European Sediment Research Network

Acronym: SedNet

EC contract No.: EVK1-CT-2001-20002

Key action: 1.4.1 Abatement of water pollution from contaminated land, landfills and sediments

The SedNet Strategy Paper

The opinion of SedNet on environmentally, socially and economically viable sediment management

AUTHORS: SedNet contractors SedNet Stakeholders Panel SedNet participants	**EDITOR:** TNO	**CO-ORDINATOR:** TNO, The Netherlands	
HOME PAGE: www.SedNet.org	**DATE:** June 4th, 2004	**CONTACT:** Jos Brils Tel +31 223 638 805 Fax +31 223 630 687 E-mail: j.m.brils@mep.tno.nl	
DELIVERABLES: D1.3	**DOCUMENT STATUS:** Final version	**FILE:** SedNet strategic paper FINAL 2004	**NUMBER OF PAGES:** 13

Contents

Preface 3
1. Introduction 4
2 SedNet 6
3 Changing perspectives on sediment management 7
4 Sustainable sediment management (SSM) 8
5 Implications for EU policy and research 11
References 13

Preface

This paper represents the opinion of the European Sediment Research Network SedNet on environmentally, socially and economically viable sediment management. This paper is based upon input from numerous participants in the SedNet network and is prepared and at least supported by the following organizations (in alphabetical order):

Organisation	Represented by*	Also representing
AKWA - Advies en Kenniscentrum Waterbodems	Dr. Piet den Besten	DGE - Dutch German Exchange on dredged material
ARGE Elbe - Wassergütestelle Elbe der Arbeitsgemeinschaft für die Reinhaltung der Elbe	Prof. Dr. Heinrich Reincke	-
ARPA** - Agenzia Regionale per la Prevenzione e Ambiente, Regione Emilia-Romagna	Dr. Giuseppe Bortone	-
Behörde für Wirtschaft und Arbeit, Strom- und Hafenbau	Axel Netzband	CEDA - Central Dredging Association
CSIC** - Consejo Superior de Investigaciones Cientificas	Prof. Dr. Damià Barceló Dr. Mira Petrovic	-
ENEA - Ente per le Nuove tecnologie, l'Energia e l'Ambiente	Leonardo Palumbo	-
ICI Regional & Industrial Businesses	Kelvin Potter	NICOLE - Network on Industrial Contaminated Land in Europe CEFIC - European Chemical Industry Council
IVM** - Instituut voor Milieuvraag-stukken / Vrije Universiteit Amsterdam	Prof. Dr. Wim Salomons	-
NSRI** - National Soul Resources Institute, Cranfield University	Dr. Philip Owens	
RIKZ** - Rijksintituut voor Kust en Zee	Dr. Joop Bakker	-
Rotterdam Municipal Port Management	Tiedo Vellinga Mark Eisma	ESPO - European Sea Ports Organisation PIANC - The International Navigation Association
TNO** - Netherlands Organisation for Applied Scientific Research	Jos Brils*** Johan van Veen Adriaan Slob Dr. Jan Joziasse	UNESCO ISI - International Sedimentation Initiative
TUHH** - Technical University Hamburg-Harburg	Dr. Susanne Heise Prof. Dr. Ulrich Förstner	-
UA** - University of Antwerp	Dr. Eric de Deckere	-
UNESCO, Ufficio UNESCO di Venezia	Dr. Philpe Pypaert	-
VPA** - Venice Port Authority	Dr. Stefano Della Sala Dr. Emanuele Zanotto Dr. Ilda Mannino Igor Folca-Nash	VIU - Venice International University

* For contact details please see the SedNet 'who-is-who' at: www.SedNet.org

** Contractor in SedNet project (EC FP5, contract No. EVK1-CT-2001-20002)

*** SedNet coordinator and contact person, e-mail: j.m.brils@mep.tno.nl

1. Introduction

What is sediment

Sediment is an essential, integral and dynamic part of river basins, including estuaries and coastal zones. Most sediment is derived from the weathering and erosion of minerals, organic material and soils in upstream areas and from the erosion of riverbanks, and is susceptible to being transported downstream by surface waters. Sediment is not restricted or limited to a particular area or part of a river basin. As flow rates tend to decline in lowland areas, where channel gradients decrease, transported suspended solids settles along the riverbanks and on the bed of the river (i.e. sedimentation). Sedimentation also occurs on floodplains during flooding, and in reservoirs and lakes. At the end of most rivers, the majority of the remaining sediment is deposited within the estuary and on the seabed of the coastal zone. A natural river tends to be in a state of dynamic equilibrium, where small variations in the flow of water and sediment are autonomously regulated.

The value of sediment

Sediment has ecological, social and economic value. Sediment is one of the key components of the aquatic ecosystem: it supports life. Sediment forms a variety of habitats and environments. Furthermore, sediment is an important source of nutrients for a variety of organisms and indirectly, for species higher in the food chain. Sediment dynamics (erosion and sedimentation) and gradients (high-low and wet-dry) form favourable conditions for a varied environment (biodiversity), from the origin of the river until the coastal zone.

Sediment is also a beneficial, socio-economic resource. For centuries mankind has recognised and utilised sediments in river systems as fertiliser for farmland and as a source of minerals and materials. Sediment is used as construction material, e.g. for the replenishment of eroded beaches and as a ‘filling material’ in dykes and land reclamation.

Sediment as part of the soil/water system

Sediment is part of the soil/groundwater/water/sediment system. Sediment is the interface between the surface water and the soil and groundwater. Threats to the sediment mean also a threat for the soil and groundwater and the other way around. Management of sediment should be planned in the context of this system.

Sediment quantity management

Sediment quantity has been managed for centuries, mostly by dredging. This was, and still is, very much needed in order to keep waterways, that tend to silt up, open to the flow of water. This ensures a proper drainage capacity for precipitation and melting snow and ice, so it aids in flood prevention. But it also ensures water supply for drinking and irrigation purpose and for shipping.

However, the natural hydrodynamic conditions of many waterways have been altered: directly by hydraulic constructions, such as dykes, dams, seawalls, and artificial drainage, and indirectly by changes in land cover and use, such as deforestation and urbanisation. These changes have resulted in the accumulation of sediment at places, where the sediment impedes economic activities. The removal of sediments for the maintenance of waterways and water quality from locks, floodplains, harbours, navigation channels and river stretches is a high capital cost for responsible authorities and agencies.

Sediment quality management

Since the beginning of the industrial revolution, hazardous chemicals were emitted to our surface waters. Many of these chemicals do not readily dissolve in water but rather stick to the sediment. Therefore, sediment quality rapidly deteriorated at several places, not helped by the fact that several chemicals do not readily break down in sediment. Thus history of mankind is reflected in the sediments. This introduced the need for a new type of management: sediment quality management.

A useful way to structure the issues related to sediment quality management is to make use of the European Environment Agencies (EEA) DPSIR framework. DPSIR stands for Driving forces, Pressures, States, Impacts and Responses. Examples of the application of this conceptual framework reasoning to sediment contamination are presented in Table 1.

Table 1 Examples of the application of the EEA DPSIR reasoning to sediment contamination.

DPSIR elements	**Examples**
Driving forces	• Industrial, agricultural and social activities.
Pressures	• Emission of polluted effluent by point sources (industry and publicly owned waste water treatment plants) and by diffuse sources (e.g. agriculture, ships, atmosphere, car washing, recreation etc.).
States	• Decreased sediment quality due to fact that contaminants adhere to suspended particles that subsequently settles along the riverbanks (sedimentation), on the bed of the river and at the end of a river in estuaries and the seabed of the coastal zone. • 'Legacy of the past': even if water quality improves, sediment contamination will remain.
Impacts (possible)	• Impacts to sediment dwelling organisms, e.g. resulting in decreased abundance of species or even a decreased biodiversity. • Impacts to species higher in the food-chain via food-chain transfer (biomagnification) of contaminants. • Contaminated sediments remain potential sources of adverse affects on chemical and physical water quality through release of contaminants to surface waters and groundwaters. • Decreased exploration capacity and/or economic value of river materials because of the supply of contaminated sediment. • Restrictions to the disposal or beneficial use of dredged material. • Conflicting objectives, for example: environment and shipping may benefit from the removal from contaminated sediment, but in this way also the habitat for sediment species will be removed (please further see below under 'legislation').
Responses	• Development and application of new tools for assessing sediment quality, such as bioassays. The application of bioassays has already detected new compounds that deserve attention, such as endocrine disrupting compounds. • Environmental dredging: removal of (severely) contaminated sediment. • Sediment and dredged material legislation. • Trans-boundary cooperation and agreements. The Rhine is a good example of that. In this case, polluters along the entire river have significantly reduced the emissions of the classic contaminants metals, PAHs and PCBs. • Changing perspective on the key-role of sediment in river systems (section 3). • A need for networking in order to (section 2): - exchange management knowledge; - find clever, new ways to manage the complex sediment issue; and - help to resolve conflicting objectives.

2 SedNet

In the next few decades, Europe faces the large-scale remediation of historically contaminated areas of sedimentation in many river basins. One of the challenges in European river basin management is the need to develop environmentally and socio-economically viable strategies and solutions for the environmental legacy, including the reduction of water and sediment contamination from point sources and especially from diffuse sources. The European Sediment Research Network (SedNet) was established in order to help to structure and facilitate a harmonised European approach on these issues. The SedNet mission is:

To be a European network for environmentally, socially and economically viable practices of sediment management at the river basin scale.

SedNet is the first attempt to organise a network that brings together sediment managers and research experts on a European scale and which aims to address all the issues related to the management of sediment on a river basin scale. The SedNet objective is to form inter-disciplinary links and trans-disciplinary bridges between scientist, engineers, sediment managers and those responsible for developing and implementing policy.

SedNet initial phase (2002 - 2004)

The SedNet activities in the initial phase (2000 - 2004) are financially supported by the European Commission (EC) as Thematic Network under the FP5 Energy, Environment and Sustainable Development programme and within area 1.4.1 on "Abatement of water pollution from contaminated land, landfills and sediments". SedNet will deal with all aspects of sediment, however in the initial phase the focus will be on the management of contaminated sediments. This issue needs urgent attention, due the water quality problems arising in many river basins and the maintenance of the European waterways.

The main deliverable of this initial phase will be a publication with guidance on sustainable sediment management (SSM guidance), from local to river basin scale. The SSM guidance document:

- contains recommendations and guidance to integrated, sustainable sediment management, from local to river basin level.
- it indicates sustainable solutions for the management and treatment of contaminated sediment and dredged material
- and it addresses practical questions of sediment management practice/stakeholders, e.g. related to existing and upcoming legislation.

SedNet next phase (>2004)

In the next phase there will not only be a focus on contaminated sediment. Also other aspects, such as those related to sediment quantity and flooding, will get more attention. The SedNet management is currently exploring options for continuation of the network.

3 Changing perspectives on sediment management

The EU Water Framework Directive (WFD) aims to "establish a framework for the protection of inland surface water, transitional waters and groundwater" and aims to achieve good ecological potential and good surface water chemical status at the latest 15, years from the date of entry into force of this Directive", i.e. 22 December 2000 (Directive 2000/60/EC, L327/1, Official Journal of the EC).

Building on the previous sections, it is clear that:

- *Sediment is an essential, integral and dynamic part of river systems, so it is obvious that there is a direct link between:*
  - sediment quality and 'ecological potential'
  - sediment quality and 'surface water chemical status'
- *Sediment is not tied to a particular area and is transported through countries in the same river basin*

The implementation of the WFD will result in a shift in the scope of water management: from local scale to river basin scale. Furthermore, stimulated by the WFD, the view on sediment is changing to the recognition of the key role that sediment plays in the natural functioning of river systems.

This changing perspective on sediment management will lead to a more sustainable management of sediments. It is realised that the contamination issue cannot be viewed in isolation, but that sediment contamination has an impact on all parts of the soil/water system. Sediment management should fit in the holistic view on the role of sediment in river basin systems.

This is similar to the policy development for contaminated soil. There, development also started with the perception that soil, like sediment, is a vital part of our environment that deserves protection by proper management (Vegter et al. 2002). The big difference, however, is that contaminated soil is a site-specific issue, while the mobility of contaminated sediment makes it a river basin issue and thus in many cases a trans-boundary issue. This means that trans-boundary management is needed for river systems that cross water bodies and national borders.

4 Sustainable sediment management (SSM)

Sustainable development

The report entitled 'Our Common Future' (WCED 1987), also known as the 'Brundtland Report', was a milestone for environmental policy. The notion of 'sustainable development' took a prominent place and emphasised that environmental policy is not only a matter of the conservation of nature, energy and other resources, but also a matter of sound development. Sustainable development has widened the scope of environmental policies to other policy domains. It has linked 'environmental thinking' to development issues, especially to social and economic policy issues.

The notion of sustainable development has several important characteristics:

- It implies limits, not absolute limits, but limitations based on present technology and social organisation on environmental resources and by the ability of the biosphere to absorb the effects of human activities (Brundtland report);
- Not only is the present situation directed to 'here and now', it is also directed to 'there and later', the future situation. This implies that it is a dynamic concept that could change over time. Preserving resources for future generations is one of its most appealing elements; and
- It is a broad concept, not narrowly defined. This means that it has to be fleshed out in a dialogue between the various stakeholders concerned. Therefore, the process aspects of sustainable development are at least as important as the substance. Sustainable development should therefore be seen as a process of social and mutual learning in which interaction among the players concerned is a necessary element.

SedNet perspective on sustainable sediment management

The SedNet mission (section 2) illustrates the perspective on sustainable sediment management. The words Sustainable, Sediment and Management mean different things to different people. SedNet will not try to establish a precise definition of these words, however there is consensus on a common perception of these words, which is as follows:

Sustainable:	The use of sediment, balancing the social, economical and environmental values, with full attention to adverse effects, so as to enhance the utility of river basins in the future
Sediment:	Suspended or deposited solids, of mineral as well as organic nature, acting as a main component of a matrix, which has been, or is susceptible to being transported by water*
Management:	A set of continuous interventions in order to achieve sustainability**

* In the view of SedNet, sediment and suspended solids are the same in terms of SSM.

** It should be emphasized that management of sediment is inextricable connected the management of soil/water system.

Sediment has several functions that play an essential role in the river and marine system, and must be viewed in this context. In Figure 1 these functions are related to sediment and categorised along the three values.

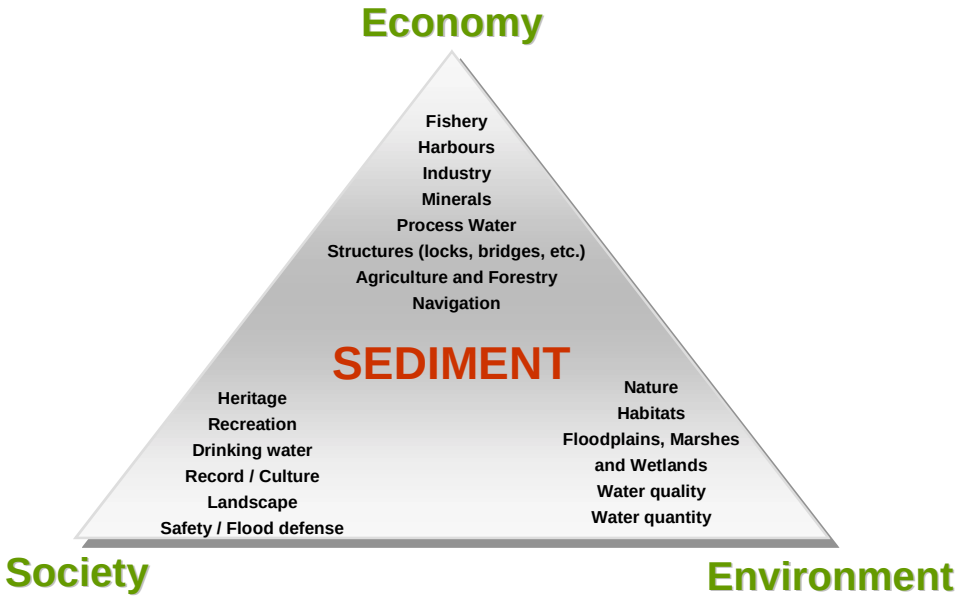

Fig. 1 The three values and sediment functions.

Society

The river system has many relationships with society. The river provides an essential life-support function and is an important source of drinking water. It is not only a supportive medium for communities, (old) cities and cultural heritage, but rivers are also important for the perception and value of landscapes and cities. Sediments provide a unique 'record' of human interventions in the river system.

Economy

Rivers are very important for the economic development of countries and regions. It is the oldest infrastructure and life source around which many economic activities began to develop. Rivers are a source of fish, drinking water and water for other economic activities such as industry, agriculture and forestry. Rivers also have an infrastructure function, i.e. transport, which in many countries is the cheapest method of transportation. Harbours are nodal points in this infrastructure and are very important for the economy of the region or country. Sediment quality and quantity have a direct impact on these activities, both fostering and obstructing these activities. For instance, fish cannot live in heavily contaminated water, harbours can silt up, whereas 'clean sediment' can act as a raw material for building material or as fertiliser for agriculture, etc.

Environment

Water quality and quantity are inextricably linked with sediment quality and quantity. Sediment is an important fertiliser in the natural environment and plays, together with water quantity and quality, a crucial role in the natural environment as the life support of habitats and species. In recent years floods have been seen as undesirable in terms of remobilising contaminated sediment from floodplains. In the past, such river functioning was perceived as beneficial in maintaining the natural floodplain environment as well as providing agriculture with inputs of sediment and associated nutrients.

The wide variety of functions is represented by a wide variety of stakeholders often with conflicting interests. For some environmentalist stakeholders that have a 'purist' point of view, water has to be as clean as possible, for others with a more pragmatic perspective, this is not feasible. Some stakeholders do not see the effects of pollution upstream, though downstream stakeholders such as harbour managers are confronted with contaminated sediment and considerable costs to manage them.

These problems require the joint efforts of states, and all relevant stakeholders to make more effective use of existing solutions and in generating new solutions that are beneficial for the river system. Balancing social, economical and environmental values will allow a bigger 'space' for solutions and enable a greater range of issues to be discussed. These integrated solutions cannot be implemented through standard policy measures. The institutional arrangements around rivers are very old and cannot cope with the challenges of the sustainable development of the river system. The EU Water Framework Directive (EU WFD, see section 3) will give a push towards new institutions and new institutional arrangements. This is an important notion for the strategy of SedNet.

Guiding principles for the SedNet SSM Guidance Document

The perspective on sustainable sediment management is leading to some principles used by SedNet to guide sustainable sediment management (SSM) approaches:

- Sediment needs to be managed at an appropriate scale: Sediment management needs to be planned in context to catchment scales and integrated into existing frameworks at this scale, such as river basin management plans.
- Sediment is part of the soil/water system. Management of sediments should be planned in the context of the soil/groundwater/water/sediment system (the subsurface).
- Work with nature: Management strategies for sediment should respect nature: working with nature, not against it. Thus it is crucial to use and improve our understanding of river system functioning and the role of sediment therein.
- Sediment balance: Taking sediment out of the system can cause sediment deficits resulting in habitat loss and destabilisation of river system functioning. Therefore, sediment management must also consider the sediment balance and its dynamic role in the hydrological and geomorphologic processes within each river.
- The stakeholder values and views on sediment. The perception of sediment is depends on a variety of roles, values and definitions and is influenced by stakeholder interests. In order to maintain a dialogue, definitions and terms used to describe sediment must be neutral and all-embracing, and sympathetic to stakeholder values and views.

Based on the above, SedNet aspires to the following guiding principles for SSM:

- *SedNet builds on the multi-value (society, economy, environment) use of sediment*
- *Interventions should not result in unwanted impacts elsewhere in the river basin (up- or downstream) and/or should not have an adverse impact in the future*
- *Integrated solutions, embracing the whole soil/water system, are needed*
- *Solutions need to respect natural processes and functioning*
- *Solutions should be found in the context of the whole river system and in close interaction with the stakeholders*

5 Implications for EU policy and research

EU policy

In many European countries the policy governing the natural environment is arranged in sectors – soil, water, air and waste – and each of these is managed by different legislation and regulations. Quality and quantity issues are often tackled separately. In some countries the organisation that regulates the water quantity, is not responsible for the quality of the surface water. A complicating factor when dealing with sediment is that natural processes occur on a number of temporal and spatial scales (geological cycle, catchments area, river foreland, and polder) and do not pay attention to political or administrative boundaries. Due to its trans-boundary nature, no single stakeholder or country feels responsible for solving sediment management problems at the river-basin scale. This makes it a common, EU management issue.

At the level of the EU, sediment management is addressed fragmentarily and it is only covered by EU policies and directives for very specific issues. EU documents with a link to sediment are the: Waste Directive, Landfill Directive, Urban Waste Water Treatment Directive, Directive for Integrated Pollution and Prevention Control, European Soil strategy, and the European Water Framework Directive (WFD).

Effective protection and management of our sediment resources needs a more focussed approach. The WFD aims to harmonise water legislation in EU countries and focuses on the management of water at the river-basin scale. Thus it gives the best possibility for integration of a more direct and less fragmented focus on sediment management and for trans-boundary management.

The WFD, therefore, represents an enormous opportunity and stimulus to come up with guidance for sustainable sediment management. The current scope of the WFD does not yet specifically deal this subject. Sustainable sediment management should eventually become an integrated part of the WFD. The requirements for a river basin-wide sediment concept will be even more challenging than the actual WFD (Förstner 2002).

EU research

For sediment related research that is meant to underpin EU policy development and implementation, the SSM guiding principles (section 4) lead to the following recommendations (extracted from Brils et al. 2003 and SedNet 2004):

- Improve our understanding of the relation between sediment contamination and water quality and between sediment contamination (hazard) and its actual risk and impact to the ecosystem functioning (ecological quality).
- Especially in the context of perturbations due to climate change, improve our understanding, and thus also our capability to predict/model, of the fate of contaminants: from emission (up stream) to adherence to soil and/or suspended particles to sedimentation (also upland) and re-suspension (downstream).
- Improve our understanding of sediment transport process (including erosion and sedimentation) at the river basins scale as a function of land and water use and hydrological (climate) change in Europe.
- Research about new architectures for policy processes with respect to sediment and soil issues that enable interaction of several involved policy domains, interaction with stakeholders, new joint knowledge production processes and joint actions.

- Research about how the connection between the different involved policy levels and between strategy and implementation can best be established.
- Evaluation (social/economic/technical/environmental) of source control programs and a cost benefit analysis of risk reduction through source control, including the management of historic contamination.
- Downscaling of global, European and country scale socio-economic scenarios to the river basin scale and their effect on sediment quantity and sediment and soil quality and research into the development of best management to comply with current and future EU regulations.

References

Brils JM, Salomons W, van Veen J. 2003. Preliminary SedNet recommendations for research priorities related to sediment. November 2003. European Sediment Research Network SedNet. EC contract No. EVK1-CT-2001-20002. Key action: 1.4.1 Abatement of water pollution from contaminated land, landfills and sediments. Paper downloadable through: www.SedNet.org

Förstner U. 2002. Sediments and the European Water Framework Directive. Editorial. *J. Soil & Sediments*. 2 (2):5.

Munasinghe M. 1998. Climate change decision-making: science, policy and economics. *Int. J. Environment and Pollution*. 10 (2):188-239.

SedNet. 2004. SedNet recommendations for sediment research priorities related to the soil research clusters.

Vegter J.J., Lowe J., Kasamas H. (edts). 2002. Sustainable Management of Contaminated land: An overview. A report from the Contaminated Land Rehabilitation Network for Environmental Technologies. Austrian Federal Environment Agency, 2002 on behalf of CLARINET, Version: August 2002 (http://www.clarinet.at/library/rblm_report.pdf)

Water Framework Directive (WFD) Directive 2000/60/EC, L327/1, Official Journal of the EC.

WCED - World Commission on Environment and Development. 1987. Our Common Future, Oxford University Press: Oxford, UK.