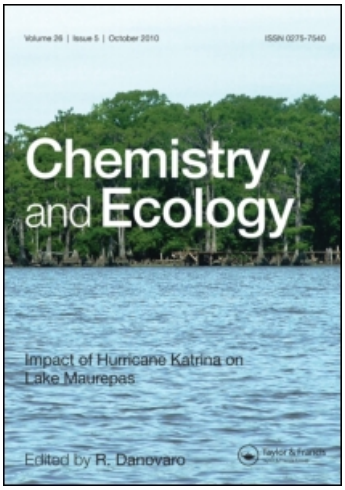

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DAMOS: TWENTY YEARS OF DREDGED MATERIAL DISPOSAL SITE MONITORING. ISN'T THAT ENOUGH?

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Since 1977, the US Army Corps of Engineers Disposal Area Monitoring System (DAMOS) has monitored New England's offshore dredged material disposal sites. DAMOS has shown that by using monitoring information to make management decisions, open water disposal of dredged sediments is possible with minimal environmental impact. Over the past two decades, DAMOS has answered many of the key questions about dredged material impacts. Yet the need for such a programme remains strong from both the technical and public interest perspectives. The programme continues to monitor projects that are extending our knowledge in the areas of deeper water capping, geotechnical behaviour of capping and capped materials, and biological response to contaminants. These investigations, along with the need for specific disposal site surveys, will continue to provide valuable technical information needed by the public, policy makers, and regulators to make critical decisions on dredged sediment management.

Keywords: Dredged material; monitoring; ocean disposal; dredging; environmental impact assessment; capping; dredged dumpside; 20 years disposal; DAMOS

INTRODUCTION

> "The more you know, the harder it is to take decisive action. Once you become informed, you start seeing complexities and shades of gray. You realize that nothing is as clear and simple as it first appears. Ultimately, knowledge is paralyzing. Being a man of action [While throwing a book away.], I can't afford to take that risk." Calvin of Calvin and Hobbes, 1996

Twenty years of "DAMOS Program" monitoring supports the conclusion that well-managed offshore disposal of dredged material has very little adverse impact on the environment. In light of such a conclusion it is not unreasonable to ask two questions. Has the programme accomplished its objectives? Has it outlived its usefulness? In my view, the answer to the first of these questions is both yes and no, whereas the answer to the second is no. Ultimately though, the responses to these questions needs to come from the users of DAMOS information both within and beyond the New England region: Corps of Engineers managers and regulators, interested resource and regulatory agencies, technical consultants, maritime and port interests, environmental groups, and the public. In the following sections I will provide one perspective on the answers to these questions, that of the Programme Manager for the past ten years.

PROGRAM BEGINNINGS

The Disposal Area Monitoring System (DAMOS), operated by the New England District (NAE) US Army Corps of Engineers, began in 1977 in response to the growing environmental awareness within the United States. Although NAE had conducted a number of independent studies prior to 1977, the new programme was designed to improve upon those by taking a unified approach to investigations, monitoring, and management (Fredette *et al.*, 1993). Since then, the programme has produced more than 100 technical reports (the DAMOS contribution series) and 60 journal or conference papers (see www.ned.usace.army.mil/environm/environm.htm).

The earliest DAMOS objectives focused on understanding the basic behaviour of disposed sediment and its near-field, short-term impacts. As stated in NUSC (1979a) the objectives were to develop "...a consistent, practical and informative monitoring scheme..." and "...to enhance the capabilities of the Corps of Engineers to monitor disposal sites and advance the state of the art..." These efforts built upon the 50 prior independent, NAE supported efforts, many of which established the foundations of our knowledge on dredged material impacts (Saila *et al.*, 1969, 1971; Gordon *et al.*, 1972; Gordon, 1973; Rhoads and Yingst, 1976). While many of the first DAMOS

investigations were descriptive in nature and designed to determine ambient conditions, they were conducted under a consistent framework rather than the earlier efforts which sometimes produced "...reports varying in content, quality, and completeness..." (NUSC, 1979b).

The overall objectives of DAMOS, as refined in 1979 (NUSC, 1979b), remain relatively unchanged today. These 1979 objectives were:

- to monitor dredged material disposal sites in the New England area by empirical methods to ensure that no significant adverse environmental impacts result from disposal operations;
- to develop an understanding of the processes and mechanisms affecting dredged material in the marine environment;
- to develop an understanding of the interaction between dredged material and the biota of the disposal site;
- to utilize this knowledge to develop management techniques that will minimize the adverse effects of disposal;
- to distribute the results of the DAMOS programme so as to provide better public understanding of the effects of dredged material disposal.

Although the objectives have remained very similar, the programme has successfully resolved many of the specific concerns that were present at the outset (e.g., disposed sediment dynamics, mound stability, benthic recolonization, capping feasibility). Perhaps the largest difference between the programme of today and that of 20 years ago is a shift to addressing more longer range, cumulative impact questions (e.g., food web impact of contaminants, beneficial fishery effects, and long-term cap effectiveness) as opposed to the near-field, short-term questions of the past.

MEETING THE OBJECTIVES

The efforts conducted by DAMOS have contributed enormously to addressing the objectives developed first in 1979 and the underlying specific concerns of the day. However, the intent and open-ended nature of the objectives, in particular the first and last two, provide a

basis for understanding the ongoing need for the programme. As we have gained new knowledge about our complex environment, the questions asked of the programme by the public and others have changed, but they have not diminished. Instead public awareness and accountability have increased. Values our society places on the ocean demand that dredged material disposal be done with careful oversight or not at all. Integral to this is the investigation of new technologies to improve our management and monitoring techniques. Thus, the need for new and up-to-date information developed through the programme to meet these challenges persists.

Key knowledge on disposal impacts and sediment management has been provided by the DAMOS programme in the areas of biological recolonization (Rhoads and Germano, 1990; Germano and Rhoads, 1984), the use of capping (Morton, 1980, 1983, 1988; Fredette, 1994; Fredette *et al.*, 1992; Science Applications International Corporation, 1995), and the long-term stability of disposal mounds (Brandes *et al.*, 1991; Fredette *et al.*, 1988; Science Appplications International Corporation, 1989). The need to efficiently manage multiple disposal sites has led to the development and refinement of monitoring tools (e.g., Bohlen, 1982; Germano, 1983; Hellemn *et al.*, 1994) as well as a tiered monitoring framework (Germano *et al.*, 1990). We know from these efforts that we can create stable, capped sediment mounds when we have carefully chosen the disposal site and that following the cessation of disposal, biological recovery can be used as a predictable tool to assess impact. Questions regarding these issues once were prominent parts of the programme objectives reviewed earlier, but have since become minor parts of the programme because of the answers provided through these studies.

The objective to inform the public and hear their concerns is addressed through multiple efforts that include periodic symposia, presentations to schools and interest groups, technical publications, and conference papers. The programme also was involved in the development of a public information brochure on the overall "Dredged Material Management Program" of NAE. More recently we have begun to make information available on the world wide web and will complete a half-hour public information video by mid-1998. While this outreach has not eliminated all public concern about contaminated sediments, it has provided the regional resource agencies

and environmental interest groups with a greater level of confidence in the abilities of the New England District to manage reliably controversial projects.

Present monitoring and investigation activities of the programme continue to adhere to the need to minimize environmental impact and to improve management capabilities. The thrust of minimizing impacts is directed at enhanced capping management (Fredette, 1994; Palermo *et al.*, 1992; Wiley, 1995), developing a better understanding of the magnitude of cumulative impacts of disposal; such as food web impacts and retrospective assessment of monitoring results (Fredette *et al.*, 1992; Rhoads *et al.*, 1995; Williams and Rhoads, 1994), and investigating beneficial uses for dredged sediments (Clarke *et al.*, 1988; Ray *et al.*, 1994; Science Applications International Corporation, 1993). In particular, recent activities related to capping management have examined expanding the use of capping to deeper water sites. In this instance, empirical field and laboratory investigations are being conducted to address public and resource agency concerns as part of a demonstration project in 60 metres of water at the Portland, ME, disposal site.

TURNING DATA INTO MANAGEMENT INFORMATION

The information generated by the programme has several distinct applications that include disposal site management, environmental compliance, verification of pre-project environmental assessments (of both permit and Corps dredging projects), technical decision support, and public reporting. One of the key goals of the monitoring programme is to provide data in a timely fashion useful for decision making. This is done in a tiered monitoring framework using tools that provide rapid data return (Germano *et al.*, 1990). The tiered approach also allows the programme to use resources efficiently by focusing the data collection on early warning thresholds (Fredette *et al.*, 1986). This has been recognized as a sound and pragmatic approach by the National Research Council (1990).

Management of disposal sites requires periodic monitoring to determine the location and extent of the disposed sediment. This is done through the use of standardized survey techniques combining

precision bathymetry and sediment profile camera photos. This information is used to avoid the creation of navigation hazards due to mounding, to guide the disposal of capping sediments, to aid in planning of other monitoring surveys, and to assess the long-term volume capacity of the site.

Biological recolonization information is used to verify the determinations of sediment quality made in the project review process. This benthic community response information strengthens the confidence placed in the sampling, testing, and decision making protocols by verifying the predictions made in the project review phase. Biological recovery is also an important component in assessing the cumulative impacts of disposal from the multiple projects that use each site. In the more than twenty years of monitoring, we have seen only very localized impacts from sediments, even those known to contain relatively high levels of contaminants (Fredette *et al.*, 1992; Germano *et al.*, 1990). The primary tool used for such initial assessments is the sediment profile camera (Germano, 1983), coupled with special investigations of on-site tissue residue concentrations (several DAMOS reports).

Lastly, substantial effort and priority is placed on production of reports and syntheses of the data for distribution to the public and environmental community. This information sharing is important not only for the purpose of informing, but also as a means of receiving feedback on whether the programme is providing a product that is useable beyond the boundaries of one office. This effort has been successful with DAMOS information and approaches being used or considered in other North American regions such as Puget Sound, New York, Chesapeake Bay, California, in addition to New Zealand and Hong Kong (Joseph Germano, personal communication). Nonetheless, the programme continues to seek out new ways to make the information available to users including the use of the world wide web and distribution of reports, GIS data layers, and station specific data on CD-ROM.

FUTURE PATH

The overall philosophical goal of this or any similar programme should be to provide sufficient answers to the environmental questions

and concerns, such that the programme itself becomes obsolete or can be substantially reduced. If society reached the point where disposal of dredged sediments in New England's marine environment was not a concern, then DAMOS could be judged as an unqualified success. While this may be an unattainable goal, it remains the primary motivating force. Nonetheless, some reductions (e.g., in survey frequency, traditional benthic sampling, sediment chemistry) in the programme have been possible, as the programme has continued to meet the monitoring and management needs with substantially fewer real dollars than were budgeted 10 or 20 years ago.

A major factor that continues to drive the programme are requests to apply management techniques to new situations. This may involve usage of techniques in different physical settings or the need to modify typical project design features to accommodate tighter budgets or limited resources. Two examples to illustrate this point can be found in the use of capping. Presently there is considerable interest on the part of navigation interests (e.g., Corps and port officials, shippers, marina operators) for information that can be used to assess capping at deeper water sites. Similarly, there are often situations where the cap material available is geotechnically different from sediments needing capping and decisions on whether this makes a project physically unfeasible are needed. Investigations by the programme may be critical in helping to determine whether such approaches are feasible. Without such options, some harbours may become dysfunctional because of shoaling.

DAMOS is an essential part of the long-term viability of New England's navigable waterways and ports. Had open water sites not been available for the last 20 years and upland disposal alternatives were necessary at 10 times greater cost (a typical cost increment for such projects), the net difference to projects would have been in the range of 1.8 billion dollars. Relative to such a number the cost of DAMOS monitoring has been minute.

The DAMOS record, consisting of more than 175 reports, clearly indicates that the objectives are being addressed and fulfilled. However, as the questions and needs continue to change, the programme will also need to change to meet these new challenges. DAMOS will continue to strive to meet the objectives that have been established, while keeping in the forefront the goal of sharpening the

distinction between the shades of gray: allowing informed decision making.

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