The role of ecosystems in marine environments with a focus on dynamics, stability, indicators, evolution or how the dredging community should embrace the MSD

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Introduction

- It is very well known that the human impact has negative impacts on the marine and coastal habitats.
  - ➔ marine activities such as fishing, shipping, oil and gas exploration, sand and gravel extraction, mariculture and tourism
  - ➔ land-based activities such as agricultural and industrial production

- These activities lead to
- ➔ loss of species and populations,
- ➔ physical damage to marine habitats,
- ➔ nutrient and chemical pollution,
- ➔ littering of the sea,
- ➔ introduction of non-indigenous species,
- ➔ noise exposure.
- ➔ ……

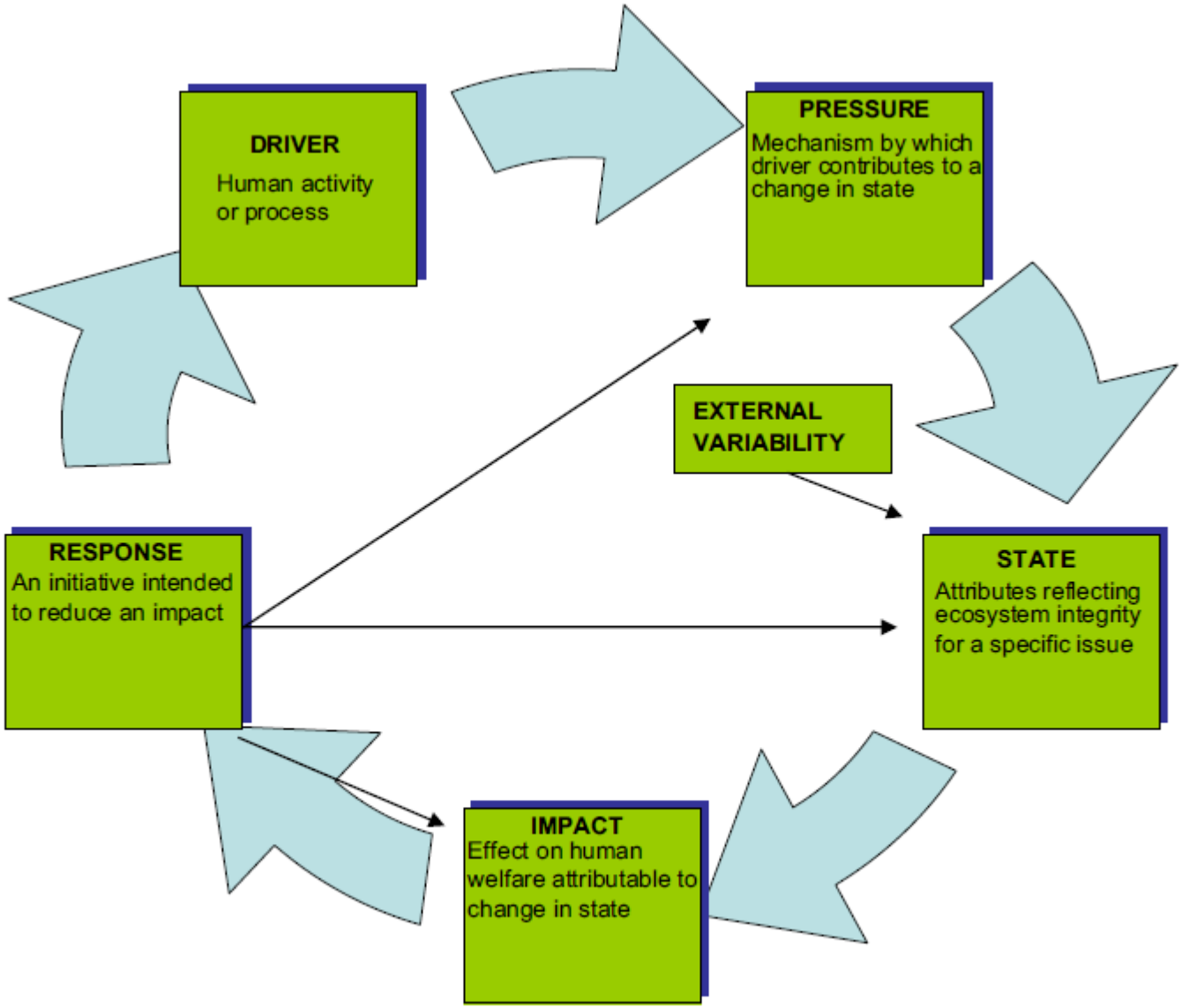


Fig. 1. *The DPSIR framework*: Human activities (drivers) exert pressures on the environment and so change the quality and quantity or state of the resources. Impacts are the measure of the effects on human welfare induced by state changes. Society then responds to these changes through economic and social policy. The loop is completed by these responses effecting future drivers and pressures. Adapted from Langmead et al. [44].

Curtin & Prezello Mar Pol 2010

Marine Strategy Directive

- On the basis of the initial assessment made pursuant to Article 8(1), Member States shall, in respect of each marine region or subregion, **establish a comprehensive set of environmental targets and associated indicators** for their marine waters so as to guide progress **towards achieving good environmental status** in the marine environment, taking into account the indicative lists of pressures and impacts set out in Table 2 of Annex III, and of characteristics set out in Annex IV.

Marine Strategy Directive

- Marine strategies shall apply **an ecosystem-based approach to the management of human activities**, ensuring that the collective pressure of such activities is kept within levels compatible with the achievement of good environmental status and that the capacity of marine ecosystems to respond to human-induced changes is not compromised, while **enabling the sustainable use of marine goods and services by present and future generations.**

- The Ecosystem based Approach could be described as ‘a comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity.’
  (ICES, 2005)

- **Descriptor 1:** Biological diversity is maintained
  - *Ecosystem level*
  - 1.7. Ecosystem structure
- **Descriptor 3:** Populations of all commercially exploited fish and shellfish are within safe biological limits

- **Descriptor 4:** All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.
  - 4.1. Productivity (production per unit biomass) of key species or trophic groups

Conclusion 1

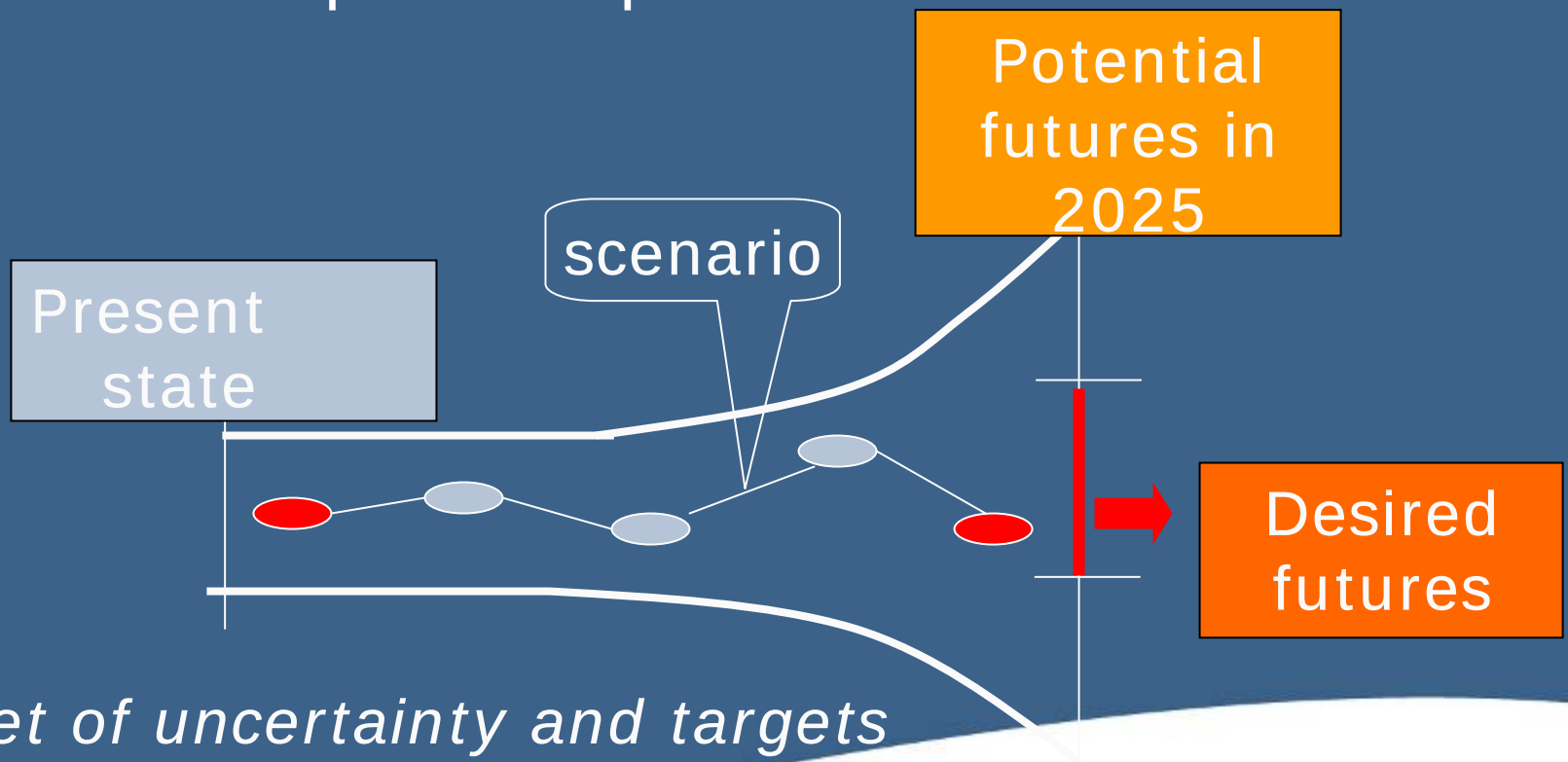
- Although the ecosystem approach clearly aims at maintaining and improving the delivery of ecosystem goods and services, these are not included in the list of indicators published last september!
- Very likely the MSD will not reach the so much needed integration and holistic approach unless we come to a complete paradigma shift.

Malawi principles for the ecosystem approach

- 1. Management should be based on **a shared Vision** and requires stakeholder engagement and participation;
- 2. Planning and management should be integrated, strategic, adaptive, and supported **by unambiguous objectives** and take a long-term perspective;
- 3. The geographic span of management should reflect ecological characteristics and **should enable management of the natural resources of both the marine and terrestrial components of the coastal zone**;
- 4. The management objectives should be consistent with the requirement for sustainable development and reflect societal choices. They should address the desired quality status of the structure and dynamic functions of the ecosystem;
- 5. Management should be based upon the precautionary principle, the polluter-pays principle, and the prevention principle. Best Available Technologies (BAT) and Best Environmental Practices (BEP) should be applied;
- 6. Management should be supported by coordinated programmes for monitoring, assessment, implementation, and enforcement and by peer-reviewed scientific research and advice and should make the best use of existing scientific knowledge.

What is a vision?

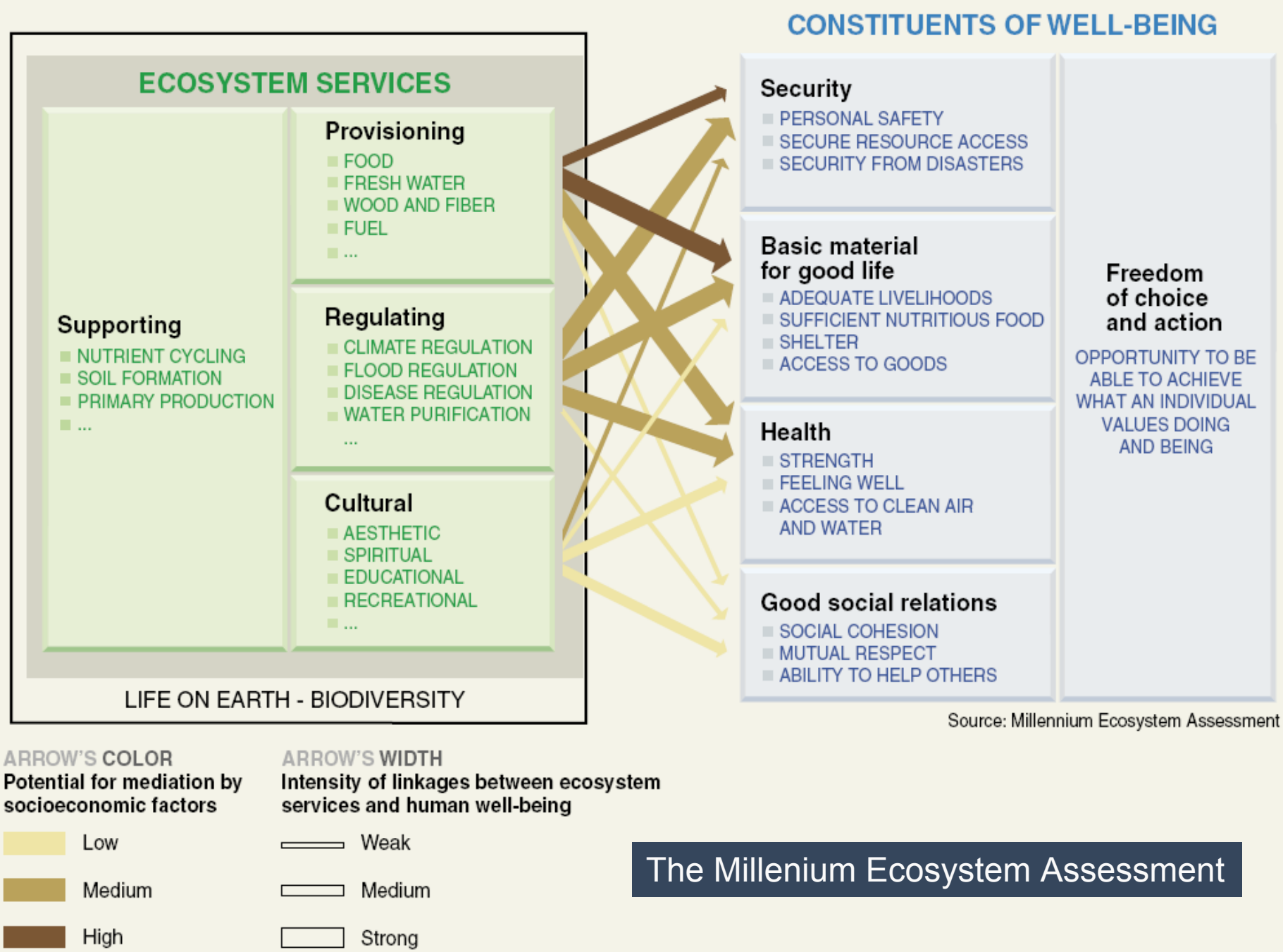
- It is not forecasting the future
- but assumptions of potential futures



Trumpet of uncertainty and targets (M.Meijer)

Ecosystem services: a common denominator for ecology and economy, a good basis for a vision?

- The concept of ecosystem services is not new, but two crucial steps were set the last decade:



Source: Millennium Ecosystem Assessment

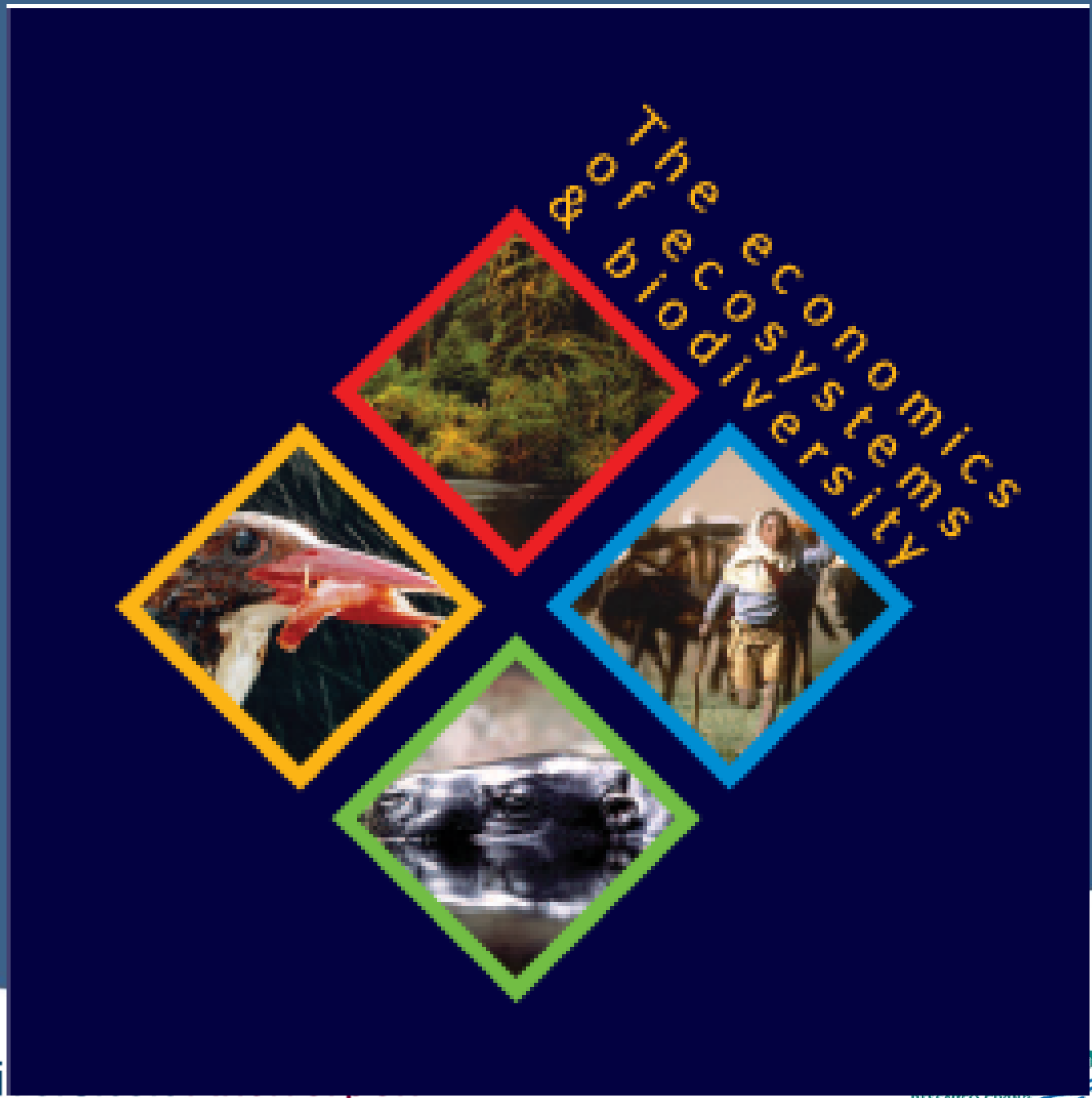
The Millenium Ecosystem Assessment

Ecological functioning versus Economy

"Goods and services"

(Costanza et al., Nature 1997)

Habitat	Value per ha ($/ha/j)	total value ($/j x 10^9)
Sea	577	20.949
Estuaries	22.832	4.110
Land	804	12.319
Forest	969	4.706
wetlands	14.875	4.879
Arable land	92	128
Total		33.268


The economics
of ecosystems
& biodiversity

- Ecosystem services are defined in TEEB as “the direct and indirect contributions of ecosystems to human well-being.” This basically follows the MA-definition except that it makes a finer distinction between services and benefits and explicitly acknowledges that services can benefit people in multiple and indirect ways

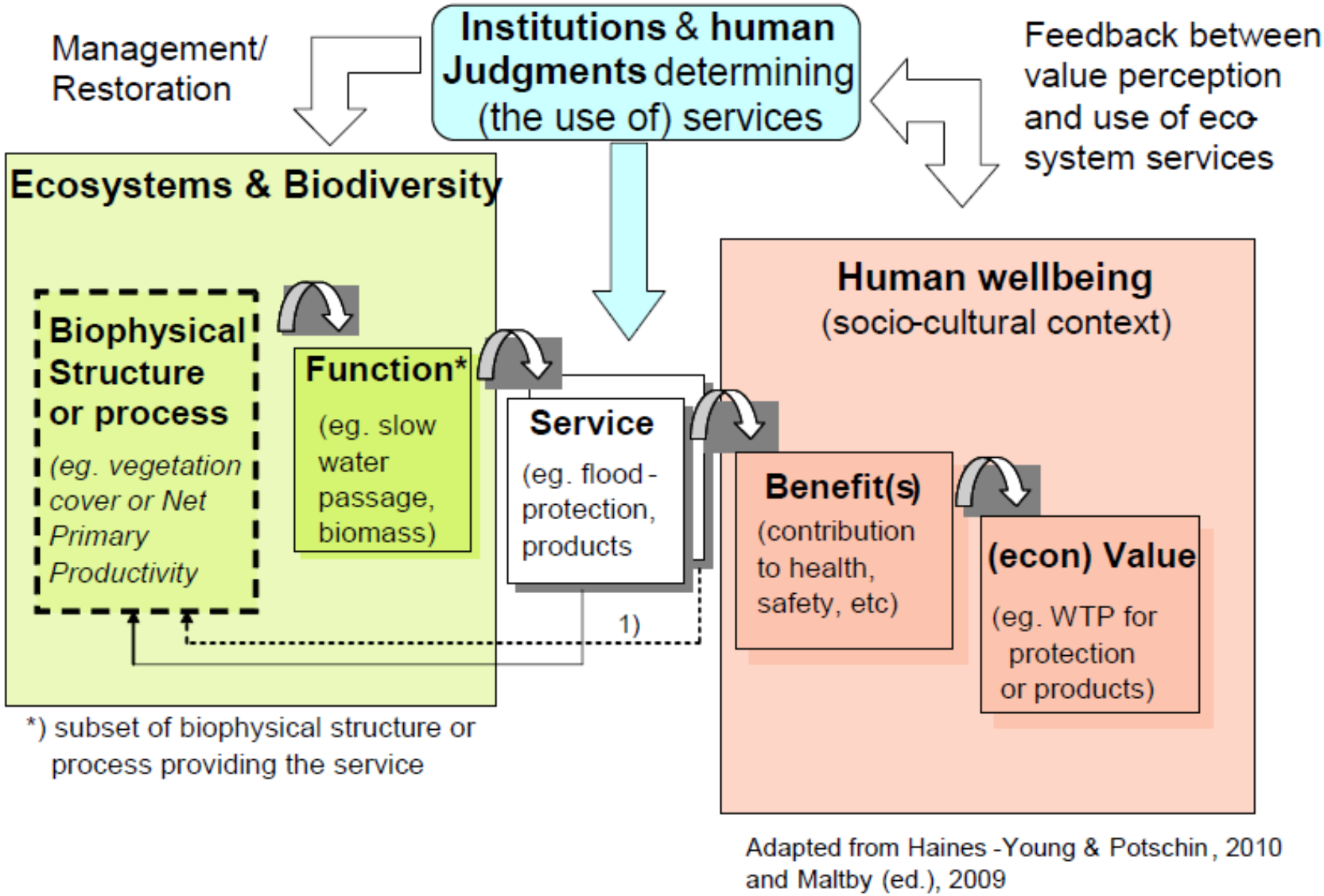


Figure 4: The pathway from ecosystem structure and processes to human well-being

	Main service types
	PROVISIONING SERVICES
1	**Food** (e.g. fish, game, fruit)
2	**Water** (e.g. for drinking, irrigation, cooling)
3	**Raw Materials** (e.g. fiber, timber, fuel wood, fodder, fertilizer)
4	**Genetic resources** (e.g. for crop-improvement and medicinal purposes)
5	**Medicinal resources** (e.g. biochemical products, models & test-organisms)
6	**Ornamental resources** (e.g. artisan work, décorative plants, pet animals, fashion)
	REGULATING SERVICES
7	**Air quality regulation** (e.g. capturing (fine)dust, chemicals, etc)
8	**Climate regulation** (incl. C-sequestration, influence of vegetation on rainfall, etc.)
9	**Moderation of extreme events** (eg. storm protection and flood prevention)
10	**Regulation of water flows** (e.g. natural drainage, irrigation and drought prevention)
11	**Waste treatment** (especially water purification)
12	**Erosion prevention**
13	**Maintenance of soil fertility** (incl. soil formation)
14	**Pollination**
15	**Biological control** (e.g. seed dispersal, pest and disease control)

	HABITAT SERVICES
16	**Maintenance of life cycles of migratory species** (incl. nursery service)
17	**Maintenance of genetic diversity** (especially in gene pool protection)
	CULTURAL & AMENITY SERVICES
18	**Aesthetic information**
19	**Opportunities for recreation & tourism**
20	**Inspiration for culture, art and design**
21	**Spiritual experience**
22	**Information for cognitive development**

Source: based on/adapted (mainly) from Costanza et al. (1997), De Groot et al. (2002), MA (2005a), Daily, Ehrlich, Mooney, et al. (2008). See Appendix 2 for details.

Measuring services

- Capacity of an ecosystem to provide a service
  - How much fish can an estuary provide on a sustainable basis
- Actual use of that service
  - Fish harvesting for food
- Valueing fish in terms of
  - Nurtition
  - Income
  - Way of life
  - ➔ Human value domain

Conclusion 2

- Ecosystem services are ideal as a common denominator and the vision could be formulated as:
- “maintaining and/or improving the delivery of ecosystem services in balance with the socio-economic development”

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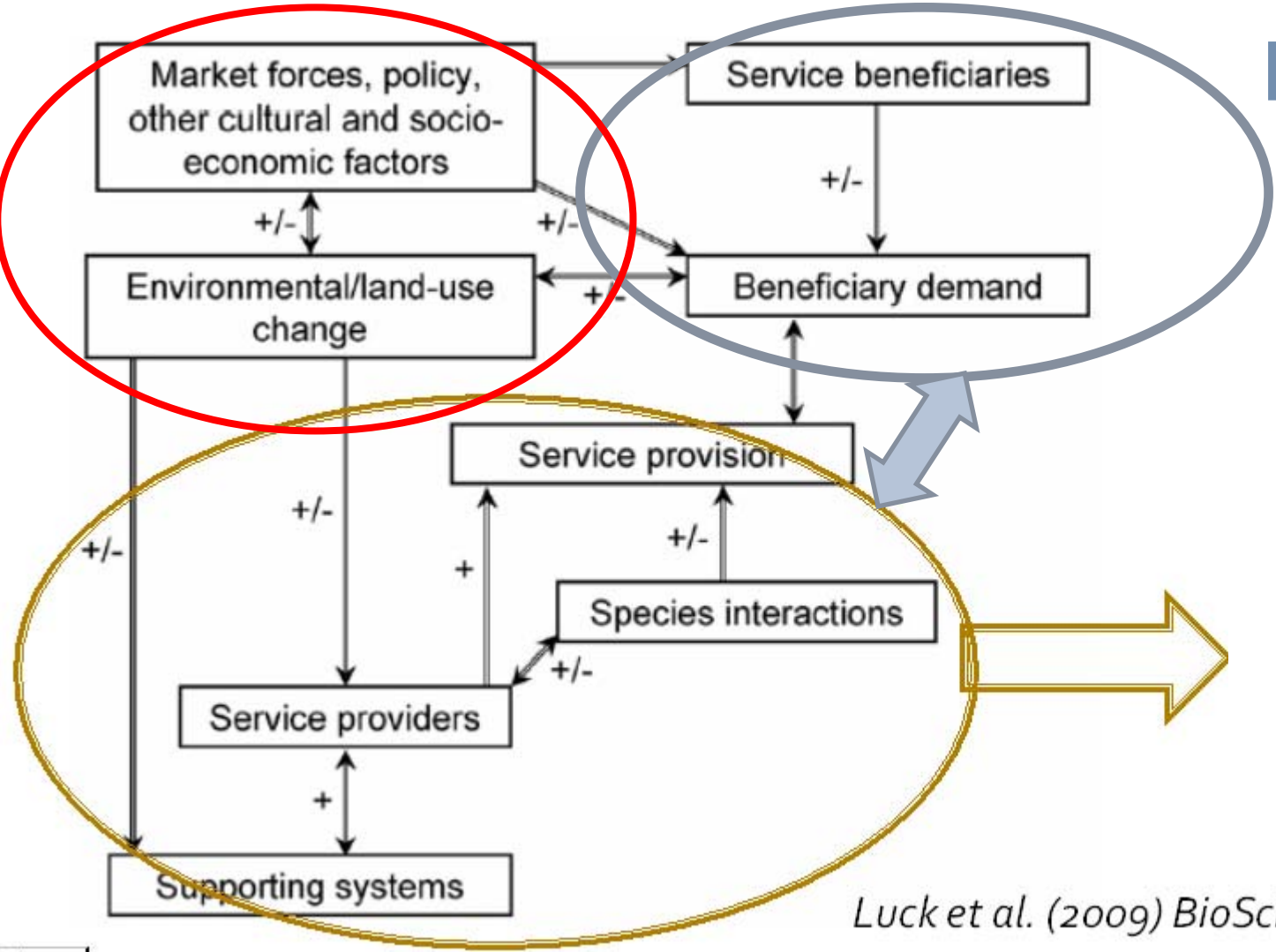

DEMAND

SUPPLY

Luck et al. (2009) BioScience 59: 223–235

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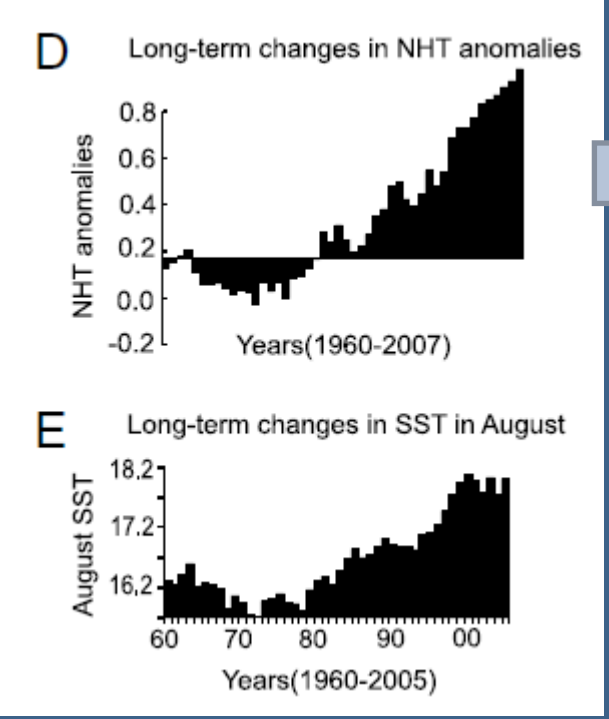
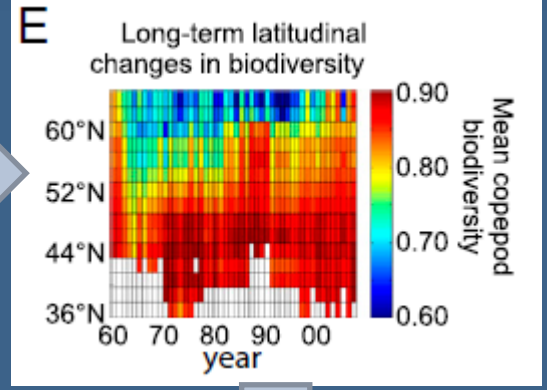
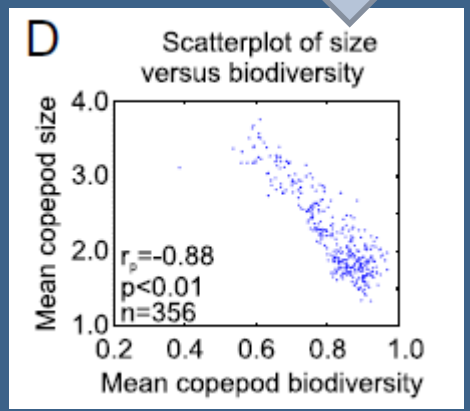
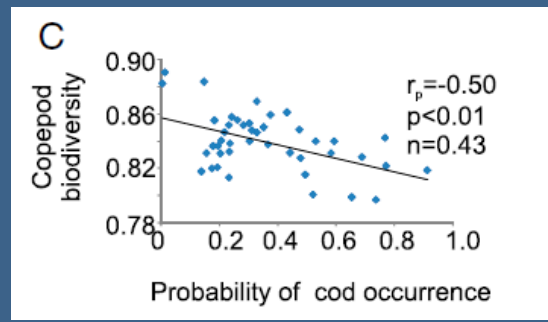
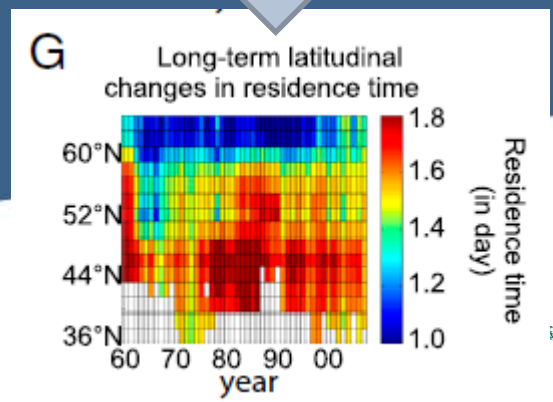
food











Beaugrand et al. PNAS 2010

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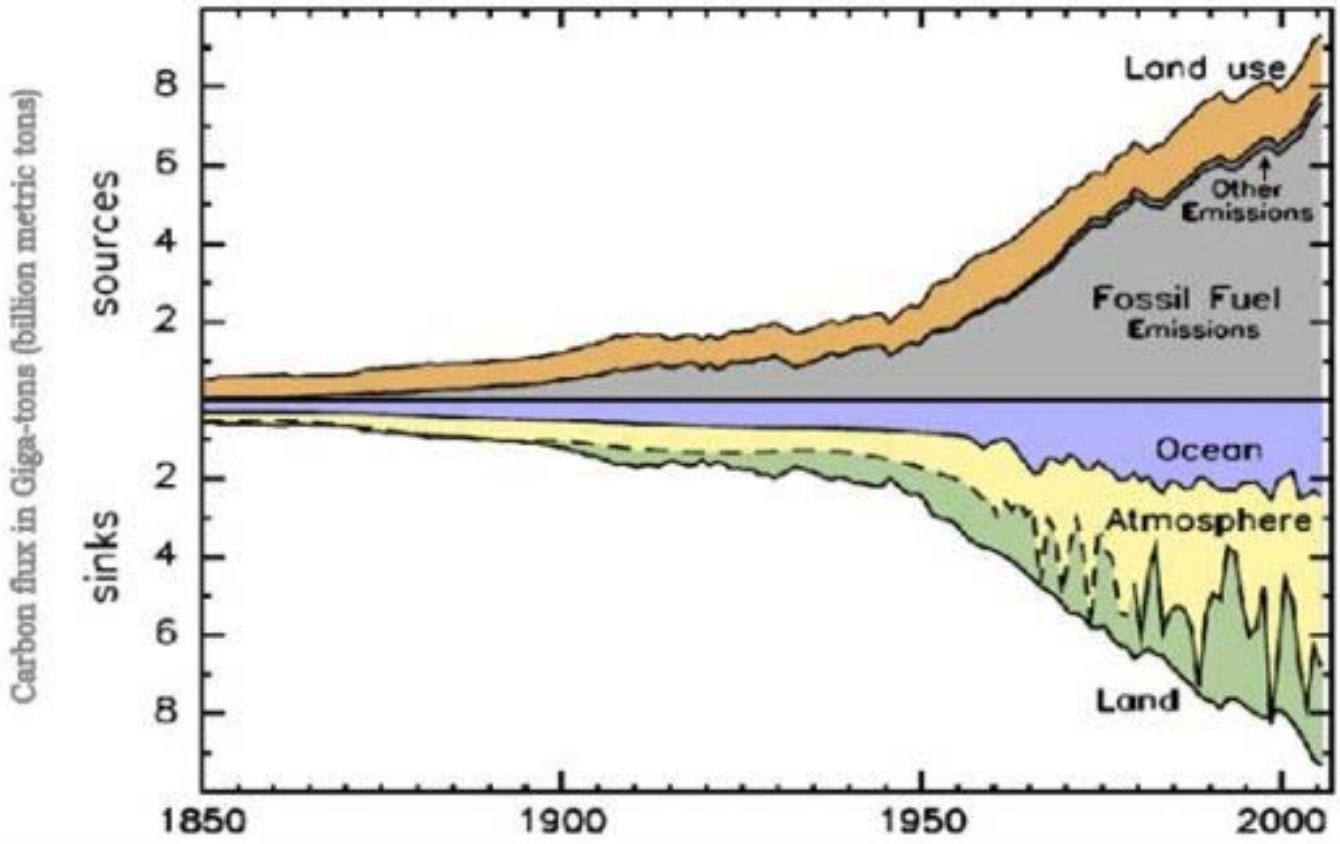
Quantification of the cumulative human perturbation of the global carbon cycle from 1850 through to 2006



Caption: this time-series representation depicts (a) the increasing scale of carbon emissions caused by human activities, and (b) the evolution of our Earth system's capacity to absorb emissions due to human activities, with specific delineation of the 3 active carbon sinks and their relative magnitude.

Image credit: University of East Anglia, United Kingdom

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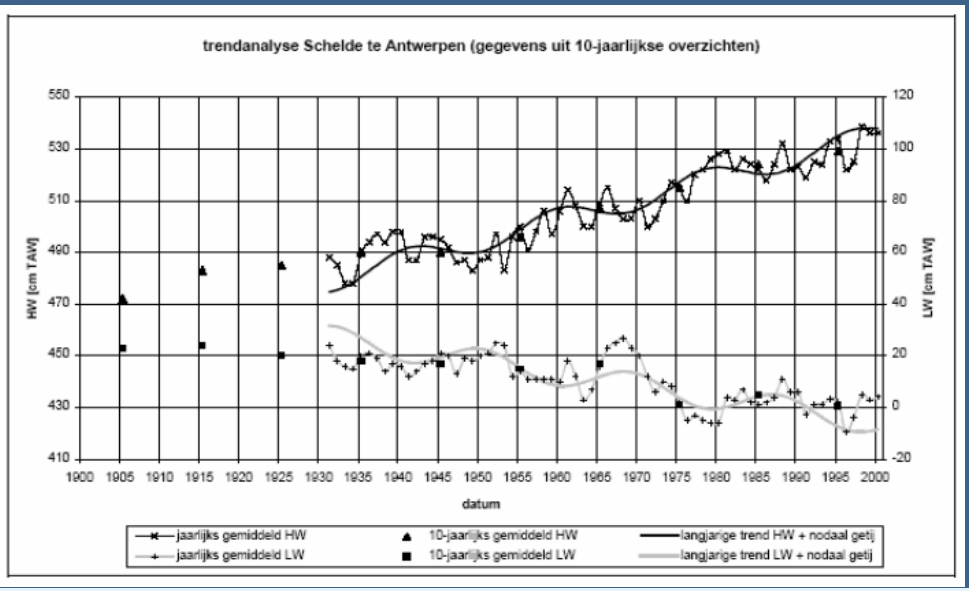
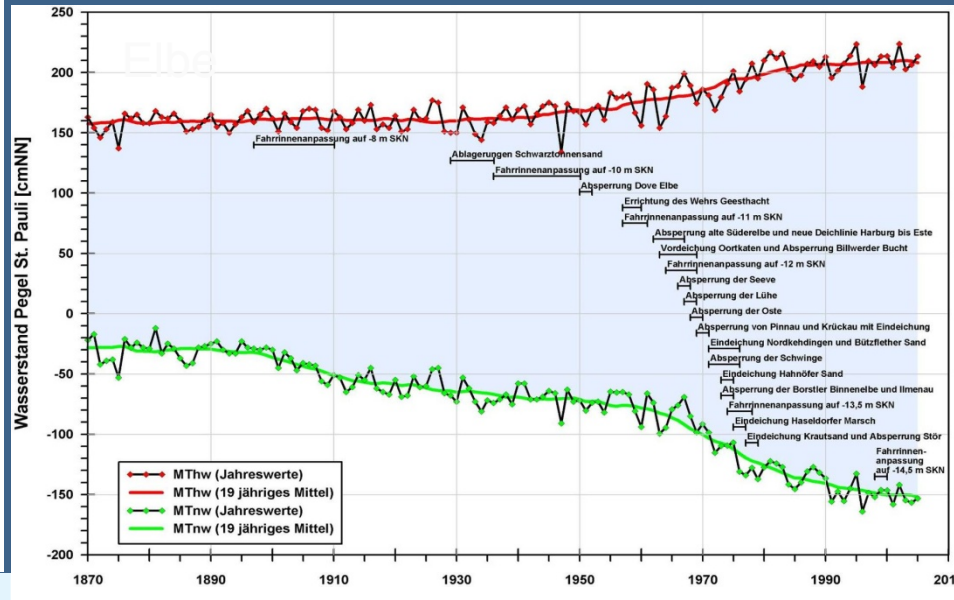
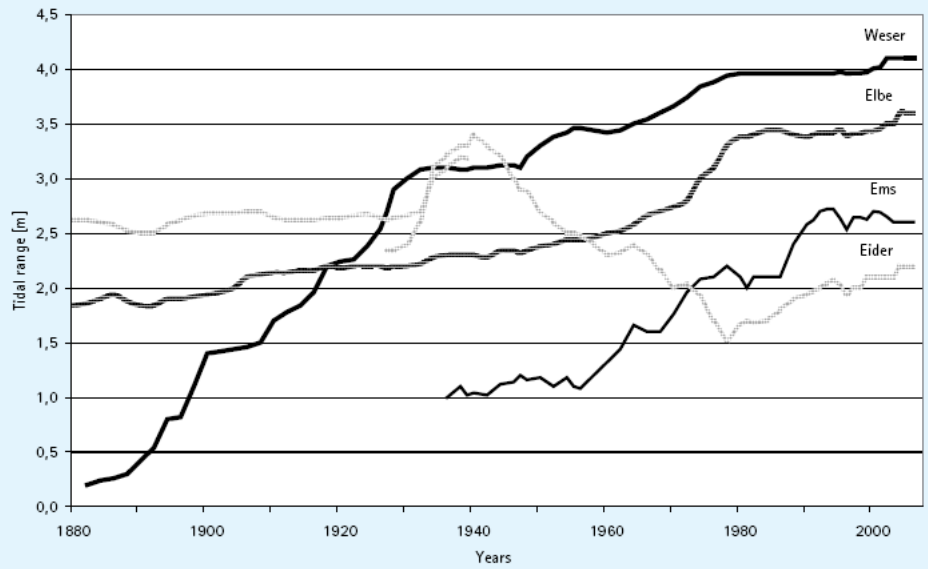
Univ

ECO SYSTEM MANAGEMENT RESEARCH GROUP

Tidal evolution







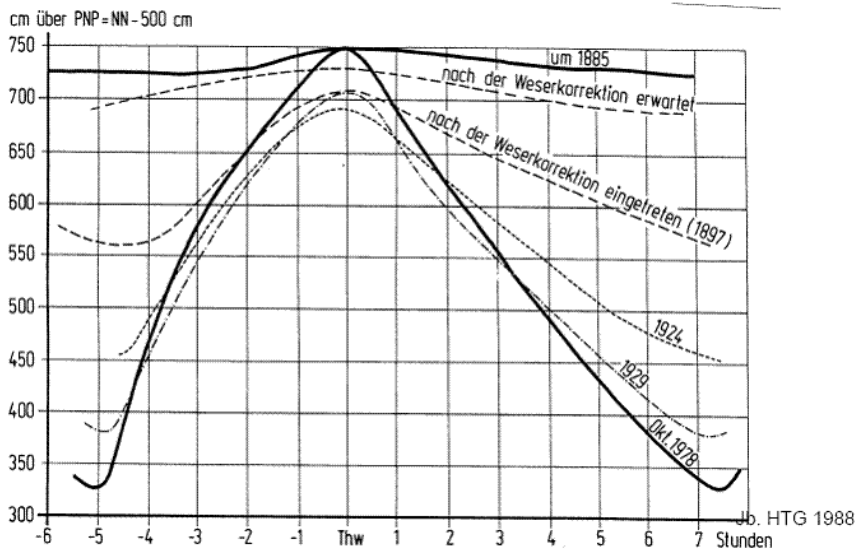
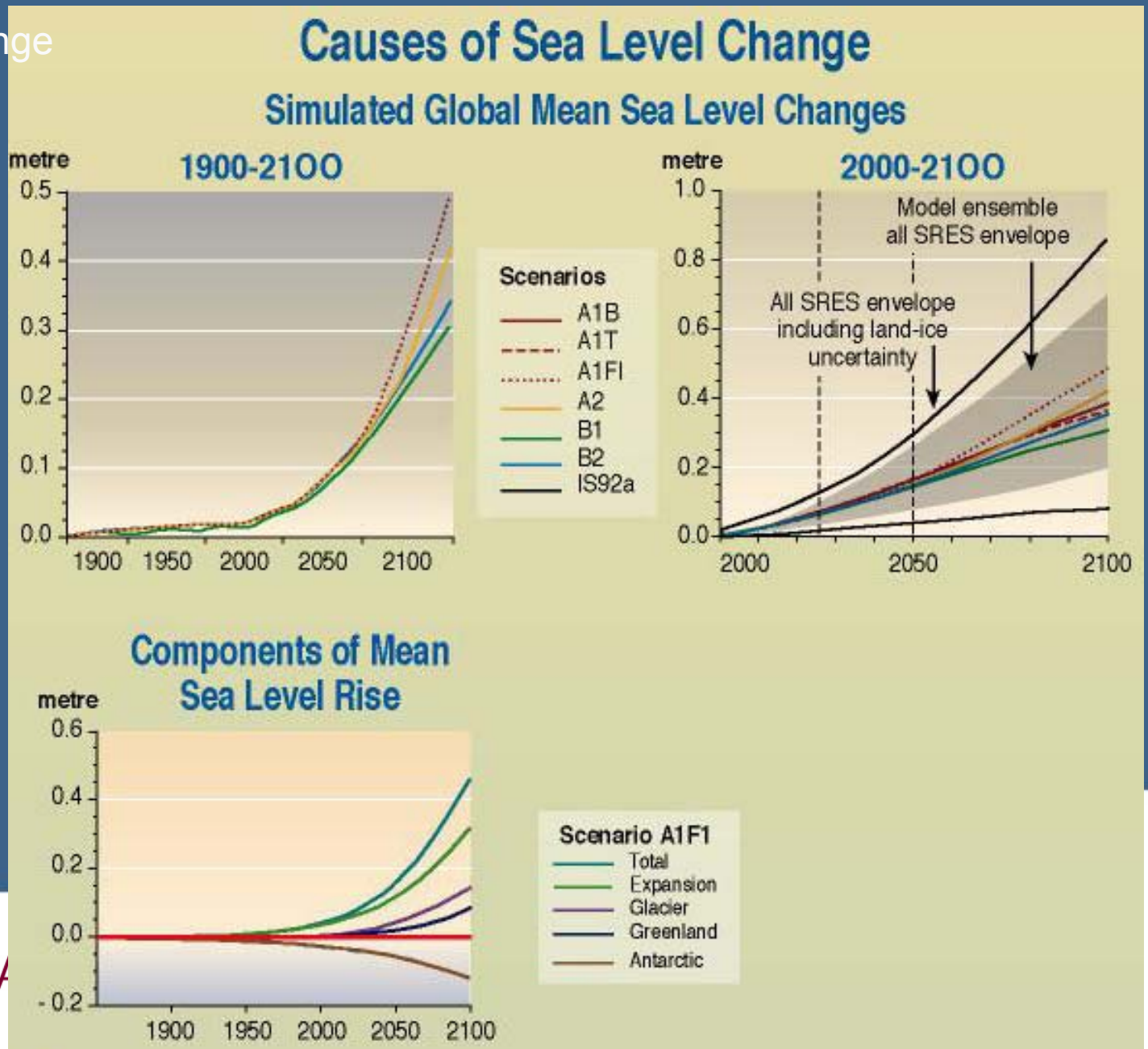
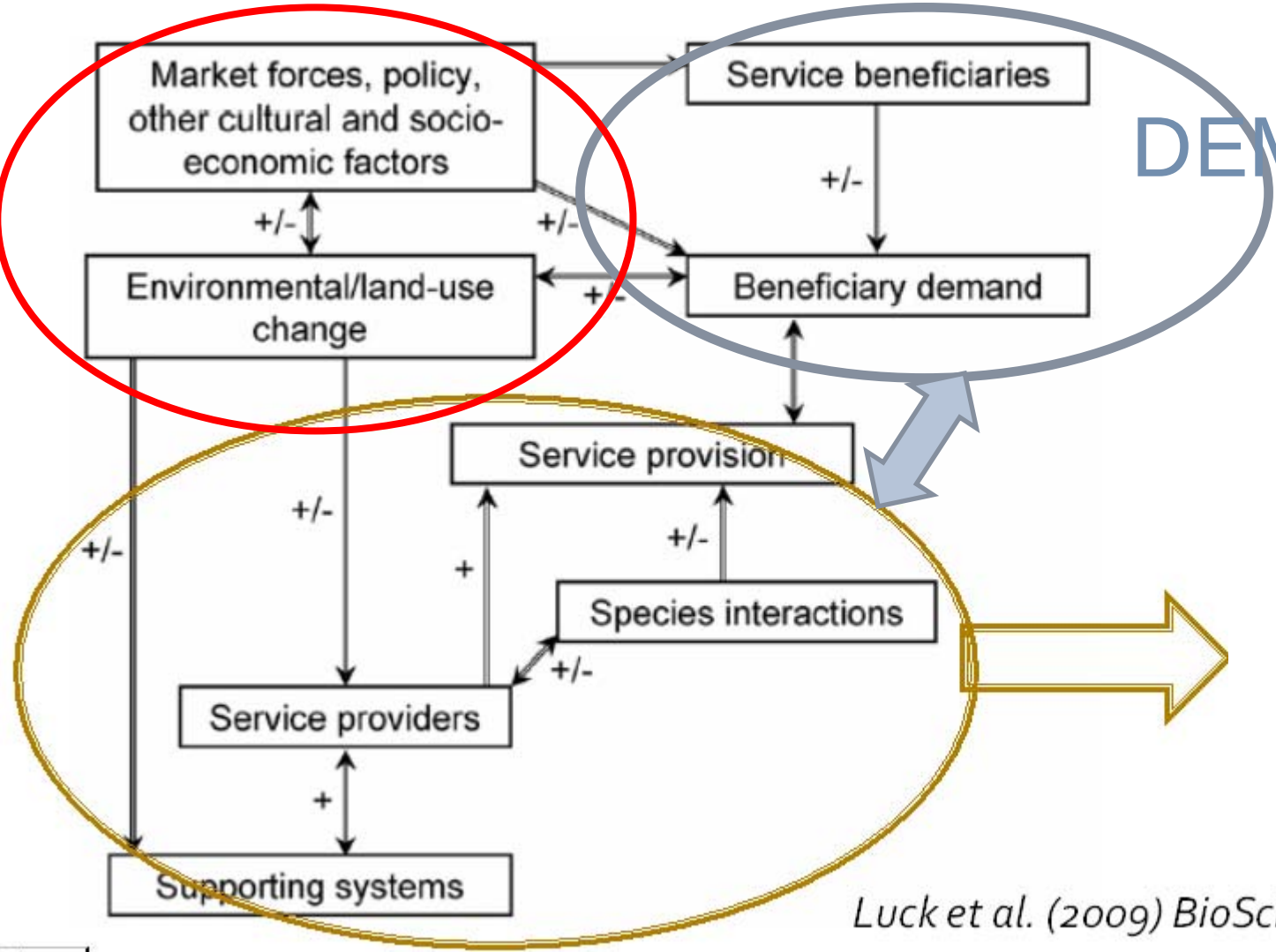


Abb. 8. Mittlere Tidekurven der Weser in Bremen nach den Unterweserausbauten

Sea level rise



UNEP, 2002 *www.unep.org, Bron: gegevens: Climate change 2001, Synthesis Reoprt, Conclusions of Working Groups I, II and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, 2001.*



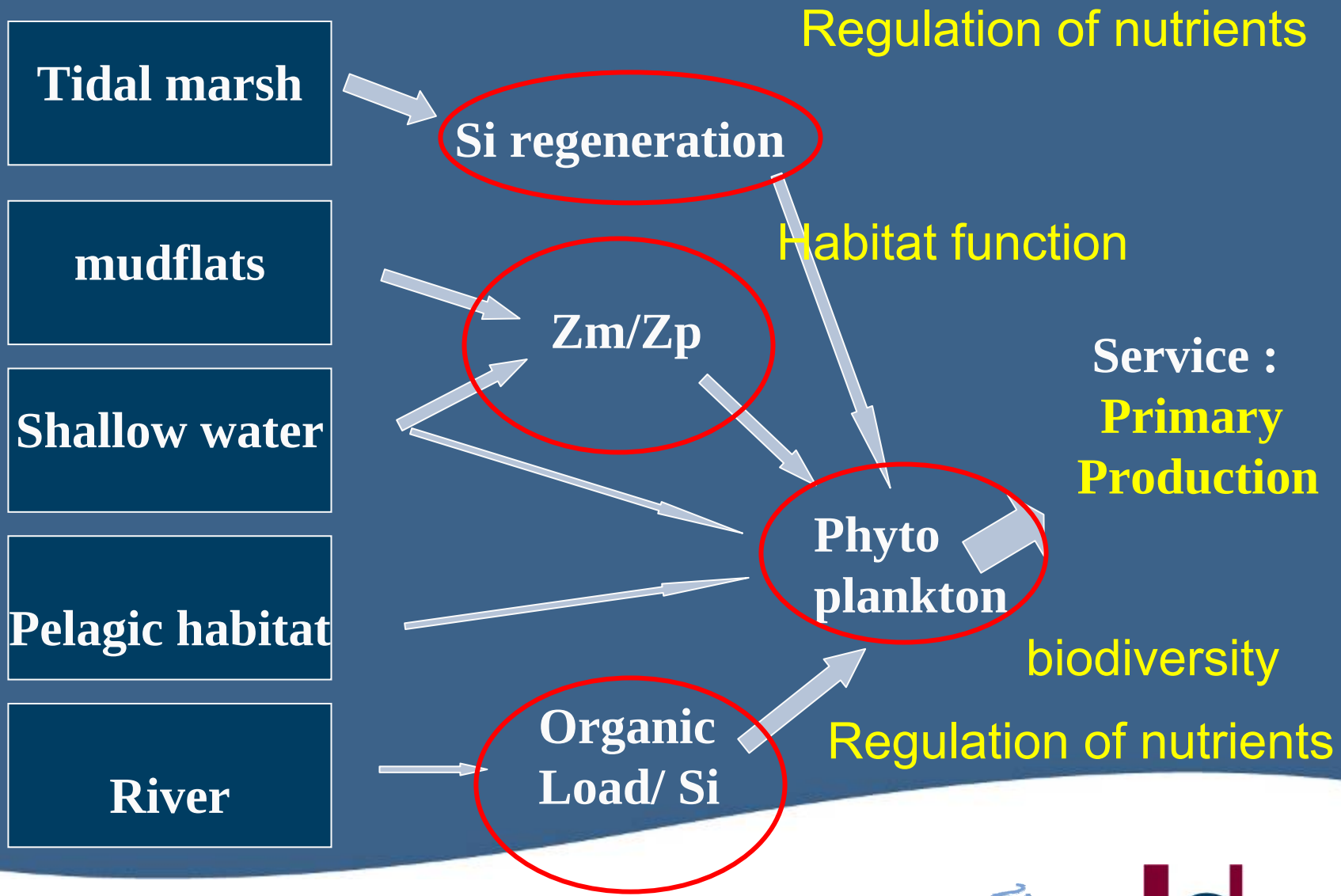
Luck et al. (2009) BioScience 59: 223–235

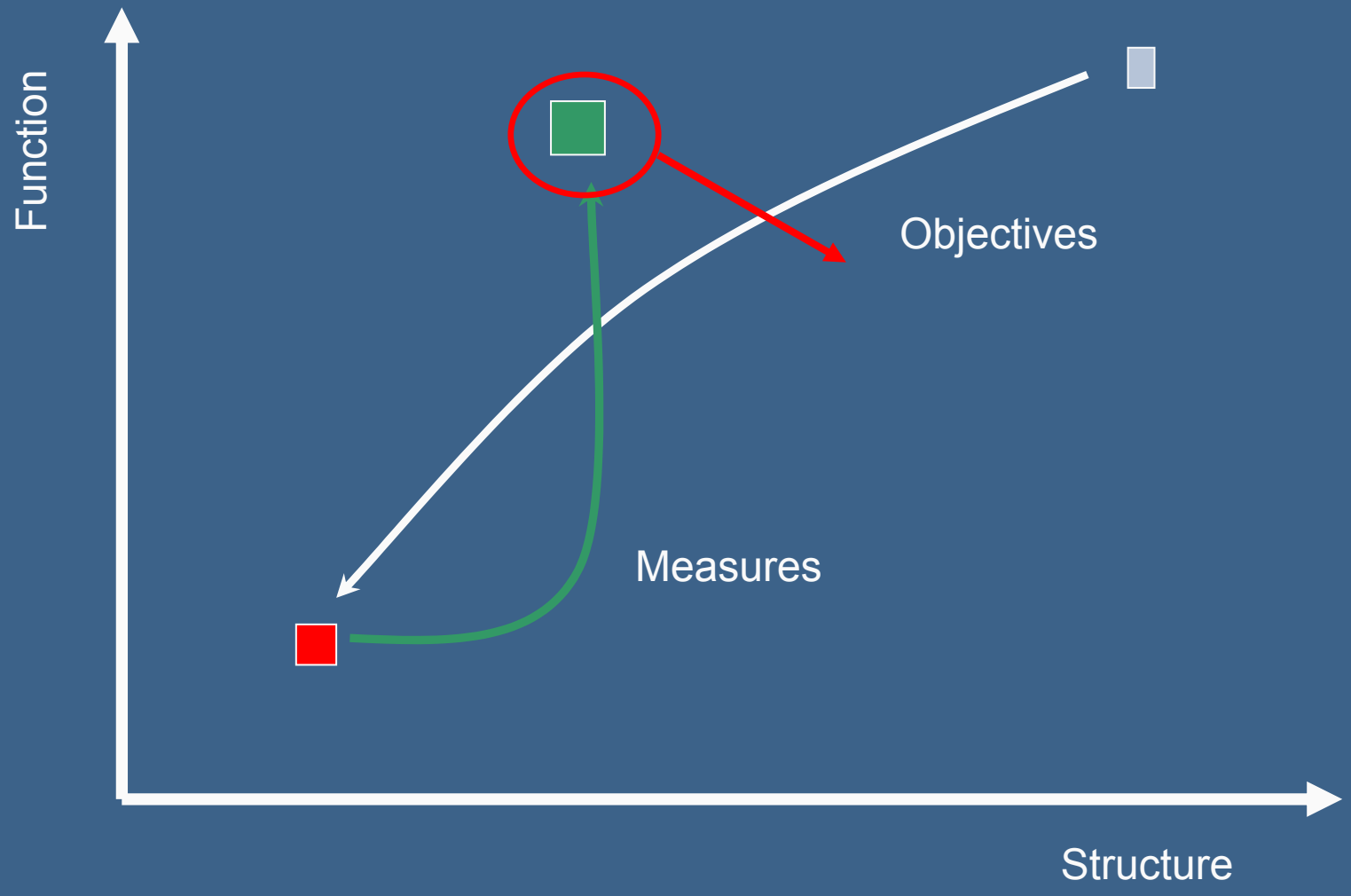
Conclusion 3

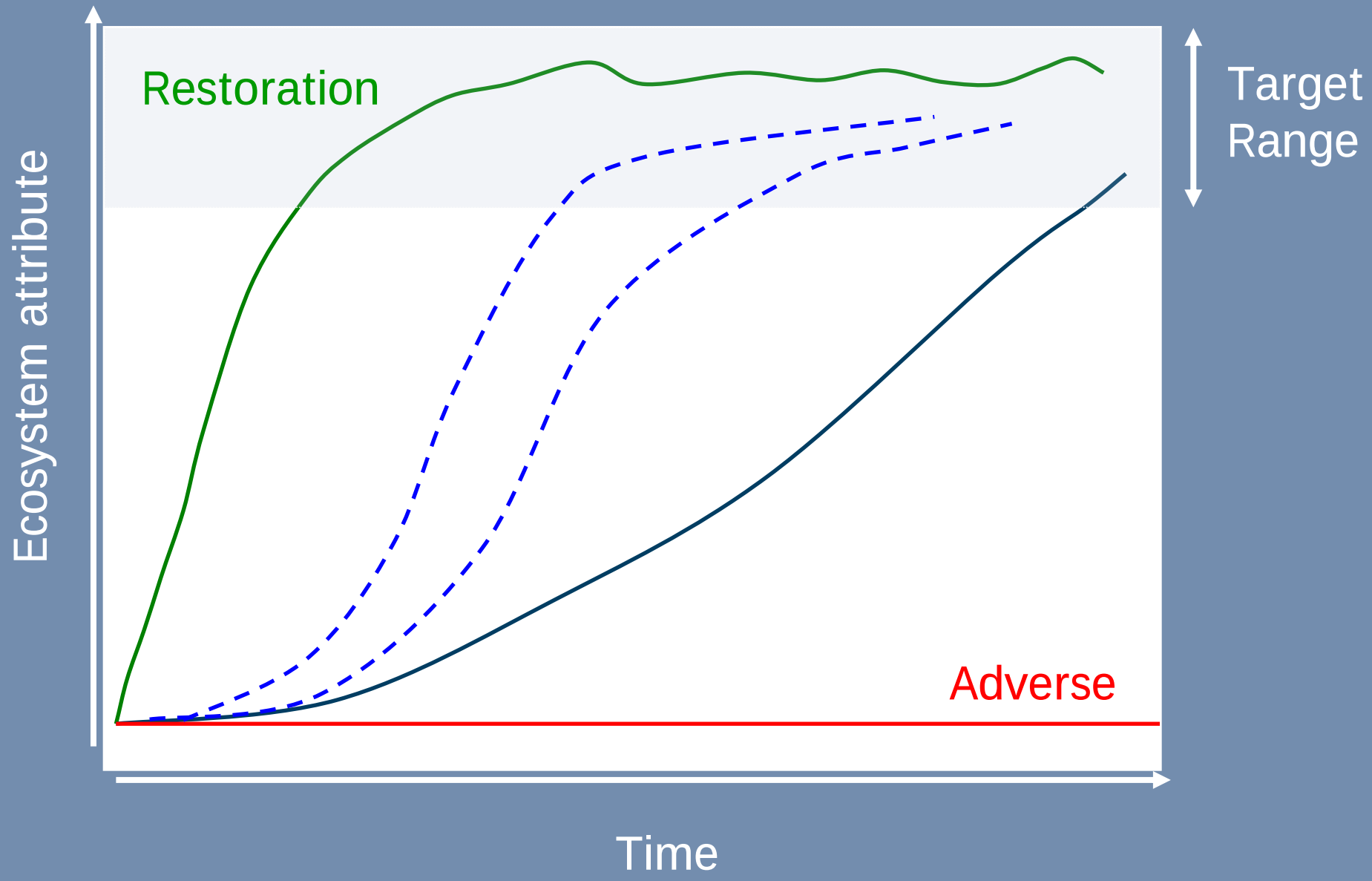
- Next to the many anthropogenic impacts climate change is likely to fundamentally impact the oceans and reduce the delivery of ecosystems services
- The “classical approach” of indicators describing the structural biodiversity are unlikely to catch these changes
- Indicators of ecosystem services are needed!
- Demand for services is growing and supply is declining
- Objectives for services should be formulated!

What to do?

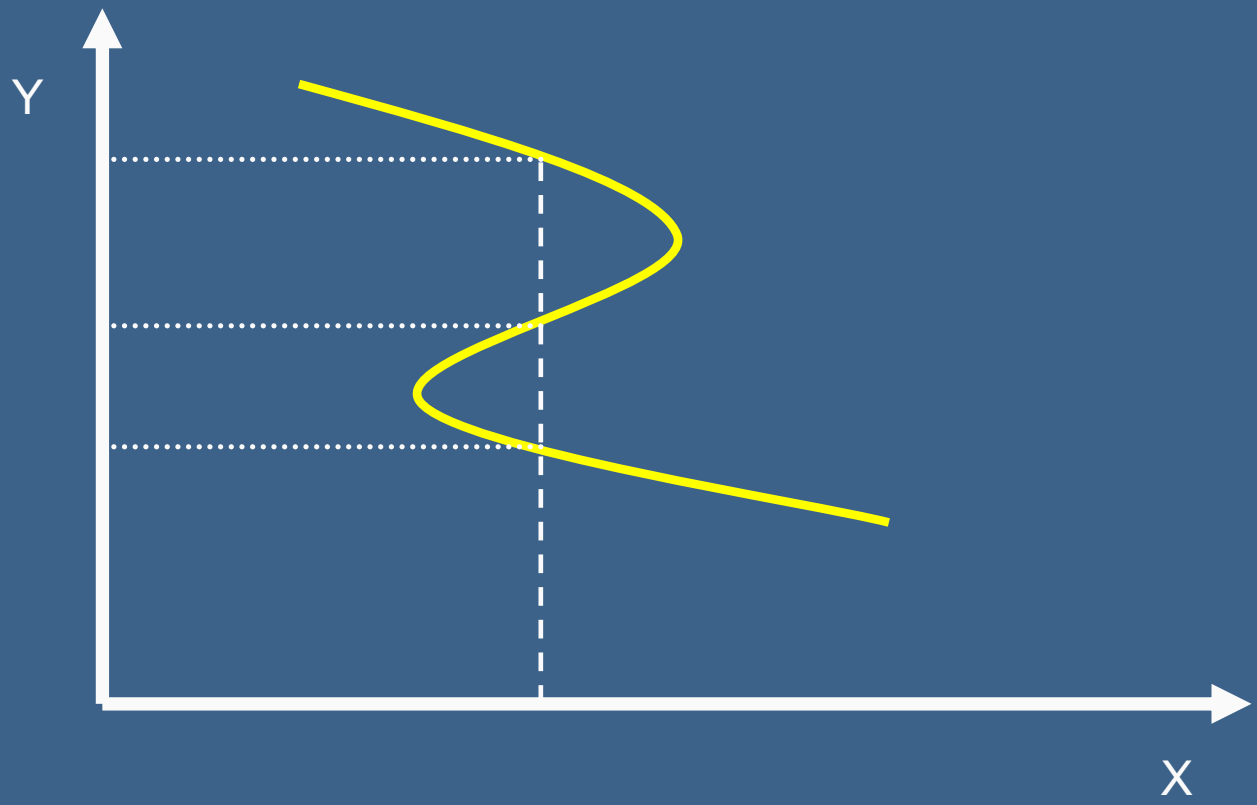
- Delivery of services is the result of a complex interaction between
  - Hydrodynamics
  - Morphology
  - Ecology
- A clear understanding of this interactions is required as this must be the basis for restoration measures and a guiding principle for new infrastructure and use

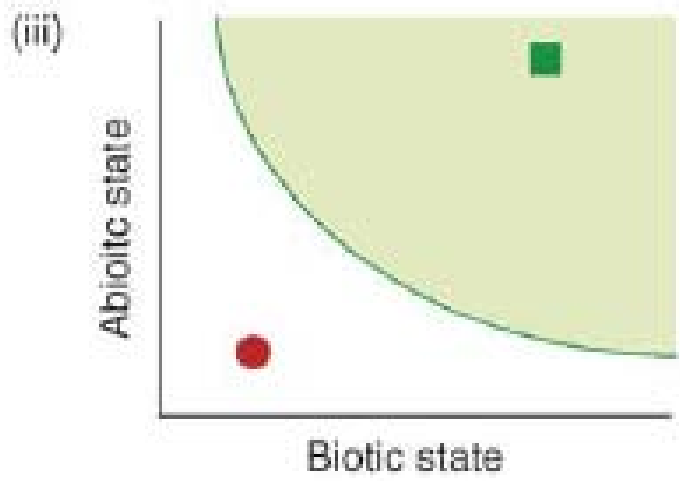

Regulation of nutrients
Tidal marsh
Si regeneration
mudflats
Habitat function
Zm/Zp
Service :
Primary
Production
Shallow water
Phyto
plankton
Pelagic habitat
biodiversity
Organic
Load/ Si
Regulation of nutrients
River

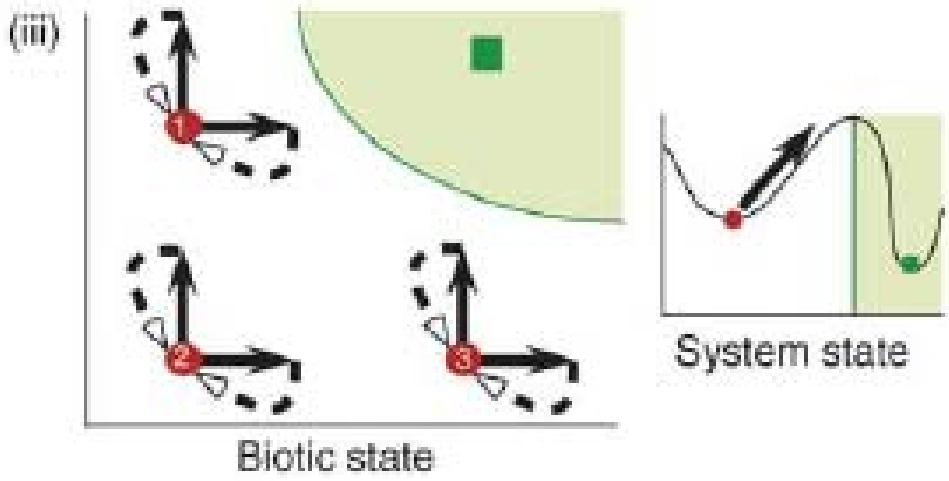

Function
Objectives
Measures
Structure

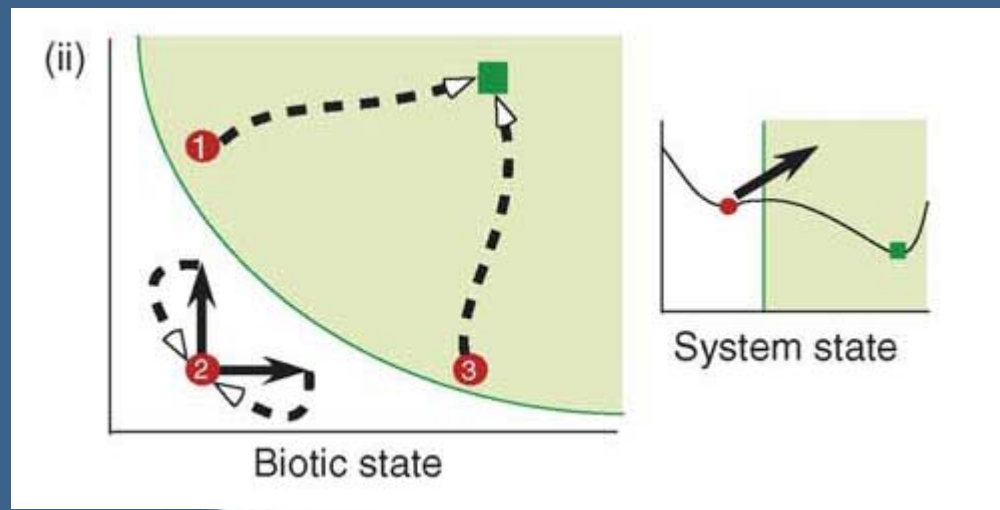

Restoration
Target
Range
Ecosystem attribute
Adverse
Time

Multiple stable states









Beyers et al. TREE 2006

Growing coastline

Eroding coastline

Afbeelding 3 van 4

er Simon Schot bedient de loskraan waarmee de wilde oesters door zijn bemanning in het ijzeren werk verdeeld worden.

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Tern island in the harbour of Zeebrugge

Bird nesting/resting island in the Seine

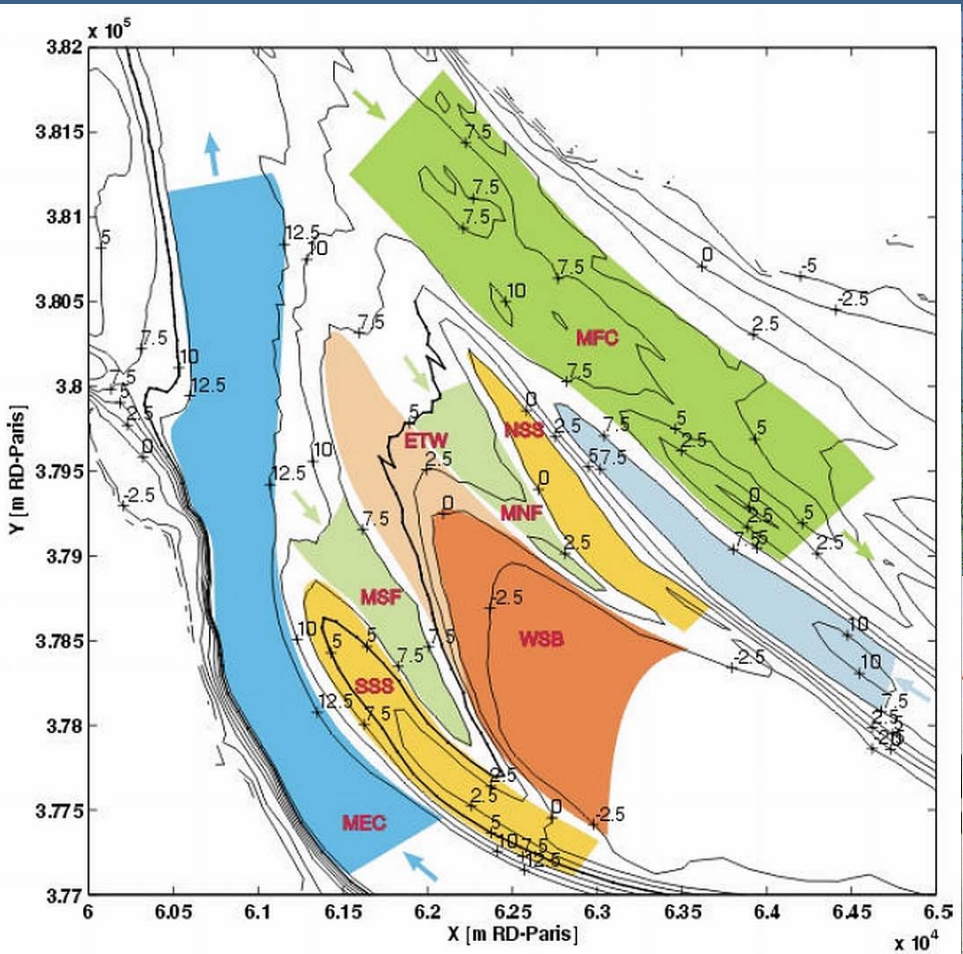
Scharhorn

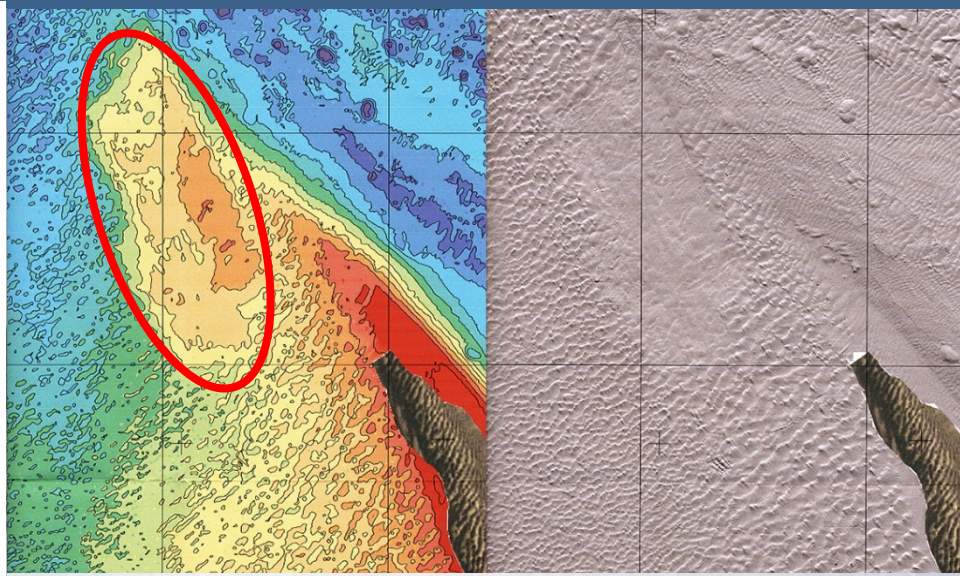
Nigehorn

ECOSYSTEM MANAGEMENT RESEARCH GROUP

Sand motor against coastal erosion

“habitat maintenance”





- Sandbar under flood flow attack (WSB)
- Main ebb channel (MEC)
- Main flood channel (MFC)
- Strong ebb flow in flood channel
- Minor flood channel (MNF & MSF)
- Sand spit (NSS & SSS)

+ Depth contours in meters TAW

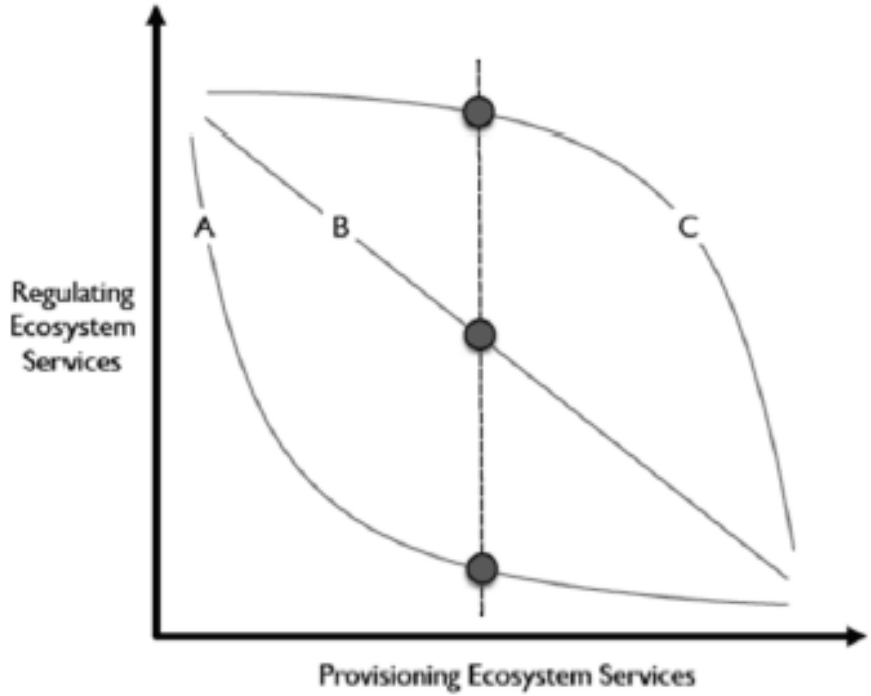
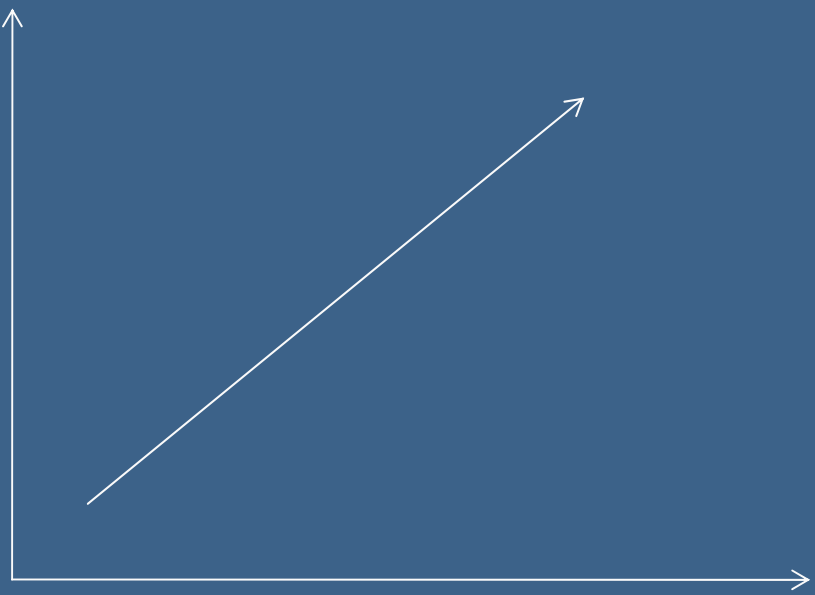


Figure 4: **Potential trade-offs between provisioning services and regulating ecosystem services.** A) Shifting an ecosystem to an increase in provisioning services produces a rapid loss of regulating services, B) regulating services linearly decrease with increases in provisioning services, and C) provisioning services can increase to quite high levels before regulating services decline. Source: Elmqvist et al. (2010).

Regulating service

Moderation of extreme events



Provisioning service
(fish population)

CONCLUSION

- Ecosystem services can change significantly the course of events and stimulates innovation in policy and management.



The keys to implementation involve recognition of:

- Biodiversity as both the driver and the insurance policy
- Multiple ecosystem services of habitat/sites
- Role of the wider landscape scale and spatial arrangements
  - Go beyond the traditional network of protected sites
  - Deal with issues of trade offs among services and potential beneficiaries

Major new developments can improve implementation

- Opportunities in current environmental legislation
  - > Marine strategy directive
  - > habitat and bird directive, …
  - >Water framework directive,…..
  - > but:
    - need for more interpretation guidelines ,
    - research needs
- Need to mainstream alongside the environmental impact assessment to the wider policy framework

Conclusion

- ES represent a significant paradigm shift in how we view our natural resources.
- The moment is right for strengthening the collaboration between the scientific community, policy makers, companies and the general public to deliver the benefits that can emerge from this new approach
- Integration is the key issue for both science and policy

THE CORPORATE ECOSYSTEM SERVICES REVIEW

Guidelines for Identifying Business Risks and Opportunities Arising from Ecosystem Change

Version 1.0

World Business Council for Sustainable Development

Meridian Institute

WORLD RESOURCES INSTITUTE

Steps in a corporate ecosystem services review

Step	1. Select the scope	2. Identify priority ecosystem services	3. Analyze trends in priority services	4. Identify business risks and opportunities	5. Develop strategies
Key activity	Choose boundary within which to conduct ESR • Business unit • Product • Market • Landholdings • Customer • Supplier	Systematically evaluate degree of company's dependence and impact on ecosystem services Determine highest "priority" services—those most relevant to business performance	Evaluate conditions and trends in priority ecosystem services, as well as drivers of these trends	Identify and evaluate business risks and opportunities that might arise due to the trends in priority ecosystem services	Outline and prioritize strategies for managing the risks and opportunities

Step 2. Identifying priority ecosystem services

Key

- ● High
- ○ Medium
- Low
- \+ Positive impact
- \- Negative impact
- ? Don't know

Ecosystem services	Suppliers		Company operations		Customers	
	Dependence	Impact	Dependence	Impact	Dependence	Impact
Provisioning						
Crops				○ -		
Livestock				● -		
Capture fisheries						
Aquaculture						
Wild foods				○ +		
Timber and other wood fibers				● +		
Other fibers (e.g., cotton, hemp, silk)						
Biomass fuel			○	● +		
Fresh water			●	● -		
Genetic resources			○	○ ?		
Biochemicals, natural medicines, and pharmaceuticals				○ +		
Regulating						
Air quality regulation				? ?		
Global climate regulation			○	● +		
Regional/local climate regulation			○	○ +		
Water regulation			●	● -		
Erosion regulation			○	○ -		
Water purification and waste treatment				○ -		
Disease regulation						
Pest regulation						
Pollination						
Natural hazard regulation						
Cultural						
Recreation and ecotourism				● +		
Ethical values				○ +		

The Marine Strategy Directive:
An opportunity for the dredging companies to develop New strategies on the way to a sustainable development