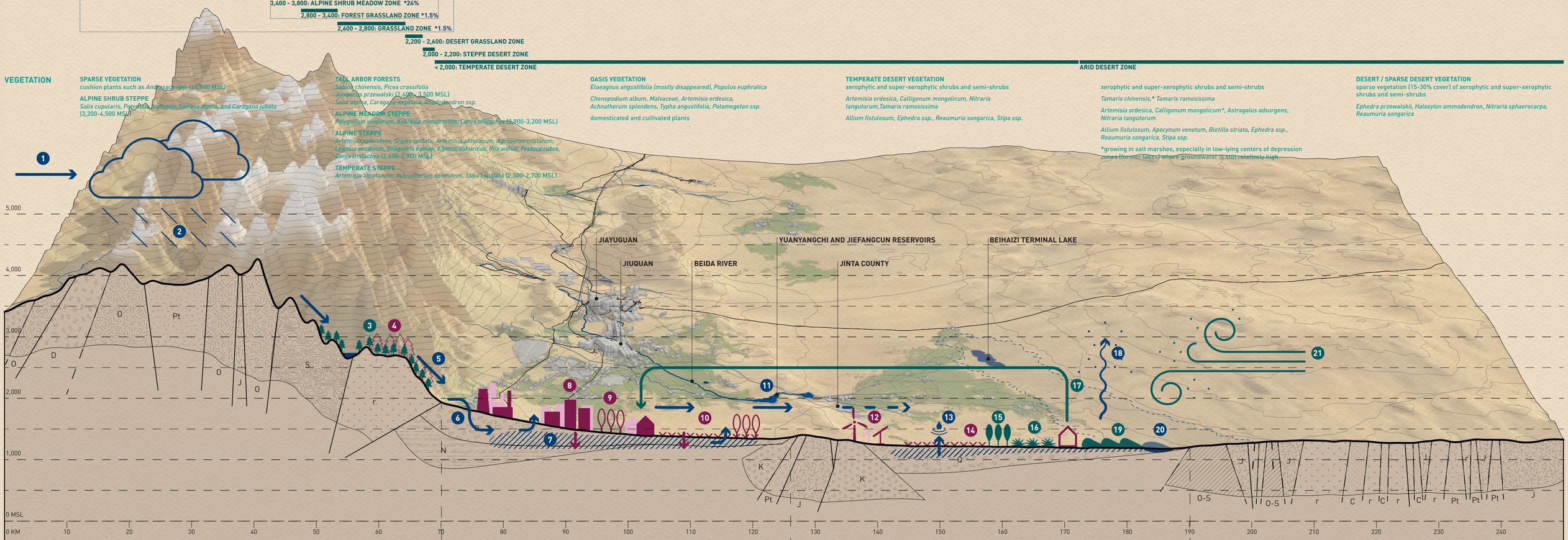
Artemisia ordesica, Calligonum mongolicum, Astragalus adsurgens, Nitraria tangutorum*

Allium fistulosum, Apocynum venetum, Bletilla striata, Ephedra ssp., Reaumuria songarica, Stipa ssp.

*growing in salt marshes, especially in low-lying centers of depression zones (former lakes) where groundwater is still relatively high

DESERT / SPARSE DESERT VEGETATION
sparse vegetation (15-30% cover) of xerophytic and super-xerophytic shrubs and semi-shrubs

Ephedra przewalskii, Haloxylon ammodendron, Nitraria sphaerocarpa, Reaumuria songarica



GEOLOGY

- Quaternary conglomerate
- Neogene mudstone and siltstone
- Cretaceous conglomerate, sandstone with less mudstone
- Jurassic mudstone, shale
- Carboniferous sandstone, conglomerate
- Devonian sandstone, conglomerate
- Ordovician / Silurian phyllite, sandstone
- Silurian sandstone, conglomerate and slate
- Ordovician slate
- Precambrian phyllite, metamorphosed limestone
- Caledonian / Hercynian granite

LANDSCAPE SYSTEMS

- Social
- Environmental
- Water

schematic transect along the Beida River from the Qilian- to Beishan Mountains, through Jiuquan- and the Jinta oasis in a sub-basin of the larger Heihe River watershed; tenfold vertical exaggeration

SOIL AND LANDFORM

QILIAN MOUNTAINS
fold mountain system consisting of seven parallel Paleozoic and Mesozoic-Genozoic uplifted folds; around 850 km long and 80 - 240 km wide; most mountains and valleys lie above 3,000 - 3,500 MSL

SLOPE ACCUMULATION ZONE
rocks, large stones, and sediments

ALLUVIAL FAN ZONE
smaller rocks and gravel

HEXI CORRIDOR
Qilian Mountain piedmont depression zone: Large deposits of diluvial and alluvial material since the Genozoic, which formed a relatively flat high plateau between 1,000 - 2,200 MSL, generally around 1,500 MSL.

ALLUVIAL ZONE
gravel, fine stones, and sediments

fertile layer of soil in and along riverbeds and in irrigated areas

FINE SOIL PLAIN
sand, clay, and fine sediments

grey and brown desert soils; aeolian sand soil covered by irrigated fertile soil layer wherever oases have been cultivated; 1 - 2.5 meters on top of original desert soil

SLOPE ACCUMULATION ZONE
rocks, large stones, and sediments

FINE SOIL PLAIN
soil quality on abandoned, formerly irrigated and cultivated land is usually good, relatively thick layer of fertile soil; yet lacking water resources for irrigation

saline-alkali soil, aeolian sand deposits

ALXA PLATEAU
Part of the Gobi Desert region. Lies at an average of 1,000-1,500 MSL in elevation and descends in northern direction. Characterized by barren rock, semi-desert steppe, and sandy deserts, separated in several inland basins and individual deserts by arid denudations. Location of several salt plains of former terminal lakes with historically relatively high water levels.

GRAVEL DESERT
sand desert, eroded stony mountains, and residual hills

saline-alkali soil, aeolian sand deposits

QILIAN MOUNTAINS | UPPER RIVER REACHES | LOWER RIVER REACHES | ALXA PLATEAU

1 RAIN CLOUDS
Evaporated water from the Asian Pacific is brought to the Qinghai-Tibetan Plateau (Asian summer monsoon cycles, only a small amount from local sources). Precipitation occurs along the Qilian Mountains according to a complex circulation system on the Tibetan plateau, including tree cover that decreases micro temperatures, increases air turbulences, and water condensation.

2 PRECIPITATION AND WATER RESOURCES
Rain and snowfall in the Qilian Mountains mainly contribute to available water resources stored in snow and ice deposits (over 1,600 glaciers), soils, and groundwater in vegetated mountain valleys. Water is discharged throughout the year, feeding 57 inland rivers that form large floodplains at the mountain foot.

3 MOUNTAIN FORESTS, AFFORESTATION PROGRAMS AND PRESERVATION
Forests in the Qilian Mountains are vital for the entire Hexi Corridor ecosystem, preventing winter snow from melting quickly and soil erosion by providing shade and stabilizing steep slopes. They store water, recharging the aquifer and springs gradually throughout the year. Only around 30-35% of suitable land is covered with forests. Since the 1980s, increasingly strict protections of land, forests, and water resources (reservoirs) were implemented, and afforestation programs were launched. Harsh climates and soil conditions hamper tree growth. Monocultures increase the risks of forest fires and diseases.

4 DEFORESTATION AND HUSBANDRY
Pastures in the temperate Qilian Mountains (warm winter, cool summer, abundant water resources) are used for grass mowing and cattle and sheep herding. Forests are cleared for pasture land, firewood, and timber, causing soil erosion, increased water and sediment runoff, and deteriorating groundwater. The population and land use increased during periods of wars and droughts.

5 FLOODS
Vegetation loss accelerates snowmelt and surface runoff, leading to sudden floods, soil erosion, and devastating mudflows. Short-term floods, instead of continuous water supply, lead to droughts in lower reaches as snowmelt is gone by early summer.

6 SURFACE RUNOFF WATER
Surface runoff seeps into the porous alluvial zone, supplies the groundwater, passes through aquifers, and reemerges in natural springs or artesian wells.

7 GROUNDWATER
The further away from the Qilian Mountains (primary water source), the less runoff water is available to recharge groundwater. This leads to sinking groundwater tables and deteriorating water quality wherever groundwater is only recharged periodically. Urban-industrial waste and agricultural fertilizer are potential pollutants.

8 INDUSTRIAL, URBAN AND ECONOMIC GROWTH
Heavy industrialization since the 1950s (mining, oil drilling, steel production), has led to increased infrastructural construction and accelerated and extended urbanization, a growth of population, GDP, and resource consumption (water, energy). This has caused environmental destruction, pollution, and spatial fragmentation.

9 VEGETATION DESTRUCTION
Vegetation loss in oases since the first colonization in increasing scales due to the harvest for timber, firewood, fodder, and clearance for land cultivation. This has caused increased erosion and desertification rates.

10 AGRICULTURE
Transformation of oasis ecosystems since the beginning of large-scale land cultivation, including water, soil, and species composition. Intensified irrigation in the upper reaches leads to decreasing water resources and accelerated land degradation further downstream. Intensive land use for farming and grazing destroys soil structure and stability, leading to desertification. Decreasing populations and land use extensification can reverse these trends to a certain degree.

11 RESERVOIR
Reservoirs were built in middle and lower reaches to mitigate floods, store water runoff, provide water resources to farming communities in lower reaches throughout the year, and, in some cases, restore lakes and wetlands.

12 RENEWABLE ENERGY
High sunshine hours, solar radiation rates, strong and persistent winds, and vast land resources provide ideal conditions for renewable energy production (especially in lower reaches). Most energy produced from solar and wind power plants is exported to provinces in central and southeastern China.

13 GROUNDWATER WELLS
Deep wells for land irrigation are drilled in lower reaches where little surface runoff is available, and groundwater tables are sinking.

14 AGRICULTURE
Agriculture in the lower reaches depends entirely on irrigation, as virtually no surface runoff is available. On plowed land, the upper soil structure is destroyed, grass and ground cover are eradicated, and less water is stored, but instead quickly seeps into the ground. Wind erosion is thus much stronger.

15 SHELTER FOREST
Local and regional afforestation projects are coordinated since 1978 ('Three North Shelterbelt Development Program'), including large-scale plantations to combat land degradation, desertification, soil erosion, and sandstorms, potentially leading to dropping groundwater tables.

16 SAND-FIXING VEGETATION
Vegetation plantations (grasses, shrubs) in lower reaches aim to fix sand and recover soil, mostly as part of local initiatives since the 1960s.

17 ECOLOGICAL MIGRATION
Water shortage, land loss, desertification, and sandstorms force many to leave the lower reaches and move up the river to more fertile areas as "ecological refugees." This leads to growing populations and water consumption in the upper reaches, adding to the pressure on downstream communities. Ancient, abandoned former oases are rich in archaeological finds since the dry climatic conditions helped to preserved ruins, irrigation channels, dams, tools, etc.

18 EVAPORATION
There is virtually no rainfall, very little or no water runoff, high solar radiation, and strong, dry winds in the lower reaches. Therefore, evaporation rates from the ground and vegetation are very high.

19 SAND DEPOSITS
Wind is the main cause of soil erosion, creating ridges and sand dunes and fragmenting land use and vegetation patterns. Sand is deposited as piles and dunes up to ten meters in height, covering agricultural fields, settlements, streets, and other infrastructures. Shrubs often overgrow smaller sand piles. Previously cultivated areas, no longer sustained by irrigation, are most vulnerable to soil erosion.

20 TERMINAL LAKE
Runoff water collects at the end of endorheic basins, forming lakes and marshlands. Today, most are only periodically recharged in periods of seasonal floods, creating water bodies only as small fractions of their ancient and pre-industrial extent. Water is still collected in the depression zones, either from irrigation runoff or groundwater that reappears in natural springs, forming small ponds and lakes, allowing reeds and grasses to grow. Ancient terminal lakes were very large and served as prime habitats for fauna. Dried-up lakes and marshes leave vast pans of fine sand and clay sediments exposed to wind erosion.

21 SANDSTORM
Sandstorms occur primarily in winter and spring at the northern end of the Hexi Corridor. Vegetation loss and desertification are major causes. Over time, they have become more frequent, intense, and destructive due to increased land reclamation, overgrazing, and the destruction of sand-fixing vegetation. They cause large-scale erosion, create massive sand deposits, destroy vegetation and buildings, and fill irrigation canals and wells. Particles from reclaimed and abandoned farmlands are around ten times more likely to be lifted than from open deserts. Sandstorms can affect areas far from their origin, including large agglomerations along the Chinese east coast.

C: LOWER RIVER REACHES

CLIMATE

TEMPERATE DESERT CLIMATE
precipitation: around 100-250mm (decreasing towards west and north)
average temperature: 6.6-9.5 °C (140-170 frost-free days)

precipitation: around 50-150mm (decreasing towards west)

ARID DESERT CLIMATE
precipitation: extremely low, around 50-100mm,
in some areas less than 10mm
evaporation: over 3,000mm

strong seasonal winds in winter and spring (coinciding with dry season)
prevailing wind direction: north-west (towards oases further south)

HABITAT

TEMPERATE DESERT ZONE

ARID DESERT ZONE

VEGETATION

OASIS VEGETATION
Elaeagnus angustifolia (mostly disappeared), *Populus euphratica*

Chenopodium album, Malvaceae, Artemisia ordesica, Achnatherum splendens, Typha angustifolia, Potamogeton ssp.

domesticated plants cultivated since the Han dynasty:
Hordeum vulgare (barley), *Sorghum bicolor* (sorghum), *Sataria italica* (millet), *Glycine max (L.) merr.* (soybean), *Vitis vinifera* (grapevine), *Morus alba* (mulberry), etc.

TEMPERATE DESERT VEGETATION
xerophytic and super-xerophytic shrubs and semi-shrubs

Artemisia ordesica, Calligonum mongolicum, Nitraria tangutorum,Tamarix ramosissima

Allium fistulosum, Ephedra ssp., Reaumuria songarica, Stipa ssp.

xerophytic and super-xerophytic shrubs and semi-shrubs:
Tamarix chinensis, Tamarix ramosissima*

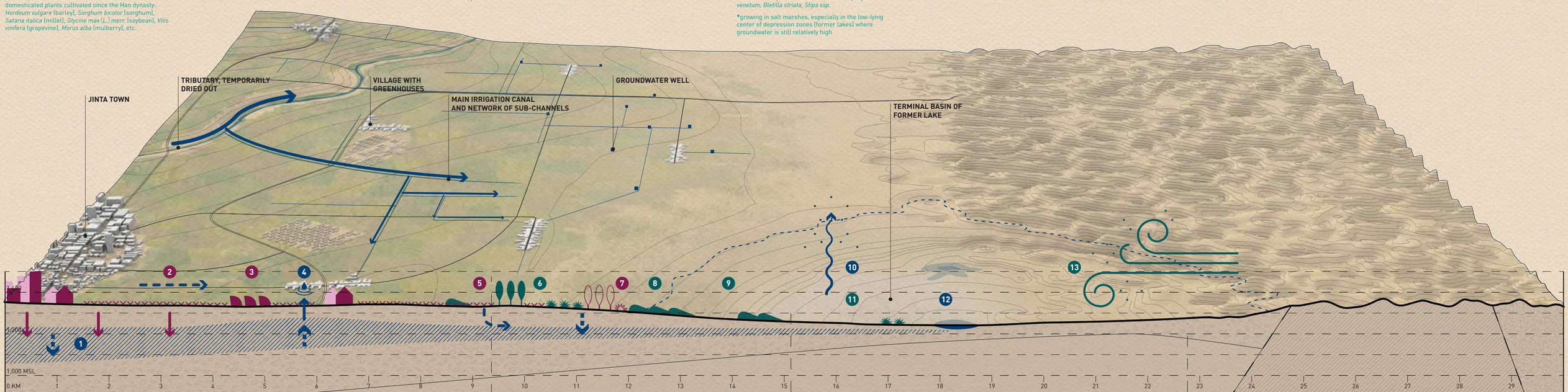
Artemisia ordesica, Calligonum mongolicum, Astragalus adsurgens, Ephedra ssp., Nitraria tangutorum*

domesticated plants: *Allium fistulosum, Apocynum venetum, Bletilla striata, Stipa ssp.*

*growing in salt marshes, especially in the low-lying center of depression zones (former lakes) where groundwater is still relatively high

DESERT / SPARSE DESERT VEGETATION
sparse vegetation (15-30% cover) of xerophytic and super-xerophytic shrubs and semi-shrubs

Ephedra przewalskii, Haloxylon ammodendron, Nitraria sphaerocarpa, Reaumuria songarica



GEOLOGY

- Quatarnery conglomerate
- Ordovician / Silurian phyllite, sandstone
- Jurassic mudstone, shale

LANDSCAPE SYSTEMS

- Social
- Environmental
- Water

schematic transect through the northern end of Jinta Oasis (Jiuquan) and the desertified basin of a former terminal lake; fourfold vertical exaggeration

SOIL AND LANDFORM

HEXI CORRIDOR LOWER REACHES
Qilian Mountain piedmont depression zone; deposits of diluvial and alluvial material since the Genozoic, which formed a relatively flat high plateau, between 1,000 - 2,200 MSL, generally around 1,500 MSL

AGRICULTURAL FINE SOIL PLAIN
sand, clay, and fine sediments

grey and brown desert soils, aeolian sand soil
covered by irrigated fertile soil layer wherever oases have been cultivated; 1 - 2.5 meters on top of original desert soil

FORMERLY CULTIVATED LAND
soil quality on abandoned, formerly irrigated and cultivated land is usually good, relatively thick layer of fertile soil, yet lacking water resources for irrigation

saline-alkali soil, aeolian sand deposits

FORMER TERMINAL BASIN
deserted land, usually with high salt concentration, aeolian sand deposits forming dunes; fertile soil and salt marshes in places where a high groundwater table persists

ALXA PLATEAU
Part of the Gobi Desert region, average 1,000-1,500 MSL in elevation, descending in northern direction. Characterized by barren rock, semi-desert steppe, and sandy deserts, separated in several inland basins and individual deserts by arid denudations. Location of several salt plains of former terminal lakes with historically relatively high water levels.

GRAVEL DESERT
deserted sand, eroded stony mountains, and residual hills

saline-alkali soil, aeolian sand deposits

JINTA OASIS LOWER REACHES | **OASIS TRANSITION ZONE (2 - 10KM WIDE)** | **DESERTED ZONE** | **FOOTHILLS ALXA PLATEAU**

1 GROUNDWATER
All groundwater tables in the Hexi region are generally sinking (e.g., around 0.3 – 0.8 m per year in eastern Minqing County) due to well drilling and overexploitation across the watershed. Decreasing groundwater leads to losses of desert vegetation and soil stabilization, which causes desertification and land loss. Water runoff from irrigation and lateral seepage is able to recharge groundwater to a certain degree in oases where it usually remains relatively high.

2 AGRICULTURE
In the lower river reaches, agriculture depends entirely on irrigation. In a vicious cycle, decreasing water availability means a higher demand for irrigation, further reducing water resources. Eventually, land is abandoned despite a relatively good soil quality. Livestock can lead to overgrazing, soil compaction, increasing erosion, land loss, and desertification.

3 GREENHOUSES AND DRIP IRRIGATION
Water-efficient farming methods are costly in their acquisition but are among the measures with the greatest potential to reduce water consumption in the Hexi Corridor. Traditional greenhouses are common across the region. In recent years, large-scale modern greenhouses equipped with drip irrigation systems have been built in many places, while fields with center-pivot irrigation remain rare.

4 GROUNDWATER WELL & IRRIGATION
Wells are drilled to tap into the aquifer for land irrigation and farming, leading to decreasing groundwater tables, requiring them to be drilled deeper at higher costs. Wells tend to lift the groundwater table, yet locally lower it at the oasis' periphery, including the transition zone where stable vegetation growth is crucial for ecosystem stability. Soil pollution (industrial and domestic waste, sewage, fertilizer runoff, mining activities) increases groundwater contamination, and if the aquifer is no longer recharged, the water quality deteriorates.

5 LAND RECLAMATION
Land reclamation in the periphery of existing oases reduces the crucial transition zone, thus moving cultivated land in direct adjacency to open deserts or desertified land, increasing the potential for soil erosion and sand deposits.

6 SAND-FIXING VEGETATION
Native plant species are usually perennial, have a much higher reproduction and regeneration ability than annual species, are better at resisting erosion and droughts, and at conserving water in the soil. Native species can potentially replace domesticated agricultural vegetation once land is abandoned, yet often, there are no longer sufficient water resources available to prevent desertification. Tree and shrub plantations are planted for soil stabilization and combatting desertification, yet in the low-lying river reaches where evaporation rates are very high, this is challenging as trees pump up groundwater, which evaporates quickly.

7 VEGETATION DESTRUCTION
Vegetation within the transition zone at the oasis edge is vital as it fixes loose sand, shields farmland from wind erosion, and maintains ecological balance. Forest belts along the oasis edge can sustain a high groundwater table and robust vegetation growth through transpiration. However, well drilling inside the oases reverses this effect. Historically, arbor forests formed protective belts, but grassland, shrubs, and trees have mostly been cut down (timber, firewood, fodder).

8 DESERTIFICATION
Large-scale land cultivation, shrinking water resources due to extensive use, and the domestication of non-native, less robust plant species led to processes of ecosystem degradation. Additional causes are vegetation destruction, overfarming, overgrazing, and chemical land degradation.

9 DESERTIFIED LAND
The oases' low ends face the strongest degradation of formerly cultivated land, are most exposed to strong and dry winds, and are surrounded by large deserts. Wind erosion causes land fragmentation with growing ridges and sand deposits, either as small sand piles (1-3m high and vegetated with shrubs) or large dunes (up to 10m high). Chinese Tamarisk (Tamarix chinensis) is the most robust species in this environment and has become dominating. With its long roots, it can reach the groundwater table but also reduce the available sources.

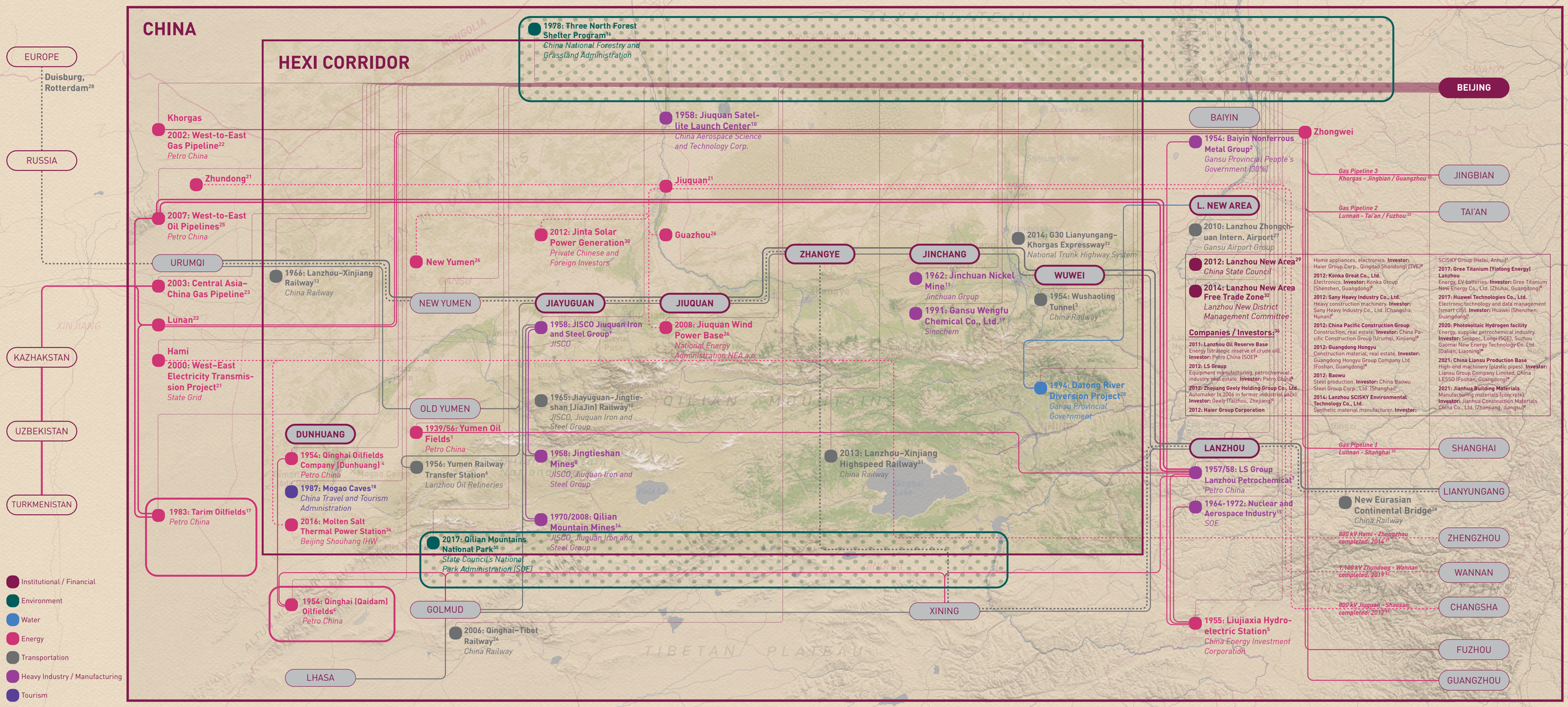
10 EVAPORATION
At the end of the river systems, there is virtually no rainfall (in some areas less than 10 mm), very little or no water runoff, very high solar radiation (over 3,000 mm), and strong, dry winds. Therefore, the evaporation is very high, both from the soil and vegetation.

11 SALINIZATION
If groundwater is not sufficiently recharged with freshwater, its salt content increases. If it continues to be used for irrigation, it leads to higher surface soil salinity, decreased fertility, and further land deterioration. In addition to irrigation with saline groundwater, the minimal precipitation, removal of deep-rooted vegetation, and high evaporation rates lead to an accumulation of excessive salt in the soil.

12 TERMINAL BASIN
At the lowest end of the watersheds, vast terminal lakes have formed in the past. Because of increased water consumption in the upper reaches, the reduced water quantity is no longer able to supply and sustain these lakes. Therefore, they have mostly disappeared, forming large basins sporadically dotted with ponds and marshes, dry pans of high salt concentration, and source areas for sand erosion and sandstorms. If a high groundwater table persists, it allows sparse vegetation to grow and ,in some places, even reeds and aquatic plants.

13 WIND, SOIL EROSION AND DEPOSITION
Winds at the low-lying northwestern end of the watersheds are particularly strong and dry. Loose sand migrates generally around 6-10m per year in southeastern direction as winds prevail from the northwest. If oases are not surrounded by robust vegetation shelter belts, sand encroaches into the oasis ecosystem where it is deposited. Reclaimed and abandoned farmlands are particularly prone to desertification, and cultivated (or formerly cultivated) soil is eroded.

D: TERRITORIALIZATION 1949 – 2022



PHASE 1: First Five-Year Plan, 1953 – 1957

1956 (1939): Yumen Oil Fields [1]
Oil drilling began in 1939. Supplied refineries and industrial production in Lanzhou, starting in 1951. Listed among 156 Soviet-aided projects in 1956. Grew to a major industrial base supplying over half of the national crude oil at its peak in 1959. Faced increasing competition and began to decline in the late 1970s. Attempted revitalization in 2007.
Operator: Petro China (SOE)

1954: Baiyin Nonferrous Metal Group [2]
Established in 1954 as China's leading copper supplier with the help of Soviet enterprises. Shut down in 1988 due to exhaustion of resources. Grew to one of China's largest enterprises in nonferrous metal industry, operating internationally.
Operator: Gansu Provincial People's Government (30%) (PPP)

1954: Wushaoling Tunnel [3]
Originally built as a series of smaller tunnels in 1953–54, connecting Hexi Corridor to Lanzhou and China. Built as one continuous tunnel in 2003-2006 and used by high-speed trains.

1954: Qinghai (Qaidam) Oilfields [4]
Beginning oil and gas exploration in the Qinghai Qaidam Basin in 1954, with the main base and headquarters established in Dunhuang. Connected with pipelines to refineries in Dunhuang, Lanzhou, Xining, and Golmud.
Operator: China National Petroleum Corporation, Petro China (SOE)

1955: Liujiaxia Hydroelectric Station [5]
Commissioned in 1955 as part of a national hydroelectric power project. Constructed between 1958 and 1974. Start of electricity production in 1969, in particular, to supply critical industries in Lanzhou and Baiyin.
Operator: China Energy Investment Corporation (SOE)

1955: Yumen Railway Transfer Station [6]
Opened in 1956, connecting Yumen Oil Fields with crude oil refineries in Lanzhou, replacing inefficient and costly road transportation and allowing to distribute oil resources from Yumen across China.
Operator: China Energy Investment Corporation (SOE)

1957/58: LS Group, Lanzhou Petrochemical Company [7]
Founded in 2000 by merging the former Lanzhou Chemical Industry Company and Lanzhou Refining and Chemical Plant, which had been established in the late 1950s as part of "165 Projects."
Operator: Petro China (SOE)

1958: Jingtieshan Mines [8]
Operation started in 1958 after 1955 discovery of iron ore resources south of Jiuquan. Connected via railway to Jiuquan's steel factory in 1965.
Operator: Jiuquan Iron and Steel Group JISCO (SOE)

1958: JISCO Jiuquan Iron and Steel Group [9]
Founded in 1958. Received massive Third Front investments in 1965/1970s. Restructured and partially privatized in 1980 by institutional separation from Jiayuguan City and merging with other Chinese steel producers. Received large state investments through Three West Construction Fund (1981–85).
Operator: SOE

1958: Jiuquan Satellite Launch Center [10]
Established in 1958 as a military testing ground for missiles and as satellite and spaceship launch port. Expanded into a production site of national defense industries during the Third Front.
Operator: China Aerospace Science and Technology Corporation (SOE)

1962: Jinchuan Nickel Mine [11]
Beginning nickel-cobalt extraction in 1962, and expanded during the Third Front. Grew to China's largest nickel mine and top-three national mineral resource production base. Attracted investments through All Front Open policies in 1978. Restructured as globally operating enterprise in 2001.
Operator: Jinchuan Group, Gansu Provincial People's Government (SOE)

1965: Jiayuguan–Jingtieshan (JiaJin) Railway [12]
Constructed 1958–1965, connecting Jiayuguan steel industries with high mountainous Jingtieshan Mines. Branch of Lanzhou-Xinjiang Railway.
Operator: Jiuquan Iron and Steel Group (SOE)

PHASE 2: Third Front, 1966 – 1978

1966: Lanzhou – Xinjiang Railway [13]
Opened in 1966 as China's longest railway line, reaching from the eastern coast to Urumqi. Extended in 1990 to Kazhak border. Electrified until Wuwei in 1994 and to Urumqi in 2012.
Operator: China Railway

1970/2008: Qilian Mountain Mines [14]
A cluster of extraction sites in the Qilian Mountains, including Huashugou (iron) and Xigou (limestone). Connected to Jiayuguan through JiaJin railway link, which was extended in 2008 to large mines in Qinghai, including Muli (coal) and Golmud (iron) as backup bases for Jiayuguan steel factories.
Operator: Jiuquan Iron and Steel Group (SOE)

1964–1972: Nuclear and Aerospace Industry [15]
Developed secretly during the Third Front in Lanzhou as industries of national significance.
Operator: SOE

PHASE 3: Reform & Opening, 1978 – 1999

1978: Three North Shelter Forest Program [16]
Officially launched in 1978 as centrally coordinated campaign, spanning China's thirteen northern provinces and including large-scale afforestation and conservation projects in the Hexi Corridor.
Operator: China National Forestry and Grassland Administration (SOE)

1983: Tarim Oilfields [17]
Large Oil and gas reserves found in 1955. Many failed exploration attempts in 1960s and 70s. Start of large-scale drilling in 1983 and fast expansion to China's largest oil and gas extraction field.
Operator: Petro China

1987: Mogao Caves [18]
Rediscovered in 1900. Protection and restoration works by central government started in 1961. Declared as UNESCO World Heritage and construction of modern tourism facilities in 1987. Gradually expanded with a visitor center (2015) and Greater Dunhuang Cultural Tourism Economic Circle.
Operator: China Travel and Tourism Administration, Ministry of Culture and Tourism (SOE)

1991-95: Gansu Wengfu Chemical Co., Ltd. [19]
Founded as one of five national fertilizer plants concerning food security (1991–1995) and northwestern China's largest phosphate fertilizer producer. Has generated a massive deposit stack of chemical waste (phosphogypsum). Faced financial difficulties and was acquired by Sinochem in 2007.
Operator: Sinochem (SOE)

1994 Datong River To Qinwangchuan Region Water Transferring Irrigation Project [20]
Constructed 1976–1994 to transfer water from Datong River to Qinwangchuan Valley for large-scale land irrigation. Extended until 2015 as several hundred kilometer-long hydrological infrastructure. Funded by the World Bank, central state and local governments.
Operator: World Bank, Gansu Provincial Government

PHASE 4: Great Western Development, 1999-2012

2000: West-East Electricity Transmission Project [21]
Since 2000, electricity transferred across provincial grids from western interior (overcapacity) to southeast (growing demand). Constant expansion of the high-voltage network, including three lines distributing wind/solar power from Xinjiang and Jiuquan through the Hexi Corridor across China.
Operator: State Grid Corporation of China (SOE)

2002: West-to-East Gas Pipeline [22]
Construction on four strands of gas pipelines from western regions through Hexi Corridor to Central China since 2002. Gas is mainly used for energy production, aiming to replace coal. Supplied by gas fields in Xinjiang, Chongqing, and the Central Asia–China pipeline via Kazhakstan.
Operator: Petro China (SOE)

2003: Central Asia – China Gas Pipeline [23]
Agreements signed with Turkmenistan, Uzbekistan, and Kazhakstan to build pipelines transferring gas to Xinjiang to meet China's growing demand. Three of four lines completed. Partially financed with Chinese loans.
Operator: Petro China (SOE)

2006: Qinghai-Tibet Railway [24]
Construction 2001–2006. Key Great Western Development Strategy project. Connects Xining and mining town Golmud with Lhasa. Connected across Qilian Mountains with Hexi Corridor via extended JiaJing Railway since 2008.
Operator: China Railway (SOE)

2007: West-to-East Oil Pipelines [25]
Total of seven branches of pipelines transferring refined oil from Urumqi, Karamay, and Dushanzi petrochemical companies to Lanzhou (completed in 2006), and crude oil from Tarim, Junggar, and Tuha Basin oilfields to Lanzhou (completed 2007). Distribution from Lanzhou across China.
Operator: Petro China (SOE)

2008: Jiuquan Wind Power Base [26]
Massive central state investments into wind power production in Gobi deserts announced in 2007, aiming for national shift away from fossil fuels. Construction on Jiuquan Wind Power Base (the world's largest) began in 2008. Unable to operate at full capacity due to transmission grid limitations.
Operator: National Energy Administration NEA, Huaneng Power International, Datang International Power (a.o. international investors)

2010: Lanzhou Zhongchuan International Airport [27]
Lanzhou's first airport built close to city center in 1930s. Construction of international airport in Zhongchuan Valley decided in 1957. Opened in 1970. Second expansion in 2010, coinciding with decision to develop Lanzhou New Area. Third expansion started in 2019, increasing total floor space four-fold.
Operator: Gansu Airport Group (SOE)

2011: New Eurasian Continental Bridge [28]
Continuous railway link, operating since 2011, connects coastal Lianyungang (Jiangsu) via Hexi Corridor, Kazhakstan, Russia, and Europe, ending in port cities Duisburg (Germany) and Rotterdam (Netherlands). Later declared as key project of Belt and Road Initiative (first announced in 2013).
Operator: China Railway (SOE)

PHASE 5: Belt and Road 2012 - 22

2012: Lanzhou New Area [29]
Lanzhou New Area first announced by central government in 2010, approved by the State Council, and officially established in 2012 as state-level city. Intended to be developed across over 800 square kilometers by 2030, offering strategic functions within interregional trading network.
Operator: Lanzhou New District Management Committee / China State Council (SOE)

2012: Gansu Jinta Solar Power Generation Project [30]
Commissioned in 2012 as first-generation large-scale photovoltaic power plant. Partially funded by Asian Development Bank.
Operator: Zhejiang Chint New Energy Development Co., Ltd. (private)

2013: Lanzhou–Xinjiang Highspeed Railway [31]
Opened in 2014. Runs, for the most part, parallel to the old railway from 1966, which was Xinjiang's only railway connection to Central China until then. Shares tracks with conventional trains and forms the Hexi section of the New Eurasian Continental Bridge.
Operator: China Railway (SOE)

2014: Lanzhou New Area Free Trade Zone [32]
Approved by the State Council in 2014. Aims to serve as geographically strategic transfer hub in transcontinental trading network between China, Central Asia, and Europe as part of the Eurasian Continental Bridge.
Operator: Lanzhou New Area Commerce Trade and Logistics Investment Group Co., Ltd. (Lanzhou New District Management Committee) (SOE)

2014: G30 Lianyungang–Khorgas Expressway [33]
China's longest continuous highway, reaching from coastal Lianyungang (Jiangsu) to Khorgas (Xinjiang), from where it continues to Kazhakstan. Opened in 2014, serving as Hexi Corridor's main road transportation route.
Operator: National Trunk Highway System (SOE)

2016: Molten Salt Thermal Power Station [34]
China's first molten salt thermal power plant west of Dunhuang. First facility completed in 2016. Second, much larger facility, started operating in 2018.
Operator: Beijing Shouhang Ihw Resources Saving Technology Co., Ltd.

2017: Qilian Mountains National Park [35]
Approved by the Central Government and State Council in 2017, replacing the former Nature Reserve from 1988, aiming for land protection to prevent vegetation loss, deterioration of water resources, soil, and biodiversity.
Operator: State Council's National Park Administration (SOE)

Lanzhou New Area: Selected Companies / Investors [34]
Lanzhou New Area intended to attract innovative private enterprises. However, the highly subsidized and regulated market lacks competition, most of the companies are state-owned, and very few are from abroad, as the below selection of businesses illustrates (see above).