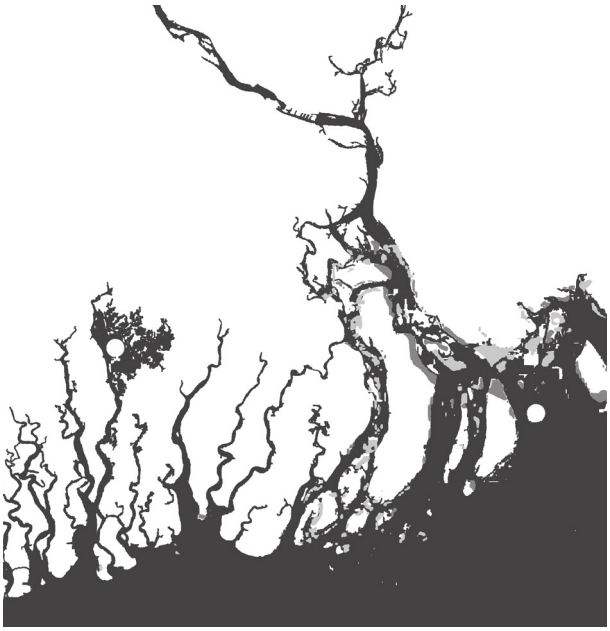

Shifting Landscapes of the Bengal Delta

Designing an Evolving Island in a Char, South Coast of Bangladesh

Anta Sharif Chowdhury

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Pre Diplom Landskap Oslo (60701) (S17)
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Pre-Diploma Supervisor: Sabine Muller

AHO Oslo School of Architecture and Design, Institute of Urbanism and Landscape

Contents

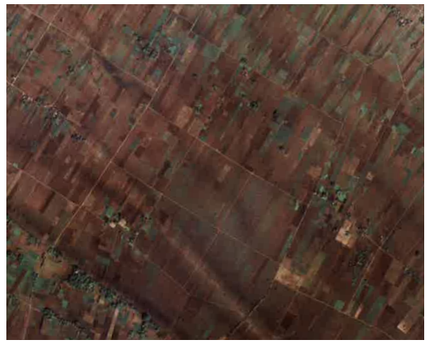
Introduction

“ When I have seen the hungry ocean gain
Advantage ou the kingdom of the shore,
And the firm soil win of the watery main,
Increasing store with loss and loss with store ;
When I have seen such interchange of state,
Or state itself confounded to decay ;
Ruin hath taught me thus to ruminate.”

Shakespeare, Sonnet LXIV.

Landscapes are continuously shifting. And coming from a country that lies in the delta region, a shifting riverine landscape, I have always been fascinated in the temporality of places and the natural processes of land transformations and its relation to water flows as well as the adaptive characteristic of the human settlements in these areas. The most dynamic areas in the country lie in the southern coastal zones of Bangladesh, where the tidal surges transform these places on a daily basis, monsoon transforms them seasonally and sedimentation and erosion are changing them over years. But the inhabitants have been adaptive to these changes for generations. With the accelerating climate changes and its impact on areas like these, there is an ever-growing need of speculating and identifying the future landscape conditions in order to be adaptive to these changes and planning the future development of these areas.

I am interested in working with the shifting landscapes in the coastal area of the Bengal delta, focusing on one riverine island to facilitate a clearer idea for proposing future interventions and developments in this island.



Shifting Landscapes of the Bengal Delta

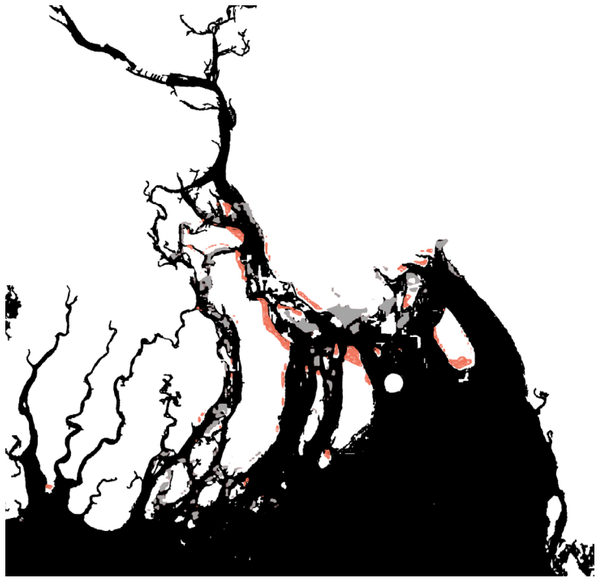
Designing an Evolving Island in a Char, South Coast of Bangladesh

"*Man continues to mark the land relentlessly shaping the surface from wilderness to cultivation. Strategies of mechanization, the necessity of irrigation and the demands of inhabitation introduce a new order. So the "countryside" which has evolved over centuries can be described as under the influence of nature but under the "control" of man. The 'natural' landscape has taken on an artificial patination. Alien materials interrupt the process of growth and decay*." (w)

This thesis aspires to investigate the logics of the natural processes of shifting landscapes; the dynamic landforms and river systems in the coastal area of Bengal delta, in order to design an island, where its inhabitants and the land uses are evolving with the landscape itself.

The shifting of the landscape is constant and unstoppable. But humans can adapt to it by evolving along with the landscapes. This project is aiming to design such an adaptive and sustainable island by proposing landscape interventions of mangrove species plantation, designing land formations to improve and re-organise land uses in a more sustainable order within a frame of one hundred years.

The intervention will generate a paradigm of shifting land use patterns in respect to the landscape changes in a coastal char context where the site is currently in a vulnerable situation due to the rapid climate change and anthropogenic activities. It will propose forestation of mangrove species and water management strategies.



Gains and losses of land between 1984 and 2007
(Edited from source: Brammer, 2013)

A Shifting Delta Landscape

A delta is a body of sediment deposited at the mouth of a river where it enters the ocean or lake. Unlike other landforms affected by running water, a delta is not created primarily by water cutting into or eroding the landscape, water does not wear down a delta; instead, it builds up a delta. And because of these fluvial processes, deltas are continuously shifting. A constant battle between land and water determines a delta's shape; a battle that is resultant of the strength of a river's flow and the amount of sediment it carries against wave and tidal currents.

The key to the creation of a delta, and its continual formation, is a river and the sediment it transports.

Bangladesh is a deltaic country, located in South Asia with a coastline of 710 km on the northern hub of the Bay of Bengal. About one fifth of the Bangladesh Delta is in the coast.

The river bank erosion and accretion is common in Bangladesh Delta. Although coastal erosion is a problem along the coastlines of mainland and offshore islands, the delta as a whole is increasing. Every year the rivers transport about a billion ton of sediment, which contributes to land accretion. Annual average land growth rate in Meghna estuary is 19km2.

A Riverine Island, Char

Char, a tract of land surrounded by the waters of an ocean, sea, lake, or stream; it usually means, any accretion in a river course or estuary.

A significant amount of land has already been reclaimed in the Lower Meghna Estuary and from the sea in the coastal area of the country. The main constraints for land use in Bangladesh are: flood (flash flood, river/monsoon flood, rain flood), drainage congestion/ water logging, drought, coastal surge, soil salinity, river bank erosion, land degradation, soil erosion, soil fertility depletion, decrease of land productivity, siltation on river bed and khals, rise of sea water level due to climate change, increase of population and settlements, and decrease of crop land. However, there is still a knowledge gap regarding reduction of sediment load due to upstream developments and projection of long term impacts of relative sea level rise etc.

However, newly emerged coastal lands are inhabited by the people very quickly, by the ones who lose their lands because of river erosion, salination of land and water or sea level rise.

As a result, these lands are not fully developed into a land high enough for a sustainable inhabitation. Introduction of polders occur due to demand of the inhabitants and for solving short term challenges. This leads to long term challenges like waterlogging, siltation and poor drainage in the polder islands.

As a result, these lands are not fully developed into a land high enough for a sustainable inhabitation. Introduction of polders occur due to demand of the inhabitants and for solving short term challenges. This leads to long term challenges like waterlogging, siltation and poor drainage in the polder islands. What if these newly emerged lands were allowed to shift and develop by enhanced or controlled natural processes and plantations, what would they become?

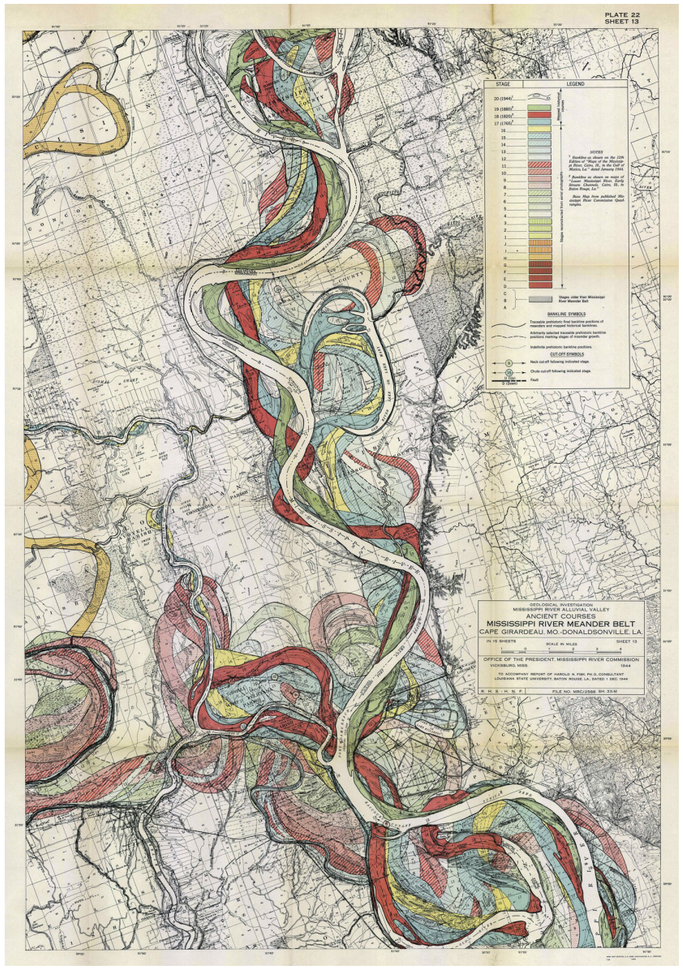
The Shifting Forces in the Delta

The major factors affecting the transformation in the landscape has been the dynamic natural processes. Apart from natural causes, some anthropogenic activities influence changes in these forces. Climate change is playing a big role in accelerating these processes.

Some of the natural processes that work as major shifting forces in the delta are River flows, Sedimentation, Erosion and Accretion, Tidal Surges, Sea level change, Earthquake

A note on the Assam Earthquake 1950

Drastic changes in the G-B Basins were observed in the past as a result of major seismic activities (Gupta et al., 2014). Seismic events in the Brahmaputra Basin (Goodbred et al., 2003) would also change the sediment scenario and its responses. The 1950 Assam earthquake, with a magnitude of 8.5 on the Richter scale, caused huge changes in the river system and the delta plains. Sarker et al. (2011) indicated that sediment generated by the 1950 earthquake, which was transported through the Brahmaputra, caused huge sedimentation in the Meghna estuary. The fine fraction of sediment rushed into the estuary within a few years, whereas the coarse fraction (fine sand) propagated downstream as a sediment wave and took nearly five decades to complete its journey to the bay (Sarker, 2009; Sarker and Thorne, 2006). Sarker, Akter, and Rahman (2013) indicated that the rate of land reclamation in the Meghna estuary was mainly a result of sediment carried to the estuary, which was generated after the 1950 Assam earthquake. The progradation of the delta would affect the water level in the Shahbajpur Channel and in the Lower Meghna River. Analysis of monsoon water levels at different gauging stations in this system shows a high increase in the Shahbajpur Channel and a small increase in the Lower Meghna River (CEGIS, 2010). However, during the preceding decade, water levels of all these stations showed a receding trend, the reason for which probably lies with the sediment input in the system or changes to the local morphology of downstream channels. Unfortunately, there are no sediment data available for this period. Sarker (2009), however, indicated that as the trailing edge of the sediment wave has already entered the bay, it could have caused a sediment deficit in this area and a temporary phase of channel degradation.



A Shifting Delta: Mississippi River Meander Belt

Climate Change and Shifting Landscape

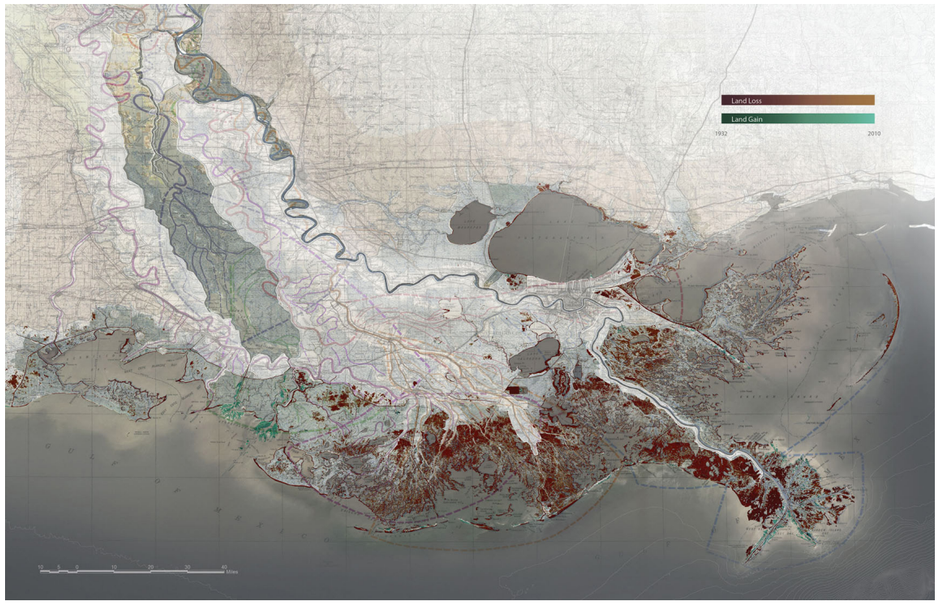
A few places in the world are vulnerable to the effects and severity of climate change; amongst them, Bangladesh will likely be one of the most experienced countries (Ahmed, 2006; Pender, 2008). Global warming, along with RSLR, is expected to cause significant changes in the flood regime (Climate Change Cell, 2006; Mirza, 2002, 2003; WARPO, 2005; Yu et al., 2010).

If nothing is done, by 2050, climate change impact could make an additional 15 per cent of the country extremely vulnerable to floods and effect more than 35 million people in the coastal districts.

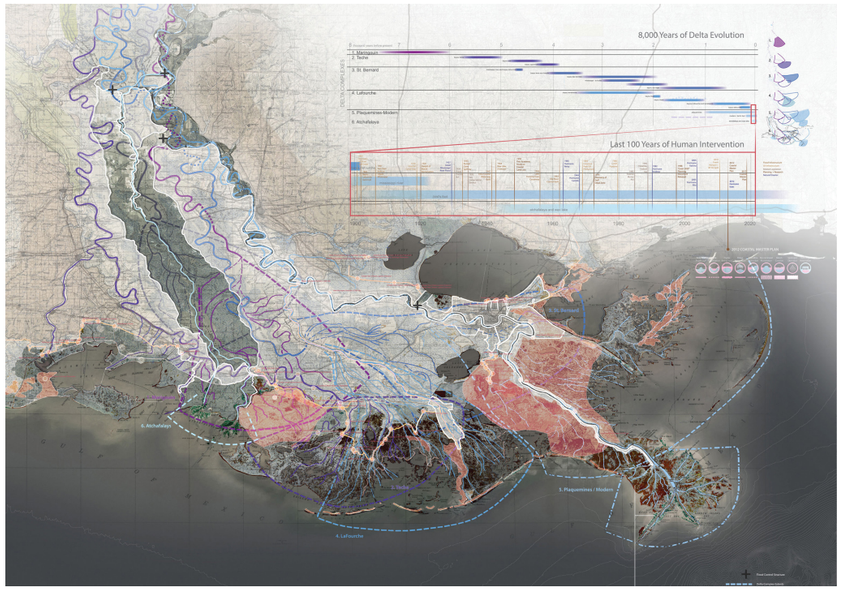
A period of fluvial process and morphological form adjustments would make the system more dynamic and unpredictable. With higher flow and sediment, the river and its estuary would be more dynamic, which would result in some net accretions. If the sediment input is reduced in the system, net erosion will take place. Therefore, the expediting rate of climate change is very likely to cause several changes in the physical processes (Sarker et al, 2016).

CEGIS (2010) also carried out research to assess the impact of climate on the morphological process of the main rivers and the Meghna estuary. They identified that with the changes in sea level, the rivers would adjust their bed and bank levels with a certain time lag, which mainly depends on their proximity to the sea. The tidal plains in the Meghna estuary would respond quickly because of its propinquity to the sea, if it were not empoldered. Moreover, impacts of climate change are presently assessed considering a fixed river system, while the river system is continuously adjusting with the changing of different parameters, such as base level, flood discharge, and sediment input from upstream. The estuary, tidal plains, and floodplains, along with the river system, would adjust themselves with the increased flood discharge and subsequent SLR. Thus, whatever the impacts of climate changes have been assessed so far, they might differ to different extents if the system is considered while taking into account dynamically adjusting processes with the changed situation. This dynamic approach needs to be considered for representing the dynamic delta (Sarker et al, 2016).

The process of understanding the responses of the delta landscape to climate change is important for fixing a strategy for adaptation to climate change- especially for a country like Bangladesh, where the delta is enormous, the rivers are dynamic.



Land loss and Land gain in Mississippi Delta



8000 years of Evolution of Mississippi

Landscape Migration

"*The act of migration is inseparable from the material and spatial dynamics in which a living thing or group of living things interact; rendering migration as "a complicated, challenging and diverse phenomenon involving changing statuses and multiple geographic trajectories*." (Michael Samers, Migration, 2010)

We are living in the age of Anthropocene, landscapes are changing faster than ever and they are not stable backgrounds.

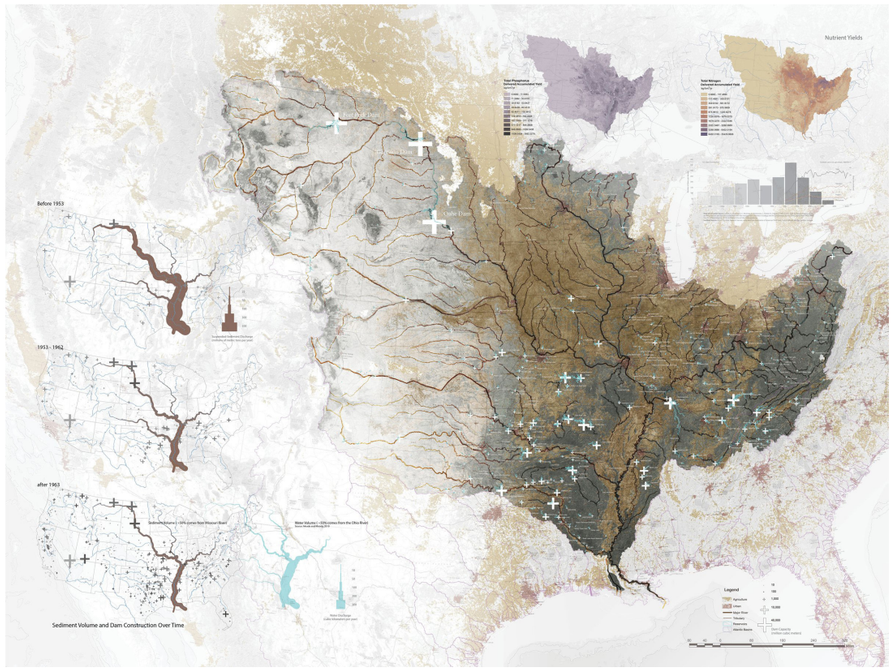
At a planetary scale, we know that landforms migrate through plate tectonics. There is no significant debate about this phenomenon. Yet, surprisingly, we've only understood this for about 50 years. In that brief span, we've become adept at visualizing, monitoring, and anticipating earthquakes, volcanic eruptions, and other geologic events.

If we accept the idea that the entire surface of the earth is migratory, then why not landscapes in particular? A landscape — as a scene, landschap, ecosystem, and socio-political territory — is a material assembly of moving entities, a dynamic medium which changes in quality and structure through the aggregate movements or actions of the things that constitute it. (Milligan, Landscape migration, 2015).

The Case of Mississippi Delta

The Mississippi Delta was built over 8000 years by deposition of sediment from the river's vast upland basin. Freshwater and sediment periodically breached the river's natural levees, creating and nourishing the marshes, swamps, and cheniers of South Louisiana. Approximately every thousand years the river switched channels, finding a quicker way to the Gulf of Mexico as a function of its own depositional patterns. This event is called an avulsion, wherein a new delta complex forms while the previous complex begins a slow deterioration. This migratory process has been altered by the construction of levees and other human interventions.

River deltas are extraordinary migratory landscapes where nearly everything is in constant motion at varying time scales, from daily tides to thousand-year intervals in river avulsions. The re-engineering of the Mississippi River was a pivotal and transformative event in its history, but infrastructural constraints do not arrest time. Landscapes never stop moving, no matter how hard we try to fix them in place. Rather, flows and processes within them are subject to distortion, to variable slowing and acceleration. Landscapes respond to constraint by moving differently, often arriving at surprising and undesirable manifestations. Mississippi Floods leaves us with a lingering question: what is the new migratory syndrome of the river and its watershed?



Engineered River, changing Mississippi

Dams throughout the Mississippi Basin (which encompasses 40 percent of the contiguous United States) have reduced the volume of sediment traveling downriver by more than half. What's more, the concrete armoring of the river's banks speeds up its flow, so that much of the sediment it does carry is swept into the Gulf of Mexico during high flows. Largely as a result of this altered sedimentary budget, the Mississippi Delta is disappearing at the average rate of one football field every hour. In less than a century, we have inadvertently reversed the trajectory of the world's third largest delta. The emerging discipline of restoration sedimentology relies on an explicitly migratory strategy, using sediment as an infrastructural base which can be colonized by other parts of the ensemble, from plants and animals to recreational boaters. (Milligan, Landscape Migration, 2015)

Research Questions

"How we represent and model landscapes influences how we perceive them."

A long term projection for the newly emerged lands are needed, focussing on the dynamic characteristics of this area. The representations of relative sea level change, change in river flows, upstream developments affecting sedimentation and river velocity and careful speculation of builidng new infrastructure are important tools for making the projections.

There a few basic concerns that are rising within this particular site and topic:

How can representations of the natural processes of water flows and sedimentation over time be a crutial tool in designing a landscape of a char?

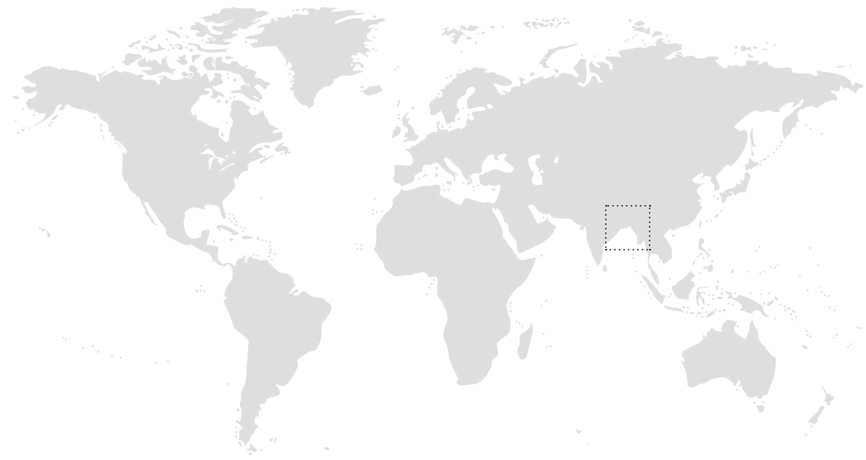
How can man-made land formations and interventions improve the water quality in a char through shifting water courses and controlling the flows?

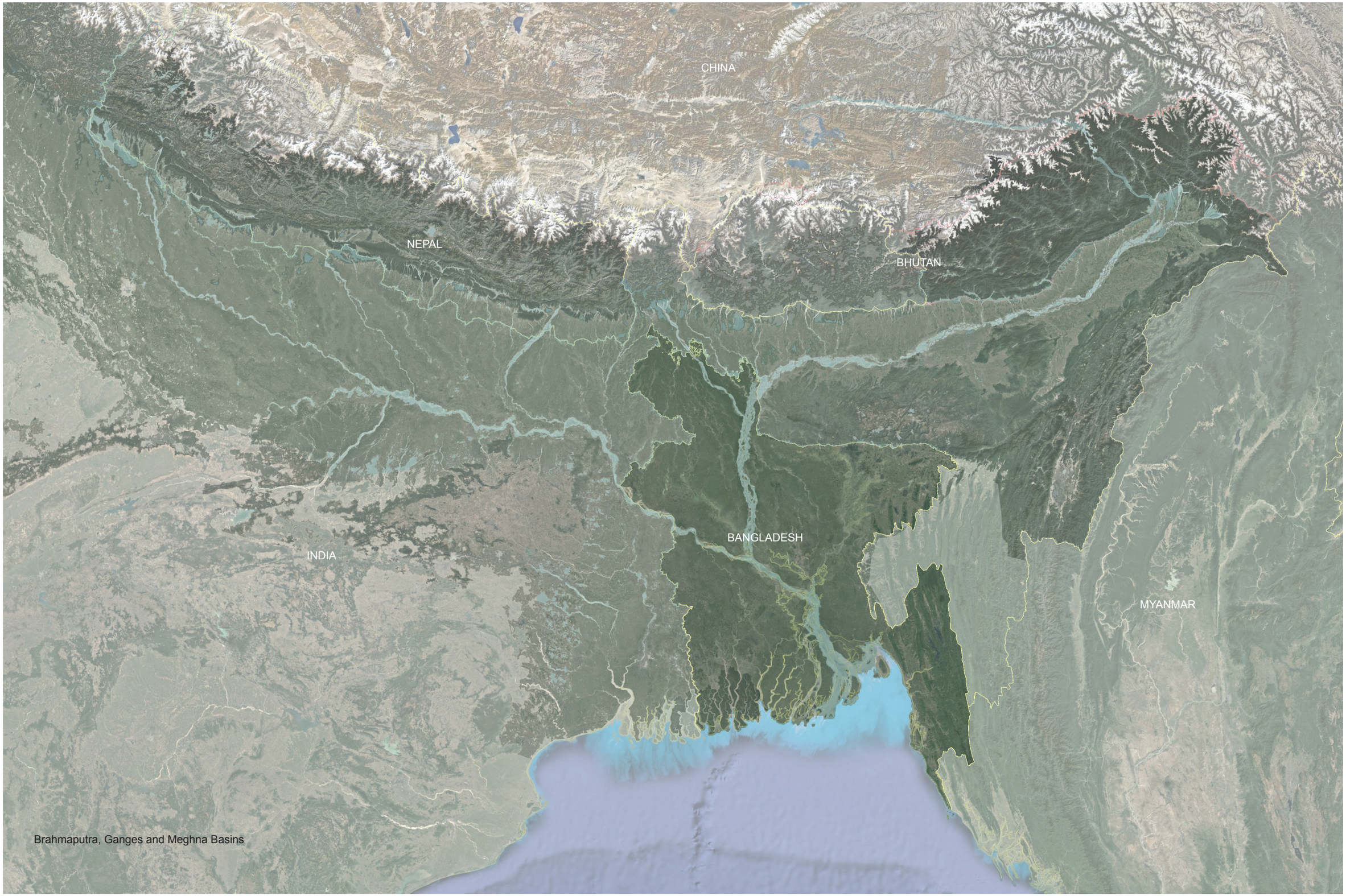
How can reorganizing wetlands and land patterns with plantation help adapt to the rapid changes in the chars due to climate change and improve the physical quality/ environment of the landscape?

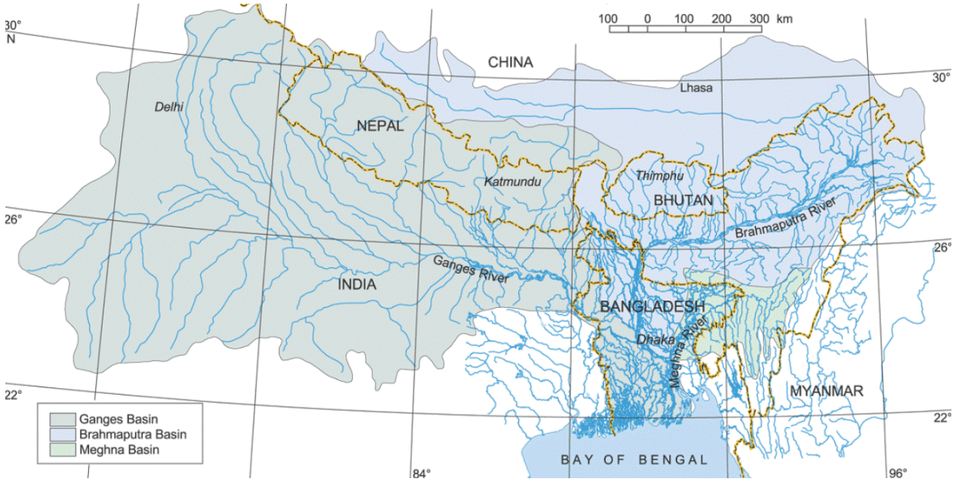
How can controlled water and sediment flow become a tool for raising the elevation of a deltaic island and making it more sustainable?

By focussing on the flow of water and sustainability of the land, a lot of issues will be addressed; such as fresh water supply, agricultural productivity, connection with mainland and overall physical environment of the island.

Aerial view of Bengal Delta




CHINA
NEPAL
BHUTAN
INDIA
BANGLADESH
MYANMAR
Brahmaputra, Ganges and Meghna Basins



Ganges, Brahmaputra and Meghna Basins

Site context

Ganges, Brahmaputra, Meghna River Delta

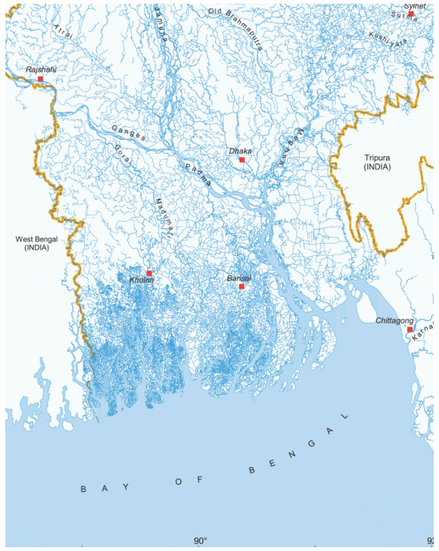
The Bengal Delta is the largest delta in the world. It drains almost all of the Himalayas, the most sediment producing mountains in the world, through the three main river systems: the Ganges, Brahmaputra, and Meghna. These systems carry the world's largest sediment load, more than 1 billion tonnes of sediment every year, of which nearly 80% is delivered during the four monsoon months (Goodbred and Kuehl, 2000b).

This has produced the Bengal Fan, a deposit of sediment on the floor of the Bay of Bengal that stretches outward 3,000 kilometers in length and 1,000 kilometers in width. In places close to shore, the Bengal Fan measures up to 12 kilometers thick. Approximately 345 kilometers wide, the delta covers an area of roughly 105,645 square kilometers.

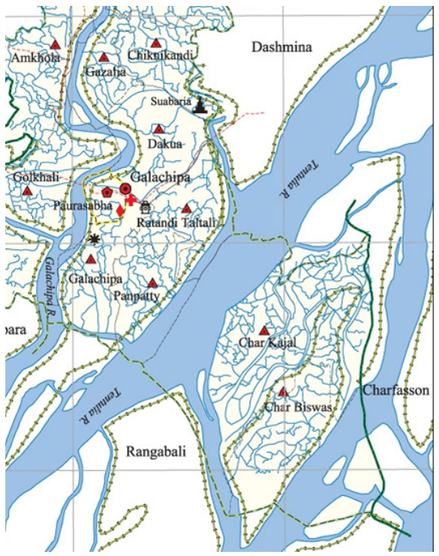
A glacier at about 6,735 meters in the Himalayan Mountains is the source of the Ganges River. The river flows southeast across India to combine with the Brahmaputra in Bangladesh. The Brahmaputra River has its source in Tibet along the northern slope of the Himalayan Mountains. From there, it flows across the Assam Valley of India into Bangladesh. The rising Himalayan Mountains provide much of the sediment load of these two rivers.

In Bangladesh, the rivers join to form the Padma, the main channel to the sea. The united rivers branch into many distributaries, forming the vast and fertile Ganges River Delta. The delta region covers roughly 25 percent of India's total territory. The delta's southern portion is covered largely with a swamp forest roughly 16,900 square kilometers in area. Known as the Sunderbans, it is home to the endangered Royal Bengal tiger.

The total land area of the country is about 148,400 km2; where the net cultivable area is 52.8%. The soil is highly fertile because of the sediments in the deltaic plain of rivers such as the Ganges, the Brahmaputra and the Meghna and its tributaries. The country is densely populated with 1,174 people per km2. Land scarcity, in relation to demand, is visible in accelerating increases in land prices. Land availability, as well as its long-term management, has important significance on overall development of the country.



Rivers and streams in coastal delta of Bengal



Rivers and streams in the Char site

Char Kajal

The government of Bangladesh, in cooperation with the government of the Netherlands, aims to create the Bangladesh Delta Plan 2100. The Delta Plan will integrate planning from delta-related sectors and from all across the country to come to a long-term, holistic and integrated plan for the Bangladesh Delta. The Water Board of Bangladesh conducted an assessment and reserach on the char areas and the chars were selected which had the potential to become sustainable. The government initiated a program in 2011 named Char Development and Settlement Project in the chars along Bay of Bengal with the objective of protection from climate change impacts. Apart from that, some community based adaptation programs are also carried out in various villages in these areas by UNDP. One of them is ‘CBA Bangladesh: Piloting Climate-Resilient Development Initiatives (CNRS)’ in a riverine island called Char Kajal.

Char Kajal is a riverine island bounded by the BuraGaurango and Tetulia rivers in Southern part of Bangladesh, with a population of approximately 21,100 people.

During monsoons, the BuraGaurango swells to 7 to 10 kilometres, making it difficult to reach the mainland. Limited access to resources on the mainland such as emergency medical services and market centers increases the vulnerability of the Char Kazal community to the negative effects of extreme weather. The community is almost entirely dependent on natural resources for their livelihood, engaging in agriculture, wage-labor and fishing as their primary occupations.

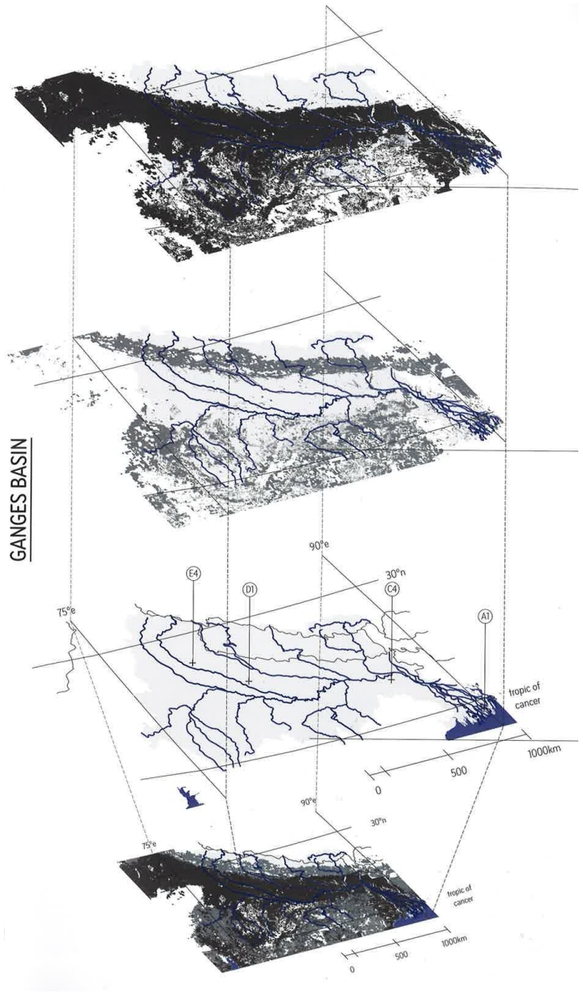
Over the last 10 to 15 years, soil erosion and degradation has decreased the amount of arable land on the island, making it more difficult to grow sufficient crops. Sand carpeting and salinity intrusion are the main causes of soil degradation and are exacerbated by recent climate shifts. Poor crop yields have forced many community members to change occupations that are further away from the village and are not always as profitable.

Climate change is projected to exacerbate these effects, bringing with it an increase in temperatures, reduced and erratic rainfall, heat waves, and more frequent rainstorms. The changing climate conditions will likely reduce the availability and productivity of agricultural land as well as disrupt aquaculture practices.

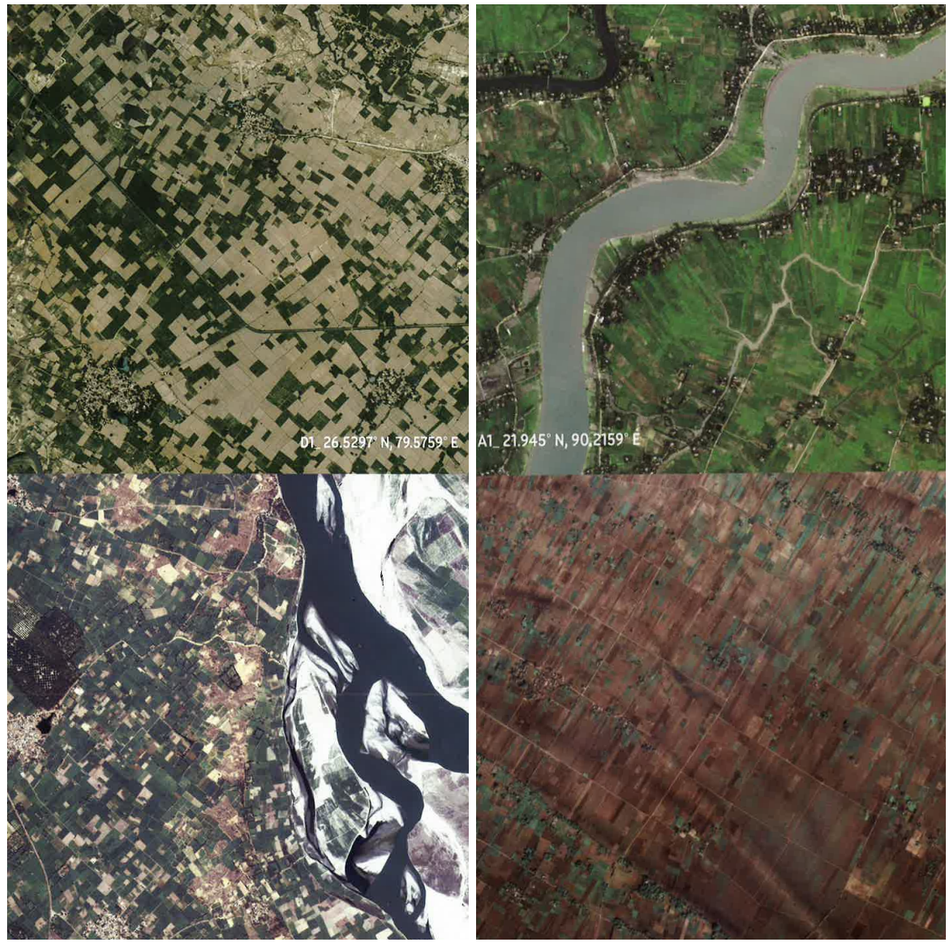
This thesis will take Char Kajal as a case study for analysis and designing which can add another layer to the existing programs in the area and being replicated in other similar chars could create a large impact on the coastal delta.

Aisles in between agricultural fields

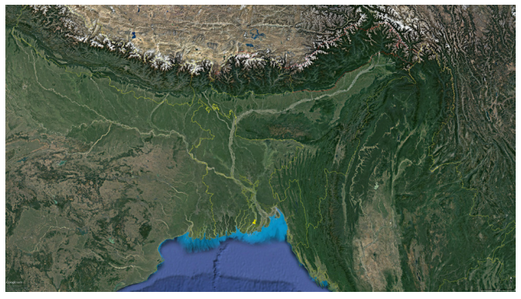
Photograph of households in the area



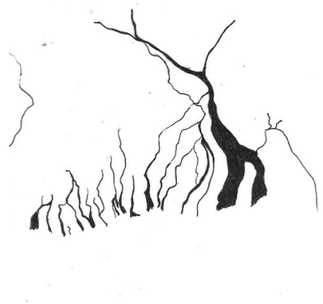
Ganges Delta
Images from ‘Ganges Water Machine’

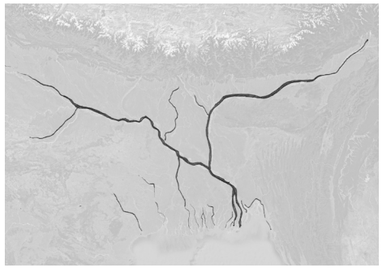


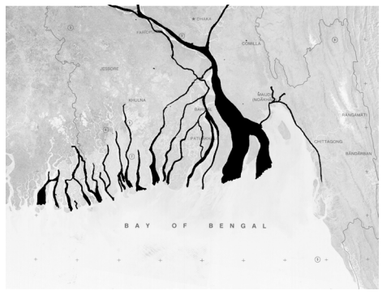
Land use patterns: Agricultural lands in Ganges Delta
Images from ‘Ganges Water Machine’



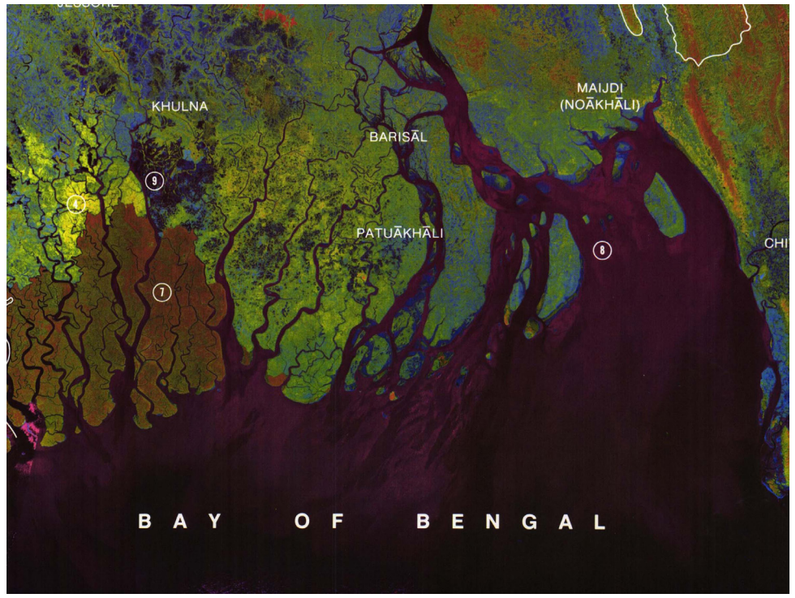
The Shifting Forces and Patterns in Different Scales



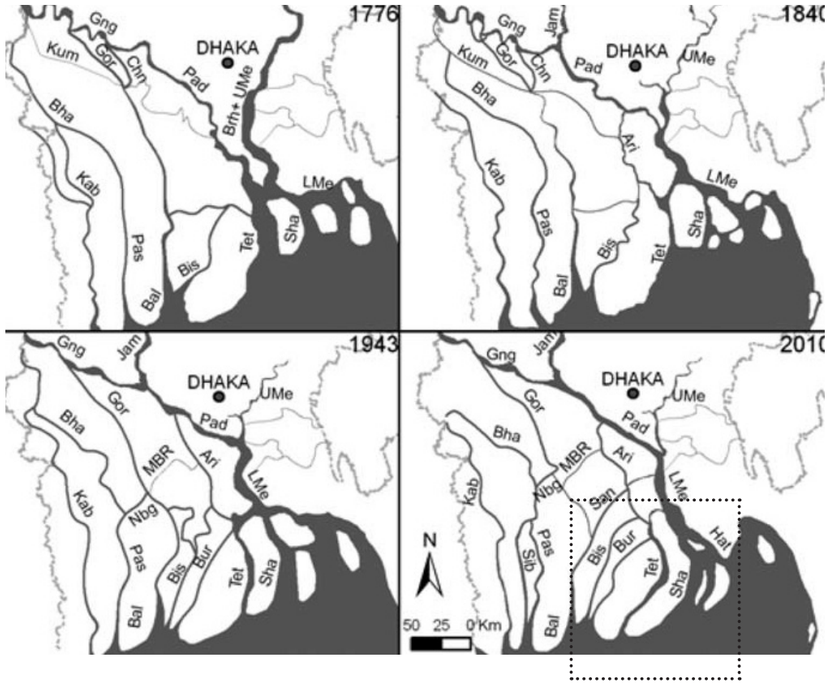




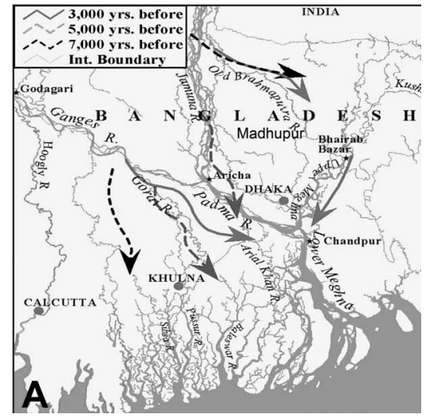
Map of Bengal and Bihar, Rennel, 1776



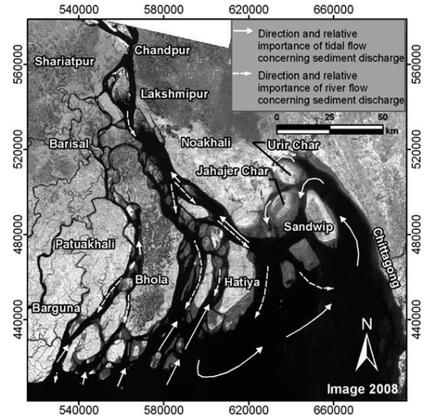
Bengal, Land Satellite Mosaic, 1984



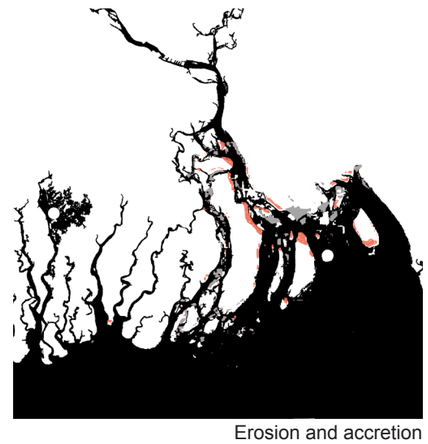
Development of the main rivers and chars in Bangladesh over time
(Source: Sarker, Akter, and Rahman, 2013)



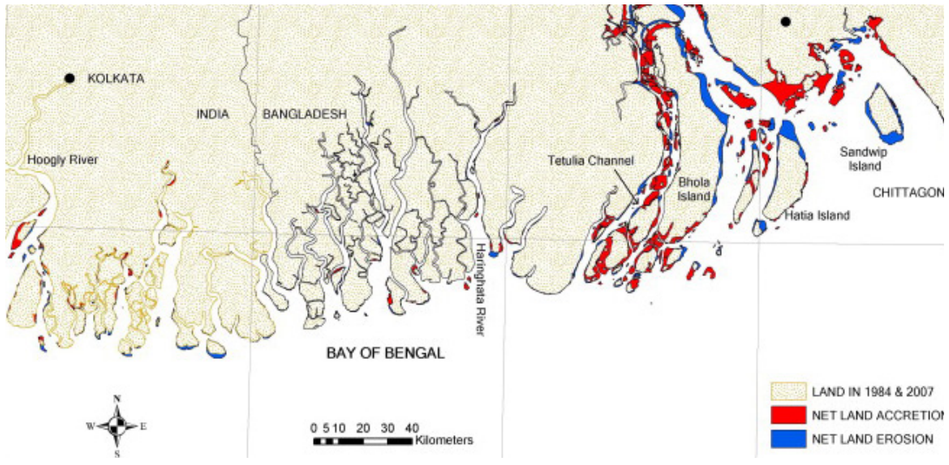
Shift in river flows



Direction of Sediment flows



Erosion and accretion



Shift in land masses
(Brammer, 2010)

Organisation

Approach

Scope and Limitations:

The thesis will be composed of two parts: Background research and Design Proposal. In the first stage, the research will work as a toolbox that will be used for proposing the design interventions. Research will be carried out on the basis of existing studies on geomorphology, evolution of river and landmass, available maps, aerial photographs and interviews with experts and local inhabitants. Studying reference projects and literatures and comparison to other delta regions and islands will be an instrument for decision making.

There is limited access to existing maps and studies of the area and GIS files are not available. The interview and conversations with locals and experts will be used as a method to identify the social and economic characteristics of the island that will play a role in the design of the evolving island. Applying nomadic cultural aspects within the design process will be another tool.

A selection of mangrove species will be done based on the water conditions, soil characteristics of the island and economic value of the species. These species will be used in the plantation scheme. With the findings from the geomorphological, social and economic research, combining with the land and river flows, the design strategy of the evolving island will be carried out within a time frame of two hundred years.

The design will generate a paradigm of shifting land use patterns in respect to the landscape changes in a coastal char context, where the site is currently in a vulnerable situation due to the rapid climate change and anthropogenic activities. This will be a case study for one island, which can be repeated in other coastal chars (riverine islands).

Material

The outcome of the project will be:

Research:

River and sediment flow
Selection of mangrove species
Nomadic and social context
Diverse productive landscapes

Design proposal:

Strategic Master plan of the evolving island
Sections of island
Plantation scheme
Water flow plans
Scenario of land use patterns in time frame of one hundred years
Model of full/ partial island

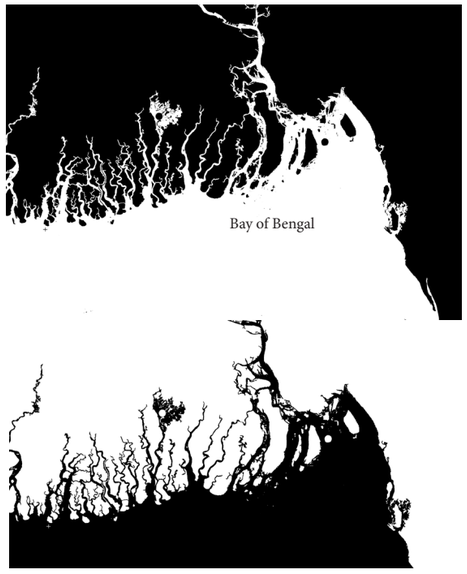
Schedule

Weekly Schedule of Diploma Semester :
Autumn 2017: Week 32- Week 50

Week 32	RESERACH + TOOLBOX + MAPPING : Controlling river and sediment flow, Land formations + Conceptual Mapping
Week 33	Controlling river and sediment flow, Land formations + Mapping
Week 34	Selection of mangrove species + Mapping
Week 35	MAPPING : Site analysis, territorial maps
Week 36	Mapping, Site analysis, Site evolution, Island maps + Design idea
Week 37	DESIGN : Conceptual sketches + Maps
Week 38	Plans + Sections + Sketches
Week 39	Plans + Sections with River flow and Land formations
Week 40	Plans + Sections with Plantation + Conceptual model

SITE VISIT: Week 41- Week 43

Week 41	Survey, Photography and Interviews
Week 42	Survey, Photography and Interviews
Week 43	Survey, Photography and Interviews, Toolbox: Nomadic and social aspects, end of site visit
Week 44	Compiling gathered data + Master plan+ Section
Week 45	SCENARIO: Design Strategy over time frame + Master plan + Conceptual model
Week 46	Design Strategy over time frame + Master plan + Section + Visualization
Week 47	FINALIZING : Master Plan, Sections, Plans
Week 48	Finalizing Presentation : Plans + Sections + Visualization + Model
Week 49	Finalizing Presentation : Plans + Sections + Visualization + Model+ Plotting
Week 50	DELIVERY



A constant battle between land and water determines a delta's shape

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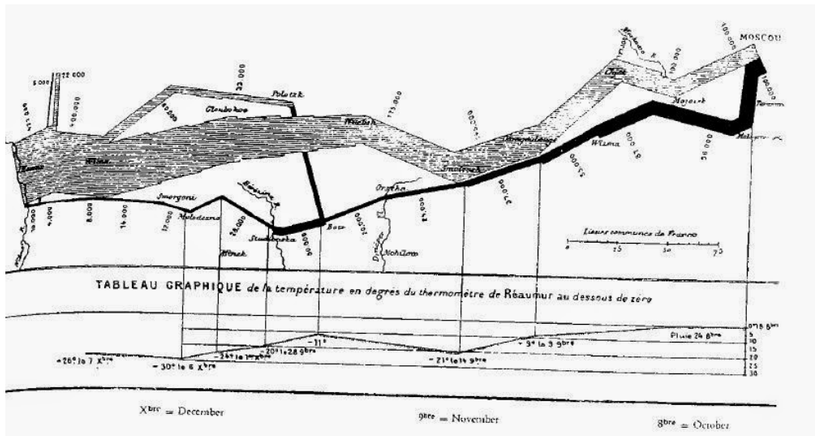


Charles Joseph Minard, *Carte figurative des pertes successives en hommes de l'armée Française dans la campagne de Russie 1812–13*, from E. J. Marey, *La Méthode graphique* (Paris, 1885).

Rhizome map
Image source: Corner, Agency of Mapping

CORNER, J. (1999), "The agency of Mapping" in The Landscape imagination, New York: Princeton Architectural Press, pp 197-239.

Summary:

The author of the book, James Corner is an American landscape architect who is focused on developing innovative approaches towards landscape architectural design and urbanism. He works in amalgamation of different disciplines including landscape architecture, urban design, landscape ecology and engineering. This article was written for the professionals and students of all these various backgrounds.

In the article, the author focuses on the more optimistic revisions of mapping practices, where mapping uncovers realities and unfolds potential. He is concerned about this topic because he thinks that the true capacities of mapping are not widely recognized in urban design and planning sector. Most planners and designers consider mapping as an unimaginative practice and often ignore some of the contents in the map during the design process. He spoke about some unconventional ways of using maps and our reactions towards these maps by using the example of the maps created by Mercator's projection and Buckminister Fuller's Dymaxion projection. As we are used to some certain ways of thinking about the world, these maps provoke some thoughts in our minds and makes us look at the same planet from a different angle. He believes that maps can have the power to have a strong impact on our perception of space and the way we generate maps can be the most important tool for the beginning of a design. He describes the operations and techniques of mapping in the article. He mentioned four different techniques of mapping in the contemporary design and planning and labeled them as drift, layering, game-board and rhizome. Drift is kind of an experiential mapping, which was first created by Guy Debord. This map is not a projection of reality, but the image of one's experience of a space or a journey. Layering is another effective technique of mapping where many different layers of information are laid on top of each other to find interesting relationships between the different layers. Game-board maps are created by the overlaid information from various experts of different backgrounds. The drift and layering techniques are applied in making game-board maps. Rhizome maps are open-ended and can represent diverse range of information within the same map.

The author underlines the fact that mapping is not merely tracing; rather it is to highlight conditions that discovers new worlds within the existing worlds. He brings up some examples of some of the famous maps to support his argument. For example, he writes about the mapping done by architect Peter Eisennman with landscape architect Laurie Olin, in which they merged building and landscape into one large fractured ground plane. The map projected facts that were not visible on the ground. He believes that this is what a good map should do. The author suggests that, mapping is already a project in the making. He believes that the world will start seeing map as a means of emancipation, for finding new worlds out of old.

Underlying question:

How can mapping be the first step of designing and a creative activity? How does drawing the map in a certain manner (Rhizome map) sets the stage for future ground work of the designer or planner?

FORMAN, RTT. (1990) ` Ecologically Sustainable Landscapes The Role of Spatial Configuration´ in Changing landscapes: an ecological perspective. Springer: New York, pp. 261-278.

Summary:

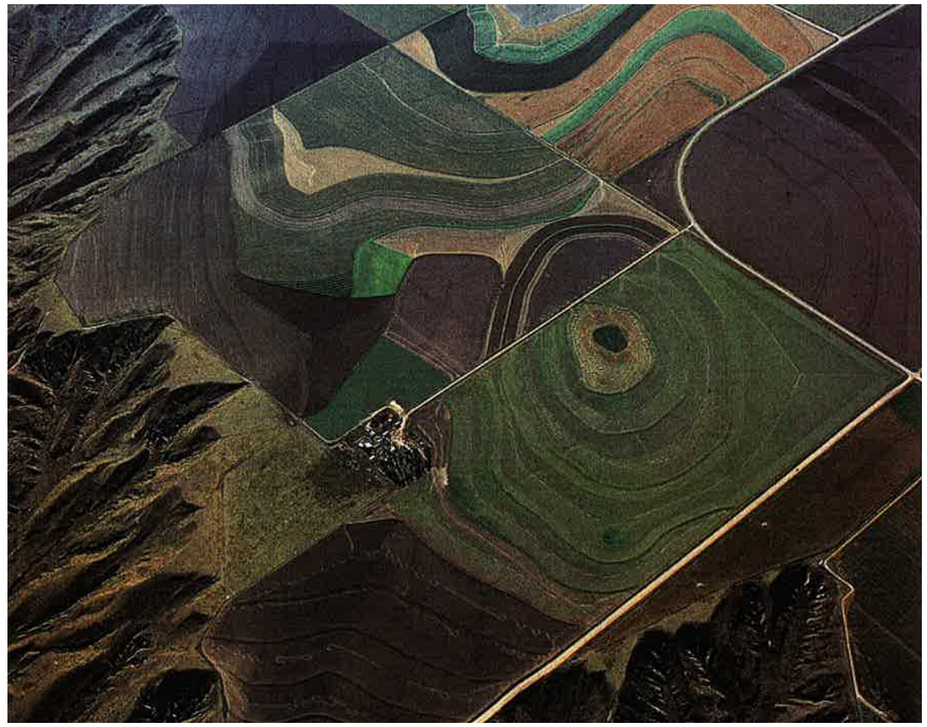
The author of the article, Richard T.T. Forman, is a Research Professor at the Harvard University. This article is based on a talk, presented at the 1988 meeting of the International Federation of Landscape architects.

In this article, the author chooses to study the concept of sustainable development, in terms of time and change, variables and values as well as spatial scales. He considered the basic types of landscapes and their potentiality as sustainable environments and used landscape ecology and spatial configuration. He wanted to portray the basic characteristics of sustainable development, explore the applicability of sustainability with landscape scale, to investigate the regulatory role of spatial configuration on the main variables of sustainability.

The author is mainly trying to find the interaction between human aspiration and ecological integrity, alternating changes over a long period of time and the spatial scale. He finds four key characteristics of a sustainable environment; mosaic stability, which permits changes and fluctuations, adaptability and change in ecological and human systems, the time period, which can be several human generations and slowly changing variables typically with irregular cycles, that he calls foundation variables and categorized them.

The author has tried to explain the main characteristics of sustainability, the influencing variables, the role of landscape ecology and finally a connection between the landscape and sustainability. He found that when a planner is considering some spatial configuration in landscape, he could achieve a specific level of a variable and by rearranging this configuration usually increase or decrease ecological integrity. For this reason, the author came up with the hypothesis, that for any landscape or a part of landscape, there is an optimal spatial configuration of ecosystems and land uses that could maximize the ecological integrity, achievement of human aspirations; or sustainability of an environment. However, the challenge lies in finding this optimal configuration.

The author also studies the role of landscape ecology with a deeper insight. Hence, he made a detailed analysis of the landscape types. He categorized all landscapes based on structural characteristics; scattered patch, network, interdigitated and checkerboard landscape. He studied the spatial configuration of these landscapes and their effects on the slow cyclic variables of sustainable environments.



Landscape mosaics: Image source: Forman, 1990

The author explored the connection between sustainable development and landscape ecology and identified some key characteristics; examined landscape as a finer scale of region and assessed the importance of spatial configuration. He recommended an operational concept of sustainable environments that minimize the values. He studied the characteristics, described the fundamental variables and classified landscapes into four different types based on spatial structure. He portrayed the key spatial characteristics of each of these landscape types based on landscape theory and case studies.

Underlying question:

How can landscape be used as an optimal spatial scale for planning and managing a sustainable environment?

How by using the optimal spatial configuration of ecosystems and land uses could maximize the ecological integrityand sustainability of an environment?

“Water is everywhere before it is somewhere. It is in rain before it is in rivers, it soaks before it flows, it spreads before it gathers, it blurs before it clarifies.”

Image source: Mathur, A., Cunha, D. (2014) ‘Waters Everywhere’ in Design in the Terrain of Water, University of Pennsylvania, School of Design, pp. 1-11.

MATHUR, A., CUNHA, D. (2014) ‘Waters Everywhere’ in Design in the Terrain of Water, University of Pennsylvania, School of Design, pp. 1-11.

Summary:

“There are waters at moments in the hydrological cycle that are not easy to picture in maps or contain within lines. It is ephemeral, transient, uncertain, interstitial, chaotic, omnipresent. It is water to which people are increasingly turning to find innovative solutions to water scarcity, pollution, aquifer depletion and other problems that are assuming center stage in local and global politics, dynamics, and fears. It is also water that is celebrated and ritualized in ordinary and everyday practices across many cultures.

It is surely not a coincidence that the turn to these waters, that resist the figure and the frame, is occurring when design disciplines are beginning to embrace measures such as flexibility, agility, and resilience, measures more closely associated with a watery imagination, while becoming circumspect of aspirations like prediction and control encouraged by a terra firma, aspirations that have proved elusive, perhaps even detrimental. This is after all a time of uncertainty and ambiguity brought on by increasing openness of economies, cultures, and ecologies.

Is this time of water and watery imagination a moment to re-invent our relationship with water? Is it a time to look to the past, present and future and ask if in seeing water somewhere rather than everywhere we have missed opportunities, practices and lessons that could inform and transform the design project? What role has representation and visualization played in confining water on terra firma? Can we look at projects in history and projects emerging today – cities, infrastructures, buildings, landscapes, artworks – with a cultivated eye for water that rains, soaks, spreads, and blurs?”

Underlying question:

“What is it to see water as not within, adjoining, serving or threatening settlement, but the ground of settlement? Is this the basis of a new vocabulary of place, history, ecology and other fields that inform the design process? And can the field of design by virtue of its ability to articulate and re-visualize lead in constructing this new vocabulary?”

MILLIGAN, BRETT (2015) ‘Migrations of the Mississipi river’ in Landscape Migration, Environmental Design in the Anthropocene.

Summary:

“How we represent and model landscapes influences how we perceive and engage with them. Designers such as James Corner, Alan Berger, Anuradha Mathur and Dilip da Cunha, Jane Wolff, and Bradley Cantrell have repeatedly demonstrated this point. In particular, Mathur and da Cunha have advanced a critical inquiry of cartographic conventions and received habits of landscape representation. Their work — a self-described activist practice — emphasizes the ways that conventional mapmaking and planning suppresses movement, variability, and flux. They problematize the drawing or projection of fixed boundaries onto inherently dynamic landscapes, showing “how these divisions and lines can harden in the landscape, in civic administration, and indeed in the design disciplines.” By interrogating these conventions, they open up “possibilities and material practices that have been marginalized, or are not even on the table.” 26 In Mississippi Floods, they pair Harold Fisk’s mappings of historic meander courses of the Mississippi River (1944) with the Army Corps of Engineers’ Design Flood Diagram, juxtaposing radically different takes on space, time, migration, and landscape agency. 27 Through their layered diagrams of meanders, flows, banks, and beds, Mathur and da Cunha illustrate just how extensively the Lower Mississippi was altered by multiple infrastructures.

River deltas are extraordinary migratory landscapes where nearly everything is in constant motion at varying time scales, from daily tides to thousand-year intervals in river avulsions. The re-engineering of the Mississippi River was a pivotal and transformative event in its history, but infrastructural constraints do not arrest time. Landscapes never stop moving, no matter how hard we try to fix them in place. Rather, flows and processes within them are subject to distortion, to variable slowing and acceleration. Landscapes respond to constraint by moving differently, often arriving at surprising and undesirable manifestations. **“**

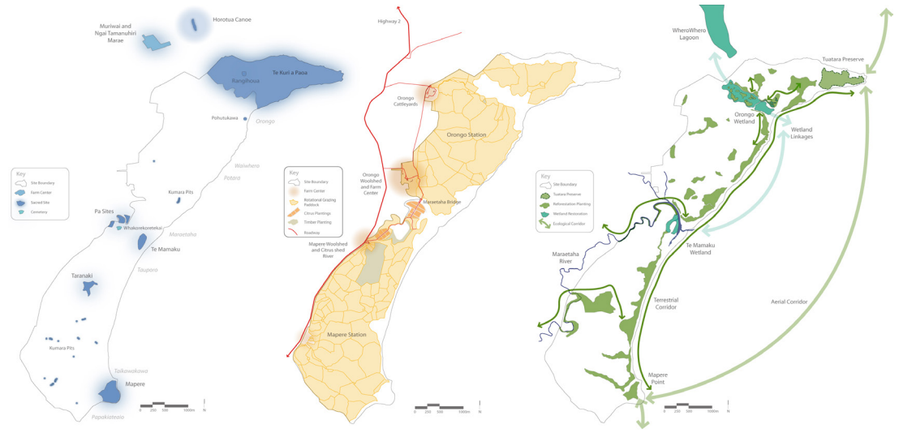
Underlying question:

“Mississippi Floods leaves us with a lingering question: what is the new migratory syndrome of the river and its watershed?”

Image: From 1931 to 2010, the Mississippi Delta lost roughly a quarter of its landmass. [Matthew Seibert, Dredge Research Collaborative and Louisiana Coastal Sustainability Studio]
Image Source: https://placesjournal.org/article/landscape-migration/

Hybrid landscape of Orongo Station
Image source: https://www.asla.org/2010awards/205.html

WOLTZ, T. (2015) ‘Orongo Station Conservation’ in North Island, New Zealand, Nelson Byrd Woltz Landscape Architects



The Cultural Landscape of the Ngai Tamanuhiri | The Farmed Landscape of Orongo Station | The Landscape of Ecological Restoration

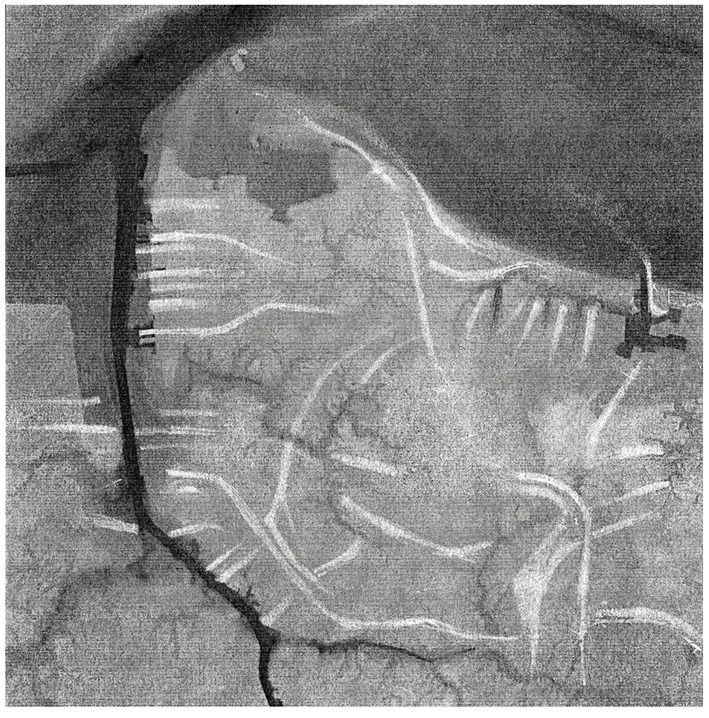
The cultural landscape, Farmed landscape and the landscape of Ecological Restoration at Orongo Station

Summary:

This project focuses on extensive regeneration of a devastated ecology in a 3000-acre sheep farm, while expanding agricultural production and revealing a cultural lansdacape.
The main strategies are creating a sanctuary for migratory birds, dense planting of coastal woodland,
re-introducing Tuatara, an endangered reptile, restoring wetlands, reforestation on uplands, integration of agriculture with cultural landscapes.

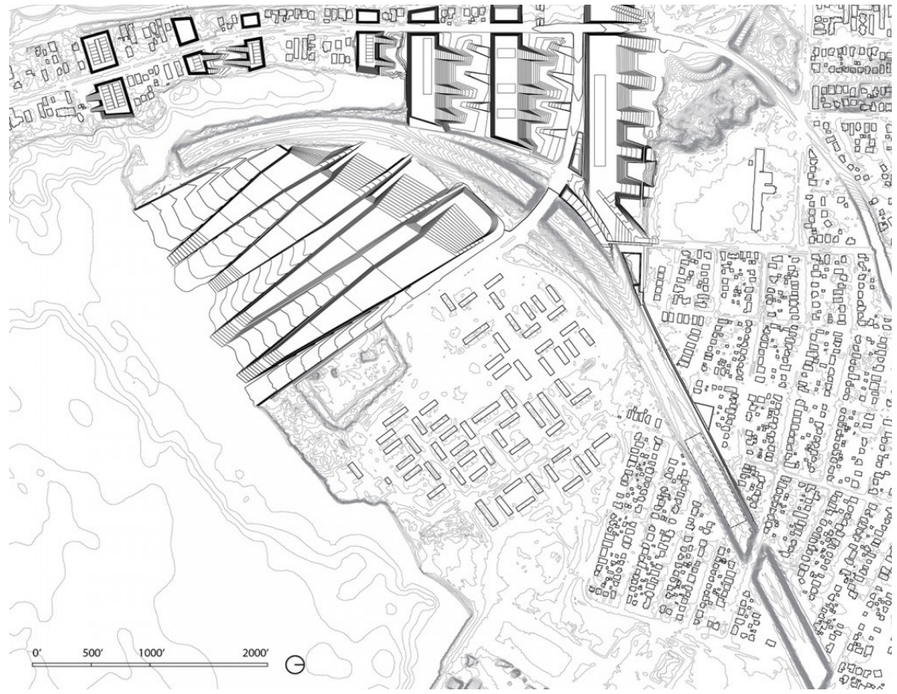
Underlying question:

How can a cultural landscape be used as a tool for restoring an ecology and maintaining a sustainable environment?



“A gathering of gradients between land and sea, structuring a coast that is more fractured, cumulative and diverse than it is continuous, linear, and abso-

MATHUR, A., CUNHA, D. (2014) ‘Fingers of High Ground’ in Norfolk, Unites States



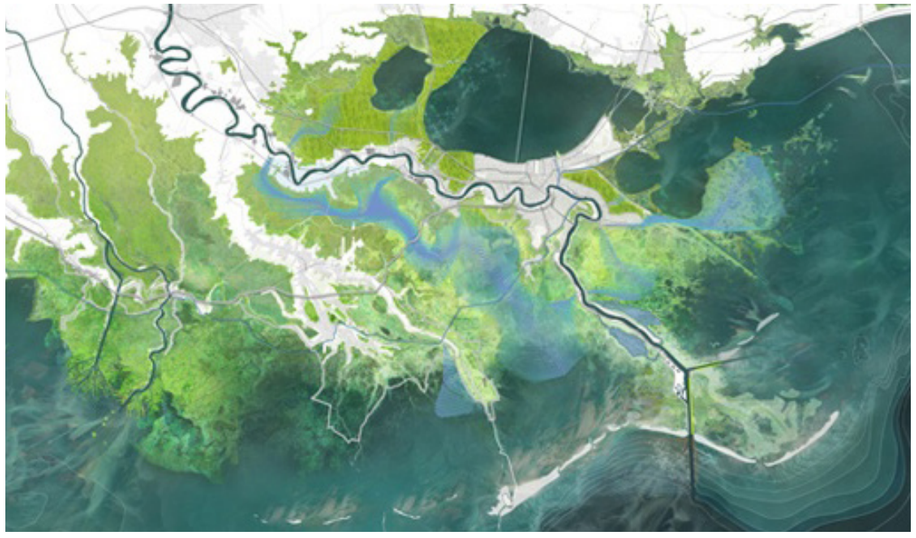
Fingers of High Ground, Norfolk

Summary:

Fingers of High Ground (FHG) are engineered landforms that meet the sea, river, or creek along their narrower dimension and extend inland between lower grounds. In the process they construct gradients along their length and width- gradients that are necessary to current ecologies and future settlement. Besides respecting the natural gradients between land and sea, FHG also pay close attention to rain. The project takes advantage of an existing ridge and transportation corridor to initiate a FHG. The FHG begins in a ‘living pier’ in the Elizabeth River and continues inland along a rail corridor and warehouse district. This spine, upon which a public walk, bike way, and emergency facilities are proposed, sets the higher elevations of the FHG at various places while the lower elevations of associated low grounds and outlet channels for rain are set by a historic creek adjacent to the proposed FHG.

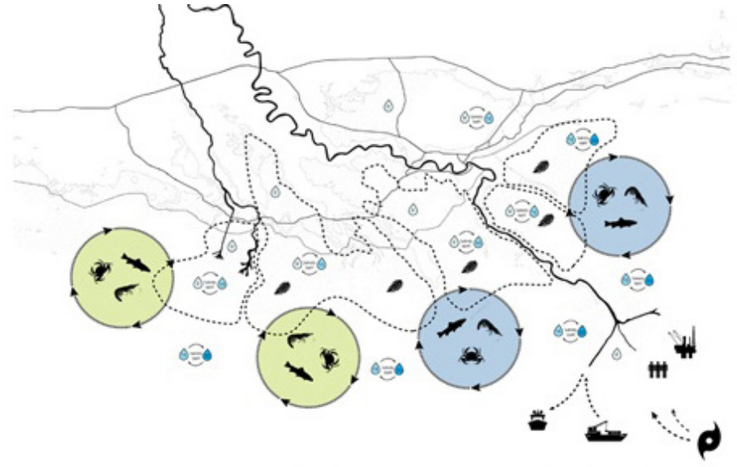
Underlying question:

How can designed landforms and their forms shaping the water flows in a coastal delta be used to construct new lands and enhance resilience of the area against strong surge events, and protect the ecosystem that exists in the transition of land and ocean?



Masterplan, The Giving Delta, West 8

WEST 8, (2014) ‘The Giving Delta’ in Lower Mississipi River Delta, Unites States



The five basin management, The Giving Delta, West 8

Summary:

The Giving Delta project proposes six primary strategies that will bring a self-sustaining Delta into being over the next century. It is proposal made by a team of Moffatt & Nichol, West 8 and LSU-CSS.

The coastal cities in USA are exposed to rising seas on fixed coastal edges. However, Louisiana can free itself from a century-long approach of flood control into one of controlled flooding and deposition. This will allow the annual pulses of the Mississippi River to sustain a thriving wetland apron and active land-building, protecting one of the crucial economic areas, enhancing ecosystem productivity, and nourishing human occupation in the coming centuries.

Underlying question:

How can controlling flow of rivers, managing river operations and linking infrastructure with an adaptive network maximize sediment deposition and bring a self-sustaining Delta into being?

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Shifting Landscapes of the Bengal Delta

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