BUILDING WITH NATURE
Balancing the urban growth of Kochi’s coastal wetlands with their ecological structures

Master Thesis Defence | October 2013

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**INTRODUCTION**

**LOCATION**

**PROBLEM STATEMENT**

**RESEARCH QUESTION**

**FRAMEWORK**

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**kochi**

population: 601,574 (2011 Census of India)

density: 6340/ sq.km

**vembanad estuary**

10 rivers flow from the eastern highlands to join the Arabian Sea on the west at four outlets - Munambam, Kochi, Andhakaranazhi and Thottapilly.

drainage area: 15,770 sq.km (40% of the area of the state)

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*where*
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- development is always done at the cost of the ecological structure
- wetlands and canals are sacrificed in the name of development
- with increase in sea-level rise and more precipitation, these become more important to the city’s flood defense system

Wetlands destroyed for construction
INTRODUCTION

- landscape doesn't guide urban form any longer
- urban form is guided by infrastructure
- this affects the city's structural identity

Settlement Pattern of Fort Kochi - Mattanchery on the west
(14th - 19th century AD)

Settlement Pattern of CBD area in mainland Kochi
(19th century AD - now)

Settlement Pattern of Kochi's eastern extension
(2000 - now)

2/4 - lack of structural identity
INTRODUCTION

- the city’s development agenda is always full
- but the city sits in a very fragile political and economic setup
- this stalls huge developmental projects

Aerial View of LNG Petronet Terminal

One of the many labour strikes in Kerala
INTRODUCTION

LOCATION

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flooding and erosion

- there are mainly two sources for flooding: rain and sea

- both types of flooding occur every year

- coastal flooding causes erosion of the coast also

- climate change will aggravate the issue

Coastal Flooding in Kochi
Source: Framework, LA Time

Flooding in the city during monsoons.
Source: The Hindu

Eroding Coast at Munambam
Photo by Author
INTRODUCTION

ECOLOGY & URBANISM

Ecological structures are destroyed for urban development without taking into consideration the benefits and services they have for the city. *eg: flood protection*

Urban development doesn’t follow a structure.

Urban development takes place in an indeterminate scenario which leaves many projects stalled.

PROBLEM STATEMENT

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Urban development doesn't follow a structure.

Ecological structures are destroyed for urban development without taking into consideration the benefits and services they have for the city. *eg: flood protection*

Urban development takes place in an indeterminate scenario which leaves many projects stalled.
Main Research Question

“How can wetlands help in flood protection, shoreline stabilisation, restore ecological diversity and be cores of urban development?”

Sub Research Questions

How can tropical ecosystems be effective flood protection and shoreline stabilisation system?
How can the ecological structure or the landscape guide the urban development of the city?
How can wetlands play the dual roles of flood management and be a core for urban development?
INTRODUCTION

LOCATION  PROBLEM STATEMENT  RESEARCH QUESTION  FRAMEWORK

Existing profile of the islands

If the current trend of urbanisation continues

What if urbanisation and ecological structure could be balanced

now, if, what if
INTRODUCTION

LOCATION  PROBLEM STATEMENT  RESEARCH QUESTION  FRAMEWORK

‘ARCH: Integrated framework for analysis of the lagoon system’
- to break down the lagoon into Natural System and Human System

Layer Analysis
- to understand the relationship between natural layer, infrastructure and urban development.

Building with Nature (BwN)
- coastal protection strategy by taking a stand along with nature to face disasters rather than take an defensive stand like in the past

Landscape Urbanism
- “produce urban effects traditionally achieved through construction of buildings simply through the organisation of horizontal surface”
- this makes it apt for an indeterminate scenario
**LITERATURE ANALYSIS**

**BUILDING WITH NATURE**

**WETLAND BENEFITS**

**LANDSCAPE URBANISM**

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**Delfland Sand Engine**

- Beach Nourishment at the Dutch coast created with Delfland Sand Engine in 2011.

- deposit significant amount of land in one location which will be gradually redistributed along the shore by the wind and the waves.

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**Coastal vegetation as buffer systems**

- ecosystems as buffers to mitigate flood related impacts

- eg: mangroves. partially destroyed mangrove forests will regenerate naturally while the costs for repairing a concrete sea wall is high.

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**The coastal defence strategy for Martinique island**

- 15% or about 78 km of the coastline of Martinique that shows vulnerability might adapt to rising sea levels by mangrove forest conservation and regeneration.
LITERATURE ANALYSIS

BUILDING WITH NATURE  WETLAND BENEFITS  LANDSCAPE URBANISM

1 Flood control
2 Groundwater replenishment
3 Shoreline stabilisation & storm protection
4 Sediment & nutrient retention and export
5 Water purification
6 Reservoirs of biodiversity
7 Wetland products
8 Cultural values
9 Recreation & tourism
10 Climate change mitigation and adaptation
11 Spatial Quality

The Convention on Wetlands of International Importance, called the Ramsar Convention formulated the benefits and services wetlands have to offer.
**structuring the horizontal surface** - demarcation of land, establish services and pathways, ensure sufficient permeability for future permutation and adaptation.

**Infrastructure** - anything that can perform or produce ‘effects’. eg: drainage, vegetation establishment, roads, utilities, bridges

**spatiotemporal production process** or **designing in phases** - encourages a more socially just, politically emancipating and ecologically sane mix of process rather than building forms.

**ecology** - nature is part of the urban and not something outside.
LITERATURE ANALYSIS

BUILDING WITH NATURE

WETLAND BENEFITS

LANDSCAPE URBANISM

Flood Management Structure

- Open-ended Design

Creating a Green Structure

- Designing in Phases

Franklin Olmsted’s Emerald Necklace, Boston

- a blue-green flood management structure for Boston along which urban development could take place

Open-ended Design

Melun-Senart by OMA in France

- spatial quality is achieved by a ‘figure of void’ that will be left empty while the surrounding area can ‘surrender to chaos’.

Emscher Landscape Park, Germany

- converting a large number of post-industrial sites to urban public spaces through green links.

Downsview Park Project Competition Entry by OMA

- the design sets the ground for future program.
- ground is set in phases anticipating and taking in the natural processes around it.

e solutions in other projects
FIELD ANALYSIS

THE LAGOON

FLOODING

WETLANDS

ADDITIONAL TOOLS

Natural System

Human System

NATURAL SYSTEM AT THE REGIONAL SCALE

HUMAN SYSTEM AT THE SUB-REGIONAL SCALE

Cherai Beach

Mangroves in the lagoon

Kochi natural harbour

Fishermen in Kochi

Cultivation of salt-resistant rice Pokkali in the lagoon

Cochin Shipyard (in the port)

simplifying the lagoon system
FIELD ANALYSIS

THE LAGOON

FLOODING

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Natural System

- Cherai Beach
- Mangroves in the lagoon
- Kochi natural harbour

Human System

- Fishermen in Kochi
- Cultivation of salt-resistant rice Pokkali in the lagoon
- Cochin Shipyard (in the port)

- simplifying the lagoon system

- reclamation
- tourism
- traditional stakeholders
- local industries
- pollution
- urban growth
- dredging
- port
- ecology
- beaches
- geomorphology of the estuary
- coastal flooding
- erosion
- salinity
- RAINS
- SEA
FIELD ANALYSIS

THE LAGOON

FLOODING

WETLANDS

ADDITIONAL TOOLS

ON THE COAST
- waves easily overtop the seawalls
- areas on the hinterland remain waterlogged

INLAND
- rain causes waterlogging
- due to river swelling during rain

December - March
April - May
June - Aug
end of Aug
September
October-Nov

PROBLEM      CONCEPTUAL SOLUTION      DESIGN SOLUTION

FLOODING IN INLAND AREAS
Fields remain non-cultivable due to water logging during monsoons
Saltwater Intrusion during dry season hinders cultivation
River run-off floods the fields
PROVIDE FLOODPLAINS
SEASONAL FARMING
aquaculture in the dry season

DRAINAGE SYSTEMS
renetworking existing canals

PROBLEM      CONCEPTUAL SOLUTION      DESIGN SOLUTION

FIELD ANALYSIS

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PROBLEM      CONCEPTUAL SOLUTION      DESIGN SOLUTION

the flood problem
FIELD ANALYSIS

- southerly littoral drift is blocked by groynes
- harsh monsoon waves erode part of the coast

the eroding problem
Canal system of Kochi, made by author based on data

- not maintained well
- central position in the city: perfect for the city to structure around
- canals in the mainland are sufficient for flood management according to calculations
- canals in the barrier islands are not enough for flood management

Canal system of Kochi superimposed on depth to watertable data
FIELD ANALYSIS

THE LAGOON

FLOODING

WETLANDS

ADDITIONAL TOOLS

Flooding on Infrastructure

Flooding on Settlements

Flooding on Natural Layer

- infrastructure and settlements are under the risk of flood

- much of the floodable areas is wetland landscape

- fragmentation of wetlands by roads makes only a part of the wetland work for flood management

- therefore, the flood mechanism consists of a seawall and that part of the wetland

Fragmented Wetlands

Flood Defence Mechanism

flood situation at the local scale
FIELD ANALYSIS

THE LAGOON FLOODING WETLANDS ADDITIONAL TOOLS

Wetlands are restricted to the outer fringe of the city

The city ate the wetlands in its expansion and thus has weakened its natural ecological structure

Thus there is a need for a strong ecological structure for the city.

Total available wetlands in the region

existing wetlands
their benefits - Flood Management and Shoreline Stabilisation
FIELD ANALYSIS

THE LAGOON   FLOODING   WETLANDS   ADDITIONAL TOOLS

Cultural Values and Products
Tourism and Recreation
Groundwater Recharge
Biodiversity and Nutrient Retention

- Cultural Values, Products, Tourism and Recreation, Groundwater, Biodiversity, Nutrient Retention
FIELD ANALYSIS

THE LAGOON

FLOODING

WETLANDS

ADDITIONAL TOOLS

Wetlands prone to Urbanisation

Wetlands prone to Pollution

threats to them - urbanisation, pollution
FIELD ANALYSIS

THE LAGOON  FLOODING  WETLANDS  ADDITIONAL TOOLS

unapparent green axis
obvious infrastructural axis
coconut wetlands
unapparent backbone for wetland - canal
mangrove wetlands
bridge to mainland

FIELD ANALYSIS

THE LAGOON  FLOODING  WETLANDS  ADDITIONAL TOOLS

An aerial view of the local wetland

studies the threatened wetland
FIELD ANALYSIS

THE LAGOON

FLOODING

WETLANDS

ADDITIONAL TOOLS

FIELD ANALYSIS

Public Green

Beaches

Abandoned Railway Lines

0 2.5 5 10

Public spaces

Structure

Infrastructure

Mangroves

Canals

Wetlands

Zandmotor

tools to create a Structure
FIELD ANALYSIS

THE LAGOON
FLOODING
WETLANDS
ADDITIONAL TOOLS

FIELD ANALYSIS

THE LAGOON  FLOODING   WETLANDS   ADDITIONAL TOOLS

zandmotor
mangroves
canals
vegetation
wetlands
public spaces
structure
infrastructure

flood and
coastal defence system

natural layers

infrastructure

settlements

City lacks Structure
City has turned its back to the water
City lacks a Public Space Structure
City lacks an Ecological Structure

Urban Form should follow the form of lagoon
Create an Ecological Structure

Use infrastructure as tool to determine urban form
Create a Public Space Structure
Tools to create a united structure

Public Spaces, Wetlands, Parks
Canals Abandoned Railway Lines

tools to guide urban development

- settlements follow infrastructure
- use infrastructure to guide urban development
STARTING POINTS FOR DESIGN

TOOLS | SYSTEMS TO ACHIEVE | METHODS TO ACHIEVE

Toolkit consists of TOOLS like
zandmotor, mangroves and wetlands, canals, other vegetation, post-industrial sites, public space and infrastructure.

Systems to Achieve

**blue-green structures** for flood management and shoreline stabilisation, **a figure of voids** which is basically the blue-green structure, a **well-connected ecological structure** and **green structures being the core** of development.

Methods to Achieve

- Building with Nature
- Landscape Urbanism
  - ‘Designing a Structure’
  - ‘Designing in Phases’
DESIGN

FLOODING AND SHORELINE MANAGEMENT

URBAN DEVELOPMENT STRATEGY

ELABORATION AT THE LOCAL SCALE

Tools used

regional strategy for flooding and shoreline management
3. Overlapping the blue and green strips gives a new structure.

4. Use infrastructure and the islands to connect these isolated systems.

Use public spaces, infrastructure, and post-industrial sites to connect these isolated systems and form a Structure.

This Structure can form a Figure of Voids.

The blue and green strips for flood management.
infrastructure
post-industrial railway lines
canals
wetlands and parks
mangroves
beaches

components of the Structure
FLOODING AND SHORELINE MANAGEMENT  
URBAN DEVELOPMENT STRATEGY  
ELABORATION AT THE LOCAL SCALE

Designing in Phases

- it’s based on urgency of the function and developmental patterns
- most urgent: Flood Management and Wetland threatened to urbanisation

Phase 01: Flood Protection + Design of Wetland
Phase 02: Green Structure
Phase 03: Public Space before Infrastructure_Pilot
Phase 04: Public Space before Infrastructure_Extension
phase 01: blue structure + design of a local wetland
phase 01: blue structure + design of a local wetland
phase 02: defining the green structure
phase 03: public space and infrastructure_pilot

LEGEND
- National and State Highways
- Functional Railway Lines
- Abandoned Railway Lines

PHASE 1
- Primary Canals
- Secondary Canals
- Mangroves
- Wetlands
- Project at the most vulnerable site in the city

PHASE 2
- Boulevard of trees connecting isolated wetlands
- New Beach

PHASE 3
- Public Space + Bike Path
- Bike Path
- Strategic Infrastructure (expansion of existing or new) to encourage urban development
PHASE 04: public space and infrastructure_extension
from existing situation to a blue-green structure centric development
Restructuring the fragmented wetland into one unit by removing the roads that break them up.

Raising the sides of the wetland to enhance water retention capacity.
The wetlands are connected with more green unifying them into one structure.

Connecting beneficial wetlands with other wetlands

Mangrove Wetlands

Coconut Wetlands
This route around the main wetland structure can form the main framework for the public space.

The public space will bring the natural landscape in touch with future urban development.
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The public space will bring the natural landscape in touch with future urban development.

sub-phase 03: making a public space structure
New infrastructure is laid along these public spaces.

This is expected to increase its land-value and attract real estate and commercial growth.
New infrastructure is laid along these public spaces. This is expected to increase its land-value and attract real estate and commercial growth.
New infrastructure is laid along these public spaces.

This is expected to increase its land-value and attract real estate and commercial growth.
Sketch of the wetland after urban development takes off on its fringes

Wetlands for flood management & cores of urban development

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wetlands for flood management & cores of urban development
wetlands for flood management & cores of urban development

Before predicted Urban Development

Plan

Section CC

After predicted Urban Development

Plan

Section CC
DESIGN

FLOODING AND SHORELINE MANAGEMENT  URBAN DEVELOPMENT STRATEGY  ELABORATION AT THE LOCAL SCALE

wetlands for flood management & cores of urban development
wetlands for flood management & cores of urban development

Before predicted Urban Development

After predicted Urban Development
wetlands for flood management & cores of urban development

How the edge would look like
Components of Flood Management & Shoreline Stabilisation being part of Urban Development

natural and cultural landscape as the common factor
CONCLUSION

Forming a structure from the blue and green of the city

a blue-green structure for the city

Urban Development along the Flood Management System (Image for Representation)
Forming a structure from the blue and green of the city

CONCLUSION

No Urban Development along the Flood Management System (Image for Representation)
Forming a structure from the blue and green of the city

Medium Urban Development along the Flood Management System (Image for Representation)

**CONCLUSION**

Forming a structure from the blue and green of the city

**a blue-green structure for the city**
Present urban form of the lagoon city

Predicted urban form of the lagoon city follows the blue-green structure

CONCLUSION

manipulating the urban form
Initial Objectives and Final Results

Natural and Cultural Landscape

- Cultural landscape like paddy fields and aquaculture farms were thought to be important for the ecological structure.
- But further research made it clear that these processes affect the ecological and hydrological structure of the estuary.
- Thus there was a clear distinction between the natural landscape and cultural landscape started becoming evident

Stakeholders

- Initially, the focus was the tension between traditional and modern stakeholders
- Finally, the focus became the tension between natural landscape and other stakeholders.
THANK YOU!