DREDGING MANAGEMENT PRACTICES FOR THE ENVIRONMENT: A STRUCTURED SELECTION APPROACH

ABSTRACT

PIANC Working Group Envicom 13 was established as a forum for the development of prudent guidance for the selection of management practices designed to provide environmental protection in dredging projects. The working group encompassed experts from around the world, working for the dredging industry, port administrations, consultancies and research institutions. The report has now been published as PIANC report Nr. 100 and provides guidance for the consideration and selection of management practices for environmental protection based on objective science- and engineering-based factors and specifications. It describes in brief the full process of a dredging project from conception to the operational phase and indicates where and how in this process the essential decisions on the implementation of management practices (MPs) should be taken. A distinction is made between MPs and best management practices (BMPs). The report also discusses the application of the “Precautionary Principle” as used in the assessment of effects on the environment and provides tools to conduct dredging projects in an environmentally sound manner. Properly applied the precautionary principle provides incentives to develop better solutions. Risks can be reduced by applying correctly selected MPs.

A CD-ROM added to the report provides detailed descriptions of potential management practices and comprehensive information.

INTRODUCTION

Dredging is required to develop and maintain navigation infrastructure throughout the world. Globally, many hundreds of millions of cubic metres of sediments are dredged annually, with most of this volume being handled in coastal areas. A portion of this total represents capital dredging, which is essential for the development of ports, harbours, and navigable waterways. Dredging involves the excavation of sediments to increase depths, for example, to accommodate the draft of vessels or to enable access to new berths. Maintenance dredging involves sustaining sufficient water depths for safe navigation by periodic removal of sediment accumulated owing to natural and human-induced sedimentation. It may vary from an almost continuous activity throughout the year to an infrequent activity occurring only once every few years.

In addition to navigation-related projects, dredging is conducted for other purposes such as land reclamation, maintenance of river flow, beach nourishment and environmental remediation of contaminated sediments. Dredging therefore is a valuable tool for the benefit of mankind, for social and economic development, and for environmental restoration.

Alongside the recognition of these benefits, over a span of decades an increasing awareness of the need to protect the environment during the conduct of dredging projects has emerged. Many of the concerns associated with either dredging or dredged material placement are not based on conclusive evidence that these operations pose a meaningful risk to the environment. On the other hand, in many cases, there is little data documenting the absence of risk from specific operations.
**THE PRECAUTIONARY PRINCIPLE**

These ambiguities and uncertainties have resulted in a wide variety of environmental management practices being applied to dredging operations with the intention of reducing or eliminating perceived environmental risks. With increasing frequency, regulators have stipulated that protective measures be taken, justified almost solely by the “Precautionary Principle”. In brief, the precautionary principle states that when decisions to protect environmental resources are required, and that decision is based on knowledge with a high degree of uncertainty, one must err on the side of caution, i.e. take a conservative approach.

In some cases the adoption of the “Precautionary Principle” is justified by the degree of risk to a known sensitive receptor. In reality, the adoption of the precautionary principle has attained acceptance as a “best management practice,” irrespective of whether or not the beneficial or detrimental aspects of this practice are known.

With regard to navigation dredging, this approach can promote restrictions and constraints that have significant logistic and financial implications. For example, silt screens or curtains are often recommended to control turbidity. These deployments entail considerable cost with a limited understanding of their ultimate effectiveness (Figure 1).

In recent years, a more controversial management practice has been adopted which involves a requirement for an “environmental window” for a given dredging project. This practice seeks to avoid detrimental impacts by constraining dredging and disposal operations to a “safe” time period. Experience in the United States and Australia has shown that environmental windows commonly complicate contracting and execution schedules for capital and maintenance dredging projects, may significantly inflate costs and lead to difficulties in coordination among regulatory agencies. In some cases, however, such practices, where properly implemented with adequate monitoring in place, could provide an acceptable protective mechanism for certain receptors during known periods of time. In the majority of cases, however, environmental windows exemplify the implementation of a management practice based almost entirely on the precautionary principle.

Few performance measures have been developed to assess the effectiveness of these management practices. There has been little cumulative effort on the part of regulatory agencies to gauge the effectiveness of the various management approaches to identify improved resource protection and economically efficient management practices. Conceivably, certain practices could provide no protection or actually add an element of risk to the specific project.

**DREDGING AND THE ENVIRONMENT**

The overall management goal of any dredging project should be to achieve a sustainable solution, subject to sound environmental, social and financial impact evaluations, weighing and balancing all associated risks.

Sediments are a basic component of habitats that support aquatic life. Because dredging and dredged material placement inherently involve disturbance of existing substrates, impacts on the environment may result (see Figures 2 and 3). To limit these impacts many national and international conventions have been developed, for example, the Dredged Material Assessment Framework of the London Convention (LC-DMAF). A central element of these conventions is the conduct of a thorough environmental impact assessment (EIA) to identify potential effects of a given dredging project prior to its execution and to reduce uncertainty about the scales of those impacts.

When an EIA determines that impacts may be significant, consideration is given to measures that can be taken in order to avoid, reduce or mitigate the scale of effect to an acceptable level. Many such measures which can mitigate against certain impacts are available. These are collectively known as “dredging project management practices”, whereby unacceptable environmental impacts of dredging and dredged material placement and in some instances their transport can be reduced. These practices encompass a diverse array of options, from relatively minor operational changes (e.g., alter the rate of sediment removal) to application of innovative technologies to restrictions that constrain dredging to certain times of the year (environmental windows).

![Figure 1. Application of a silt curtain at Vuosaari, Finland harbour construction works. Silt curtains are often recommended to control turbidity but their deployment is often costly and their effectiveness is not completely clear.](image-url)
The term “best management practice” has entered the jargon of many disciplines. Herein recognition is given to the fact that not all management practice options are inherently the “best” practice. For the purposes of the report the following definitions have been developed:

Management Practice (MP): A practice intended to improve the environmental performance of a dredging project, inclusive of excavation, transport, and placement of dredged material.

Best Management Practice (BMP): A management practice, or combination of management practices, that is determined after impact assessment, examination of alternative practices, and appropriate stakeholder participation to be the most effective, practical, and sustainable means (including technological, economic, social, and institutional considerations) of achieving an environmental performance objective.

Many factors influence the selection of appropriate MPs for reducing or mitigating environmental impacts. Also the perception and importance of potential impacts varies among different stakeholders (e.g., project owner or sponsor, resource agency with regulatory authority, conservation organisations and the public). For that reason, a good understanding of the physical changes that result from dredging and the impacts these changes might have on the environment is a prerequisite to the selection of effective MPs. In addition, economic factors, social consequences of the project, and acceptance by stakeholders are all important considerations in optimising costs and benefits of implementation in derivation of the BMP. Most importantly, all parties should recognise that BMPs need to be determined on a project-by-project basis.

DEALING WITH ENVIRONMENTAL RISKS IN A DREDGING PROJECT

MPs are meant to improve the environmental performance of a dredging project. In the ideal situation, all environmental risks associated with a dredging project would be quantifiable, making the need for specific management practices clear. In reality, dredging can potentially affect diverse assemblages of organisms or their habitats on varying spatial and temporal scales.

It is important to recognise that even with extensive baseline data and input from qualified professionals, an element of uncertainty will always be associated with the results of an environmental assessment, simply because of the dynamic nature of marine and freshwater environments and
In the face of uncertainty about the risk associated with a dredging project, applying MPs adds assurance that the environment is protected, consistent with the proportionality clause of the Precautionary Principle. In practice, however, the wholesale or random application of MPs may or may not protect the environment. Determining the necessary level of protection in proportion to the risk and then selecting only those MPs known to be effective at providing the required protection is a more robust, rational, technically defensible approach. In addition, the MPs should, to the extent possible, include numerical or other appropriate thresholds.

Risk perception is very much driven by social, political and/or historical circumstances. No solutions can be given here. Only the necessity of thorough, elaborate and effective communication amongst stakeholders from the very beginning of a project can be underlined. Figure 4 presents a diagram of a project management network.

MANAGEMENT OPTIONS AND IDENTIFICATION OF APPROPRIATE MPS

The report gives a comprehensive overview of approximately 100 management practices applicable to dredging, transport and placement of dredged material.

The identified management practices are categorised. They may be either related to the planning and design phase or to the construction phase of a dredging project. Management practices that are specifically relevant in the planning and design phase are tools related to equipment choice, dredging and reclamation methods, institutional and control tools. The construction phase management practices are tools related to equipment choice, dredging and reclamation methods, institutional and control tools. The management practices are described in detail with references for more in-depth information on a CD-ROM, which is enclosed with the report.

To work with the MPs a thorough understanding of technical, environmental and economic characteristics of the various dredging techniques, and of the potential
environmental effects, is required. MPs that improve one aspect of a project activity could have a negative influence on other aspects, or one MP might enhance another MP, that in its own right would be less attractive. In general, a greater level of environmental protection will introduce higher costs. Decisions about MP application must be made within the context of balancing environmental gain against economic and social consequences.

In order to facilitate discussion on these aspects the report gives a brief description of how dredging projects are executed and how the environment may be affected by the project. A key element of the report is the outline of a methodology for arriving at a selection of management practices which could be defined as the "Best Management Practice" (or practices) for the project.

The selection of the best management practice is project specific. The process of selecting management practices should be based on appropriate baseline data and understanding of the ecosystem and sensitivity of habitats within the area of influence of the project. But of similar importance, as stated above, is a high level of understanding of the technical and economical aspects of the dredging process. Proper identification of the best management practice for a dredging project therefore requires input from ecological experts and dredging specialists.

The PIANC report Nr. 100 is written for a broad spectrum of stakeholders involved in the dredging process, including port authorities, regulatory agencies, the dredging industry and non-governmental organisations such as environmentalists and private sector consultancies. It aims to provide guidance to assist in decision-making on the necessity for and selection of appropriate management practices.

A section of the report describes how to identify specific MPs that address risks associated with a given project. Once identified, potentially appropriate MPs are then screened and ranked according to their effectiveness, logistical feasibility and potential cost (Figure 5).

The evaluation chart ranks the potential practice options relative to each other. It is not intended to identify the specific level of effort and effectiveness required. The different shapes and forms show that a possible range of effort and effectiveness may have to be taken into consideration. This exercise has to be undertaken by experts in their fields. Following this structured approach should ultimately result in a technically defensible project with reduced environmental impact, balanced cost effectiveness, and increased transparency to the stakeholders.

The chart is therefore also meant as a basis for discussion between all those involved or interested in a dredging project. It is not possible that "everybody knows everything", but it is important to recognise that good, clear communication needs good, clear groundwork.

**THE ROLE OF MONITORING**

Monitoring can take many forms and fulfil various objectives before, during and after any dredging and placement project. Monitoring is a necessary element in the context of BMP application. In particular, monitoring can be proposed as a management practice in itself or used to assess the effect of other management practices.

The objective of monitoring is to show that the implemented MPs are delivering the expected environmental performance. Monitoring is particularly important toward further reducing uncertainty for a specific project or for the future evaluation of MPs. It is the first step in determining whether additional MP or corrective actions will be necessary to ensure the required outcomes of the project. Monitoring programmes can be categorised into three types:

**Surveillance monitoring**

This is also known as BACI monitoring (Before-After-Control-Impact). This type of monitoring assesses temporal and spatial changes to selected parameters between the prior condition and the current condition. This monitoring is the most used and simplest to design. The preceding EIA study will have identified and predicted the impact on the relevant parameters for the BACI monitoring programme. The objective of a surveillance monitoring programme is verification of the hypotheses made during the project preparation.

**Feedback monitoring or adaptive monitoring**

Feedback-(Europe) or Adaptive (US) Monitoring is a special form of surveillance monitoring where a few fast reacting and predictable environmental variables are forecast by modelling and then monitored...
continuously during the dredging and/or landfill operations. The purpose of this monitoring is to ensure that possible exceedance of environmental criteria can be forecast in such good time that dredging plans can be altered accordingly and costly down-time avoided.

**Compliance monitoring**
This ensures compliance with contractual restrictions. A major objective in planning a control and/or monitoring programme is to ensure that the dredging process is executed in accordance with the various restrictions, which are legally or contractually imposed. Restrictions can vary markedly from one project to another depending on the prevailing human and ecological conditions at the site. They can be either physical (e.g., dredging depth, location or transport mode, limitation on turbidity or sedimentation rate at a vulnerable site nearby), or seasonally related (e.g., special seasonally related, that is, special restrictions during breeding season) or quality oriented.

One additional objective of any monitoring programme is to increase knowledge about the environmental conditions and effects of a given dredging process. This knowledge serves as a basis for a better assessment of the environmental effects during future dredging projects.

**CONCLUSIONS**

Generally dredging serves many purposes which are for the well-being of the whole community, as is the case with ports and waterways. Very often dredging projects take place in the coastal and estuarine zone which is a highly dynamic environment. This is also an area of high productivity and high biodiversity. In this respect, dredging has to work with nature, not against it. This is common knowledge in the dredging community and the acceptance of this fact has led to the development of a wide range of MPs.

That dredging will have an effect on the environment is generally acknowledged; projects without any impact are not possible. To assess these effects an EIA needs to be undertaken, which will determine the significance of potential impacts and also consider cumulative and in-combination effects. This enables dredging to be put into context with other activities, e.g., fisheries, navigation and so on. As dredging often takes place in a natural environment, uncertainty and therefore risk has to be accepted in the assessment. This uncertainty can be reduced, but not eliminated with modelling or additional studies.

A key message is that it is incorrect to assume that applying all possible MPs to a given project will lead to the best protection of the environment. In fact indiscriminate application of MPs can actually have a net detrimental effect and can quickly render a project unaffordable and unworkable. It may therefore hinder sustainable development and its subsequent benefit for society.

Discussion is encouraged between those involved in a dredging project (be it the client, the permitting agency, environmental NGOs or other groups) on how to assess and manage risks. Risk perception varies between groups and individuals and is value driven. There is no quick solution to this potential conflict, early and open discussion is considered essential. The complex nature of the aquatic environment and the interference created by dredging related operations make it necessary to consult experts.

Characterisation of the environment in which the dredging project will occur, design of the project, and monitoring during the work are fundamental scientific and engineering activities. However, as nature cannot be modelled completely, reliance on expert judgment and recommendations, within the context of regulations, is necessary to achieve a rational outcome and should be acknowledged and respected.

Successful planning, development, and implementation of a dredging project may require involvement of other experts, such as regulatory authorities, lawyers, as well as politicians and public interest specialists. Technical experts must acknowledge the importance of these participants and their input must be incorporated into the project discourse. Permitting authorities should refrain from specifying the means and methods by which the work will be performed. Rather, they should set performance standards which are relevant, site-specific, practical and measurable. For project control, biological parameters should be translated into measurable physical parameters wherever possible, in order to enable monitoring to proceed.

Selection of management practices should be flexible and allow for changes to respond to unforeseen conditions during project execution. To assess both the environmental effects and the result of the application of management practices specific monitoring is likely to be required. Even the most sophisticated BMP will become ineffective if not implemented in the correct way.

**REFERENCES**

