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

PROJECT REPORT

Present and Future Quality of Sediments in the Rhine Catchment Area

Current and Future Policies and Regulatory Framework

Substances and New Criteria to Watch

Dredged Material in Relation to the North Sea

February 2001

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Project Report

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Further information, is available under:

http://w3g.gkss.de/i_a/dredged_material/index.html

or http://www.gkss.de, Institute for Coastal Research

- links to project partners
- workshops and initiatives
- downloadable reports

Supplements to this Report as Separate Volumes

Appendix to Project Report

Appendices to Part B-E of the Project Report

J. Gandrass, W. Salomons (eds.). GKSS Research Centre, 28 February 2001, 78 pp.

Workshop Report I

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. J. Gandrass, W. Salomons, U. Foerstner (eds.). GKSS Research Centre, 31 August 2000, 83 pp.

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. W. Salomons, K. Turner (eds.). GKSS Research Centre, 31 October 2000, 84 pp.

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Part A EXECUTIVE SUMMARY AND INTRODUCTION TO THE PROJECT

1 Executive summary

Sediments and related dredged material

On a worldwide scale rivers are denuding continents and transport eroded material as suspended solids to the coastal areas. Deltas, estuaries and their associated wetlands are natural sinks for this material. Man has interfered with this 'natural way of things' in three ways:

- changes in the catchment area like agriculture, urbanisation and deforestation have changed the erosion patterns and sediment supply;
- the sediment supply itself has been decreased by damming parts of river systems; and finally
- the composition of the sediments has been altered.

Notable are the increased loads of already present compounds like heavy metals but also the introduction of man-made organic substances like pesticides, polychlorinated biphenyls (PCBs) and flame retardants just to name a few.

These changes at the catchment level are a major challenge to river basin managers and to the coastal zone managers who are 'at the receiving end' of the catchment. Notably are the issues faced by port authorities, which have to deal with the sedimentation of riverine suspended solids in their ports. Ports who require quit conditions for shipping become efficient sediment traps. The amount of trapped sediments is enhanced when through tidal action marine sediments/suspended solids are transported into the harbour areas. In the case of the port of Rotterdam most of the sediments to be dredged derive from the marine environment.

Figure 1-1: Sea port - interface between river basin and coastal zone

The settled sediments spent a comparatively short time in the port areas before they are removed by dredging. Through relocation to the marine environment they are mixed with sediments already present there and continue their normal transport pattern in the coastal environment. In the North Sea the sediment transport pattern is well known; sediments are transported in a northerly direction with the general circulation pattern (*figure 1-3*). Part of the sediments become deposited in the shallow areas like the Wadden Sea, but ultimately they will end up in the 'deep holes' like the Norwegian Trench.

Figure 1-2: Maintenance dredging

Sediments consist of clay minerals, organic matter and several silicate minerals. Due to the nature of the clay minerals and the organic matter these constituents are excellent scavengers for contaminants introduced into the environment.

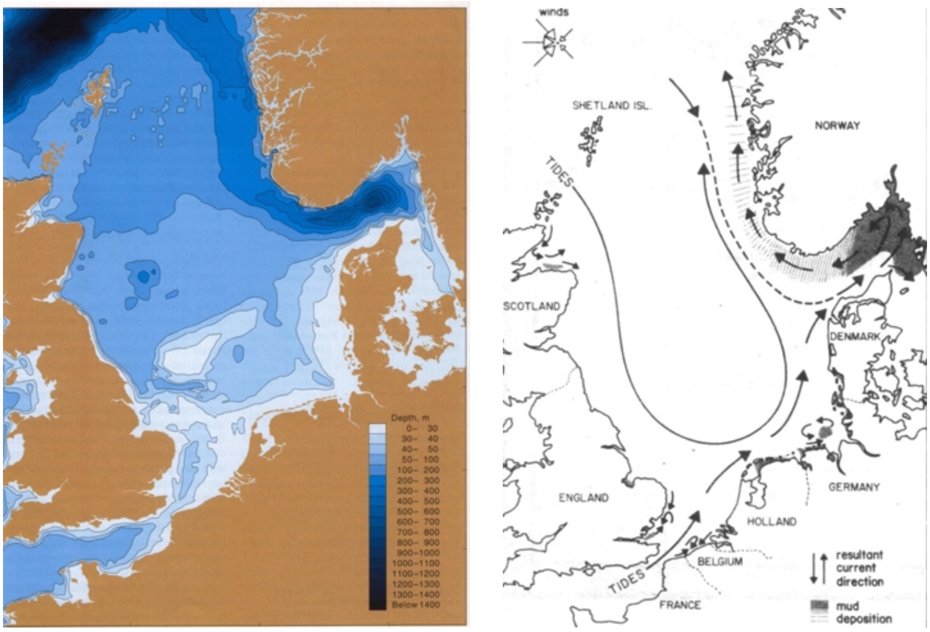

Figure 1-3: Bathymetry of the North Sea and the transport of sediments in the North Sea (Eisma, 1988)

In river catchments, the main inputs are through point and diffuse sources. Point sources are direct discharges into the river systems by industrial activities, sewage treatment plants etc. Diffuse sources include agricultural activities, runoff from paved areas, erosion of (contaminated) soil and sewage overflows. In the marine environment, the main sources are river inputs, shipping and in particular atmospheric deposition.

Since the seventies, when the negative effects of these inputs became apparent, measures have been taken and priority chemicals for control were identified. A large number of national and international organisations became involved or were installed to regulate discharges into the freshwater and marine environment.

This has resulted in a strong decrease of in particular heavy metals and PCB inputs in the marine environment. In fact, the latter compounds were banned from use. The large changes in concentrations are shown in figure 1-4 relative to background values. For this example the concentrations of cadmium were selected, since this heavy metal showed the highest elevated concentrations in the eighties. In the early eighties the concentration in the eastern parts of the port of Rotterdam was more than 60 times the background level decreasing to slightly more than 10 in the Europoort in the western port area. Addition of more marine sediments along the coast and in the Wadden Sea caused a further decrease. The values in the Eastern Wadden Sea were 2.5 times the background level.

In the late nineties, the concentrations in the eastern and middle part of the port of Rotterdam approached the values found in the Wadden Sea in the former time period, showing the drastic decrease of inputs from the Rhine. In fact, the concentrations in the Europoort are at the background level and the concentrations along the coast now show a tendency to a slight increase, for which admixture of older (still contaminated) sediments can be an explanation. In the Wadden Sea itself there is no difference anymore between the eastern and the western part, concentrations are at background levels.

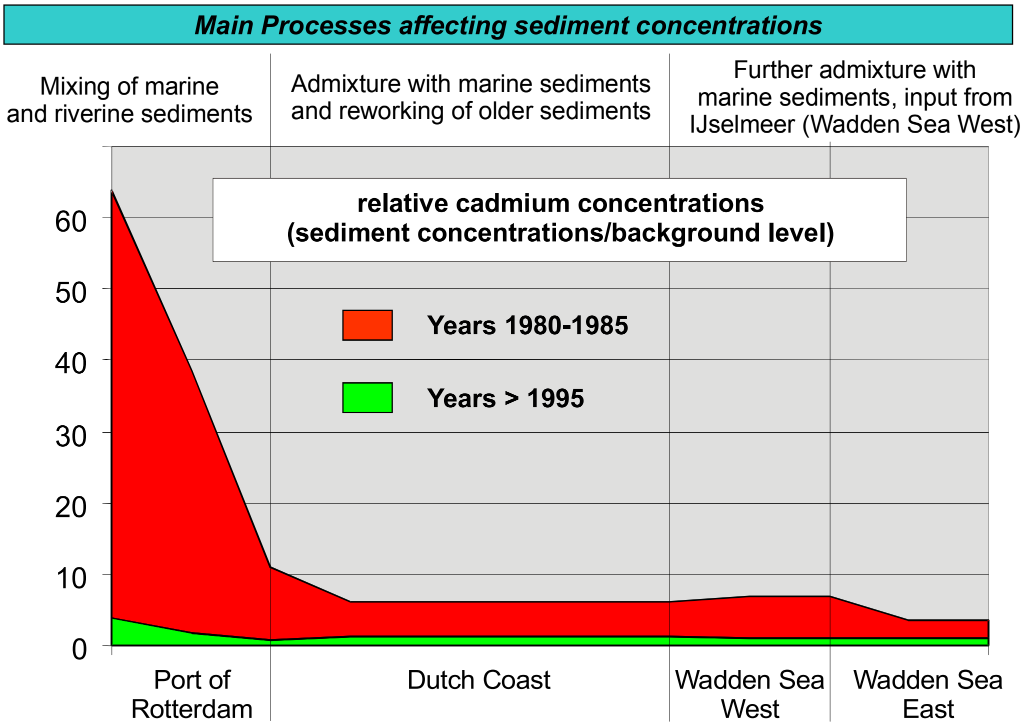

Figure 1-4: The relative concentrations (measured divided by background concentrations) of cadmium in the port of Rotterdam, the Dutch coast and the Wadden Sea.

The decision on relocation or withdrawal (confined disposal) of sediments from the marine system should take two effects on the coastal ecosystem into account. On the one hand the withdrawal of slightly contaminated sediments will reduce inputs of contaminants (positive), on the other hand withdrawal of large amounts of sediments will upset the sediment balance in sedimentation areas (negative). In a modern impact analysis both aspects should be put in a context of questions about sustainable river management and sea level rise, with increasing coastal erosion and impact on mud flats.

Several organisations are currently involved in identifying 'chemicals of concern' which are not part of the current regulatory lists. An important new regulatory framework on a European scale through the 'Water Framework Directive' is on the horizon. Last but not least, the 'classical' list of chemicals for hazard assessment had the advantage that they could be easily and economically analysed. The plethora of new compounds necessitates the introduction of new additional methods (bioassays) for hazard assessment. These methods are not compound-specific but rather try to identify the toxicity of the mix of compounds present in water or sediments.

In particular, but not only, for port authorities the regulatory efforts and the (scientific) assessment of dredged material quality are in a state of flux. In the following we will give an overview of:

- point and diffuse sources in the Rhine catchment and identify their past, present and future inputs and how they determine sediment quality,
- the present and future regulatory bodies that are relevant for dredged material as well their proposals for “new priority chemicals”, and
- the issue of hazard assessment of contaminated sediments/dredged material through new methodologies and their relation to risk assessment at the disposal site.

Sediments from the Rhine catchment area

Sediments in the Rhine basin become contaminated through point and diffuse sources. Inputs of contaminants into the Rhine system follow different pathways and contaminant-specific retention or loss processes. Inputs can be divided into three broad categories: Indirect inputs from rural and urban areas and direct inputs, e.g. from waste water treatment plants or as discharges from industry or shipping.

Several heavy metals, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) are of concern with regard to the quality of sediments in the Rhine catchment area and are as well criteria for the relocation of dredged material to the North Sea. In the eastern parts of the port Rotterdam, mainly influenced by inputs from the river Rhine, zinc, copper, PCBs and PAHs frequently exceeded the so-called Sea/Slufter values in dredged material; hence this contaminated material has to be stored in a special depot: the Slufter.

The question arises, how the contamination of dredged material will develop in future and whether it will reach levels that allow its relocation to the North Sea.

For this purpose, a model with a geographical information system (MONERIS, figure 1-5), developed for quantifying nutrient emissions along the various pathways in river basins, was adapted for heavy metals, PAHs and PCBs.

MONERIS incorporates digital maps as well as data on land use, soil types, waste water treatment etc. Contaminant-specific information as emissions from point sources, concentrations in top soils, atmospheric deposition were gathered and used as input data.

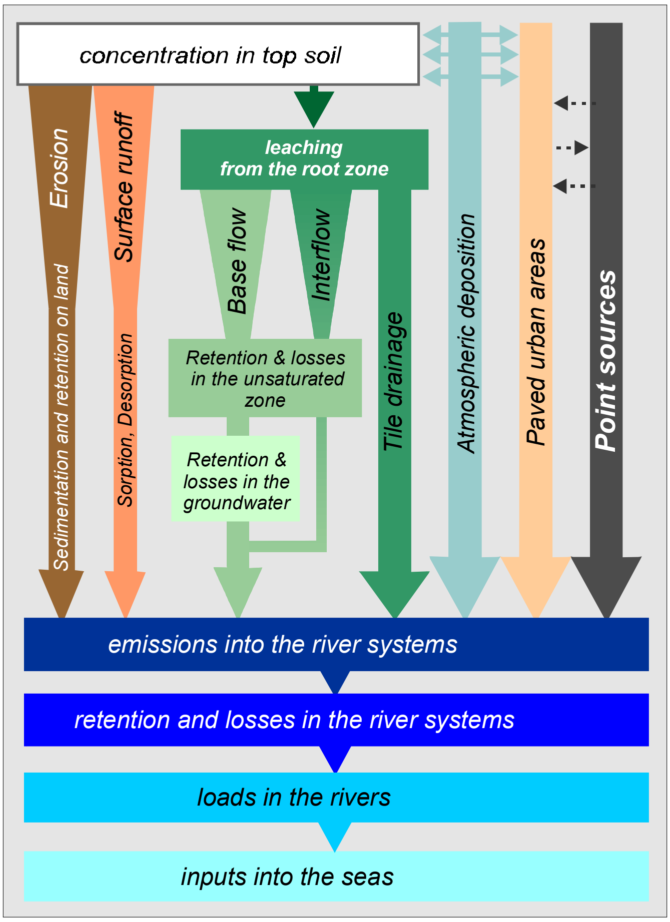

Figure 1-5: Pathways and processes in MONERIS

The inputs for heavy metals, PCBs and PAHs from different sources and their contribution to contaminant loads in the Rhine system were quantified and linked to the quality of sediments/dredged material in the port of Rotterdam. Subsequently two types of scenarios were modelled, taking the present state as a starting point, for the time period until 2015.

The 'business as usual' (BAU) scenarios take measures into account which are already agreed on or are 'in the pipeline', i.e. the implementation can most probably be expected. The 'Green' scenarios consider as well additional reduction measures that might be realised but largely depend on upcoming policies. Contribution of different relevant sources/pathways are exemplarily illustrated for zinc and benzo(a)pyrene, a polycyclic aromatic hydrocarbon, in figure 1-6.

Examples for measures that had been taken into account in the BAU and Green scenarios

Urban areas: Decoupling of paved areas from the sewer system and enlargement of rainwater storage basins (*Green*). Active replacement of building materials as uncoated galvanised steel, copper and lead (*Green*).

Erosion: Infrastructural measures in agriculture (*Green*).

Waste water treatment plants (WWTPs): All WWTPs of category 3 include a denitrification step and WWTPs of category 4 a P-elimination step (*BAU*). Phophorus-elimination in WWTPs of category 3 and microfiltration in largest (category 5) WWTPs (*Green*).

Industry: Application of 'best available techniques' (BAT) with regard to emissions to rivers and atmosphere (*Green* and/or *BAU*).

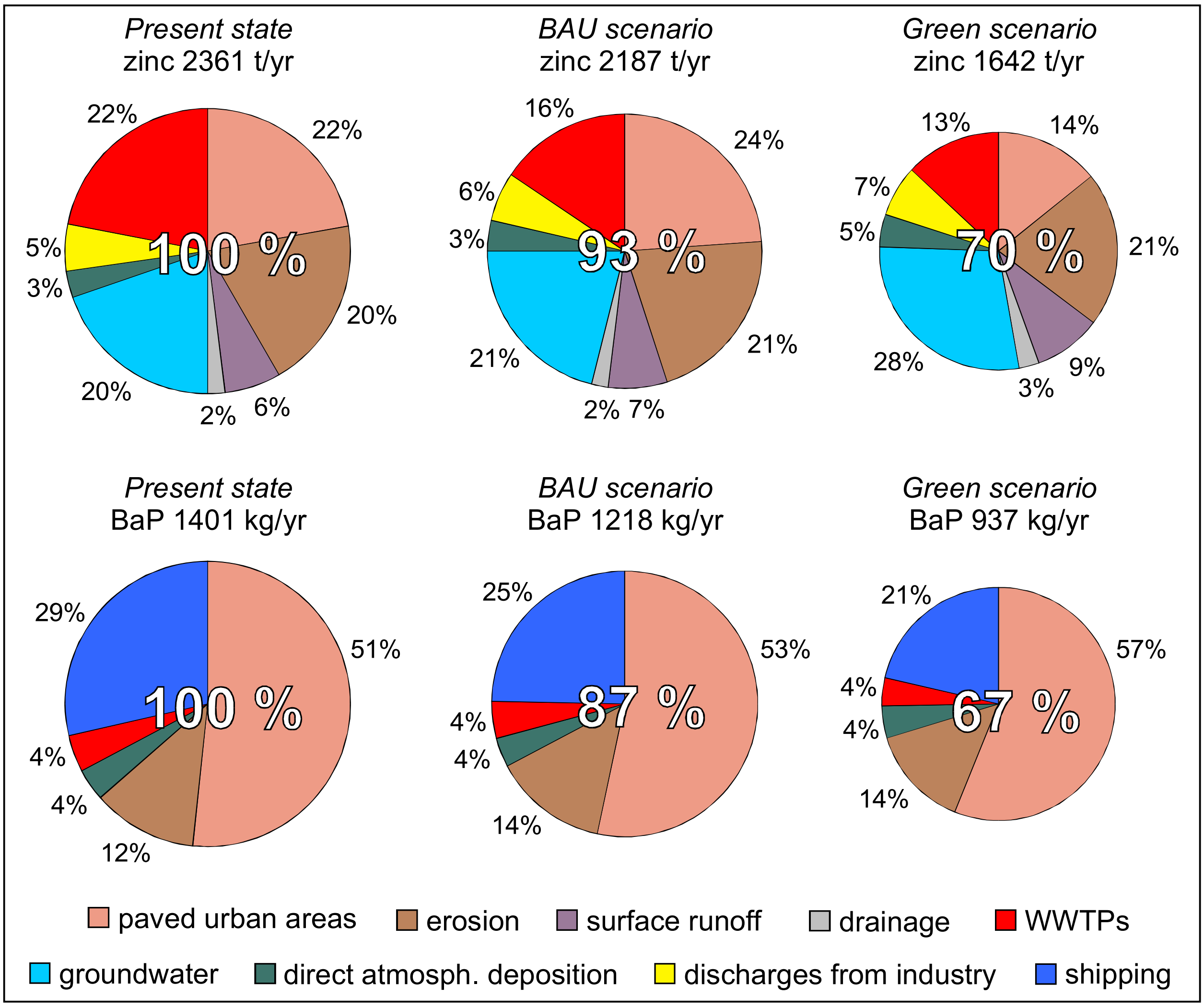

Figure 1-6: Results of the scenario analysis for zinc and benzo(a)pyrene inputs in the Rhine basin upstream Bimmen/Lobith

Taking the present state as a starting point, the changes in modelled future inputs in the Rhine basin were extrapolated on the development of the quality of sediments in the eastern parts of the Port of Rotterdam and were compared to current Dutch quality criteria for relocation of dredged material to the North Sea (figure 1-7).

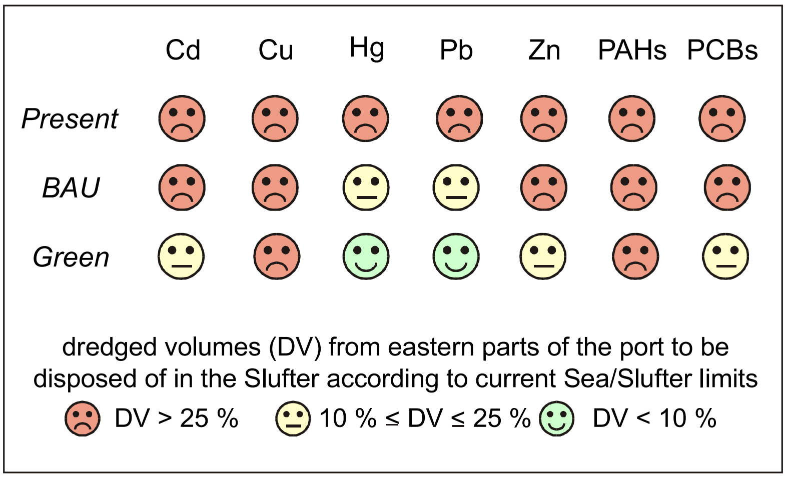

Figure 1-7: Present and estimated future quality of dredged material in the eastern parts of the port of Rotterdam according to current Dutch criteria

Measures, accounted for in the *BAU* scenarios, are not expected to result in a substantial decrease in contamination of sediments/ dredged material for most of the investigated sub-stances. Additional measures (*Green* scenarios) could achieve more satisfying results towards reaching the Sea/Slufter limit values. However, even in the Green scenarios, defined target values will be still exceeded for the investigated compounds until 2015, with the exception of lead (not shown in figure 1-7).

Pathways incorporating the highest reduction potentials for copper, zinc and cadmium are inputs from urban areas, from wastewater treatment plants and to a lesser extent erosion from agricultural areas. Additional related measures, bringing the highest net reductions, are substitution of building materials as uncoated galvanised steel and copper, decoupling of paved urban areas from sewer systems, enlargement of rainwater storage basins and erosion reduction measures in agricultural areas.

PAHs are mainly released by combustion of fossil fuels and related processes resulting in elevated atmospheric deposition rates in urban areas. This pathway and related additional measures, especially towards emissions from residential combustion, incorporates the highest reduction potential. PAH inputs by shipping (releases by ship paints, spills) could not be quantified in satisfactory manner and cause a larger uncertainty in the modelling results for PAHs than compared to heavy metals.

PCBs, used e.g. as dielectrics in capacitors and transformers or as hydraulic oil in mining, have been banned in many countries and are restricted in marketing and use by the European Council Directive 76/769/EEC. New PCB inputs are mainly driven by atmospheric deposition, re-emissions from soils becoming more important. Major pathways are paved urban areas and direct atmospheric deposition on surface waters. Additional reduction measures are decoupling of paved urban areas from sewer systems and enlargement of rainwater storage basins.

An issue of special importance for PCBs is the 'historic' contamination of sediments in the Rhine basin. As new inputs of PCBs will continue to decrease, the relative contribution of 'historically' contaminated sediments to PCB loads in the Rhine basin will gain in importance. This process, is governed by re-erosion during high water discharges, by relocation of dredged material stemming from weirs and locks in the upper Rhine or tributaries of the Rhine and related retention and loss processes. Due to scarce data the described processes could not be included in the model. For that reason the forecasts for PCBs might be too optimistic, i.e. the estimated improvement in the quality of sediments/dredged material might be reached later than 2015.

Further reduction measures should be evaluated in an integrated approach comprising the Rhine catchment area as well as the receiving coastal zone as one system. Notable improvements have already been achieved in the Rhine basin, the port of Rotterdam as well as in the North Sea since the 80s. For the Dutch coastal zone, this is examplarily depicted for particulate PCB concentrations, revealing a decreasing relative contribution of PCB inputs from dredged material; other inputs, especially by atmospheric deposition, gaining in importance (figure 1-8). The ultimate goal, however, should be to achieve a sustainable situation, which enables to relocate dredged sediments to the North Sea with no further need for land disposal.

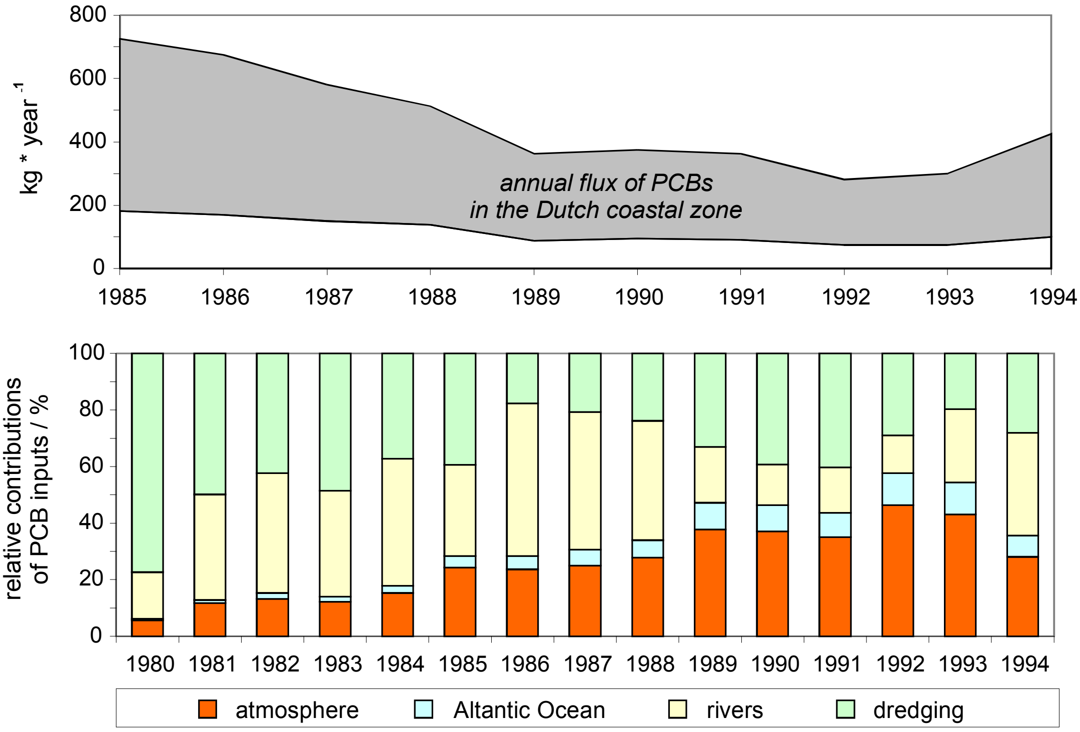

Figure 1-8: Decreasing contribution of PCB inputs from dredged material in the Dutch coastal zone (Laane et al., Journal of Sea Research, 1999)

Regulatory frameworks

Dredged material management comprises the relocation of dredged material in rivers, the relocation to the sea or disposal at land as well as the beneficial use in coastal protection, agriculture etc. Addressing the relocation to the marine environment, guidelines have been defined on an international level by the Oslo and Paris, the Helsinki and the London Convention. The implementation takes place on the national level. Dredged material management is not an explicit issue on the EU agenda. From the European legal point of view dredged material is addressed in terms of waste whereas sediments are covered by the European Water Framework Directive (EU-WFD).

Dredged material management in estuarine harbours, being the interface between river catchments and the coastal zone, is influenced by immission control (sediment quality targets in the river basin and the marine environment) as well as by any policies and regulations concerning emission control and related issues. This complex system of policies, regulations and the involved stakeholders is roughly summarised in figure 1-9.

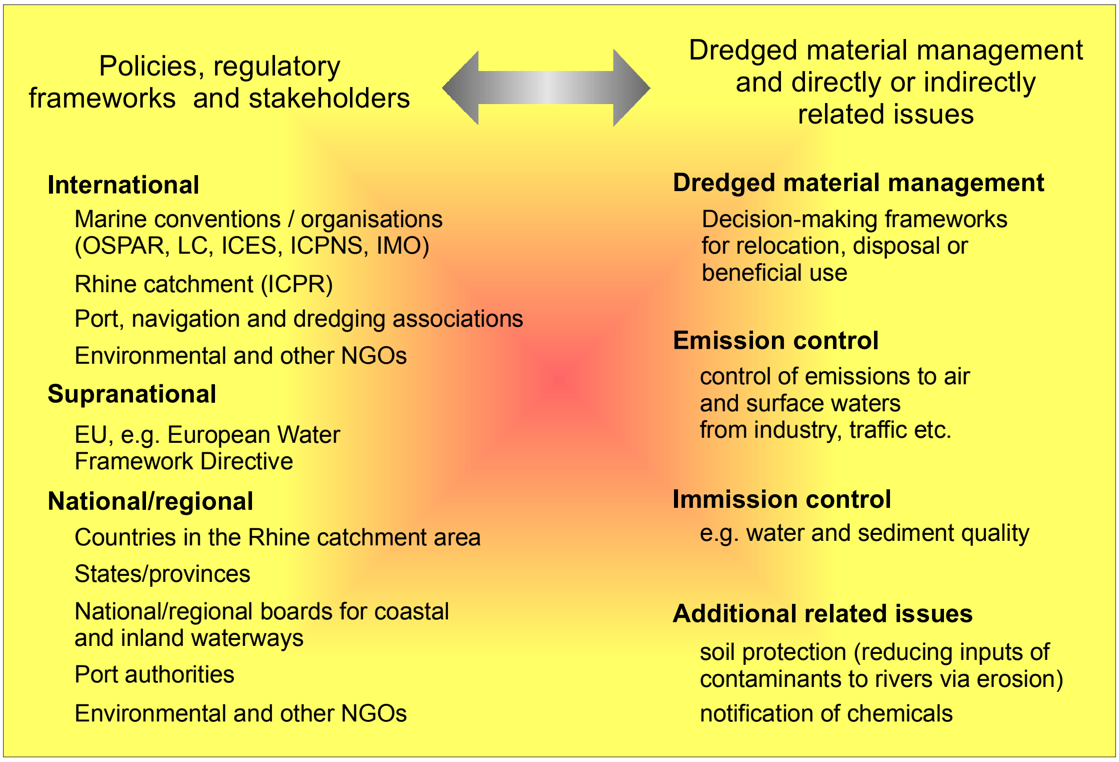

Figure 1-9: Policies and regulatory frameworks related to issues directly or indirectly influencing sediments/dredged material management in the continuum system Rhine basin/coastal zone

At present, in the Netherlands classification systems for sediments/dredged material quality are defined. For relocation of dredged material to the North Sea a number of chemical criteria are applied, the so-called Sea/Slufter limit values, previously mentioned. This classification system is currently under revision and a limited set of bioassays is evaluated and is scheduled to be implemented in 2002, supplementing the chemical parameters.

Substances of concern, showing elevated concentrations especially in the eastern parts of the port of Rotterdam, as zinc, copper, PAHs and PCBs, are mainly stemming from the Rhine catchment area. The International Commission for the Protection of the Rhine (ICPR) has an active part in improving the quality of the Rhine by establishing quality targets, international monitoring programmes and action programmes for prioritised substances. The implementation of emission and immission control occurs on the national level.

The new EU-WFD, adopted by the European Parliament and Council in September 2000, will have a direct impact on national approaches towards immission and emission control. A list of priority chemicals is proposed and shall be reviewed at least every four years. For substances, included in this list, the EU-WFD demands that the European Commission submits proposals for:

- quality standards applicable to surface water, sediments and biota (within 2 to 6 years)
- controls for the progressive reduction of discharges, emissions and losses
- controls of cessation or phasing out of discharges, emissions and losses (the timetable should not exceed 20 years).

Priority chemicals with regard to the North-East Atlantic, including the North Sea, are defined by OSPAR. In the 'Sintra Statement', OSPAR stated with regard to hazardous substances that the ultimate aim is to achieve concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made chemicals. This is as well considered in Article 1 of the EU-WFD.

The EU-WFD demands to establish river basin management plans in order to achieve certain quality levels depending on the type of water bodies. For heavily modified and artificial water bodies a lower quality level is required than for surface waters in general. The designation of water bodies will be performed by the individual EU member states. This will be crucial due to the currently 'wide' definition of heavily modified water bodies. The further specification of criteria for this type of water bodies is currently under discussion on the European level.

Conclusions and future perspectives

- Currently and based on existing and upcoming regulations there will remain an urgent need for harmonisation of sediment quality targets/criteria in river catchments and those for the relocation of river sediments to the marine environment. **The river catchment and the coastal zone should be treated as a continuum/one system.**
- Emission control is essential in further improving sediment and dredged material quality. The **EU-WFD** follows a combined approach of **emission and immission control** with emphasis on the latter. With this respect, the **designation of water bodies** (rivers) as **'heavily modified'** is of importance as it might result in less stringent water quality control and consequently contaminated sediments. From a dredged material management point of view and for the protection of the coastal zone (the receiving environment), this classification should be interpreted carefully.
- At the international level, regulations concerning dredged material and contaminated sediments are part of the Oslo and Paris (OSPAR), the Helsinki and the London Convention. The OSPAR Commission is of importance in setting guidelines for the disposal of dredged material in the marine environment, which are reflected in national criteria for disposal. It is expected that OSPAR will continue in this role. **The feed-back system from contaminated sediments to the reduction of emission needs to be improved.**
- **Sediment management should get on the agenda of the EU.** The objectives should be both to improve the awareness concerning contaminated sediments and to harmonise regulations concerning the management of dredged material, especially between coastal and freshwater zones and within Europe.
- Efforts to improve sediment/dredged material quality should approach 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. **This implies the need for harmonisation of approaches and the integration of stakeholders in the decision-making process.**

TBT - a compound currently in the lime light

A 'most-talked-about' compound in relation to dredged material is tributyltin or for short TBT. Since the 1970s most ships' hulls have been coated with paints containing TBT to prevent fouling by organisms and in this sense it is effective. However it is slowly leached and thus enters the aquatic environment. TBT has a wide range of harmful effects to numerous aquatic organisms including microalgae, molluscs, crustaceans and fish. Marine snails are in particular very sensitive towards TBT, which affects their endocrine system, causing imposex already at very low concentrations.

Elevated TBT concentrations are found along major shipping routes in the coastal environment and especially in sea ports. Due to the increased settling of suspended solids (mainly of marine origin) in estuarine ports, the affinity of TBT to suspended solids and the residence time of commercial ships in ports, sediments in large commercial sea ports usually have high concentrations of TBT.

Average annual TBT concentrations in 1996 of suspended solids increased from 0.01 mg/kg in Lobith (Dutch/German border) to 0.104 mg/kg in Maassluis, situated a few kilometres downstream of Rotterdam.

Figure 1-10: MAM-PEC model

As part of this project, TBT emissions from ships in the port of Rotterdam and related concentrations in sediments were estimated by using the MAM-PEC model (Marine Antifouling Model to Predict Environmental Concentrations) for different environmental scenarios. Predicted environmental concentrations (PECs) for TBT in sediments of different harbour sections were in the range 0.7 - 1.6 mg/kg, reaching maximum values of 2.2 to 2.8 mg/kg in poorly flushed regions. These concentrations are not exceptional compared to other sea ports.

The majority of TBT emissions were caused by the larger ship classes (> 100 m); the relatively large number (46%) of small ships contribute only 6% to the estimated total TBT emissions.

The proposal by the International Maritime Organisation (IMO), to ban the use of TBT on all vessels from 2003 on, and its removal from ships' hulls by 2008, will in time ameliorate the situation. Furthermore, based on the currently available data, it appears that many of the proposed or already marketed alternative biocides are more degradable and have a lower affinity towards suspended solids or sediments. Sediment concentrations (PECs), predicted with the MAM-PEC model for two potential alternative products (Irgarol 1051 and Seanine-211), are more than one order of magnitude lower than sediment PECs predicted for TBT.

In the meantime, the dredging and disposal of sediments, which have been subject to TBT contamination, is of major concern for those port operators who have to maintain their navigable waterways.

'New' substances - substances to watch

Concerning the assessment of the quality of sediments and dredged material in the Rhine catchment area, naturally the question arises, which 'new' substances, at present not implemented as criteria, are currently discussed or might come up in future.

The European Inventory of Existing Commercial Chemical Substances (EINECS) lists over 100,000 chemical compounds. Little is known about the toxicity of about 75 % of these chemicals. In this context, the task to identify compounds which are hazardous with regard to the aquatic ecosystem or human health via the aquatic exposure route, such as the consumption of drinking water or fish, is challenging. The implementation of monitoring programmes and conduction of risk assessments for this 'chemical universe' is not feasible and not appropriate.

An approach to overcome this obstacle is the definition of so-called priority chemicals by combined effect and exposure scoring approaches. Currently of most importance, in Europe or for the North-East-Atlantic including the North Sea, are the new European Water Framework Directive (EU-WFD) and the OSPAR activities.

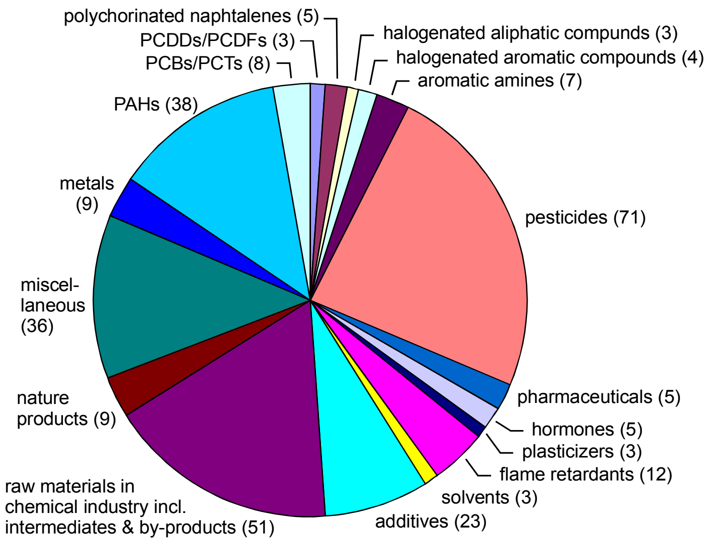

Figure 1-11: Classification according to use or chemical classes of ranked and/or prioritised substances

Focussing on substances relevant for sediments, several EU and OSPAR ranking and prioritisation lists as well as substances from ICPR lists (International Rhine Monitoring Programme, Rhine relevant substances) were combined and evaluated. Individual chemicals are not discussed here, but a classification of these substances and groups of substances, in total 295, according to their use or chemical classes is given in figure 1-11.

Comparing the OSPAR list of chemicals for priority action with the proposed EU-WFD list and the list of Rhine relevant substances, it is obvious that these lists overlap only to a limited extent (figure 1-12).

Ideally, relevant substances should be identified for the river catchment area (as done e.g. by the ICPR for the Rhine), which will be influenced by the proposed EU-WFD list of priority chemicals. For these priority chemicals the setting of quality standards applicable to surface water, sediments and biota is demanded by the EU-WFD within 2-6 years; and subsequently, if necessary, reduction measures, such as emission control of point and diffuse sources or phasing-out of certain chemicals.

Furthermore, chemicals prioritised under OSPAR, which mainly enter the North Sea via rivers like the Rhine should ideally be included in the EU-WFD list of priority chemicals or at least be implemented on the catchment level.

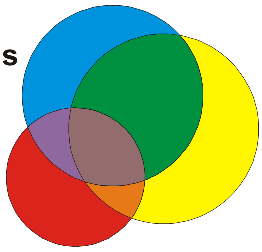

Figure 1-12: Comparison of lists of priority chemicals with Rhine relevant substances

Including additional priority chemicals, defined under OSPAR, in the proposed EU-WFD list is currently under discussion, although no or only minor changes before the adoption by the European Parliament and the Council are expected.

The ranking and prioritisation of chemicals is an on-going task on the regional/national (river catchments) and international level. For the Rhine catchment and the North Sea the EU-WFD and OSPAR approaches are the most important international ones. As 'new' chemicals become of concern and are/will be prioritised it can be expected that the list of chemical criteria for the quality of sediments/dredged material will be updated in future.

Bioassays - a promising tool?

Bioassays are used to estimate toxic potentials of substances. The application of bioassays for the assessment of sediment or dredged material quality is required/advised by the dredged material management guidelines of international conventions like the Oslo and Paris (OSPAR), the Helsinki and the London (LC) convention. However, on a national level the implementation of bioassays for the purpose of dredged material management is still under development. In the Netherlands a number of bioassays are evaluated and their implementation is scheduled for 2002.

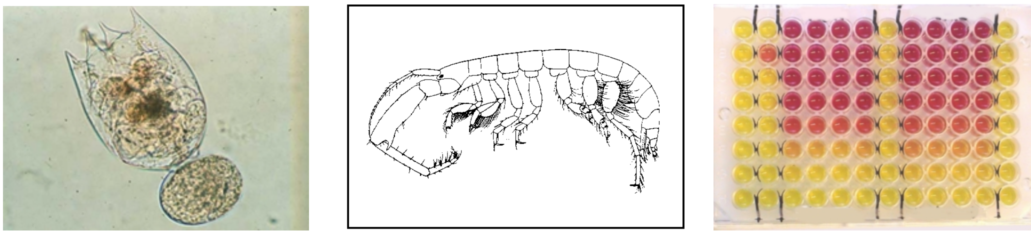

Figure 1-13: Examples of test organisms used in bioassays (Brachionus plicatilus[1], Corophium volutator[1], receptor-based yeast-screen)
[1] pictures by courtesy of Joost Stronkhorst, RIKZ

Bioassays seem a promising tool addressing explicitly two issues:

- The implementation of bioassays as additional criteria for the quality of sediments/dredged material might cover chemicals with different modes of action, otherwise overseen relying on a limited set of chemical criteria.
- An integrated approach, combining bioassays and chemical analysis (so-called TIEs, Toxicity Identification Evaluation) can identify culprit chemicals.

The first can complement the chemical monitoring in a cost-effective manner by investigating integrated toxic effect potentials of the 'cocktail' of substances present in the aquatic environment. The latter not only detects effect potentials but can link them to individual chemicals, which could serve as a basis for more detailed studies and subsequently enable the implementation of specific measures at the sources.

At present the management of dredged materials comprises hazard assessment of the dredged sediments. Despite the inherent difficulties of conducting risk assessments at the disposal site (the receiving environment, e.g. the North Sea), it should be integrated in future approaches for decision-making frameworks. Further research is needed before implementation.

For the sake of being cost-effective, hazard assessment should be carried out in a multi-level approach:

- Level I: limited chemical criteria, limited test battery with bioassays
- Level II: application of an extended battery of bioassays as well as case studies in order to identify the culprit chemicals

Level II should only be applied for toxic or highly toxic materials where the toxicity can not be explained by the presence of the investigated chemicals. TIE-like procedures can be used to establish links between effect potentials and causative chemicals as well as to distinguish between toxic potentials from man-made and natural compounds (e.g. phytoestrogens).

Additional recommendations, derived during two international workshops, organised as part of this project, dealing with issues related to bioassays and sediments/dredged material

- At present the application of 3-4 suitable standardised bioassays for acute toxicity including at least one whole sediment test is recommended.
- Before the implementation, bioassays should be evaluated in a ‘research mode’ parallel to the currently implemented chemical criteria.
- Effort should be taken to tackle the interpretation of bioassay results with the long-term goal to integrate the results from different bioassays and possibly even the chemical criteria into one ‘yardstick’ for the classification of contaminated sediments / dredged material.
- The development and standardisation of chronic tests and receptor-based assays / biomarkers should be carried out in order to cover other modes of actions and sublethal effects. The latter might in future replace chemical analyses undertaken at high costs (e.g. CALUX assay for chemicals with dioxin-like mode of action).
- More harmonisation and standardisation of international regulation (guidelines and frameworks) addressing chemical analysis and bioassays as well as hazard/risk assessment is required; 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 will also serve to highlight the need for consistency of approaches adopted towards each contaminant.

2 Introduction to the project

The port of Rotterdam – interface between Rhine catchment area and North Sea

The port of Rotterdam is located in the Rhine estuary and is a sedimentation area, being the interface between the Rhine and the North Sea. Marine sediments accumulate through tidal action mainly in the western port areas (depicted blue in figure 2-1) whereas the eastern port areas (depicted red) are mainly influenced by fluvial sediments, transported by the Rhine.

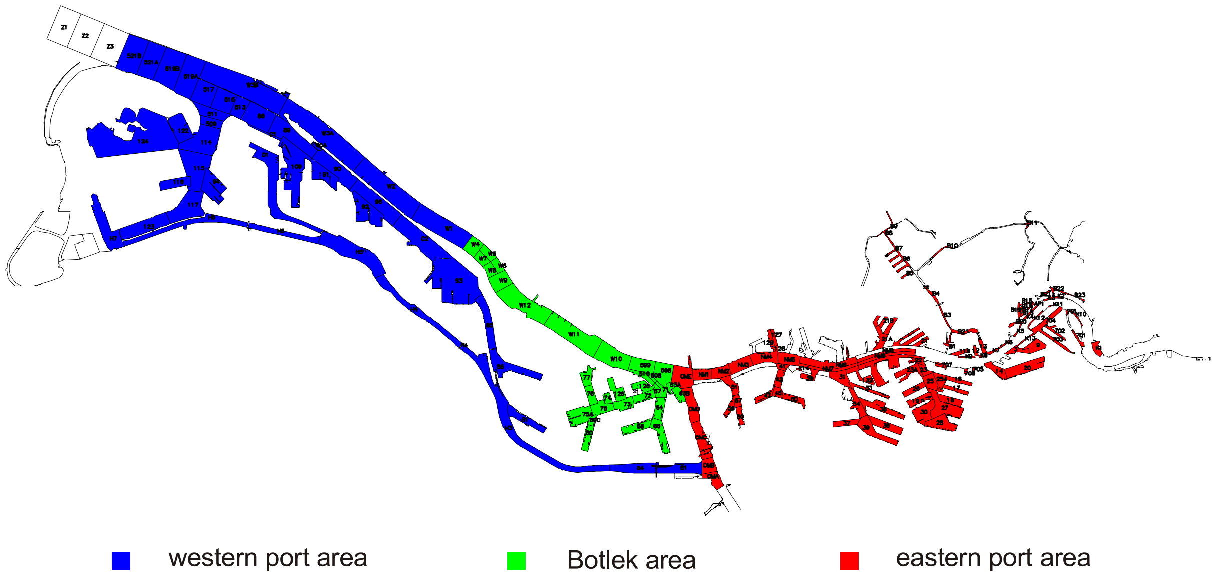

Figure 2-1: Overview of sections in the port of Rotterdam

To maintain adequate port facilities, 15 to 20 million m^3 of sediments are dredged per year. The relocation of this dredged material to the North Sea, the preferred disposal option, is regulated by a set of chemical criteria, the so-called Sea/Slufter limits. Dredged material exceeding these limits, mainly sediments from the eastern port areas (and partly from the Botlek area), has to be disposed of in a confined site, the Slufter (figure 2-2).

Figure 2-2: The Slufter – a confined disposal site for contaminated dredged material

Major substances of concern are some heavy metals, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs), suspected to originate mainly from sources in the Rhine catchment area (figure 2-3).

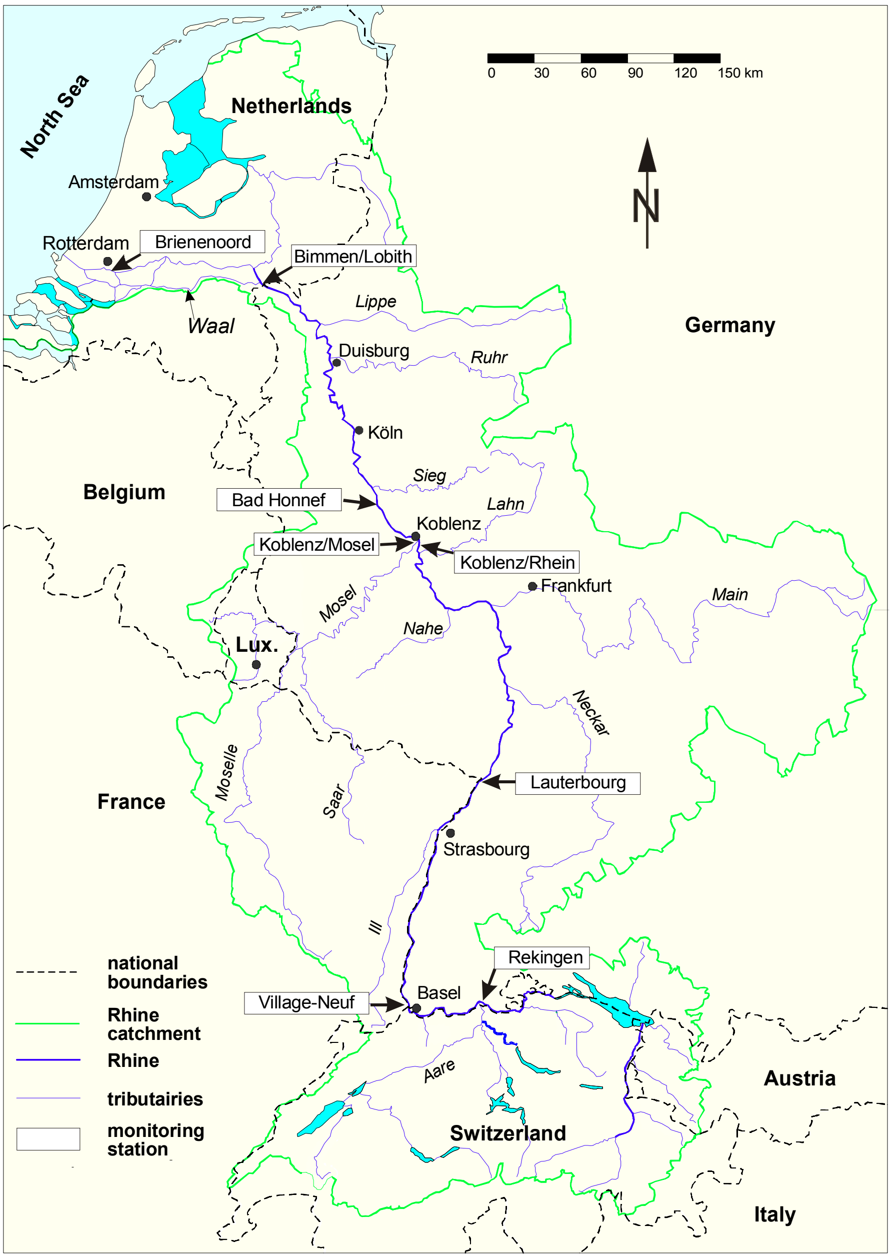

Figure 2-3: Rhine catchment and selected monitoring stations

Rhine Research Project (POR) of the Rotterdam Municipal Port Management

The Rotterdam Municipal Port Management (RMPM) launched the 'Rhine Research Project' (POR) in 1984. This project was especially aimed at point dischargers, clearly identifiable companies along the Rhine and in the port itself. Agreements were successfully reached with major discharging companies in the following years resulting in significant reductions in their discharges. The quality of sediments in the Rhine and consequently of sediments in the port of Rotterdam improved. However, a sustainable situation has not yet been achieved. The majority of dredged material from the eastern port areas and partly from the Botlek area still has to be disposed of in the Slufter. As a follow-up study RMPM launched the 'Rhine Research Project II' (POR II) and commissioned this study, which is part of POR II.

The study 'Dredged Material in the Port of Rotterdam –Interface between Rhine Catchment and the North Sea' as part of POR II

A main objective of our study was to quantify inputs from point and diffuse sources in the Rhine catchment area and to analyse their current and future impact on sediments/dredged material quality using scenarios with a time horizon of 15 years (Parts B and C of this report).

This is directly related to current and future policies and regulatory frameworks concerning

1. water and sediment quality targets for rivers, especially the Rhine, and for the North Sea;
2. emission control, which influences directly or indirectly the sediment quality of the Rhine; and
3. dredged material management.

This complex system, comprising the national, European and international level of policies and regulations, is closely related to the scenario analysis and is a major part of this study (Part D).

The current Dutch criteria, concerning the relocation of dredged material to the North Sea currently are under revision. Bioassays as additional criteria, complementing the chemical criteria, are scheduled for implementation in 2002. Also the chemical criteria themselves are currently under revision. A substance, which received a lot of retention recently is tributyltin (TBT, an antifouling agent), which is released from TBT-containing ship paints. Furthermore several organisations are currently involved in identifying 'chemicals of concern' in the North Sea (Oslo and Paris Convention) and in European river basins (European Water Framework Directive). These issues, which will/might influence dredged material management in future, both TBT and the 'new' substances as well as the bioassays are covered in detail (Part E).

The relocation of dredged material in the North Sea needs to be considered in the whole framework of sediment movement combined with the inputs of contaminants from various sources; these issues are included in Part F of this report.

To ensure feedback from both the science and the policy community we organised, as part of this project, two international workshops with the main theme 'River Sediments and Related Dredged Material in Europe', published as separate volumes:

- Science-Oriented Workshop: Scientific Background from the Viewpoints of Chemistry, Ecotoxicology and Regulations;
- Policy-oriented workshop: River Sediments and Dredged Material as Part of the System Catchment-Coastal Sea: Policy and Regulatory Aspects.

A spin-off of these workshops is an initiative for a European, stakeholder demand driven, Sediment Network 'SedNet' (further information: http://www.mep.tno.nl/sednet).

The outcome of this study was presented on the 4th International Rhine Conference In Rotterdam (22-24 November 2000), organised by the International Commission for the Protection of Rhine (ICPR) and the Rotterdam Municipal Port Management. The conference was attended by experts from national and international organisations, e.g. the OSPAR Commission, the EU-Commission, environmental agencies, research institutes, port authorities, industry and non-governmental organisations. It was acknowledged that in the past years much has been achieved concerning the reduction of inputs from point sources but inputs from diffuse sources still are of concern. Organisations, involved in the management of the Rhine basin and the North Sea, like the ICPR, Oslo and Paris Commission and other stakeholders expressed the need for a balanced action for the protection of the continuum river basin – coastal zone.

Publications and further information

Further information is available under:

http://w3g.gkss.de/i_a/dredged_material/index.htlm

or

http://www.gkss.de under Institute for Coastal Research

- links to project partners
- workshops and initiatives
- downloadable reports (Project Report, Appendix to Project Report, Workshop Reports)

Acknowledgement

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