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EDITORIAL

Adaptive management principles and sediment management

A call for discussions

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1 Adaptive management

1.1 Background

In general, the premise behind decision making for management is that we can predict the effects of management actions and compare these to the effects of other actions, including no action. Using past experience, research, scenario studies, models and pilots, we quantitatively or semi-quantitatively predict the responses to various actions, and select the "best" actions, based upon our chosen set of criteria. Whilst this premise may be correct for the simplest of problems (though even seemingly "simple", environmental problems have a tendency to surprise us), as we move to more complex problems, attempting to manage the effects of multiple stressors on complex ecosystems at various scales, this becomes increasingly difficult. Our scientific knowledge of how various components of the ecosystem (both those we will monitor and those we do not consider) respond to natural and anthropogenic changes will always be incomplete, and the variability and heterogeneity in natural systems can never be replicated in model systems or fully characterized in monitoring systems. Thus, no amount of research will completely reduce the uncertainty inherent in ecosystem management, and formal rule-based management frameworks and presumptive remedies may at times fail to achieve their objectives, or may even cause unanticipated impacts.

1.2 Adaptive management approach

Adaptive management concepts arose from concerns that conventional resource management approaches inadequately considered system dynamics and uncertainties, and that some problems in large-scale ecosystem and resource management can only be understood through experiments (NRC 2003). These principles, closely linked to the Ecosystem Approach, acknowledge the natural variability in ecosystems, recognise that ecosystems are dynamic, and accept that there can only be incomplete knowledge of these systems. As a consequence, the premise of adaptive management is that management frameworks should not be static, but should be continually reassessed and updated as circumstances change. To attempt to adjust and adapt to (often unexpected) changes and processes, adaptive management permits a wide variety of possible hypotheses and strategies, taking into account the perspectives of both biological and social sciences (WBGU 1999).

Adaptive management represents an evolving philosophical approach to environmental management; a review of the literature reveals that there is no consistently used specific definition. It has been called "learning by doing", but, to be successful, requires a system of monitoring, structured feedback and decision making in which indicators of both desired (and undesired) potential outcomes are monitored, and responded to in an informed way. A well-designed adaptive approach uses ecological indicators to support the operational objectives, and requires that monitoring and assessment are of sufficient accuracy, precision, and frequency to ensure that the effects of

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management measures can be evaluated in a timely manner, and adjusted as necessary (ICES 2005). Adaptive management is the alternative to rigid and inflexible management frameworks, and is part of the Ecosystem Approach (ICES 2005), which is the basis of most recent European environmental policy (Apitz et al. 2006).

2 Sediment adaptive management

The issues faced by sediment managers are complex; the problems involve a large number of variables, the systems involved are dynamic, and the uncertainties associated with them are large and often dominate the decision-making process. Selecting the best management actions under such circumstances is difficult and sometimes not possible. The concept of adaptive management acknowledges the complexity involved in the selection of and implementation of a set of alternative actions that are tracked through monitoring. Alternatives that perform well are promoted and poorly performing alternatives are adapted or eliminated. Successful adaptive management relies heavily upon well-designed monitoring activities that provide key information for the adjustment of management designs and actions (Wharfe et al. 2007).

Long established in ecological restoration (Walters 1997), the concepts of adaptive management are increasingly being embraced by the contaminated sediment management community. In the US, they have been invoked as an approach to develop and test methodologies for implementing bioavailability considerations in policy; for better managing megasites and for more intelligently developing, testing and validating remedial strategies (NRC 1997; NRC 2001; NRC 2003; NRC 2007). In Europe, they are at the core of the UK's development of indicators for its Marine Strategy; they are invoked as the basis for ecosystem-based management of soil biodiversity and the development of Integrated Coastal Zone Management (COM 2002); and are stated to be guiding principles of basin-scale management (www.sednet.org).

Adaptive Management seems intuitive to many as an approach to addressing the complexity and uncertainty inherent in managing contaminated sediments. A review of recent publications, presentations and web pages on sediment management reveals an ever-increasing number of references to this approach and claims that various sediment management studies, strategies and frameworks are adaptive. However, there seems to be no consensus on what it takes to make sediment management "adaptive" or what, exactly, various approaches are adapting to. Furthermore, an informal, unrepresentative but international straw poll of the sediment management community suggested that adaptive management, though often invoked, is still being only infrequently and often only retrospectively applied (Apitz and Porebski 2009).

3 A call for discussion

3.1 Adaptive management, a reactive mode?

As with the growing use of other ecological concepts in sediment management (Apitz 2008a, b), it is important that we are clear about what we mean when we invoke adaptive management. If we are adopting ecological concepts into other disciplines, it is essential that we understand the underlying principles, and how they do and do not pertain to our own fields of expertise. Ensuring that adaptive management concepts move from being the darling of expert groups and think tanks to a set of tools that can be used on the ground by practitioners and decision makers, requires substantial changes in the way we design, communicate and carry out sediment assessment, monitoring and management.

Adaptive management is at times considered or used as a fig leaf for iterative, undirected, reactive management. Rather than defining and monitoring clear management goals, many in environmental management "lapse into a reactive mode, under the guise of being 'adaptive'", with unanticipated effects leading to a series of ad-hoc actions (Rogers 1998). However, truly adaptive management is not reactive, but should be an experimental but goal-based process in which well-designed indicators of management objectives are monitored to inform management strategies. This approach is inconsistent with rigid, standards-based sediment decision frameworks, and also with presumptive remedies that are still being promoted in some regions (Apitz 2008b). Adaptive management requires that monitoring programmes are clearly linked to indicators of success (or failure) of a management strategy. From an ecosystem status viewpoint, these indicators should be linked not only to the control or reduction of anthropogenic stressors such as contaminants or suspended sediments, but also to the health and sustainability of ecosystem status, structure and function. Such indicators, however, are not clearly linked to standard regulatory criteria, but rather are based on a definition of what, in terms of ecosystem status, we are trying to achieve. Rogers (1998) calls these "conservation goals", which he defines as "…scientifically rigorous, spatially and temporally bounded targets of flux in ecosystem condition." He advocates a system in which "…each goal can be traced back to its origin in both policy and science, as well as to the institutional structure responsible for its achievement." There are a growing number of approaches to provide a clear, logical and unbroken chain linking and translating the fundamental science and its underlying assumptions to the

applied issues and decisions they inform (Apitz 2007, 2008a, b)—but the development of such frameworks requires "…a durable partnership between service provider (science) and client (management)" (Rogers 1998). Such partnerships face substantial institutional barriers.

3.2 Barriers to adaptive management

3.2.1 The myth of certainty

One barrier to the success of adaptive management is that the public and decision makers (and some researchers) are reluctant to repudiate the myth of certainty. There seems to be an impression that, given enough research, uncertainty will be removed, and that the "true" solution will become apparent, but, as discussed above, this is not possible in complex systems. Decision makers, long used to neat lines generated by theoretical models and well-controlled laboratory experiments, can at times find the broad variability and uncertainty that results from more realistic field measures distressing. However, these are the realities of the systems we are trying to manage. Academic departments must do more to reward collaborative, interdisciplinary work. Traditionally, many research scientists have scorned the perceived oversimplification necessary to communicate across disciplines and with the public, preferring the communication and company of their own peer group—but this is unsupportable if we are going to manage complex sediment problems. Scientists must avoid the temptation to "research every detail to death", while working with decision makers to identify those parameters most critical for adaptive decisions. Decision makers must learn to accept that rigid decision frameworks, even if very conservative, are not any more protective than risk-based, adaptive ones.

3.2.2 Data access

Data access can also be a problem. In many countries, much data collected by public agencies and their contractors is then continually re-sold to potential users. Academics are often reluctant to share data until they have published their papers (and sometimes even after that). Thus, many studies cannot access data, even if it was collected with public monies. Although there is a growing trend to make more data available, we have much to learn about how to archive and communicate data so that it can be used for purposes we do not currently foresee. Furthermore, if we are to learn from mistakes, researchers, managers and journals must be more willing to publish negative or "messy" results, as the lessons learned from these are important. Another barrier to successful adaptive management is that research funding cycles are often too short for the careful evaluation of ecosystem responses to management actions. There is a perception that long-term monitoring of pilot studies and management actions is too expensive, but it is, in the long run, not nearly as expensive as failed management, cycles of reactive management, and gridlock. Clearly, rigid decision-making tools and a lack of transparency in decision-making processes are anathema to adaptive management. Antiquated monitoring programmes, designed on the basis of regulatory criteria and historical programmes, rather than indicators of ecosystem status and goals, need to be reconsidered.

3.2.3 Risk-based remedial decision making

Many of the issues described above are similar to the barriers to risk-based remedial decision making in Europe (Apitz 2008a, b; Förstner and Apitz 2007). In fact, the uncertainty inherent in sediment risk management requires that risk-based and ecosystem-based management decisions are carried out using adaptive management principles. There is ample support within European objectives and policy for risk-based sediment management (Apitz 2008a, b), but barriers remain. Addressing these will be a challenge, but will be well worth the effort.

4 Call

As an Intercompartment Subject Editor for JSS, I encourage those in the sediment (and soil) communities to share their thoughts, experiences and case studies, both successful and not, on this topic. We can only truly manage adaptively when we are willing to learn from both our successes and our failures.

References

Apitz SE (2007) Conceptual frameworks to balance ecosystem and security goals. In: Linkov I (ed) Environmental security in ports and harbors. Springer, Dordrecht, pp 147–173

Apitz SE (2008a) Editorial—managing ecosystems: the importance of integration. Integr Environ Assessment Manag 4(3):273

Apitz SE (2008b) Is risk-based, sustainable sediment management consistent with European Policy? J Soils Sediments 8(6):380–385

Apitz SE, Porebski L (2009) Adaptive management of contaminated sediments—an international survey. Proceedings of the Fifth International Conference on Remediation of Contaminated Sediments. Jacksonville, Florida, February 2–5, 2009 (www.battelle.org/sedimentscon)

Apitz SE, Elliot M, Fountain M, Galloway T (2006) European environmental management—moving to an ecosystem approach. Integr Environ Assessment Manag 2:80–86

COM (2002) Recommendation of the European Parliament and of the Council of 30 May 2002 concerning the implementation of Integrated Coastal Zone Management in Europe (2002/413/EC). Official J European Communities L 148/24, 6 June

Förstner U, Apitz SE (2007) Sediment remediation: U.S. focus on capping and monitored natural recovery. Fourth International Battelle Conference on Remediation of Contaminated Sediments. J Soils Sediments 7(6):351–358

ICES (2005) Guidance on the application of the ecosystem approach to management of human activities in the European marine environment. Copenhagen: ICES Cooperative Research Reports. Report no 273

NRC (1997) Contaminated sediments in ports and waterways—cleanup strategies and technologies. National Academy Press, Washington DC, p 295

NRC (2001) A risk-management strategy for PCB-contaminated sediments. National Research Council. National Academy Press, Washington DC

NRC (2003) Bioavailability of contaminants in soils and sediments—processes, tools and applications. National Academies Press, Washington DC

NRC (2007) Sediment dredging at superfund megasites—assessing the effectiveness). Committee on Sediment Dredging at Superfund Megasites, National Research Council. National Academies Press, Washington DC

Rogers K (1998) Managing science/management partnerships—a challenge of adaptive management. Conservation Ecology [online] 2(2):R1

Walters C (1997) Challenges in adaptive management of riparian and coastal ecosystems. Conservation Ecology [online] 1(2):1

WBGU (1999) World in transition: conservation and sustainable use of the biosphere. German scientific advisory council for global environmental change. Springer, Berlin, Germany, p 478

Wharfe J, Adams B, Apitz SE, Barra R, Bridges T, Hickey C, Ireland S (2007) In situ based measures, an important line of evidence in the environmental risk framework. Integr Environ Assessment Manag 3:268–274