European Sediment Research Network

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WORKING GROUP 4
PLANNING AND DECISION MAKING:
OPPORTUNITIES FOR RIVER BASIN PLANNING OF SEDIMENT MANAGEMENT

Minutes of first workshop

Existing guidelines and the EU Framework directives

October 28th and 29th, Cranfield University at Silsoe, UK

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Working Group 4: Planning and decision-making:
Opportunities for river basin planning of sediment management

First workshop - Existing guidelines and the EU framework directives

A one and a half day workshop was hosted at the National Soil Resources Institute, Cranfield University at Silsoe on October 28th and 29th 2002. 13 Participants from 5 countries attended, representing sediment interests in policy, practice and research.

Name	Affiliation	Country	Representation	Role at workshop
Alison Collins	NSRI, Cranfield University at Silsoe	UK	Problem solver	Organiser
Phil Owens	NSRI, Cranfield University at Silsoe	UK	Problem solver	Organiser
Ramon Batalla	University of Lleida	Spain	Problem solver	Author of discussion paper, driver
Heinz Glindemann	Dept. of Port and River Engineering	Germany	Problem owner	Author of discussion paper, driver
Sjoerd Hoornstra	Ministry of Transport & Water Management	Netherlands	Problem owner	Author of discussion paper, driver
Harald Koethe	Federal Institute of Hydrology	Germany	Problem solver	Author of discussion paper, driver
Sabine Apitz	SEA Envrionmental Decisions	UK/USA	Problem solver	Participant
Julie Carter	IWE, Cranfield University at Silsoe	UK	Problem solver	Participant
Roy Morgan	NSRI, Cranfield University at Silsoe	UK	Problem solver	Participant
Gareth Old	Centre for Ecology and Hydrology, Wallingford	UK	Problem solver	Participant
John Quinton	Lancaster University	UK	Problem solver	Participant
Sue White	Institute of Water and Environment, Cranfield University at Silsoe	UK	Problem solver	Driver
Helen Wilkinson	Environment Agency	UK	Problem owner	Participant
Gavin Wood	NSRI, Cranfield University at Silsoe	UK	Problem solver	Participant

The first workshop of WG4 took the form of a discussion forum with keynote presentations at intervals throughout the meeting to focus thought and catalyse debate in order to satisfy specific objectives. Key points were transcribed to flipcharts to summarise the outputs and conclusions of each session. Prior to the workshop, discussion papers outlining the key topic areas were distributed to all WG members to inform and allow preparation for the discussions.

Programme

Activity	Title	Proposed drivers	Duration (min)	Start Time
Monday 28th October				
Welcome	Formal welcome to NSRI	Mark Kibblewhite (Director of NSRI)	10	1.30
Welcome	Working Group 4 and workshop agenda	Phil Owens	10	1.40
Introduction	Definition of sediment and sediment processes	Sue White	10	1.50
Discussion			20	2.00
Keynote	Decision making and planning at the river basin scale	Sjoerd Hoornstra Alison Collins	20	2.20
Discussion			60	2.40
Coffee				
Keynote	Overview of EU water framework directive and opportunities and constraints for sediment management	Phil Owens (with comments also supplied by H. Blöch via document))	20	4.00
Discussion			60	4.20
Close of session				5.20
Tuesday 29th October				
Keynote	Existing sediment management guidelines	Harald Koethe	20	9.00
Discussion			60	9.20
Coffee				
Keynote	Sediment management of tidal and sweet river systems and the EU Directives	Heinz Glindemann	20	10.40
Discussion			60	11.00
Keynote	Sediment management in reservoirs and water supply basins	Ramon Batalla	20	12.00
Discussion			30	12.20
Wrap-up	Review of workshop and outputs		40	12.50
Close of workshop		Phil Owens Alison Collins	10	1.30
Lunch or departure				

The following sections briefly review the main sessions of the workshop. More detailed information on each session can be obtained from the pre-workshop discussion papers, which are contained after the review and summary.

<u>Summary of the main workshop sessions</u>

1) Building a common language and understanding

A definition for sediment was developed in agreement with the WG leaders meeting/SedNet policy paper. Sediments are part of a complex environmental system, from supply to management. Sources, supply and transport processes are highly spatially and temporally variable. More extenisve sediment monitoring is needed to identify problems and assist management. Understanding the sources of sediment is fundamental for sustainable sediment management in order to control sediment transfers and dynamics at the source and not just manage a symptom of the problem or issue.

2) Decisions in sediment management – a decision making framework

The key decisions in sediment management were identified:

DECISION		ACTIVITY
1.Identify problem		1.Identify problem
2.Scope of site investigation		2.Explore problem
3.Intervention necessity		3.Assess severity
4.Nature/scale of problem	→	4.Explore causes
5.Scope of solution		5.Explore solutions
6.Selection of solution		6.Assess solutions
7.Adopt implementation		7.Planning/organisation
		8.Implementation and monitoring

3) The EU Water Framework Directive and sediment management

- Within WFD several key points of interest for SedNet
- River management is at the river basin scale
- All waters are to be protected – surface, ground, tidal and coastal waters
- Steamlining European legislation – integrating all water related legislation
- Issues of sediment management are not really addressed explicitly
- Focus is on chemical and ecological quality
- SedNet is, and must be, broader and more comprehensive than sediment as covered by the Water Framework Directive

4) Existing sediment guidelines

- Sediment management means all steps in the sediment "issue" process
- Existing *river* programmes at the basin scale, e.g. programmes for flood management – *we need to learn from these*
- There are decision support systems (tools) to support sediment management
- Existing sediment management guidelines (none river basin scale) include–Conventions for the protection of the marine environment
  –Conventions for the trans-boundary movement of hazardous waste
  –Recommendations for the management of dredged material
  –European regulations
    •Water legislation
    •Soil legislation
    •Waste legislation

5) Reservoirs and tidal systems

- These environments have associated sediment issues
- In the case of tidal, changes to the natural system mean that the river system is not able to behave as it would likeMany tidal zone environments – like salt marshes – require sediment inputs In the case of reservoirs, sedimentation reduces lifespan, and may cause sediment deficit downstream of reservoir
- Sediment management involves dealing with both clean and contaminated sediment - problems and issues associated with each will be different, although interconnected

<u>Summary of WG4 issues and perspectives</u>

At present sediment has no dedicated legislation at local, national or European levels, but interfaces with many other legislative fields such as the Water Framework Directive, Waste Directives, Soil Regulations, and a range of treaties and conventions. Within these related policies sediment takes on a variety of roles, values and definitions. For example, sediment is often *classified as waste by legislation frameworks generating a negative image for sediment, and leading to practical difficulties in handling and managing sediment.*

Not only is sediment insufficiently supported by legislation, but also lacks integrated, comprehensive and river basin scale management guidelines or frameworks. Neglecting to manage sediment in a sustainable way, either by a lack of adequate sediment management strategies, or the cursory inclusion of sediment in generic policy and legislation can result in costs to both society and the environment

In order to effectively manage sediment a greater understanding and appreciation of the complexity of sediment balances, scales of operation and key principles requires development, including the recognition that:

- Sediment supply, transport, and deposition are spatially and temporally variable
- Sediment size is a continuum - from fine (clays and silts) to coarse (sands and gravels etc.)
- Any changes in the delicate balance of sediment quality and quantity can be significant for many inter-related natural and anthropogenic systems
- Sediment controlling processes are highly dynamic and variable and therefore effective sediment management must be site specific and understand the dominant spatial and temporal processes at catchment scales
- Sediment management must consider the specific sediment balance and its role in the hydrological and hydraulic processes within each river. Sediment cannot be unrestrictedly taken out of the river system without negative consequences for a plethora of systems that depend on its functioning.
- The basin-scale approach means that we need to recognise, there are many different environments within a river basin – land, river, lakes/reservoirs, tidal and coastal zone
- There are gaps within our knowledge base, specifically a lack of information on sediment, sediment problems, sediment behaviour at the river basin-scale (system scale), and a lack of monitoring data and programmes

It is recognised that a European drive towards sustainable sediment management is required with the following key recommendations:

- Long-term integrated sediment <u>monitoring</u> programmes require co-ordination and implementation to provide an information base for decision-making
- Sediment management needs to be planned in context to <u>catchment scales</u> and integrated into existing frameworks at this scale such as river basin management plans
- Sustainable strategies must include the ‘friendly’ transfer of sediments from upstream areas to river mouth, with <u>respect to the natural processes</u> of erosion and deposition (since these allow the healthy functioning of habitats, related environmental systems and river system equilibrium)
- A sustainable <u>sediment balance</u> for river systems should be budgeted to satisfy multi-objective requirements (such as good ecological and navigational status) and existing sediment deficits in floodplains, estuarine and coastal zones need to be <u>replenished</u> in order to prevent habitat loss and destabilisation of river system functioning
- The <u>definitions and terms</u> used to describe sediment must be neutral and all- embracing
- Management strategies for sediment should seek to <u>work with nature</u>, not against it, for ecological and economic sustainability
- There is a need to bring in those people that influence WFD (EU directives) into SedNet family

- In WG4 we all agree on the need to consider:
  –Upstream (source) and downstream issues
  –Clean and contaminated sediment
  –Problems of sediment excess and deficit
  –Multiple interconnected environments in a river basin

Main outputs from the workshop

- We have started to develop a decision-making framework
- We have assembled information on existing sediment management guidelines
- We have evaluated the positive and negative aspects of the WFD and identified gaps that need addressing
- We have assembled information on sediment issues and sediment studies for the catalogue
- We are beginning to shape ideas on a sediment management guide
- We are thinking collectively that sediment management really does matter

Associated material

As a result of discussions at the workshop, a brief statement document on ***The importance of sediment and sediment prcoesses for river basin management*** was produced by key members of WG4. This can be located and viewed at http://www.sednet.org/materiale/WG4/WG04_riverbasin.pdf.

The following papers were presented as keynotes at the workshop, to introduce discussion topics. Some of these have been revised. Also, some of these papers will probably be submitted for publication. For this reason, copyright lies with the authors and with SedNet Working Group 4. Please contact either Phil Owens or Alison Collins for further details.

Existing Sediment Management Guidelines: an overview

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Introduction

On the formation meeting of SedNet WG 4 at the inaugural conference in April 2002 in Venice it was decided that a survey of existing sediment management guidelines was an obligatory pre-requisite to elaborate on the opportunities for river basin planning of sediment management.

For the success of this task it is essential to have a common and clear understanding of the main terms (sediment, management) particularly on an international (European) level. These terms will be discussed in greater detail at the workshop, but for the purposes of this paper sediments are understood as a sedimentary deposition of mineral, organic and anthropogenic particles on the water bottom in a river system. The definition of International Navigation Association (INA, formerly PIANC) defines sediment further reading as

"*a material, such as sand, silt, or clay, suspended in or settled on the bottom of a water body. Sediment input to a body of water comes from natural sources, such as erosion of soils and weathering of rock, or as the result of anthropogenic activities, such as forest or agricultural practices, or construction activities. The term 'dredged material' refers to material that has been dredged from a water body, while the term sediment refers to material in a water body prior to the dredging process*" (PIANC ENVICOM 5, 2002).

Sediment management means all the steps in sediment handling (uptake/dredging, transport and disposal) including characterisation and assessment of the sediment quality which is needed in river maintenance, construction and remediation. Furthermore an optimum sediment management concept needs a holistic understanding of the processes which are involved in sediment genesis and erosion under the specific hydrological conditions in each river system to work together with the forces of nature and not against them. Sediment management includes also the understanding of sediment contamination with the overall aim of source control.

The demand of the new Water Framework Directive (2000/60/EG) to enlarge the focus on the whole river basin and its catchment area is a new challenge. The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. "Transitional waters" are bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows (refer to discussion paper *Sediment Management in tidal and fresh water systems with reference to the EU directives*, Glindemann (2002).

"Coastal water" means surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters. Consequently this means that the special features of the existing sediment management procedures in different river sections (inland, transitional, coastal) and existing simulation models and modelling systems have to be combined to understand their relationships regarding sediment transport on a river basin scale.

It is therefore necessary to develop the understanding of the different human activities in the river basin (in water and on land in the catchment area) and their influencing factors which are relevant to the sediment transport (see table 1).

Table 1: Important human activities and influencing factors regarding sediment managment
Note: table does not claim to be exhaustive

	Purpose	Factor
Water	Energy production	Water power plant, Barrage
	Water supply	Reservoir, Barrage
	Navigation	Maintenance dredging, capital dredging (river development), Barrage
	Raw material extraction, mining	Sand and gravel extraction
	Flood protection	Dams, dikes, barrages and other constructions
Land	Agriculture	Changing of land uses, erosion
	Mining	Introduction of suspended matter
	Flood protection	Dams, dikes in flood plains
	Urban development	Changing of land uses

It comes clear that the different players in the river basin have to work together to reach the optimum management strategy on a river basin scale.

From this perspective it is worthwhile to look which programmes on a river basin scale already exist.

Existing Programs for Flood Management
Because water is the main carrier medium for sediments it is important to know that there are some EU-projects for flood management working on a river basin scale with an integrated approach. Strategies and tools for sediment transport and management should use the knowledge and understanding being developed already in context of flood management programmes. Two important EU-projects are highlighted below as an example.

EUROTAS (http://www.hrwallingford.co.uk/projects/EUROTAS/home)
The EUROTAS project (1998-2000) responded to the second call for proposals in the Environment and Climate programme of the Fourth Framework research programme of the European Commission under contract number ENV4-CT97-0535. The EUROTAS project was directed at the development and demonstration of a framework for integrated catchment modelling; for the assessment and mitigation of flood risk and at the development of appropriate modelling and management procedures. The framework is not tied to any particular modelling system but sets protocols for communication between different modelling components.

IRMA-SPONGE (http://www.ncr-web.org/pub18.php)
The IRMA-SPONGE Umbrella Program is funded by the European IRMA Programme, which stands for Interreg(ional) Rhine-Meuse Action Programme. The acronym SPONGE stands for 'Scientific Programme ON GEnereting sustainable flood control' - but during the course of the program in was found that 'flood risk management' more adequately covers the scope of our research than 'flood control'. The 13 projects that form IRMA-SPONGE cover an enormous range of subjects from a large number of scientific perspectives. To achieve consistent results and streamline the output from the 13 projects, they were grouped in three Scientific Clusters that acted like a ‘focussing instrument’ between the projects and the Dutch National Centre for River Studies (NCR) during the final stages of the program. Projects within these Clusters are looking at interconnected issues from related scientific backgrounds:
- Flood Risk and Hydrology [projects 1, 3 and 12].
- Flood Protection and Ecology [projects 6, 7, 8, 9, and 11].
- Flood Risk Management and Spatial Planning [projects 2, 4, 5, 10 and 13].

As an example IRMA-SPONGE Project 2 "Integrated management strategies for Rhine and Meuse" could act as an umbrella where a sediment management strategy on a river basin scale could be linked to.

Decision Support Systems (DSS)
In the last decade, mathematical models, databases, expert systems and geographical information systems all have been applied as separate tools in the research and management of water sources. A DSS aims to integrate these tools and thereby provide an adequate scientific description of water systems for the comparison of different strategies and measures. Flexibility is an important point of concern during the development of the DSS. The DSS must on the one hand suit the needs of the river manager for (long-term) policy development and, on the other hand, support

interactive development of flood protection measures and landscape planning. Within the DSS accepted methodologies for alternative development and evaluation are formalised and are automatically consistent for various scale levels. The user is guided through an integral and multidisciplinary evaluation process in order to facilitate a well balanced and sustainable development of a river system. As an example IRMA-SPONGE Project 4 is dealing with Decision Support Systems (DSS) for large rivers.

It has to be considered how a DSS for an integrated sediment management on a river basin scale can be developed on the existing experiences of flood management. As tools there are various simulation models and modelling systems for sediment transport or soil erosion available which have to be collected and proved for their use in a DSS as part of an integrated sediment management framework to be developed.

Existing Sediment Management Guidelines
Against the above given background it can be stated that there is presently no comprehensive river basin sediment management guideline on international (European) or national level.

Management guidelines which are of high relevance for sediment management exist mostly for the purpose of environmentally sound handling for navigation. For the maintenance of waterways and harbours sediments have to be handled in an environmentally sound and economical way. There are some special international and national regulations for dredged material which have different legal and technical backgrounds, purposes and limited competence. The way to find the appropriate regulation within legislation has to follow the question: **What shall happen with the sediment/dredged material?**

Conventions for protection of the marine environment
Three conventions are of relevance for sediment management in Europe because they have set into force dredged material guidelines for the disposal of dredged material into the sea. The purpose and primary aim of these guidelines is the environmentally sound disposal (relocation) of dredged material within the sea.

a) The **London Convention - LC** (1972) on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, which is signed by 75 countries around the world:
Dredged Material Assessment Framework - DMAF (1995)

b) The **OSLO-PARIS (OSPAR) - Convention** (1992) on the Protection of the Marine Environment of the North - East Atlantic (North Sea):
OSPAR-Document 1998-20: Guidelines for the Management of Dredged Material

c) The **Helsinki (HELCOM) Convention** (1992) on the Protection of the Marine Environment of the Baltic Sea Area:
HELCOM RECOMMENDATION 13/1 (1992): Disposal of dredged spoils

The dredged material guidelines of those conventions are harmonised to the greatest possible extent. With regard to the Water Framework Directive the competence of these guidelines ranges for the coastal and transitional waters due to national implementation. Consequently they are of importance for sediment management in the estuarine and coastal area of a river basin. Some countries have implemented these guidelines in special national guidelines like the *HABAK (Directive for the handling of dredged material in coastal waterways, 1999)* in Germany or in Portugal the *Technical Rules for Excavation/Dredging and Management of Dredged Material (Ministry Order, n.º 141- June, 1995).*

Specifically, tributyltin (TBT) has accumulated in sediments predominantly around harbours and dockyards in high concentrations. Consequently the **International Maritime Organisation** (Marine Environment Protection Committee - MEPC) has introduced following **resolution** in November 1999, which is of big importance for sediment management: *Global prohibition on the application of organotin compounds which act as biocides in anti-fouling systems on ships.*

In the meantime the OSPAR Convention incorporated TBT as an obligatory parameter within the dredged material guideline. Because of the severe impact of TBT to some species of the aquatic ecosystem special national concepts how to handle TBT contaminated sediments were made or are in work. E.g. Germany has introduced a national concept for the handling of TBT-contaminated dredged material in coastal waters in November 2001 (*TBT-Konzept*, *BLABAK*).

Convention for the trans-boundary movement of hazardous waste
If sediments are heavily contaminated they have to be classified as hazardous waste (waste code 170505 in the European Waste Catalogue) the **Basel Convention** on control of trans-boundary movement of hazardous waste and their disposal (1989/1990) has to be considered when the sediments shall be transported (after dredging) into other countries for the purpose of treatment and disposal. From current experience sediments

are never or very rarely hazardous waste from their degree of contamination and the transportation of contaminated sediments into other countries is not known or the exception.

International Recommendations for the management of dredged material
Various recommendations (incl. frameworks) for the management of dredged material are available from the **International Navigation Association** (INA, formerly PIANC, see http://www.pianc-aipcn.org/). The most recent and important ones are:

Working Group PTC I-17 "Handling and Treatment of Contaminated Dredged Material from Ports and Inland Waterways "CDM" Vol. 1 +2" (1996/1997)

Special Report of the Permanent Environmental Commission "Dredged Material Management Guide" (1997)

Working Group PEC 1: "Management of aquatic disposal of dredged material" (1998)

PIANC Arbeitsgruppe ENVICOM 5 ‚Environmental Guidelines for Aquatic, Nearshore and Upland Confined Disposal Facilities for Contaminated Dredged Material' (2002)

Furthermore the series of guides "Environmental Aspects of Dredging" from **Central Dredging Association (CEDA) and International Association of Dredging Companies (IADC)** give general guidance in dredged material management (see http://www.dredging.org)

Guide 1: Players, Processes and Perspectives (1996)

Guide 2a + 2b: Conventions, Codes and Conditions: Land Disposal. (1997)

Guide 3: Investigation, Interpretation and Impact (1997)

Guide 4: Machines, Methods and Mitigation (1998)

Guide 5: Reuse, Recycle or Relocate (1998)

Guide 6: Effects, Ecology and Economy (2000)

Guide 7: Frameworks, Philosophies and the Future (2001)

European regulations

Water legislation
If sediments (dredged material) shall be relocated or disposed (e.g. in a confined or contained way) within the water (river) water legislation applies. The water legislation is significantly changed by the Water Framework Directive (WFD, 2000/60/EG). Despite the fact the terms "sediment" and "dredged material" are not highlighted or even not mentioned in the WFD sediments are a natural and essential part of the aquatic environment and their management has an important role within water legislation. It is obvious that a comprehensive sediment management concept has to be part of each river basin management plan which has to be produced and updated by each EU member country to fulfill the demands of WFD. From this perspective it is a clear mandate for SedNet Working Group 4 to give guidance how this challenging task could be reached.

The existing international experiences (e.g. dredged material guidelines of international conventions, see above) show that the first and most important option for sediment management, in pratice, is to leave the sediments in the water in an environmentally sound way. Consequently there are special national guidelines available which provide assessment criteria for the aquatic disposal (relocation or confinement) for inland and coastal waters. Whereas the coastal guidelines are in line with the guidelines of the international conventions (see above) national guidelines and criteria may differ for the inland part of the rivers.

The water legislation regulates also the protection of groundwater. With regard to sediment management the upland disposal (incl. beneficial use and treatment) of sediments has to be regarded. For upland disposal usually the soil or waste legislation applies. Consequently the relevant guidelines for sediment management have to searched in those fields of legislation (see next chapters). It can be stated that - depending from country to country - relevant sediment guidelines are on one hand available as independent documents or on the other hand hidden in the laws and their ordinances. The report "Dredged Material and Legislation"(in prep. 2002) from the Dutch-German Exchange on dredged material (DGE) shows this complex legislative situation in form of a comparison for The Netherlands and Germany as an example very clearly.

<u>Soil legislation</u>
A European regulation for the protection of soils is in preparation. Some European countries have set Soil Protection Acts into force already. For example in The Netherlands sediments (subhydric soils) are part of the Dutch Soil Protection Act, in Germany they are excluded. This difference is important for sediment management because the Soil Protection Act prescribes a duty for remediation if a certain degree of contamination is exceeded (invention values).

The soils in the floodplains (e.g. alluvial clay) which carry the same characteristic of contamination as the sediments in a river basin (due to flood events) is also under the scope of soil protection legislation. If sediments shall be re-used or disposed on soils in the floodplains the higher background concentration of contaminants in floodplain soils should be regarded to prevent an inadequate handling. In any case a scientific expertise of the soil in the floodplain and the sediment foreseen for disposal is part of a sediment management framework.

Furthermore one goal of soil protection is the avoidance of soil erosion which means prevention of increased introduction of suspended matter into the river. Special guidelines in this direction are also part of sediment management.

<u>Waste legislation</u>
Waste legislation is applicable for sediments if the definition of waste in the European Waste Directive (75/442/EEC, Article 1a) applies:

"Waste" means any substance or object which the holder disposes of or is required to dispose of pursuant to the provisions of national law in force.

This definition is independent from the quality of sediments. If the term waste applies for sediments, the European Waste Catalogue (2001) contains two waste codes for sediment (170505 "Dredging spoil containing dangerous substances" and 170506 "Dredging spoil other than those mentioned in 17 05 05").

The handling of waste legislation follows the principle: 1. Avoidance of waste – 2. beneficial use (incl. treatment) – 3. landfill. All three options are part of an integrated sediment management and there are several technical guidelines in waste legislation which apply for sediments and differ to some extent on national level.

Uncertainties with the handling of dredged sediments in the case of treatment and landfilling are expressed in the preamble of the European Landfill Directive (1999):

> *"Whereas further consideration should be given to the ... processing of dredging sludges".*

If dredged sediments can remain environmentally sound in the aquatic environment the term "waste" should <u>not</u> be used because water or waterway legislation apply in this case. This is expressed in the exception of the European Landfill Directive in Article 3 that "*... the deposit of non-hazardous dredging sludges ....in surface water including the bed and its sub-soil"* is exempted from this directive.

Aquatic disposal can be practised in an environmentally sound way for the overwhelming amount of dredged sediments world-wide. Sediments are in the first case natural and important part of the aquatic system and cannot be taken out unrestrictedly without negative consequences for the water system. A purely formal classification as waste would cause a negative image (which is already there) and unneccessary troubles in permitting procedures for aquatic disposal, which may lead to an inadequate handling. European countries are dealing in different ways with this problem currently.

Conclusion and outlook
There is currently no integrated, comprehensive sediment (dredged material) managemant guideline on a river basin scale. Asking the question "What shall happen with the sediment/dredged material?" to different fields and different sets of legislation and regulations apply. Due to national implementation of international conventions and EU Directives the European member countries have developed special dredged material guidelines with different (limited) competences in practices. It can be concluded that there is a need to have a more simple, pratice-oriented and harmonised guidance for sediment/dredged material management in Europe**.**

Because of the complex situation a joint venture between expert groups from The Netherlands and Germany, the *Dutch-German Exchange on Dredged Material* (DGE), has started in 1999 on an informal governmental level under the headship of the Ministries for the Environment and Transport. Designed to elaborate the state of the art situation in relevant disciplines (legislation, treatment, ecotoxicology etc.) of dredged material management. The first DGE-document called *"Dredged material and legislation"* and the second called "Treatment and Confined Disposal of Dredged Material" are very close to publication. Independent to this initiative the European Dredging Association (EUDA) has drafted a paper called *"Regulatory guidance for the disposal of dredged material in Europe"*.

For the first workshop of SedNet WG 4 some key questions for integrated sediment management on river basin scale are:

- How shall all those existing regulations from different fields of legislation be harmonised into one river basin sediment management framework?
- Should the sediment management framework be linked to existing river basin frameworks (e.g. flood management)
- What are the relevant existing tools for sediment management?
- How can the relevant tools be linked together e.g. in a Decision Support System?

Sediment Management in tidal and fresh Water Systems with reference to the EU Directives

Heinz Glindemann
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Introduction
SedNet activities are primarily focused on fresh water river systems, as the European Commission must delimit its competence from salt water systems in the coastal areas covered by OSPAR (Oslo-Paris-Convention/Oslo-Paris-Commission) responsibilities.

The EU-WFD (European Water Framework Directive) focuses on complete river systems such as fresh water and salt water influenced systems.

Tidal river systems cannot be assigned to either fresh or salt water systems. These systems are unique in that they link fresh and salt water systems by a 'brackish' zone. Sediment transport is a complex product of, amongst other factors, the flood and ebb stream, driven mainly by astronomical forces like the moon and sun.

Before any decision-making guidelines can be formulated greater understanding on tidal river systems is required.

Tidal River Systems
The saltwater influence from the mouth of an estuary leads to distinct effects and phenomena such as two-way flows of salt and fresh water layers flowing in different directions simultaneously. These flows mix in the brackish water zone with production of suspended matter, which contributes a significant part of clay material for the creation of marshlands.

At the mouth of the river erosion and sedimentation processes simultaneously occur in large quantities. The morphodynamics of a tidal river system is influenced highly by hydraulic forces, with sediments from saltwater reaches settling in fresh water areas. Sediments originally from down-stream and can therefore be found at the river mouth or in the coastal zone area.

This mixing process is a product of many other factors such as fresh water discharge or wind effects, of which the balance can change simultaneously. Permanently changing morphologic features in and around the channel are the result of these morphodynamic effects. Variations in water depth, current and velocity are also indicative of tidal river systems, with all variations producing a distinct set of marine habitats with associated flora and fauna.

The rise of mean sea level over thousands of years triggers further sets of processes. The tidal pumping of sediments from the river mouth upstream is a process caused by increases in sea level. Wider river sections or harbour basins develop into shallow water-systems, 'wadden' areas or 'greenland', rivers degenerate into multiple channels and shallow water areas vanish.

Human activities
Activities such as dike building encourage the development of tidal river areas into marshlands. Dredging plays another important role, for example, by maintaining fairways as well as supporting nature by restoration works. Ecological effects caused by these human activities can lead to positive and negative effects for the environment depending on whether activities work with and respect natural processes or work against them. The ecological state and the water quality, the main topic of the EU-WFD all depend on the balance of these factors and processes.

Without any doubt, experts might have problems with such a strong simplification of a complex hydrological and ecological system, however for the purposes of our SedNet objectives it provides a good basis for our discussions.

First conclusions
Driven by nature or man made, the role of tidal river sediments is a very complex one and can only be managed correctly when it is done by reflecting the context of the whole system. It is challenging to appoint rules and guidelines on how to manage the system and to balance economic and ecological aims in a sustainable manner. Manmade influences on tidal rivers must be managed well in order to achieve ecological quality.

No tidal river system will remain as it is. Dynamic change is a part of the sustainability that can be reached and should be focused on when discussing the aims of EU-WFD for tidal river systems. All of these systems in Europe currently require some degree of continuous help by dredging to reach such dynamic sustainability.

After understanding this complex system and accepting the aims of EU-WFD we have to think about other EU-Frameworks such as the Habitat Directive or EU-Landfill Directive, which are often in contradiction to well-balanced sediment management.

In order to successful managed sediment in tidal river systems we must accept that sediment is a substantial part of the tidal river system, and any solutions for local situations must be made in context to the complex system of processes and balances that is their nature.

Sediment Management in reservoirs and water supply basins

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Silting of reservoirs and effects

Viewed over a long term, runoff erodes the land surface, and the river network carries the erosional products from drainage basins. **Transport of sediment** through the catchment and along the river system is a **natural continuum**. Dams trap most sediment in circulation through the river network, and changes in sediment loads propagate downstream for years and decades (Kondolf, 1997). **Sedimentation** seriously impairs **reservoir basic functioning**. If reservoirs are to represent renewable sources of water supply, sediment management has to be part of both existing and future dams (Morris, 1993).

Reservoir sedimentation is a Europe-wide problem, but especially in areas with high sediment yields and high degree of impoundment, such as Mediterranean climate regions. In such areas, water availability and demand are out-of-phase and, thus, the **degree of river impoundment** tends to be higher than in more humid regions. Most dams are built for water storage instead of flood control. For example, Spain owns more dams than any other country in Europe and 2.5 % of the population of dams of the world. Representative surveys indicate that almost 10% of reservoirs in Spain have experienced a reduction in capacity of 50% or more (Avendaño et al., 1997). Assuming that the other half reservoirs have no significant silting problems, mean weighted reduction of dams' capacity in Spain can be estimated around 10%. Dams built during the 20th century in Spain are, on average, 35 years old. Combining these two figures, we obtain a mean annual reduction of reservoir capacity of 0.3%, with a sedimentation of **170 hm^3/year** ($hm^3 = 1 \cdot 10^6\ m^3$).

Sedimentation in reservoirs causes a progressive reduction of dam impoundment capacity, at an estimated rate of **US $6 billion** in replacement costs every year (Fan and Springer, 1993). In addition, it creates serious problems for reservoir operation, especially near outlets of dam. **Hydropower facilities** suffer most, due to the sediment progressively blocking paths to the plant. The passage of sediment to the plant can also erode turbines, requiring frequent repair of plant facilities. Moreover, water quality in storage can be degraded, due to phenomena such as eutrophication.

Deficiency of sediment in rivers is primarily a consequence of a lack of sediment captured by dams, which may get worsen by in-stream gravel mining. Dams release sediment-starved, or **hungry water** which may transport sand and gravel without replacement from upstream, resulting in armouring of the surface layer, thus causing loss of spawning gravels (Kondolf, 1997). The excess energy water may erode the river bed, resulting in **incision**, thus damaging bridges[1] and undercutting banks, thereby causing widening. Dams also reduce sand supply to coastline and deltas. The erosion of the Nile Delta (150 m/y), 1000 km downstream of Aswan High Dam demonstrates the importance of sediment supply from the upper catchment. Current sediment yields in the Ebro River are around 200,000 t/y (Vericat et al., 2002) 1% of the sediment load from the beginning of the 20th century (Nelson 1990). Lack of sediment due to dams and reduction of sediment transport capacity may be related to the retreat of the delta observed since the seventies.

Sediment management

Sediment flows naturally through the drainage network. Any disruption of its continuity may create within-reservoir and downstream problems. Some sediment management actions may also have non-desirable effects downstream. But if no action is taken, reservoir may get progressively full, affecting dam operation and worsening environmental effects downstream. Any comprehensive attempt of sediment management in river systems must consider this fact. Long-term programmes must be implemented to monitor sediment transport in river basins, in order to assess its deficits. But **short-term regular actions** can be undertaken. Active management of sediment has to be incorporated into decision-making and planning for current and future reservoirs.

Sediment **management techniques** capable of maintaining reservoir capacity have been developed and applied at a small, but growing number of reservoirs (Morris, 1993). They can be grouped under three types: a) reduction of sediment yield from the basin, 2) sediment routing through or around the reservoir to downstream reaches, and 3) sediment removal. Controlling slope erosion and/or constructing traps and debris-control basin upstream reservoirs can reduce sediment yield and retard sedimentation in the reservoir. Such techniques have been applied worldwide and described elsewhere. Main differences between techniques of types (2) and (3) is that sediment routing prevents sediment deposition while sediment removal focuses on the erosion of deposited sediments (Morris, 1993). Sediment routing methods transport hydraulically fluvial sediments beyond the dam. They include: sediment by-pass using a diversion tunnel, with examples in Switzerland, France, South Africa and Taiwan (in Morris, 1993), and off-stream reservoirs (Morris, 1993). Transitional techniques such as reservoir drawdown (Wu, 1984) and seasonal use reservoir

[1] A recent case was the collapse of a bridge in the Duero River upstream Castel de Paiva (Portugal), on March 4th 2001, causing the death of seventy people.

(Hwang, 1985), would led to a certain amount of sediment to be deposited only at a flood or seasonal level. Reservoirs in series provide interesting opportunities for sediment management (Zhang Hao et al., 1976). During floods, most sediment is trapped by the downstream reservoir. Once the water is diverted for beneficial uses, the remaining clear water in the upstream reservoir is released to scour deposited sediment in the downstream site. Their implementation might be feasible in flood-control basins and reservoirs in temperate climate areas, but would be more difficult to apply in large water conservation structures under highly variable climates, such as the Mediterranean. This report will focus on techniques of the type (3).

Mechanical extraction and off-site disposal

Dredging is sometimes applied to restore reservoir capacity. In United States dredging is typically used in small reservoirs. Cost is the most important constrain, ranging from US $0.3/m^3 for the Lake Springfield in Illinois (Morris, 1993) to US $15-50/m^3 for the Feather River in California (Kondolf, 1995). **Dredged material** is usually placed on specific sediment placement sites and/or in lateral canyons, as it does the LACDPW (Los Angeles County Department of Public Works) (USACE and LACDPW, 1994), or downstream of the dam. This option is less costly but, dependently on river capacity of entrainment downstream deposits, it may posse important environmental problems, as it happens after sluicing (see 4.2. for additional information). Sediment extracted from reservoirs or debris-control basins have been use to **enhance fish habitat**, for instance in the Sacramento River, at a cost of US $ 22 milion/year (Buer, 1994), and to protect **river infrastructures**, in the Rhein River downstream Iffezheim Dam, where an average of 170,000 tonnes of gravel are added to the river (Kuhl, 1992). Sediment removed from reservoirs could also be used to refill gravel pits in the valley and feed beaches. These options were considered in the case of the San Gabriel Canyon (USACE and LACDPW, 1994) and in the Ventura River (Edmund Andrews, USGS, personal communication), but rejected due to high costs of transportation. Sediment mined from reservoir deltas can also be use as **aggregated**, if grain-sizes are appropriate. Sand and gravel are commercially mined from some debris basin in Los Angeles and from Rollins Dam in the Bear River, where 200,000 tonnes are extracted every year, and sold at US $10 per tonne of aggregate. In Taiwan, virtually all dams are mined for construction aggregate. In Israel, the Shikma Reservoir in Israel is mined in its upper part to produce sand and gravel for construction aggregate and in its lower to produce clay for use in cement and bricks (Laronne, 1995). In the Talarn Reservoir in the Noguera Pallaressa River (Spain, Central Pyrenees), more than 0.6 hm^3 of sediment has been removed for aggregate within the last 10 years (J. Carles Balasch, personal communication). Noise, NO_x and other emissions and dust due to heavy machinery used for sediment excavation, are among the most significant **environmental impacts**. If contaminated sediments are present in reservoirs, they could be transported and adversely impact soil and groundwater at the disposal site.

Hydraulic removal and downstream deposition

Within reservoirs, cohesive sediments near dams may be difficult to remove by hydraulic action of water alone. Sometimes they have to be previously mobilized with explosives, such as in the Zhiyu Reservoir in China (Morris, 1993) or compress air, such as in the Barasona Reservoir in the Esera River in Spain. There, 40 meters of silt and clay deposited since 1969 had to be mobilized prior consecutive sluicings between 1995 and 1997, at a cost of several ten million dollars.

Hydraulic flushing consists of the release of water from a reservoir by opening the low level outlets and permitting the reservoir to drawdown sufficiently to resuspend sediment and move bedload. If low levels are open at high flow and the reservoir is drawdown, a small reservoir behaves essentially as a reach of river, passing inflowing sediments through the dam outlets. In such action, sediment is delivered downstream of the dam at similar concentrations as prevailed in the pre-dam regime (Kondolf, 1997). Successful attempts of **sediment pass-through** are reported in the old Aswan Dam on the Nile River and on the Bhagurk Reservoir on the Yeluard River in India (Stevens 1936, in Kondolf 1997), and in the River Inn in Austria and Germany (Hack, 1986). **Flow Assisted Sediment Transport (FAST)** is the sediment pass-through option proposed by the LACDPW in the San Gabriel Canyon Sediment Management Plan (1994). It involves making releases from the bottom gate at the Cogswell Dam (11 hm^3) during storm season to emulate the outflow rates that would have occurred under natural pre-dam conditions. The range of sediments expected to remove annually from the reservoir vary from 32,000 m^3 during dry years to 175,000 m^3 during wet periods. Another sediment management plan, which included sediment-pass through as an option to prevent the accumulation of sediment, was issued for the Rock Creek – Cresta Reservoirs in the North Fork of the Feather River in California (Harrison, 1992). The Jansanpei Reservoir in Taiwan is left empty with open low-level outlets for the first two months of the rainy season (May and June), so sediments accumulated over the months of July-April can be flushed by the first high flows of the season before storing water in the latter part of the rainy season (Hwang 1994). However, at present, **sediment pass-through** is not commonly done, probably because of limited capacity of many low-level outlets and because of concern that debris may become stuck in the outlets, making them impossible to close later, and making diversions impossible during the rest of the wet season until flows drop sufficiently to fix the outlets. Large reservoirs cannot be drawn down sufficiently to transport sediment through their length to the outlet works, for such a drawdown would eliminate carryover storage from year to year, an important benefit from large reservoirs (Kondolf, 1997). **Loss of fisheries** due to frequent drawdowns is an environmental consequence that has to be taken into account. Finally, a **minimum pool** is required to prevent prograding delta deposits from reaching the intake structure near the dam itself and therefore preserving dam function (Patricia Wood, LACDPW, personal communication). This fact prevents the implementation of FAST in reservoirs devoted to water conservation.

If sediment is permitted to accumulate and released during baseflow (**sediment sluicing**), the river's transporting capacity is inadequate to move the increased load and the most severe effects are likely to occur. The abrupt increase in sediment load and decrease dissolved oxygen level may alter substrate and aquatic habitat conditions downstream of the dam. Examples of harmful effects of sluicing can be found for instance, in California (e.g. Kern River downstream Democrat Dam, San Gabriel River downstream Morris Dam, Carmel River below Los Padres Dam) (Kondolf, 1995, G. Mathias Kondolf, personal communication) and Spain (Noguera Ribagorzana downstream Santa Anna Dam, Ésera and Cinca Rivers downstream Barasona Dam) (Palau, 1995). In all cases sediment remain within the channel years after the operation. Despite substantial environmental impacts, further sluicing are still proposed in Spain.

If topographic conditions are suitable, sediment-laden floodwater may be routed around a reservoir in a diversion tunnel or permitted to pass through the length of the reservoir as a density current vented through a bottom sluice on the dam (Morris 1993). The Nan-Hwa Reservoir in Taiwan was designed with a smaller upstream forebay from which sediment is flushed into a diversion tunnel, allowing only relatively clear water to pass into the main reservoir downstream (Morris 1993).

Other possibilities

Beach nourishment with imported sediment dredged from reservoirs and harbours has been implemented along beaches in southern California (Allayaud, 1985). However, the high costs of transportation, sorting for the proper size fractions and cleaning of contaminants of dredged materials, as well as the difficulty in securing a stable supply of material make these options infeasible in many places (Inman, 1976).

Final considerations

Sediment needs to be managed in reservoirs, as does the water, through gradual implementation of correction steps on a **long-term strategy**. Ironically, sediment gets trapped within reservoirs while rivers are profoundly altered downstream and coastline and deltas suffered from an intensive **sediment deficit**. Only few places, such as Israel, California and Taiwan have undertaken official **pilot programmes** for a better understanding of the degree of river alteration created by those activities, as basis of management strategies. Some considerations can be learnt from current plans:

1. Assessment of sediment deficit in regulated and mined rivers requires **long-term monitoring programmes**, which most countries do not have. Instead, sparse data have to be used to evaluate **sediment budgets in regulated rivers**.
2. The long-term sedimentation problem might not be completely solved but **periodical actions** stabilise the situation at a short-term.
3. **Sediment pass-through** during floods would be the most environmentally sound action, but it is costly due to the value of water stored in reservoirs. Cost of installing low-levels outlets, where necessary, will generally be less than cost of mechanical removal of sediments. The need for a **minimum pool** on each reservoir for effective protection of valves, and the climatic variability prevents the use of water-methods on a regular basis.
4. Sediment management in regulated rivers may imply a range of **impacts**, from higher sediment loads, to river-bed sedimentation and effects on native fish species.
5. Reservoirs can be proposed as an **alternative source of sediment for aggregate**. Sediment Management Plans should include policy tools such as tax breaks for mining aggregate from reservoirs, and incentives to overcome costs of processing sediment and transporting it to markets.

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A Decision Framework for Sediment Management in River Basins

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INTRODUCTION

Sednet Working Group on Planning & Decision-Making
At its first meeting (Venice, 23 April 2002), SedNet working group 4 (Planning & Decision-making) identified the necessity to develop a general framework for sediment management. Such a framework should:

- distinguish the different types of decisions that can be taken in sediment management within and at the catchment scale;
- comprise decisions on the identification and assessment of problems as well as the generation and selection of remedial options.

This paper presents the results of discussions on this issue at the first workshop of working group 4 (Silsoe, 28-29 October 2002). Objectives of the framework are:

- to create a logical order of decision-making steps for planning purposes;
- to describe relations between different working fields within sediment management, in particular those currently under elaboration by various SedNet working groups.

Building a framework
The framework has been built upon two assumptions:

- there is a need for sediment management and its inherent decisions only if and where sediment-related problems (are likely to) occur;
- decisions should primarily be linked in a chronological order.

Thus, a scheme emerges which starts with the identification of a potential sediment-related problem at a specific location within a catchment. Subsequent steps cover the characterization of the problem and the identification and selection of solutions, based on general problem-solving theories. In accordance with these theories, each step may be subdivided into smaller steps, and one or more steps may need to be followed more than once in order to yield an acceptable result (iteration).

Identification of potential problem
In an ideal situation, river management authorities have full knowledge of transport and quality of sediment in their part of a catchment area and, therefore, can identify immediately any changes that may have adverse affects on human uses of the water system or ecology. This hardly ever is the case as this would require detailed and expensive monitoring.
In practice identification of a sediment-related problems emanates from:

- Targeted research programmes (e.g. for shipping, fisheries or water quality);
- Malfunctioning infrastructure (damage to bridges, reduced reservoir capacity);
- Large interventions in the sediment fluxes or composition subject to environmental impact assessment (dams, gravel mining, new waste water discharges);
- Complaints from society.

The former two sources of information on potential problems often use predefined standards which express the operational objectives that exist for eg shipping (depth), fisheries (stock), constructions (stability) and reservoirs (volume).

The identification of a potential problem is regarded as “step 0” in the scheme below. Subsequent steps and their respective key decisions are briefly addressed below. Implementation of selected measures is not explicitly in the scheme (“step 7”).

Step	Decision	Activity
0	--	Identification of potential problem
1	Scope of site investigation	Explore problem
2	Intervention necessity	Assess severity
3	Nature/scale of problem	Explore causes
4	Scope of solution	Explore solutions
5	Selection of solution	Assess solutions
6	Adopt implementation plan	Planning/organisation

7	--	Implementation & monitoring

SEDIMENT MANAGEMENT DECISIONS

Scope of site investigation
With the identification of a sediment problem, decision 1 is to decide whether or not to start a dedicated site investigation. Environmental or socio-economic interests will largely govern this decision. Stakeholders are likely to be the water management authority, water users and possible bank owners/users. Within the site investigation design process there may be a range of sub-decisions with regard to scope and level of detail. *Staged* investigation approaches are quite common. Such an approach starts with a limited number of samples or parameters in order to target subsequent, more costly investigations.

In the case of an *external development (exogenic factor)*, it is important to distinguish between interventions that have already taken place (recently), and those in a planning stage. In the latter case the "potential effects" need to be evaluated, e.g. in an environmental impact assessment, using expert judgment or scientific models.

Intervention necessity
Given the outcome of a site investigation, decision 2 is whether or not it is desirable / necessary to make a *targeted intervention*. This decision relates to the severity of the environmental or socio-economic problems that emerge from the site investigation. Predefined standards (criteria) are helpful to ensure an equal treatment in all cases and prevent discussions on the severity of the problem in each individual case. It may be helpful to distinguish between the severity of a problem and the urgency, where the former assessment has a theoretical/scientific emphasis (generic potential risk) and the latter a practical/site-specific emphasis (specific actual risk).

Nature/scale of problem
Given the necessity to intervene, decision 3 is to explore and determine the nature of the problem. This requires a wider investigation, if possible at the river-basin scale, to assess the origin of the sediment – or its contamination - problem. Such an assessment is likely to use hydrological and geomorphological knowledge as well as an understanding of the fate and behaviour of contaminants [working group 2].

The decision states:

- The scale of the problem (predominantly local or catchment-wide)
- The type of problem (predominantly quality or quantity of sediment).

It may appear that a common cause gives rise to a range of problems beyond the original site investigated. In case of *external developments* this is not unlikely. Depending on the outcome, the stakeholders will need to be redefined.

Scope of solution
Given an appreciable understanding of the nature of the sediment problem(s), a logical next step is to generate intervention strategies (or: mitigation options). Decision 4 is the determination of the initial scope of this exercise. This includes the scale of the solution – whether it is taken at the catchment scale e.g. change in land management practices or the micro-scale e.g. installation of a sediment trap on a tributary as well as a range of solutions in between these scales. In addition to geographical scope, it is also important to decide upon technical scope e.g. whether or not to include solutions other than dredging, etc. Again, this has repercussions for the stakeholders.

Also, the scoping decision includes a predefinition of the characterization of different strategies (parameters); in other words: how to describe and, at a later stage, assess these strategies. In addition to socio-economic and environmental efficacy (cf. problem-related criteria used in step 2), parameters such as timing, sustainability and formal responsibilities are likely to be important [working group 6]. In the particular case of removal of sediment (dredging), it is also necessary to elaborate consequences of different destinations for dredged material [working group 2].

Selection of solution
Given a proper description and analysis of intervention strategies, decision 5 is the selection of the mitigation option, or mix of options, that best meets the predefined criteria. This decision determines whether the best solution is one that changes practices (i.e. modifying land use practices or industrial processes) or one that active intervenes and installs a structural solution or one that removes the problem (e.g. sediment traps or dredging). Due to differences in the nature of the criteria concerned, and differences in the values attributed to these criteria by different players (which, in turn, depends on their interests), this type of decision will commonly be taken in a *political context*, if only for budgetary implications.

As in step 2, this decision can be divided into different stages: e.g., a strategic decision can be that dredging with a certain frequency is the best intervention strategy, but further analysis is required to decide on the most appropriate destination of the dredged material.

Furthermore, if it is clear from preceding steps that there is a complex set of interrelated problems on a (sub) catchment scale, then step 5 can be an expeditious sediment management planning exercise.

Adopt implementation plan
Once an intervention strategy has been selected, decision 6 relates to the adoption of an implementation plan for a coherent programme of distinct measures. Such a plan describes all of the measures envisaged, relevant participants and suitable deadlines. Also, it is necessary to determine the way in which the implementation is actually managed. The *timing* of the start of implementation is subject to a wide range of external factors, such as:

- Budgetary issues;
- Confluence with other initiatives in the area concerned;
- Vulnerability of environmental systems e.g. it may not be possible to carry out works during spawning season.

In particular this step requires intensive contact with stakeholders.

WAYS FORWARD

Now that major decisions in sediment management have been identified and have been put in a sequence, it is necessary to further elaborate for each step:

- The decision-makers and stakeholders concerned;
- The (technical) instruments to assist decision-making.

Working group 4 has adopted this task, in particular with a view to:

- Ensure full applicability to all types of sediment-related problems (sediment quality and sediment quantity);
- Further elaborate **sediment planning** (step 5) on a river basin scale.

In addition, the scheme may be helpful in identification of relationships between the activities of SedNet working groups, and potential gaps in these activities.

Getting Europe's waters cleaner -getting the citizen more involved

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Abstract

The European Union has just thoroughly expanded and restructured its water policy by the EU Water Framework Directive[i]. The key objectives of the new policy are:

- all waters to be protected, groundwaters, rivers, lakes and coastal waters
- all waters to achieve good quality ('good status') by 2015, using a "combined approach" of emission controls and quality standards
- water management based on river basins
- economic instruments (economic analysis; water pricing) supporting environmental objectives
- mandatory participation by citizens, stakeholders and NGOs
- integrating all water–related EU legislation into a coherent managerial frame.

The European Parliament has attached particular attention to negotiations on the Directive, aiming throughout the co-decision procedure at a high level of protection and binding and enforceable objectives and tools.

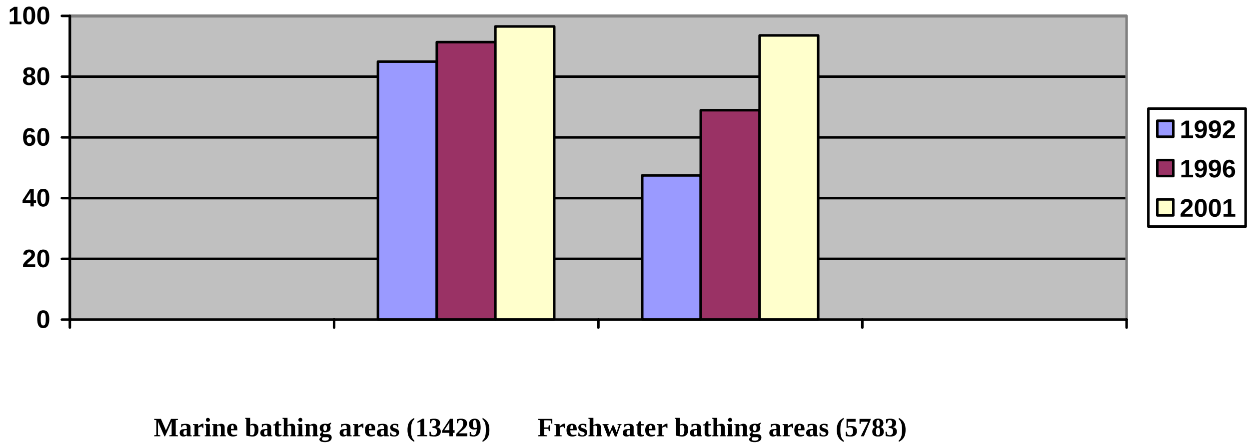
Implementation of the new European Water Policy will be a challenge for all involved parties. In an unprecedented way a Common Implementation Strategy has been set on track, involving not only Member States and Commission, but Candidate Countries, NGOs and stakeholders as well, providing a living example of Good European Governance.

This contribution provides an overview on European Union legislation on protecting our waters, its development as well as its future key objectives and tools.

An early beginning in the 1970s and 1980s

Early European water legislation focused, in a "first wave" in the 1970s and 1980s, mainly on quality standards for certain types of waters - bathing waters, fish and shellfish waters and waters used for drinking water abstraction. Success stories of this period are, inter alia, the 1976 Bathing Water Directive and the 1980 Drinking Water Directive.

Table 1: Development of bathing water quality in Europe: compliance with the EU Bathing Water Directive[ii]



The 1990s: addressing pollution from waste water, agriculture and large industries

In the 1990s a "second wave" of European water legislation addressed pollution from urban waste water, from agriculture and from large industries:
The **Urban Waste Water Treatment Directive** of 1991 provides for waste water collection and treatment for all settlements and agglomerations but the very small ones. Its deadlines are phased for 1998, 2000 and 2005, depending on the size of the settlement and the characteristics of the affected water.

Table 2: Urban Waste Water Treatment Directive: standard provisions

Parameter	Value (concentration)	Value (% reduction)
Biological Oxygen Demand BOD_5	25 mg/l	70 – 90 %
Chemical Oxygen Demand COD	125 mg/l	75 %

24–hour average; either concentration or percentage of reduction shall apply; strict compliance rules. Mandatory design rules for treatment plants (minimum requirement = highest maximum weekly average load throughout the year.) as well as sewerage systems.

Table 3: Urban Waste Water Treatment Directive: provisions for sensitive areas

Parameter	Value (concentration)	Value (% reduction)
Total nitrogen Plants of 10 000 –100 000 p.e. Plants >100 000 p.e.	 15 mg/l 10 mg/l(	70 – 80 %
Total phosphorus Plants of 10 000 –100 000 p.e. Plants >100 000 p.e.	 2 mg/l 1 mg/l	80 %

Annual average; either concentration or percentage of reduction shall apply.

The Directive has already contributed to an improvement of the quality of our big rivers. However, there are delays, in some cases even scandalous delays, with still prevailing discharges of untreated or insufficiently treated waste water; Brussels and Milano are only two 'highlights' of this negative hit list, addressed last year by Environment Commissioner Wallström in a "name and shame" seminar. The Commission will continue to expose to the public such lack of commitment to environmental obligations, but also to take the necessary legal action at the Court of Justice, including applications for penalty payments.

The **Nitrates Directive** sets out clear rules for nitrates pollution from agriculture, one the main sources of groundwater pollution as well as of eutrophication of surface waters in many regions of Europe. There is a two level approach:

- Within nitrate vulnerable zones (i.e. regions with elevated nitrates concentrations in groundwater or surface water >50 mg/l, and/or with eutrophicated waters, or in danger of become eutrophic) legally binding measures are required. These requirements entail minimum manure storage capacities coherent with the nitrogen demand of soil and crop; restrictions for manure application in terms of time, location and nitrogen load per hectare and year etc.
- Outside vulnerable zones codes of good agricultural practice have to be promoted on a voluntary basis.

Throughout the countries a monitoring system is established, both as a planning instrument and as a tools for compliance checking.

Many Member States have so far shown insufficient progress in implementing this Directive. Following legal action by the European Commission, a range of rulings by the European Court of Justice has already been passed. The Commission will continue to expose to the public lack of commitment to environmental obligations, but also to take the necessary legal action, including applications for penalty payments.

The **Directive for Integrated Pollution and Prevention Control (IPPC)** addresses large industrial installations, looking at pollution to water, air and soil. Emission controls for installations covered have to be based on best available technique. Requirements apply to new installations as well as, after a transition period until 2007, to existing installations.

A new European water policy

Water problems throughout Europe have a lot in common, e.g. pollution from waste water and agricultural sources. However, local and regional water problems can present a quite diverse pattern, both as regards quality and quantity, in the North and in the South of the Union, in the present Member States and in Candidate Countries in Central and Eastern Europe and the Mediterranean. This is true for the quality of our groundwaters, lakes and rivers, for flood events in some regions, for local and regional scarcity in water in others, and for the protection of our waters as a resource, be them fresh waters or marine waters.

Based on experience gained but also gaps identified; mid-1995 saw pressure for a fundamental rethink of EU water policy coming to a head, and agreement between the Commission, the European Parliament's Environment Committee and the Council of Environment Ministers found on the need for a fundamental reform.

The Water Framework Directive presents a breakthrough in European Water Policy, not only as regards the scope of water protection, but also as regards its development, and, I dare say so, its implementation.
The Commission has, right from the start, developed this new policy in an open and transparent way involving all stakeholders, NGOs and the scientific community. Only based on a broad consultation exercise including a two-day Water Conference with all interested and involved parties did the Commission come forward with its legislative proposals [iii] [iv] [v], with the following key elements:

- all waters to be protected, groundwaters and surface waters including coastal waters
- all waters to achieve good quality (‘good status’) by 2015
- water management based on river basins
- "combined approach" of emission limit values and quality standards (for waters, sediments and biota), plus phasing out particularly hazardous substances
- economic instruments (economic analysis; water pricing) supporting environmental objectives
- mandatory participation by citizens, stakeholders and NGOs.
- streamlining legislation, and integrating all water–related EU legislation into a coherent managerial frame.

Implementing the new Directive –a common challenge to all

In implementing the Water Framework Directive, all parties – Member States, European Commission, Candidate Countries and all other involved parties - face considerable technical challenges, in terms of substance as well as deadlines:

Table 4: Key obligations and deadlines

Obligations for Member States	
Transposition into national legislation	December 2002
Analysis of impacts and pressures	December 2004
Economic analysis of water use	December 2002
Monitoring programmes operational	December 2006
Latest date for starting public participation	December 2006
River basin management plans	December 2009
Obligations for the Commission	
List of Priority Substances	✓ adopted
Daughter Directive emission controls - Proposal	December 2003
Daughter Directive quality standards - Proposal	December 2003
Inter-calibration of quality classification	December 2004

Further, the majority of river basins in continental Europe are shared between countries. A common understanding of the Directive and common approaches are therefore of crucial importance for a successful implementation. This is why, in an unprecedented effort, Member States and European Commission have agreed on a Common Implementation Strategy.

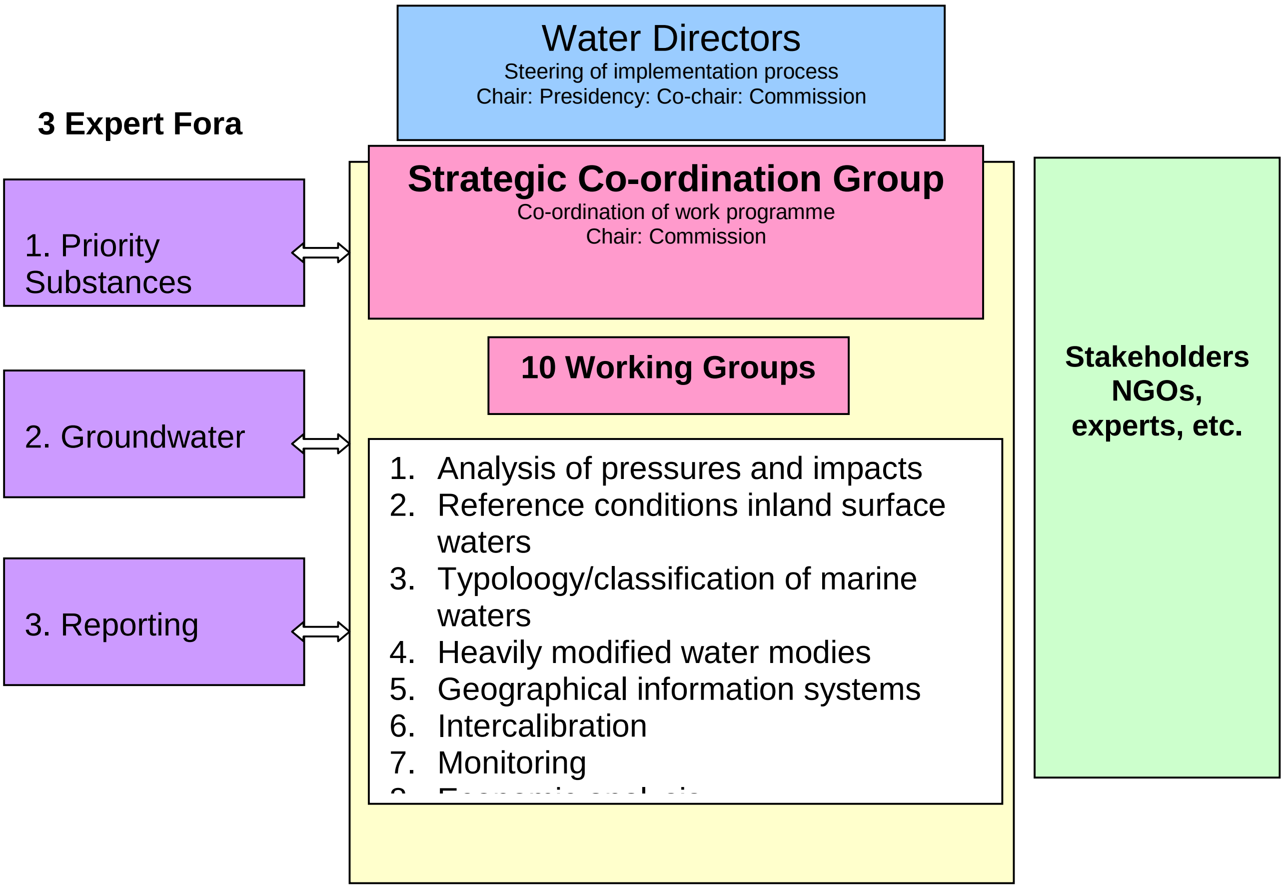
Key activities within the Strategy are

1. exchange of information
2. development of guidance documents
3. management of information and data
4. application, testing and validation

Logo of the Common Implementation Strategy for the Water Framework Directive

During summer and autumn of 2001 a range of working groups have taken up work, with the specific task of developing guidance documents for selected target areas. Those groups are led by various Member States, the Commission and the European Environment Agency. A Strategic Coordination Group guides and coordinates the process.

Working structure under the Common Implementation Strategy



Immediately after start of the work, full integration of Candidate Countries, stakeholders and NGOs has been ensured. Detailed information is available on the Internet, as is the full text of the Common Implementation Strategy[vi].

Expanding the scope of water protection

All of Europe's waters will be protected under the Water Framework Directive, surface waters and ground water (in the past only a limited number of water for specific human use, such as fish waters, shellfish waters, bathing waters are protected under European legislation). Unlike previous water legislation, the Water Framework Directive covers surface water and groundwater together, as well as estuaries and marine waters. Its purpose is threefold: to prevent further deterioration; to promote sustainable water consumption based on the long-term protection of available water resources; and to contribute to the provision of a supply of water in the qualities and quantities needed for its sustainable use.

"Good status" for all waters by a set deadline

Under the Directive Member States will have to ensure that 'good status' is achieved or kept in all waters by a set deadline, 15 years after coming into force, i.e. 2015. Certain limited derogations will be possible.

For groundwater, good status is measured in terms of both quantity and chemical purity; for surface waters ecological quality and chemical quality are the criteria. Member States will need to establish programmes for systematically monitoring the quality and quantity of their groundwaters and surface waters.

Water management based on river basins

One of the Framework Directive's innovations is that rivers and lakes will need to be managed by river basin - the natural geographical and hydrological unit - instead of according only to administrative or political boundaries. Several EU Member States already take a river basin approach but this is at present not the case everywhere. For each river basin district – many of which will transcend national frontiers - a river basin management plan will need to be established and updated every six years. This plan will have to include an analysis of the river basin's characteristics, a review of the impact of human activity on the status of waters in the basin, and an economic analysis of water use in the district. Groundwater and coastal waters would be assigned to the nearest or most appropriate river basin district. Regions and river basins like those in the Rhine or Elbe/Labe basins have served as a positive example for this approach to water management, with their cooperation and joint setting of objectives across Member States borders and even beyond the borders of the EU: The salmon is back again to Rhine and Elbe !

The Danube: Europe's largest river basin, size 817.000 km^2, shared between 18 countries.

Programme of measures, emission limit values and water quality standards

Central to each river basin management plan will be the requirement to establish a programme of measures to ensure that all waters in the river basin achieve the objective of good water status. Our waters do not know political or administrative borders. Therefore wherever Member States share a river basin, they are under obligation to jointly develop and establish the
The starting point for this programme is the full implementation of any relevant national or local legislation as well as of a range of Community legislation on water and related issues. If this basic set of measures is not enough to ensure that the goal of good water status is reached, the programme must be supplemented with whatever further measures are necessary. These might include stricter controls on polluting emissions from industry or agriculture as well as from urban waste water sources.

The Directive takes a "combined approach" to pollution control
- limiting pollution at the source by setting emission controls, and
- establishing water quality objectives for water bodies.

In each case, the more stringent approach will apply. Thus Member States will have to set down in their programmes of measures both limit values to control emissions from individual point sources and environmental quality standards to limit the cumulative impact of such emissions as well as of diffuse sources of pollution. The emissions limit values will have to be set in line with Community, national and regional legislation, inter alia, with the Directive on Integrated Pollution Prevention and Control (IPPC) and the Urban Waste Water Treatment Directive for installations and discharges covered by these Directives.

For relevant pollutants and pollution sources the Water Framework Directive foresees EU Daughter Directives for emission controls and water quality standards. The first List of Priority Substances has already been agreed[vii].

For particularly hazardous substances ("priority hazardous substances") a mechanism for their phasing out (cessation of emissions, discharges and losses to or via the aquatic environment) is a legal obligation. The List of Priority Substances agreed in 2001 lists also those substances foreseen for 'phasing out'.

Daughter Directives will now have to address the emission controls, the phasing out and quality standards for waters, sediments and biota. These Daughter Directives are being developed in a broad consultation exercise and based on technical-scientific studies. Details on the progress of the process as well as all relevant background documents are available on the European Commission's WebSite [viii] and the information exchange platform CIRCA [ix]

As for waters used for drinking water abstraction, they will be subject to particular protection, Member States being required to set environmental quality standards for each significant body of water that is used for abstraction or may be in future. The quality standards must be designed to ensure that under the expected water treatment regime the abstracted water will meet the requirements of the Drinking Water Directive.

Water quantity addressed

The Water Framework Directive is the first piece of Community water legislation to address the issue of water quantity. It stipulates that the programme of measures established for each river basin must aim to ensure a balance between the abstraction and recharge of groundwater. Moreover, all abstraction of surface water or groundwater will require prior authorisation except in areas where it can be demonstrated that this will have no significant impact on the status of the water. These provisions, together with the full cost-recovery pricing, will contribute towards protecting our waters as a resource.

Getting the prices right

The need to conserve adequate supplies of a resource for which demand is continuously increasing is also one of the drivers behind what is arguably one of the Directive's most important innovations - the introduction of pricing. Member States will be required to ensure that the price charged to consumers of water-related services - such as for the abstraction and distribution of fresh water and the collection and treatment of waste water - contribute to the wise use of this limited resource.
However, the principle of affordability to the citizens may also be taken into account when fixing water charges, e.g. in less-favoured areas or to provide basic services at an affordable price.

Getting the citizen involved: participation of the public

Caring for Europe's waters will require more involvement of citizens, interested parties, non-governmental organisations (NGOs). To that aim the Water Framework Directive will require information and consultation of all interested and involved parties when river basin management plans are established. In this spirit the Common Implementation Strategy does from the beginning fully integrate NGOs and stakeholders.

Streamlining legislation, and ensuring coherence between all water–related legislation

The Water Framework Directive

- will provide a coherent managerial frame for all water-related EU legislation via the mandatory provisions of the river basin management plans
- will rationalise EU water legislation by absorbing the operative provisions of 7 old directives[x], and repealing them at a later stage.

By contrast, the Water Framework Directive will complement and complete other key pieces of water-related legislation. In particular, the 1991 Directives on Urban Waste Water Treatment and on Nitrates Pollution, the body of rules governing the authorisation and use of pesticides, and the 1996 Directive on Integrated Pollution Prevention and Control (IPPC). For their part, the new Drinking Water Directive of 1998 and the Bathing Water Directive[xi] will be little affected and will continue to exist in their own right. At the same time, the Water Framework Directive will comprehensively support efforts to provide good quality drinking water (without major treatment of water necessary) and for keeping our bathing beaches clean.

Conclusions

The Water Framework Directive commences with the words

***"Water is not a commercial product like any other but,
rather, a heritage which must be protected …"***

In many fields progress has been achieved, however Europe's waters are in need of more protection, in need of increased efforts to get them clean or to keep them clean, as emphasised by reports recently published by the European

Environment Agency [xii] [xiii] [xiv] [xv]. After 25 years of European water legislation this is a demand not only by the scientific community and other experts, but also to an ever-increasing extent by citizens and environmental organisations.

Let us take up the challenge of water protection, one of the great challenges for the European Union for the new millennium. Let us seize the initiative generated by the present political process on the Water Framework Directive. It will lead us to a sustainable management of our waters, for the benefit of all Europe’s citizens and our waters.

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This contribution reflects the views of the author and not necessarily those of the European Commission.

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[ii] European Commission, Report „Quality of bathing waters“, Brussels 2001, http://europa.eu.int/comm/environment/water/water-bathing/index_en.html
[iii] European Commission Proposal for a Water Framework Directive of 26.02.1997, COM(97)49, OJ C 184 of 17.06.1997
[iv] European Commission Proposal for a Water Framework Directive, amendment of 26.11.1997, COM(97)614, OJ C 16 of 20.01.1998
[v] European Commission Proposal for a Water Framework Directive, amendment of 17.02.1998, COM(98)76, OJ C 108 of 07.04.1998
[vi] European, Commission, Member States and Norway: Common Implementation Strategy for the EU Water Framework Directive; Internet: http://europa.eu.int/comm/environment/water/water-framework/implementation.html
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[viii] European Commission WebSite on the EU Water Framework Directive
http://europa.eu.int/comm/environment/water/water-framework/implementation.html
http://europa.eu.int/comm/environment/water/water-dangersub/pri_substances.htm
[ix] European Commission WebSite WFD-CIRCA http://europa.eu.int/comm/environment/water/water-framework/information.html
[x] 1975 Surface Water Directive and its 1979 Daughter Directive on Smpling and Analysis, 1976 Dangerous Substances Directive, 1977 Decision on Exchange of Information on Surface Waters, 1978 Fishwater Directive, 1979 Shellfish Water Directive, 1980 Groundwater Directive.
[xi] Bathing Water Directive currently under review; Commission Proposal for a new Directive to be published autumn 2002
[xii] European Environment Agency: Environment in the European Union at the turn of the century: Luxembourg 1999
[xiii] European Environment Agency: Sustainable use of Europe’s waters? Copenhagen 2000 (part 1); Copenhagen 2001 (part 2)
[xiv] European Environment Agency: Sustainable use of Europe’s waters? Copenhagen 2002 (part 3)
all EEA publications available at the EEA WebSite http://eea.eu.int
[xv] European Environment Agency: Eutrophication in Europe’s coastal waters", Copenhagen 2000;