Research Group
Ecosystem Management
University of Antwerp

Towards an integrated estuarine management: innovative approaches in the Schelde and other European estuaries.

University of Antwerp

Introduction

Managing estuaries in the face of Climate Change and the many human pressures such as harbour development, deepening, reclamation, pollution,…. is one of the major challenges of the 21st century.

The Schelde estuary in Flanders and the Netherlands is a typical example of an estuary impacted by all of these changes.

Research Group
Ecosystem Management
University of Antwerp

Schelde estuarium

Introduction

The challenges for managing the Schelde are manifold:

- Transboundary issues
- Economic development
- Major changes in morphology and hydrodynamics
- Ecological degradation

This session wants to present some of the key messages learnt during about 2 decades of intense cooperation between stakeholders at both sides of the border and put this in an international context.

Changing boundary conditions I:

- Impact of changes in fresh water, sediment and nutrient fluxes from the catchment on estuarine functioning

Changing boundary conditions II:

- Impact of sea level rise on estuarine hydraulics and morphology

Ecosystem services delivered by an estuary: Can they be a common denominator for both ecology and economy?

Towards solutions I:

- Storing the water: Flood protection and creating ecological benefits

Towards solutions II:

- Taming the tides: Large scale habitat creation in the outer estuary to reduce tidal amplification in the estuary and improve navigability

Towards solutions III:

- Managing people: Communication, participation, planning

From the Schelde to the World:

- Exploring the global potential for ecosystem-based adaptation of estuaries and deltas
- Approaches in the United Kingdom: A complex estuarine management regime.
- Approaches in Germany: The Elbe management proposals from a Port Authority
- Approaches in France: The Seine and the Somme – restoring ecological functions in an industrialised and a non-industrialised estuary
- Estuarine management and bio-geomorphological evolution of the Yangtze estuary, China
- Vulnerability and resilience of the Ganges-Brahmaputra Delta to climate change: Global challenges in integrated coastal zone management

Research Group
Ecosystem Management
University of Antwerp

7

Research Group
Ecosystem Management
University of Antwerp

Changing boundary conditions I:

Changes in fresh water, sediment and nutrient fluxes from the catchment

Tom Maris & Patrick Meire

University
of Antwerp

Changes in boundary conditions

- ➔ Decrease in low water discharge (summer)
- ➔ less nutrients (WFD)?
- ➔ discharge peaks
- ➔ more run-off
- ➔ more erosion?
- ➔ more nutrients?

Consequences

Changes in discharge/tides

➔ more tidal assymmetry?

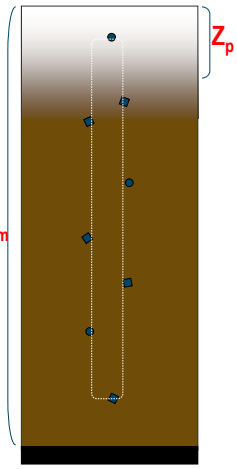
Regime shift to hyper turbid system?

Changes conditions for phytoplankton

Ecology: primary production

Fytoplankton (algae)

needs light to grow



Zp: photic depth, depending on turbidity

➔ **modified**

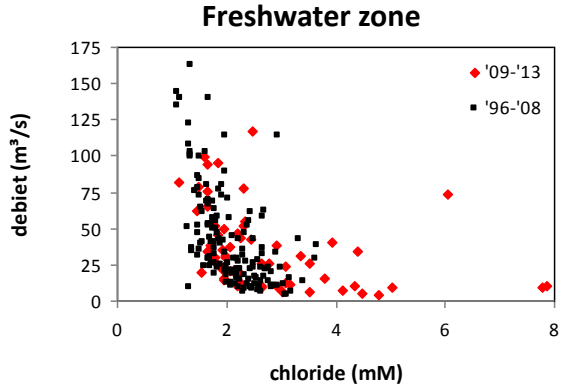
Zm: mixing depth, depending on depth and shallow areas

➔ **modified**

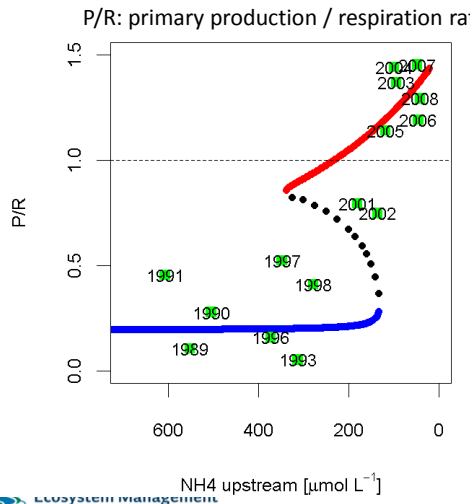
Phytoplankton in tidal fresh

Chlorides depend on discharge

Correlation is changing! Changes in the tide?



Changes in nutrients can cause a regime shift from heterotrofic to autotrofic



P/R based on oxygen balance

Net oxygen consumption with high ammonia inputs

Net oxygen production with low ammonia inputs

Alternative stable states with intermediate ammonia inputs

DELTAS IN TIMES OF CLIMATE CHANGE II

department Mobility and Public Works

Changing boundary conditions II: Impact of sea level rise on estuarine hydraulics and morphology

Prepared by Ir. Yves Plancke

Rotterdam, 24-26 September 2014

Vlaamse overheid

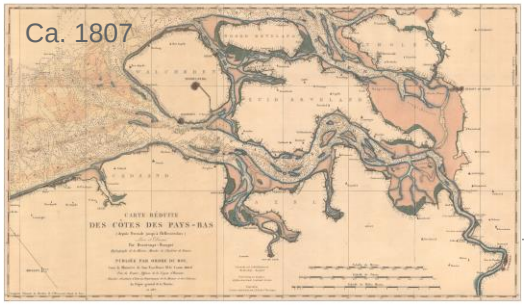
EFQM

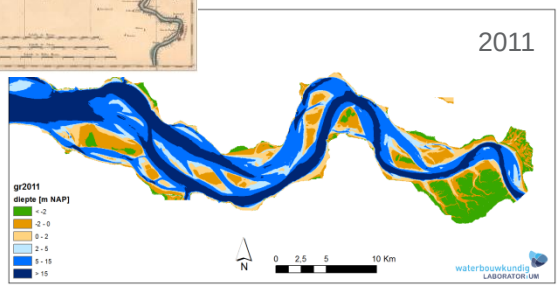
flanders HYDRAULICS RESEARCH

flanders HYDRAULICS RESEARCH

department Mobility and Public Works

Morphology is changing





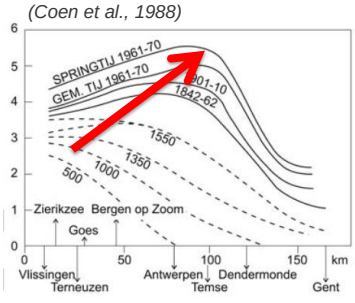
flanders HYDRAULICS RESEARCH

department Mobility and Public Works

Tides are changing

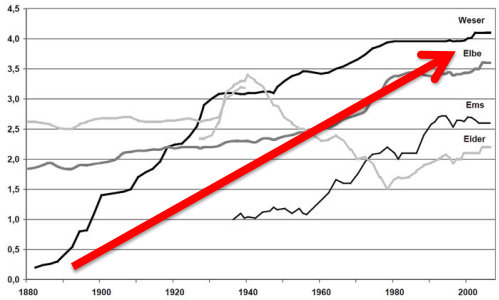
Tidal range Schelde

(Coen et al., 1988)



Tidal range Weser, Elbe, Ems, Eider

Source: Tide toolbox



department
lity and
c Works

- Human induced morphological changes have a major impact on tidal charachteristics and create a fast increase in high water levels.

flanders HYDRAULICS RESEARCH

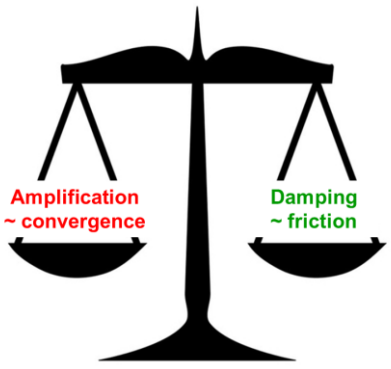
TIDE

The Interreg IVB North Sea Region Programme

European Union The European Regional Development Fund

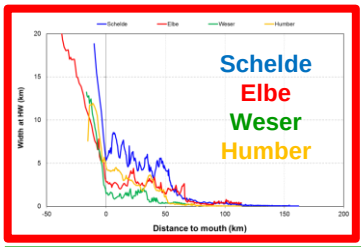
department
Mobility and
Public Works

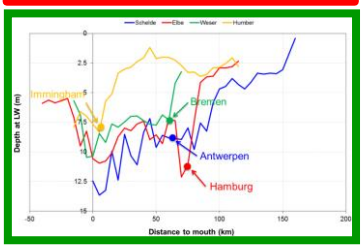
Tidal propgation: processes



Poldering
Hard bordering
…

Sediment extraction
Deepening
…





Source: Vandenbruwaene et al., 2013

Key Message

Habitat loss has a significant impact on the tidal propagation

- Intertidal and subtidal areas are crucial habitats causing friction
- channel depth, relative surface intertidal area, covergence length scale, bed roughness

Changes in the tidal characteristics are the driving force behind estuarine development

Management measures should aim at controlling the tidal development and prevent a regime shift to occur

Clear goals be defined for the tidal characteristics

Restoration of the intertidal is a key factor!

In restoration projects, the impact of the realingment should be focussed much more on its impact on tidal characteristics than on structural biodiversity.

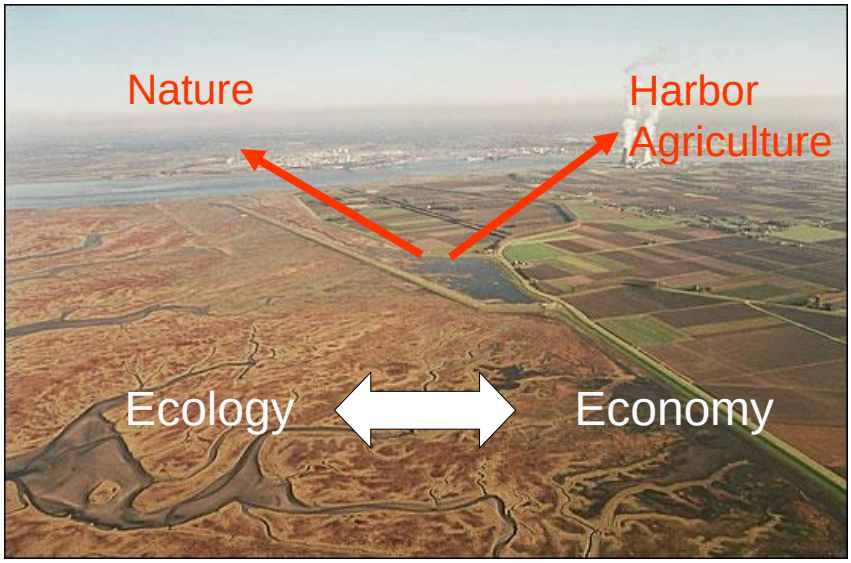
This must be taken into account in compensation schemes

Research Group
Ecosystem Management
University of Antwerp

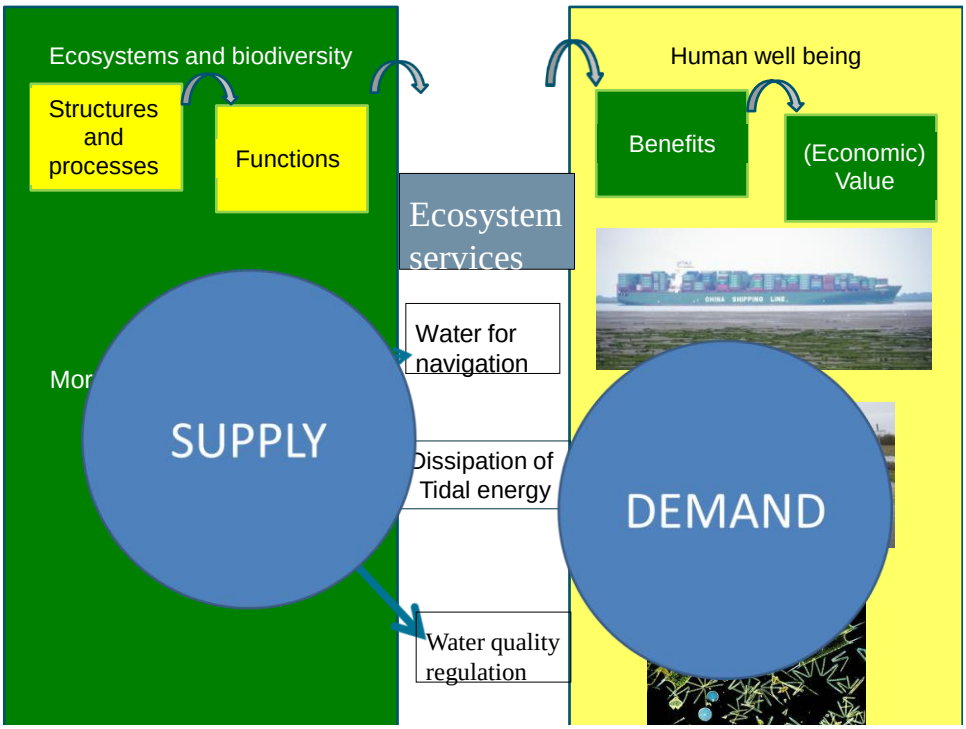
Ecosystem services delivered by an estuary: Can they be a common denominator for both ecology and economy?

Prof. dr. Patrick Meire,
University of Antwerp, Belgium

University
of Antwerp



Research Group
Ecosystem Management
University of Antwerp



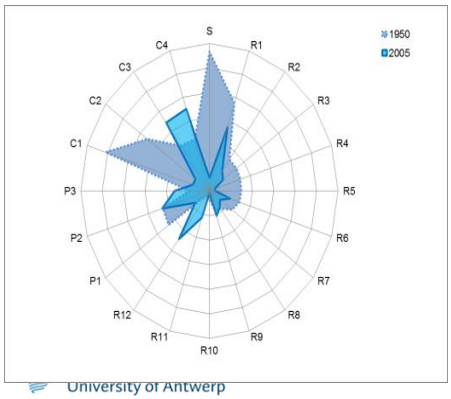
How essential are the services produced?

Selection of 20 “important” ES for TIDE

Important Ecosystem Services in TIDE estuaries	Category
Food: Animals	Provisioning
Water for industrial use	Provisioning
Water for navigation	Provisioning
Climate regulation: Carbon sequestration and burial	Regulating
Regulation extreme events or disturbance: Flood water storage	Regulating
Regulation extreme events or disturbance: Water current reduction	Regulating
Regulation extreme events or disturbance: Wave reduction	Regulating
Water quantity regulation: drainage of river water	Regulating
Water quantity regulation: dissipation of tidal and river energy	Regulating
Water quantity regulation: landscape maintenance	Regulating
Water quantity regulation: transportation	Regulating
Water quality regulation: transport of pollutants and excess nutrients	Regulating
Water quality regulation: reduction of excess loads coming from the catchment	Regulating
Erosion and sedimentation regulation by water bodies	Regulating
Erosion and sedimentation regulation by biological mediation	Regulating
"Biodiversity"	Supporting
Aesthetic information	Cultural
Opportunities for recreation & tourism	Cultural
Inspiration for culture, art and design	Cultural
Information for cognitive development	Cultural

How did the delivery of ES change over time?

- Insight that loss of a single habitat results in the loss of bundle of ES



Example: Weser 1950-2000

Key messages

ES approach gives a clear framework for a qualitative assessment of the importance of different habitats

Insight of the importance of intertidal areas not only for biodiversity but for supporting and regulating services is becoming apparent.

The concept of ES is a good communication tool for an interdisciplinary approach

Key message

The concept of ES gave us a better insight in the **real impact** of changes in the estuary

Habitat loss resulted in a significant **loss of regulating services**

➔ **Loss of ecosystem services leads to an economic loss.**

Research Group
Ecosystem Management
University of Antwerp

The concept of ES gives a framework for integrating this goals ➔ FORMULATE GOALS FOR ES!!

Restoration of habitats is necessary and will result in big savings on maintenance costs and should add to the delivery of ES

Better understanding of the functioning is a crucial step towards better management and detailed monitoring programs are necessary. An interestuarine comparison is key to a better understanding

TOWARDS SOLUTIONS I

Storing the water: flood protection & creating ecological benefits
ir. Michael De Beukelaer-Dossche, Waterways & Sea Canal BE

Sigmaplan
Ontmoet de Schelde

Waterwegen en Zeekanaal NV
weg van water

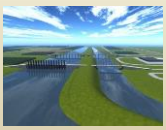
Agentschap voor
Natuur en Bos

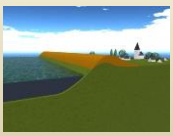
Sigmaplan

Sigmaplan: Protects Nature and People
Blue & Green improvement




1. Who? The Sigma Plan, roles & research
2. Why? Sigma, the original & Sigma update 2005
3. What? Operating principles
4. How? Sigma so far? *study, decide and implement*



Sigmaplan

WHO? Roles & Research

FLEMISH GOVERNMENT

Department Mobility & Public Works

WATERWAYs & SEA CANAL (W&Z)

Agency for Nature and Forest (ANB)

Multifunctional approach partners

- **Research**

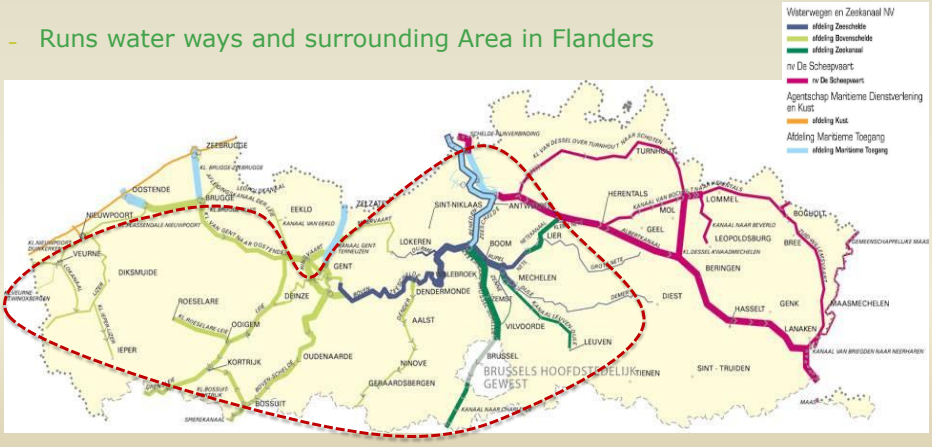
Universities /UA, Ugent, KUL
Flanders Hydraulics Research/WL
Institute4TechnologyResearch/VITO
Institute4Nature&Forest /INBO)

Consultancy (IMDC, Technum-Tractebel Engineering, Antea, Arcadis, Grontmij, Haskoning, SBE, …)

Sigmaplan

WHO? Waterways & Sea Canal
W&Z Independent Agency

- Runs water ways and surrounding Area in Flanders



Sigmaplan

WHY? A little history (1976 | 2005)

- **Sigma, the Original °1977**
  - **Why?** 1976: 800 ha of Flanders flooded
  - **Goal?** Protection of the Sea Scheldt on 1/10.000 storm
- **Sigma 2.0. °2005**
  - **Why?** ClimateChange&Adaptation | Scheldt estuary LT 2030 | VL/NL NOPSE | IntegralWaterManagement | Finish S/Σ°1976
  - **Goal?**
    . 1. Stimulate multifunctional & sustainable use of waterways
    . 2. Ensure safety & reduce flooding risk
    . 3. Manage living, enjoying & experiencing the rivier

Sigmaplan

WHY? International scope

EU Water Framework Directive

- Sound ecological position
- Natura 2000 demands

NOPSE Scheldt Estuarine Nature Development Plan

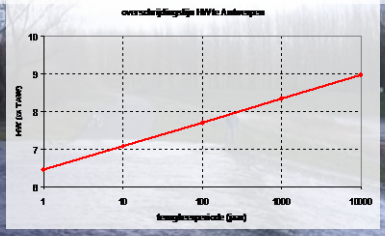
Improving the chemical, physical & biological functioning of the estuary

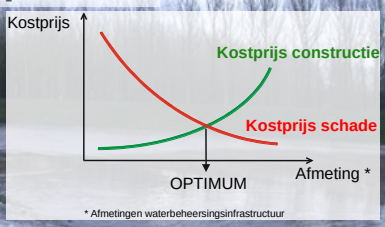
SIGMA Plan

- Ecological Multiple-criteria decision analysis (MCA)
- EIA / SCBA /Agricultural Impact Assessments (AIA's)
- University of Antwerp and INBO: Habitat analysis

Sigmaplan

WHAT? New Safety Concept





NEW Sigma Safety Concept : 'ROOM 4 the RIVER' approach

1. **New river areas** (de-poldering | shift the embankment)
2. **Flood controlled areas** (FCA with outlet sluice)
3. **Upgrade: FCA +'controlled reduced tide'** (GGG/CRT)

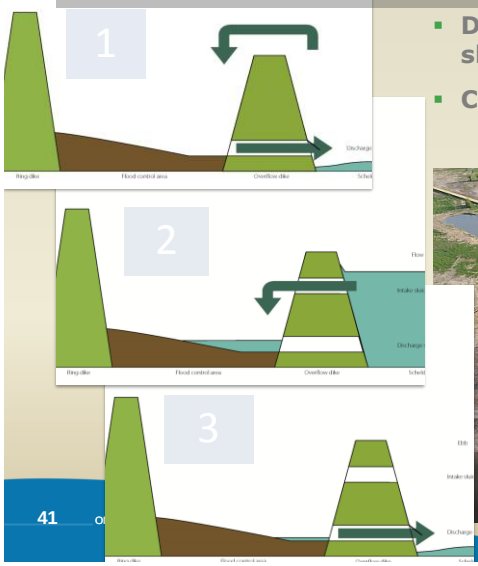

Sigmaplan
WHAT? Room4theRiver: Operating principles
1. New River Areas | De-poldering
New Dike
Dike removal


Sigmaplan
WHAT? Room4theRiver: Operating principles
2. Flood Control Area (FCA)

Sigmaplan

WHAT? Room4theRiver: Operating principles
3. FCA with Controlled Reduced Tide

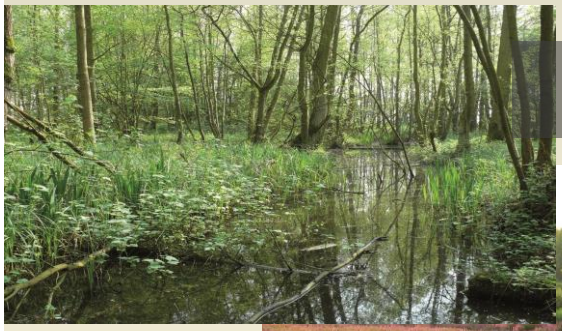
- Daily reduced tide trough the inlet sluice in the overflow dike
- Control with inlet and outlet sluice



41 ONTMOET DE SCHELDE

Sigmaplan

WHAT? Integrated project…
Objective Nature: Enhancing Natural Quality & Life Cycle



- Allow the sustainable development of the Scheldt ecosystem (WFD)

42 ONTMOET DE SCHELDE

Sigmaplan

NOW? Sigma So Far: F&F

- **dykes = 645 km → 512 km finished**
- **Σ 1.0 = 1133 ha → 533 ha finished**
- **Σ 2.0 = 3344 ha → 146 ha finished**

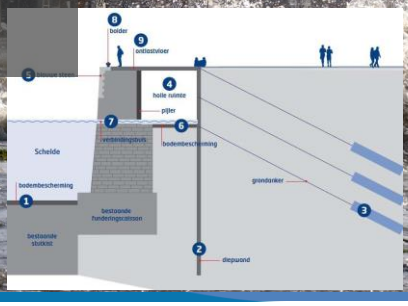
(Lillo, Lippenbroek, Bergemeersen, Paardenweide)

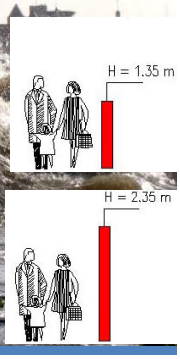
Sigmaplan

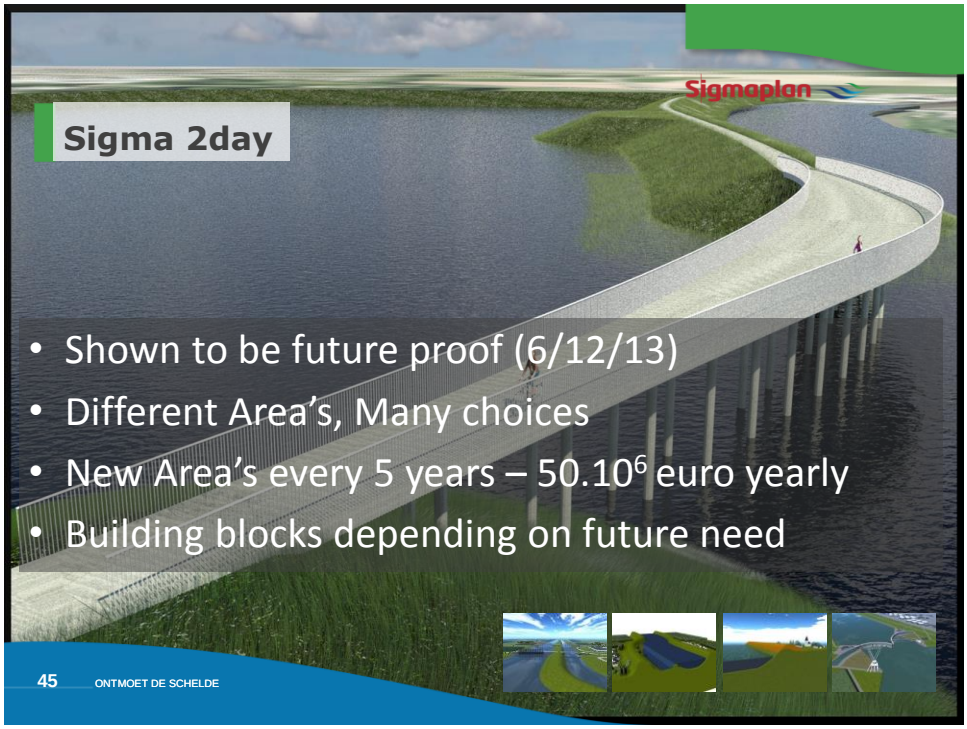
Sigma2day: Different type of projects Protecting Antwerp against Flooding

- **Scheldt Quays Antwerp= City Sigma Project**
- **Unique in many ways:**
  - Symbiosis of updated safety Infrastructure, quay wall renovation and a new public domain;
  - Participation with city of Antwerp and locals;
  - Specific Renovation in line with Heritage

1. Restore ancient connection between Antwerp citizens & the river Scheldt
2. New city development area
3. Improve accessibility
4. Respect maritime history







DELTAS IN TIMES OF CLIMATE CHANGE II

department Mobility and Public Works

Towards solutions II:
Taming the tides: Large scale habitat creation in the outer estuary to reduce tidal amplification in the estuary and improve navigability

Prepared by Ir. Yves Plancke

Rotterdam, 24-26 September 2014

Vlaamse overheid

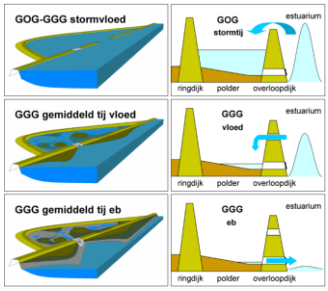
EFQM

flanders HYDRAULICS RESEARCH

flanders HYDRAULICS RESEARCH

department Mobility and Public Works

Measures: present and future



Source: cCaspar, 2012

Crucial to strive for win-win-situations !

… or doing more with less!

More information:
Ir. Yves Plancke
Yves.Plancke@mow.vlaanderen.be
Flanders Hydraulics Research
Berchemlei 115
B-2140 – Antwerp
Belgium

TOWARDS SOLUTIONS III

Managing people: Communication, Participation, Planning

By ir. Michael De Beukelaer-Dossche, Waterways & Sea Canal W&Z, BE

Sigmaplan
Ontmoet de Schelde

Waterwegen en Zeekanaal NV
weg van water

Agentschap voor Natuur en Bos

Sigmaplan

SIGMA =Integral Project
Objective: Creating Life Along the Riverside

- **Stimulate recreation & tourism in the water area**
- **Improve the water-city relationship**

Sigmaplan

Communication :
Make the look & feel REAL


Sigmaplan
Stakeholdermanagement =
Need 4 different perspectives
• Childeren engagement & education:
• Go DIGITAL (4 ex. ROUTE YOU, GAMING…)
• Private investments (Koolputtensite);
• Stimulate Dreaming (CosmoGollem)
• Do not ignore emotions
53 ONTMOET DE SCHELDE


Sigmaplan
Participation
listening to stakeholders
▪ Multiple goals, several win-win's, many stakeholders
- Protection & Safety: waterway managers, local residents & farmers, land owners…
- Protecting & Developing Nature: environmental organisations, lobby groups…
- Sustainable Economy: ports, rural industry, boatmen, local facilities and business…
- Experiencing Water Area: cyclists, hikers, canoeists, pleasure crafters, runners…
54 ONTMOET DE SCHELDE


Sigmaplan
Technical construction (dyke) as Art Object
• Drawing in Vlassenbroek
• Dutch Artist Wapke Feenstra with W&Z, the Flemish Lead Architect, the city of Dendermonde
55 ONTMOET DE SCHELDE


Sigmaplan
Stakeholdermanagement = Partici'learning' on local engagement
Many lessons learned on local ownership!!
• Easy accessible information & transparency key issue
• Identify win-win's, stimulate tourism
– Try to keep contestation local
– Emphasize own positive story and benefits (f. ex. rising value of property)
– Engage local organisations (guides, schools, nature organisation)
– Keep dialogue ongoing
56 ONTMOET DE SCHELDE


Sigmaplan
Sustainability: FutureProofedProject
Local Win Win's: tourism, PPS, learning
SEE & LOOK into the future (Cosmo GOLLEM)
SUSTAINABLE Sediment Management (PRISMA)
STEP PROJECT
– Detailing the European Charter Sustainable Tourism
– Sustainable visitor management
– Stimulation (tourist) industry
– Public-private cooperation
'Investeren in je toekomst'
Grensoverschrijdend samenwerkingsprogramma
2007-2013 Medegefinancierd door de Europese Unie
(Europees Fonds voor Regionale Ontwikkeling)
Natuur en Bos
STEP
57 ONTMOET DE SCHELDE

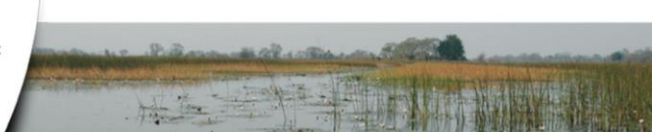

Sigma 2day
Sigmaplan
• Bridging the GAP : local enthousiasm
• Large visibility in large area (international)
• Succes: cooperation with local authorities
58 ONTMOET DE SCHELDE

Exploring the global potential for ecosystem-based adaptation of estuaries and deltas

prof. Stijn Temmerman

University of Antwerp, Ecosystem Management research group

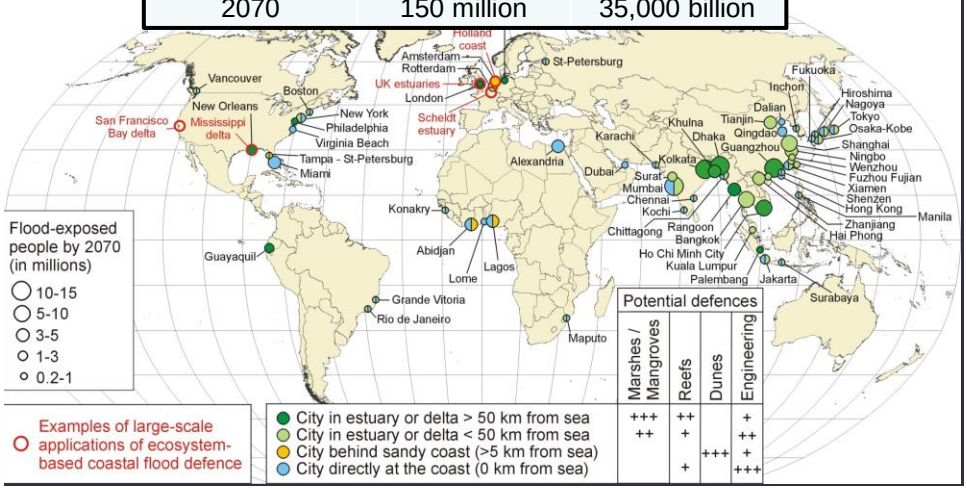
Research Group
Ecosystem Management
University of Antwerp



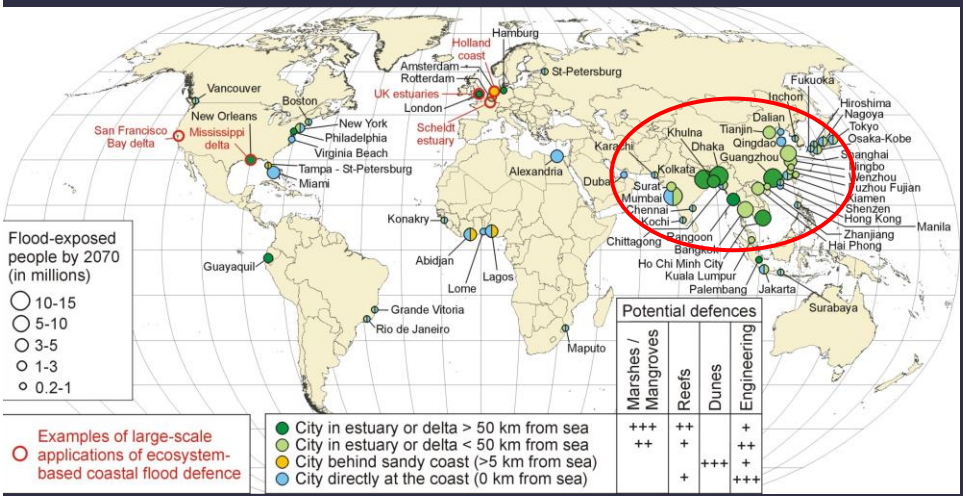
Globally increasing need for adaptation to coastal flood risks due to global change

year	Flood-exposed urban people	Property (USD)
2005	40 million	3,000 billion
2070	150 million	35,000 billion

(Nicholls et al. 2007)



Especially in large cities in deltas & estuaries in Asia, Europe, USA



How to adapt to increasing flood risks?

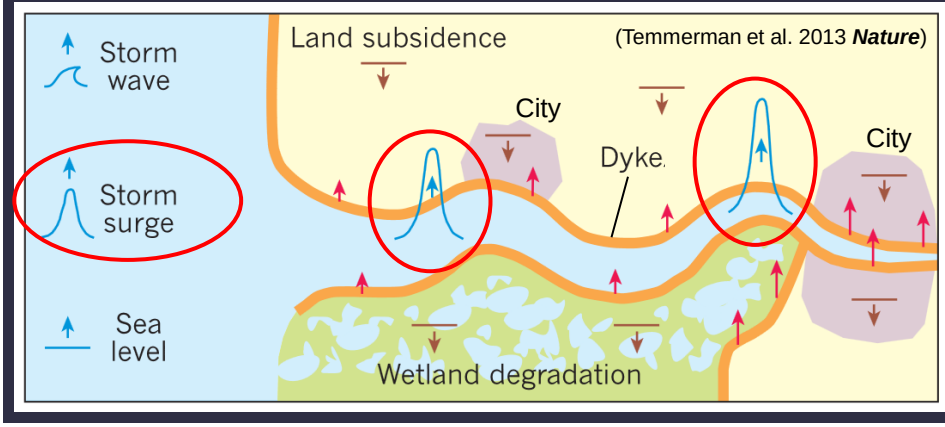
Traditional engineering

Combining with new ecosystem-based adaptation

How to adapt to increasing flood risks?

Traditional engineering increases flood risks in long term !

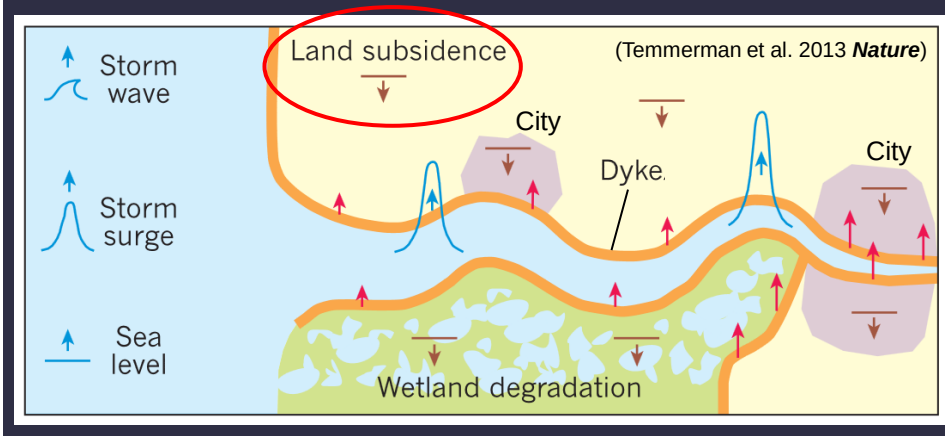
NOT SUSTAINABLE WITH GLOBAL CHANGE



How to adapt to increasing flood risks?

Traditional engineering increases flood risks in long term !

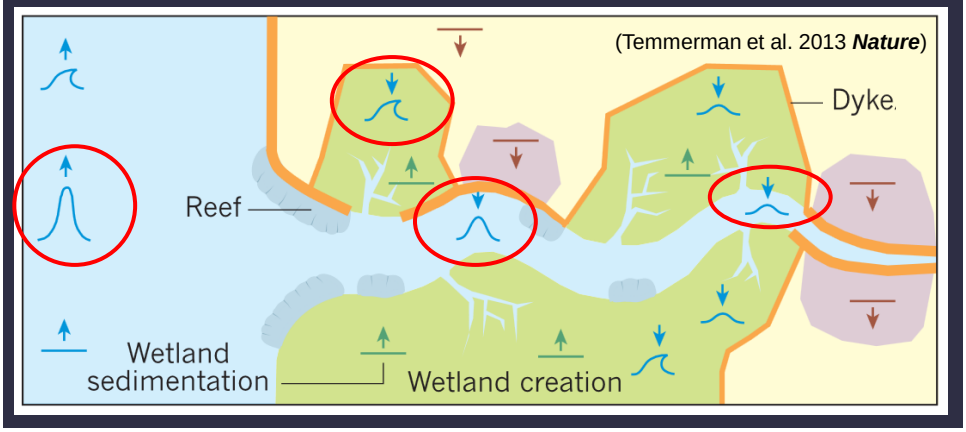
NOT SUSTAINABLE WITH GLOBAL CHANGE



How to adapt to increasing flood risks?

Ecosystem-based adaptation

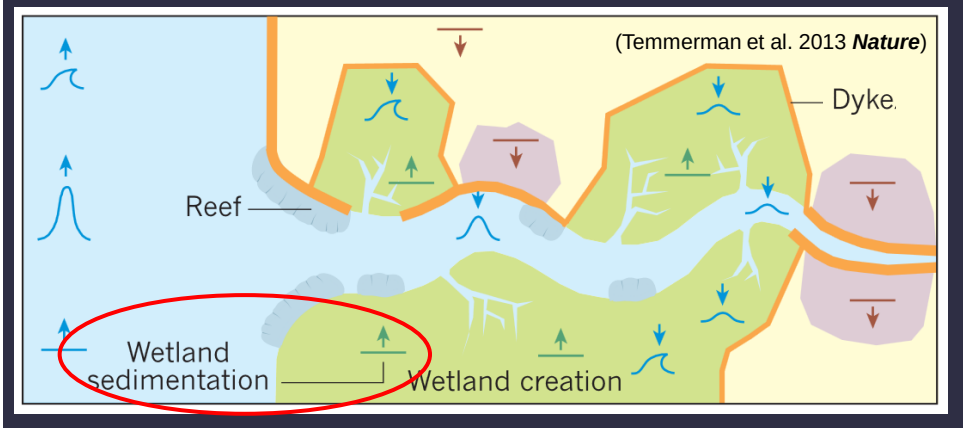
provides LONG-TERM SUSTAINABLE flood defense



How to adapt to increasing flood risks?

Ecosystem-based adaptation

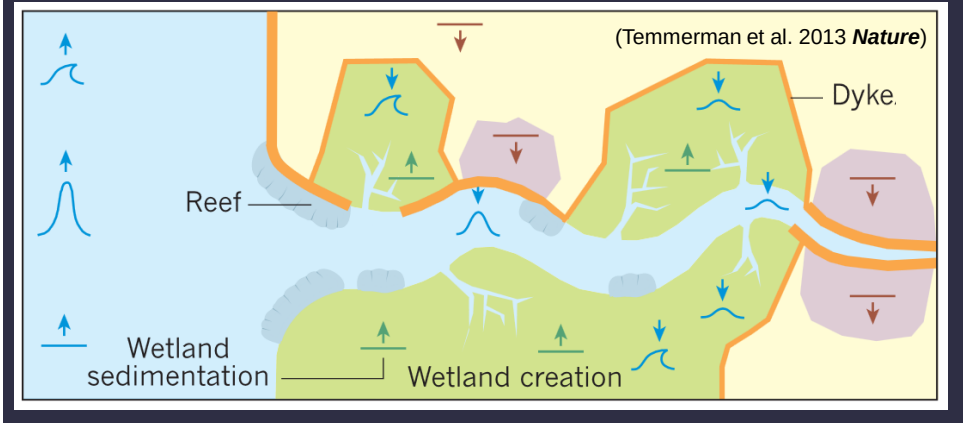
provides LONG-TERM SUSTAINABLE flood defense



How to adapt to increasing flood risks?

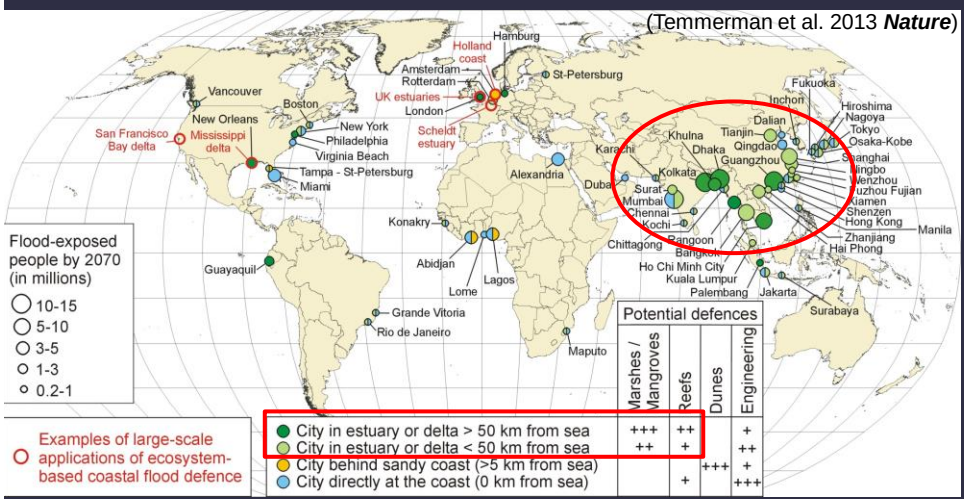
Ecosystem-based adaptation

often COST-EFFECTIVE
because MULTIPLE ECOSYSTEM SERVICES



HIGH GLOBAL POTENTIAL for ecosystem-based adaptation to coastal flood risks

Especially in Asia, Europe, USA

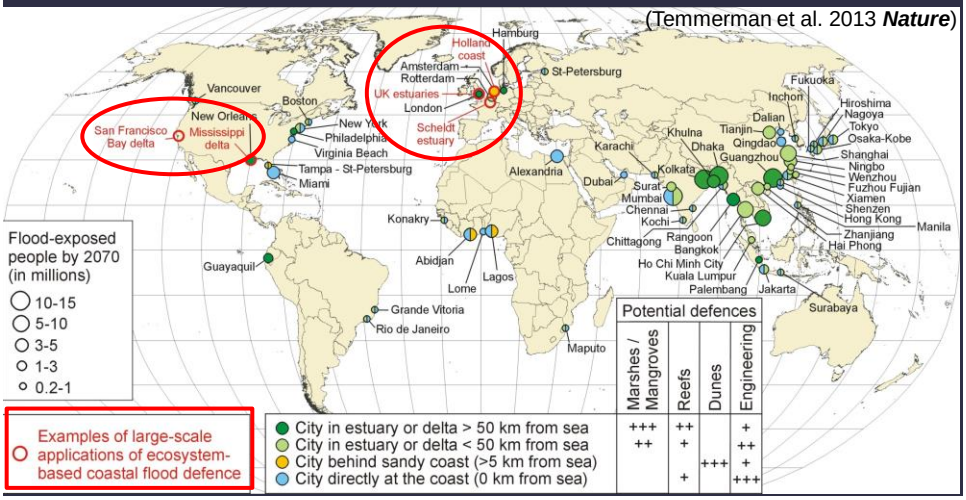


HIGH GLOBAL POTENTIAL for ecosystem-based adaptation to coastal flood risks

Especially in Asia, Europe, USA

Existing large-scale applications still scarce (Eur, USA)

(Temmerman et al. 2013 ***Nature***)



Summary of key message

There is

an increasing need for coastal flood protection
&
high global potential for ecosystem-based adaptation

especially for large populations
far inland in deltas & estuaries

Read more?: Temmerman et al. 2013 ***Nature***

Approaches in the UK: A complex estuarine management regime

"To develop a holistic management planning framework for seas and estuaries using a multi-manager sectoral framework. But: not to re-invent the wheel or alienate legitimate sectoral planning bodies. Instead, to build on existing expertise and linkages and have an inclusive system involving stakeholder expertise and understanding."

Professor Mike Elliott
Institute of Estuarine and Coastal Studies (IECS), University of Hull, Hull HU6 7RX, UK

Challenges for science & management:

There is only one big idea in estuarine management: *how to maintain and protect ecological structure and functioning while at the same time allowing the system to produce ecosystem services from which we derive societal benefits.*

- Recovery/coping with historical legacy
- Endangered coastal and marine ecosystem functions
- Legal & adminstrative framework
- Economic prosperity and delivery of societal benefits
- Coping with climate change & moving baselines

The 10 tenets:

UNIVERSITY OF Hull

To be successful, management measures or responses to changes resulting from human activities should be:

- Ecologically sustainable
- Technologically feasible
- Economically viable
- Socially desirable/tolerable
- Legally permissible
- Administratively achievable
- Politically expedient
- Ethically defensible (morally correct)
- Culturally inclusive
- Effectively communicable

Management tools needed to cover all of these!

(cf. PESTLE for business)

Marine Pollution Bulletin 74 (2013) 1–5

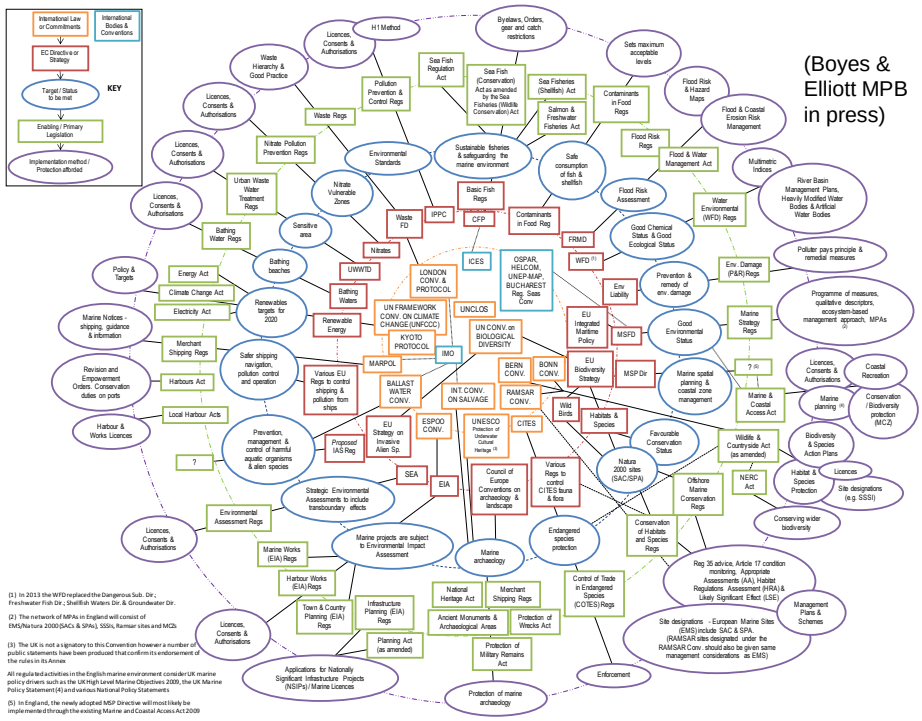
Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

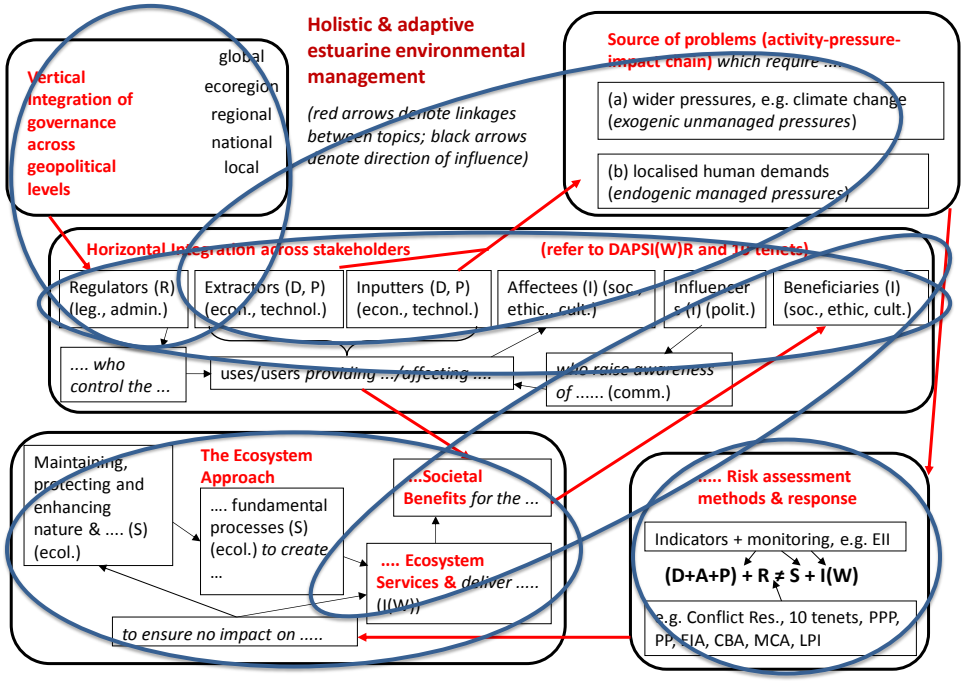
Editorial

The *10-tenets* for integrated, successful and sustainable marine management



(Boyes & Elliott MPB in press)

(Elliott 2014 Mar. Poll.Bull.)



Management of the Elbe: proposals from a Port Authority

Challenges

In-land location of sea port requires countinuous maintenance of the fairway ⟶ high costs for dredging & effects on ecology.

Port managers have to deal with:

- **Anthropogenic & natural changes** affect(ed) hydromorphology and ecology e.g. currents, sediment transport and habitats & species.
- **Climate change** i.e. lower discharge in summer will affect sediment transport.
- Increased tidal pumping (upstream transport of marine sediments) leads to **high sedimentation rates**.
- **Polluted sediments** from upper Elbe (historical load) cannot be relocated within the estuary.
- Different **legislation** due to federal system require time consuming negotiations.
- Various **uses** of the estuary plus implementation of EU legislation lead to conflicts.

Management of the Elbe: proposals from a Port Authority

Approaches & experiences for managing the complex system (1)

NATURA 2000 Management Plan

- **Apply holistic approach, overcome federal borders** ⟶ Co-operation between federal states, HPA and national Waterways & Shipping Administration (WSV)
- **Improve environment, create win-win situations** ⟶ Management measures
- **Create acceptance** ⟶ Public consultation

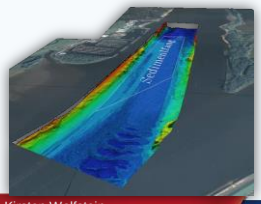
International co-operation ⟶ **Learn from others** *(www.TIDE-toolbox.eu)*

Management of the Elbe: proposals from a Port Authority

HPA Hamburg Port Authority

Approaches & experiences for managing the complex system (2)

- ***Sediment Management Plan & Dialogue Process*** **(HPA & WSV)**
  - **Carry out management measures** ⟶ River engineering measures
  - **Work with nature** ⟶ Flexible and adaptive strategy for sediment relocation
  - **Improve water & sediment quality** ⟶ Land disposal & treatment of polluted sediments
  - **Remediate pollution at the source** ⟶ ELSA Project
  - **Minimise conflicts, develop strategies for adaptation to climate change** ⟶ Dialogue process with stakeholders




Kirsten Wolfstein

DELTAS IN TIMES OF CLIMATE CHANGE II

OPPORTUNITIES FOR PEOPLE, SCIENCE, CITIES AND BUSINESS

ROTTERDAM
THE
NETHERLANDS
24-26 SEPTEMBER
2014

Local/regional governments: key players in scientific research

Jean-Paul Ducrotoy
Institute of Estuarine and coastal studies
The University of Hull
UK

Seine-Aval
GROUPEMENT D'INTÉRÊT PUBLIC

UNIVERSITY OF Hull
Institute of Estuarine and Coastal Studies

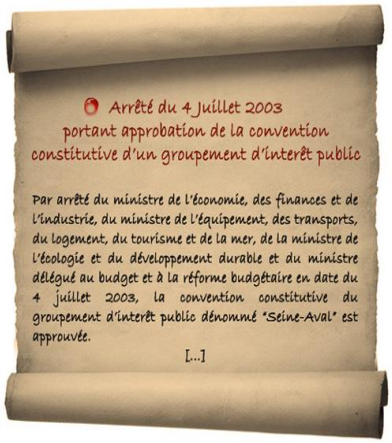
liteau

Case study: the GIP Seine Aval ?

- A full research programme : a scientific component of national and international research

Established in 1995 as a research programme and in 2003 as a GIP

- A tool for decision making with an operational component
  - Dissemination to the scientific community, the estuary's stakeholders and the public
  - Use of the available scientific information to the benefit of decision makers and managers of the estuary


Arrêté du 4 juillet 2003
portant approbation de la convention constitutive d'un groupement d'intérêt public

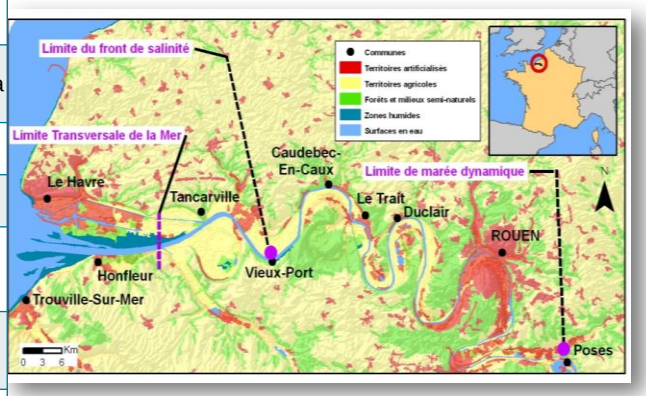
Par arrêté du ministre de l'économie, des finances et de l'industrie, du ministre de l'équipement, des transports, du logement, du tourisme et de la mer, de la ministre de l'écologie et du développement durable et du ministre délégué au budget et à la réforme budgétaire en date du 4 juillet 2003, la convention constitutive du groupement d'intérêt public dénommé "Seine-Aval" est approuvée.

[...]

GIP: a cluster in support of science

The Seine estuary

	Seine
Water catchment area (km^2)	**79 000**
Estuary area (km^2)	**50**
Tidal intrusion (km from sea)	**160** (limited by a dam)
Maximal tidal range (m)	**8**
Mean freshwater discharge ($m^3.s^{-1}$)	**480**
Highest freshwater discharge ($m^3.s^{-1}$)	**2200**
Lowest freshwater discharge ($m^3.s^{-1}$)	**100**
TMZ (t)	**20 000 to 400 000**
Mean water residence time	**25-30**



Drowned valley estuaries have common features but can differ radically

Evolution time scales vary from 100s to 1000s years

Discharge and area are important, BUT energy inputs from

- tides,
- waves and
- river flow

act on a suite of sediment materials embracing

- inherited geology and
- ongoing sediment inputs to the coastal system

→ need to be incorporated into the regime relationship for each estuary

estuary geological frame or

'Accommodation space': characteristic of individual

Ecological + sociological continuum: from local to global

- Water shed and costal habitats are linked through estuaries
- Difficult to define a **reference** based on pristine conditions in present-day disturbed/urbanised estuaries
- More appropriate to identify **trends** rather than thresholds
- Take into account local **natural variations** of ecosystem conditions and **human activities**

should incorporate a social dimension to be incorporated into a multiscale approach

Patrimonial view of estuarine ecosystems…

- Climate change will make "habitats" of interest more fragile and less resilient
- European and national legislation aim at protecting habitats
  - are species based
- Need to allow species to adapt to new local biophysical conditions

need to restore appropriate habitats locally adapted to changing geomorphology

- Restoration to focus on ecosystems not species
- Risk of protected habitats to become "fossilised«
- Need to focus on functioning at ecosystem level (goods and services) rather than on structure

---

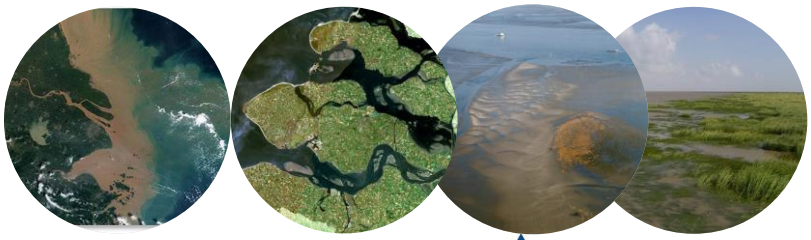
Eco-morphological evolution and estuarine management in the Yangtze and Westerschelde estuary

---

Tom Ysebaert

NIOZ, Spatial Ecology Department, Yerseke The Netherlands

IMARES – Wageningen UR, Yerseke, The Netherlands



DELTAS IN TIMES OF CLIMATE CHANGE II

OPPORTUNITIES FOR PEOPLE, SCIENCE, CITIES AND BUSINESS

ROTTERDAM
THE NETHERLANDS
24-26 SEPTEMBER 2014

IMARES WAGENINGEN UR

NIOZ

Yangtze and Westerschelde estuary

- differ in many physical and biological aspects, but
- experience similar societal developments and human activities;
- especially with respect to morphological changes and how these interact with ecological patterns and processes.

Wetlands (2011) 31:1033–1042
DOI 10.1007/s13157-011-0239-7

ECO-HEALTHY ESTUARINE WETLANDS

Eco-Morphological Problems in the Yangtze Estuary and the Western Scheldt

Huib J. De Vriend · Zheng Bing Wang · Tom Ysebaert · Peter M. J. Herman · Pingxing Ding

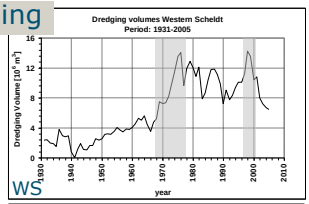
IMARES WAGENINGEN UR

NIOZ

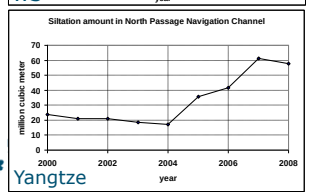
Human activities

- Two categories of human activities within the estuary influence the eco-morphological development of both estuaries:
  - 1) activities for improving and maintaining navigability;
  - 2) activities related to shoreline management, including land reclamations and setbacks

Dredging

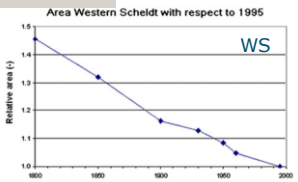


WS

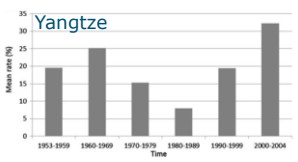


Yangtze

Reclamation



WS

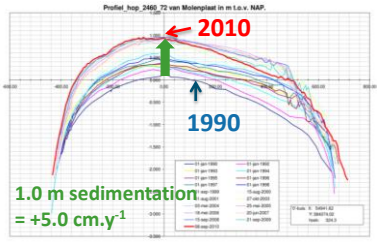


Yangtze

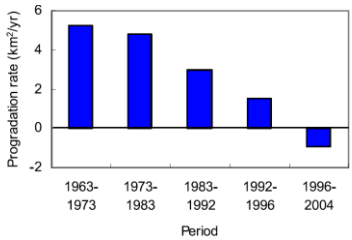
NIOZ

Eco-morphological development

- Human activities evoked changes & **feedback mechanisms** between hydrodynamics, sediment dynamics, ecol. processes.
- **Mega-, macro- and meso-scale** developments: change in sediment balance, natural channel structure, tidal flats, etc.;
- Consequences for **habitats**, **biodiversity** (e.g. species distributions) and **ecosystem services**.



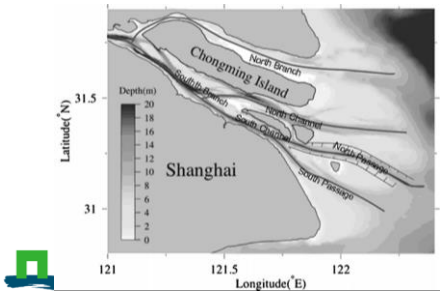
Change in tidal flat profile in the Westerschelde
Source: Rijkswaterstaat

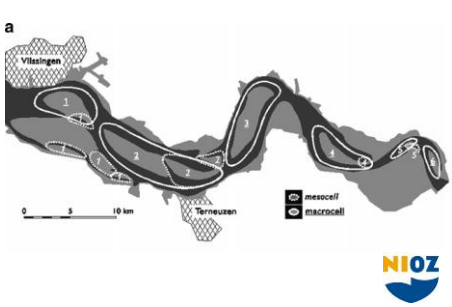


Varation in progradation rate of intertidal wetlands in Yangtze. Yang et al_Geophysical Research Letters 2006

Lessons learned

- It is clear that many issues are **common** to the two estuaries.
- human interventions can push estuaries so far out of their (dynamic) **equilibrium**, that mutual balance between the physical processes becomes disturbed.
- This reduces **resilience** of estuaries, setting in motion autonomous developments, possible pushing the estuary beyond a **tipping point**, which cannot yet be predicted.





Management strategies

- Need to rethink management strategies, esp. in the light of climate change.
- Special attention, relevant for both estuaries as well as for many other estuaries = **morphological equilibrium**, including channel–shoal/flat interaction and bifurcating channels.

Westerschelde: new disposal strategy: relocate material along tidal flats, safeguarding multi-channel system, while creating ecologically valuable habitat.

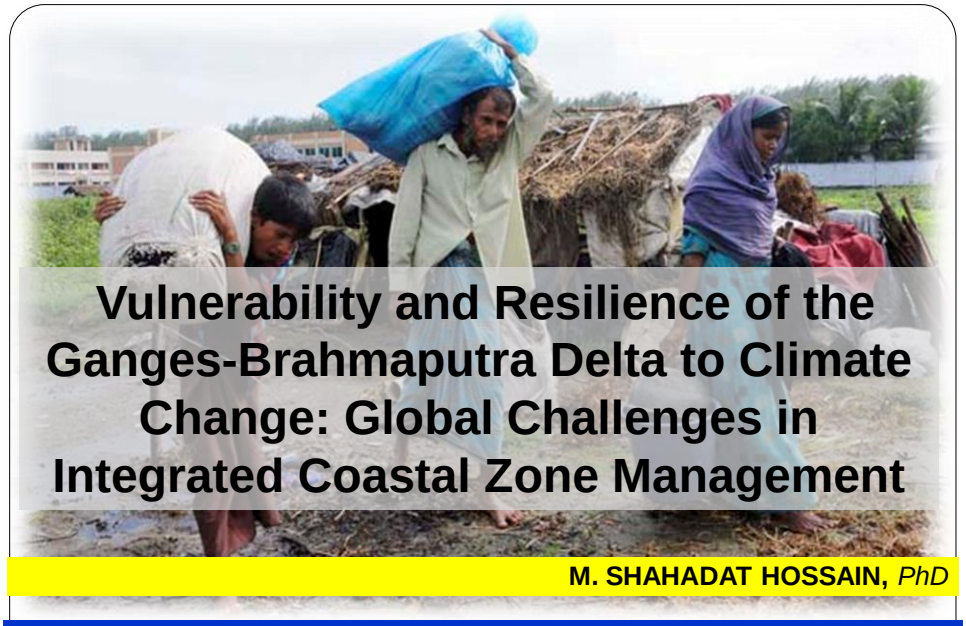
Lessons learned and common challenges

- BUT: what is **optimal scale**: should one change the overall system characteristics, interfere at the level of large portions of the estuary or apply a multitude of local mitigation measures?
- AND: how can minimal interferences be planned for **maximal effect on ecological value**?
- this requires a better understanding of the **eco-morphological development** and **ecosystem functioning** of estuarine systems at different **spatial & temporal scales**

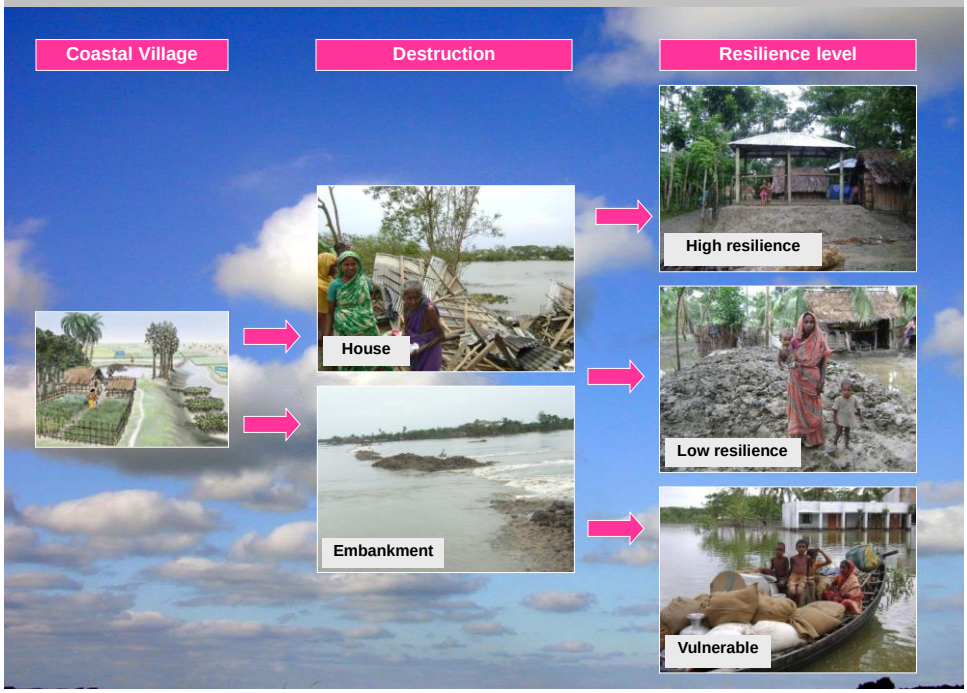
Future strategies

- The (habitat) problems that arise nowadays call for new management strategies, esp. in the light of climate change.
- BUT: what is optimal scale: should one change the overall system characteristics, interfere at the level of large portions of the estuary or apply a multitude of local mitigation measures?
- AND: how can minimal interferences be planned for maximal effect on ecological value?
- Pressing need for better understanding of eco-morphological development & ecosystem functioning of estuarine systems.

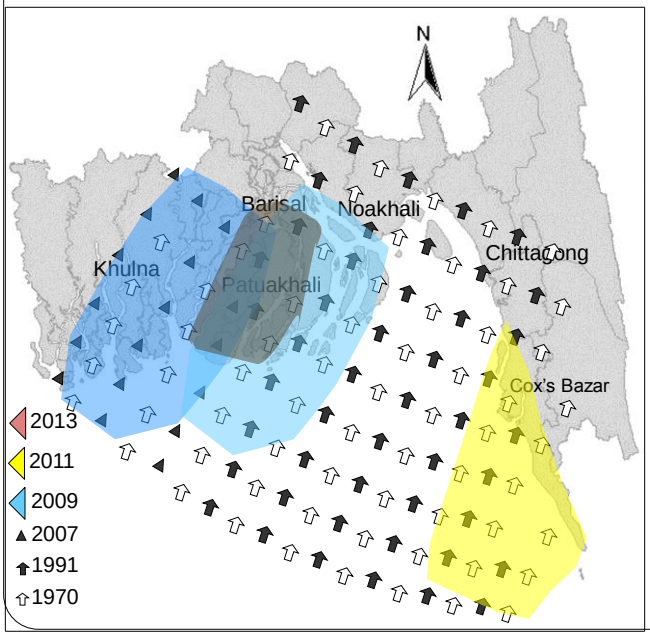
IMARES WAGENINGEN UR



COASTAL PEOPLE'S RESPONSE TO CYCLONE



Devastating cyclones & tidal surges along the coast



Cyclone classification

a) Low pressure system: maximum air speed 27 km/hour

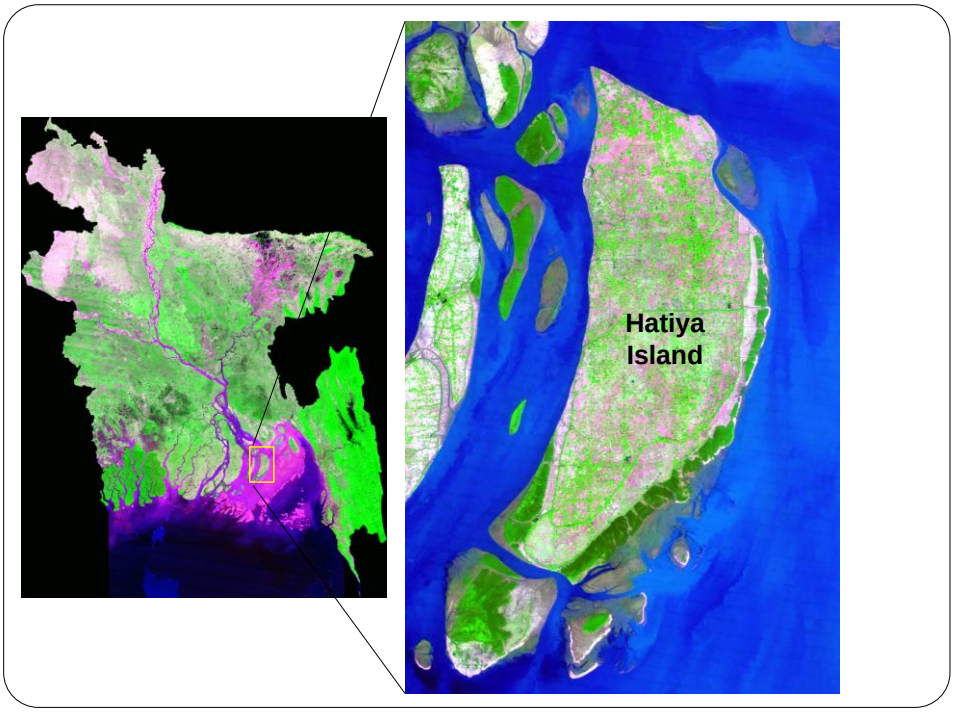
b) Depression: maximum air speed 59 km/hour

c) Cyclone: maximum air speed 113 km/hour

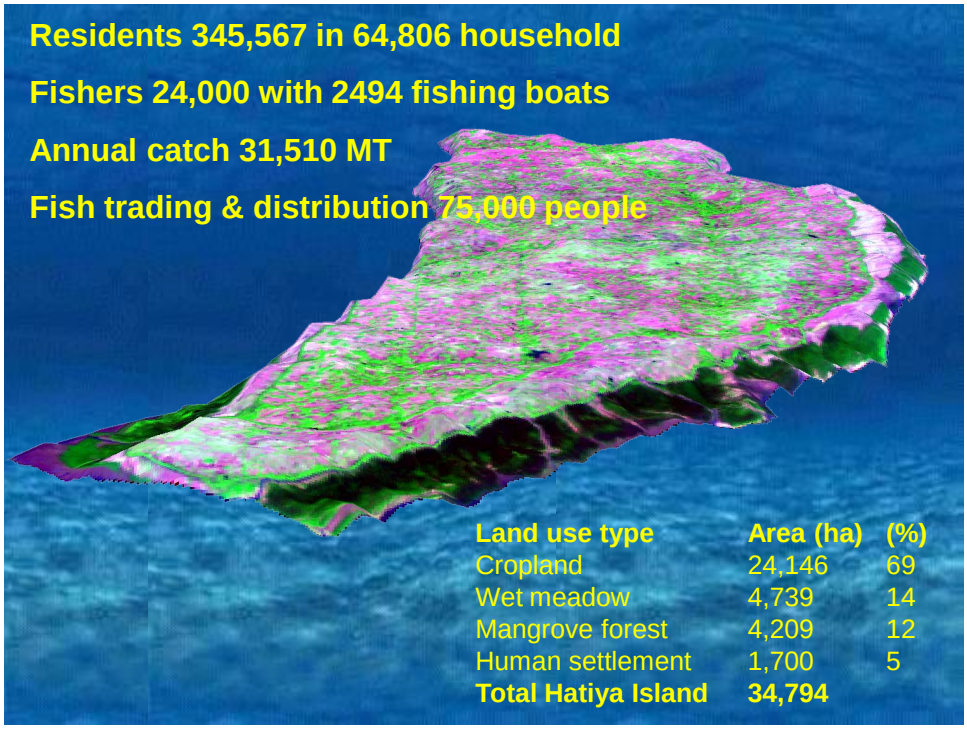
d) Devastating cyclone: maximum air speed >113 km/hour

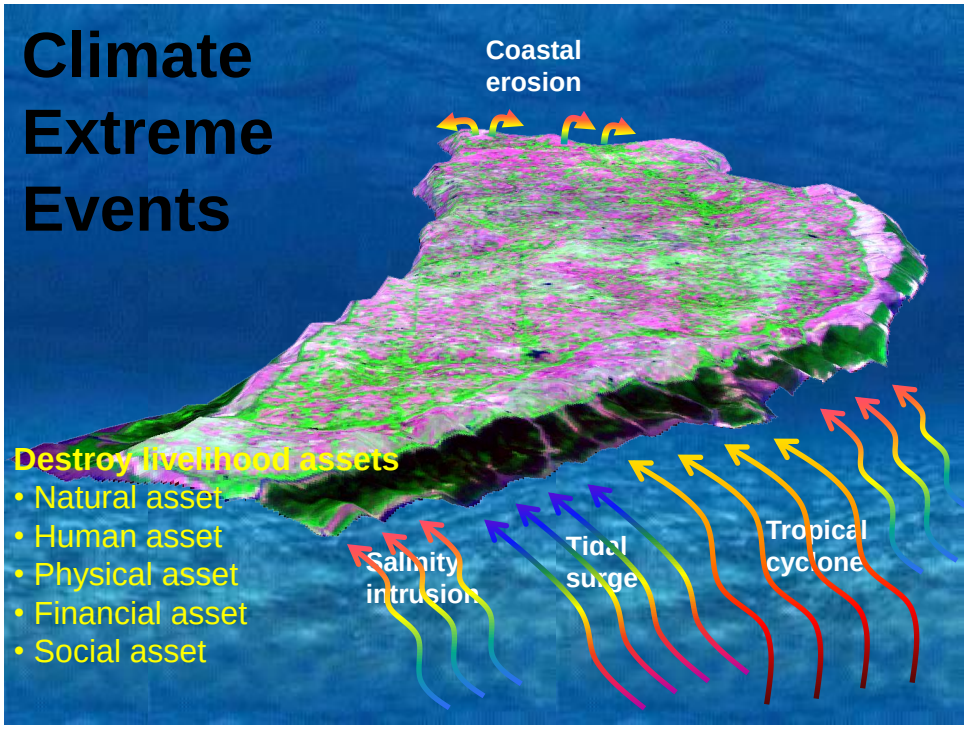
Cyclone: 1970
November 12-13
Max. speed 241km/hr
Surge height 10m
Causality: 500,000
Damaged: 86.4 million US$

Cyclone: 1991
April 29
Max. speed 193km/hr
Surge height 6m
Causality: 150,000
Damaged: 1780 million US$

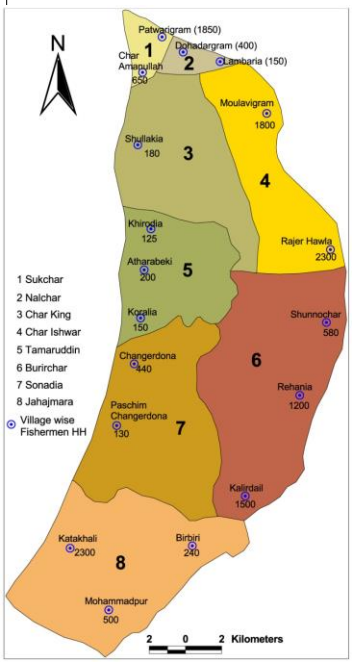

Hatiya
Island


Ecosystem resources
Fisheries, mangrove, wet meadow, rice/paddy


Residents 345,567 in 64,806 household
Fishers 24,000 with 2494 fishing boats
Annual catch 31,510 MT
Fish trading & distribution 75,000 people
Land use type | Area (ha) | (%)
Cropland | 24,146 | 69
Wet meadow | 4,739 | 14
Mangrove forest | 4,209 | 12
Human settlement | 1,700 | 5
Total Hatiya Island | 34,794

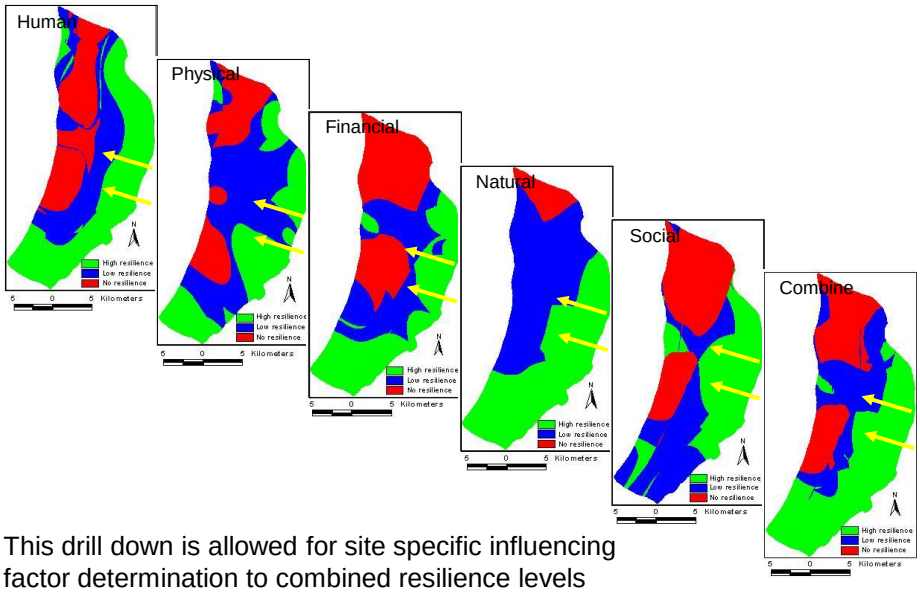

Climate Extreme Events
Coastal erosion
Destroy livelihood assets
• Natural asset
• Human asset
• Physical asset
• Financial asset
• Social asset
Salinity intrusion
Tidal surge
Tropical cyclone

Characteristics of fishing villages



Characteristics	Villages
No embankment, no mangrove	Patwarigram, Dohadargram, Lambaria, Moulavigram, Char Amanullah and Shullakia
Only embankment, no mangrove	Khirodia, Atharabeki, Koralia, Changerdona and Paschim Changerdona
Both mangrove and embankment	Rajer Hawla, Shunnochar, Rehania, Kalirdail, Birbiri, Mohammadpur and Katakhali

Down drilling



This drill down is allowed for site specific influencing factor determination to combined resilience levels

Desired outcomes from resilience modeling

- ⇨ Cyclone resilient housing & community infrastructure
- ⇨ Support fishing equipments
- ⇨ Embankment construction
- ⇨ Mangrove affrestation

Community level adaptation options

On-farm training for food production

- Sustainable aquaculture (fish, prawn, crab)
- Livestock rearing (cow, buffalo, goat)
- Poultry farming (chicken, duck)
- Agriculture on dike slope

Off-farm training for cash income (women)

- Tailoring and embroidery
- Nursery (fruity, woody & medicinal plants)
- Cell-phone repairing