Dredged Material in the Port of Rotterdam
– Interface between Rhine Catchment Area and North Sea –

WORKSHOP REPORT II

River Sediments and Related Dredged Material in Europe

River Sediments and Dredged Material as Part of the System Catchment-Coastal Sea: Policy and Regulatory Aspects

Marine Safety Institute, Rotterdam, The Netherlands

17-19 April 2000

The Workshop was organised by the GKSS Research Centre and the Centre for Social and Economic Research on the Global Environment as part of the Rhine Research Project II (POR II) for the Rotterdam Municipal Port Management on the current and future contamination of dredged material and related emissions and immissions in the Rhine catchment area.

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Workshop Report

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Contents

Executive Summary

The workshop focused on policy issues surrounding the disposal of dredged material disposal. The disposal of dredged material is dealt with at the international, national and regional level. From the international perspective, the London Convention, OSPAR, HELCOM and ICPR gave presentations of the frameworks in which their organisations operate and deal with the issue of dredged material. The London Convention deals with issues of marine disposal at the global level, OSPAR with the North-East Atlantic, HELCOM with the Baltic Sea and the International Commission for the Protection of the Rhine (ICPR) with the Rhine catchment area. In addition national representatives from the Netherlands, Germany and the United Kingdom gave an overview of their national regulations. From the presentations it became clear that no uniform guidelines exist with regard to the disposal of dredged material in the various countries. Guidelines issued by international organisations are adapted/interpreted to/for local conditions. Furthermore the presentations and the discussions in the working groups showed that the catchment, the estuary and the marine environment are treated as single units, rather than as a continuum. However, a systems perspective to encompass the catchment-coastal zone continuum is required for cost-effective measures for the reduction of point and diffuse sources and for the identification of priority pollutants for both the fresh water and marine environment.

Two working groups dealt with either the short term (up to five years) developments in the dredged material regulations or longer term developments.

Both OSPAR and the EU have extended the lists of “chemicals of concern” from their present lists which include the heavy metals, PCB and PAH. Analysis for all these components was considered to be too onerous a task and therefore the conclusion was that in the future bio-assays in combination with chemical assessment would become more and more important. Bioassays, covering different modes of action and hence 'new chemicals' as well to some extent, provide an additional economic (in the sense of costs of analysis) tool for hazard assessment. However, there is a need to link hazard assessment of sediments to risk assessment at the actual disposal site.

In the long term it is anticipated that, with continuing control of point and diffuse sources, both capital and maintenance dredging will converge in a sense that both can be treated as relocation of geological material. The continued integration of stakeholder opinion is needed; and a scenario approach might be helpful in this respect. Recommendations include:

1. More harmonisation and standardisation of international regulation (guidelines and frameworks) while maintaining the integrity of local systems and approaches. An approach which adopts the marine system as the reference point for all other catchment based numbers and ranges might provide a step towards mitigating the issue of uncoordinated regulation, and also will serve to highlight the need for consistency of approach adopted towards each contaminant.
2. Increased stakeholder participation in the process of environmental regulation setting and monitoring, in particular to exploit local scale solutions and consensus-building practices.

3. The adoption of a scenario approach to allow the assessment of biological, physical, chemical and economic factors, and the balancing of these gains and losses against political, economic and social welfare decision criteria.

1 Introduction

The GKSS Research Centre carries out, on behalf of the Rotterdam Municipal Port Management, and in collaboration with the Institute for Environmental Studies (IVM, Amsterdam), the Institute of Freshwater and Fisheries Ecology (IGB, Berlin) and the Technical University of Hamburg-Harburg (TU-HH, Hamburg) an integrated science-policy study (Rhine Research Project II, POR II) on the management of dredged material. Primary aims are to investigate and predict the future quality of sediments originating from the Rhine catchment area and current and future policies on regulations with regard to dredged material.

As part of the project this policy-oriented workshop was organised by the GKSS Research Centre and the Centre for Social and Economic Research on the Global Environment (CSERGE). This workshop was preceded by a science-oriented workshop which focused on the scientific aspects of evaluating and implementing bioassays within decision-making frameworks for dredged material management. The results of this workshop were presented (see Appendix I) at this follow-up workshop which dealt explicitly with policy and regulatory aspects.

The policy-oriented workshop, reported on in this document, was attended by invited experts from Europe and incorporated a series of lectures during the first public day. During the following two non-public days two parallel working groups and a plenum session were devoted to discussions focussed on the major issues, as described in the background paper (Appendix II). The workshop agenda is outlined in Appendix III.

The discussion focused on regulatory aspects, both regional, national and international, of dredged material management. Working groups dealt with both short-term (up to five years) and more long-term issues.

2 Abstracts of lectures and additional abstracts of workshop participants

Management of dredged material in the OSPAR maritime area

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The Convention for the protection of the marine environment of the North-east Atlantic (OSPAR Convention) was signed on 22 September 1992 and replaced both the Oslo Convention (1972) for the prevention of marine pollution by dumping from ships and aircraft sources. The OSPAR Convention came into force 25 March 1998.

The OSPAR Convention consists of a main general text part (definitions, general obligations, rules, etc.), 4 Annexes and 2 Appendixes. A fifth annex on species and habitats has been adopted but is yet not in force. Annex II on the prevention and elimination of pollution by dumping or incineration is the annex under which dredged material falls. Annex II is based upon the reversed list principle which means that the dumping of all wastes or other matter is prohibited except for (a) dredged material; (b) inert material of natural origin; (c) sewage sludge until 31st December 1998; (d) fish waste from industrial fish processing operations; and (e) vessels or aircraft until, at the latest, 31st December 2004.

For these exceptions an authorisation or regulation should be granted by the competent authorities. Such an authorisation or regulation needs to be in accordance with relevant applicable criteria, guidelines and procedures adopted by the OSPAR Commission. For the purpose of dumping of dredged material the Commission adopted in 1993 guidelines for the management of dredged material. These guidelines consist of 2 parts and 3 technical annexes: part A deals with the assessment and management of dredged material, part B provides guidance on the monitoring of dredged material disposal operations, technical Annex 1 deals with the analytical requirements for dredged material assessment, technical Annex 2 gives normalisation techniques for studies on the spatial distribution of contaminants and technical Annex 3 advises on Best Environmental Practice.

It should be noted that these guidelines were still based upon the Oslo Convention but also adopted under the OSPAR Convention. For the moment they are a little bit old fashioned. They were on the work programme of SEBA (the working group on sea based activities) for review in 1999-2000. But because of restructuring measures within OSPAR this review hasn't been done yet.

The guidelines were designed to assist Contracting Parties in the management of dredged material in a way that will prevent pollution of the marine environment. It is recognized that both removal and disposal of dredged sediments may cause harm to the marine environment. Consequently, Contracting Parties are encouraged to exercise control over dredging operations as well as disposal using a Best Environmental Practise (BEP) approach to minimise the quantity of material that has to be dredged and to minimise the impact of the dredging and disposal activities in the marine area.

To define the conditions under which permits may be issued, Contracting Parties should develop criteria on a national basis. These criteria may be described in terms of chemical characteristics and/or biological effects (e.g. sediment quality criteria); reference data linked to particular methods of disposal or disposal sites; specific environmental effects that are considered undesirable outside designated disposal sites; and the contribution of disposal to local contaminant fluxes. With a view to evaluating the possibilities for harmonizing or consolidating criteria, Contracting Parties have to inform the OSPAR Commission of the criteria adopted as well as the scientific basis for the development of these criteria.

The following information needs to be obtained: amount and composition, amount of substances and materials to be deposited per day (week, month), form in which it is presented for dumping, physical (especially solubility and specific gravity), chemical, biochemical (oxygen demand, nutrient production) and biological properties, toxicity, persistence, accumulation in biological materials or sediments, chemical and physical changes after release, probability of production of taints reducing marketability of resources.

In the absence of appreciable pollution sources dredged material may be exempted from chemical and biological testing. Dredged material which may be exempted is defined the guidelines.

Advice is given on the suitable numbers of sampling stations in order to obtain representative results assuming a reasonable uniform region to be dredged. The number of stations is linked with the amount to be dredged. If a survey indicates that the material is essentially clean, surveys need not to be repeated more frequently than once every 3 years.

Analysis should normally be carried out on the whole sample but material greater than 2 mm grain size should be excluded. Information on density, per cent solids, grain size fractions, TOC below 2 mm is necessary in order to allow assessment of data on contaminant levels in terms of their likely impact. For non-exempted sediments analysis of heavy metals is mandatory. With regard to organochlorines, PCBs should be analysed and others may be analysed. The permitting authority may after considering local inputs to decide upon analyses for arsenic, oil, PAHs and triorganotins. More detailed requirements are provided in part B of the guidelines.

Concerning the characteristics of dumping site and method of deposit, very detailed information is given in the guidelines, including e.g. geographical position, depth and distance from coast, location in relation to living resources, location in relation to amenity areas; methods of packing (if any), initial dilution achieved by proposed method of release, dispersal, horizontal transport and vertical mixing characteristics, existence and effects of current and previous discharges and dumping in the area.

Attention is also given to the physical impact of dredged material disposal and guidance is provided on management techniques to minimize the physical effects of disposal.

Monitoring has to be undertaken in order to establish whether licensing conditions have as intended, prevented adverse effects on the receiving area as a consequence of dumping; to improve the basis on which licence applications are assessed and to provide the necessary evidence to demonstrate that the control measures applied are sufficient to ensure that the dispersive and assimilative abilities of the marine environment are not exceeded.

The purposes of monitoring are to determine contaminant levels in organisms, the biological effects and consequences for the marine environment due to the dumping of dredged material and, ultimately, to allow managers to control exposures of the organisms of concern to dredged materials and associated contaminants.

In order to approach the monitoring programme in a resource-effective manner it is essential that the programme should have clearly defined objectives. In order to establish such objectives, it is first necessary to derive an impact hypothesis describing predicted effects on the physical, chemical and biological environment.

For the analytical requirements for dredged material assessment is set up a technical supplement in the guidelines. A tiered approach to testing is recommended. The sequence of the tiers is as follows: assessment of physical properties, assessment of chemical properties and assessment of biological properties and effects. For the first two, detailed information is given. But for the last one no guidance is offered.

The second annex of the guidelines provides information on normalization techniques. Normalization is defined as a procedure to compensate for the influence of natural processes on the measured variability of the concentration of contaminants in sediments.

Technical annex 3 on BEP was prepared bearing in mind that, although the guidelines strictly only apply to the disposal of dredged material. Contracting Parties are encouraged also to exercise control over dredging operations.

Dredged material management global requirements and guidance

René Coenen

IMO - Office for the London Convention 1972

Introduction

Dredging is essential to maintain navigation in ports, harbours and inland waterways and for the development of port facilities. Much of the material removed during these necessary activities requires disposal at sea. The greater proportion of the several hundred million tonnes of material dredged annually worldwide is, by nature, similar to undisturbed sediments in inland and coastal waters. A smaller proportion of dredged material, however, is contaminated by human activity to an extent that major environmental constraints need to be applied when depositing these sediments.

At the global level sea disposal of dredged material is governed by the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972, or the London Convention 1972. Under this Convention - in force since 1975 and with currently 78 States as Contracting Parties - dredged material is identified as one of the six main categories of waste materials, which in principle, are allowed to be dumped subject to various provisions set out in the Convention including the issuance of a permit by a designated national authority. Dredged material is given the same position under the 1996 Protocol to the London Convention 1972, which, upon its entry into force, will supersede the Convention itself.

Dredged material has always had a special position under the Convention. About 70% of all dumping permits notified to IMO under the Convention concerned dredged material. This percentage rose to 80 - 85% following the cessation in 1991 of incineration at sea and the prohibition in 1996 of dumping of industrial wastes.

Assessment of dredged material under the London Convention

Specific guidance for the implementation of the London Convention to dredged material has been developed since 1986 and is currently set out in the so-called Dredged Material Assessment Framework (DMAF). When the DMAF was adopted in 1995 it was acknowledged that until emissions of hazardous substances in internal waters are effectively controlled at source problems with depositing harbour sediments would continue due to major environmental constraints. In May 2000 the DMAF will be reviewed.

The DMAF is developed for decision makers in the field of management of dredged material and sets out the basic practical considerations required to determine the conditions under which dredged material might (or might not) be disposed at sea.

In applying the DMAF as an iterative process a permit issuing authority should obtain satisfying answers to a range of questions, including:

- At the outset: Is dredging necessary, can it be avoided?

- What are the physical, chemical and biological characteristics of the sediments[1]?
- Does an adequate scientific basis exist to determine the characteristics and composition of the sediments concerned as well as the potential impacts on marine life and human health?
- Would the material be acceptable for dumping based on Action Levels set by the national authority; and if not, can it be made acceptable e.g., by application of treatment or disposal management techniques?
- Are the sources of contaminants affecting the sediments identified, evaluated and controlled?
- If based on answers to the above questions the material is, in principle, found to be suitable for disposal at sea, is it possible to use the material as a resource rather than a waste? (beneficial use *e.g.,* for land creation, beach nourishment, as construction material, or for restoration and establishment of wetlands) and should treatment of the material or disposal management options be considered?

If use of the material as a resource is not feasible and dumping is more and more becoming a serious option, the DMAF prescribes that detailed attention be given to possible disposal sites, prior to making an assessment of the potential effects (Impact Hypothesis) of each disposal option. On this basis it can finally be decided whether or not a dumping permit can be issued and what the environmental monitoring requirements should be.

If dumping is the selected option a permit and specific permit conditions can be prepared including the monitoring requirements to be fulfilled. In this context monitoring is necessary to verify that permit conditions are met - *compliance monitoring* - and that the assumptions made earlier were correct and sufficient to protect the environment and human health - *field monitoring*.

Feedback from field monitoring data is essential to modify or terminate the field monitoring programme; to modify or revoke the permit; and to refine the basis on which applications to dump dredged material at sea are assessed.

It is felt that if the DMAF is rigorously applied to dredged materials considered for sea disposal the requirements of the London Convention are met.

New guidance on assessment of quality of marine sediments

A report called *"Guidance on Assessment of Sediment Quality"* is about to be published, prepared under the auspices of the Global Investigation of Pollution in the Marine Environment (GIPME[2]) by a small, multidisciplinary group of scientists, familiar with the problems of assessing and managing contaminated marine sediments.

Several attempts had been made to develop approaches for evaluating the degree to which contaminated marine sediments could adversely affect marine resources. None of these approaches had been widely accepted, largely because they lack the practicality and consistency that managers are seeking.

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1 Exemptions from detailed characterization may apply if certain criteria are met.
2 Unesco-IOC, UNEP and IMO sponsor GIPME.

In response thereto the GIPME report examines various approaches to assessing anthropogenic impacts on marine sediments, and associated risks to marine life and human health. It is concluded that numerical sediment quality criteria are unsuitable for widespread application. The scientific basis for assessing sediment quality must incorporate biological, chemical and physical considerations.

In addition to considering new approaches to the assessment of sediment quality, the contributing scientists were asked to address 3 specific questions. These questions, and concise answers to them, are:

- *Can the concept of sediment quality guidelines be used to derive simple and uniform procedures for marine environmental protection?*

  Answer: Yes – uniform and relatively simple procedures can be developed to distinguish serious contamination from that which is trivial. Test protocols can be developed based on biological and/or chemical testing for guiding management decisions in local and possibly national situations.

- *Can such procedures be applied in a manner that provides the benefits expected by managers while still being based on sound scientific principles and methods?*

  Answer: Yes

- *Can the toxicity of sediments to marine life be predicted by chemical measurements alone?*

  Answer: No – at present no chemical measurements exist that can reliably predict sediment toxicity.

The GIPME report does not provide a rigid framework for assessment of sediment quality but does identify empirical procedures that can be used to distinguish among natural sedimentary conditions, anthropogenically disturbed (*e.g.,* contaminated) sediments, and sediment conditions causing adverse effects (*i.e.,* pollution). In essence, it defines possible approaches that meet the criteria of scientific validity and regulatory utility. Most importantly, it offers simple guidance to managers who require rules, regulations, criteria and standards for use in the assessment and management of the marine environment. It may also be helpful to those responsible for licensing waste discharges and dredging operations, implementing environmental regulations and interpreting the results of monitoring programmes.

Final observation

Many international agreements and guidelines have been developed to protect the marine environment and related interests. Guidance is also available to obtain information necessary to make well-informed decisions to implement these agreements. These are available "tools". The World Commission on Water for the 21st Century recently listed various major rivers as the world's most polluted and endangered rivers, including the Nile, the Yellow River, the Colorado River, the Volga River Basin and the Ganges. The mere fact that this list exists suggests that we need more than tools alone. If drawing on experience elsewhere is part of the answer, should the clean up of the Rhine and the contributions thereto by the Municipality of Rotterdam and others be held up as a model or was it a unique case? If the answer is affirmative, how could this experience help shorten the list of the World Commission on Water?

The Rhine: pragmatic answers to sediment questions

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The River Rhine

The Rhine is Europe's most densely navigated shipping lane connecting the world's largest sea port Rotterdam with the world's largest inland port Duisburg. Vast industrial complexes line up along the river, for example in the Ruhr, Main and Rijnmond areas. Most of Europe's important chemical production plants are found on the banks of the Rhine.

Rhine water is used for industrial and agricultural purposes, for energy generation, for the disposal of municipal wastewater, for recreational activities and for the production of drinking water for more than 20 million people. Furthermore, the Rhine is the natural habitat for a great diversity of plants, birds, fish and other species.

It is obvious that so many different claims on the river must lead to conflicts or problems: water, suspended mater and sediment quality problems, ecological and flood related problems.

The Rhine Commission

The organisation of the Rhine Commission has been adapted several times to accommodate changes in policy. The new “Rhine Convention” signed in Bern in April 1999 is the legal basis for the Commission's work.

Every two to three years ministerial conferences define the Commission's political goals and act as platform for assessment and evaluation of the activities carried out. The Commission itself, consisting of the highest officials from the different member states, meets annually and decides on working programmes, finances and all formal procedures. A co-ordination group is responsible for planning and co-ordinating ICPR work.

Three permanent working groups cover the areas water quality, ecology and emissions. Two project groups deal with the Action Plan on Floods and the preparation of a new Programme for the Sustainable Development of the Rhine. Expert groups deal with specific problem areas related to the work of the working and project groups. All groups consist of government experts from the ICPR member States. NGOs can directly participate in the work of many of the ICPR working group meetings.

The Commission's work is supported by a small international secretariat with a permanent base in Koblenz, Germany.

Rhine basin management: the answer to many questions

The ICPR has gained much experience in the development of a river basin management approach. It has developed a management strategy by “learning and doing”. The basis for ICPR work is co-operation based on mutual confidence and solidarity. With the Rhine Action Programme thinking and planning in the ICPR shifted from the "end-of-pipe" approach to an integrated approach. Precaution and prevention became the basic principles and for the first time a 90% emissions reduction was realised within ten years. With the introduction of ecological goals for the river, the Rhine Action Programme extended the scope of river management from sole "water quality management" to broader "water management". The following two aims have been important for the improvement of sediment quality:

- Sediments must be depolluted to such an extent that they may again be used for land filling or be dumped into the sea.
- The protection of the North Sea.

Successful implementation of future Rhine policy will only be possible on the basis of a general consensus about targets and means. River management is not only a government responsibility but also a responsibility of every citizen, farmer, municipality or industry in the Rhine catchment. Openness, public participation and close co-operation with all actors involved are the logical and indispensable means to support the above mentioned integrated approach. The new Rhine Convention provides the ICPR with the infrastructure for discussions, agreements and implementation of future Rhine policy.

The next step in this continued process of developing a management approach for the Rhine has already been taken. On the basis of the new Rhine Convention, the ICPR now focuses on the sustainable development of the river.

New goals have been fixed and a more forward looking pro-active approach will be applied. With a view to implement this approach the ICPR will present a new Action Programme on the Sustainable Development of the Rhine in early 2001. This programme will comprise the practical measures to realise the goals defined in the new Rhine Convention and will integrate all necessary elements for a future sustainable development of the river Rhine: quality, quantity, ecology, floodings, groundwater etc. The programme is developed in close co-operation with non-governmental organisations and also addresses important issues as education, raising public awareness, the use of modern online instruments etc. One of the tools of the programme is the system of target values for water and sediment quality.

Target values: chemistry's answer to sustainable development

By means of target values defined as scientifically substantiated tools for assessing the chemical and physical water quality, emission reduction measures as well as their effect on the recovery of the Rhine ecosystem are assessed. Target values are no legally binding threshold or standard values.

They are derived for each parameter of the following assets meriting protection:

- aquatic communities
- drinking water production
- suspended matter/sediments

For "aquatic communities" the target values are above all established on the basis of NOEC-values (no observed effect concentration) and standardised long-term biological tests. Normally, test results from primary producers (e.g. green algae), primary consumers (e.g. water flea), secondary consumers (e.g. fish) and decomposers (e.g. different kinds of bacteria) are available. The target value for “aquatic communities” is based on the lowest test result. Gaps in knowledge are taken into account by integrating safety factors. Additionally, threshold values in force according to present law relating to food and drugs are fixed as maximum tolerable contamination of fish. These values are above all related to effects on human health. Taking into account factors of biological concentration, these target values for fish are translated into target values for water.

The target values for “drinking water supply” are based on the A-1-values of the EC-directive “Quality of surface water for the production of drinking water” (75/440/EEC). For xenobiotic hazardous substances not coming under this directive, drinking water values, particularly according to the EC-directive “Water for human consumption” (80/778/EEC) or recommendations of values based on toxicological or hygienic recommendations are applied.

The target values for “suspended matter/sediments” are mainly based on the soil standards set for the application of sewage sludge on agricultural land (mainly background values). Present knowledge about needs for protecting organisms living in or on the sediment and about dumping sediments into the sea is however insufficient for a solid basis. As soon as OSPAR will have fixed values for sediment dumping, the ICPR will use these values as a basis for determining target values.

For each substance the lowest value established for the different assets meriting protection is selected as target value.

The protection of the North Sea: an open international question

According to one of the main targets for ICPR work Rhine sediments are to be of such good quality that they may be dumped into the North Sea without causing any environmental harm. Unfortunately, international quality criteria (e.g. EU- or OSPAR directive) setting standards for the dumping of dredged material into the North Sea are not available. Therefore, the ICPR regularly compares the quality of suspended matter with Dutch quality criteria for dumping dredged material into the North Sea (test value North Sea). These values have been derived form the present pollution of North Sea sediments, taking into account the interdiction of any further degradation.

The comparison of the quality of suspended matter between 1990 and 1997 at the German-Dutch border with Dutch quality criteria for dredged material showed that several parameters are regularly in excess of the quality criteria which means that it would not be possible to dump this material. In most cases heavy metal values were in excess. Copper and zinc rank first among these heavy metals, regularly excess values were recorded regarding lead and nickel, to a lesser extent regarding mercury. Between 1990 and 1997 the number of excess measurements only decreased with respect to nickel.

Hexachlorobenzene (HCB) and some PAH range among the organic micropollutions which were most in excess of quality criteria. As far as HCB is concerned, which mainly originates from the Upper Rhine, 50 % of the samples of suspended matter were in excess of quality criteria. Among the PAH, values in excess of the test value were in particular stated for phenantrene.

PCBs are only occasionally in excess of the test value. However, in the last two years several values in excess of the norm have been recorded, while, during the years before this period, no values in excess were recorded.

The main sources of pollution

In 1995 it became obvious that the targets for sediment quality would not be reached, even though the point sources were reduced by up to 90 per cent and the concentrations in the river dropped too. As a result of the periodical inventories of emissions of priority substances the interest of the ICPR focused on the sources and pathways of diffuse heavy metal pollution.

The rough estimate of diffuse heavy metal pollution in the Rhine catchment stressed the urban storm water discharges as the most important pathways. More than half the diffuse sources can be attributed to storm waters from streets and roofs of the cities reaching the river either via separate storm sewers or via overflows of combined systems. Due to the wide use of combined systems, overflows dominate in about 85% of all municipalities although the concentrations of most of the considered metals are higher in storm water than in the normal sewage, which usually is the more contaminated water. Often, there are insufficient facilities to keep the metals in the storm water from directly flowing into the rivers. Combined systems overflow about 50 times a year and insufficiently treated waste and storm water then enters the river. Only the first, usually extremely polluted part is held back.

Other important diffuse pathways are erosion and drainage amounting to about one fourth of all diffuse sources. Erosion is of greater importance for nickel and chromium, drainage flows for cadmium. The atmospheric deposition on water bodies takes a share of less than 5 %. It is of greater importance for mercury. Waste incinerating plants where mercury from thermometers or batteries is burnt, as well as industrial or other combustion plants are primary sources of deposition.

The combination of all other considered pathways (farmyard seepage, spray drift and runoff due to manure spreading, untreated waste water, households not connected with public sewerage and uses at or in the waters) contributes with less than 5 % to the diffuse inputs.

Geogen sources hold a share of about 10 % or 15 % of diffuse sources. The actual emissions are on the average 10-fold higher then the natural ones. In the worst cases zinc and cadmium emissions are 25-fold higher. Only for chromium the geogen share is already significant.

Dredged material: a pragmatic recommendation

Due to very elevated anthropogenic inputs in former years, pollutants concentrated in water sediments and thus in dredged material. In order to avoid increasing the contamination concentration in new sediments by whirling up old sediments when dredging, the ICPR has passed a recommendation for moving dredged material. The moving of sediments is normally carried out as a measure of maintenance work in a body of water: sediments are dredged in one place and dumped in another within the same body of water.

At the time being it is not possible to evaluate which effects released contaminants have on the Rhine ecosystem when dredged material is being moved. When assessing dredged material, priority should be given to ecotoxicologic criteria. However, as we do not yet dispose of uniform assessment procedures, ecotoxicologic criteria may not be applied on an international scale.

The second best assessment principle for dredged material is the „interdiction of degradation“ which compared to an assessment on the basis of ecotoxicologic criteria, is only an interim solution. Therefore, the ICPR has proposed criteria related to the present quality of sediment in areas where sediments are moved which imply a continued improvement of the situation. If dredged material does not fulfil the below listed criteria, it may not be moved and must thus be disposed in accordance with national criteria:

- Dredged material may only be moved within a body of water if the mean concentration of each pollutant contained in the dredged material is lower than thrice the present contamination concentration in suspended matter.
- The present contamination concentration of suspended matter is determined by establishing the mean concentration of each pollutant in suspended matter in the three years preceding the dredging. Pollution concentration in suspended matter is established on the basis of the data material available at the next national or international monitoring station downstream of the area, where sediments are to be moved.
- Technical measures, such as separate dredging or treatment are to be applied to heavily contaminated shares of the dredged material. Only the less contaminated share may be moved.
- The moving of sediments must not lead to an oxygen content less than 4 mg/l in the body of water concerned.
- When moving dredged material negative effects on the biocoenosis in the river bed should be avoided as far as possible. The extent of interference must be judged case by case.
- Sediments may only be moved when river flow is clearly above the mean longstanding minimum flow.

Principles of dredged material management in the HELCOM area

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This paper presents a short description of general principles for dredging and management of dredged material in the HELCOM area. Next, some specific solutions adopted in Poland and problems encountered are discussed.

In comparison with the 1974 version, the new (1992) Convention on the Protection of the Maritime Environment of the Baltic Sea Area (Helsinki Convention) has extended its area of influence to the entire catchment system. However, with regard to dredging and management of dredged spoil the HELCOM recommendations concern only the marine area. There are no recommendations presenting solutions for the management of river sediments. This may prove an important omission, since rivers provide a significant input into the sediment budget of the coastal zone.

Dredging operations in the Baltic Sea area are in principle regulated by the following HELCOM Recommendations:

- Recommendation 13/1 (adopted in 1992) “Disposal of Dredged Spoils”, and
- Recommendation 19/1 (adopted in 1998) “Marine Sediment Extraction in the Baltic Sea Area”.

Indications concerning the general policy in the coastal zone, in that the extraction and discharge of spoil, are also contained in Recommendations 15/1 (adopted in 1994) “Protection of the Coastal Strip” and 16/3 (adopted in 1995) “Preservation of Natural Coastal Dynamics”. All these recommendations are only partly implemented in the HELCOM area, since they have not been yet fully incorporated by the coastal states into their national legal systems.

The Guidelines for the Disposal of Dredged Spoils, which are an integral part of Recommendation 13/1 are, both in terms of procedures and requirements, the same as the OSPAR guidelines. Even the threshold values of contamination are for the time being the same, until values for the Baltic Sea will be worked out. Probably they will have to be differentiated between the various basins of the Baltic due to differences in salinity and in background levels of contaminants in the bottom sediments.

Recommendation 19/1 stipulates that prospection and extraction of marine sediments requires a permit of national authorities, and that an EIA shall be an obligatory part of the extraction permission procedure. The EIA should consider, among others, the short and long term influence of the operations on the flora and fauna, the chemical and physical parameters of the water column and sediments, the hydrological and morphological processes, and the interference with other legitimate uses (e.g. fishery, coastal defence, recreation, archaeological sites, etc.), both at the extraction site and outside it. The EIA should also provide guidelines for monitoring during and after the extraction activities. The Recommendation gives also lists of types of areas, in which extraction of marine sediments should be prohibited or strongly limited. The list is more or less typical. However, it may be worth mentioning that marine areas near the coast with significance for coastal sediment transport or with protective function for the coastline are listed as a type of area where strong limitations on extraction should be enforced.

The relevant rules with respect to extraction and disposal solutions, contained in Recommendations 15/1 and 16/3, consist in establishing a specially protected coastal strip, extending 100 to 300 m landwards and seawards from the mean water line, in requiring that natural marine sediment transport systems should be protected as far as possible, and in giving preference to “soft” coastal protection measures.

In Poland, Recommendation 13/1 is fully implemented in national law, but (at least for the time being) not in day-to-day practice. This is due to:

- insufficient laboratory facilities to carry out all the required tests, and
- a lack of realistic, fitting to the conditions of the Polish marine area, threshold values of contamination of spoil established as national standards (such draft standards have been recently developed).

Another drawback is the in Poland available dredging equipment, which does not allow proper separation of spoil with the various levels of contamination.

On the other hand, at least as far as marine sediment extraction and disposal operations are concerned, all the remaining requirements of all the four Recommendations are fully implemented in Poland in practice, though Poland does not have a legally established protected strip extending seawards of the mean water line. The practice is that all clean sandy material from maintenance dredging in navigation channels must be used for beach nourishment. Also, except in navigation channels, no mining or extraction of marine sediments is allowed from the dunes/cliffs, beach and within a strip of coastal waters reaching 6 km from the coastline. Permits for extraction within the coastal waters may be given only exceptionally, when it is proven beyond all doubt that the operations will have no short or long term influence on the morphodynamics, flora and fauna of the coastal zone.

"The old waste and the sea"

Folkert Post

North Sea Directorate, Ministry of Transport, Public Works
and Water Management, The Netherlands

The maintenance of the Rotterdam harbour and the approach channels requires regular dredging, since sediments from the North Sea and the river Rhine are constantly settling in the harbour area. Most of the sediment is of marine origin. Once settled on the grounds the material adsorbs contaminants, which originate from human activities like shipping or industry. Dredged material from the seaward part of the harbour is considered to be just slightly contaminated and is therefore allowed to be disposed of by way of dumping in the North Sea. During the summer of 2000 a new, confined type disposal site is put into use. Contaminated sediments are disposed on-shore in an insulated location.

Disposal of dredged material in the sea is subject to licensing under the Dutch Seawater Pollution Act. To consider whether a waste can be disposed of in the sea a classification system is used by the authorities. However, this classification has shortcomings.

The limited number of chemicals to be analysed causes uncertainties as to the fact that not all the effects on the ecosystem will be predicted. The Netherlands system of licensing uses a long time for the procedure comprising examination of samples and public hearings. The long time span between samples taking and the actual disposing on- or off-shore means there might exist a difference between the data used for licensing, the actual contamination as well as between the estimated effects and reality.

For these reasons, from the year 2002 on, a biological effect assessment will be applied in addition to the chemical assessment. With this combined approach the authorities expect that the current (finite) disposal sites could be used more efficiently both for the ecosystem as for the on-shore disposal sites.

Do we need regulations for dredged material in Europe?

Hans-Peter Baumert

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Bonn, Germany

Ladies and Gentlemen I would like to thank you for the invitation to this symposium, and for giving me the opportunity to speak here on a subject which I feel is very important – dredging material. It is a highly neglected and unloved child, which people don't like talking about in public. And yet sensible management of dredging material is crucial to both the economic infrastructure and to the conservation of the environment for future generations across entire regions. My talk has the somewhat challenging heading: "Do we need regulations for dredging material in Europe?" The first issue this raises is, of course, whether we actually have any regulations on a national level. Obviously, I can only speak for Germany on this matter. What regulations does Germany have for handling dredging material? In order first of all to quantify the importance of handling dredging material in Germany, I will give you figures which make the ecological and economic dimensions of this issue clear. In Germany, maintenance dredging in waterways and ports alone results in 40 million cubic metres of dredging material per year. If we compare this to other problem areas, 1996 figures showed that Germany produced an annual 46 million tonnes of domestic waste and industrial waste similar to domestic waste; altogether – excluding construction waste – around 100 million tonnes of waste. We can, however, observe a permanent decline in quantity.

The German provisions on waste are tightly knit. The Closed Substance Cycle and Waste Management Act represent an umbrella regulation, and 17 Ordinances and three administrative provisions based on or supplementing this Act have been passed. Another Ordinance regulates only the emissions from waste incineration plants. Taking this mass of regulation into consideration, we can certainly assume that Germany has a number of legally binding regulations for the waste sector. While I don't wish to imply that management of dredging material is a legal free-for-all on a national level, it is nevertheless a revealing fact that there is no law and no nationally valid Ordinance for this sector. True, we have 'directions for action' for the management of dredging material for both inland and for coastal areas (respectively, HABAB - Handlungsanweisung für den Umgang mit Baggergut im Binnenland and HABAK - Handlungsanweisung für den Umgang mit Baggergut im Küstenbereich) These directions provide authorities with a scientific reference guide for managing and assessing dredging material. However, the manner of applying these directions is at the discretion of the authority concerned, and this reveals that there is a very wide range of decisions being applied to similar types of problem. The topic of waste is certainly one which is debated intensively on a national level in Germany. Every day you can read media reports about deficiencies, excessive regulation explosion of costs, lack of capacity in disposal plants and even infringements against waste regulations. New regulations, which are considered necessary or superfluous depending on the perspective, are demanded or rejected. It is, in short, a continually developing area of law-making.

What, in comparison, is being discussed on the subject of dredging material? It would be an exaggeration to say nothing at all, but it is undoubtedly true that there is no such intense debate on this topic. One issue, concerned with the effects of a substance used world-wide, is occasionally dealt with. I am referring here to tributyltin - an anti-fouling paint used on ships. Its endocrine effects on mussels raise concerns among the population, and for this reason the subject produces emotional reactions. Consequently, dredging material polluted with TBT is occasionally the subject of public debate. I would like to make it clear here that I do not at all wish to play down this problem. TBT is a highly effective substance with unacceptable effects on the biosphere. Furthermore, due to it not being easily biodegradable, it creates a problem which will not be solved in the short term, even if approaches to a solution have already been found. I hope that the discussions currently taking place in both an international and a European framework will soon come up with a permanent solution to this. Nevertheless one thing must be clear: even if a complete international ban on TBT was achieved and port sediment were then free of this substance, the problem of dredging material would by no means be solved.

There are many other substances, which in future will pollute dredging material and remain a problem on account of their ecotoxic effect. I am confident, though, that national and European regulation will bring about continued reductions in the environmental burden this substance causes. But are these pollutants the only problems posed by dredging material? I work in the Waste Directorate and I am consequently thinking here in terms of waste. In the Closed Substance Cycle and Waste Management Act a principle of action conforming to European Law has been introduced. This principle can be described as graded instructions for avoidance, reduction, recovery and disposal. Legally speaking, dredging material is also waste, and this is a point I will come back to later. In the case of waste, manufacturers of products can sometimes avoid, and at any rate can reduce waste through intelligent process management. The consumer can also help to avoid waste, especially by changing his or her lifestyle. Manufacturer and consumer alike can recover wastes and reduce waste quantities by separating materials and having separate collection. The rubbish still remaining must then be disposed of, and recently it has been declining in quantity. Does this plan also work in the case of dredging material? There is a fundamental difference to normal waste. Dredging material cannot be avoided. It is impossible to reduce the quantities by any significant margin. The reason for this is that currents in rivers and ports, as well as tides, make the accumulation of dredging material inevitable. Avoiding dredging material would mean either neglecting or ultimately dismantling the shipping lanes infrastructure. The potential for reducing waste from dredging material has reached its limit.

Any relocation of dredging material has, for some time now, been undertaken with the aim of minimising its accumulation in water bodies, as costs are incurred through such accumulation. I have digressed somewhat, but I would now like to return to the question 'is the pollution load in dredging material the only problem?' In the case of waste we can at least hope that the quantity will continue to be reduced by avoidance, reduction or recovery. Where dredging material is concerned, this is not possible. We will always be confronted with large quantities of this material, and we must get this problem of quantity permanently under control. In other words: solely on account of the large quantities of dredging material which accumulate every year in Germany- and undoubtedly not only in Germany - we are faced with the problem of dealing with these quantities correctly. Closing our eyes and pretending that the problem isn't there certainly doesn’t provide a solution; but neither, at the opposite extreme, does the approach that all dredging material must be managed as waste.

The first idea would, in the short term, be interesting from an economic point of view, but would by no means represent a sustainable solution. The second would only appear to be the ecological approach. In practice, it would lead, in the extreme, to a situation where there are no more available sites for dredging material landfills. This approach might give us clear water bodies, but we would have hardly any areas remaining for other uses. At the moment 40 million cubic meters of dredging material per year require landfilling. Neither approach offers a sustainable solution. We must adopt a method which provides problem-specific solutions for dealing with different types of dredging material. I would now like to come back to the assertion that in a legal sense, dredging material is waste. "Dredging spoil" is listed in the European Waste Catalogue, in accordance with the Council Directive on Waste. Consequently, it is maintained, dredging material management should conform with this Directive. However, for about a year the European Union Landfill Directive has also existed. The preamble to this Directive states that its rules are not appropriate for dealing with dredging material, and calls on the Commission to submit proposals for this sector. This already gives us an initial response to the question which I posed at the beginning of my talk. The European Parliament and the Council have already answered with a clear yes. We do need European regulations for dredging material. Up to now, however, there has been only one code of waste for dredging material and therefore no distinctions are made according to its origin and pollutant load. To my mind, this is an unacceptable generalisation, and further distinctions are needed if a sensible solution is to be found. Dredging material of varying pollution loads must be given different codes. For this reason Germany has also made proposals for such distinctions in the Technical Advisory Committee, which lays down technical rules based on the Council Directive on Waste. The discussion of these proposals will, we hope, begin before the end of this year. And I also hope that the European Commission recognizes the importance for the whole of Europe of correct management of dredging material. The Commission proposals should therefore not be delayed too long. Looking at the problems with dredging material which are apparent in Germany, I can say that they differ considerably from region to region.

In general it can be seen that the dredging material accumulating in the Baltic Sea is polluted mainly with nutrients, and consequently, transporting it into water bodies is very problematic. In the case of the dredging material in the North Sea ports, the pollution is caused by heavy metals rather than nutrients. The pollution load here also varies greatly depending on its place of origin. Pollution of dredging material from water bodies of the Erz Mountains is characterised by the naturally occurring heavy metals. Other water bodies like the Rhine and Elbe are polluted with man made inputs. Dredging material from flowing water bodies must receive different treatment to that from stagnant water. These problems, well-known to the experts, show that it will not be an easy task, for the solutions must be applicable throughout the European Union. Like my colleagues from the Netherlands, however, I believe that if we are now looking for national regulations, and it is imperative that we do, then we should consider a European solution from the start. In this light I would like to thank these colleagues for giving impetus to the joint discussion. Several Länder have already expressed an interest in further cooperation, showing this initiative to be on the right track. And I also see today's discussion as a preparatory contribution to a comprehensive solution. Thank you once again for inviting me here today.

Anyone demanding solutions should also be able to suggest possible approaches to those solutions. In most cases, the discussion about the correct way to deal with dredging material is and always has been an argument about limit values. But all experts know that what might apply to an inland water, situated far from industry and used primarily for excursion vessels or small private boats, cannot be valid for the Rhine or Elbe estuaries – nor vice versa. Laying down limit values would mean, then, conducting endless debates regarding what should be tolerated where and why, and what is no longer acceptable. This cannot be achieved on a European scale. As a possible solution, I would like to refer to a principle here which might be ideally suited for getting around this difficulty. I mean the principle of defining regional environmental quality goals. This entails describing the current status on the basis of reliable monitoring. Founded on scientific principles, the environmental quality goal and environmental goals must be defined with regards to content and time periods. In order to achieve them, environmental action goals must be laid down which are geared towards the social and technical framework conditions. At appropriate intervals they must be monitored for suitability and modified where necessary. Obviously, the goals and action goals must be laid down in such a way as to be binding. I feel that this could make a practical harmonised solution conceivable in a European context too. Naturally I have not come up with these ideas myself, and I would like to take this opportunity to refer again to the Dutch example. The national environmental plans of the Netherlands have already applied this principle. In 1998, the German Bundestag study commission "Schutz des Menschen und der Umwelt" – "Protection of People and the Environment" also made proposals along these lines. These are the ideas which we must develop in relation to dredging material. My talk has not provided any new technical aspects for discussion – and I am not an expert on the subject of dredging material. I hope nevertheless that the presentations at this event can provide a foundation on which to build a European solution where the subject of dredging material can be accommodated for all Member States. I hope too that I have played a small role in laying that foundation.

The Environment Agency of England and Wales and dredging: local impacts and strategic planning

Peter Barham

Nene Strategy Manager, Environment Agency, United Kingdom

Introduction

The Environment Agency

The Environment Agency was established in 1996 to provide an integrated approach to the environmental management of air, land and water. It has been recognised for some time that the application of emerging environmental principles such as BPEO (Best Practicable Environmental Option) and BATNEEC (Best Available Technique Not Exceeding Excessive Cost) would work best through management of the environment as a whole. The adoption of an integrated approach means that the full environmental impact of actions can be determined for the whole of the environment rather than for one aspect of it. This is important in terms of both regulation and mitigation. It is important from a regulatory point of view because it allows integrated approaches to the wealth of environmental regulation of air, land and water to be developed, with considerable benefits through increasing cost-effectiveness and reducing unnecessary beaurocracy. It is also important for the environment through ensuring that the full consequences of actions can be determined and that differing actions and impacts can be assessed collectively as well as individually. This last point is of real importance in managing systems holistically, especially where there are sites of conservation value protected under the Habitats Directive.

Dredging and the environment

Against this background, in recent years we have seen major changes to the way that dredging is perceived and managed and the factors that shape these perceptions and their subsequent management have also changed. This paper describes some of those changes and the response made to them by a number of bodies within England and Wales. Most importantly, the adoption of more holistic and integrated approaches means that (as in other parts of the world) dredging can have a beneficial impact on the environment if managed correctly.

Regulation

A number of bodies have responsibilities for dredging in the UK. The principle agency for the management of dredging below high water mark is MAFF (Ministry of Agriculture, Fisheries and Food). In addition the Department of Environment Transport and the Regions (DETR), Environment Agency, English Nature and the Countryside Council for Wales also have roles to play. These bodies are responsible for managing dredging through a number of Acts which set out legislative duties. These include:

- Coast Protection Act 1949
- Conservation (Natural Habitats and c) Regulations 1994. The Habitats Directive
- Deposits in the Sea (Exemption Order)1985
- Environment Act 1995
- Environment Protection Act 1990
- Food and Environment Protection Act 1985. (FEPA)
- Harbours Act 1964
- Harbour Works (Assessment of Environmental Effects) Regulations 1998
- Landfill tax Regulations 1996
- Waste Management Licensing Regulations 1994
- Numerous local harbour powers

The regulator of the disposal of dredgings in England and Wales is MAFF through a FEPA disposal licence. The Environment Agency regulates applications for waste disposal licences for contaminated dredged material to landfill sites. Consent is also required from DETR Ports Division for certain marine works, including maintenance dredging and disposal where there are implications on the provision of safety of navigation, under the Coast Protection Act 1949. However, dredging activities in enclosed areas which exclude the tide, dredging under local Acts or dredging to remove anything causing obstruction or danger to navigation are exempt from obtaining such consent.

Greater scientific advances and responses to new or revised legislation is meaning changes in the work required to obtain a licence for disposal. For example, the consent procedure is often facilitated if detailed assessments of the effects of disposal of dredged material, including beneficial uses, have already been carried out. This is discussed further below, but is already a routine part of the FEPA process.

Dredging activity

The application of legislation and science to dredging and changes in dredging practice will depend on the nature of the dredging as well as the reasons for dredging. In simple terms dredging can be divided into maintenance dredging or capital dredging and regulation will relate to both the removal of material and the dumping (disposal) of material. The reasons for dredging will largely be under the groupings of port activity navigation channels or for sand and/or gravel extraction. In some cases the dredging may also be specifically for the removal of contaminated material. Finally, the other major variant is the nature of the material dredged; broadly categorised as silts/muds or sands/gravels.

In many cases maintenance dredging has been undertaken for many years with good understanding locally of the methods used and any subsequent impacts. In many ports the method of dredging puts dredged material into suspension rather than removing it. A consequence of this is that the process, through not involving disposal, is outside the MAFF licensing process and is regulated by the Harbour authority.

What is increasingly the case with capital dredging programmes and even large scale maintenance dredging, as for example on the Humber, is that the dredgings are seen not so much a waste as a resource. This is particularly the case with the use of dredged material for beach nourishment, an action increasingly undertaken on the coast in England as part of the move towards managing coasts in more sustainable and therefore environmentally aware ways.

It is this thinking which is changing the way that dredging is seen and the opportunities which dredging creates rather than the threats it imposes. There are a number of reasons for this but the principle ones are:

- It is recognised that most dredged material is subject to some form of contamination. This is often in the form of heavy metals, oil, TBT etc. These will often be locked in the sediments and are often historic in origin and from distant sources. The mobilisation of these sediments can pose real threats to the environment and therefore the regulation (for example through the FEPA licensing process and the Environment Agency's waste regulation activities) of removal and disposal is essential in maintaining environmental well-being. However, the occurrence of contaminated sediments in the UK is not high; this gives much greater room therefore for dredgings to be treated as a resource and this is having a major impact on the management of dredging.
- In recent years there has been a considerable move towards managing coastal resources in much more holistic and strategic ways. This has manifested itself in a number of forms which principally involve the determination of broad objectives for the coast and the subsequent identification of actions to achieve them. In addition these plans and the programmes they support are increasingly done through partnership where the actions can be identified as having common benefits or where the consequences of actions can be of considerable benefit to others.
- The increased use of geomorphological understanding of estuaries and coasts means that the impacts of dredging on navigation channels can be put into coastal models alongside those of flood defence or coastal protection practices. This is of particular importance in estuaries like the Humber where the Agency is completing an Estuary Shoreline Management Plan for flood defences. Port activity in the estuary is enormous (c.25% of the country's imports and exports pass through the estuary's ports). Capital dredging first took place in 1968 and since that time dredging has taken place annually with an average of 6.7 $x 10^6 m^3$ dredged each year. The fate of this material, which is all retained within the estuary, has been studied intensively with the conclusion that much of it migrates to the shores and that there are no significant impacts on the estuary (ABP, pers comm). It must be pointed out however that the Humber has a long history of pollution and it is widely understood that the sediments within the estuary are likely to have some degree of contamination.

Beneficial use of dredgings

With the removal of the fear that dredging represents an environmental threat, many opportunities arise whereby dredged material may be used to contribute to real environmental gain. This is particularly the case where the beneficial use is a direct action arising out of long term strategic plans for environmental management and improvement.

Habitat creation

Loss of habitat through coastal squeeze is a well understood issue and has resulted in the loss of many thousands of hectares of mud flat and salt marsh along the eastern coast in the UK. The growing understanding that these habitats have important roles for coastal flood defence management as well as being important habitats in their own right means that they are increasingly an important part of integrated coastal management plans. The Environment Agency is responsible for flood defences at the coast and in response to direction from MAFF is producing Shoreline Management Plans for coasts and estuaries for the whole of England and Wales. These Plans recognise the importance of understanding coastal processes and the need to incorporate these into plans for flood defence which are sustainable in both the short and long term. The plans also recognise the importance of coastal habitats as building blocks for flood defences. This is of course is going on in many parts of the world and the UK is gaining valuable experience from the practices of others.

Linked to these plans are the wider needs of others in estuaries and coasts including port activities and particularly the need to maintain or enlarge navigation channels. The linkage of these needs is bearing fruit in a number of places, an example of which is given for the Essex coast.

The economic growth of port activity in Harwich is directly linked to the enlargement of the navigation channel. The Environment Agency working in partnership with English Nature, Royal Society for the Protection of Birds (RSPB), Tendring District Council and Harwich Haven Authority have agreed proposals to build new beaches and other habitats on the Essex coast using material excavated from the port and the approaches.

The new habitats created will protect the coasts from the forces of erosion while many will also create new nesting sites for birds. In addition there are important savings to the taxpayer through this use of softer flood defence mechanisms. Working with local fishermen has also meant that suitable material could also be used to create new habitats for oyster and lobster, resulting in potential new fisheries. The work is jointly funded by the Agency and Harwich Haven Authority, will cost c. £1.2 m and will take place over the next four years.

Sand and gravel dredged from the marine bed have been used for beach nourishment in many parts of Europe and is now accepted as good practice throughout the UK. A recent initiative takes this one step further where a marine dredging company has become part of a consortium to manage beaches on the southern coast of England as part of a Private Finance Initiative. This initiative will be responsible for maintaining defences and improving beaches along the coast at Pevensey for 25 years through the use of dredged gravels imported from off-shore sites.

Conclusion

The recognition that port activity and the maintenance or enlargement of navigation channels is an essential part of the sustainable growth of coastal regions is the key to understanding that dredging may provide a resource to sustainable coastal management rather than a threat. Regulatory mechanisms ensure that environmental impacts of dredging continue to be minimised, while recent collaborative projects have shown that this can be taken further and that dredging can contribute to strategic plans which acknowledge the need for flood defences as well as conservation resources. The outcome is that dredgings have been used to promote new habitats as well as provide significant contributions to flood defences at the coast. Such actions have also resulted in the reduction of money required for conventional approaches.

There remain however issues associated with more strategic ways of thinking which we must address if continued progress is to be made:

- The resuspension of contaminants remains an obstacle to beneficial use of dredgings in some estuaries. This is of particular importance in estuaries such as the Humber where dredged material is retained in the system but where the opportunity for habitat creation has not been fully investigated
- Better understanding of geomorphology is essential to designing navigation channels which are more easily maintained. Including in this is the need to understand better the impacts on sediments of features such as training walls (e.g. the Wash)
- What are the cumulative impacts of activities (e.g. flood defence work and channel dredging) and can estuary or coastal plans be constructed which accommodate these (e.g. Wester Schelde)

Living Rivers

Gerard Litjes

WWF-The Netherlands

World Wide Fund for Nature helps to restore the Rhine and Meuse estuary

The Dutch division of the World Wide Fund for Nature (WWF) has been playing an important role in rehabilitation of riverine and coastal wetlands in the Netherlands since 1991. A great number of “Living Rivers” and ”Growing with the Sea” projects are being launched along the Meuse and Rhine and in the coastal region, in which room is created for natural processes, such as river and tidal dynamics and grazing with large herbivores. All of the projects give free access to the public. Hundred thousands of men visit our projects, schoolchildren get education about nature, excursions are made (see our websites).

New Rotterdam Level (Nieuw Rotterdams Peil)

One of the recent projects is located in the Rhine and Meuse estuary around Rotterdam, in an area of about 600 square kilometres. Its objective is to restore the contact between the 1,5 million residents in this urbanised region and their original estuarine nature. A number of pilot projects show how the natural processes, like tidal dynamics, river dynamics and grazing can be restored on a large scale, even in a region with strong economic growth and expansion.

The change in land use because of flood management, fresh water supply, mineral supply, housing and recreational use is a big challenge for restoration of nature. It can lead to more prosperity for the residents that now mostly believe that nature always is in decline and far away.

Partners in our projects are the Port of Rotterdam, the ministry of Transport, Public Works and Watermanagement, the community of IJsselmonde and community of Hoogvliet, nature foundation Het Zuid-Hollands Landschap and the sugarfactory Suikerunie. The cooperation with companies, ngo’s and communities is an essential part of the strategy of the World Wide Fund for Nature.

Re-opening of the Haringvliet dam

In 1970 the Haringvliet dam was closed, because of the Deltaworks. It gave more safety for the risk of flooding, but it lead to a disaster for estuarian nature in the Haringvliet, Hollands Diep and the Biesbos wetlands, with a total area of about 15 thousand hectares. The tidal influence reduced from 1,6 meters to 0,3 m in the Biesbos, the gradient from salt to brackish and fresh water was destroyed completely.

In 2000 the government will decide to partly reopen the dam for several reasons. It will allow tidal influence in the large wetlands, restore migration of fish and other organisms and improve the primary production under water. But also the reopening is beneficial for safety of the coastal region on a longer term. It will restore morphological dynamics in the area and the adaptation to sea level rise. It will slow down the total sedimentation of the wetlands. The fresh water supply for the polders and waterplants surrounding the Haringvliet has to be reallocated to this new situation. WWF is very in favour for this large scale nature restoration project.

Living Rivers and Natural Safety

In 1992 the Dutch World Wide Fund for Nature launched the plan Living Rivers, a strategy for the restoration of riverine nature in the Rhine, Waal and Meuse rivers. For the first time a method was described to reestablish a more or less permanent flow in secundary sidechannels in the river forelands by mining of holocene clay. The side channels are the only remaining place where natural processes can develop completely, because of the intensive use of the summerbed for navigation and the discharge of water, ice and sediment. The complete foodchain, including algae consuming macro invertebrates living on snag and waterplants can return in the shallow, permanent flowing sidechannels. Without this component, the nutrient rich river ecosystem remains in poverty. Water insects could be eaten by fish, fish by birds, birds by larger birds and other predators, and so on. The first secundary side channel was opened in 1994 by a clay mining company, the river authority and the WWF at the Waal in Leeuwen. The water quality has become good enough to be successful, in Living Rivers is stated that the lack of suitable habitats is causing more damage to the river ecosystem than the water quality. Nevertheless, the water quality must be guarded also!

Restorating nature with bricks

The mining of clay is an economic process. The clay can be used for bricks and for the enforcement of levees or dikes. The clay layer is 0,5 to 3 meters thick and lays on the surface, covering a shallow, sandy pattern of islands, riverbanks and riverbeds that were active in the latest past hundreds of years. By studying historical river cartography up to 1500 AC, we found out that our rivers were much more dynamic and alluvial until the start of the great normalisation of the Rhine and the Meuse since early 1800. The forelands are silted up heavily in a few hundred years, which is stimulated by the making of summerdikes, groins and so on. It is lucky that the clay can be mined by industrial activity. WWF is cooperating with the Dutch brick industry, by saying if you build houses and brick pavements, you help to restore riverine nature. Thousands of hectares of forelands will change in this way from pasture into nature, covered with alluvial forest, marshes, grasslands and riverdunes.

The removal of the surface layers and cutting of summerdikes will also improve the discharge capacity of the river .This attracted the attention of the river authority, which is more and more concerned about the future discharge of the rivers. Instead of an extra expensive and environmental unsuitable enforcement of dikes, the governments present policy is to enlarge the discharge capacity of the winterbed by using Living Rivers strategy.

Natural safety

In 1999, the World Wide Fund for Nature together with the State Forestry Service launched a report called Natural Safety. It is an alternative to the technocratic way of solving high water problems in the Dutch river delta in the near future.

Natural Safety aims to restore the spunge capacity of rivers and streams in the whole Rhine and Meuse river catchment, using the surplus of agricultural land. Doing so, you'll not only solve the floodproblems but also store valuable, fresh water for periods of drought. The clue is that smaller rivers and streams can in some regions relatively easy be renaturated. The natural vegetation reduces the quick discharge and stores water longer than in the present situation. This improves the quality of the ecosystem at that place, and helps to reduces the flood in the main channels.

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Dredged material: Solved in one generation?

E. Matser, M. Beekman

Greenpeace Nederland

Since the boom of the (chemical) industry, enormous amounts of hazardous substances are produced. Through discharges at chemical plants and spraying in agriculture these substances reach the environment. They are also used in many products from which they slowly leach. These toxic chemicals heavily pollute sediments in industrial harbours, like Rotterdam and Antwerp. Up to now most emphasis is put on a small amount of relatively well-known chemicals and emissions sources. Due to the measures taken the concentrations of these well-known chemicals tend to decline. Nevertheless toxic sediment is still generated. The current legislation does not prevent toxic effects from harbour sludge on the marine environment. It is commonly known that at this moment part of the dredged material released in the environment is toxic. Only very few chemicals are analysed and combination toxicity is not taken into account. Also the choice for substances and standards is not based on scientific knowledge. The TBT issue is given as an example.

In 1998 the 15 environment ministers and the environment commissioner of the EU agreed that before 2020 all releases of all hazardous substances to the marine environment have be stopped (one generation goal). According to Greenpeace substitution or elimination of all hazardous chemicals can only achieve this. Instead of reducing the emissions of hazardous chemicals, these chemicals should not be used in the production processes and products. This will also lead to sediment without hazardous chemicals (*long-term objective*). To avoid further pollution of the environment by dredged material; (a) known toxic chemicals, like TBT, should be added to the standard, (b) bio-assays should added to the standard and (c) all toxic sludge must be put in special depots or separated in a toxic (store) and non-toxic fraction (release) (*short-term objective*).

CEDA Position Paper

Neville Burt

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CEDA (Central Dredging Association) welcomes the initiative taken by GKSS Research Centre and CSERGE in organising the Policy Symposium and workshop and is pleased to accept the invitation to participate.

CEDA is a non-government organisation that provides a forum of information exchange and discussion on matters related to dredging. It actively participates in both the London Convention 1972 and the OSPAR Convention. Through the activities of its Environmental Steering Committee it has been responsible for the production of a series of state-of-the-art publications concerning environmental aspects of dredging jointly developed with IADC (International Association of Dredging Companies). The list of the publications comprising the series is attached (Annex 1).

CEDA is a member of WODA (World Organisation of Dredging Associations) which has adopted the following policy statement:

> *"The World Organisation of Dredging Associations (WODA) recognises that carefully designed and well executed dredging conducted in an environmentally sound manner contributes to a stronger economy. WODA believes that dredging projects can be conceived, permitted, and implemented in a cost-effective and timely manner while meeting environmental goals and specific regulatory requirements. WODA is committed to the development and implementation of appropriate environmental safeguards and performance guidelines for construction, maintenance, mining and remedial dredging. Beneficial use of dredged materials is encouraged. Open lines of communication among stakeholders, such as port interests, dredging contractors, regulatory agencies, other business interests, environmental interest groups, and the public, should be standard elements of any project. WODA encourages investment in and expeditious transfer of new technologies, and the development of new, more efficient techniques for improving the evaluation and safe handling of dredged material."*

With regard to "waste" legislation in Europe, CEDA takes the view that most dredged material is uncontaminated natural sediment and that it should be recognised as a resource in the same way that the surplus soil from a road construction scheme on land would be regarded as a resource. This principle has been accepted by the London and OSPAR Conventions for many years. As a resource it should be regarded as a special case when formulating legislation to control waste disposal. Ideally it should not be classified as a waste at all because this gives the image that it is something to dispose of rather than to use it in a beneficial way. To call it a waste is, in our view, contrary to the principles of sustainability adopted by the countries subscribing to the Rio Convention.

For information and consideration we attach Fig 1. from Guide 5 of the above mentioned IADC/CEDA Environmental Guides. The figure gives a framework to assist managers to select the best option for use or disposal of the dredged material. It takes fully into account the Dredged material Assessment Framework (DMAF) of the London Convention 1972 and expands it to give guidance on the other options, including beneficial uses, confined disposal and treatment technologies when these are necessary.

CEDA takes the view also that there should be more harmonisation between the legislation controlling marine, estuarial and riverine dredged material disposal to facilitate the selection of the best environmental option taking into account economic and social factors as well as environmental factors. At present the situation can arise whereby prohibition on marine placement may force material to be placed on land whilst placement on land may be a less satisfactory environmental option.

CEDA is pleased to participate in discussions and make available its knowledge and experience of dredging matters to those involved in the policy making and legislative organisations of Europe as far as its resources will allow.

Statement prepared by Neville Burt,

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IADC/CEDA Series on Environmental Aspects of Dredging

IADC/CEDA (1996). Guide 1: Players, Processes and Perspective.

IADC/CEDA (1997). Guide 2a: Conventions, Codes and Conditions: Marine disposal.
Guide 2b: Conventions, Codes and Conditions: Land disposal.

IADC/CEDA (1997). Guide 3: Investigation, Interpretation and Impact.

IADC/CEDA (1998.) Guide 4: Machines, Methods and Mitigation.

IADC/CEDA (1999). Guide 5: Reuse, Recycle or Relocate

IADC/CEDA (to be issued in May 2000). Guide 6: Effects, Ecology and Economy

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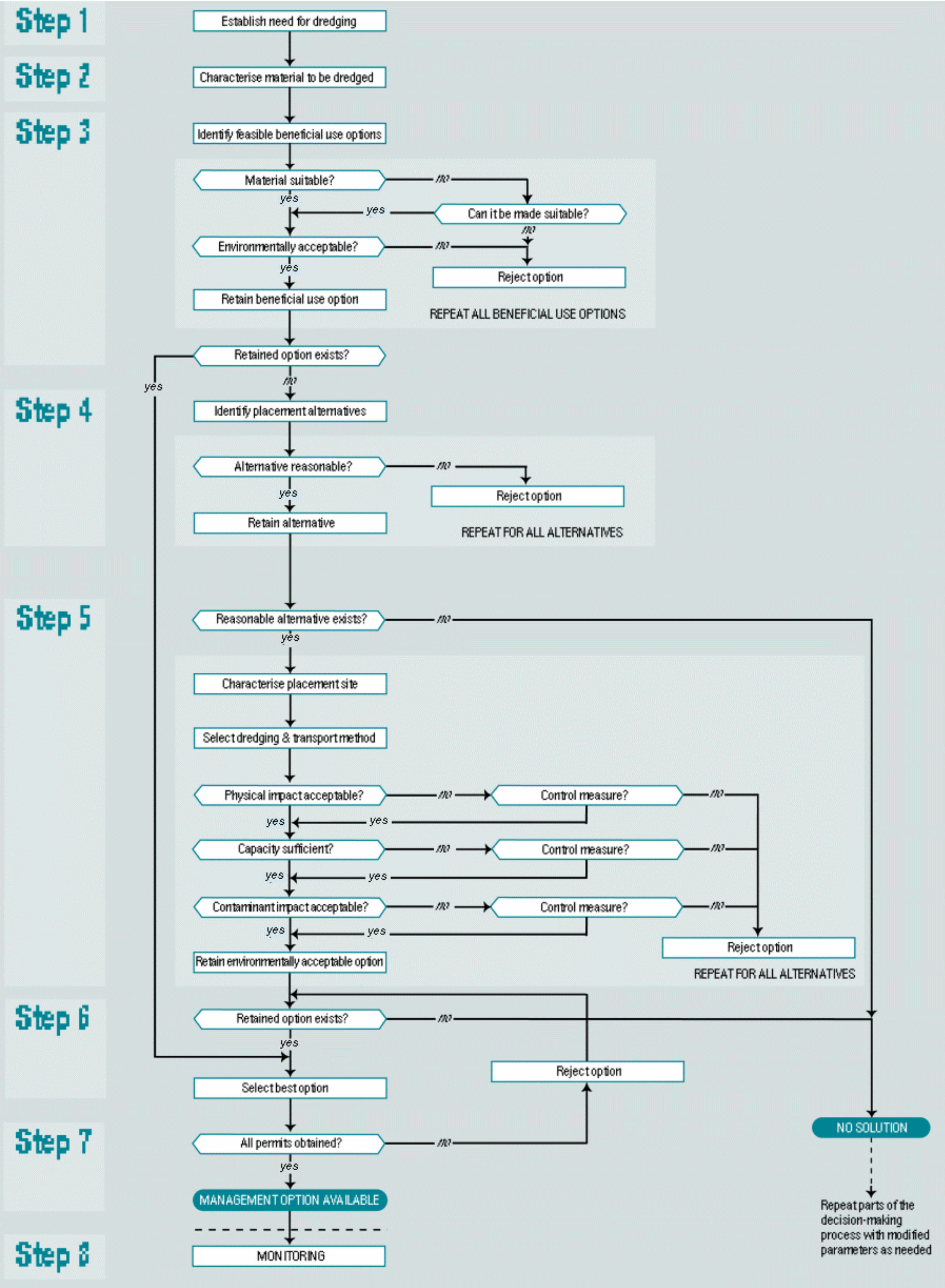

Flow chart for selecting the most appropriate management alternative (CEDA/IADC Guide 5, 1999)

Dredged Material Treatment in Hamburg
Concept and Future Development

Axel Netzband

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History

Dredging in Hamburg has a century long tradition. Many times over the years the port had to be restructured and adapted to the requirements and the necessities of the trade and the developments of vessel traffic.

Of course in former times the amounts of sediments to be dredged and the equipment at hand were much smaller than they are today. Traditionally the dredged sediments were used beneficially for land development and agriculture. Most of today’s port area is heightened by sediments.

About 20 years ago - as at other places too - the contamination of dredged sediments and the resulting influences on the environment came into focus. This led to a broad political discussion in Hamburg. But there was no quick solution available. A Dredged Material Research Programme was initiated – as at other places. There was an exchange of thoughts with other countries and harbours who started to have the same problem. Soon it could be seen although it was the same problem due to the special local circumstances local solutions had to be found.

For example in comparison to Rotterdam Hamburg could not act upstream to prevent further emissions into the river Elbe. Only the immense pollutant loads coming with the river over the iron wall could be measured, but nothing was known about their origins, not to talk even about the possibility of discussing efforts to reduce them.

Hamburg had to find a solution of depositing the dredged sediments in its limited city borders. This is not the place to go into details, but the temporary solution consisted (and consists) in pre-treatment, i.e. separation into sand and (contaminated) silt and the environmentally safe disposal of the silt. By disposing the silt on former flushing fields this way also old disposal sites could be reclaimed. The construction of the silt mounds is done taking into consideration federal landfill regulations.

Of course in comparison to other ports this is costly solution. But it was not thought to be a solution for ever.

River Elbe and its contamination

A chance came when in 1989 the iron wall fell. Since 1991 the degree of contamination of the sediments of the river Elbe is constantly decreasing. For a long time mercury was one of the main contaminants in the river. The mercury contamination in Elbe suspended solids at the former German-German border was in 1985 to up to 75 mg/kg d.m. and has now values of about 3 mg/kg. This still is too much, but it shows the rapid and positive development. The total load could be reduced from 28 tons of mercury in 1985 to 1.6 tons in 1998.

To a large part the reason of this development is the shut-down of whole industries in former German Democratic Republic. To another much smaller part it is based on financial support Hamburg gave to a Czech chemical company. Spending 150,000 € two settling basins could be built reducing the mercury load emitting from this factory from 1.7 to 0.8 tons per year. This is not accordingly the *polluter pays* principle, but it’s a pragmatic approach to get things done. Viewing the huge social problems in Eastern Europe one might have to wait a long time until things are accomplished in the ecological field.

Of course a lot of efforts have to be undertaken by those responsible for emissions into the river. The first international treaty the reunified Germany signed was the one of founding the International Commission for the Protection of the Elbe. The IKSE made an action plan with the aim that in the year 2010 the fine sediments of the river shall be clean again (“can be used for agricultural purposes”). A lot of money has to be and is already spent in Germany and Czech Republic to reach that goal.

TBT – contaminant of the year

But now there is another ‘pollutant of the year’ with special concern to ports and waterways: TBT. TBT can be found everywhere where seagoing vessels sail and especially near dock-yards etc. It is spread all over oceans and rivers and enriches in sediments. It is until now a legally applied very effective and (at the same time or therefore) very toxic active agent. Again those responsible for ports and waterways only have limited influence on the source of the problem but have to cope with its effects on the sediments.

The Hamburg policy on this is manifold: first Hamburg supports the ban of TBT in the international context (which means the IMO decision of a ban in 2003 / 2008 or maybe an European initiative). Because of the international nature of vessel traffic a national or even regional solo attempt would only lead to shifting the traffic to other ports. This can not be in the sense of a responsible policy and doesn’t help the environment either.

Secondly the direct inputs in the port have to be minimised. Dockyards have to undertake measures to reduce their TBT-emissions. Techniques for excess water treatment have to be developed and put into operation as well as for example techniques to reduce emissions during application of TBT-containing paints.

Third if there are higher contaminated sediments due to dockyard activities they have to be taken out of the aquatic system in case they have to be dredged and treated on land. At the time being there are no possibilities to reduce TBT concentrations *in situ* or in board of a dredger.

Forth there has to be a base on which to decide if sediments can be relocated or not. Until now this decision is based on chemical standards.

Treatment on land

Hamburg is operating the large scale METHA plant for pre-treatment of dredged material. It went into operation in 1993 and has been extended since then by new developments. It will have a throughput capacity of 1 Mio. m^3 sediments per year in the near future. Its products besides smaller amounts of coarse material are sand, fine sand and silt.

The sand is used as construction material and nearly contaminant free.

The fine sand can be used in the industry as raw material or additive. For the first time the beneficial use of this product resulted in a small positive income.

The silt is used beneficially as a sealing material in the construction of the dredged material disposal sites or was built into former harbour basins for backfilling. It is also used as raw material in brick fabrication. Trials showed that this is a feasible possibility upon which has to be decided now also under consideration of relatively high additional payments.

For the disposal of the contaminated silt Hamburg has two silt mounds on its own territory. They have a capacity for 8 resp. more than 20 years from now.

The waste and excess water from transport of the dredged material, pre-treatment and disposal is treated since more then 10 years in a two stage treatment plant for solids removal and nitrification.

Another possibility which was examined in the last years was the filling large caverns which were formerly used for salt winning. This also proved to be a feasible possibility. But there are rather low contamination limits for the silt to be filled in and very high costs on a long run for the City of Hamburg.

Relocation of dredged material

Relocation of dredged material is widely used all over. The sediments coming from the river are given back into the aquatic system. No material is taken out of the large-scale system. This system should be disturbed as little as possible, but dredging has to be done to allow vessel traffic. The influences of relocation on the environment should be minimised – the concept of sustainable relocation.

Under consideration of the positive development of the river Elbe in 1994 large scale tests were started to examine the effects of relocation of dredged material into the river. They had positive results and led to an agreement between Port authority and environmental agency in Hamburg.

It contains two main restrictions:

The contaminant assessment is based on a recommendation "Handling of contaminated dredged material at the River Elbe" which was decided by the environmental ministers of the German federal states neighbouring the river. Its base is a (chemical) classification system for different contaminants. Class II is the target value, for class III or II-III an impact hypotheses shall be made, class IV of the 4 classes shall not be relocated in any case.

Furthermore there is an environmental window which allows relocations only from November until March. This is to protect the water quality (low oxygen concentrations in the river during the warm period) and especially fish life in spring and summer.

This means that roughly one third of the average sedimentation amount can be relocated.

Future development

For the time being the dredged material concept of Hamburg has different supporting legs:

§ the amount of sediments to be dredged is reduced as possible by means of hydraulic devices like the current deflecting wall

- the modestly contaminated sediments are relocated in the Hamburg part of the river Elbe
- the larger amount is treated on land. It is used beneficially or
- deposited in upland confined disposals sites (silt mounds)

In the future the amount of material to be relocated shall be increased, therefore also new relocation sites have to be found.

Beneficial use shall be increased, but realistic possibilities seem to be limited.

A disposal also on the long run (10 years and on) seems to be necessary, therefore new disposal sites have to be created. Because of its environmental efficacy and the comparable lower costs the subaquatic disposal (like for example the Slufter or the Ijsseloogdepot) shall be followed.

Guidelines for dredged material

Now there are different guidelines applicable for dredged material at the River Elbe:

- the already mentioned Elbe guideline
- the guideline for inland waterways of the federal waterways administration
- the guideline for coastal waters of the federal waterways administration, in the future possibly replaced by a combined guideline of federal government and states
- the international OSPAR and London guidelines. They have to be put into operation by the above mentioned coastal guidelines.

Some comments have to be made on these:

It should be clear that dredged material treatment (material from maintenance works) is not an appropriate mean of aquatic protection politics. In any case emphasis has to be put on source control. This is a central argument in the DMAF of the LC. When it comes to dredged material in the estuaries, the contaminants are already diluted and spread over large areas or amounts of sediments. Sediments are not to relocate where they are contaminated due to local emissions.

Also in the upper reaches of a river besides source control it has to be thought about possible transport or higher contaminated sediments to downstream areas. This is especially true at the River Elbe because of old mines, dumps etc. In this case sediments have to be taken out of the river there.

Because of the trans-boundary transport of sediments common solutions have to be found to treat these ‘memories of the river’.

When standards for assessment of dredged material are set these should be in accordance with the measures of source control.

It has to be kept in mind that when sediments are taken out of the river or sea the problem is not at end. Also treating them on land has negative ecological effects, besides that it costs an awful lot of money because of the large amounts. Treating or disposing sediments should take into consideration their special properties and requirements. When formulating the European Landfill Directive (1999) this was not the case. The result is that the acknowledged subaqeous disposal of dredged material now poses great permitting problems.

Conclusions

World-wide experiences about handling contaminated dredged material are exchanged, for example through the Rotterdam workshop or PIANC working groups. They nowadays lead in the same direction.

In any case emphasis has to be put on source control.

Generally the concept of sustainable relocation should be followed.

In case of land treatment beneficial use should be strived for, but realistic possibilities seem to be limited.

For the next time the confined disposal seems to be the main solution if the sediments shall not stay in the aquatic system.

Because more and more guidance comes through European directives an exchange of experiences of those who have to handle dredged material becomes important. It should in the end lead to the development of appropriate recommendations and guidelines on broader level (supra-national or –regional) which allows a case-by-case approach to solve the special local problem.

The upcoming European Water Framework Directive - general purpose and implications, consideration of sediment-quality and subsequent questions

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General purpose

The EU Water Framework Directive (WFD) will be passed this year. The new Directive will establish a modern and coherent European water legislation, which will replace various European regulations concerning the European water-management. The WFD shall be implemented into national right by the Member States at the latest in 2003.

One of the overall purposes of the WFD is to establish a framework for the protection of inland surface water, transitional waters, coastal waters and groundwater which prevents further deterioration and protects and enhances the status of aquatic ecosystems (Art. 1 (a) WFD).

Beside other environmental objectives, the Member States shall aim to achieve the objectives of preventing deterioration of ecological status and pollution of surface waters and restoring surface waters, with the aim of achieving a good surface water status or, for water bodies designated by the Member States as "heavily modified" or "artificial bodies", a good ecological potential and a good surface water chemical status (Art. 4 WFD). These objectives shall be realised at the latest 16 years after the date of entry into force of this Directive.

To achieve these objectives a combined - i.e. emission and immission - approach for point and diffuse sources is constituted (Art. 10 WFD). As a central tool of the WFD "programmes of measures" and "river basin management plans" are contemplated (Art. 11, 13). Both shall be created in 2010.

Implications

The environmental objectives depend on the type of water body. For heavily modified and artificial bodies a lower quality level - a good ecological potential and good surface water chemical status - is to be achieved, whereas for the other surface waters a good surface water status is required. The two quality status types mainly differ in their biological and hydromorphological quality elements, while the requirements concerning chemical pollution are identical (Annex V 1.2 WFD).

"Heavily modified water body" means according to the WFD "a body of surface water which as a result of physical alterations by human activity is substantially changed in character, as designated by the Member State in accordance with provisions of Annex II" (Art. 2 WFD). If changes to the modified characteristics of one of the five main aspects mentioned in Annex II, like navigation or "human development", would be affected, Member States may designate a body of surface water as heavily modified.

The first result is that the large scale environmental objective depends strongly on how many surface waters the member states will designate as "heavily modified water bodies". Due to the wide and open definition of "heavily modified water body" e.g. Germany could designate 90% of its water bodies (BREYER 1999).

Statements about sediment-quality

The quality elements for the classification of the ecological status comprise also criteria which deal with sediment quality. The biological elements for the classification of rivers include the composition and abundance of benthic invertebrate fauna and phytobenthos. The structure and kind of substrate of the river bed are two of the hydromorphological elements. The chemical and physico-chemical elements do not explicitly refer to sediment.

The strategies against the pollution of water include a priority list of 32 substances (Annex X WFD) for which the Commission shall submit proposals for controls on the principle sources of the emissions concerned. In doing so it will take account of both point and diffuse sources and shall identify the cost-effective and proportionate level and combination of product controls and emission values for process controls (Art. 16 No. 4 WFD).

For the selection of the 32 priority substances also sediment relevant substances were considered (list C in the proposal of the Commission from 18.02.00). The priority list includes e.g. polycyclic aromatic hydrocarbons (PAHs) listed as a group. The PAH anthracene and naphthalene are listed separately, because they are manufactured directly whereas the others are mainly by-products. The priority list shall be reviewed every six years.

The Commission shall also submit proposals for quality standards applicable to the concentrations of the priority substances in surface water, sediments and biota (Art. 16 No. 5 WFD). The procedure for the setting of chemical quality standards by Member States contains the application of acute and chronic bioassays. A "base set" comprising algae and / or macrophytes, daphnia orrepresentative organisms for saline waters, and fish is suggested as testspecies (Annex V 1.2.6 WFD). This base set doesn't include explicitly bioassays to assess sediment contamination. However, especially to assess the solid-associated contaminants bioassays with whole sediments are necessary (e.g. RÖNNPAGEL et al. 1995). For the setting of chemical quality standards safety factors shall be applied and where data on persistence and bioaccumulation are available, these will be taken into account.

Beside the substances included in the priority list, the Commission may prepare strategies against pollution of water by any other pollutant or group of pollutants, including any pollution which occurs as a result of accidents (Art. 16 No. 7 WFD).

The Commission shall submit proposals at least for emission controls for point sources and environmental quality standards within two years (Art. 16 No. 6 WFD).

Subsequent questions

- To what extend will the Member States designate surface waters as "heavily modified water bodies"?
- Will the Commission prepare strategies against pollution of water by any other pollutant or group of pollutants? How effective will they be?

- Is the emission approach too weak, especially for pollution sources which are not comprehended by the IPPC Directive (Integrated Pollution Prevention Control)?
- Will the WFD and its implementation in the national legislations of the Member States be sufficient for the requirements of the SINTRA statement? (At the Ministerial Meeting of the OSPAR Commission on July 1998 in Sintra (Portugal), the ministers declared according to hazardous substances: "We agree to prevent pollution of the maritime area by continuously reducing discharges, emissions and losses of hazardous substances (i.e., substances which are toxic, persistent and liable to bioaccumulate or which give rise to an equivalent level of concern), with the ultimate aim of achieving concentrations in the environment near background values for naturally occurring substances and close to zero for man-made synthetic substances. We shall make every endeavour to move towards the target of cessation of discharges, emissions and losses of hazardous substances by the year 2020...")

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Elements of methodology for integrated management of contaminated river/harbour sediments

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The task of developing information bases and decision support frameworks for managing sediments within river/estuary/harbour systems poses distinctive difficulties in both scientific and socio-economic terms. The physical systems in question are complex. They must be considered as functioning ecosystems and as providing a variety of « services » (sometimes called « environmental functions ») to human users. The rivers, estuary, marine ecosystems and adjacent wetlands are dynamic systems whose elements include water, biodiversity, fish and wildlife habitats, built and unbuilt landscapes, and whose functions are as diverse as shipping lanes, flood buffering, waste reception and picnic sites.

The purpose of these notes is to sketch a framework of analysis and communication that may be useful for situating the technical, chemical and financial components of dredging and sediment management, in a wider perspective of governance involving integrated hydrosystem management and long-term goals for environmental quality and sustainable development.

1 What Management Perspective for River/Harbour Sediment ?

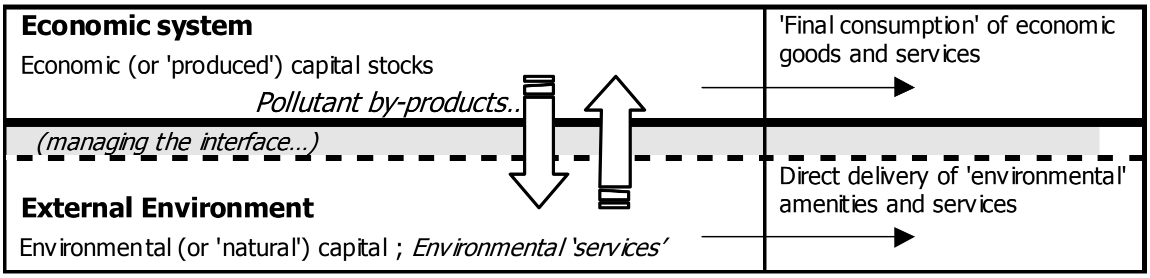
For more than two centuries economic growth — the enlargement of the annually produced economic cake — has been promoted as the base for improved societal well-being and, also, as an effective way of alleviating distributional contests between social groups. Science and technological advance have been fundamental in this vision, with technical knowhow being put to the service of improved productivity and product innovation. However, economic production involves exploitation of the "external" environment as a raw material source, a physical site, and a waste sink. These so-called environmental functions are limited. Considered in its systemic biophysical dimensions, it is not possible to enlarge infinitely the ecological «pie» upon which economic activity depends.

In this context, the policy objective of sustainable development refers not just to sustaining produced wealth and income flows but also to the maintenance and renewal of human habitats

[1] These notes have been prepared as a contribution to the Workshop on "River Sediments and Related Dredged Material in Europe", held in Rotterdam, 17-19 April 2000. The 'Tetrahedral Framework' presented below, has been developed by the research group "Environmental Evaluation and Natural Capital" at the C3ED (Université de Versailles—St Quentin en Yvelines), within *The ©DICTUM Project* (Democratic Information and Communication Technologies for Promoting sustainable Use and Management of ecosystems and living resources). In collaboration with Silvio Funtowicz and Angela Pereira at the ISIS (JRC, Ispra) and other European colleagues, currently the framework is being applied through the development of interactive information and communications technologies (ICT) in the domains of climate policy, agriculture, water resources, deforestation and fisheries (a similar four-way demarcation has been proposed by, for example, the FAO in work on indicator systems for sustainability management of fisheries). Further information and literature references are available on request from the author.

— the living tissues of ecosystems interwoven with social and economic infrastructures. If we think of ecosystems as providing a variety of material flows, services and supports for economic activity, then ecological "goods and services" (natural resources, amenities, waste reception, environmental life support functions) are complementary to economic goods and services as the biophysical basis of human well-being.

Sustainable development may, in this view, be defined as process of economic and ecological resource management aiming at the joint delivery of economic and ecological benefits and services.



Is sediment a resource or a waste? This is already a regulatory question (e.g., classification of dredged sediments as coming under directives for disposal of wastes…). The appropriateness of existing regulations and classifications must be appraised with reference to the ‘multi-functionality’ — and the greatly different qualities and situations — of sediment materials.

The places of sediment in an ecological economic perspective can be explored in terms of the classification of broad categories of ‘service’ roles or ‘functions’ that the sediments may perform. It is convenient to adopt the 5-S classification : **S**ource, **S**cenery, **S**ite, life-**S**upport and **S**ink. In brief, sediments can be :

- *Useful material resource — SOURCE*

  Raw materials (sand, gravel, etc.) for building, landscape design, land reclamation, minerals…

- *Components of biophysical support structures, hydrodynamic forms, etc. — SITE, LIFE-SUPPORT and SCENERY*

  Notably for ports, local ecosystems as nature reserves and parks, flood protection etc.,

- *Absorption/storage for contaminants — SINK*

  The sink role can be deemed either beneficial or problematical, depending on whether the effect is to keep toxics and unwanted materials ‘out of harm’s way’, or, on the contrary, to hold them unstably or too much in proximity as potential contaminants of human and other habitats.

The paragraphs that follow are principally addressed to reconciling the “sink” functions with the other environmental functions (source, scene, life-support and site) in an overall context of sustainable development. In a general way, setting ‘sustainability’ as a goal means seeking to maintain a structural solidarity over time, through ensuring that desired ‘environmental functions’ are sustained while other undesired functional potentials are inhibited or controlled.

2 The 'Tetrahedral' Framework for constructing and evaluating Integrated Sediment Management Scenarios

Relative to, e.g., human health safety for swimming or for aquatic food sources, viability of river species and of coastal fish populations, and so on, sediments can be considered as :

- *Relatively uncontaminated*
- *Old contaminated*
- *Potential future or newly being contaminated*

Within a river/harbour system, there can be complex temporal and spatial interdependencies. All policies for water system management (ecological conservation, water flow control, draining and building, pollution monitoring and control, etc.) involve choices for the redistribution through space and time of economic opportunity and of access to services and benefits provided by the biophysical environment. Out of the range of possible sediment management, dredging and decontamination trajectories, there are choices to be made about which environmental features and functions, which ecosystems and habitats, and which spectra of economic opportunities, might be sustained - and for whom?

2.1 Systems science and social significance

Our overall concern is to define ways to organise the scientific and also the socio-economic data so as to bring out the significance of changes to river-estuary-sediment functioning for existing or possible future socio-economic and environmental values. A central challenge of **integrated environmental assessment (IEA)** is, indeed, the bringing together of physical, biological and economic systems science on the one hand, and political, institutional and sociological analyses on the other hand, for a structured view of the governance problems being addressed. Integrative analyses are seen as interactive learning exercises where individual and organisations must pay attention to their participation in larger political and economic contexts.

It is useful to highlight four key dimensions of knowledge that are essential for building a good representation of a resource management issue in support of concerted governance and policy. These are:

- *“local-level” information — that is, knowledge based in the immediate experience of the “stakeholders” in their "ordinary" activities in their homes, places of commerce, workplaces, with friends, on the wharves and on their travels…*
- *statistically aggregated economic information — such as systems of accounts and models quantifying volumes of sectoral production, sediment flows and pollutant emissions on a watershed, national or other basis;*
- *spatially defined environmental information — such as, in this case, an integrated representation of a watershed showing dynamics of contaminant stockage and transportation as well as water and sediment dynamics from upstream sources to coastal seas.*

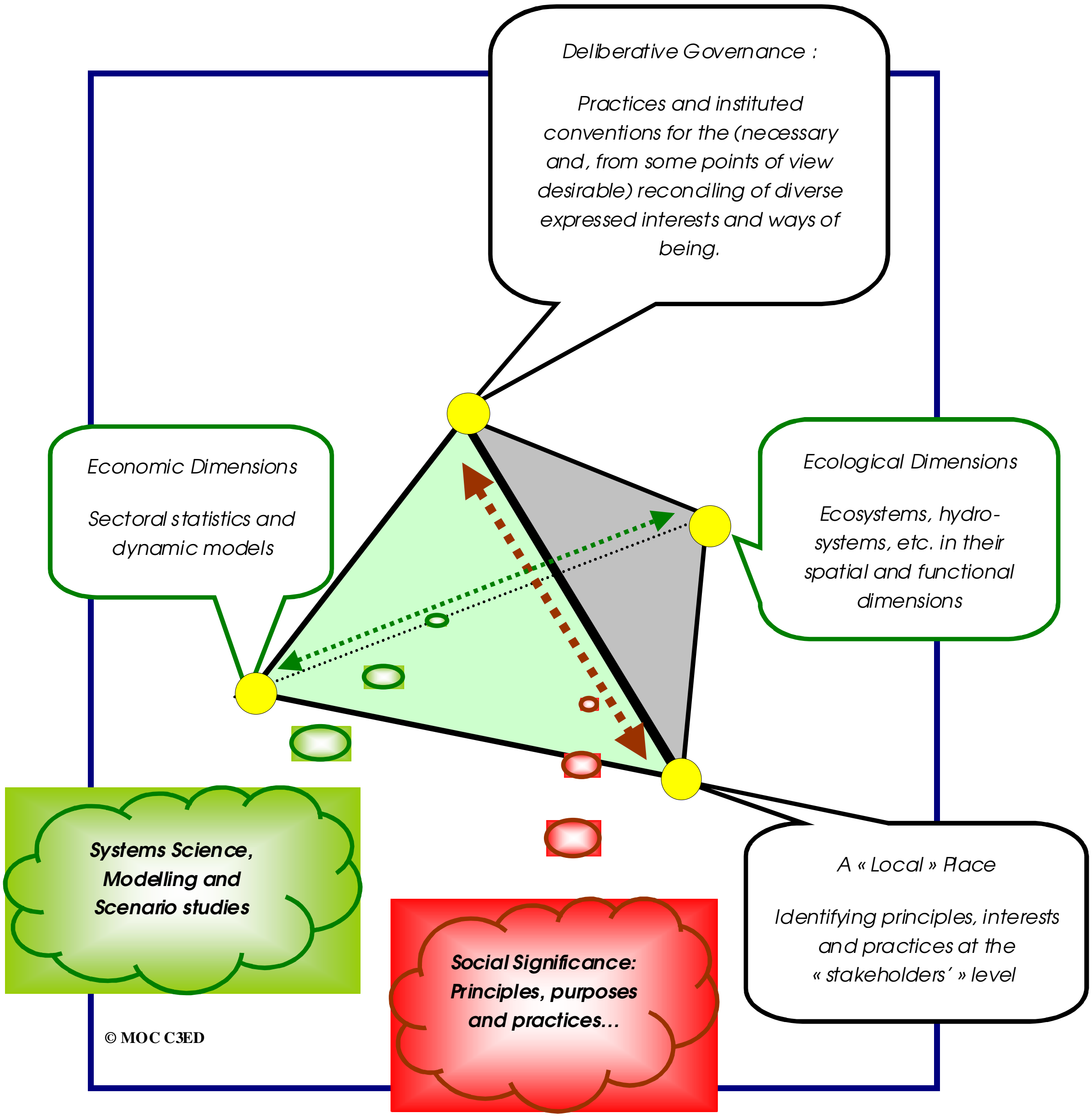
- *governance information — meaning, the terms in which a regulation and coordination of human action is conceived, which link local and aggregated economic and ecological information to frameworks of collective purpose and policy implementation.*

We refer to this as the "tetrahedral organisation of knowledge" (see diagram below). The tetrahedron has four corners, each one linked to the others. The four 'types' of knowledge or understanding are complementary — in a reciprocal way not in hierarchical relation. Knowledge is a dynamic complex process, and so this framework draws attention to the different contexts and needs of action to which representations and knowledge claims relate.

There are, of course, many "local" or « stakeholder » perspectives and contributions to relevant information. In physical terms (ecological and economic), the actions of all stakeholders cumulate (or concatenate) up to the systems dimensions that "integrated » systems analyses try to represent. At the level of meaning and values, the preoccupations of stakeholders (including the researcher, business and public policy communities themselves) all contribute, one way and another, to define the resource governance and policy challenges.

Keeping this in mind, we distinguish two complementary axes of integrative analysis within the tetrahedron:

- *SYSTEMS SCIENCE, the ecological—economic systems dimensions. This refers to various forms of systems representation and quantification about river and harbour hydrodynamics, anthropogenic contributions to sediment flows, transportation and contamination, etc. These are the analyses that, in a scenario framework, can portray responses to the FEASIBILITY aspects of the question "Sustaining of what, and for whom?". Economic analysis and natural/ecological systems sciences (including biology, statistics, risk analysis, etc.) have primary applications here.*
- *SOCIAL COORDINATION and SIGNIFICANCE, or, in short-hand, the social dimensions. The relevant information here is based in human cognitive experience and inter-subjective signifying practices at "local" lived levels. It illuminates different considerations that bear on the DESIRABILITY (or otherwise) of different possible outcomes (desirability of what and for whom…?) Regulatory frameworks and political processes are historically emergent institutions and conventions for "co-ordination" and conflict management. The key disciplines and skills relate to the humanities, notably the sociological disciplines (including anthropology, ethnomethodology, etc) and the political disciplines (social philosophy, public administration, business management, diplomacy…) for understanding and implementing coordination and governance processes in society.*



Based on this synthetic framework for organising the knowledge forms engaged in integrated environmental analysis, it is suggested that IEA practices can usefully be organised as a recursive cycle of analysis, such as the following:

- *STEP 1: Diagnosis of Stakeholder Interests and first specification of the resource management "problems to be solved".*
- *STEP 2: Scientific Analysis of the Hydrological System (Hydro-system Modelling, Population ecology, etc)*
- *STEP 3: Analysis in biophysical terms of the "Environmental functions" of the resource*
- *STEP 4: Quantification of Socio-economic Significance of Environmental Functions (« Services rendered*

- *STEP 5: Economic analyses (cost and benefit assessments of options, constructed on a platform of Multi-Criteria Appraisal and Scenario Analyses*
- *STEP 6: Communication of Results (resource management options, evaluation results, etc.)*
- *STEP 7: Stakeholder appraisal of results, leading to re-specification of problems and options*

The first step privileges the *"Social Co-ordination and Significance"* axis of the Tetrahedral framework; the next four steps privilege the *"Systems Science"* axis, and the last two steps again privilege the *"Social Co-ordination and Significance"* axis. In this way there is a closing of the recursive loop through specifying a "Return to STEP 1".

By starting explicitly, in STEP 1, with the social significance axis of learning, it is emphasised that the information and appraisal requirements for IEA include both formalised and "informal" knowledge, the latter being typically held by members of local communities (viz., categories of stakeholders) without necessarily being abstracted or theorised into systematic models. In an operational sense, the social co-ordination and significance axis is privileged by interactive stakeholder-linked approaches which stress the need to present and discuss scientific and socio-economic findings to interest groups with a range of different interests, on a permanent (i.e. recursive) basis. This again highlights that the analytical systems representation and modelling components of IEA are complementary with the social process and communication aspects.

The paragraphs below mention some aspects of analysis carried out in such a perspective. The key analysis and decision support techniques are deliberative stakeholder concertation on the one hand (using a variety of participatory processes, supported by institutional and documentary procedures, etc.) and management option scenarios on the other hand (which can incorporate components of cost-benefit, cost-effectiveness and multi-criteria analysis). Management policy options will certainly differ according to which of the three categories (uncontaminated, existing contaminated, or potentially contaminated) the sediment is being classified under. In all cases, however, the basic issues can be framed by exploring, as complementary :

- *Notions of what is FEASIBLE (prospects and limits of ecological-economic system design and control…)*
- *Notions of what is DESIRABLE (sustainability of what and for whom ?)*

Following the recursive framework sketched above, management options can be diagnosed and characterised using analysis methods such as simulation modelling, multi-criteria evaluation and policy scenarios — such as land-fill or other siting and sea-dumping projects. Brief notes on this aspect of diagnosis follow in Section 2.2 below. These diagnoses of dydtems dynamics, feasibility limits and options must simultaneously be validated and evaluated for social acceptability (including economic costs and benefits). This may entail a variety of analytical and deliberative techniques, which are aimed at ensuring solutions that are ‘legitimated’ through stakeholder consultation and concertation as well as being economically cost-effective, as discussed in Section 2.3 below.

2.2 Contaminated sediment management: basic notions for scenario development

These notes explore analysis perspectives where sediment contamination is an important concern. So they leave to one side the wide range of situations where 'clean' sediments must or might be dredged and relocated, e.g., for river and port engineering, coastal erosion control, as a source of gravel or sand, and so on.

In the case of contaminated sediments, or contamination risks, in order to develop scenarios exploring feasible futures it is important to furnish 'systems science' information going beyond inventories of contaminants, to include dynamic management dimensions. In this regard, the basic questions to be answered are :

- *What system boundaries should be set for the analysis, e.g., complete river watershed or only lower part (treating inflows from upstream as exogenous) ?*
- *For the system in question, to what extents can the passage between the three sludge categories be controlled by technical, policy/management choices?, over what time-frames?, with what uncertainties? and at what (economic and ecological ?) opportunity costs ?*

In effect, we are concerned about definition of scenarios of possible actions (public policy choices for built/natural systems management), and characterisation of these scenarios in multi-criteria terms. Frontiers of ignorance will be confronted in this exercise. More particularly, the consequences can be teased out of the (limits on) political and physical controllability, in terms of the 'sustainability' objectives that can feasibly be pursued.

Consider the following simple sequence of questions that are aimed at organising key issues for dealing with already-contaminated sediments and those at risk of becoming contaminated sediments :

- ***ALREADY CONTAMINATED SEDIMENTS — situations of « HISTORICAL LIABILITY »***
  - *Is the sludge causing toxicity trouble where it is, or is the problem the need to dredge/shift it ?*
  - *If in situ toxicity is the problem, what are the options for cleaning or containing/isolating the sludge ?*
  - *If dredging is required for e.g., port engineering reasons, can the toxicity element be contained or is there a risk (or a certainty ?) that it may be mobilised in suspension, etc. ? If it can't be contained, but the dredging is an imperative, what odds ? If the toxicity can be contained, what are the 'disposal' options – purification for recyclage/recuperation, stockage on land or at sea, or dispersal (in deep sea ?) — cf. nuclear wastes…*
  - *What are the economic costs and the ecological opportunity costs (and risks) of the various options ?*
- ***SEDIMENTS "AT RISK" — emphasis on avoidance of undesirable future build-up***
  - *Ideally, a « cradle to grave » dynamics systems approach ought to be applied. The spatial system boundary should be chosen to bring into focus all sources that may bear on water/sediment quality for the planning/management time horizon.*

- *It is important to specify : which contaminants are objects of concern; is it flow or stock of contaminant(s) that is troublesome (or both); and how are geographical distribution and time-lags linked (transport, accumulation, dispersal of pollutants…) ?*
- *Can the sources be controlled, and if so, over what timescale (Note: it is not a black and white yes/no, rather it is an historically situated permanent question, depending on regulatory, political, military and economic as well as biophysical realities) ?*
- *If control at source is contemplated, several questions arise: On the basis of what management criteria and principles (norms, precautionary principle, user pays, health limits ?) What institutional arrangements can be developed ? What stakeholder negotiations will or might take place to set and monitor and enforce controls ?*
- *If control over the future or upstream potential sources is not possible (or not in the meantime), what are the projections for management constraints and options (as the "AT RISK" sediment becomes ALREADY-CONTAMINATED — refer above) ?*

The role of scenario studies is to portray or represent the watershed (source to sea) system as a unit — biophysically indivisible as a complex dynamic hydrosystem, and also indivisible as a complex of inter-dependent economic activities with their proper social-economic values.

- *Each scenario should specify and explore a set of sediment management practices that, depending on circumstances, may assure the maintenance over time — the "sustainability horizons — of specific economic and ecosystem components (port, sectors, wildlife, etc.), or may put a number of these values at risk.*
- *Explicit institutional and regulatory hypotheses will have to be introduced, so the scenarios are 'political' as well as ecological-economic in character.*

Such scenarios do not aim to predict. Nor is it as simple as identifying which is the "best" management scenario. Rather, the exploration of economic and physical feasibility is interwoven with assessments — quite often non-consensual — of the adequacy or not of existing institutional arrangements at local, regional and national levels (and perhaps also at European community level, where relevant directives apply) for effective negotiation and conflict resolution.

Note: This implies close attention to appraisal of really existing and proposed institutional frameworks, regulatory processes, the role of emissions and concentrations standards, problems of harmonisation and watershed versus local perspectives (etc.). However, such an appraisal cannot be purely methodological, rather it should be developed in a particular management application.

2.3 Stakeholder involvement in option identification and evaluation

For decision-support purposes, a scoping study must first be carried out, which would usually involve a stakeholder mapping plus a provisional scientific and ecological-economic analysis of identified sediment management possibilities.

In theory, the stakeholder mapping, a type of institutional analysis, can be carried out as a formal research task, through documentary analysis and selected interviews. This would identify significant social actors and their interests, concerns for the future, and de facto entitlements in regard to water resource use benefits, including jurisdiction over water flows and water uses. The stakeholder interests are quite diverse.

They include, on the one hand, all the « users » of the river/estuary system as a resource:

- *whether upstream or downstream,*
- *whether as an in situ use or extractively,*
- *whether commercial or recreational,*
- *whether they degrade or improve the water and sediment quality, etc.*

They include, on the other hand, the various agencies presumed (whether in the public eye or by duly constituted authority) to have competence for managing the water resource, the sediments, the ports, the coastal ecosystems and the surrounding lands.

Stakeholder consultation can be an efficient (if not indispensable) source of insight and information to analysts and decision-makers on management options. Often, however, the communication process goes the other way, from pressure groups to policy and decision-makers. In this case the stakeholder mapping does not need to be done as a desk exercise. Rather, it is built up de facto, and emerges through real stakeholder communication! What is needed is a good documentation of the “historical record” of the real policy process at it comes to ‘include’ different persons and institutions as 'actors' who make heard and felt their ‘claims’ on the process in various ways.

Whether the stakeholder mapping is carried out ex ante or ex post, we make here the presumption that stakeholder concertation is to be deliberately fostered as part of the policy process. Research design then seeks explicitly to incorporate stakeholder interests within key stages of analysis, in order to achieve a « tuning » of the categories of analysis and of result presentation and enhance prospects of legitimacy of proposals.[2] The explicit identification of stakeholders as participants within the loops of research and evaluation makes plain the nature of the applied research as social-scientific analysis responding to high-stake public policy issues.

3 New Governance Challenges for Sediment Management

Integrated management of sediment and contamination as a component of river and port management, is an emerging demand within society. It is recognised that new institutional frameworks must be developed, that can facilitate the stakeholder consultation and deliberative pats of goal setting and option evaluation, and also efficient and effective processes of regulation, monitoring and enforcement. The building up of integrated systems representations and scenarios exploring management options will, in practice, evolve interdependently with the new governance frameworks being established and experimented with.

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[2] For example, it is sometimes useful to engage stakeholders at an early stage in an exercise of representing watershed, pollutant source and sink dynamics in an integrated way, in this way building up a shared understanding of the causes of sediment contamination, the options for pollution control and sediment management, the justifications for and against various policy options, the obstacles to effective implementation and the perspectives of co-operation. Current user-friendly technologies for interactive system simulation on desktop or laptop computers, can even permit stakeholders to work together in construction of simple diagnostic models.

Resource management involves the identification of trade-offs that may need to be made. It includes the development of social processes of conflict resolution that give legitimacy to decisions for or against different entitlements (including distributions of income, and distributions of decisionmaking power in society), and political choices for or against different forms of compromise, conflict management and co-operation. People's « valuations » of particular resources, infrastructures (such as posts and river channels) and environmental features are not expressed solely through individual time and money expenditures, they are also embodied in collective practices, political goals and public perceptions and expectations….

This is why the above framework places emphasis on systems science based explorations of FEASIBILITY on the one hand, and humanities based explorations of DESIRABILITY (interests, justifications and social acceptability, etc.) on the other hand. Stakeholder participation can be important for contributing to high quality of analyses of options, opportunities and the risks and benefits associated with each. It is also indispensable for the political validation of options and analyses.

In this context, validation is measured, in part by scientific coherence and, in part, by achievement of a (widespread, though not always unanimous) acceptance of the scenario visions and evaluation of options as being a « fair » basis for developing the sediment management alternatives. This second — social — dimension of validation is a necessary starting point in the searching for compromises between different goals and ideals of sediment management, and establishment of durable institutional frameworks for continued governance of river/port resources.

Once the variety of management options is identified and characterised in terms of the various economic and ecological systems options being sustained (or foreclosed), there can be an further step of analysis, looking at the main axes of conflict and the possibilities for seeking compromise solutions. Here also, deliberative procedures can be effective for appraising the pros and cons of identified options, and for giving legitimacy and acceptance to finally preferred options.

In conclusion, the main advantage found in applying this methodological framework is the high level of transparency it provides as a decision-support tool, through clearly identifying the stakeholders, and through describing the management issues simultaneously in natural science and socio-political terms. Of course, transparency is an advantage when the key actors and stakeholders are committed to an 'open society' with respect of differences. In this regard, it is important to note that that acceptance of a governance process as fair and transparent, is not the same as having complete consensus about specific decisions and outcomes. In a pluralistic process, a variety of justifications will properly be put forward which, while not individually being fully respected, should not be wholly ignored either (see example, in Box below, concerning the evaluation of pollutant risks/uncertainty).

Stakeholder Deliberation as the Simultaneous Consideration of Contradiction Counsels

Consider, as an example, the question of the « burden of proof » concerning the possible ecotoxicity of chemical residues being released into rivers which might accumulate in sediment.

- *On the one side will stack up optimists and certain commercial interests who emphasise the advantages of the products and argue that any future problems with by-products can be dealt with if and when they manifest themselves (viz., 'the future can look after itself').*
- *On the other side will stack up those evoking a 'precautionary' attitude, who will argue about the risk of 'Type II Error', that is, emphasising that the absence of proof of danger is not the same as proof of the absence of danger. Where uncertainty and possibly grave dangers reside, it is then suggested, the contamination risk should not be run.*

Neither of these positions, in their pure forms, is satisfactory. Often, it is not possible to furnish definitive proof of danger, nor definitive proof of non-danger. In reality, some risks must be run (otherwise there are the dangers and contradictions of paralysis…), yet a heedless rush into chemical novelty seems (to many people) an excessive enthusiasm for producing problems.

So, we have a situation where neither rule can, strictly speaking, be applied, yet each precept acts as a 'caution' on (or, indeed, a 'refutation' of) the other, creating a sort of dilemma or impossibility. This is quite typical of environmental governance problems. It is impossible to 'go beyond' this sort of situation of contradictory imperatives, or contradictory counsels of 'good reasons'.

What this means is not that a "reasoned" base for policy is impossible, rather that reasoning must be employed in a complex deliberative way. An analyst needs to be like a "midwife of problems", helping to raise into visibility, "questions and issues towards which you can assume different positions, and with the evidence gathered and arguments built for and against these different positions" (Rittel). A new type of regulatory procedure must be formulated, which "relativises" the contradictory positions while seeking entirely to dispose of any of them. The challenge is thus to work with a permanent 'argumentation' between the two — or more — positions. What is sought is an explicitly 'reasoned' accommodation of the dialectical opposites. This is not achieved by having recourse to probabilities or expected values (which, themselves, are subject to arguments about being badly or well-founded…). Rather, it is a matter of reasoned judgement and justification in a reciprocal way. Indeed, it is the fluid, unfinished, ambiguous process of inter-subjective communication, with its affective and non-rational as well as rational dimensions, that can permit the emergence of novel perspectives of compromise.

An example in the case of toxic products or wastes might be the application of the following 'rule' as a requirement placed on any scientist or decision-maker or innovator promoting a new product or waste management solution:

"Consider the possible significance of « Type-II error »,
and justify publicly your decision to neglect it."

Since the dangers in question can implicate large populations and diverse interests within society, the challenge is, how to establish transparent procedures for airing of concerns and argumentative process of justification that accommodate the diversity of stakeholder populations and interests while remaining committed to getting outcomes. What is sought, therefore, is a process whereby the society as a whole is engaged in the judgement about acceptability, or not, of specified risks. This means making the acceptance to « run specified risks» into a explicit — and deliberated — collective choice. In general, people will only accept to "be entailed in a risk" if they are persuaded that, somehow, there is a « fair » sharing of the burdens and benefits including for themselves. So justice and non-exclusion considerations are deliberately being worked into the decisionmaking procedure in this way.

Regulation of marine dredged material disposal in the UK, future approaches and implications for source control

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Regulation

In the UK the majority of material dredged for navigation purposes is deposited in the marine environment, either in marine disposal sites, or placed for beneficial purposes. The deposit of material at sea is controlled under Part II of the Food and Environment Protection Act, 1985. The Ministry of Agriculture Fisheries and Food, MAFF, is the licensing authority in England and Wales, in Scotland it is the Scottish Executive Rural Affairs Department, SERAD, and in Northern Ireland, the Department of the Environment, DOE(NI).

Table 1 provides a summary of the licences granted in 1993-1997, quantities disposed, and the major metal contaminants associated with those deposits.

Table 1: Dredged materials licensed and disposed at sea, from UK, 1993-1997

					Metal Contaminants (tonnes)						
Country	Year	Licences issued	Licensed quantity (Tonnes)	Wet tonnage deposited	Cd	Cr	Cu	Hg	Ni	Pb	Zn
England and Wales	1993	110	66,074,966	26,086,503	7.3	875	606	5.2	458	1,004	2,461
	1994	106	53,187,009	34,049,468	8.0	1,295	734	5.9	587	1,375	3,375
	1995	109	54,300,948	35,215,761	5.8	1,298	625	5.2	548	1,380	3,161
	1996	120	82,395,490	48,516,353	8.8	1,556	744	6.9	673	1,731	3,991
	1997	113	56,536,922	38,627,349	6.5	1,181	573	5.5	470	1,241	2,939
Scotland	1993	26	3,174,050	2,025,525	2.4	50	44	0.8	21	63	132
	1994	23	3,643,250	1,822,053	0.9	42	36	0.5	20	56	122
	1995	32	6,186,600	4,782,421	1.1	155	120	3.5	66	153	349
	1996	30	3,971,045	2,601,864	0.4	56	89	0.7	26	81	155
	1997	29	3,910,900	2,436,745	0.2	23	30	0.3	12	38	94
Northern Ireland	1993	7	996,500	3,392,994	1.8	11	26	1.1	13	23	70
	1994	5	113,200	91,314	0.0	0	0	0.0	0	0	1
	1995	9	335,280	249,593	0.2	2	1	0.1	2	2	8
	1996	6	166,000	135,550	0.0	2	2	0.0	3	2	4
	1997	7	206,000	176,919	0.1	1	1	0.0	1	1	5
UK Total	1993	143	70,245,516	31,505,022	11.5	937	676	7.1	491	1,090	2,663
	1994	134	56,943,459	35,962,835	8.9	1,338	770	6.4	608	1,432	3,498
	1995	150	60,822,828	40,247,775	7.2	1,455	746	8.7	616	1,535	3,518
	1996	156	86,532,535	51,253,767	9.2	1,613	835	7.6	702	1,814	4,149
	1997	149	60,653,822	41,241,013	6.7	1,206	604	5.8	483	1,280	3,037

CEFAS is an Agency of the UK Government's Ministry of Agriculture, Fisheries and Food. CEFAS is responsible for carrying out scientific evaluation of each application for a licence to deposit material at sea from England and Wales, and advising MAFF on licence issue. A licence is granted only if this evaluation clearly indicates that the disposal will not adversely affect the marine environment and there are no practical alternatives to disposal at sea.

Contaminants in dredged material

An important consideration in the assessment of the suitability of the dredged material for sea disposal is the level of both organic and inorganic contaminants it contains. When considering the presence of chemical compounds in dredged material, CEFAS follows the guidelines set out by the OsPar Commission for the management of dredged sediment (Oslo Commission, 1993). These guidelines recommend the methodology for sampling and list the contaminants to be measured in the sediment prior to dredging and sea disposal. Licence applicants are required to submit samples for chemical analysis at the CEFAS laboratories. Data for the levels of a number of contaminants in dredged material have been compiled over several years.

The overall situation

The majority of sediments analysed by CEFAS and assessed for sea disposal are judged to be acceptably low in contaminants for sea disposal to be permitted in appropriate disposal sites, and subject to particular conditions. Some 10% of the applications from England and Wales are assessed by CEFAS to be too highly contaminated by TBT or other contaminant to be acceptable for sea disposal. For the majority of these dredged areas, licences are issued for some of the dredged material, with the specific exclusion of material from the contaminated areas. A small number of licence applications each year, (1-2%), are refused sea disposal licenses outright based on the contaminant content of the dredged material, and these require alternative land based solutions for their disposal or treatment.

Tributyltin (TBT)

Our data on a significant environmental contaminant routinely measured in dredged material prior to licence assessment, tributyltin (TBT) is considered here, by way of an example of the relationship between contamination of dredged material, consequences for disposal, and the need for source control.

The OsPar guidelines recommend sediment sampling to characterise the spatial distribution of contaminants. While some samples are requested from the whole dredged area to ensure that samples are representative, and hence contaminant loads can be calculated, additional sample locations are selected by CEFAS to reflect areas where sediments are fine enough to retain contaminants. The results presented here are, consequently, not typical of background U.K. levels of contaminants, but represent areas that are likely to contain fine material acting as a sink, and which may also have point source inputs, for example, marinas, docks or harbours.

An extraction of the data for 8 areas around the coast is shown in Table 1. The data shown in this table are the mean values of the results of several samples taken at a different number of sites for each area.

Between 1992 and 1998, a total of 1507 sites were sampled. Of these, 49% (738 sites) contained TBT levels in dredged material below 0.1 mg kg^{-1}, 39% (587 sites) fell between 0.1 and 1.0 mg kg^{-1} and in 12% (182 sites) TBT levels were above 1 mg kg^{-1}.

TABLE 2: Concentration of TBT in some samples submitted in support of licence applications for sea disposal. (Murray et al, 1999)

Year	Range of Mean Concentrations			TBT (mg kg^{-1})				
	Falmouth	Humber	Mersey	Severn	Solent	Thames	Tyne	Wash
1992							3.02	
1993	34.88	0.05-0.56			0.05-0.38	0.06	0.14-1.3	0.08-0.18
1994	15.38	0.11-5.09	0.21-2.06	0.01	0.13-0.48		0.13	
1995		0.56	0.14-8.84		0.01-0.66	0.15	0.01-1.7	
1996		0.28	0.15-0.44		0.01-0.44	0.26	0.55-8.24	0.03
1997		0.02-0.13	0.01-2.45	0.01	0.3-0.99		4.47-65.25	0.04
1998		0.09	0.25		0.05-0.24	0.17	0.02-2.4	0.003

TBT has a wide range of harmful effects (sub-lethal to mortal) to numerous organisms (bacteria to fish) at greatly differing scales (genetic damage to local extinctions). Marine snails are so sensitive to TBT that a no observed effect limit has yet to be confirmed. TBT has been shown to disrupt endocrine function in molluscs leading to intersex and imposex (masculinization of females), which in Dogwhelks has led to local extinction of populations, and it is of some concern that imposex has been observed in Whelks from the open North Sea. TBT has now been detected in the tissues of marine mammals around the UK coast, indicating bioaccumulation up the food chain. The implications of this have yet to be determined.

Inputs of organotins to the aquatic environment arise from the use of triorganotins as biocides and diorganotins as catalysts, timber preservatives and stabilisers in the plastics industry. TBT is widely used as the biocidal component in boat antifouling preparations on vessels over 25 m, buts its use on vessels less than 25 m was banned in 1987. TBT in antifouling paints has been widely used throughout Europe and is often detected in environmental samples close to harbours, docks and marinas.

The assessment of TBT concentrations in dredged material follows guidelines set out by OsPar. The assessment considers the nature of the material, the quantity to be disposed to sea, and other physical and chemical analyses. The characteristics of the disposal site are also taken into account in the assessment.

The majority of dredged material analysed for TBT contained <0.1 mg kg^{-1} and was considered to be acceptable for disposal to sea. However, some sites were contaminated with TBT to an unacceptable degree, for example, sites within Falmouth River and River Orwell in 1993, Lyme Bay, River Humber and River Mersey in 1994, River Mersey in 1995, River Tyne in 1996 and River Mersey, Swansea Docks and River Tyne in 1997.

Where TBT concentrations were considered to be above an acceptable level for sea disposal, additional sampling was undertaken to investigate possible local sources of contamination. An assessment of the extent of the contamination was undertaken. Licences for sea disposal of material from these sites were then either refused outright, or, where the contamination was restricted to part of the dredging site, granted only for dredgings from the non-contaminated areas. In such situations, the applicant may be required to first remove the contaminated material for land-based disposal or remediation, before dredging and sea disposal of the cleaner sediment is permitted. In other situations it has been judged sufficient for the contaminated area to remain undredged.

Validation monitoring

The success of this approach in preventing dispersal of contaminants into the marine environment via dredgings disposal is checked through a programme of monitoring a number of dredged material disposal sites around England and Wales. While the metals listed in table 1 have been measured in sediments at disposal sites for several years, it is only recently that TBT has been measured in sediments from a few selected disposal sites. Early indications are that there are some slightly elevated TBT levels occurring at a number of disposal sites, but that higher contamination is present at a disposal site off the River Tyne, and this is now under further detailed investigation.

Sources of contamination

Following the identification of the elevated TBT levels at the disposal site, an extensive survey has been conducted of the sediments in the Tyne River to determine the extent of contamination of Tyne sediments with TBT. The Port and Wharf operators are now considering the consequences for any future dredging. The possible sources of TBT contamination have been considered, and possible remediation methods are now being evaluated.

Further research

Following the discovery of elevated TBT concentrations at some disposal sites, further work has been initiated to provide a list of priority disposal sites of concern with regard to TBT. The research is also aimed at addressing the biological impact on sensitive species, and to evaluate methods available for the remediation of TBT contaminated dredged material prior to disposal.

Use of biological assay techniques

The need for biological testing protocols was recognised in the UK some years ago, and MAFF has funded development work in this area. CEFAS has applied the battery of biological tests it has developed for use on sediments to a large number of dredged material samples, together with corresponding chemical analyses. The requirement now is for development of this work into a practical application that can be used to substantiate disposal licence assessments. Work is now underway to develop these existing protocols into a risk assessment procedure for use in licence assessments, and to develop further protocols for chronic tests and bio-accumulation tests that will be capable of incorporation into the procedures.

Comment and implications for source control

The continuing high concentration of TBT in sediments following the ban in use of TBT on small vessels in 1987 is disappointing. There have been dramatic reductions in TBT in sediments in some rivers and marinas following the ban, reflected in lower levels of TBT in material dredged from these marinas, and indeed by demonstrable recovery of the living organisms in those areas, (Rees *et al*., 1999. Waldock *et al*., 1999). In contrast the continuing, and increasingly high, levels of TBT in some dredged materials was unexpected.

The evidence suggests that dockyard practices are continuing to give rise to contamination of river and estuary sediments in some areas of the country, and that scrubbing and cleaning of vessels causes localised contamination in some harbours. The proposal by the International Maritime Organisation, IMO, to ban the use of TBT on all vessels from 2003, and for its removal from vessel hulls by 2008, will in time ameliorate the situation. In the meantime, the dredging and disposal of these highly toxic sediments which have been subject to TBT contamination is a major concern for those port operators who require to maintain their navigable waterways, and for whom sea disposal of the dredged material is no longer an option. Source control, including the adoption of good practice which prevents contamination reaching the sediments, is essential if the practice of sea disposal of dredged material is to continue.

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The impact of contaminated sediments on dredging in the Humber estuary

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The dredging of sediments is now a regular and essential part of water resource management. The resultant environmental impacts are varied and can be severe. Dredging causes habitat disturbance and stresses to the local biota, it can also impact upon sediment budgets and increase the potential for flooding. Dredging is particularly hazardous when the sediments are contaminated, and it this issue which is focussed upon in this extended abstract.

Case study: the Humber estuary, U.K.

The Humber is a large estuary in the North East of England. The catchment area of the Humber covers 1/5 of England and there is considerable local industrialisation. The estuary is not extremely polluted but copper concentrations regularly exceed recommended environmental guidelines. During the previous 6 years an investment in the region of £60 million has been made to reduce copper waste discharges from the local point sources. The copper concentrations remain elevated despite this expenditure due partially to the diffuse inputs from the rivers and the sediments.

Copper discharges have been made to the Humber over the past 200 years as a result of various human activities. Copper concentrations in the estuarine sediments significantly exceed the natural baseline concentrations. These sediments are now a source of copper to the estuary, as previously deposited copper diffuses from the sediments into the over lying waters. As local point inputs are reduced, the dissolved concentrations decrease causing a gradient between dissolved and sedimentary concentrations, and resulting in the re-mobilisation of previously deposited contaminants. The contamination of the Humber sediments also impacts upon the dredging in this area.

The Humber estuary has one the largest U.K. port complexes and is dredged by the Associated British Ports (ABP) on a regular basis to maintain safe navigation channels. The contamination of the sediments causes a twofold problem for the dredging of sediments. Firstly the dredging of sediments can exacerbate the issue of re-mobilisation of previously deposited copper. Dredging disturbs the sediments and can cause a rapid increase in dissolved concentrations of contaminants.

Secondly the contamination of dredged material has an impact upon its disposal. The dredged material is currently disposed of at various sites along the estuary. Alternative means of disposal are currently under investigation by the Environment Agency. The disposal of dredged sediments can have beneficial results; for example utilising the sediments for improving coastal defence, reducing erosion, habitat creation and land reclamation. These beneficial methods have not been implemented, as there is justifiable concern over the contamination of these sediments. If the sediments are to be used in this manner they may first have to be de-contaminated, and the cost of this process may outweigh the benefits of the use of the sediments. The benefits of utilising dredged material must be carefully assessed, and balanced against the costs of de-contamination and the risk to the environment.

De-contamination technologies must be suitable from an economic, technical and environmental perspective. It is anticipated that de-contamination technology companies can be economically viable, self sustaining industries. To achieve this, however, close association of scientists, engineers and regulators will be essential.

Regulation

At the current time no regulation directly addresses sediment contamination. As a result in the U.K. sediment monitoring is minimal. In the case of the Humber Estuary the surface sediments are monitored by the Environment Agency on a twice yearly basis, and no sediment cores are taken. It is difficult to draw conclusions or make predictions about the impact of dredging from such minimal data. Analysis of sediment cores provides a valuable insight into sediment dynamics, which is useful when assessing the environmental impact of dredging. Contamination profiles can be obtained from cores, providing estimates of the probability of re-mobilisation. This information is integral to ensuring minimal environmental damage is caused by dredging.

Regulation needs to take a preventative position to ensure that the continued contamination of sediments does not occur. At the current time environmental damage is being caused, and opportunities are lost, due to the historical pollution of sediments. Regulation must take a long-term approach to prevent the continuation of this effect. This includes controlling point and diffuse sources. Following discharge the distribution of contaminants should be assessed, as the impact of contaminants is dependent upon their end point. Contaminants that are deposited in estuarine sediments are considered to be removed from the system in the short term, but as discussed here the long term impact can be significant.

Concluding discussion points

- To prevent continued contamination of sediments both point and diffuse sources must be targeted. The potential for sediments to act as a source of pollution must be assessed, and the impact of historical inputs should not be under estimated.
- Monitoring schemes, which include sediment cores, should provide an integral part of this regulation, providing information on sediment dynamics, current sediment contamination and future potential for contamination.
- Dredging does not only impact the physical environment, it can also alter the chemical composition of an environment, causing an equally significant detrimental effect.
- The potential costs and benefits associated with disposing of dredged material need to be addressed. If sediments need to be de-contaminated prior to disposal efficient technologies should be researched and utilised. Beneficial uses for the dredged material also need to be assessed. A win-win scenario for the environment and de-contamination companies should be targeted.

3 Report of Working Group I

Elements of a Methodology for Long-term Integrated Management of River, Estuary and Harbour Sediments

Chair: R. K. Turner, Rapporteur. N. Beaumont

Luc Absil, Peter Barham, Hans-Peter Baumert, Martijn Beekman, Marc Braun, René Coenen, Charlotte Hagner, Hartmut Kremer, Brigitte Lauwaert, Axel Netzband, Martin O'Connor, Ronan Uhel, Tiedo Vellinga, Rona Vink

Introduction

The management of sediments within river, estuary and harbour systems poses distinctive difficulties in both scientific and socio-economic terms. Given the generic policy objective of sustainable development, regulatory authorities will have to ensure that an acceptable balance between efficiency in resource usage and equity in resource allocation is achieved, with due deference to the precautionary principle. To achieve this balance a transdisciplinary approach is essential to link natural science with social science, and policy analysis and discourse theory (encompassing all relevant stakeholder interests).

The river, estuary, and marine ecosystems, are fundamentally dynamic and inter-related systems. To encompass the catchment-coastal zone continuum a systems perspective must be adopted. The dynamic nature of the system demands a long-term perspective; the impact of previous contamination must be considered, and the potential for future contamination must be predicted and controlled. It is anticipated that ports will continue to develop for be maintained for the foreseeable future, and the issue of dredging and sediment relocation and disposal will remain problematic during this period, hence a long-term approach is essential.

A pragmatic approach to a future strategy would be one in which all the relevant parties engage in an long-term iterative search process which should deliver a sustainable management system for sediments and related economic activities such as dredging and other port activities. The objectives of such a strategy would be to maximise the beneficial use of sediments where environmentally appropriate, together with waste minimisation at source (sediments as a “natural resource' philosophy); and to minimise the disposal impact of contaminated sediments via cleaning and separation techniques and “controlled” disposal operations and containment sites.

What are the Management Issues for River and Harbour Sediments?

Sustainable development should ensure secure economic wealth creation, and also the conservation of ecosystems. These two long run goals are intrinsically linked as ecosystems provide essential material flows, services and support for economic activity; for example, natural resources, amenities, waste reception, and environmental life support functions. To maintain the integrity of the ecosystem, from an economic and environmental perspective, the management strategy must be designed to maximise ecosystem function diversity, and therefore functional value diversity. Such a strategy is compatible with the need to adopt a spatial scale extensive enough to encompass the catchment-coastal zone continuum and the range of pressures and socio-economic driving forces involved in the environmental change process.

Sediments can provide a wide variety of benefits, both in situ and when returned more or less naturally into the river system, as well as following extraction and relocation. They can be an essential component of physical support structures, for example flood defences, beach recharge, and local ecosystems such as mudflats. They also provide sinks, given a strict set of conditions, for the adsorption and storage of contaminants. This latter role is beneficial if the contaminants are "permanently" deposited and effectively removed from the system. If, however, they are deposited in an unstable state, and/or in too close proximity to human and other habitats they may become a source of pollution, and a cause of environmental and quality of human life degradation.

Following extraction sediments have a number of beneficial uses, which include:

- ***Engineered uses*** – land creation and improvement, beach nourishment, offshore berms, capping material and fill
- ***Agricultural and product uses*** – aquaculture, construction material, liners
- ***Environmental enhancement*** – restoration and establishment of wetlands, upland habitats, nesting islands, and fisheries

Where practicable these uses all contribute to the maintenance of functional diversity (and therefore the values provided by the functions) in ecosystems.

Definition of the Sediments

It is important to use consistent terminology, hence in this paper the term sediments is used to include all dredged material. In a management context sediments can be considered as:

- Relatively uncontaminated existing stock and flow replenishment
- Existing contaminated stock (often with a long history of accumulation) and flow replenishment.
- Potential future or new contaminated flows and stocks

Management policy options differ according to which sediment category is relevant. The division of sediments into these categories is highly dependent upon the perception (both expert and stakeholders) of contamination, and precise methods of classification are required. There can be complex temporal and spatial inter-dependencies within a catchment. Management of the system involves balancing economic opportunity with sustaining environmental services. Choices must be made which allow the environment to be effectively utilised to its full potential, whilst ensuring equity and efficiency through time and space.

A Framework for the Integrated Management of Sediments

The general goal is to define ways in which to organise the scientific and socio-economic data in order to emphasise the significance of changes to river-estuary-sediment functioning for existing or potential future socio-economic and environmental gains and losses. One way to scope and audit these management contexts is through the use of scenarios, see diagram.

In this context appropriate analysis and decision support techniques include methods such as cost benefit analysis (CBA) and risk-benefit analysis, buttressed by deliberative stakeholder consultation (using a variety of inclusionary processes, supported by institutional and documentary analyses, etc.) and management option scenarios. The management options characterised via the scenarios must then be evaluated for social acceptability and economic costs and benefits. This may entail a variety of analytical and deliberative techniques, which are aimed at ensuring solutions which are 'legitimated' through stakeholder consultation as well as being economically cost effective. The legitimation process serves to increase "trust" and "accountability" in the decisions making process.

In order to develop scenarios which explore feasible futures it is important to include information that goes beyond inventories of contaminants, and encompasses dynamic management dimensions. The decision support system provided in the diagram provides a framework for developing these future scenarios. This scenarios methodology operates on the basis of a series of questions. For example if contaminants are present upstream, and there is no option to treat or contain these sediments in situ these sediments, the problem will be transferred downstream by natural processes. The 'no' answer can result from a lack of technology, motivation or unacceptable costs. Once the sediments have been transferred downstream if there still remains no option to treat the contaminated sediments, or sustainably relocate them within the system, and there is no viable cleaning option, the end result is the 'do nothing' situation. The 'do nothing' option does not signify ignoring the issue. This option still requires regulatory effort, (e.g. monitoring), but does not involve the removal of the sediments from their intermediate or final sinks. It also gives some weight to the argument that natural systems recovery processes do exist and that "irreversible" change is not always inevitable.

Case Studies

The scenario approach was tested by investigating several case studies:

- ***HCB contamination of the Upper Rhine***

  During the period 1960-1970 Pentachlorophenol was produced, and HCB's were produced as a side product. All production had stopped by the 1970's but by then the older sediments of the Upper Rhine had become severely contaminated. These contaminated sediments have since been moved downstream by high water flow and dredging. The majority of these sediments are periodically remobilised and are concentrating in various locks such as Gambsheim and Iffezheim Locks, which are the last sediment traps before the Rhine enters the Netherlands.

  As an interim measure the HCB contaminated dredged material was allowed to accumulate in sites within the Rhine river stocked on land, but these containment areas, including Iffezheim, are now full. One option is to let the contaminated sediments continue moving down stream to the Netherlands, and eventually Rotterdam. This will solve the problem on a local scale, but merely serve to shift the HCB contamination to another location, thus shifting the environmental and political problem. The International Commission for the Protection of the Rhine (ICPR) does not have any regulatory power to influence this decision, but has operated successfully with a via voluntary agreements approach between countries.

- ***TBT***

  The contamination of sediments with TBT (an antifouling agent) has been reduced since its use on vessels <25m has been forbidden. Dockyards still have very high TBT sediment concentrations however due to the continued use of TBT on larger vessels. Contaminated TBT sediments are disposed of in containment sites, as there are no suitable treatment or de-contamination techniques available. TBT contamination cannot currently be easily eliminated at the source because of the financial implications, although a number of alternatives have now been developed. The proposal by the International Maritime Organisation to ban the use of TBT on all vessels from 2003, and for its removal from vessel hulls by 2008, will in time ameliorate the situation.

- ***Fire Retardants***

  Fire retardants are a new contaminant. They are increasingly used in many aspects of daily life, and enter the water and sediments as a diffuse source. Little is known about these contaminants and although they are present on the OSPAR contaminant list, they have not been included in the European Waste Directive. These contaminants are therefore not controlled, and a 'Do Nothing' response results when the Scenario approach is applied.

The application of the scenario approach to these case studies has demonstrated its usefulness. The scenario approach should be applied as a support process to aid decision making, highlight areas of concern, and improve the transparency of the decision making process. The application of this approach to these case studies has emphasised the fundamental lack of an appropriate institutional framework covering the catchment coastal-zone continuum, and the absence of harmonisation and standardisation within the regulation regimes.

Harmonisation and Standardisation of Regulation

The application of the scenario approach to the previous case studies highlights the lack of harmonisation of regulation, and the resulting effects. The issue of sediment contamination is generally included in Waste Directives, although it can be argued that sediment regulation should form a part of the Water Directives. The regulation of the contaminated sediments tends to fall between these 'two stools', and as a result it is not well integrated into any regulation.

Freshwater environments are treated differently to marine waters. It is scientifically sound to have different guidelines for contaminants in fresh and saline waters as the impact of contaminants varies in these different environments. To ensure a systems approach is adopted however, the regulation of the saline and fresh water environments should be linked together. Greater harmonisation and co-ordination is an urgent requirement at the international level in order to produce effective and efficient guidelines and frameworks. An effective dialogue between scientists and regulators is also essential, to derive a harmonised set of environmental standards which can be applied to the entire system. Environmental agencies and managers must also interact with other stakeholders to develop guidelines which encompass the entire catchment, whilst incorporating local scale issues.

Contaminants are treated differently by different regulators. For example, OSPAR has a list of approximately 400 contaminants, whereas the European Waste Directive lists in the region of 30. It is likely, however, that OSPAR will continue to refine its candidate substances list and may also end up with around thirty priority substances. Different countries interpret these lists in different ways depending on a variety of issues, including local economic and environmental pressures. This can inhibit the adoption of a systems approach as contaminants are prioritised differently in different areas. The presence of these two lists also has benefits as the OSPAR list is more precautionary, listing contaminants such as the Fire Retardants, and provides guidance, and recommendations, for future contaminants to be listed on the European Waste Directive. The documentation of contaminants that could potentially cause environmental damage is a useful step towards encouraging precaution in regulation.

Regulation still tends to be reactive to environmental issues, and precautionary measures remain in the minority. In the U.K. the Environmental Agency has drawn up a list of endocrine disrupters which will be regulated despite the fact that no detailed analysis has been undertaken. In the UK, this pro-active approach is considered an important step towards predictive and precautionary regulation. It considers actions are needed now to minimise discharges of certain substances such as: those already subject to statutory control for other reasons such as their toxicity and persistence, but/or which endocrine-disrupting effects have also been reported; and some alkylphenols and steroids not currently subject to statutory controls but according to recent evidence, may be harming wildlife. But the precautionary approach is not a simple panacea, its application may well entail substantial economic costs and depending on exact circumstances may not even result in environmental gain if alternative more ecologically efficient and effective options are not available.

The lack of standardisation and harmonisation of regulation is of significant concern, and the derivation of mechanisms to overcome this is considered an essential part of future catchment-coastal management. The specific components of the system should continue to be researched and managed on a local basis, but an over-arching management scheme must also be implemented to ensure the successful adoption of a systems approach. An approach which adopts the marine system and sink capacity as the reference point for all other catchment based numbers and ranges provides a step towards mitigating the issue of regulatory co-ordination.

The meaningful adoption and deployment of the Polluter Pays Principle (PPP) in this sediment management context seems to be a difficult challenge. Many of the pollution sources involved are diffuse in nature and cover wide temporal and spatial scales. One way in which an economic incentive instrument might be deployed in order to encourage separation and treatment of dredged material, and to inhibit future potential contaminants is via a landfill disposal tax/charge. The UK now has limited experience of the operation of such a charge and not all of it is positive. A charge is levied if sediments are placed in disposal sites rather than subjected to treatment. It remains an open question as to whether this type of instrument could be deployed more extensively in other countries.

The Integration of Stakeholder Opinion

The scenario approach provides an appropriate tool for improving the transparency of the situation, and highlighting potential problem areas, and therefore aiding the consultation and negotiation process. The role of stakeholders should be integral to this process. The incorporation of stakeholders requires time and money, but if the public's opinion is neglected science can lose the respect of the general public and suffer from trust and accountability deficits. This effect has been observed in the case of Genetically Modified Foods in the U.K. Public opinion was not fully integrated into the decision making process, and this coupled with poorly communicated information has resulted in significant distrust of science on this issue. To avoid this effect, and ensure science is successfully incorporated into stakeholder values and belief systems the derivation of environmental regulation must become a more inclusionary process.

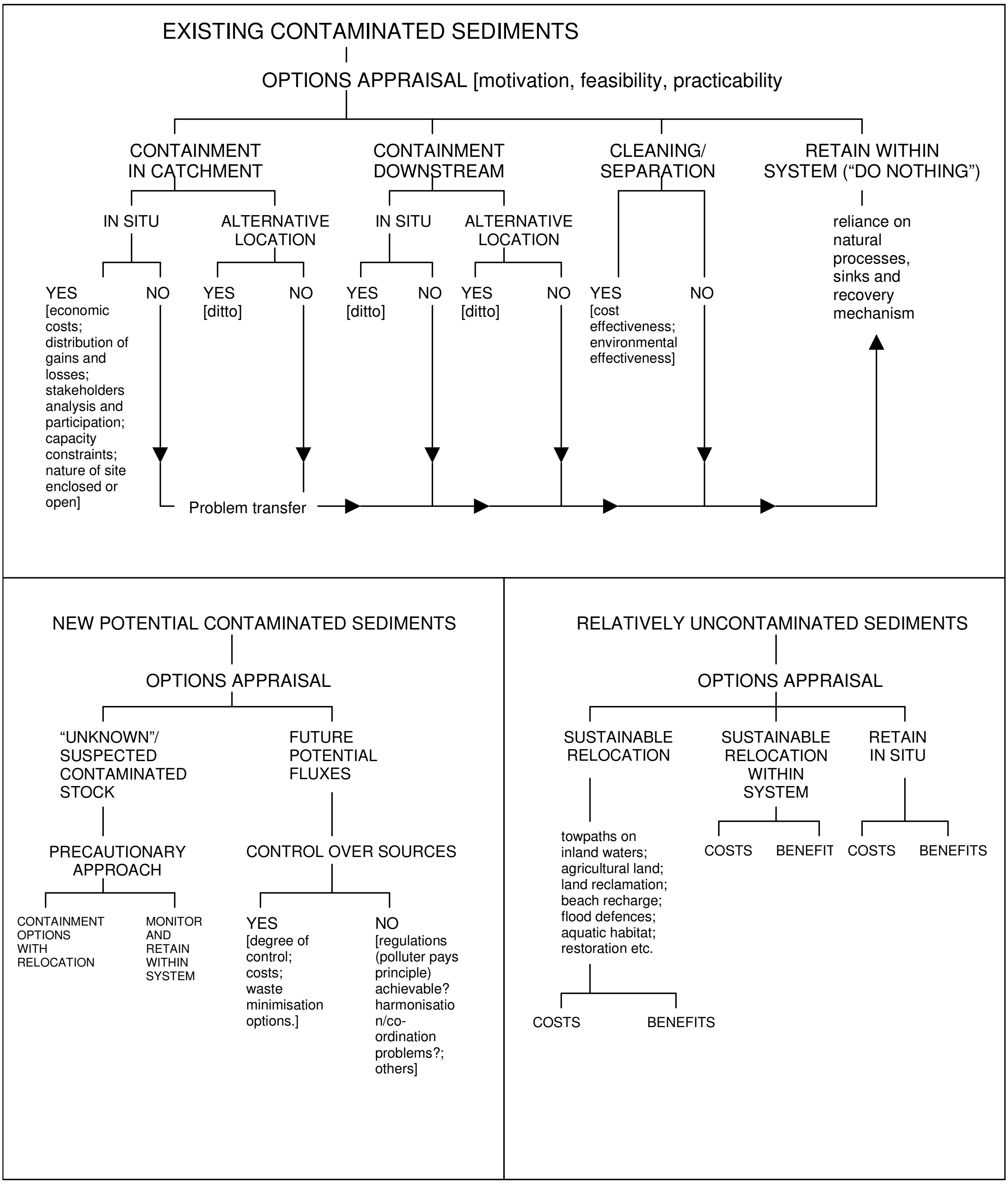
Stakeholder participation aids the development of equitable and acceptable regulation. Environmental regulation tends to involve balancing costs and benefits and the integration of stakeholder opinion into this process can result in the derivation of regulation which is perceived to be fair by a majority in society.

At the current time the inclusion of stakeholders in the regulation setting regime is considered to be insufficient. In some cases where the stakeholder opinion is included it does not have any significant effect on the decision process. Poor communication of information results in the inclusion of only those who are already closely involved in the process and/or have specific claims on the environment. It is also the case that stakeholder opinion is included in the process but not at the most appropriate level, for example the ICPR and OSPAR incorporate stakeholder opinion but it has little impact upon the higher order decision-making levels. It is recommended that organisations broaden their remit to involve the participation of stakeholders in a more effective manner.

Recommendations

- More harmonisation and standardisation of international regulation, (guidelines and frameworks) while maintaining the integrity of local systems and approaches An approach which adopts the marine system as the reference point for all other catchment based numbers and ranges provides a step towards mitigating the issue of uncoordinated regulation, and also serves to highlight the need for consistency of approach adopted towards each contaminant.
- Increased stakeholder participation in the process of environmental regulation setting and monitoring in order in particular to exploit local scale solutions and consensus-building practices
- The adoption of a scenario approach to allow the assessment of biological, physical, chemical and economic factors, and the balancing of these gains and losses against political, economic and social welfare criteria.

SEDIMENT MANAGEMENT SCENARIOS



4 Report of Working II

Dredged Material: Short-term issues and solutions

Chair: M. Scholten, Rapporteur: R. Peerboom

L. Absil, A. Cieslak, M. Eisma, K. Groen, B. van Hattum, H. Köthe, P. Mollema, L. Murray, C. Peters, F. Post, K. Pröpping, J. Stronkhorst

Introduction

All participants were invited to identify their “topic of concern” in relation to short-term issues of dredged material on the basis of a “dredged material management tree” (see Figure 1).

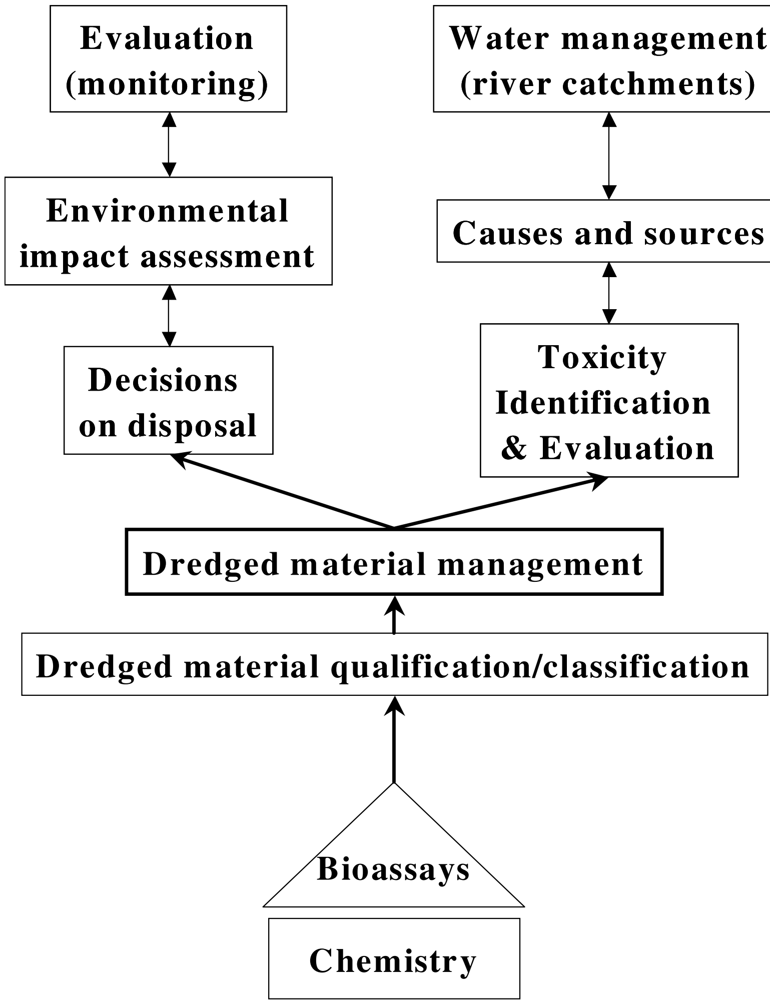


Figure 1: Dredged Material Management Scheme

From this inventory round six items for discussion emerged:

- Pragmatic approach dredged material management
- Disposal solutions
- Sources of pollution

- Added value bioassays
- Implementation level
- Goals 2005

In the following, a short description is given of the group discussion with respect to these topics.

Pragmatic approach for dredged material management

From the side of the Dutch North Sea directorate a need for a pragmatic approach to permit granting and disposal of dredged material was expressed, which should be more effective (division shore/sea) and more efficient (smaller time gap) than the present Dutch system. It was recognised that the approach should serve economy, ecology and the public (not necessarily in this order). Furthermore, clear objectives should be set with respect to the volumes (m^3) and to the 'acceptable level of toxicity or pollution of concern' (at the disposal site) of the dredged material. Both objectives are linked, as lower toxicities allow larger volumes to be disposed and vice versa. Scientist would be involved to identify "the most toxic volume of the dredged material" as a basis for using the capacity of confined disposal sites in the most effective way. A risk-based, pragmatic approach, which is transparent to all stakeholders should be the result of all this. Monitoring, evaluation and subsequent adjustments would lead to continuous improvement (learning by doing), aiming at decreasing adverse effects and increasing the benefits gained by disposal. It was recognised that short-term effects are covered by above-mentioned approach, but some hesitations were expressed whether this also counts for long-term effects.

Disposal solutions

The method of choice depends of course on the specific properties of the material (type of material, type and level of contamination). Relevant criteria for disposal options are the risks involved, sustainability (environmentally sound solutions) and cost-effectiveness. For clean material, relocation in the system was identified as the preferred option, as this is most beneficial to the environment. Contaminated material can be beneficially used by land reclamation and active sediment management (sediment for dike construction). Confined sub-aquatic disposal with natural or artificial fixation is an alternative option. However, this might not be a long-term solution for material containing persistent pollutants. If one aims at total exclusion of risks, treatment and re-use are the options. The cocktail of pollutants found in contaminated material, however, make treatment a technically difficult and costly operation. Finally, land-fills and transport over land were not favoured as disposal options.

Sources of pollution

Dredged material contamination is related to activities in the catchment area, the harbour area and the marine area. The latter involves shipping-related pollution such as antifoulings, oil and chemical spills. From the catchment area various diffuse sources (pesticides) and domestic chemical residues originate. Finally, in the harbour area local pollution loads from shipping, docking and industrial activities are added to the sediment (future dredged material). Pathogenes might be an additional pollution of concern. Bioassays are useful for hazard indication, but also for source identification by the so-called Toxicity Identification and

Evaluation (TIE) approach, which is currently under development. Knowledge of local in-harbour sources and loads of pollution is important in getting a clear view on the other part of pollution. Furthermore, this type of inputs is under the control span of the harbour authorities, as opposed to the diffuse sources upstream in the catchment area. In this field many actors are involved and the issues are complex; agricultural practices, consumer behaviour, substance/product cycles, which should be tackled at a higher level. It was recognised that “the cleaning of the sources” cannot be triggered by the quality of dredged material alone. These things are beyond the focus of dredged material management and should not be addressed in this way. The strategy could be a transparent identification of the pollution of concern (by means of international priority chemicals lists) followed by a harmonised approach at a (inter)national level.

Added value bioassays

Chemical-based analyses are not always indicative for environmental risks of contaminated sediments. Materials with a high chemical load can be assessed by chemical considerations, but for moderately contaminated materials a toxicological consideration seems more appropriate. This is were bioassay fit in. As discussed extensively at the Science workshop in Geesthacht, the added value of bioassays is the fact that they address bioavailability, combination toxicity and not-analysed toxicants. The goal is not an extended analysis of dredged materials, but a better indication of hazard. In practise, a few, selected bioassays must provide a sound hazard indication. Important in this respect is a transparent judgement of bioassay results, which must prevent confusion in decision-making. Some aspects are not covered by bioassays and chemistry still has to be used. Weighing the results from bioassays and chemical analysis is a challenge.

Level of implementation

Is an international implementation of approaches for dredged material management preferred? The group distinguished three different aspects in this respect. For a general risk management approach, international (generic) guidelines were considered helpful. However, for the setting of quality criteria (actual action levels), international harmonisation would not do justice to the specific local (or catchment-related) situation. Finally, in the improvement of information exchange, international fora could again play a useful role. OSPAR was suggested as a suitable forum for networking, whereas transfer of knowledge could be established in the framework of the IMO/London Convention office.

Goals 2005

As the short-term issue group, working group II was asked to describe the goals for the year 2005, which turned out to be a summary of the above mentioned items. The aims can be divided in improved dredged material management and in pollution control. The first aim involves a pragmatic, transparent approach based upon risk management, at which bioassays are considered helpful diagnostic tools. Dredged material should be more beneficially relocated or used, considering it a valuable resource instead of waste. By evaluation of cases and monitoring, adjustments should lead to continuous improvement. Objectives with respect to the sea form a point of concern in this respect. Additionally, in the year 2005 pollution control should be addressed on a catchment basis. In this complicated, international, multi-actor process, dredged material quality can serve as an indicator for success. Via the link of sediment quality, the European water framework directive could act as a reference in this respect.

Appendix I

Synoptic Report from the Workshop

River Sediments and Related Dredged Material in Europe

Scientific Background from the Viewpoints of Chemistry, Ecotoxicology and Regulations

GKSS Research Centre, Geesthacht, Germany

3-5 April 2000

Martin Scholten, TNO, The Netherlands

In preparation of the policy workshop on "River sediments and related dredged material in Europe", a science workshop had been held at the GKSS in Geesthacht. The first day of that workshop was used for a series of presentations on the evaluation of the pollution and ecotoxicity of dredged materials form riverine/estuarine harbours. It appeared that in many countries (Netherlands, Belgium, Germany, Spain, UK, USA and Canada) bioassays has been introduced to assess the ecotoxicity in addition to chemical analysis of the pollution level. A plethora of test methods were developed; various methods are used in the evaluation of the test results. In the plenary forum-discussion at this first workshop day, the main discussion points were touched: what is a sound practice in ecotoxicity testing of dredged materials; how can they be used for Ecological Risk Assessment for redistribution (disposal) of dredged materials; how can they be used for Ecological Risk Assessment for redistribution (disposal) of dredged materials downstream or at sea; how can observed toxicity be linked to causal pollution sources (Toxicity Identification and Evaluation concept).

These issues were further discussed in two working groups at the second day of the science workshop. An application-oriented working group discussed the environmental evaluation of dredged materials on basis of chemical analysis and bioassay testing; another science-oriented working group discussed methodological aspects and the exchange of information amongst scientists.

The reports of these working groups will be published in the proceedings of both workshops on "River sediments and related dredged material in Europe" in Geesthacht and Rotterdam. The main conclusions, recommendations and concerted actions, resulted from the Geesthacht workshop, were:

- The ultimate goal of biotest application is the assessment of ecological risks for the receiving environment,
- The test should be ecological relevant and informative; a few standardised bioassays are available; more specific chronic tests and biomarkers are under development,
- The decision on dredged material disposal is based on action levels, rather than on science based quality criteria (SQS). In the future SQS might substitute action levels,

- The interpretation of bioassay tests requires reliable criteria which are transparent and easy to handle. Harmonisation is recommended; references should well be defined,
- A tiered approach is recommended with a first TIER I assessment on limited chemical criteria and few bioassays, and an extended TIER II assessment on toxic material to identify culprit chemicals (using Toxicity Identification and Evaluation = TIE methods) or a confirmation of no environmental impacts at the disposal site for slightly / non-toxic material,
- Toxicity Identification and Evaluation can be a helpful tool when research and development (R&D) is better co-ordinated; an international thematic network should be established,
- The predicted value of biotests with dredged material (hazard assessment) for environmental impacts in the receiving environment (risk assessment) needs to be confirmed; a proposal for such a study (BIOSAFE) was launched during the workshop.

Appendix II

Background Paper

distributed to the invited participants

1 Introduction

The loading and unloading of ships needs the presence of quiet areas, often located in estuaries, with little or no wave action (e.g. harbours). These human made areas unfortunately function also as excellent sediment traps. In this way the transport of sediments from the river to the sea is temporally interrupted. In tidal harbour areas, sediments from the sea become additionally trapped and thus temporally removed from the coastal system. Continued access to harbours by shipping requires the removal of these trapped sediment. In a "simple worldview" one may state that dredging also remedies the impact harbour construction has on the natural transport of sediments from the river to their final destination area.

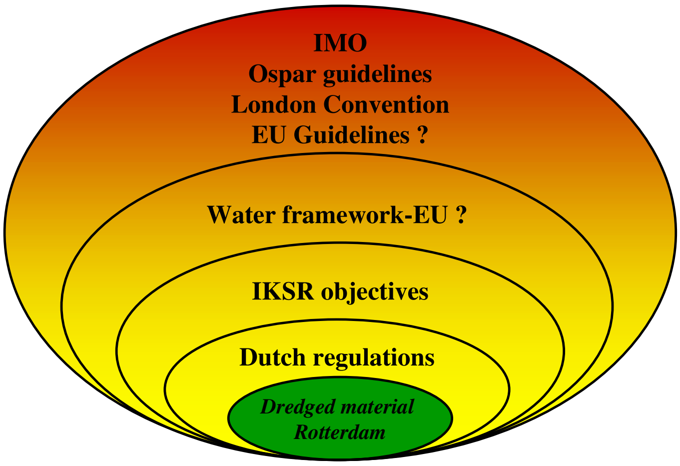


Figure 1: Some of the regulations-organisations-treaties, which are relevant for dredged material management

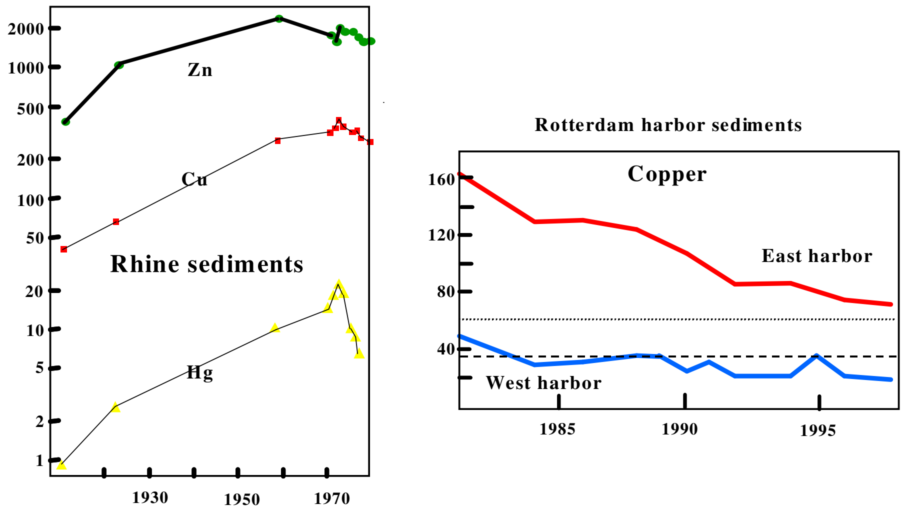
However, this simplistic worldview is more complicated in the "real world". The main reason has been the presence of contaminants in the sediments, in particular in the early seventies and eighties. This has resulted in a plethora of testing methods, local, national and regional regulations, which have sprung up over the last decades. Currently, the amounts of the "traditional contaminants" like heavy metals, PCB's and PAH's have decreased considerable from their extreme high levels in the seventies (figure 2B), however concern is being expressed that these contaminants do not reflect the true "toxicity" of the sediment to the ecosystem. Also, these classical contaminants represent only a minor part of the substances introduced by human society in our waterways. As a result integrative testing using bioassays are being promoted or are on the verge of implementation. The plethora of testing methods of local and national regulations has lead to differences in the cost for dredged material management in European harbours. No EU regulation is currently in place.

In view of the decrease in contaminant levels in sediments, the plethora of testing methods and regulations, the introduction of new testing methods and new ideas concerning river catchment /coastal zone management makes a reassessment of the dredged material issue timely.

We will address these issues in more detail in this workshop and use the Rotterdam harbour as an example. In the last section we will offer a number of topics for discussion during the workshop itself.

2 The Rotterdam harbour case

The total volume of maintenance dredging in the Rotterdam harbour is around 20 million cubic meters a year. A characteristic gradient in contaminant concentrations is observed from East to West, which is due to the mixing of river and marine sediments. The easterly harbours are more under the influence of the Rhine and hence have higher concentrations compared with the westerly harbours where the marine sediments dominate (figure 2 B). This is a characteristic of most estuaries. Efforts to reduce the point sources, through the first Rhine Research Project of the Rotterdam Municipal Port Management and the Rhine Action Plan of the International Commission for the Protection of the Rhine (ICPR), have been quite successful (see figure 2B).



A B

Figure 2: The history of Zn, Cu and Hg contamination in Rhine sediments (A) and the development in dredged material quality ion the Rotterdam harbour for copper (B)

However, despite these efforts concentrations of zinc, copper, PCB's and PAH's often exceed regulatory limits for those harbours that are directly under the influence of the river Rhine. This material has to be stored in a specially built permanent depot: the "Slufter". The "Slufter" should be seen as an intermediate solution and therefore finite solution. The Slufter's capacity is about 100 million cubic meters and at this moment, the depot is half-full. However, to reach a further reduction it will be necessary to tackle diffuse sources, since they dominate currently in the Rhine (and probably in most European rivers) the inputs (figure 3).

At the same time it should be realised that only 50% of the contaminated river sediment that passes Rotterdam settles and needs to be dredged. The other 50% is transported directly into the marine system. The end of pipe solution covers therefore only 50% of the problem, while the primary source control is effective for 100% of the problem.

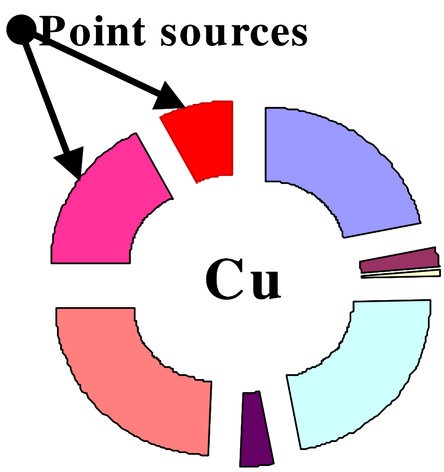


Figure 3: Sources for copper in the Rhine catchment

This requires a direct link with catchment management and future action plans for catchments. Furthermore should the implementation of the Water Framework Directive of the EU be sufficient to solve environmental issues downstream, which are in this case determined by policy regarding the quality of the North Sea ecosystem (OSPAR, North Sea Action plan, National Dutch policy on dredged material etc.).

In the Rotterdam harbour, as in all harbours, dredging means maintenance dredging (no end to it), and requires management with a long time frame perspective. Apart from the issues already mentioned:

- Management of diffuse pollution: source control, “polluter pays principle”
- Harmonisation of policy objectives for the catchment and the coastal sea

There are two more issues on the horizon. The current list of compounds which are used for regulation of disposal of dredged material contain a number of heavy metals, PCB’s, PAH’s, pesticides and mineral oil. However, these are only a minor part of the potentially harmful substances in sediments. There is quite a debate in the scientific world and also outside on potentially other harmful substances. Of course TBT is a well known issue, but not anymore for the long-term view, since the IMO has taken action in this respect. Other compounds include the “endocrine substances”. Here again there is an urgent need for harmonisation between catchment and coastal sea regulation to come up with identical lists and appropriate methodology to enforce source control.

Long-term management of dredged material has also to take into account the changing regulation to test the quality of dredged material. Currently all testing is based on concentration limits for chemical substances like heave metals and PCB’s. However it is more and more realised that these lists of substances reflect only a small part of human introduced substances in the environment. Hence bio-assays which test the toxicity of sediments are becoming more popular and in the case of the Dutch regulations are due for implementation in 2002 for disposal of dredged material in the North Sea. Preliminary testing has shown that in some cases the results of the chemical based methods are different from those based on bio-assays. Hence long term management has to take into account:

- The presence of “new substances” in the contaminated sediments subject to regulation
- The introduction of bio-assays

Both items may cause different management strategies and if not uniformly implied lead to differences in implementation between the different river catchment and coastal sea systems in Europe and differences between European harbours in their dredged material management.

Finally, there are no EU guidelines for dredged material. It appears to be covered by: upcoming regulations like the European Landfill Directive, European Waste Catalogue and the already mentions, Water Framework Directive, while the marine disposal is covered by regional conventions, based on the London Convention.

This leads to the third issue on the horizon:

- Importance, relevance and principles of EU-regulations for dredged material

3 Discussion items for the workshop

From the discussion based on the case study of maintenance dredging of a major harbour located at the end of major catchment and subject to national and international regulations we identified the following issues:

I. The presence of “new substances” in sediments

Currently already a number of substances potential concern have been identified (which are not on the “lists”) and more will be in the future. Here the question are the (emerging) regulatory issues and whether pro-active action is needed to reduce their inputs by identifying point and diffuse sources in the catchments.

II. The introduction of bio-assays

The introduction of bio-assays as hazard identification is planned in some countries. However, there are different kinds of bio-assays (acute toxic and chronic and the receptor-based assays /biomarkers tests) responding to different classes of chemicals. Not all of them harmonised and/or validated. Here the question is how they will be integrated in the current guidelines etc. and can they be integrated in management and risk assessment. Perspectives for bio-assays as a management and regulatory tool.

III. Management of diffuse pollution: source control, “polluter pays principle”

This issue become important since the control of point sources at the catchment level is not sufficient to decrease contaminant levels in river sediments below the chemical guidelines. The question we have to discus is how can we tackle diffuse pollution sources.

IV. Importance, relevance and principles of EU-regulations in as far as they directly or indirectly apply to (river) sediment quality and for dredged material

Here we have to answer the questions on the relevance of the various EU regulations, since apparently there is none which directly addresses the (river) sediment issue or the disposal in the marine environment of dredged material.

V. Harmonisation of policy objectives for the catchment and the coastal sea

Here the need is obvious for the contaminated sediments issue, but can we achieve this and if yes how can it be done. Dredged material management as part of river sediment management.

Appendix III

Workshop Agenda

Monday, April17th

10:00 - 10:20	Welcome and introduction to the workshop *Wim Salomons, GKSS, Germany*
Session I	**Chair: Kerry Turner, CSERGE, United Kingdom**
10:20-10:40	Report back from Science workshop *Martin Scholten, TNO, The Netherlands*
10:40-11:00	Management of dredged material in the OSPAR maritime area *Brigitte Lauwaert, MUMM, Belgium*
11:00-11:20	Dredged material management: global requirements and guidance *René Coenen, IMO (London Convention Office 1972), United Kingdom*
11:20-11:40	The Rhine: pragmatic answers to sediment questions *Marc Braun, ICPR, Germany*
11:40-12:00	Principles of dredged material management in the Helcom area *Andrzej Cieslak, Maritime Office, Poland*
12:00-14:00	Lunch and poster break
Session II	**Chair: Martin O'Connor, Université de Versailles Saint-Quentin-en-Yvelines, France**
14:00-14:20	The old Waste and the Sea *Folkert Post, North Sea Directorate, Ministry of Transport, Public Works and Water Management, The Netherlands*
14:20-14:40	Do We Need Regulations for Sludge in Europe? *Hans-Peter Baumert, Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany*
14:40-15:00	The Environment Agency of England and Wales and dredging: local impacts and strategic planning *Peter Barham, Environment Agency England and Wales, United Kingdom*
15:00-15:20	Living Rivers *Gerard Litjens, WWF, The Netherlands*
15:20-15:40	Dredged material: Solved in one generation? *E. Matser & M. Beekman, Greenpeace, The Netherlands*
15:40-16:10	Tea break
16:10-17:00	Forum

Tuesday, April 18th

09:00-09:15 Introduction and outline of themes of two working groups (Wim Salomons)

(1) Working Group I : Elements of a methodology for long-term integrated management of river, estuary and harbour sediments
Chair: Kerry Turner (CSERGE, United Kingdom)
Rapporteur: Nicola Beaumont (Plymouth Marine Laboratory, UK)

(2) Working Group II : Dredged material: short term issues and solutions
Chair: Martin Scholten (TNO, The Netherlands)
Rapporteur: Renée Peerboom (IVM, The Netherlands)

09:15-12:00 Parallel sessions of the working groups

12:00-14:00 Lunch break

14:00-14:15 Plenum: Reports from working groups on issues discussed

14:15-17:00 Parallel sessions of the working groups

Wednesday, April 19th

09:00-11:15 Plenum (Chair: Wim Salomons, GKSS, Germany)
Presentation of the results of the two working groups and discussion

11:15-12:00 Final discussion in the working groups

Appendix IV

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