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Dredged Material Disposal in the Sea

Abstract

Dredging is an economically essential activity to most countries, but it also has the potential to have a variety of negative effects on marine flora and fauna. To regulate these potential impacts, International Conventions have been set up which realise the importance of properly managing the disposal of dredged material.
In this paper the International Conventions are reviewed, with special attention to the Draft 1996 Protocol to the London Convention of 1972, which includes the Dredged Material Assessment Framework (DMAF) and an explanation of the so-called "reverse list". It also reviews the Oslo and Paris Convention (the OSPAR) recently revised in 1992. National and regional requirements derived from these, as well as assessment procedures and monitoring programmes are also described.
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This subject is further elaborated in a recently published book by Mr Burt and Ms Fletcher, *Guide 2: Conventions, Codes and Conditions, Marine Disposal and Land Disposal,* reviewed on pages 14-15 of this issue.

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Introduction

Dredging is an economically essential activity to most countries and offers a solution to the problems of siltation of channels and trends of increasing ship sizes. However, dredging activities have the potential to have a variety of negative effects on marine flora and fauna, from disturbance of habitats for benthic communities in the dredged area, to physical smothering or chemical contamination of those on the disposal site. Inappropriate selection of disposal sites can also result in impacts on fishery activities, recreation and navigation. In recognition of these potential impacts, International Conventions have been set up which realise the importance of properly managing dredged material. Issues addressed include limiting dredging to what is strictly necessary, encouraging beneficial use and controlling the disposal of dredged material. These issues are approached differently and to varying levels by individual countries through their own policies and legislative system. However, for several countries, certain International Conventions and regional treaties are involved in dredging activities and are incorporated within individual member countries legislation. Despite this, large differences do exist due to differences in historical evolution of legislation, philosophy and attitudes to the best management approaches.

International Conventions

In the 1970s protocols for the control of disposal of material to sea were set up, two of which include the London Dumping Convention and the Oslo Convention. They were set up primarily to regulate the disposal of noxious substances into the oceans, but they included the regulation of the disposal of dredged sediment as well. This inclusion was in a way expected, given that the annual volume of dredged material disposed at sea is by far the largest compared to any other material ending up at licensed disposal sites.

Although only a very small proportion of the dredged material that is disposed at sea is contaminated, dredged material is generally regarded as waste, and a number of national and international regulations and conventions have been drawn based on this perception. This paper reviews the main and more recent requirements of the London Convention and the recently revised Oslo and Paris Convention, named the OSPAR Convention.

At the heart of both these conventions are two basic principles:

1. The precautionary principle, by virtue of which preventative measures are to be taken when there are reasonable grounds for concern that substances or energy introduced into the marine environment may bring about hazard, harm, damage or interference, even when there is no conclusive evidence of a casual relationship between inputs and the effects.

2. The polluter pays principle, by virtue of which the costs of pollution prevention, control and reduction measures are to be borne by the polluter.

Figure 1. The International Maritime Organization building in London, UK, an agency of the United Nations, where the "London Convention 1972" was conceived. In November 1996 a Draft Protocol to the LC 72 was issued for ratification by member nations.

A logical development of the first principle is the "reverse list", whereby only substances which have been proved not to cause harm are permitted to be disposed at sea.

London Convention 1972

In 1993 the London Dumping Convention was renamed the London Convention 1972 (LC 72) because it did not want to be regarded as a "club" for people who did dumping (Figure 1).

The LC 72 Articles

The LC 72 has ten main Articles which by and large address the obligations of the Contracting Parties to ensure that the properties of the material to be disposed of at sea are in accordance with the Conventions requirements, that the Parties encourage cooperation between them and seek the formation of Regional Agreements, and that measures are taken to prevent and punish any conduct in contravention of the Convention. Other articles are concerned mainly with the details of procedures for setting up and operating the Convention.

Revisions of the LC 72 have been undertaken and a new 1996 protocol to the London Convention 1972 has recently been adopted by the Special Meeting of Contracting Parties to the London Convention on the 7 November 1996. The new protocol will replace the previous Annex system and introduce the "reverse list" approach whereby substances which are permitted to be disposed of at sea are listed. This protocol is not expected to be fully implemented for some 3 to 5 years but will be put up for ratification in April 1997. Twenty-six countries have to ratify it of which 12 have to be contracting countries. Amendments which have been undertaken include the promotion of "sustainable use" in line with the Rio declaration on Environment and Development and Agenda 21. Another amendment of importance is the inclusion of the sea bed in the definition of the marine environment. The effect will be to bring most dredging activities (i.e. not just disposal) under the control of the Convention.

There are two principal aims of this revision process. The first is to strengthen the control over disposal at sea, the second is to make the acceptance of the Convention more global.

Dredged Material Assessment Framework (DMAF)

The Convention has adopted a new method of assessment of the suitability of material for disposal. This is known as the Waste Assessment Framework (WAF). The implementation is not clear yet and it is still up to individual countries to adopt it within their legislative and regulatory systems. The dredged material guidelines (DMAF) have been formed in such a way as to complement the Waste Assessment Framework (WAF). DMAF offers generic guidelines for decision makers. A schematic outline of DMAF is given in Figure 2 and it is discussed in detail throughout this paper.

Disposal of material for which contamination is not a concern will still be subject to an audit such that sea disposal will be permitted subject to consideration of beneficial use options and assessment of disposal site impacts.

OSPARCOM

The revision of the Oslo and Paris Conventions was completed in 1992 and they are now known as OSPAR Convention. The two original Conventions were the "Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft, 1972" and the "Paris Convention of the Prevention of Marine Pollution from Land-based Sources, 1974".

The new OSPAR Convention has four Annexes:

Annex 1 on the prevention and elimination of pollution from land-based sources

Annex 2 on the prevention and elimination of pollution from dumping or incineration

Annex 3 on the prevention and elimination of pollution from offshore sources

Annex 4 on the assessment of the quality of the marine environment

The disposal at sea Annex 2 is set out in the form of a reverse list of materials that may be disposed of at sea, with the dredged material being at the top of the list.

OSPARCOM Dredged Material Guidelines

As with the LC 72, there are dredged material guidelines. In 1989 the Oslo Commission decided to review the 1986 Guidelines. France organised a seminar in Nantes in November 1989 on the environmental aspects of dredging and examined ways of reducing the impact. A number of management tools were identified for incorporation in the revised dredged material guidelines.

These revised guidelines are presented in two parts. Part A deals with the assessment and management of dredged material disposal, while Part B provides guidance on the design and conduct of monitoring of marine and estuary disposal sites.

The main constituents of Part A of the OSPARCOM revised guidelines are:

- Conditions under which permits for disposal of dredged material may be issued
- Assessment of the characteristics and composition of dredged material
- Guidelines on dredged material sampling and analysis
- Characteristics of disposal site and method of disposal
- General considerations and conditions
- Disposal management techniques

Similarities and Differences with LC 72

The OSPARCOM Guidelines and the LC Guidelines are very similar in both structure and content. An important difference between them is that OSPAR offers flexibility in the case where concentrations of contaminants exceed "trace" levels. If under OSPAR it is shown that marine disposal is the "option of least detriment to the environment" this form of disposal may be permitted, whereas under LC Guidelines the marine disposal of materials with "black list" contaminants exceeding "trace" levels is prohibited. Another difference between LC and OSPARCOM is that oil and its products are listed in LC's existing Annex 1 but are not included in the OSPARCOM. As the reverse list is implemented fully these distinctions between the Annexes will disappear and it will be necessary to demonstrate acceptable impacts for the disposal material.

Other Conventions and Regional Treaties

There are a number of other international conventions and regional treaties set up with the general aim of protecting the aquatic environment (Figures 3 and 4) and a list is given in an Appendix.

Assessment of Material

Philosophies and General Approaches

International Conventions and regional statutory requirements, such as EC Directives, have been incorporated within individual member countries legislation and in order to meet these commitments, different regulatory systems have been set up by each country. However, large differences in approaches and interpretation occur. The management and control of dredged material is addressed differently and to varying levels by individual countries through their own policies and legislative system. This is due to differences in historical evolution of legislation, philosophy and attitudes to the best management approaches. Three general approaches which exist are discussed below, however, they are not always applied in isolation and the legislation of an individual country may involve a hybrid of these approaches.

Standards Approach

A system of standards defining the quality of the dredged material in terms of contaminants present (as either concentrations or total loads) is used in some countries. This system prohibits sea disposal of dredged material if selected contaminants are present at concentrations above a specified value. Sediment standards have evolved by a number of philosophies and methods. Different approaches include knowledge of background contaminant concentrations in the area, assessment of

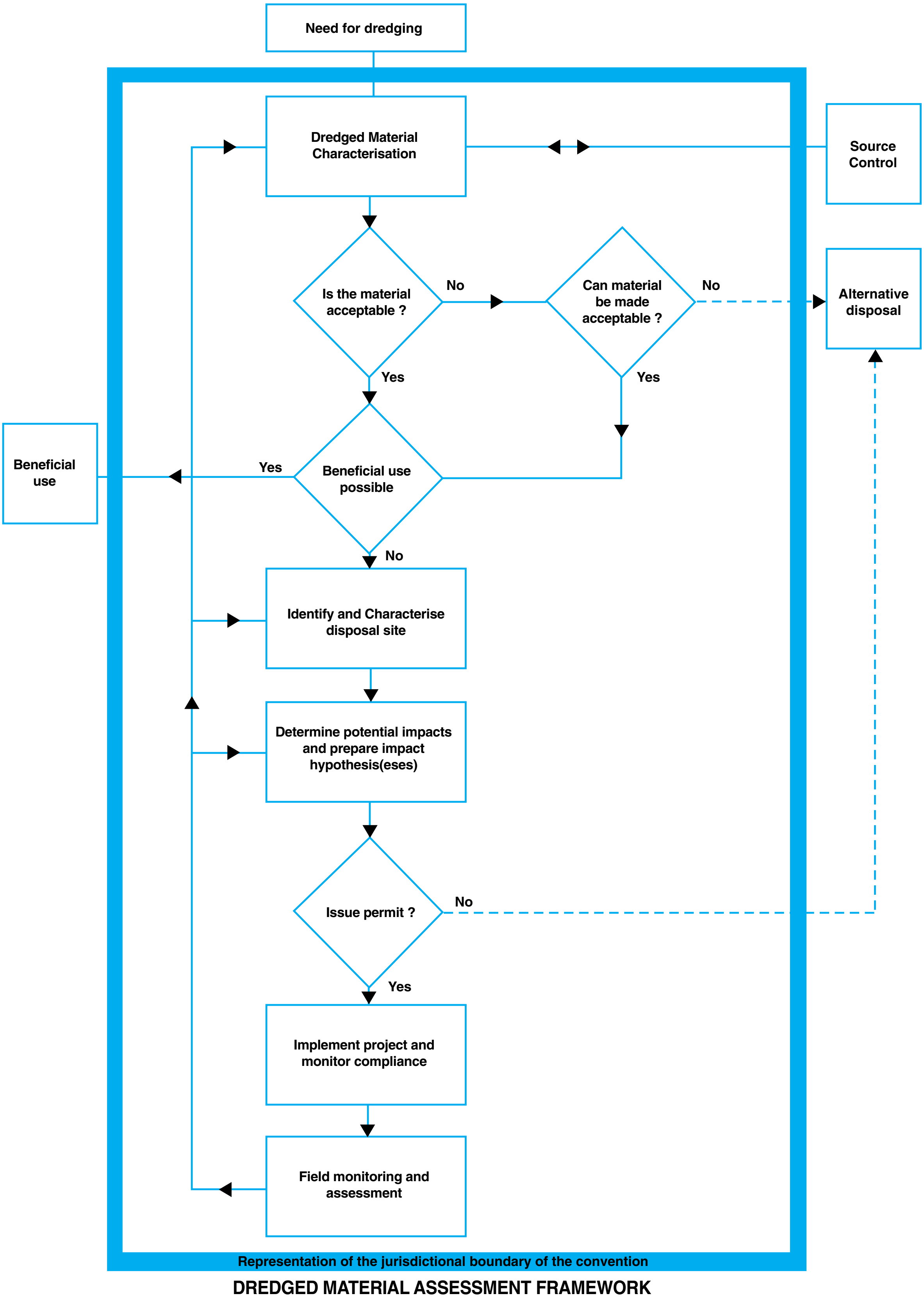

Figure 2. The London Convention Dredged Material Assessment Framework (DMAF).

benthic community structures for various contaminant levels and a "standards" biological effects-based assessment.

The strength of this approach is that it relies only on measurements that can be made in most analytical laboratories and contaminant concentrations or loads can be easily compared to the guidelines. The standards approach, therefore, offers a clear management tool and a basis for licensing.

The weaknesses of this approach is that it is inflexible and may therefore impose unreasonably harsh restrictions in some cases or be too permissive in a sensitive environment.

Ecotoxicological Approach
This approach addresses the impact of contaminated sediments on ecology more directly. There are various techniques which adopt this philosophy and are outlined below.

Generally the strengths and weaknesses are common for these techniques. A strength is that such a system is related to the sediments specifically and therefore addresses their physico-chemical properties on a more site specific basis. Weaknesses lie in the uncertainty of measuring and predicting ecotoxicological impacts and the lack of scientific knowledge and appropriate technologies. However, scientific knowledge is advancing and methods for predicting ecotoxic effects are improving.

Elutriate test
This assesses toxicity by measuring the releasable contaminants from dredged material and therefore indicate the potential contamination of adjacent surface and groundwaters. Elutriate tests give an indication only of the bioavailable fraction.

Bioassay approach
This approach observes the responses of selected test species to specific contaminants under laboratory conditions.

Implementation of this method at a specific site requires collection of data on in-situ sediment chemistry, on the chemistry of contaminant-spiked sediments, and on the responses of test organisms. In addition, data is generated through laboratory experiments and sufficient field validation (which addresses contaminant interaction and the effects of physical sediment variables on the responses of benthic organisms) are required. Therefore this approach to date mainly involves single contaminants or relatively simple mixtures of contaminants on various sediment types.
A strength of this method is its suitability for all classes of chemicals and most types of sediments.
A weakness of this method is the inability to reproduce the field conditions in the laboratory and the separation of the effects of contaminants from other stresses, such as pore water sulphide content. In addition, this method is costly to use as a regulatory tool. Also, these tests give a determination of the effects at a species level and at best are only indicative at an ecosystem level.

Case-specific Approach
This approach assesses each case individually and is usually regarded as a pragmatic approach. The suitability of the dredged material for disposal may be assessed on its quantity and quality and on characteristics of the disposal site. Bioassays may also be employed if necessary, but essentially the philosophy is to assess the dredged material disposal based on specific characteristics of the dredged material and the receiving site.

Assessments on a case-by-case basis has the advantage of giving flexibility to adopt the best environmental option for that area. However, the lack of uniform guidelines makes it difficult for dredging operators to make informed decisions and frequently a lengthy consultation process is required with involved authorities.

Reducing the Amount of Maintenance
The new LC 72 DMAF asks the question "Is it necessary to dredge?" (Figure 2). The immediate answer is usually "yes" but the matter is worthy of further consideration on both economic and environmental grounds. There are several options.

One of the more radical ones was adopted by the Port of Rotterdam in simply re-defining "the bed" in terms of a density measurement. This acknowledges the existence of fluid mud through which vessels can safely navigate and eliminates the need to remove such material.

Another example is the dredging carried out by the Tees and Hartlepool Port Authority Ltd. A review was carried out in 1990 which showed:
i) allowing overspill of the hopper was creating a mechanism whereby dredged material was being carried further upriver by stratified flow, requiring it to be redredged later;
ii) the estuary was being gradually deepened by dredging more than was necessary for safe navigation.

Engineering solutions have also been found in a number of situations for example the deflector wall at Hamburg which controls the formation of an eddy in a tidal basin. A United Kingdom example is the recent construction of groynes on the Diver's Shoal in the Thames Estuary. These were designed to concentrate the flow into the navigation channel and therefore enhance self scouring. The scheme was tested in a physical model and appears to be working well in nature.

Figure 3. Open sewers discharging into this Asian harbour pollute the sediment which then needs to be dredged and disposed of.

Assessment of the Dredged Material Properties

Adequate characterisation of the dredged material is a prerequisite to proper assessment of the environmental impacts of disposal. The quantity, physical properties, chemical properties and biological impacts need appropriate assessment. As discussed earlier in this paper, a number of countries have developed their own assessment procedures and approaches. In a large number of cases, standards to compare sediment properties with have also been developed. Some of these standards, it can be argued, are country-specific, where as others could be adopted by neighbouring countries. This paper, however, will review the basis of the assessment of the dredged material properties, as well as the procedure of the London Convention Dredged Material Assessment Framework (DMAF) as shown schematically in Figure 2. Under these guidelines assessments of the quantity and physical characteristics are required while exemptions for the chemical and biological assessments exist if the material is from an area known to have no contaminant sources. Emphasis is placed on a requirement for sufficient information on contamination and the physico-chemical conditions while biological investigations required will depend on the potential impacts.

London Convention Dredged Material Assessment Framework

DMAF has been adopted in the text of the Draft 1996 Protocol to the London Convention 1972 and offers generic guidelines for decision makers. It is up to individual countries to adopt within their legislative and regulatory systems. The new protocol will replace the Annexes and introduce the "reverse list" approach whereby substances which are permitted to be disposed of at sea are listed. This protocol is not expected to be fully implemented for some 3 to 5 years but will be put up for ratification until April 1997. To be implemented, 26 countries have to ratify it, of which 12 have to be contracting countries.

The LC Guidelines for contamination levels in dredged material follow a qualitative approach whereby the contaminants are categorised in two Annexes:
Annex I lists contaminants which are known to cause harm to aquatic organisms even in low concentrations. These contaminants are organohalogens, mercury, cadmium oil an oil products, radioactive substances, materials for biological warfare and persistent plastics.
Annex II lists the contaminants which should not be present in concentrations higher than 1,000ppm (i.e. 0.1%), with the exception of lead which should not be found in concentrations higher than 500ppm (i.e. 0.05%). Annex II listed contaminants are Arsenic, Lead, Copper, Zinc, Organosilicons, Cyanides, Fluorides and Pesticides. Under the London Convention, if any of the Annex I or II substances are found in significant concentrations, a special permit would be required in order to dispose of the dredged sediment. A general permit for offshore disposal, under the LC, is however required in order to establish whether or not the disposal at sea of the dredged material containing Annex I and II substances might cause undesirable effects. Such effects are considered to be either chronic or acute, and toxic for marine or human life. This present system is however going to change in the future as the new reverse listing approach has been adopted. It is however not ratified yet.

Under the new protocol, the Annex I now outlines the reverse list principle and lists wastes and other matter which may be considered for dumping being mindful of the objectives and general obligations of this protocol set out in articles 2 and 3. Dredged material is included on this list.
Annex 2 outlines WAF where waste minimisation by prevention at source, assessing other disposal options, characterisation, action lists, dump site selection, assessment of potential effects, monitoring and permits procedures are outlined.

Quantitative assessment of dredged material properties

As mentioned previously, a number of countries around the world, active in the dredging and disposal scene have developed their own quantitative assessment procedures for dredged material properties. With the exception of the USA approach to the assessment of the properties, which is both chemical and ecotoxicological, the rest of the quantitative assessments are

Figure 4. Estuaries are still too often used as dumping grounds for all types of waste.

based on the chemical composition of the dredged sediment. The chemical parameters mainly considered are the majority of the heavy metals known for their toxicity to life, and a wide range of organic contaminants such as hydrocarbons, polychlorinated biphenyls and pesticides. These parameters were chosen because of their ability to cause either chronic or acute harm to living organisms.

Some of the chemically-based quantitative assessment of dredged material properties also considers the concentrations of organic matter and fine sediment (i.e. silt) particularly the concentration of particles sizes below 63μm. The reasoning behind this consideration is the affinity that certain contaminants have for either, or both organic matter and fine sediments.

Some countries' sediment quality numerical standards are much stricter than others. Although a number of countries around the world base their sediment quality assessment on the numerical standards, there is increasing recognition that a case-specific approach is more effective as it tends to concentrate on local parameters influencing sediment quality.

Potential contamination release from dredged material
A wide range of physico-chemical reactions take place from the moment a waterway sediment is being dredged until it is finally deposited at its disposal site. These reactions may lead to the release of substances which have the potential to harm life and interfere with human welfare. Such substances are particularly found in soft sediments because of their affinity to adhere to fine particles (smaller than 63µm). The options for beneficial use of such soft sediment may therefore be restricted.

The considerations mentioned above are simply an extract from a much longer list. This paper only aims to review but a few. But let not such review give the negative impression that beneficial uses of dredged material cannot be reasonably achieved. On the contrary, experience on both sides of the Atlantic Ocean has shown that good planning, good communications between project team and funders, understanding of all factors involved, (particularly of their interactions), and good understanding of the timescale involved, can turn a traditionally thought of waste into a useful resource.

Requirement to explore beneficial uses
As part of the assessment it is now required that consideration be given to other possible disposal routes including the use of material beneficially. Such uses are mostly at their development stage at the moment. Questions that DMAF raises are "is the material acceptable?" and "can the material be made acceptable by some sort of treatment?". Generally there is more success in finding uses for granular material, sands and gravels than fine silts which form the majority of maintenance dredgings in many countries.
The development of beneficial use options for such material is required (Figures 5 and 6).

Assessment of Sea Disposal Sites

Assessment
Existing Conventions require that, if sea disposal is proposed, appropriate assessment of the dredged material and the proposed disposal site needs to be undertaken so that any likely impacts of the disposal operation can be identified. The guidelines developed by the London Convention and OSPARCOM provide

Figure 5. Example of contaminated sediments being processed in Hamburg, Germany.

the user with a tool for predicting the consequences of the disposal and for validating those predictions against observations. This objective approach means that the impact of disposal of dredged material upon the marine environment can be meaningfully addressed, with the main aims, as previously mentioned, being;

- to protect the marine environment
- to prevent interference with amenities or other legitimate uses of the sea

Studies and tests to be carried out during the assessment generally include;

- the general requirement of the LC 72 and OSPAR-COM
- chemical and physical analysis
- biological testing
- formulation of an impact statement
- the development and use of quality standards
- monitoring

In addition, the OSPARCOM guidelines suggest that information on density, % solids, grain size fractions and total organic carbon should be obtained in addition to mandatory analysis of substances listed in Annex 1 and Annex 2 of the Convention. A technical annex to the Oslo Convention sets out primary and secondary determinants.

It has been demonstrated by Gurbatt and Campbell (1989) that modelling has a role in the assessment process, where the effects models fall into two categories; those concerned with immediate effects at and near the disposal site (near-field) and those with longer-term consequences of contaminant dispersion (far-field). The disposal site evaluation should involve assessments of the sea bed, the water column and proximity of the operation to areas of interest.

Contamination of the dredged material has the potential to impact on biota with valuable fish and shellfish stock being of importance. However, it is also important to appreciate that sea disposal of uncontaminated dredged material can also cause major environmental impacts through, for example, smothering the sea bed and suspended sediments reducing essential light penetration. The significance of the impacts will depend on whether the site is a retentive or dispersive site.

The physical effects are an unavoidable result of most disposal operations. Questions which need to be addressed are outlined in DMAF. Therefore, monitoring and field assessments are typically required and are discussed later in this paper.

Impact Hypothesis

The London Conventions DMAF states that impact assessments should lead to a concise statement of the expected consequences of the disposal operation. This is being termed the "impact hypothesis". This comprises a summary of the potential effects on human health, living resources, amenities and other legitimate uses of the sea. It should define the nature, scale and duration of expected impacts based on reasonably pessimistic (i.e conservative) assumptions.

Approaches and content of these impact assessments will vary depending on whether the site is a retentive site or a dispersive site. These differences are outlined in DMAF Section 6.3 and 6.4.

Licensing and Permits
In most countries the responsibility for licensing/ granting of permits and enforcement is undertaken by a Government Department, usually a Ministry or Department of the Environment or similar body. Sometimes it is delegated from such bodies to an Environmental Protection agency or similar body. While some governments put the responsibility to Transport, Marine or Fisheries Departments.

Anyone wishing to dispose of dredged material should apply for a licence in advance. A licence application should generally contain the following information although as previously mentioned in some cases (eg "clean" sand) some testing of chemical and biological parameters can be omitted. The licence application lists the requirements of the assessment process and is given below;

A. Concerning the material
1. Source, total amount and average composition (e.g. per year)
2. Form (solid, sludge, liquid, gaseous)
3. Properties; physical (e.g. solubility and density), chemical and biochemical (e.g. oxygen demand, nutrients) and biological (e.g. presence of viruses, bacteria, yeasts and parasites)
4. Toxicity
5. Persistence: physical, chemical and biological
6. Accumulation and biotransformation in biological materials or sediments
7. Susceptibility to physical, chemical and biochemical changes and interaction in the aquatic environment with other dissolved organic and inorganic materials
8. Probability of production of taints or other changes reducing marketability of resources (fish, shellfish, etc)

B. Concerning the method of disposal
9. Details of the dredgers or barges to be used
10. Details of the proposed method of placement
11. Rate of disposal
12. Proposed monitoring system

C. Characteristics of the disposal site
13. Location
14. Dilution and dispersion characteristics
15. Water characteristics
16. Sea bed characteristics
17. Existence of other dump sites in the area

D. General considerations
18. Possible effects on amenities
19. Possible effects on marine life
20. Other uses of the sea
21. Availability of alternative land disposal or treatment
22. Consideration of possible beneficial uses

Contaminated Dredged Material
The Conventions aim to limit sea disposal of contaminated dredged material with a view to minimising adverse environmental effects in the marine environment. Alternative disposal options such as open water disposal followed by capping, upland confined disposal and controlled beneficial use will then need to be evaluated on a case-by-case approach. A framework for such an assessment has been developed by PIANC (PIANC PTC 1-17, 1996). If none of the disposal options mentioned are feasible and the dredged material is heavily contaminated, it is always possible to consider treatment provided that treatment costs can be met. Good preliminary research is essential for any treatment project. The licensing/permit authority has to be able to predict any impact contaminated dredged material may have of the proposed disposal on the receiving environment and man.

Ultimately, the problems of contaminated dredged material disposal can be controlled effectively only by control of point source discharges to waters from which dredged material is taken.

Enforcement and Compliance
Under LC72 each party shall take in its territory appropriate measures to prevent and punish conduct in contravention of the provisions of the Convention. They are also obliged to apply the Convention to vessels registered in its territory or flying its flag. It also applies to vessels loading in their ports any material

Figure 6. Processed sediment being used in landscaping project, Hamburg, Germany.

Appendix. List of International Agreements, Protocols and Guidelines

Global

1 United Nations Convention on the Law of the Sea, 1982.
2 International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78).
3 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Dumping Convention).
4 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989 (Basel Convention).

Regional

5 Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft, 1972 (Oslo Convention).
6 Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1974 (Helsinki Convention).
7 Convention on the Prevention of Marine Pollution from Land-based Sources, 1974 (Paris Convention) – 1988 Amendment.
8 Convention for the Protection of the Mediterranean Sea against Pollution, 1976 (Barcelona Convention) – 3 protocols.
9 Convention for the Protection of the Natural Resources and Environment of the South Pacific Region, Noumea, 1986 (SPREP Convention)– 2 protocols.
10 Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution, 1978 (Kuwait Convention) – 2 protocols.
11 Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific, 1988 (Lima Convention) – 4 protocols.
12 Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region, 1981 (Abidjan Convention) – 1 protocol.
13 Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region, 1985 (Nairobi Convention) - 1 protocol.
14 Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, 1983 (Cartagena Convention) - 1 protocol.
15 Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment, 1982 (Jeddah Convention) - 1 protocol.
16 Guidelines for the Protection of the Marine Environment Against Pollution from Land-based Sources (Montreal Guidelines, 1985).
17 Convention for the Protection of the Environment between Denmark, Finland, Norway and Sweden (Stockholm Convention, 1974).

which requires disposal. This gives the state the right to enforce the Convention on ships (i.e dredgers) on non-contracting parties.

The Convention gives the right to stop, board and inspect any vessel suspected of illegal dumping. Any Contracting party may adopt additional measures in accordance with the principles of international law to prevent disposal at sea.

The question of penalties is a matter for each state to decide. The guiding principle is that it should relate to the damage caused, however, this is difficult to evaluate since much of the damage is likely to be ecological. The only indication of enforcement and compliance by contracting parties to the Conventions are the licences or permits issued for disposal operations. For example, the Secretariat of the London Convention receives reports from contracting parties notifying annually the permits issued in the previous year, or reports stating that no permits have been issued in that year, the so called "nil reports". However, many contracting countries do submit reports or contact the secretariat. Of the 71 contracting parties registered in 1992, 11 have reported irregularly in recent years, while 25 can be regarded as "consistent non reporters". Reasons suggested for this is that some countries are land locked while others have only recently signed up.

Field Monitoring and Assessment

Any monitoring programme assessing a disposal option, particularly when contaminated dredged material is involved, should be regarded as essential. The whole essence of monitoring is to control the implementation of the proposed disposal and prevent environmental quality implications. When an impact hypothesis has been made it will form the basis of a monitoring programme.

There are two main components to a monitoring programme; surveillance and scientific investigation. Surveillance involves an assessment of the spatial and temporal changes in the distribution, fates and effects of contaminants introduced by specific dumping operations. It aids in demonstrating the acceptability and compliance of the overall intent of the Convention.

Scientific investigation is aimed at improving understanding of the fates and effects of contaminants released into the marine environment.

Setting up a Monitoring Plan
Monitoring plans should have clear, attainable and meaningful objectives, with a built-in element of flexibility. A logical and realistic sequence of stages should form the basis for designing a monitoring plan. There are five steps for developing a physical/biological monitoring programme for open water disposal of dredged material, which can also be adopted in the case of contaminated dredged material disposal. These steps are:

1. Designating site-specific monitoring objectives
2. Identifying components of the monitoring plan
3. Predicting responses and developing testable hypothesis
4. Designating sampling design and methods, which include selection of equipment and techniques
5. Designating management options

An assessment of the disposal operation should at least comprise a baseline monitoring plan, alongside a site survey plan, and a post-disposal monitoring plan.

Baseline Monitoring
Baseline monitoring is undertaken *before* the project begins and forms the basis for the assessment of the disposal. The purpose of a baseline monitoring, coupled with a site survey, is to determine the amount of material to be dredged, the extent of the contamination and set a reference for post-project monitoring.
Baseline monitoring should be done sufficiently in advance of the first project stage so that conditions and additional data requirements can be assessed before operational decisions are made.

Post-disposal Monitoring
Post-disposal monitoring should be consistent with the baseline monitoring. That is, the monitoring locations, and the types and quantities of samples must be the same before and after the disposal. Post-disposal monitoring plans should however have some flexibility to allow for a certain degree of modification after the operation so that special needs created by failures or operational difficulties can be accommodated (PIANC PTC 1-17, 1996).

Long-term monitoring is advisable when contaminated dredged material is disposed of. At the disposal site the amount of monitoring required after disposal will depend on the size and location of the disposal site and the degree of contamination at the site.

Feedback Information
The conscious execution of a monitoring plan should help determine more realistic preliminary project costs in future projects. Since monitoring is not a stand-alone activity, it encourages the co-operation of the subcontractors, particularly when the project manager requires regular feedback on working programmes and detailed cost estimates.

Although monitoring programmes are project-specific, the experience obtained from each plan can form a very good starting point for other projects.

In addition, the information gained needs to be used to modify or terminate the field monitoring, modify or revoke the permit licence or refine the basis of the assessment process.

Conclusions

Recognising that:

1. Both capital and maintenance dredging are necessary operations.
2. They are costly operations.
3. In general they do not create wealth, especially maintenance dredging.
4. Contamination of the dredged material is rarely the fault of the person wishing to dredge.
5. Uncontaminated dredged material is a resource, not a waste.
6. Taking good care of our environment (both marine and on land) is important both for our own well-being and that of future generations.

Leads to the aims that:

1. Dredging should be carried out with least detriment to the environment.
2. Dredging should be carried out at minimum cost compatible with achieving (1).
3. Pollution should be controlled at source.
4. Wherever possible beneficial use should be made of the dredged material.

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