How can science inform the pathway toward more harmonized environmentally safe and sustainable solutions?

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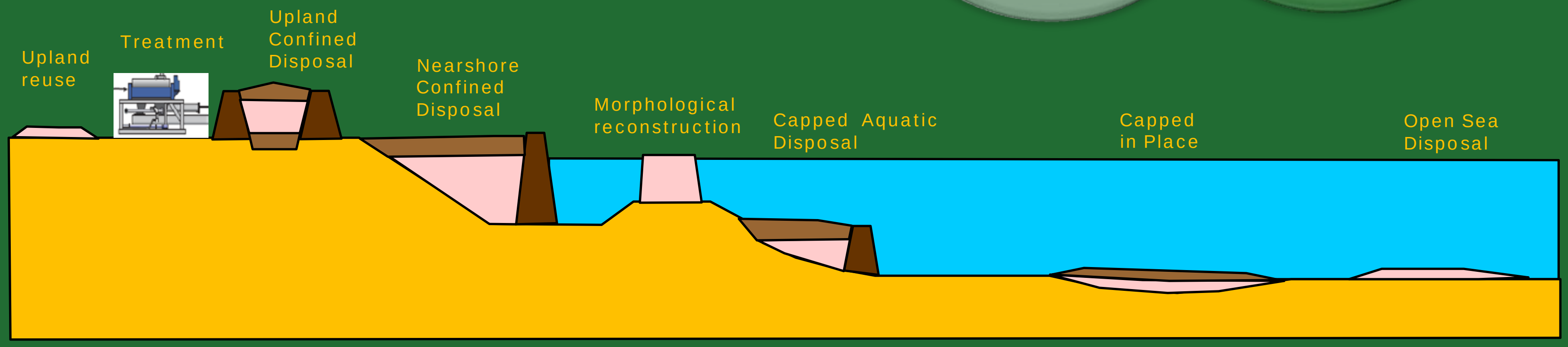
Dredged Sediment Management

A (relatively) simple problem that requires advanced solutions, to avoid environmental risks, maximize benefits and be sustainable

Combining social, economical and environmental criteria to produce sound decisions is in fact a challenging issue



Key aspects for safe & sustainable solutions

Environmentally safe

No / Acceptable Risk

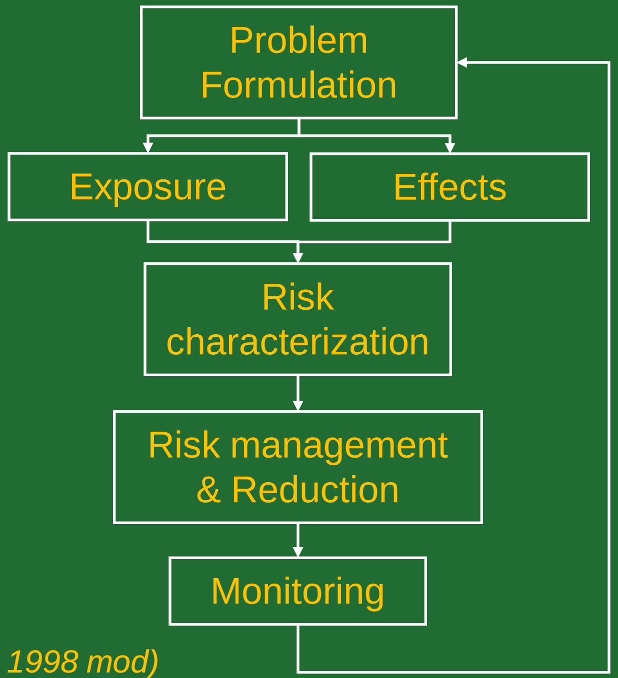
Systemic / Holistic approach

Sustainable

Sediment as a Resource (Reuse of DM)

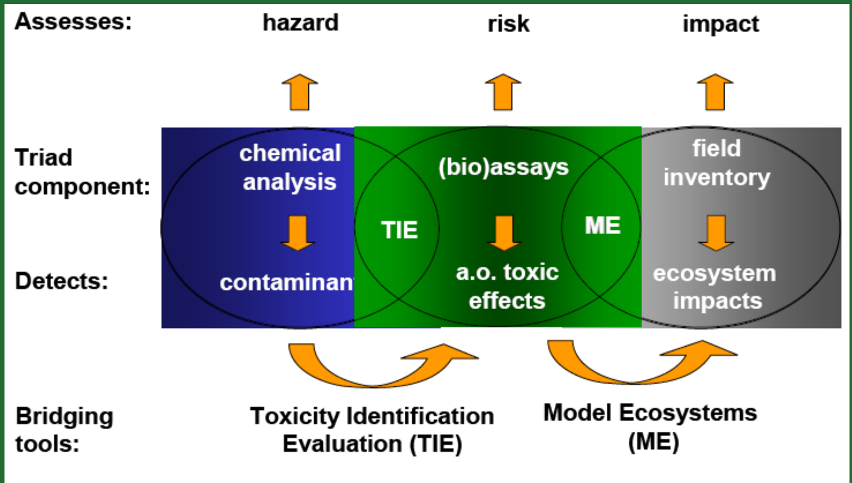
No / Acceptable Risk

- ✓ Risk reduction must be the goal of all sediment management practices
- ✓ Risk Assessment is a wide and complex concept *per se*.
- ✓ Prioritize risk and risk mitigation measures



(USEPA, 1998 mod)

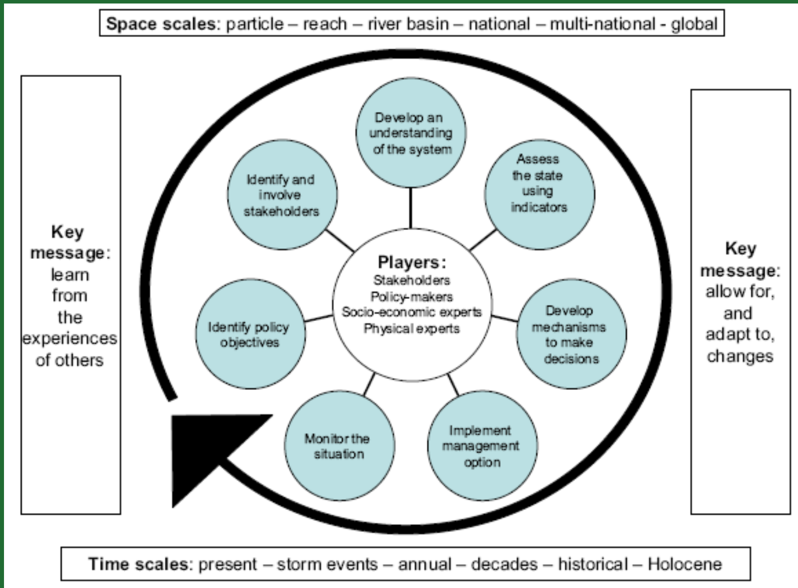
- Bioavailability and bioaccumulation
- Toxicity
- Role of hydrodynamics and transport
- Transfer through the trophic network
- Effects on the ecosystem (from individuals to population to ecosystem)
- …
- …



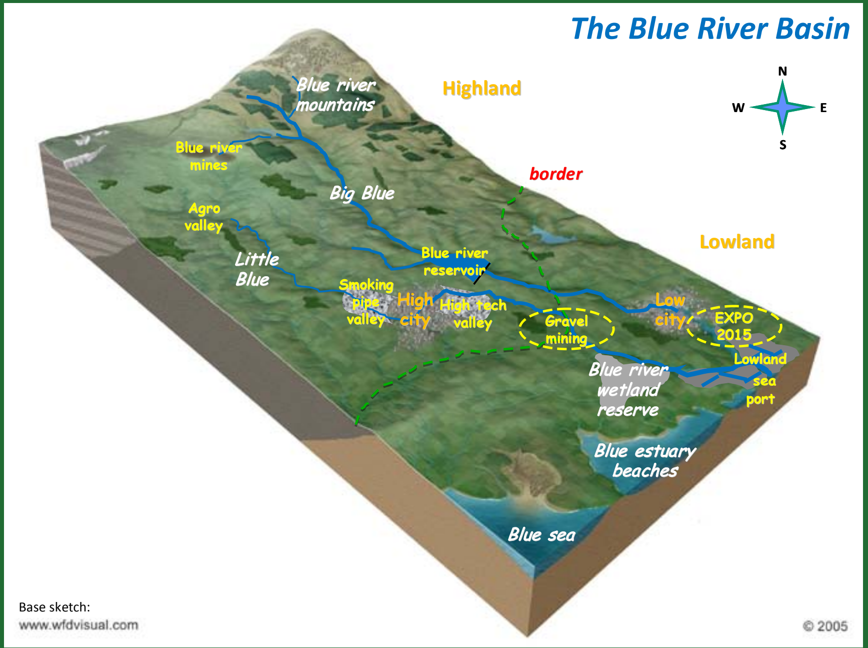
(Chapman, 1996)

Systemic / Holistic approach

- ✓Management options need to be proposed and evaluated taking into account the system as a whole
- ✓Balancing of pros & cons should be considered in a wide perspective
- ✓Spatial and temporal scales are important
- ✓Temporal scales mean also climate change (effects on ecosystems, system dynamics, rates and processes,..)



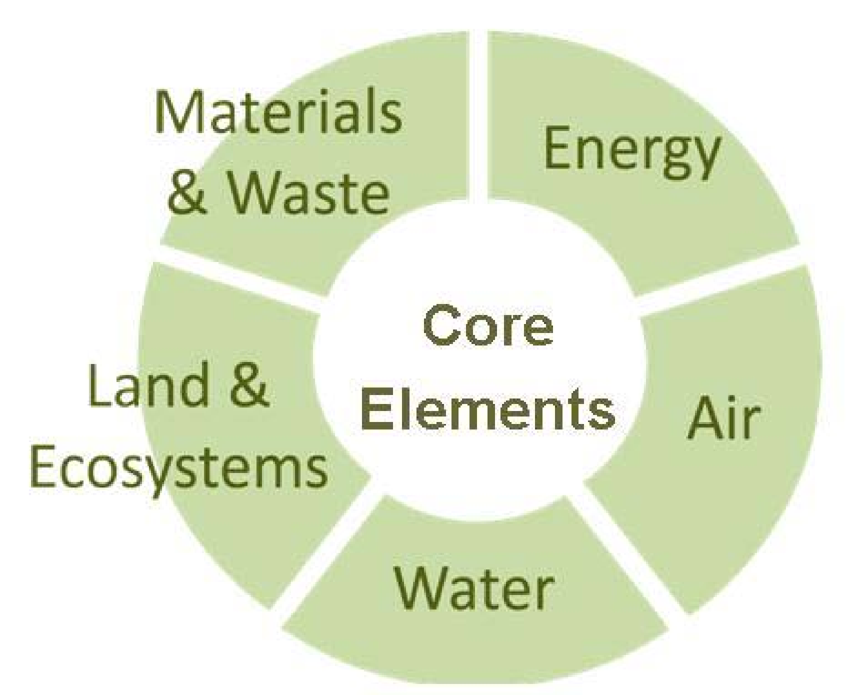
(Owens et al., 2008)



(SedNet, 2009)

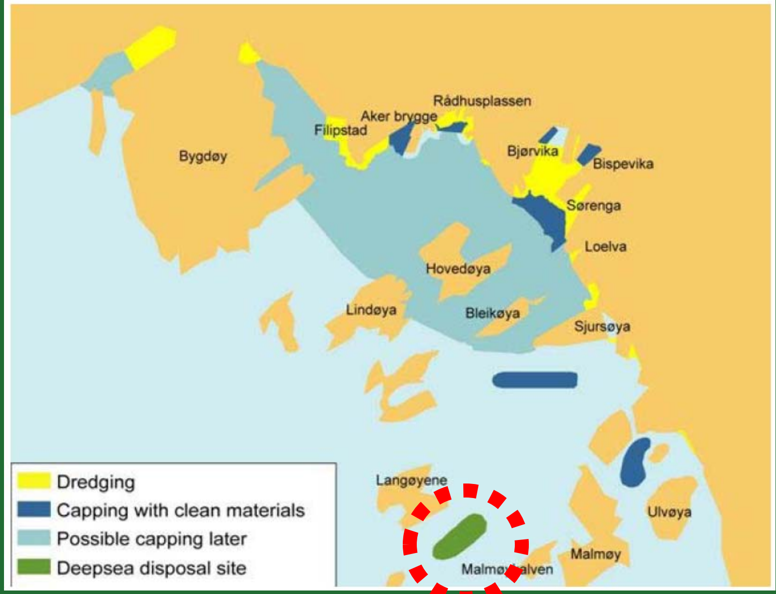
Sediment as a Resource (Reuse of DM)

- ✓Reduce the consumption of natural resources
- ✓Solve problems through beneficial uses (habitat development; beach nourishment and shoreline stabilization; agriculture; construction and industrial use)
- ✓Reduce the “environmental footprint” of DM management

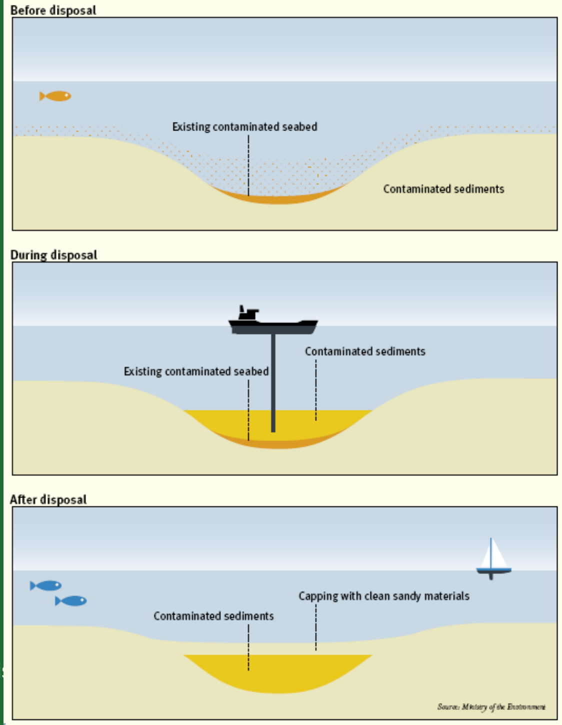


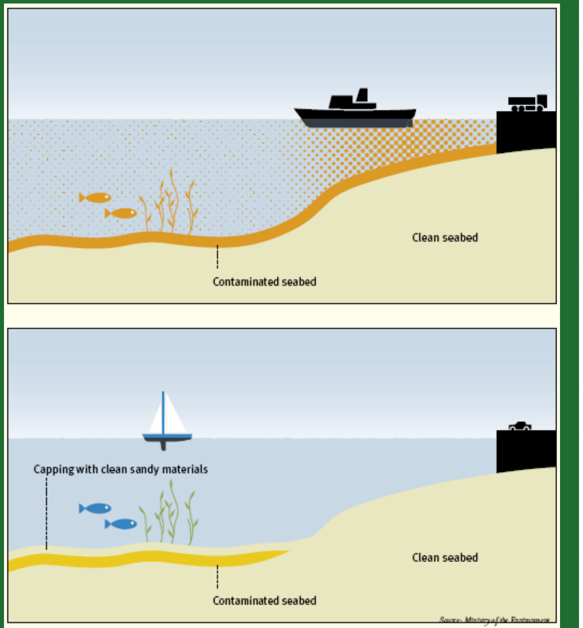
How can science contribute: case studies
Risk

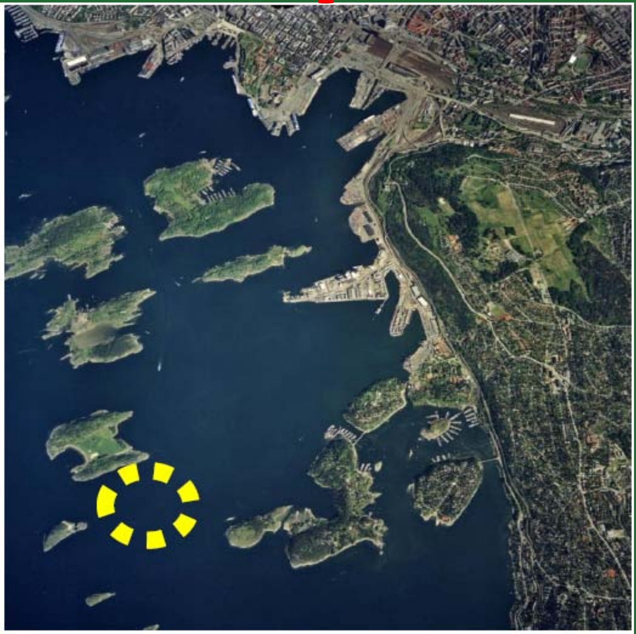
- Oslo Harbour Remediation Project (Norway)
- Disposal of 650.000 m^3 of sediment in a controlled aquatic disposal site in Oslo fjord + in place capping
- 15 years of studies to verify the absence of risk of the subaquatic disposal solution
- Control & Monitoring from NPCA & NGI + communication and stakeholder involvement



(NGI, Port of Oslo, 2007)





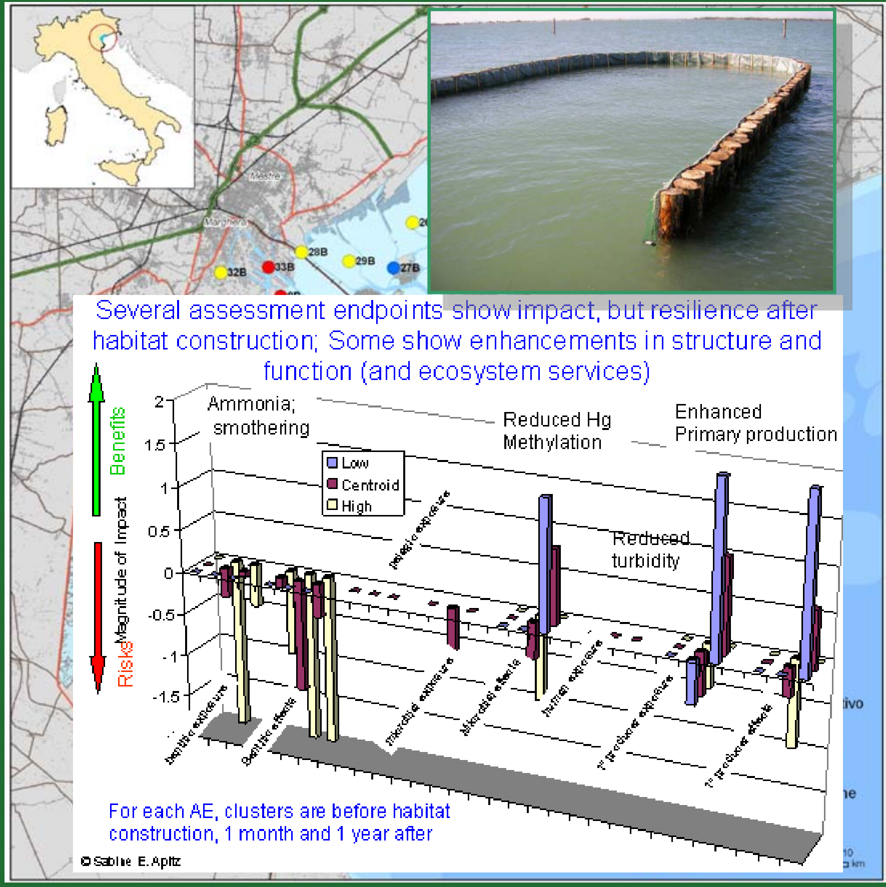


Venice Lagoon - ICSEL + SIOSED Major Results - Lessons learned

- Sediment quality assessment suggested no ecological risk in most of the lagoon basin, with the exception of the Industrial area

- Negative impacts (risks) to lagoon ecosystem, associated with sediment translocation and due to pressures (ammonia, smothering) are transient – communities are either resistant or resilient

- Positive impacts (benefits) of habitat construction include reduced Hg methylation, enhanced primary producer communities, reduced erosion and turbidity – communities are enhanced or restored compared to current baseline



Extensive research in Venice Lagoon has illustrated the risk and benefits of more sustainable management and of the role of sediments in regional ecological and socioeconomic objectives

Development of sediment EQS and decision frameworks (Draft Technical Guidance for Deriving EQS under the Water Framework Directive, 2010)

Sediment EQS should only be regarded as high-level screening values and be used accordingly:

- as a start of diagnostics (using tiered approaches)
- using different lines of evidence, and linking sediment state to impacts
- for certain measures (such as source control) target values and a good understanding of the system are necessary
- the role of EQS is different in upstream parts of the river basin compared to that in downstream parts (estuaries)
- EQS may not be appropriate for sediments in highly variable situations where measurable state-impact links are not well understood

(SedNet Opinion, 2006, 2009)

Implementing basin scale sediment management

• Include Sediment Management into River Basin Management Plan (2000/60/CE)

- ✓ **Sediments are an integral part of the ecosystem and affect ecological and chemical status**
- ✓ **Providing a better understanding of the linkage between sediment quality / quantity and WFD objectives will enable better RB planning, e.g.:**
  - ✓ developing conceptual model of sediment fluxes and contaminant transport
  - ✓ sediment balance and dynamics of the system
  - ✓ link sediment features to ecological and chemical status
  - ✓ climate change issues – potential consequences
- ✓ **Developing a Guidance on how to include sediment management in RBMP's, with examples that demonstrate how sediment management makes RBM more effective**

(Elbe Case Study)

(Report on the 2nd SedNet Round Table Discussion - Integration of Sediment in River Basin Management - Hamburg, 6-7 October 2009)

How can science contribute: case studies

Holistic / Systemic Approach

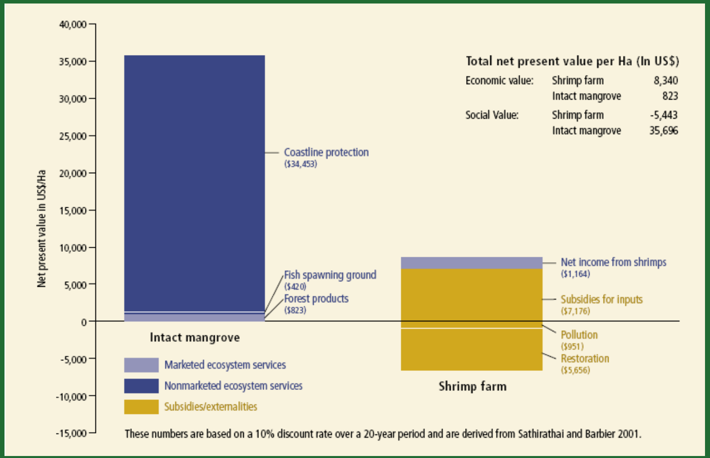
Ecosystem Services approach may provide excellent support to sediment management

Ecosystem Services:
- The benefits people obtain from ecosystems
- The "services of nature"

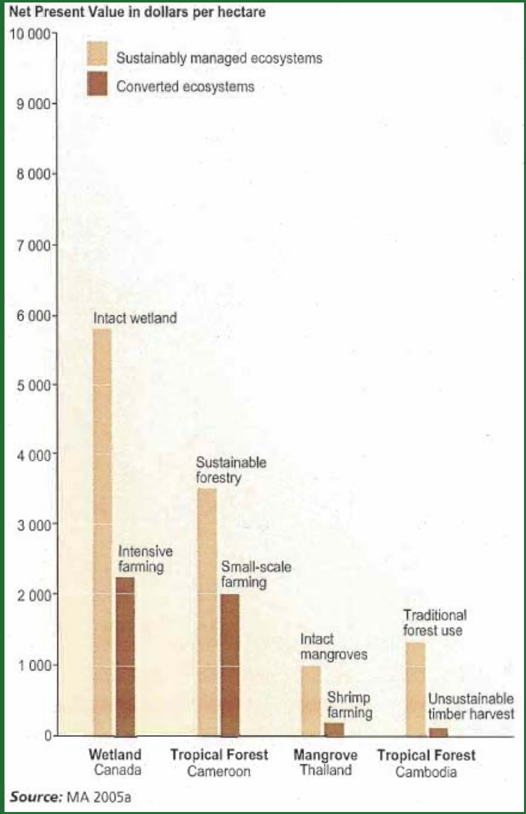
Advantages:
- Ecosystem oriented
- Holistic / systemic
- Partecipatory

Limitations:
- Difficult to communicate
- Not fully operational yet (methodology, standardization,..)

Comparing the Economic and Social Value of Mangroves and Shrimp Farms *(WRI, 2008)*



Value of Services provided by converted and sustainably managed ecosystems *(WRI, 2008)*



Millennium Ecosystem Assessment - Categories of Ecosystem Services

Provisioning Services:

- Food production
- Raw materials
- Genetic resources
- Medicinal resources

Supporting Services:

- Nutrient cycling
- Pollination
- Soil formation
- Habitat

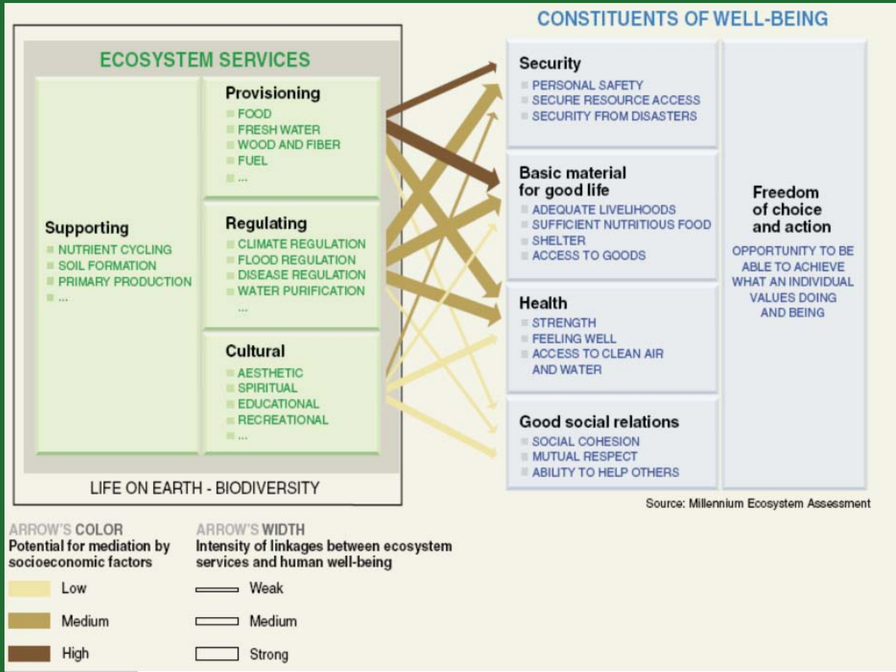
Regulating Services:

- Climate regulation
- Disturbance regulation
- Water regulation
- Waste treatment

Cultural Services:

- Recreation
- Aesthetics
- Existence
- Science / Education

Ecosystem services and human well-being



How can science contribute: case studies

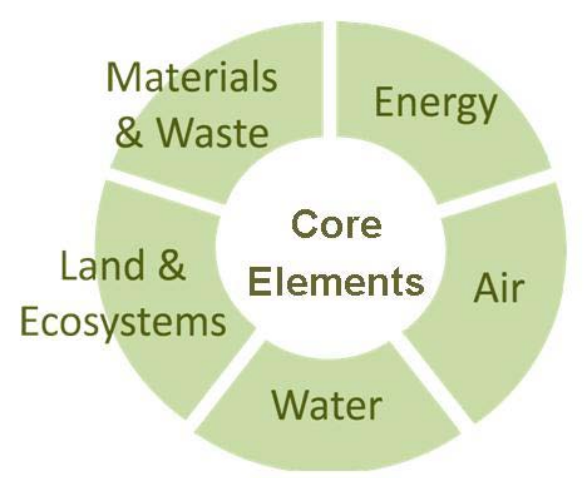
Holistic / Systemic Approach

Sediments need to be considered as an important natural resource and provider of important ecosystem services

Some ecosystem services directly or indirectly related to sediments

Provisioning **Supporting** **Regulating** **Cultural**	Carbon regulation & sequestration Nutrient regulation Habitat for animal and vegetal benthic species Habitat for wildlife Fertilizer Hydromorphological control Protection against aquifer salinization Physical defence (protection against erosion and flooding) Pollutant source / sink Landscape Recreation (e.g. beaches)

Applying the “Environmental Footprint” approach (LCA and other tools) to sediment management



Definition (Green Remediation – USEPA, 2008):

“The practice of considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprints of cleanup actions.”

Core Element	Negatives	Positives
Energy	Total energy use: gas, electricity, fuel	Renewable energy applied
Air	Total air pollutants, GHG emissions, dust	GHG emission reduction
Water	Total water use	Water recovery
Land & Ecosystems	Land & Ecosystems disturbed	Land reuse, Coastal defence, Morphology
Materials & Waste	Waste generated	Beneficial reuse

How can science contribute: case studies

Holistic / Systemic Approach

Boundaries definition (space, time)

↓

Inventory of relevant elements and activities

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Define indicators and metrics and quantify effects (LCA principles)

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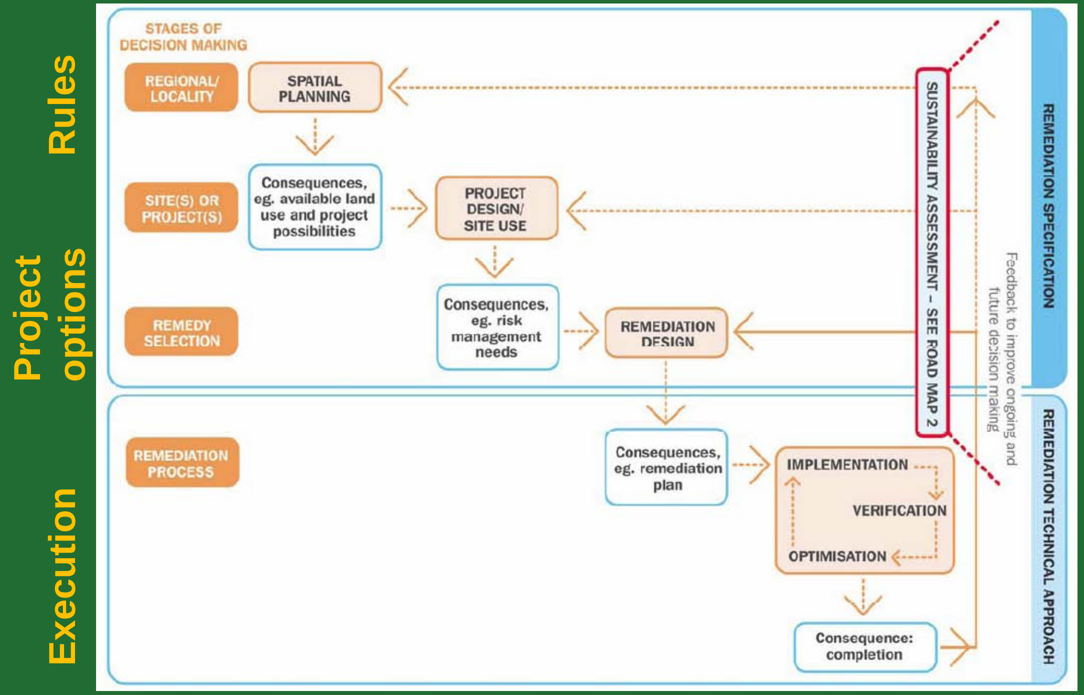
Integrate and estimate the “Environmental Footprint”

Road Map for sustainability management (Nicole, 2010)



We still miss tools and guidelines to make the approach operational (especially for sediments):
definitions, selection criteria, indicators, metrics, integration (MCA), standardization, effort, consensus (suspects of *“green washing”)*, policy & legislation,…

Building with Nature - Long-term sustainable development of Holland Coast

Coastal safety along the sandy shores of Zeeland, Holland and the Wadden Islands is maintained by beach nourishment. Until 2050 85 million m^3/year of sand will be needed, assuming that until 2050 sea level will rise by 12 mm/year.

Sand-extraction sites will have to be reserved soon. Research must also be conducted soon to determine how such large volumes can be distributed as efficiently as possible in terms of the ecology, economy and energy efficiency.

(Deltacommissie, 2008)

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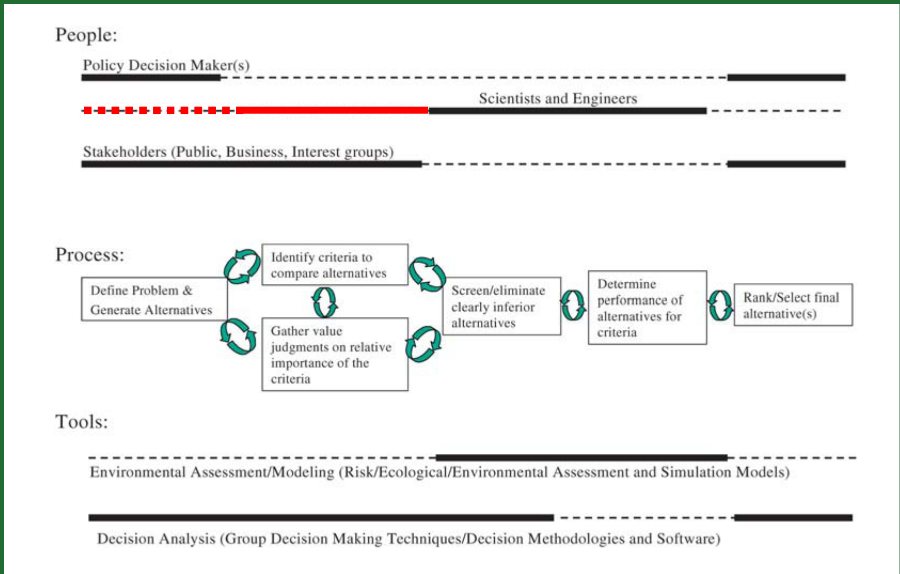
How can science contribute: case studies

Conclusions

- ✓Complex problems require a combination of tools
- ✓Such tools must be strongly scientifically based, used by skilled technicians and supervised/validated in their application
- ✓Tools to manage complexity bring added value and are not (or must not be) obstacles for decision-making
- ✓Uncertainty is hard to address and communicate and is often not accepted nor understood. We have to accept to deal with it, through formalized adaptive management strategies
- ✓Involvement of scientists since the early stages of the decision process is needed
- ✓Science is needed also to communicate, sustain participatory approaches and build consensus. Most importantly, when themes are complex and can be misunderstood

Synthesis of decision-making ingredients (Kiker et al., 2005, mod)



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Conclusions

How do we bridge the gap between science and policy?

"Delivering a refereed journal publication to a manager's desk is not sufficient if we wish our best science to move quickly into management application. We must develop improved means to communicate effectively and clearly the results of management experiments, as well as basic research."

(Christensen et al., 1996 - Report of the Ecological Society of America Committee on the scientific basis for Ecosystem Management)

"Es ist nicht genug zu wissen, man muss auch anwenden; es ist nicht genug zu wollen, man muss auch tun.“

"Knowing is not enough; we must apply. Willing is not enough; we must do."

"Conoscere non è abbastanza; bisogna mettere in pratica ciò che sappiamo. Nemmeno volere è abbastanza; bisogna fare."

(J. W. Goethe)

Thank you for your attention

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