



# Land-Ocean Interactions in the Coastal Zone

**Fluxes to the coastal ocean: changing land and sea use and global scale processes in coastal waters/Deltas**

**Hartwig Kremer, GKSS Research Centre, Geesthacht & LOICZ SSC**

***LOICZ Mission:***

***Providing science that contributes towards understanding the Earth system in order to inform, educate and contribute to the sustainability of the world's coastal zone***



## **Purpose of this talk**



- 1. To provide an overview of LOICZ in its second phase and to introduce its Priority Topics**
- 2. To illustrate the science with certain retrospective and future examples that may provide the rationale for focussing on global Deltas**



# Change and Science

CZ changes resulting from and in:

Human pressure and use - the "Anthropocene"

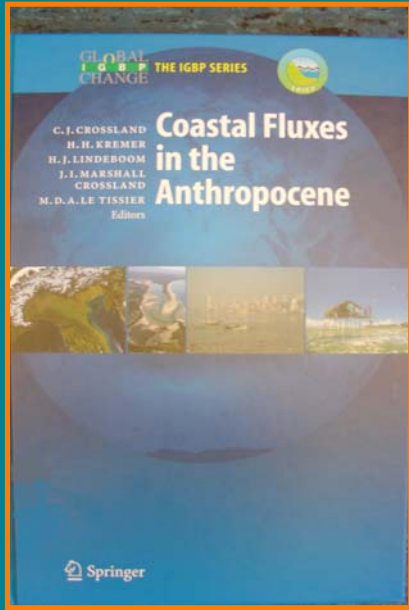
(multiple effects on quality & quantity of resource, products & amenities, multiple needs for intervention across scales and regions)



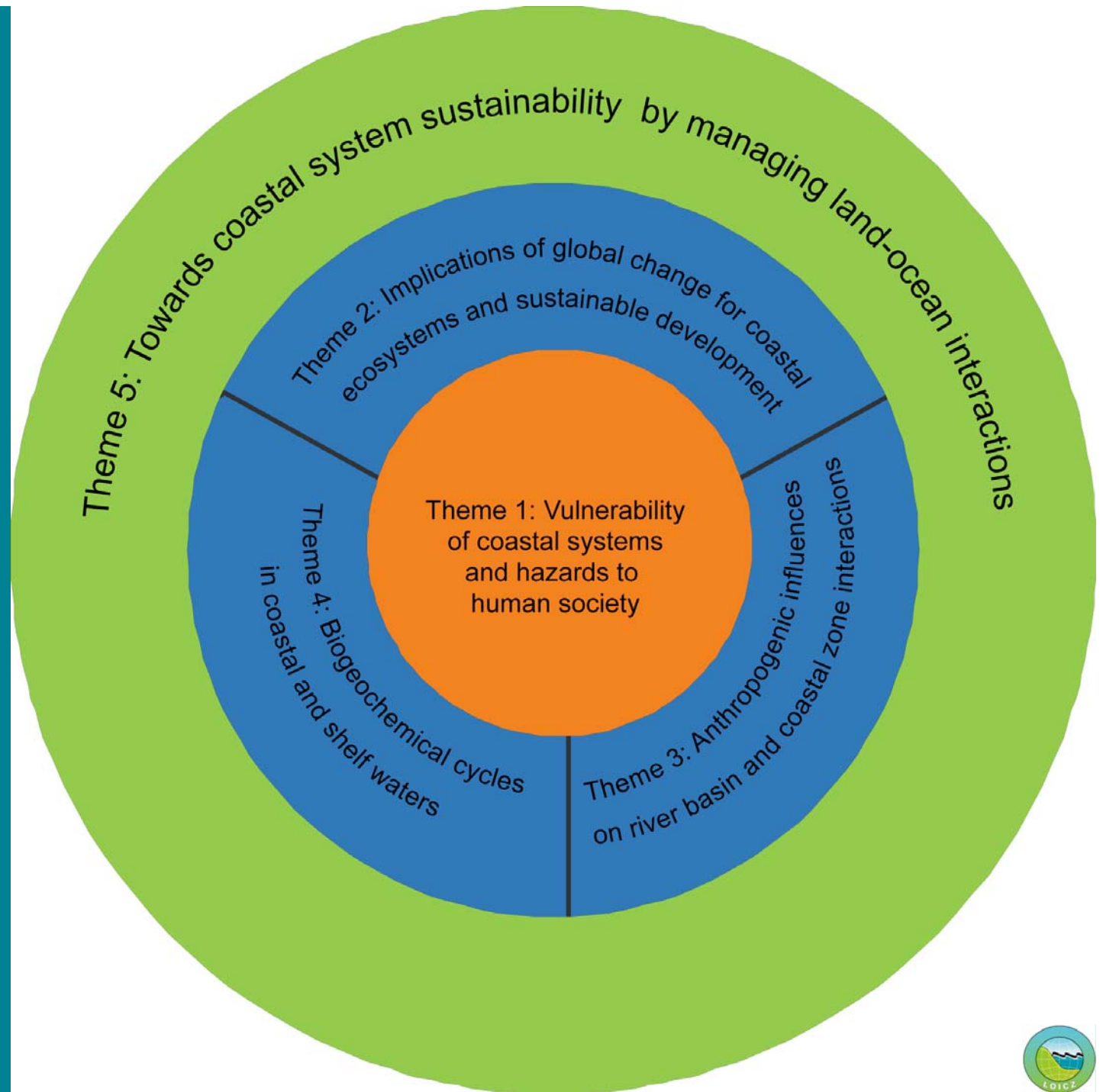
Most impacted coastal areas: population density  $> 60 \text{ km}^{-2}$  & cropland use  $> 10\%$



Pictures by Kjerfve and Syvitski



First  
Synthesis  
published in  
2005





POPULATION  
CONSUMPTION  
TRADE

CLIMATE  
SEA LEVEL RISE  
TECTONICS



RIVER CATCHMENT

MATERIAL  
FLUXES

Quantitative  
Biogeo-  
chemical  
Fluxes,  
"Functions"

Qualitative  
Purposes,  
Descriptions

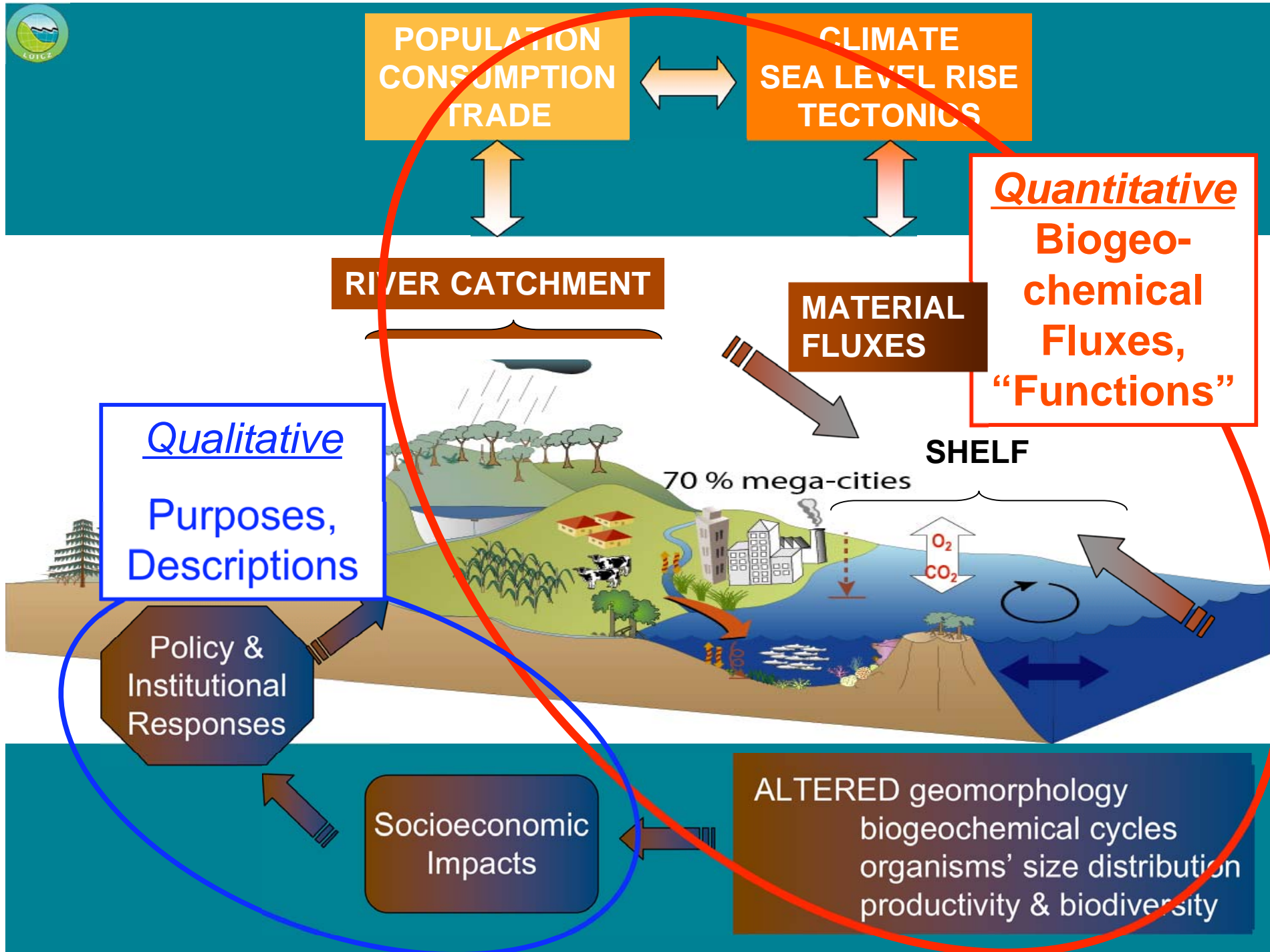
70 % mega-cities

SHELF

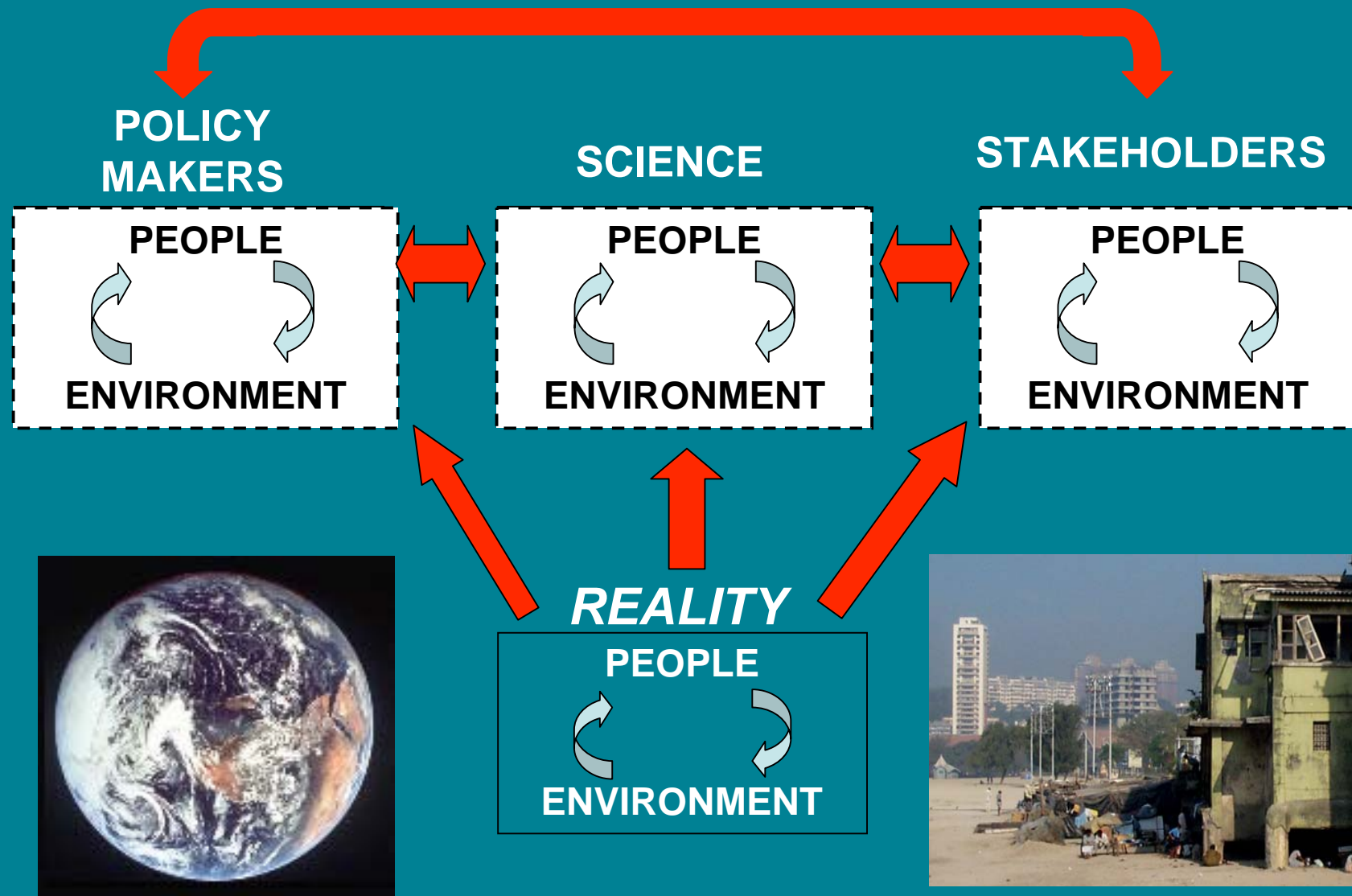
Policy &  
Institutional  
Responses

Socioeconomic  
Impacts

ALTERED geomorphology  
biogeochemical cycles  
organisms' size distribution  
productivity & biodiversity



# The challenge for Managers Bridging different "Reality Views"





## Priority Topic 1

# Linking social and ecological systems in the coastal zone

**Objective:** *to gain insights on the likely future state of the marine environment in various economic and social scenarios*

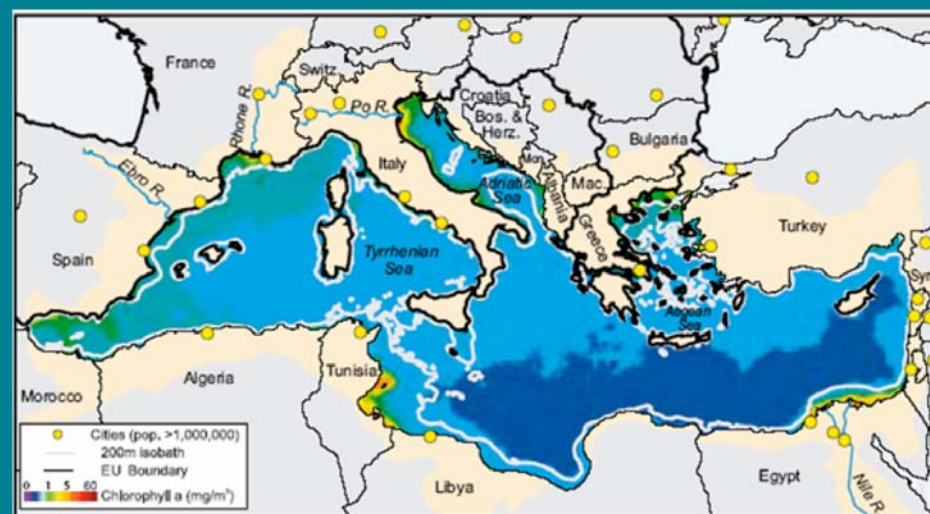
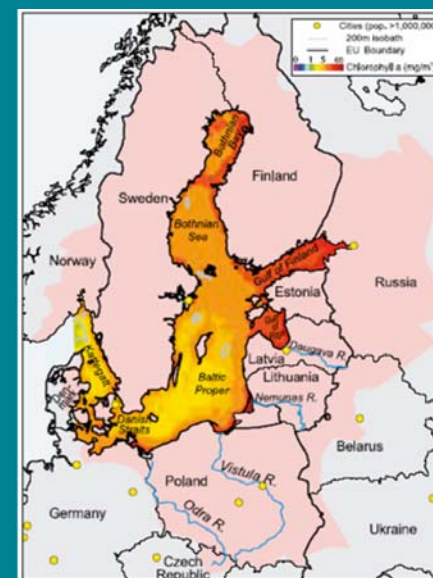
(activities coordinated by L. Mee, Plymouth, action currently being carried out through EU projects, ZMT Bremen, and WZB Berlin, current regional focus of contributing projects Europe, Indonesia, Brasil)

# so why is it difficult to model the coasts in a socio-ecological systems perspective?

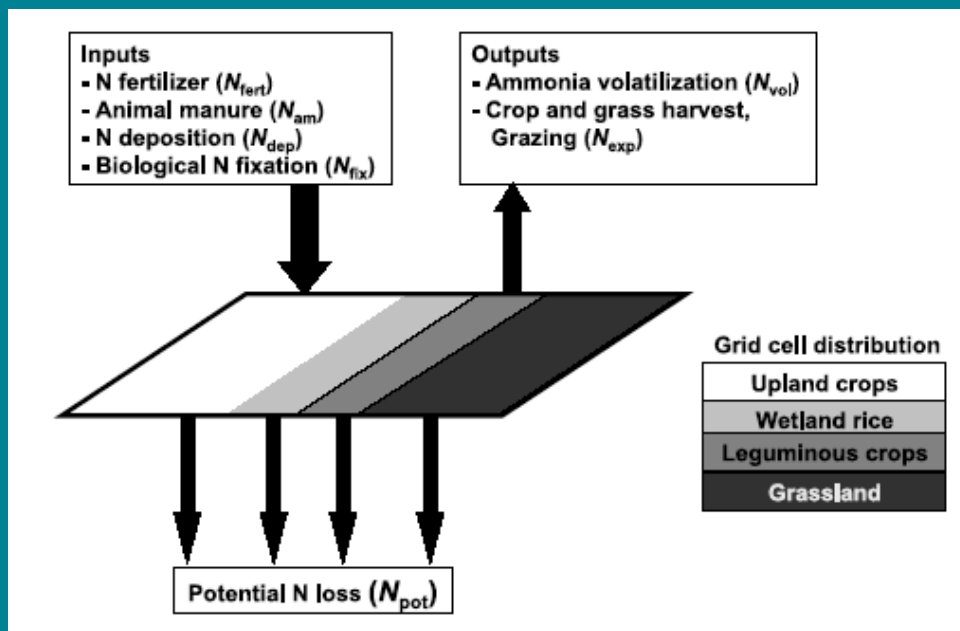
Natural and human sciences have different epistemologies and often lack a common currency.

S-E systems demonstrate:

- Non-matching scales (e.g. Regional Seas scale analysis requires understanding of sub-systems)
- Surprises (non-linearities)
- Interconnection with other systems
- Memory effects
- Choke points





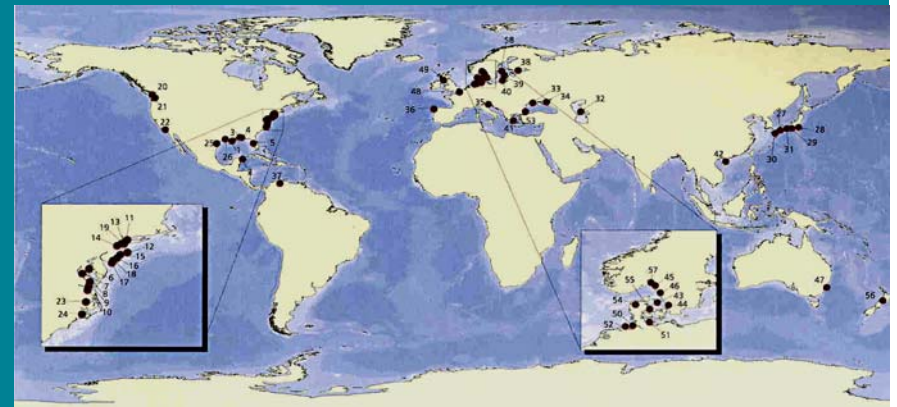
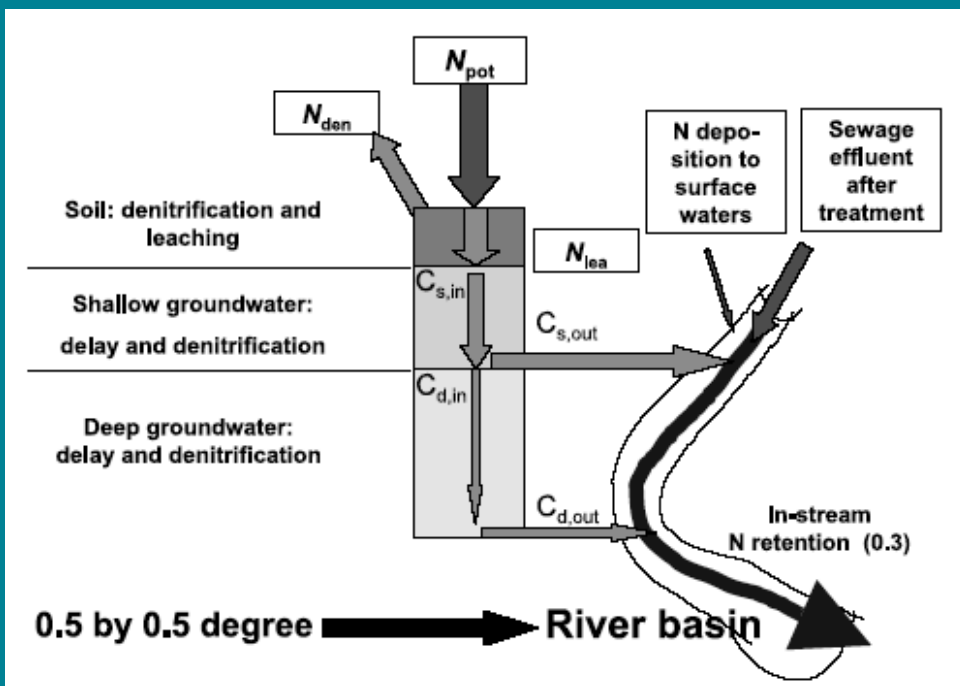


## River nitrogen export to the Coast:

Will increase by 27% for Developing countries:

What are the impacts on coastal human populations & coastal ecosystems?

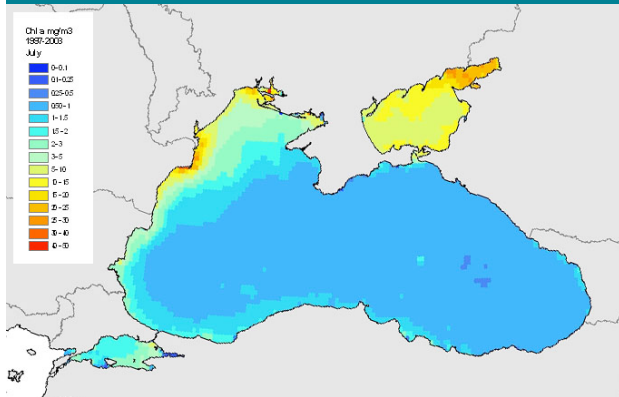
What are the resulting vulnerabilities resulting from eutrophication?



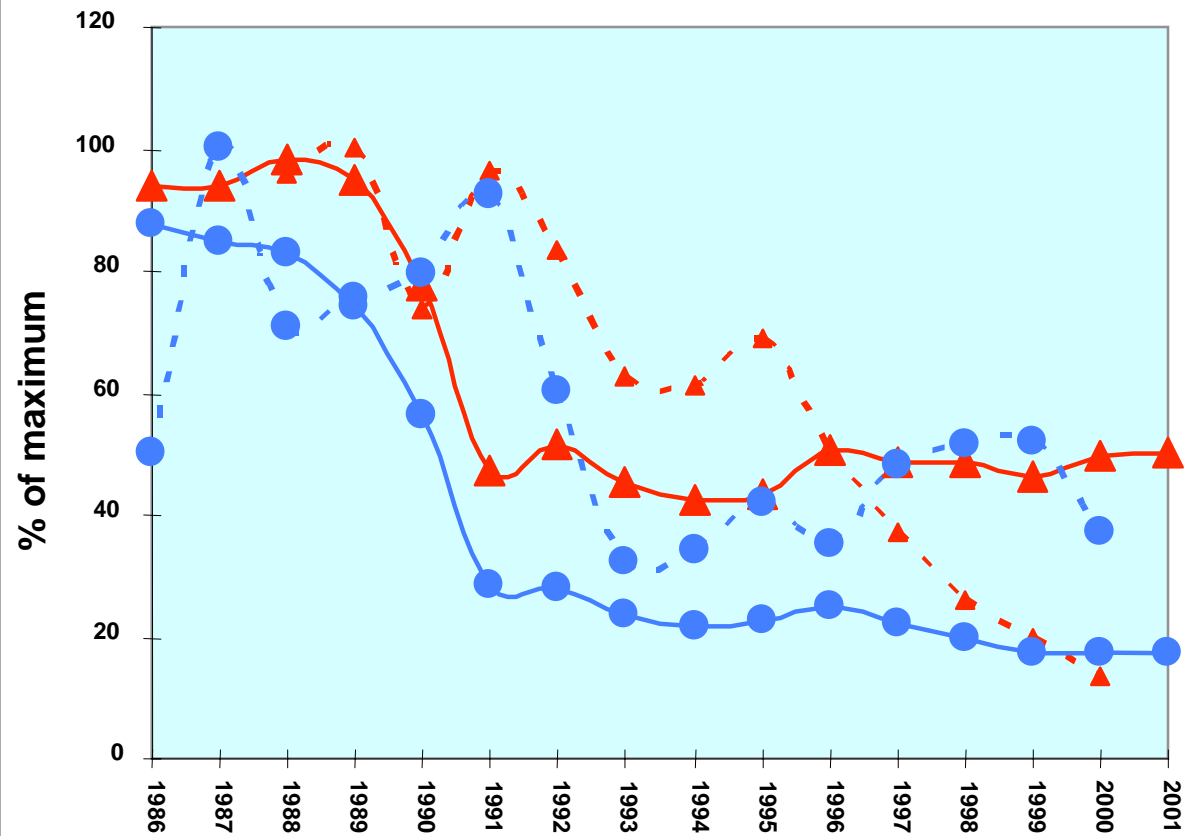
**Global distribution of hypoxia zones (current LOICZ / SCOR WG 128)**

# Fluxes in Context - the Black Sea Example:

Danube N discharge closely related to fertiliser application in the Basin



Normalised basin-wide fertiliser use and N and P discharge to the Black Sea

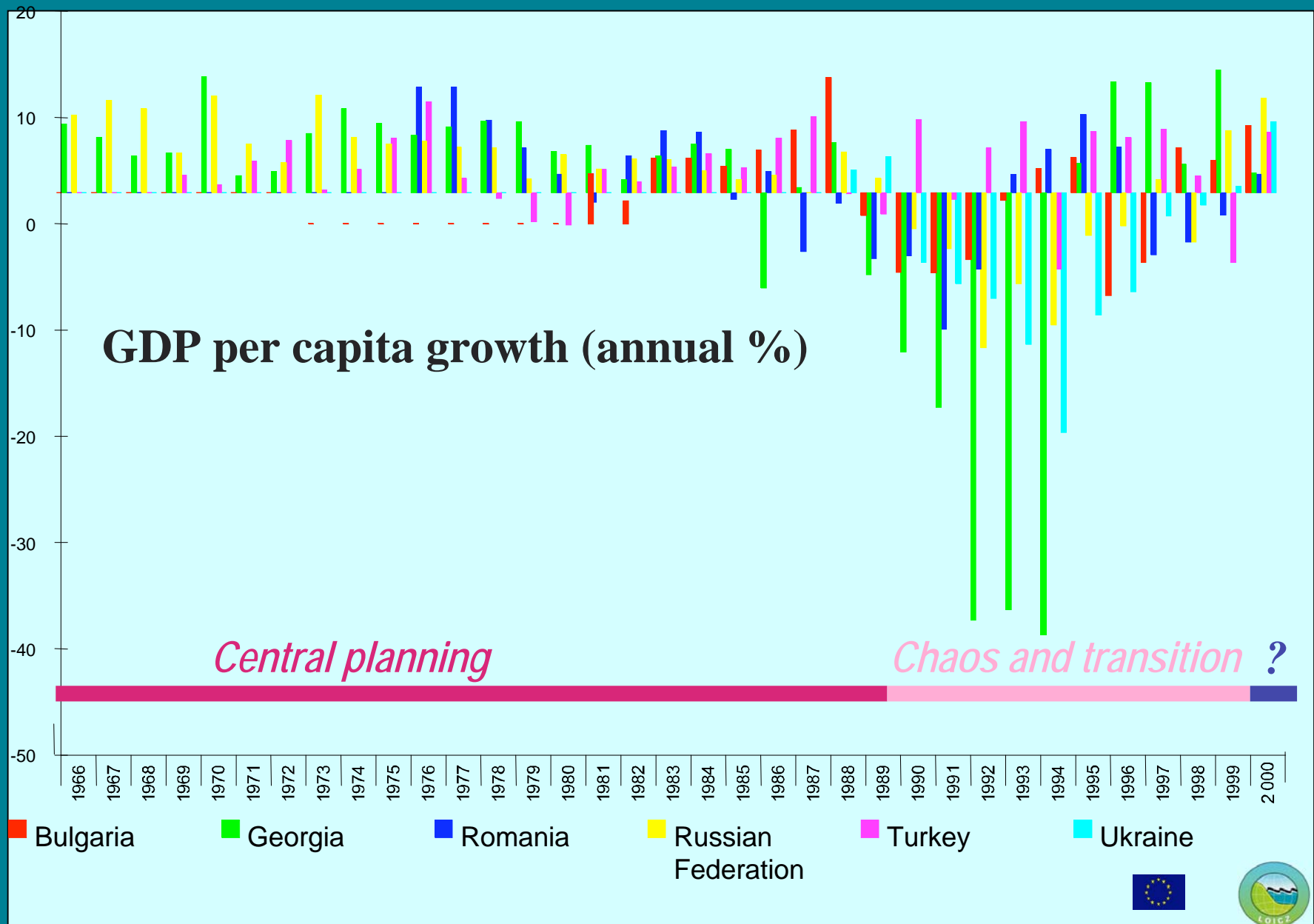


- - - Total N discharge  
- - - Total P discharge

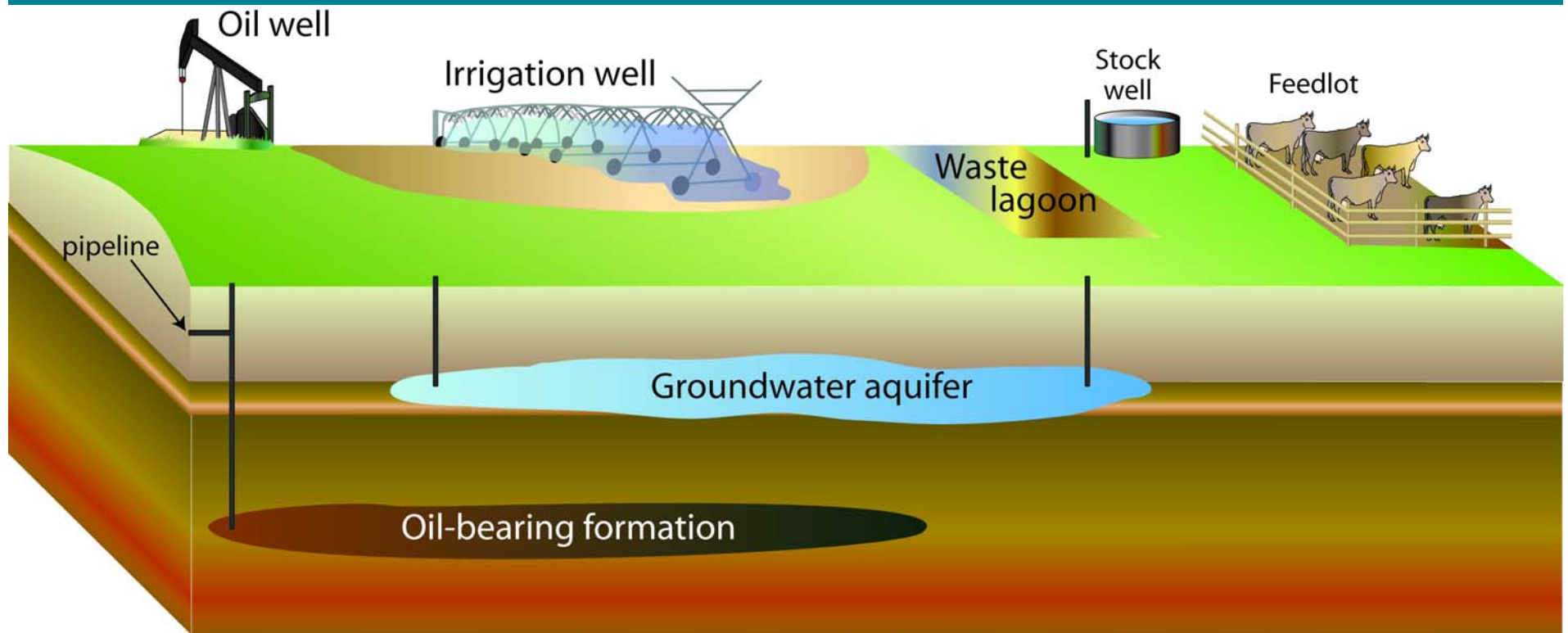
- - - N fertiliser  
- - - P fertiliser



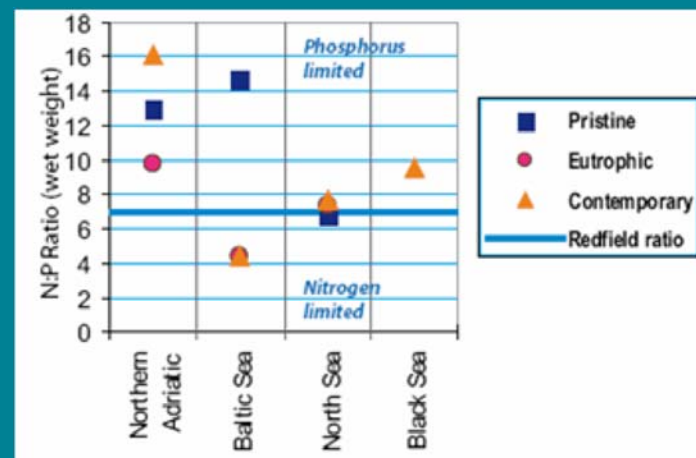
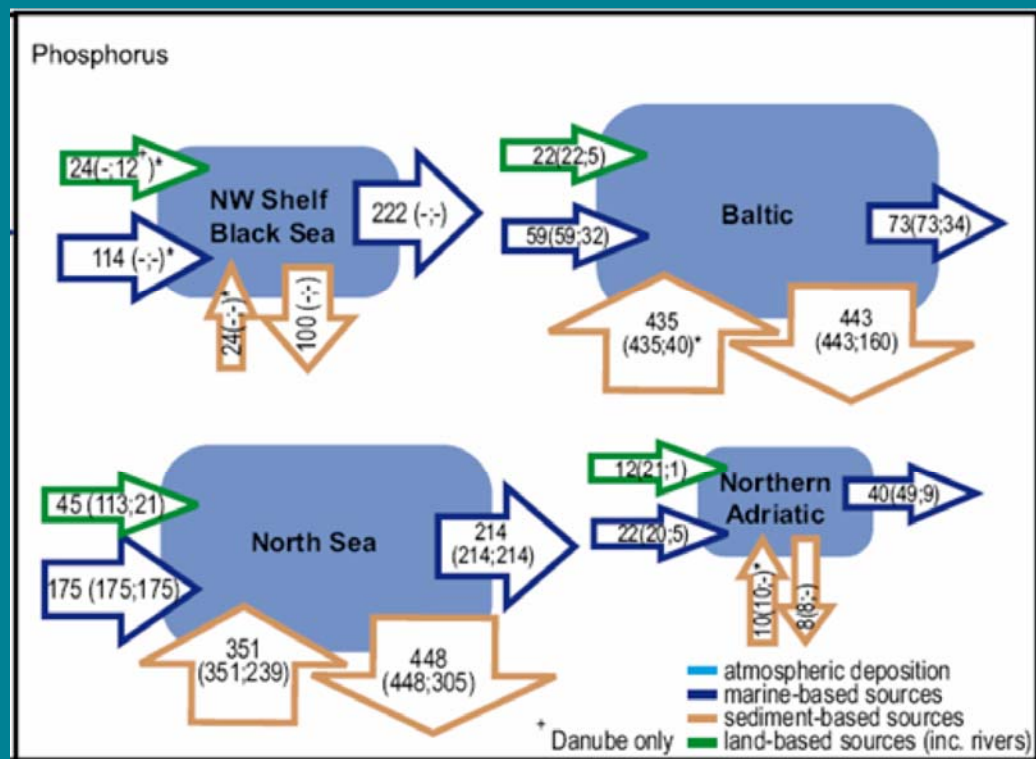
# An unprecedented social and economic crisis...



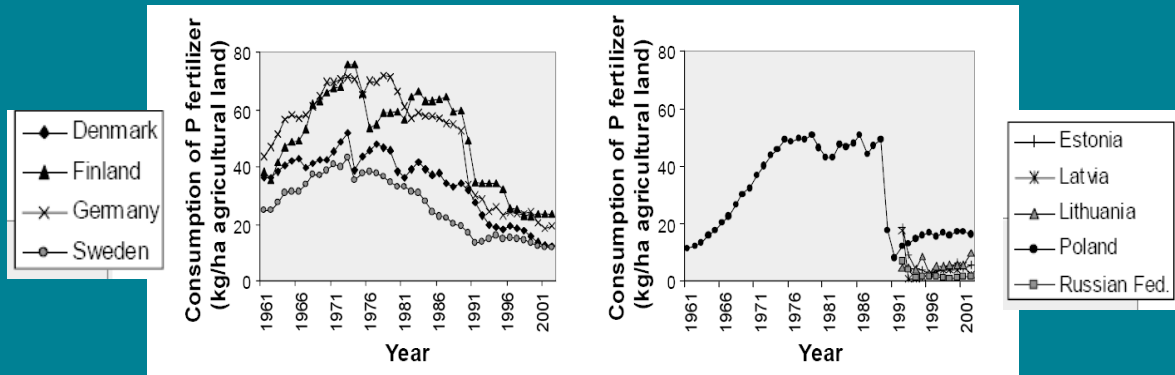
Dramatic land-use and cover change may again result from non-sustainable use of subsurface resources – a potentially predictable effect on global Deltas.



# Mass balance modelling and nutrient accounting

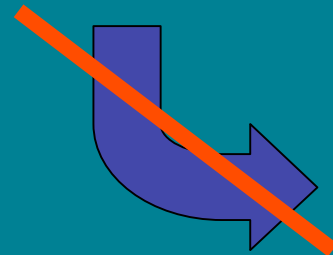


# Systems have memory effects

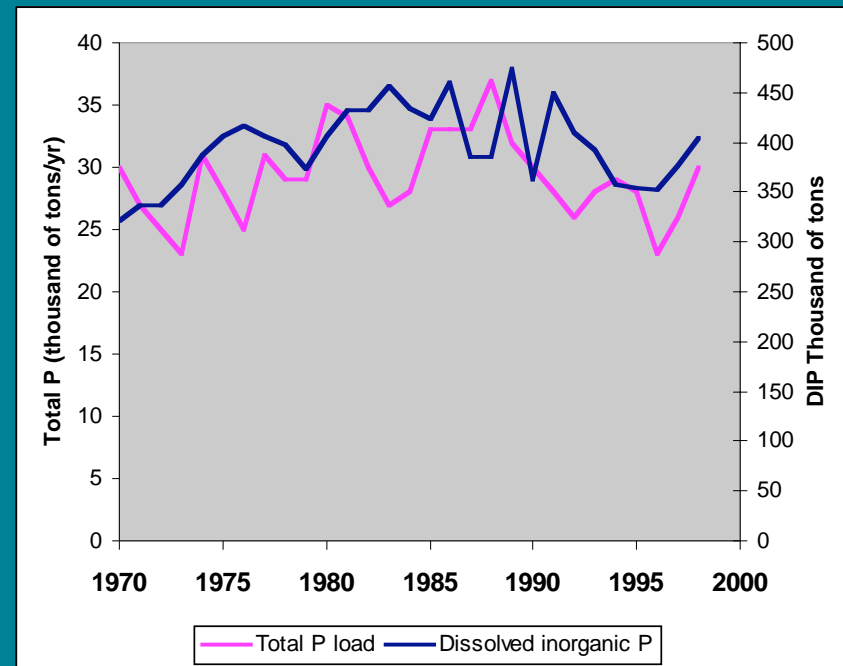


**BALTIC:**

**Large decrease in P consumption for agriculture**



Little change in P in system





## Priority Topic 2

# Assessing and predicting impacts of environmental change on coastal ecosystems

**Objective:** *to examine the changes in runoff, groundwater flows, nutrient and sediment loads associated with climate change and human activities in coastal watersheds and the response of coastal and shelf ecosystems to these changes*

(coordinated by D. Swaney, N. Rabalais Cornell, Louisiana, Nutrient Flux model-review, nutrient accounting, IMBER-LOICZ OSM, Shanghai Sep 07-Shelf research, Deltas at Risk collaboration with GWSP, Sep 07)



LOICZ Basins 1999-2005

The river-  
continuum:

Expert

Typologies

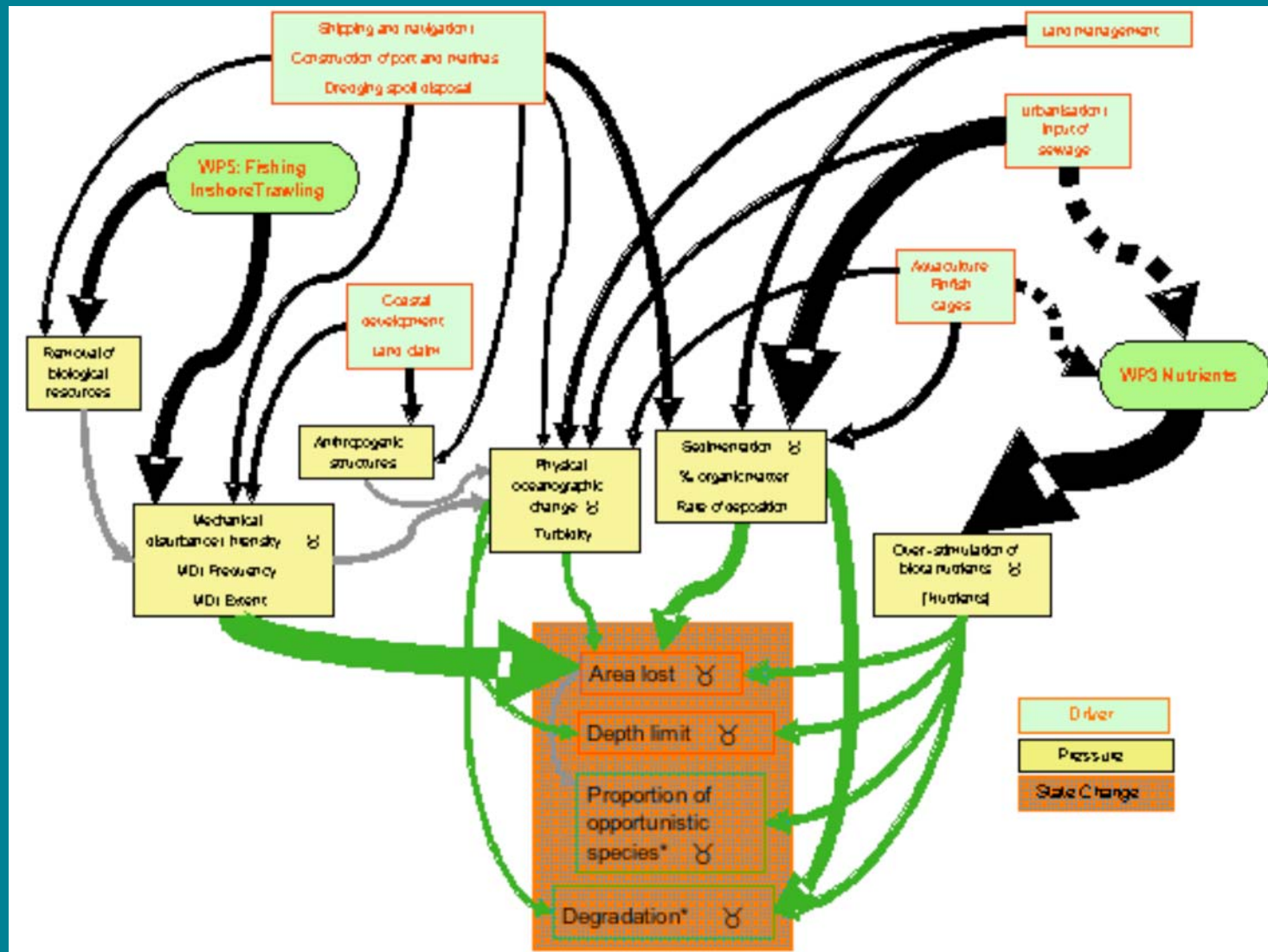
in a useful

way



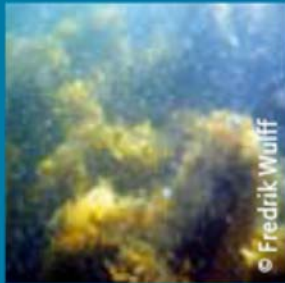


# Initial conceptual model



# Winners and losers: e.g. Baltic

## Winners



- Winners shown here are benthic microalgae, coastal zoobenthos and sprat

- Losers are native eelgrass, zostera and large predators such as cod.

- There are habitat-forming winners and losers, indicating a fundamental change in the natural ecosystem

- Winners providing goods to the human population (fish in the case of the Baltic) are of lower economic value than the losers.

## Losers





## Priority Topic 3

# Linking governance and science in coastal regions

**Objective:** *to employ comparative analysis to inform the improvement of the governance of human activities in changing coastal ecosystems*

Governance here addresses the values, policies, laws and institutions by which issues of change and response are tackled – target groups are coastal communities – coastal scale is question dependant

(coordinated by S. Olsen, Rhode Island, methods development, governance baseline assessment, current regional focus and train the trainer WS (Lat. Am.), collab. IHDP, IAI)

# Linking governance and science in coastal regions

## *How can comparative analysis inform the improvement of the governance of human activities in changing coastal ecosystems*

Governance addresses values, policies, laws and institutions. It probes the fundamental goals and the institutional processes and structures that are the basis for planning and decision-making. Management, is the process by which resources are harnessed to achieve a known goal within an institutional structure.

### Major Expressions of Governance

#### Government

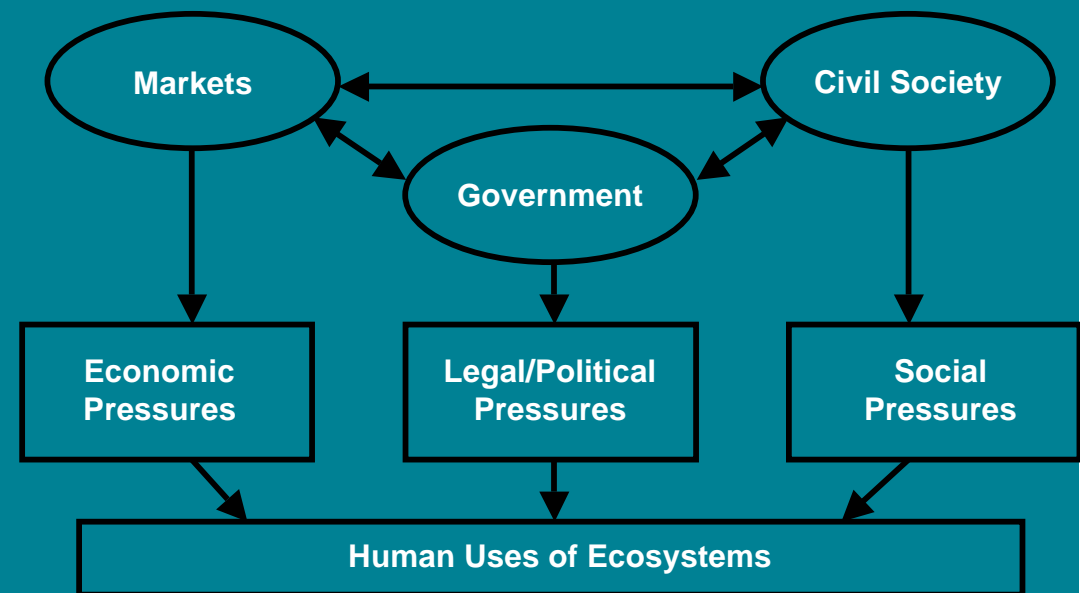
- laws and regulations
- taxation and spending policies
- education and outreach

#### Marketplace

- profit-seeking
- ecosystem service evaluation
- mitigation/remedy cost evaluation
- eco-labeling & green products

#### Institutions and organizations of civil society

- socialization processes
- constituency building
- co-management



The three mechanisms of governance



## Schematic presentations of administrative and/or political limits in river catchments and their associated coastal zones

Extended basin-coast entity (1):

A: Limits across river network.

B: limits following river courses.

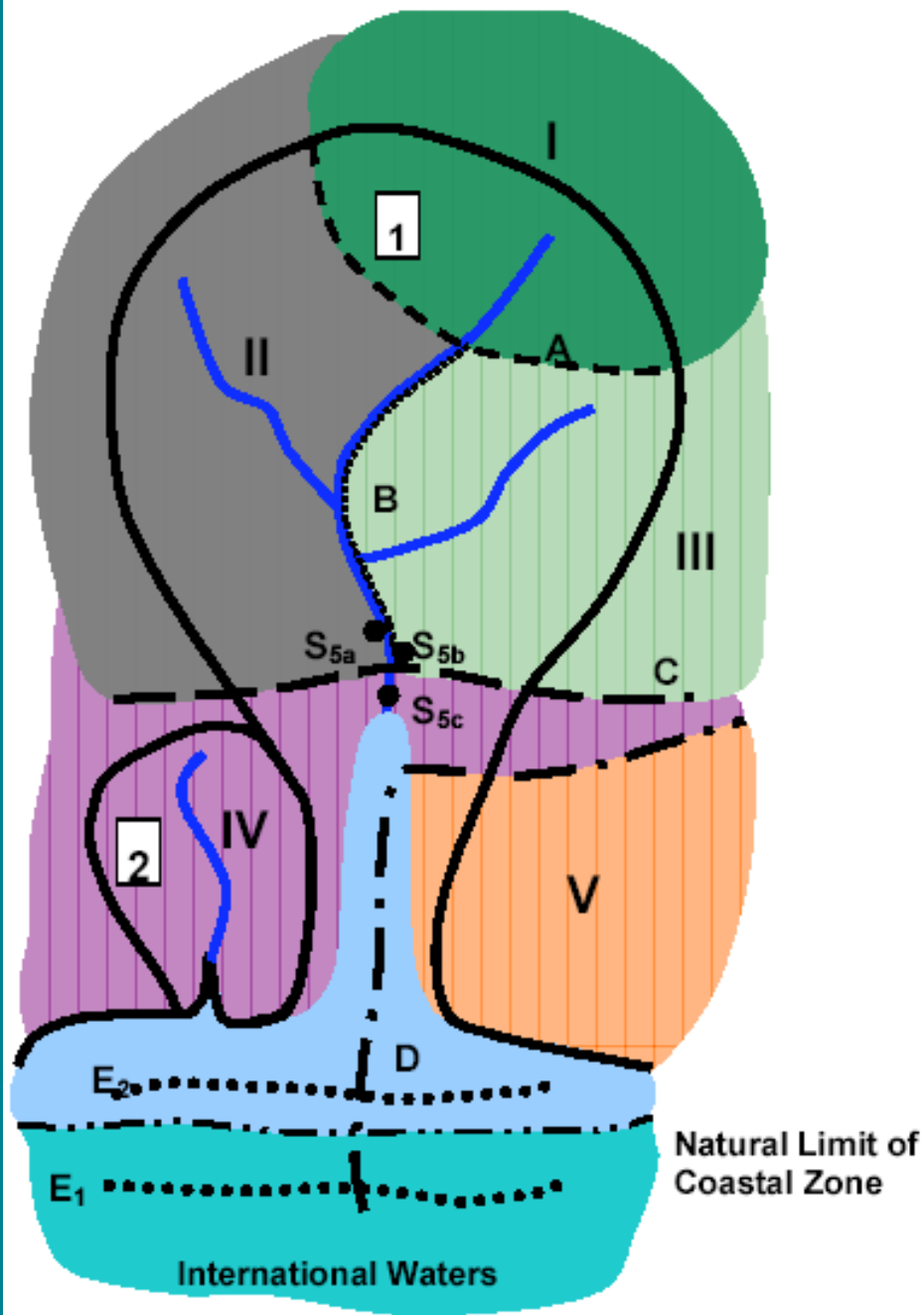
C: coincidence of river catchment control station (S5) with international boundary.

D: shared estuary between regions or countries.

Limits of international waters exclusive economic zone outside (E1) and (E2) the geomorphic limit of the coastal zone.

Political or administrative entities: I to V.

The smaller basin/coast entity (2) is entirely within IV.



after Meybeck & Vogler 2005

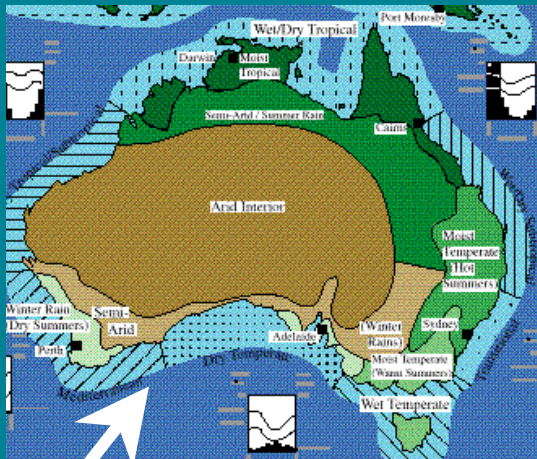


# Scales of Governance in light of current and future dimensions of Land and Sea use : 📍 Mississippi

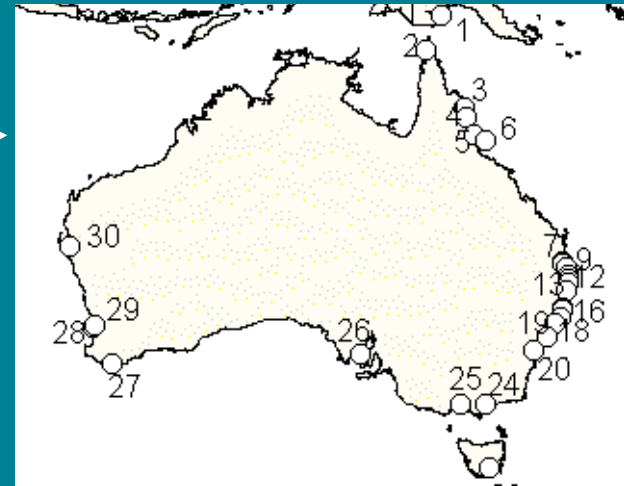




# LOICZ Cross-Cutting activities and Data issues



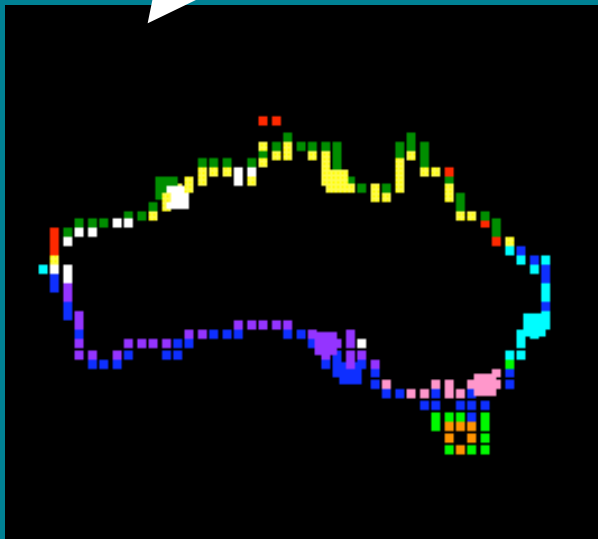
Expert typology



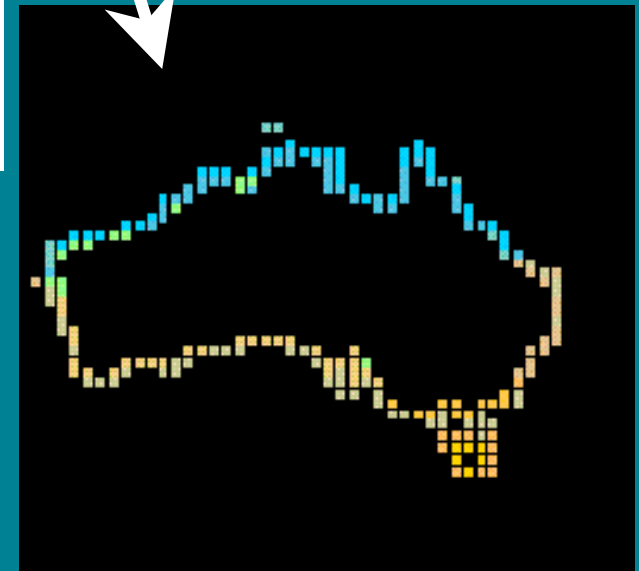
Budget Types

**"Calibration"**  
of clustering by  
expert judgment

Typology  
approaches for  
upscaling and  
classifying the  
coast - **human  
dimensions ?**



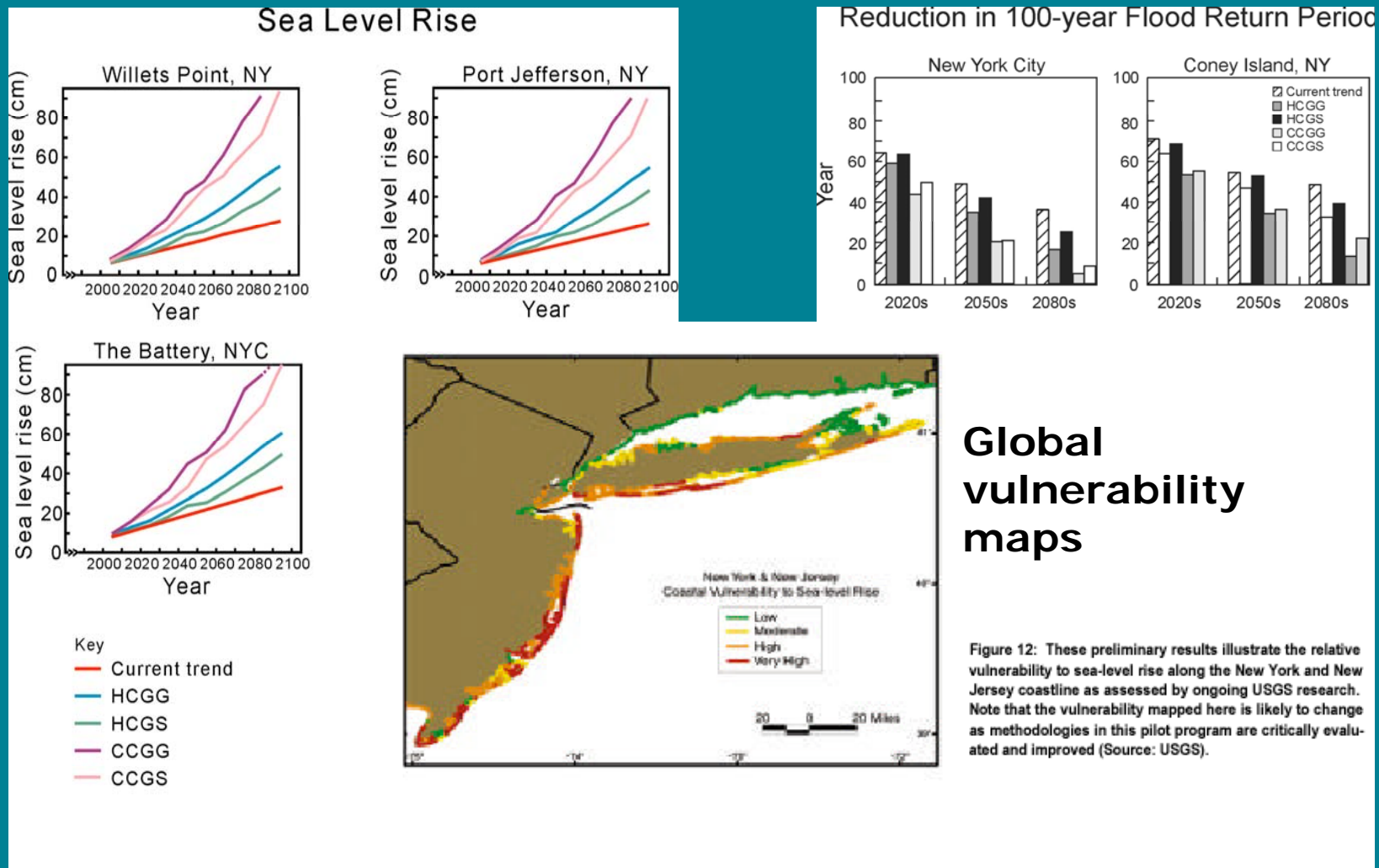
Alternative 1



Alternative 2

# Typologies for direct information here: Risk & Human Safety

need to be investigated to improve our understanding of vulnerability of society and ecosystems to global change hazards in the coastal zone including this direct disturbance, e.g., altered hydrology and sea level rise



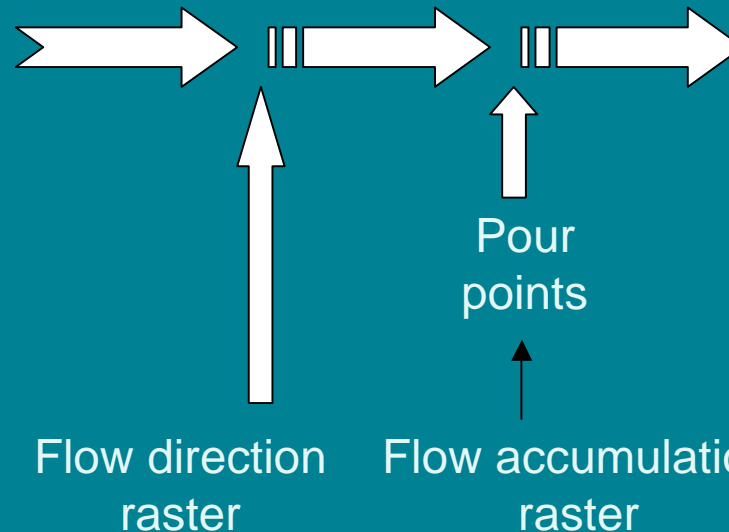
taken from Syvitski et al.



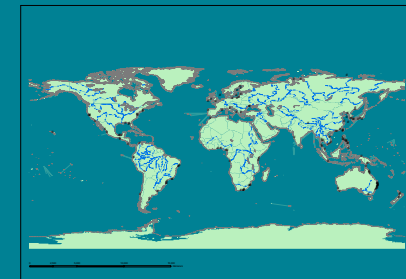


# Linking coastal biogeochemistry and ecosystem functions with land (catchment) based processes and drivers

LOICZ Sites  
watersheds



LOICZ Sites  
coastline segments  
estuaries



Delineating catchment areas affecting specific coastal sites:  
GIS based “cookie-cutters” for spatial, demographic and socio economic data;  
chances and problems (such as data gaps that lead to missing catchments)



## Data Needs

Uses

Classes

Subclasses



w/ direct  
(indirect)  
impact on

Fluxes of

Water

Nutrients

Sediment

(contaminants)

The same for preservation, alteration, or replacement of communities, ecosystems, land/seascapes.

A consistent set of use classes across land and water.

Clear conventions for multiple use classification.

- LOICZ to provide links to the socio ecological systems group, experiences and approaches,
- to the bgc modeling efforts (e.g. LaguNet), GNews,
- On site dataserer and typolgy database facility plus workplace for further assimilation and processing



# The Rational for a Delta Focus

- Understanding and modelling global change in the Anthropocene requires joined-up thinking between natural and human sciences across the **water-continuum**.
- Scanning the horizon so far demonstrates useful simulations of coupled socio-ecological systems are possible.
- In particular for **Deltas**, current human impact seems to be coupled to affluence (economic growth) and technology; this “picture needs” global evaluation
- Science needs to neutrally inform future ways to decouple economic growth from its impact.
- Deltas and boundary waters are “Society's Edge” which deserve our priority focus to inform **risk management and a discourse on adaptation**