Sustainable management of sediment resources:

sediment management at the river basin scale

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www.sednet.org

Four SedNet books by Elsevier in series:

Sustainable Management of Sediment Resources

- Barcelo D & Petrovic M (Eds) (2007). Sediment quality and impact assessment of pollutants.
- Bortone G & Palumbo L (Eds) (2007). Sediment and dredged material treatment.
- Heise S (Ed.) (2007). Sediment risk management and communication.
- **Owens PN (Ed.) (2008). Sediment management at the river basin scale.**

Chapter and authors

1. **Sediment behaviour, functions and management in river basins – *Phil Owens***
2. Conceptual and strategic frameworks for sediment management – *Sue White and Sabine Apitz*
3. Regulatory frameworks for sediment management– *Susan Casper*
4. Sediment and contaminant sources and transfers in river basins – *Kevin Taylor, Phil Owens, Ramon Batalla and Celso Garcia*
5. Decision support tools for sediment management – *Marcel van der Perk, Will Blake and Marc Eisma*
6. Costs and benefits of sediment management – *Adriaan Slob, J. Eenhoorn, Gerald Jan Ellen, Carlos Gomez, J. Kind and J, van der Vlies*
7. Sediment management and stakeholder involvement – *Adriaan Slob, Gerald Jan Ellen and Lasse Gerrits*
8. **Towards sustainable sediment management at the river basin scale – *Phil Owens, Adriaan Slob, Igor Liska and Jos Brils***

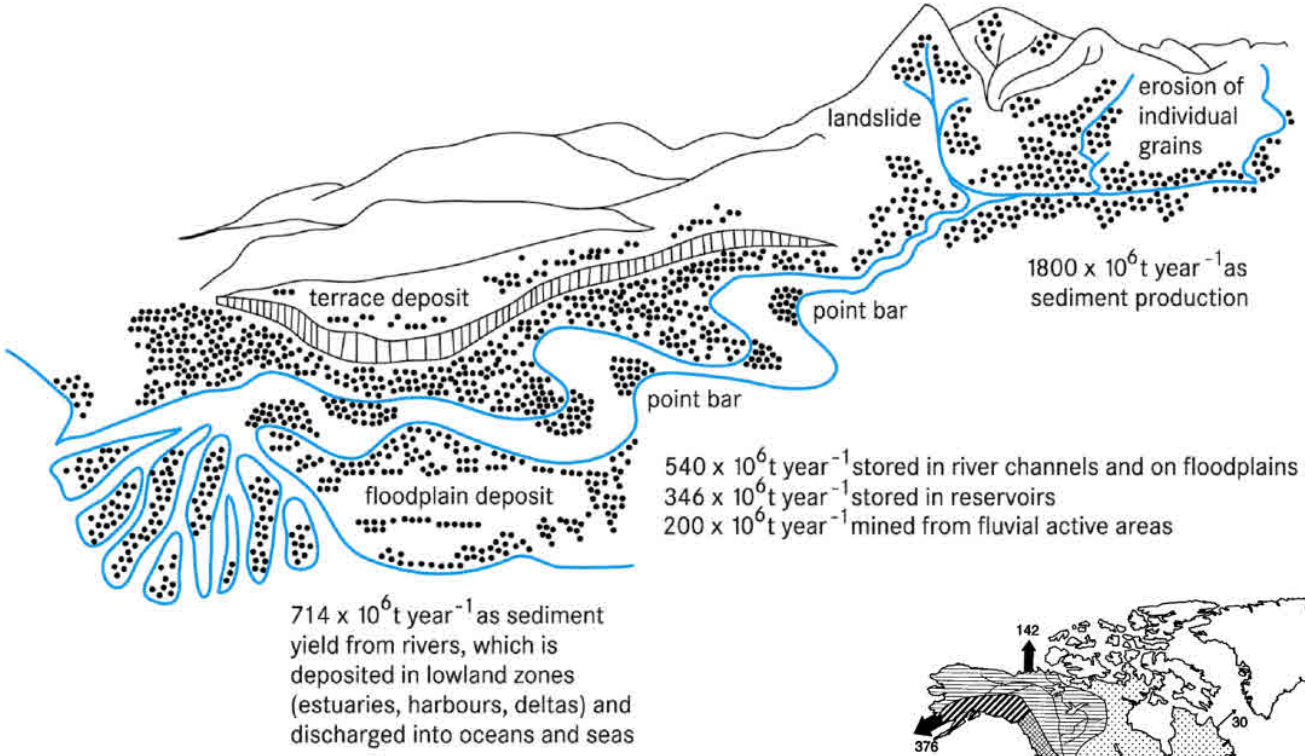
1) Why do we need to manage sediment? And why at the river basin scale?

2) What information do we need? And what tools and approaches do we have to assemble this information?

3) Towards improved management: Some conceptual and technical considerations

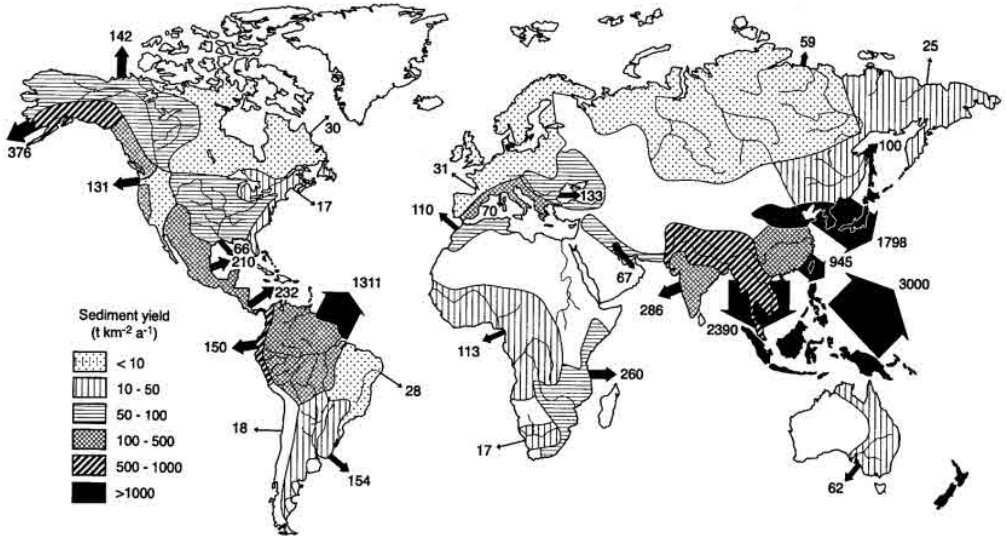
1)Why we need to manage sediment? And why at the river basin scale?

The scale of the problem: sediment fluxes



a) Europe

b) The world



From:

a) Owens PN (2005). Journal of Soils and Sediments, 5, 201-212.

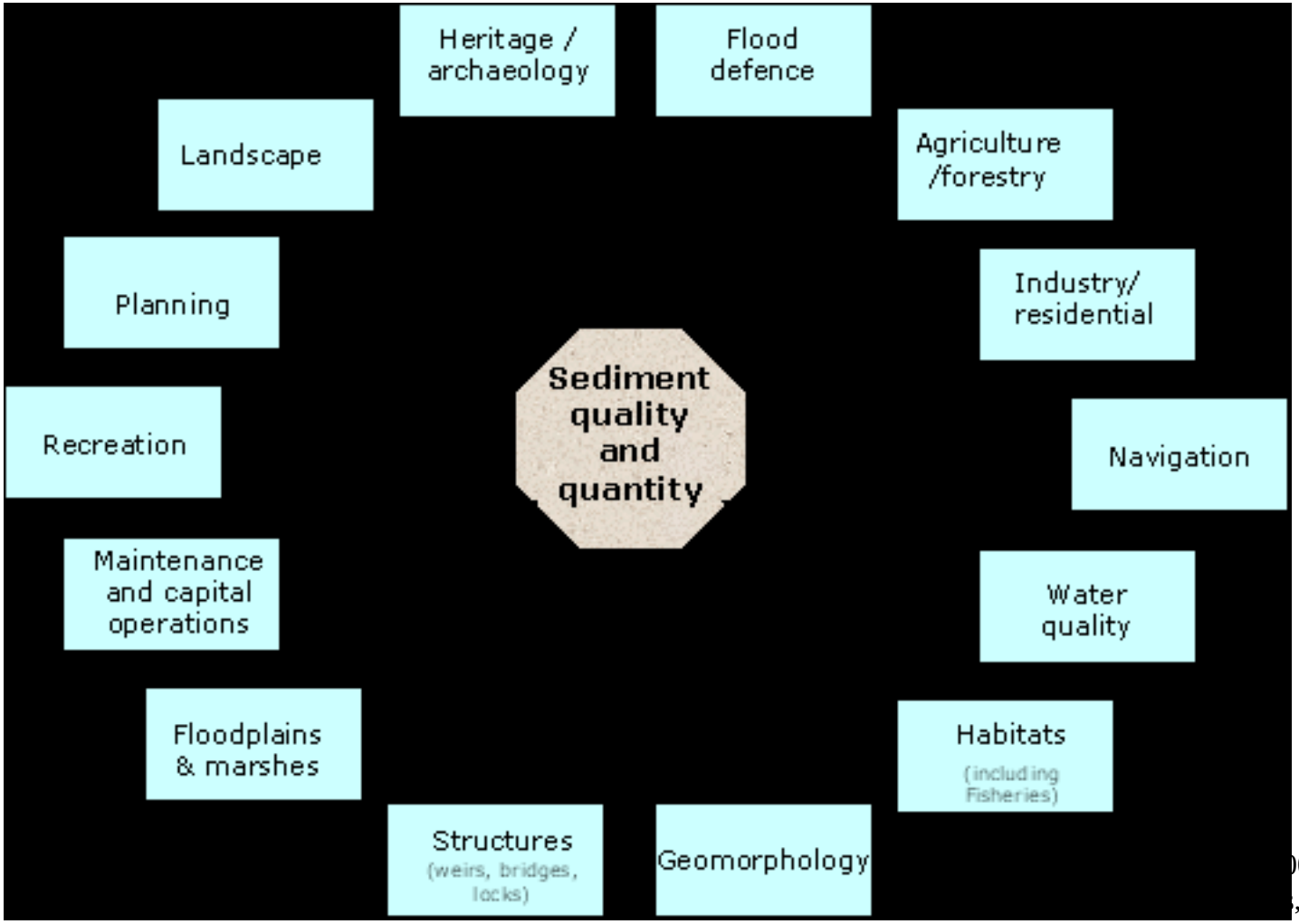
b) Milliman JD (1990). Nature and Resources, 26, 12-22

Sediment management

- Sediment management has tended to focus on **local** issues – generally ones associated with sediment **quantity** in channels, harbours, reservoirs etc.
- Recently, sediment **quality** issues have become important, particularly with the introduction of policy and legislation for water quality and ecological habitats

- With sediment management needing to address both sediment quality and sediment quantity issues **in combination** we need to operate at the river basin scale, for several reasons:

Multiple users and uses of sediment



004). Journal
, 4, 219-222.

Multiple uses and users of sediment

- Most of Europe's main river basins are heavily populated, and thus there are many different uses and users of sediment
- Need to balance these uses and users for effective and sustainable resource management
- Basin scale is most appropriate scale and unit for evaluating these uses and demands

Controlling (diffuse) sources

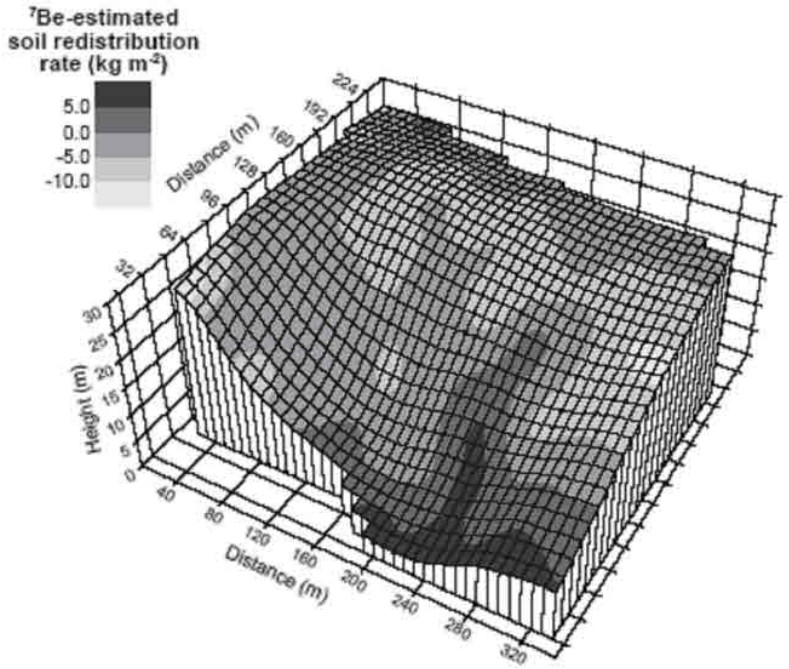
- Source control represents the optimal long-term solution: environmentally, economically and socially

- With improvements in point sources, diffuse sources are increasing in importance

- Diffuse sources tend to be spread throughout the basin and thus require a basin-scale approach for management

2)What information do we need?

And what tools and approaches are available to assemble this information?



From Walling *et al*. (1999). Water Resources Research, 35, 3685-3874.

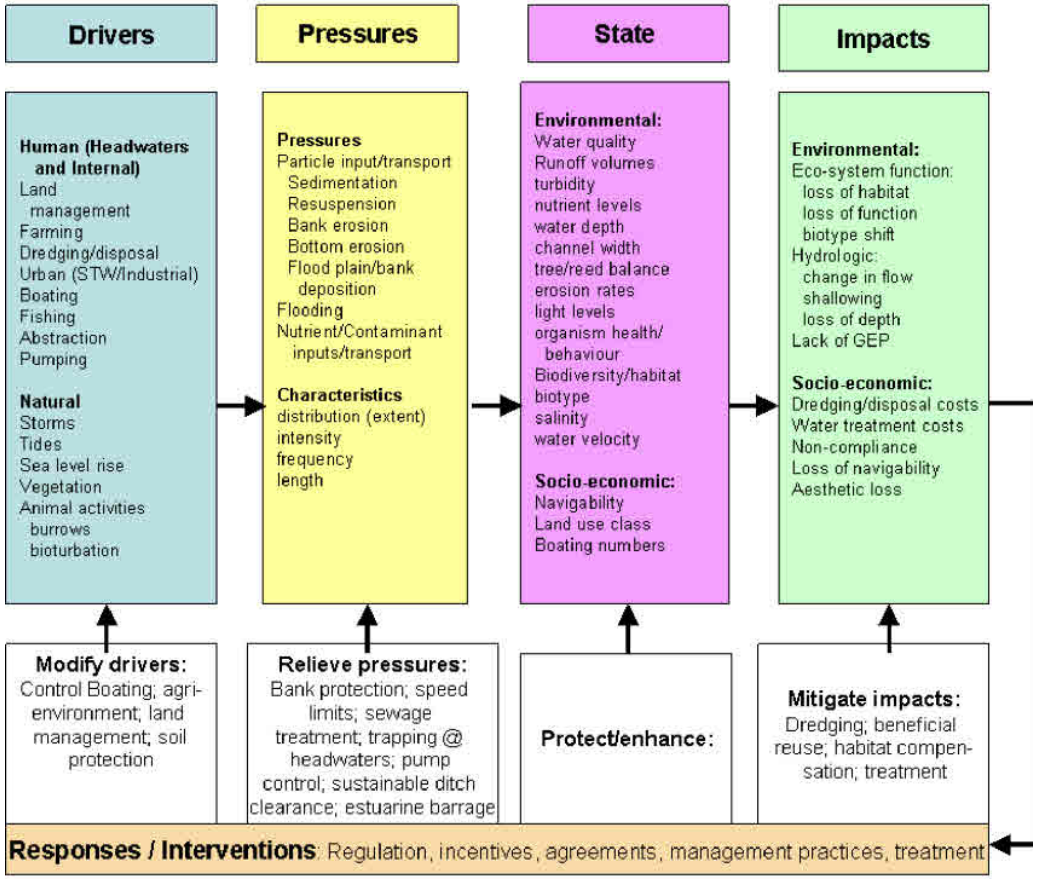
Information needs

- What are the drivers for management and what are the operating constraints in terms of regulations and policies?
- What are the sources, pathways and transport processes of sediment and contaminants (i.e. need to understand the sediment–contaminant system)?
- Who are the stakeholders and how can they be engaged to provide information and facilitate progress?
- What approaches and tools are available to help us decide what decisions to make?

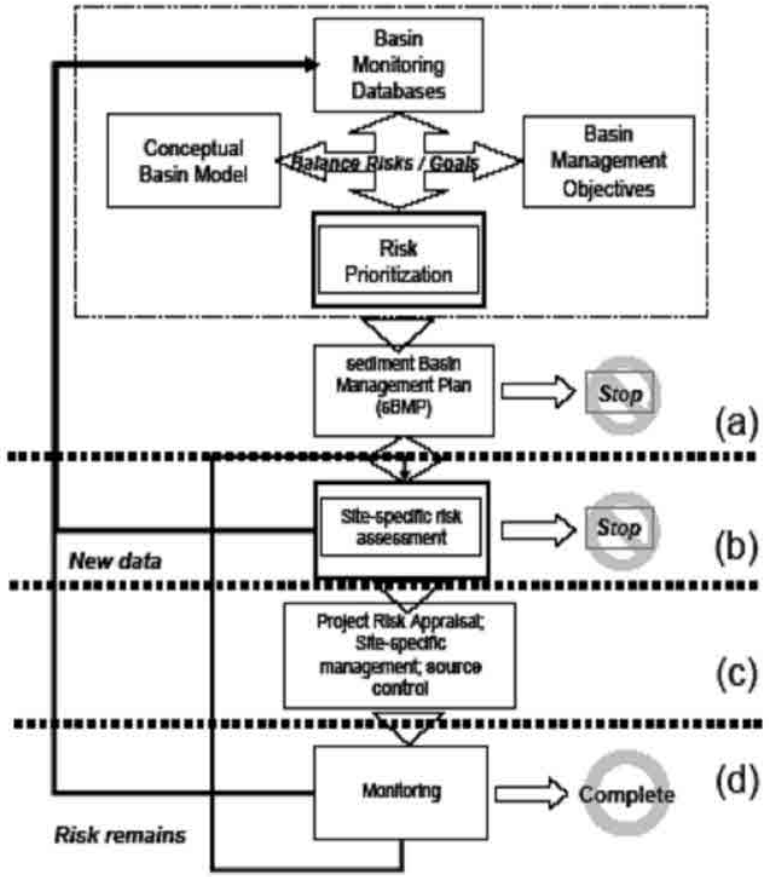
Chapter 2 *by White and Apitz*

Conceptual and strategic frameworks

Identifying policy objectives and "road maps" to achieve this



From: White *et al.* (2006). Report to Broads Authority.



From: Apitz *et al.* (2007). In: Heise (Ed) SedNet book 3.

Chapter 3

by Susan Casper

Regulatory frameworks

Understand and inventorize regional, national and international legislation and policy provisions that relate to sediment (and water) systems

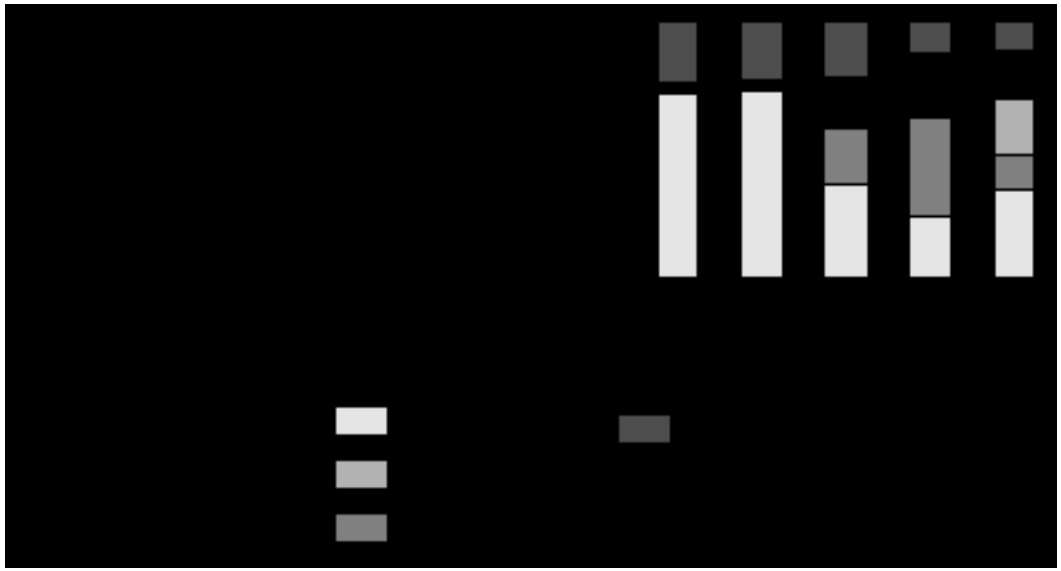
Table 2. Selected examples of EU Directives in water legislation (source: adapted from [13])

Legislation	Main purpose
Dangerous Substances Directive 76/464/EEC	To control the release of dangerous substances to water.
Freshwater Fish Directive 78/659/EEC	To ensure water quality meets the requirements for a healthy freshwater fish population.
Shellfish Directive 79/923/EEC	Aims to ensure a suitable environment for the growth of shellfisheries, and water of good quality to reduce the risk of food poisoning.
Bathing Water Directive 76/160/EEC and Revised Bathing Water Directive 2006/7/EC	To protect the environment and public health, and maintain amenity use of designated bathing waters (fresh and saline) by reducing the risk of pollution. The revised legislation aims to protect bathers from microbiological health risks, and promotes water quality and management actions.
Groundwater Directive 80/86/EEC	To prohibit the direct and indirect discharge of List 1 substances to groundwater, and limit the discharges of List 2 substances.
Surface Water Abstraction Directive 75/440/EEC	To protect the quality of water intended for use as drinking water.
Urban Wastewater Treatment Directive 91/271/EEC	To prevent the environment from being adversely affected by the disposal of insufficiently treated urban waste water, and ensure all significant discharges are treated before discharge to inland surface waters, groundwaters, estuaries or coastal waters.
Nitrates Directive 91/676/EEC	Aims to reduce pollution of surface and groundwaters by nitrates from agricultural sources.

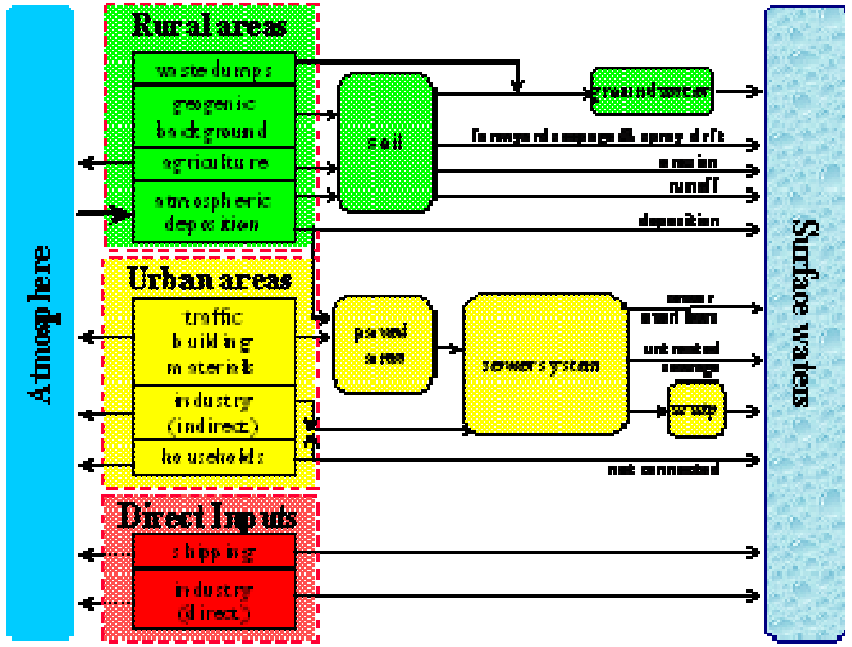
"In conclusion, there is a clear need for greater legislative recognition of the role and influence of sediment quality and quantity issues in supporting habitats and the achievement of ecological objectives, and fully integrated sediment basin management to tie together the diverse interests of the basin stakeholders." Susan Casper, page 79

Chapter 4 *by Taylor et al.*

Sediment and contaminant sources and pathways



From: Carter et al. (2003). Science of the Total Environment, 314-316, 513-534.



From Vink (2002). PhD

"The task of obtaining a complete understanding of sediment–contaminant sources, pathways and transport processes at the river basin scale probably represents one of the greatest challenges facing those concerned with sediment management. Without a comprehensive understanding of the system that we are trying to manage, it is unlikely that we will ever have the knowledge to make the best decisions." Taylor *et al*., page 125

Chapter 5

by van der Perk et al.

Decision support tools

Use appropriate tools (including models, monitoring and tracing) to assemble relevant information to understand the system and help make management decisions

"There are a variety of tools available for scientists and managers to facilitate the decision-making process. .....(however), there is a need for models which couple better sediment fluxes and dynamics in the riverine parts of 'river basins' with those in the estuarine and coastal parts of the basin."

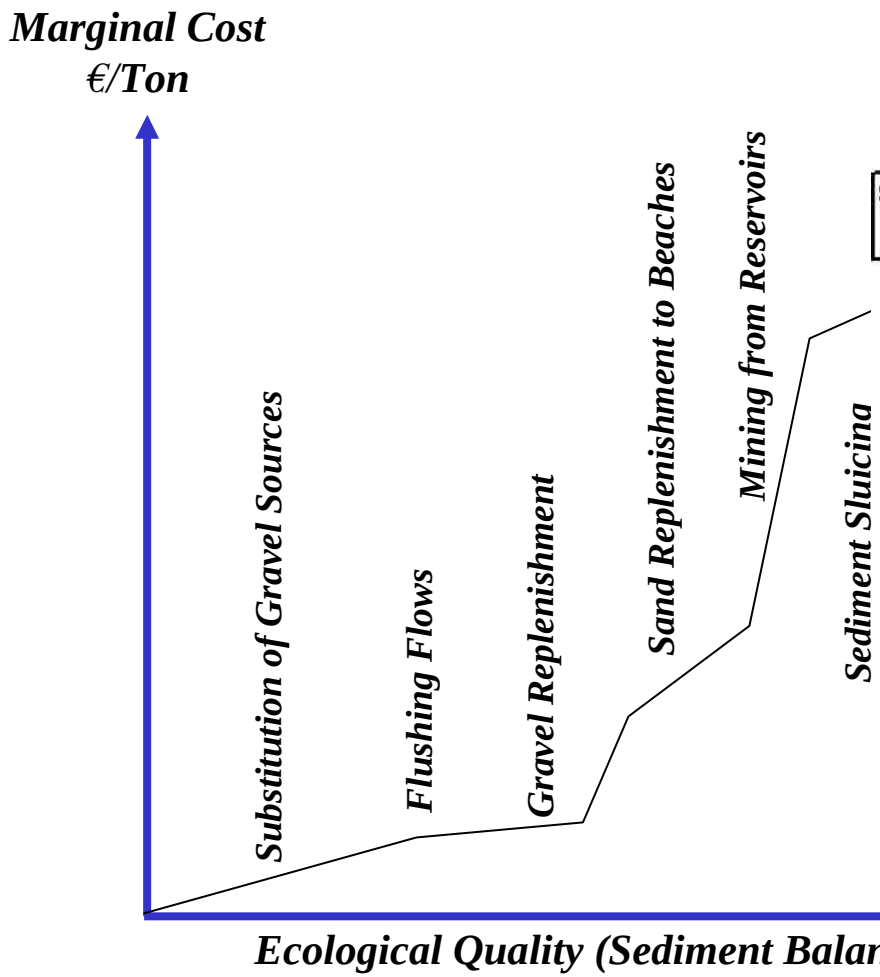
Van der Perk *et al.* , page 166

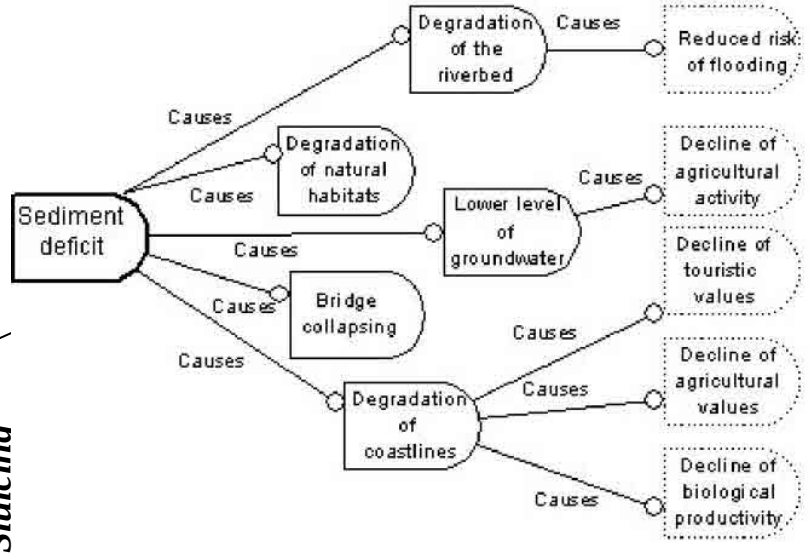
Table 4. Examples of hydrodynamic and sediment transport models

Name	Model dimensions	Model domain	WWW
Sobek	1D	rivers and estuaries	http://www.sobek.nl/
Delft3D	2D/3D	rivers, estuaries, seas	http://www.wldelft.nl/soft/d3d/intro/
Mike 11	1D	rivers and estuaries	http://www.dhigroup.com/Software/WaterResources/MIKE11.aspx
Mike 21C	2D	rivers	http://www.dhigroup.com/Software/WaterResources/MIKE21C.aspx
SMS	1D/2D	rivers	http://www.erms-i.com/SMS/SMS_Overview/sms_overview.html
Telemac	2D*	rivers, estuaries, and near-coastal areas	http://www.telemacsystem.com/
TRIM-2D	2D	rivers and estuaries	http://www.baw.de/vip/en/departments/department_k/methods/hnm/trim2d/trim2-en.html
HEC6	1D	rivers	http://www.hec.usace.army.mil/software/legacysoftware/hec6/hec6.htm
ECOMSED	1D/2D/3D	rivers, estuaries, and near-coastal areas	http://www.hydroqual.com/ehst.html
CCHE1D/ ...2D/3D	1D/ 2D/3D	rivers, estuaries, and near-coastal areas	http://www.ncche.olemiss.edu/index.php?page=freesoftware
Cosmos	1D/2D/3D	rivers, estuaries, and near-coastal areas	http://www.baird.com/baird/en_html/NumModSed.html
SedNet	2D	catchments	http://www.catchment.crc.org.au/cgi-bin/WebObjects/toolkit.woa/1/wa/productDetails?productID=1000013

Chapter 6 *by Slob et al.*

Costs and benefits of sediment management





"SCBA can be a very useful and powerful tool to help societal decision-making and to facilitate the more efficient allocation of society's natural resources, of which sediment represents one type."

Slob *et al.*, page 197

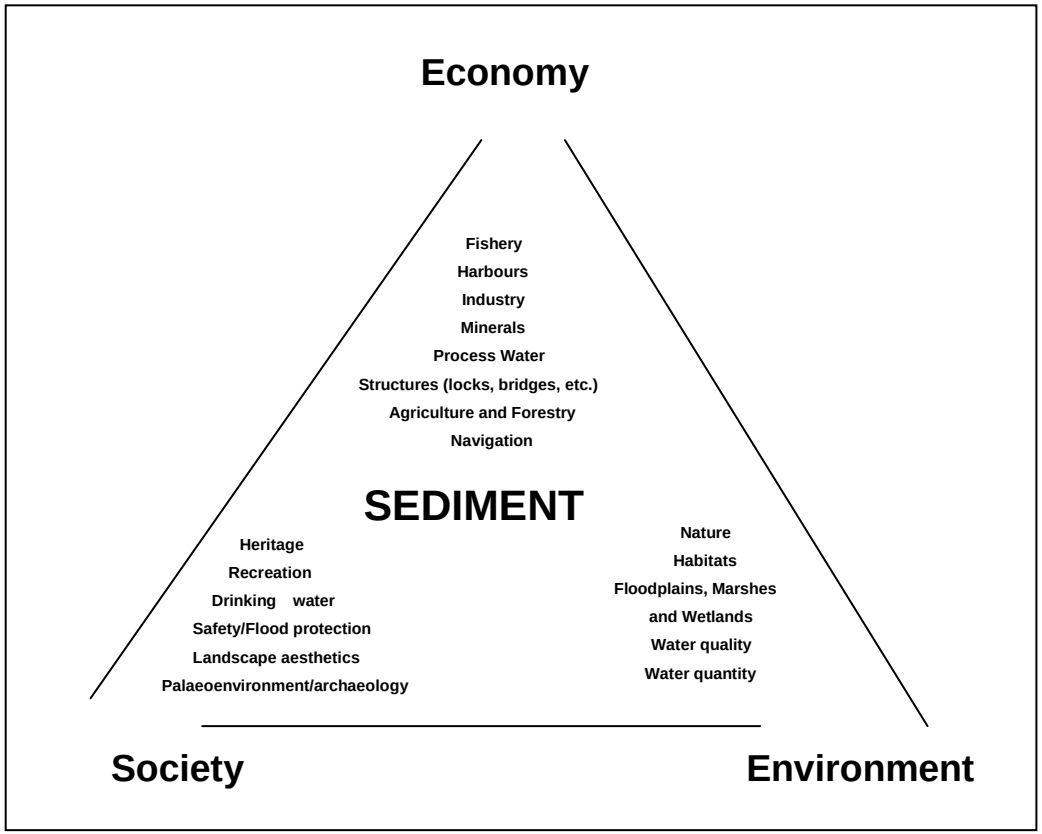
Chapter 7 *by Slob et al.*
Stakeholder involvement

"Future management of sediment – whether at specific sites or at the river basin scale – will have to incorporate the views, interests and perspectives of the various stakeholders."
Slob *et al*., page 214

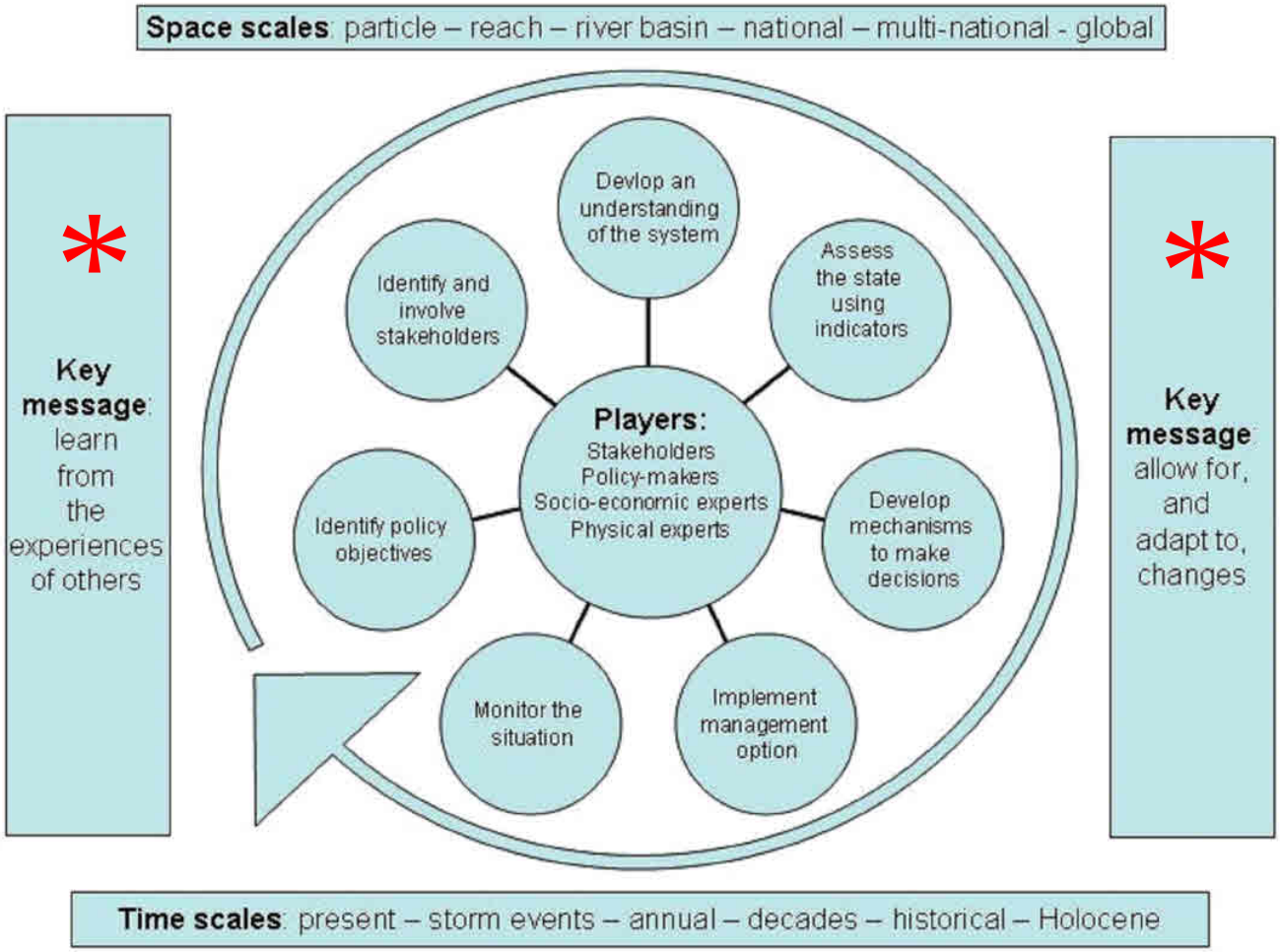
Table 1. Language and blind spots of the different perspectives on sediment

Perspective	Language	Blind spots
Controller	Danger/safety of sediment	Long-term impact
	Flooding caused by sediment	Experimental or 'risky' solutions will be overlooked
	Sediments influence the quality of the environment and nature	Ownership of solutions with stakeholders (the controller wants to keep control over the solutions)
	Regulation	
	Research on every aspect of sediment	
	Government control of sediment regulation	
Guardian	Ecosystem: harm to flora and fauna	Economically viable
	Waste sediments are contaminated and are damaging the ecosystem	Efficient solutions
		Costs are not important
	Risk oriented: polluted sediments can harm the ecosystem	
	Regulation to prevent damage	
User	Challenge and profit	Long-term impact
	Sediment problems can be solved using technology and treatment	Ecosystem is not an issue because technology can solve all problems, and the ecosystem will restore itself
	Pragmatic: if sediments cause problems they have to be managed	Risk issues can easily be solved
	Costs: the management of sediment can be costly	Control and regulation is not necessary

3)Towards improved management: some conceptual and technical solutions



Adaptive framework for river management



- Enter at any stage of cycle
- Stages do not need to be followed in a set order
- May not need to undertake all stages
- Can leave cycle at any stage

Learn from experiences of others

- We don't need to keep "re-inventing the wheel"
- Sediment quantity and quality issues are faced by all countries in one way or another
- Many existing and useful initiatives:
  - US EPA, US ACE
  - Environment Canada
  - Australian Land Care initiative
  - Chinese International Sediment Research and Training Centre
  - World Association for Sediment and Erosion Research (WASER)
  - International Association of Sediment-Water Science (IASWS)
  - International Commission on Continental Erosion (ICCE)
  - UNESCO-International Sediment Initiative (ISI)
- Example of environmental stewardship in river basin management (the Fraser Basin Council) in Canada (see poster)

Allow for, and adapt to, change

- Change is inevitable
  - Climate change
  - Land use change
  - Public perception and policy drivers (*4 generations of environment policy*)
  - Costs (*current fuel crisis*)
  - Current global food trade (*affects transport, land use*)

- Management options risk failure if too rigid" Need to think ahead and allow for some "wiggle-room" in management plans.

- Management frameworks need to be adaptive

Some take-home messages

- Sediment management should be part of broader soil-water-sediment management.
- The river basin scale represents a meaningful unit for management.
- But it is important that any management approach is also able to incorporate site-specific assessment.
- It is important to link freshwater, estuarine and marine environments: the former is only one part of the system.
- Stakeholders should be involved from the start in the decision-making process.
- Tools (conceptual, numerical and physical) are required to assemble information for system understanding.
- The “one size fits all” approach is probably not suitable as each basin will be different and may require a specific management plan: management must allow for temporal and spatial variability.
- A flexible, adaptive management approach may be better suited to complex, and changing, systems such as sediments (and water).

Thanks to:

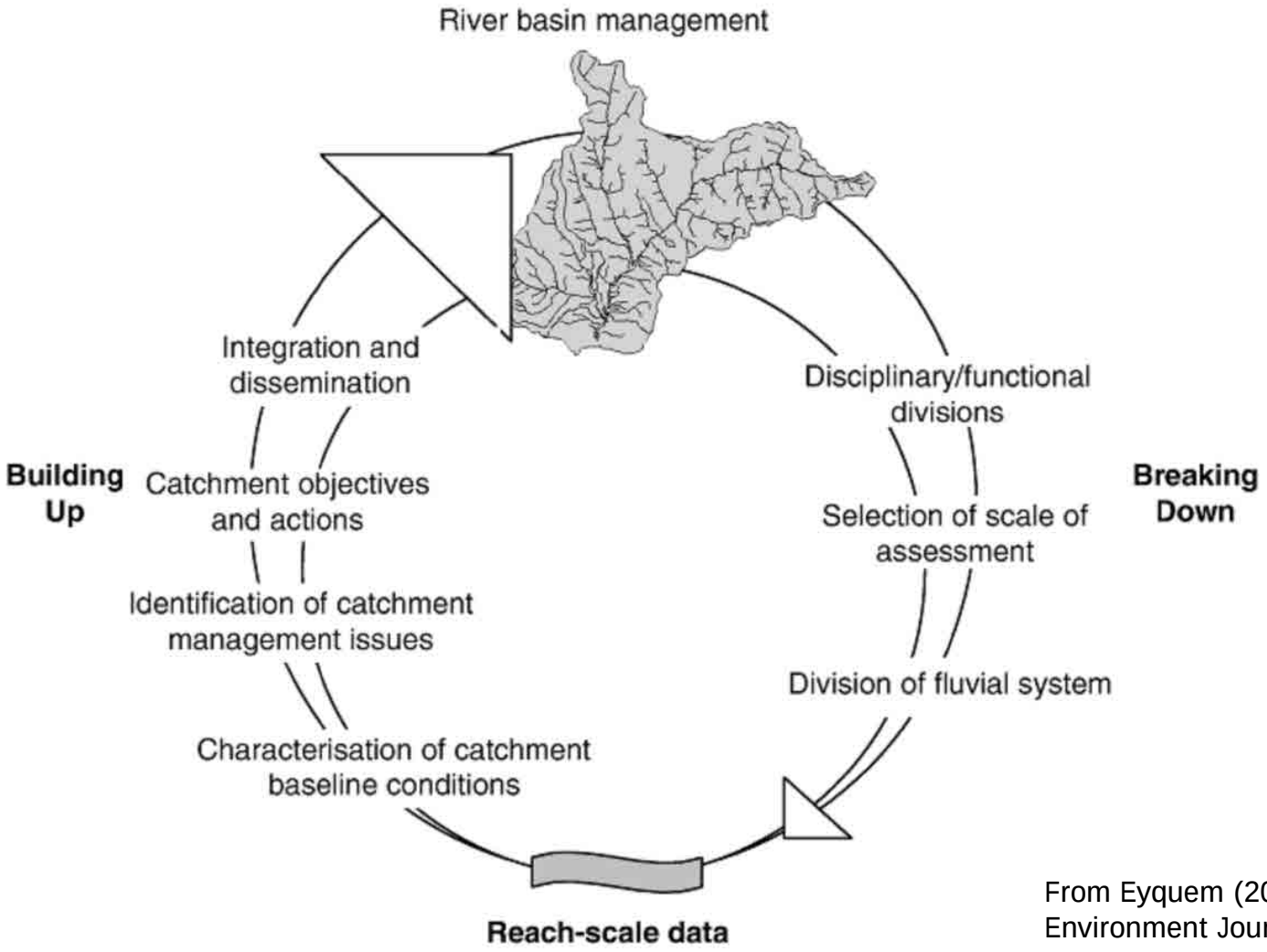
- Chapter authors
- SedNet “family”
- Jos Brils
- Elsevier

University of Northern British Columbia, Canada

Develop mechanisms to make decisions

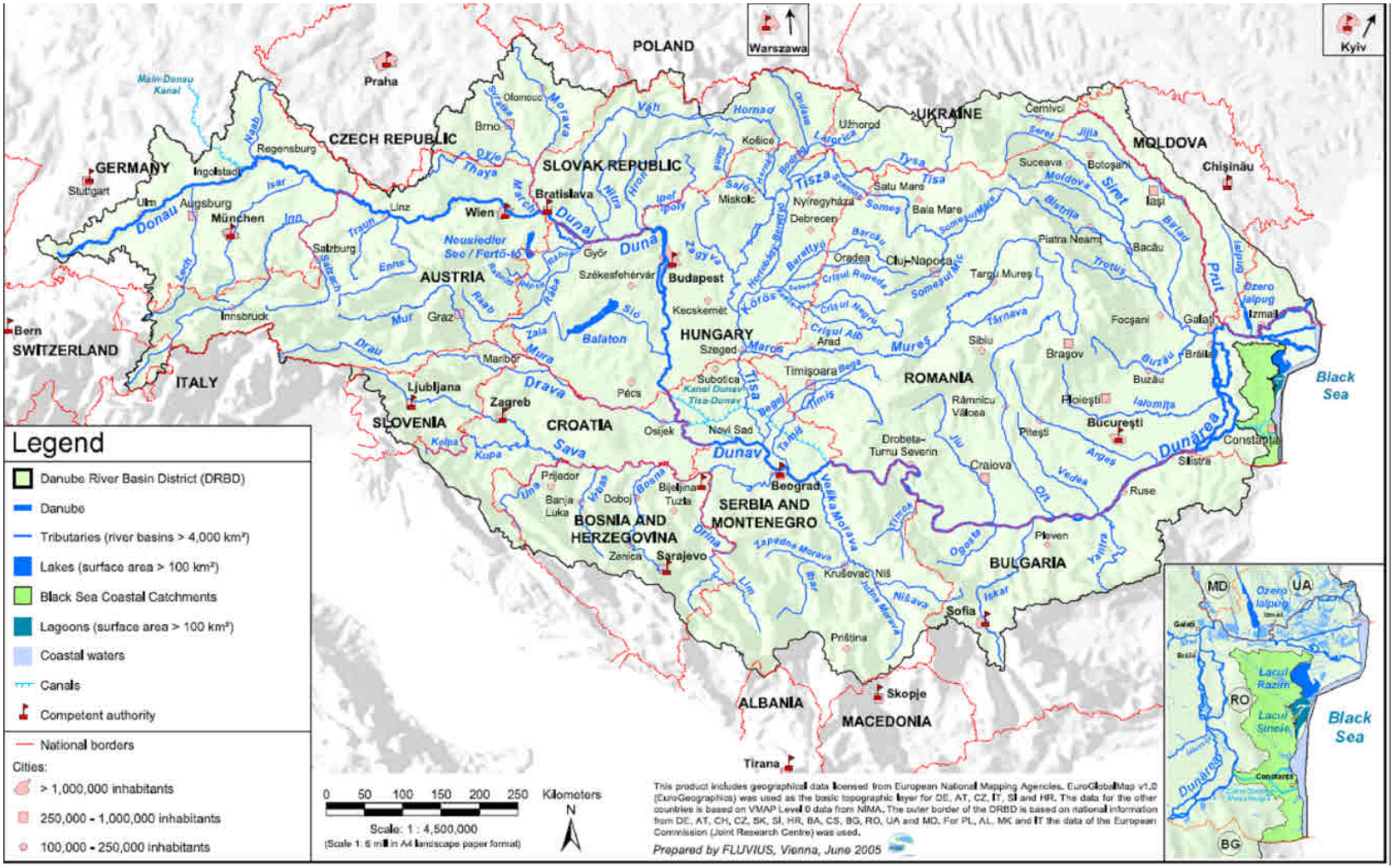
- At the end of the day, management is about making decisions – usually about the best option to take to achieve policy objectives
- Need to have clear and open ways to reach decisions that are defendable to (all) stakeholders
- Several tools and approaches that are available to help make decisions
  - risk assessment and analysis
  - (societal) cost-benefit analysis

Breaking-down and building-up



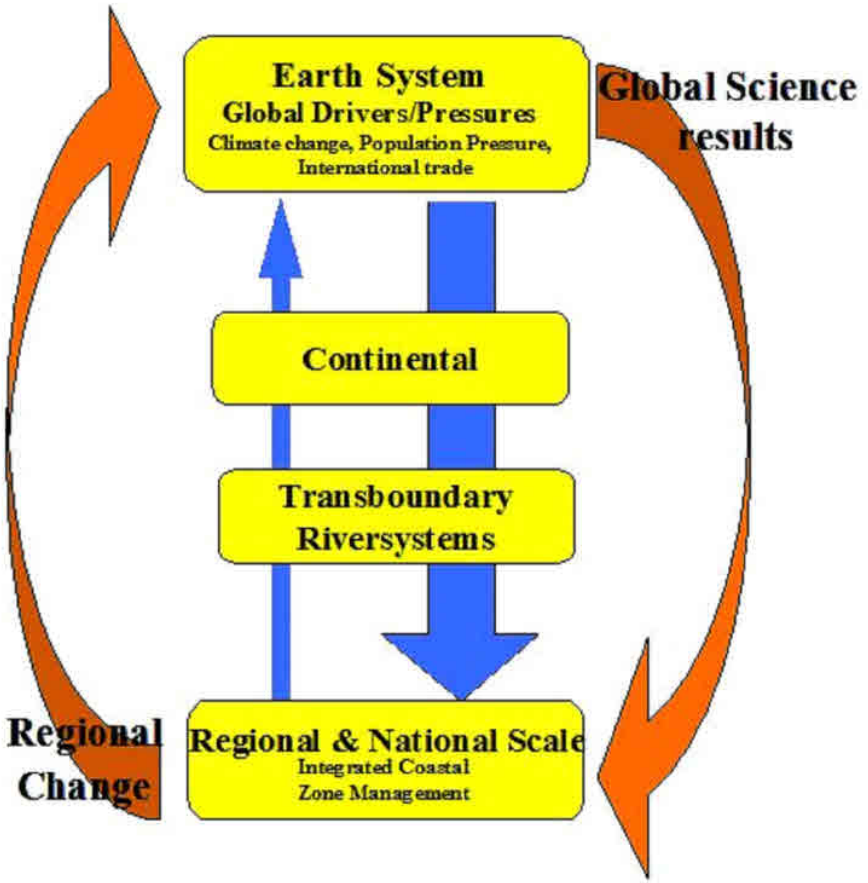
From Eyquem (2007). Water and Environment Journal, 21, 54-60.

The Danube river basin



From: ICPDR (2005). Technical Report.

Drivers for sediment management



UNESCO-IOC, UNEP, SCOR, IGBP

EU, OSPAR, HELCOM, ICES, ASEAN, SADC, MERCOSUR

National: CZM-Organizations, Authorities, River Commissions, City Councils

EC directives:

water (WFD)
soil (TSSP, SFD?)
marine (MS, MFD?)

From: Salomons (2004). EUROCAT Report. & Salomons and Brils (2004). SedNet Report.