Integrating research and development into decision making for natural resource management in coastal northern Australia

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ABSTRACT

A brief analysis of the requirements in fostering mechanisms for the integration of recent and current research into decision making is undertaken in this paper. This analysis is illustrated by some of the activities of the CSIRO Coastal Zone Program in north Queensland, particularly the development of a decision-support environment for addressing the off-site impacts of land use change and development of the Herbert Resource Information Centre. This collaborative and community-based resource is aimed at improving the basis of decision making in natural resource and related management in the Herbert River Catchment.

INTRODUCTION

The 1992 Inter-governmental Agreement on the Environment commits all levels of government in Australia to achieving a balance between economic development and environmental integrity through the concept of Environmentally Sustainable Development. The impacts or potential impacts of increasingly intense natural resource exploitation in the coastal zone on the marine environment, the Great Barrier Reef being of particular note in north eastern Australia, are well recognised (Resource Assessment Commission 1993). As a result, strategies are demanded that balance economic development in the coastal zone with downstream impacts, such as that on the marine environment (Brown 1995).

Scientists traditionally respond to such challenges by advocating that further research is needed to fill gaps in our understanding. This reflects the pre-eminence of a belief system that asserts that there can be rational and objective management of natural resources (Lang 1990; Funtowicz and Ravetz 1990 for a more general discussion). Indeed Boehmer-Christiansen (1994) asserts that 'The very success of physical and natural sciences ...lies in the self-seeking belief which scientists (but few others) tend to share that there is a very direct link between more knowledge and appropriate action.'

Continued research may be needed to enable more informed and appropriate management of natural resources at the terrestrial–marine interface in northern Australia. The rational scientific approach is increasingly being challenged by our greater understanding of the complexity and indeterminism of natural systems and by the apparent irrelevance of much research to decision making (in as far as it often has minimal impact on practical resource management). Together these have eroded the belief that knowledge is all that is required. In order to more effectively integrate scientific understanding into the decision making process, researchers are now seeking to understand the process itself.

In this paper, we propose that the adage that 'further research is needed' provides scientists with little opportunity to have a positive impact on sustainable natural resource management. Only by being prepared to invest in understanding the context of decision making and by finding novel ways of facilitating the uptake of past and future research by decision makers can scientists hope to have a significant and consistent impact on practice. We explore this new role for research and development (R&D) providers by reference to some current activities in integrated natural resource management at a catchment scale in the Herbert River Catchment of north Queensland.

Limitations to the contribution of science to natural resource management

Research addressing natural resource management issues is based on an unwarranted confidence that it will lead to 'objective and rational management of natural resources'.

This implies that there are demonstrably correct solutions to natural resource management problems; that is that we can achieve decisions based on unanswerable and irrefutable logic. This is naive, in that it does not recognise that natural resource management is *inherently* a political process in which different needs and interests are balanced. Where policy is presented as being based solely on scientific evidence, this is almost inevitably a politically expedient 'fig leaf' for more complex motivations and compromises (Boehmer-Christiansen 1994). Effective natural resource management can occur without formal research but not without an effective political process.

Quite apart from the political nature of natural resource management, 'objective and rational management' may often be unattainable. Science is itself a political process (though highly institutionalised), being based on attaining consensus amongst peers with the consensus achieved in ecology generally more speculative than in physical sciences. Predicting processes at an ecosystem scale may simply be an intractable task since issues may be so complex and indeterminate that predictive understanding may be practically, or even theoretically, unattainable. Certainly, a strong case can be made that process-based understanding of ecosystem behaviour in response to stresses can often only be weakly predictive (Peters 1991). Catchment scale resource management deals with complex ecological, social and economic interactions in a dynamic situation with long time-frames and often considerable separation between cause and effect and the potential for irreversible outcomes (e.g. Norton et al. 1996). As a result, uncertainty and ignorance need to be managed and communicated so that they become recognised inputs to the decision making process (Funtowicz and Ravetz 1990; Costanza et al. 1992; Dovers 1995).

In short, the traditional assumption that science can provide unambiguous answers becomes hard to defend when applied to natural resource management. Given the uncertain and complex nature of ecosystems, we have to accept that more scientific knowledge does not necessarily lead to better answers at a scale and within a timeframe appropriate for action.

Maximising the contribution of science to decision making

While research rarely solves natural resource management problems, it clearly can contribute to their solution. We argue that, in order to optimise this contribution, researchers need to:

- understand the context of decision making;
- understand and seek to facilitate the processes of analysis and synthesis for natural resource management; and
- seek to facilitate the integration of research outputs into these processes.

Understanding the decision making context

The context of decision making encompasses legislative, economic, historical and social considerations. Knowledge and data are the fuel for the decision making process in natural resource management, but the same fuel can be placed in different engines to quite different effect. A failure to appreciate context of application, the nature of the engine, is a recipe for irrelevant research.

Northern Australia has a history of limited planning and control. Government planning and management remains anathema to many rural residents, particularly in the north. So, while effective natural resource management is agreed as being necessary, the process is politically unacceptable. At the same time, centralised government resources are being constantly reduced. In response to both these pressures, the State and Federal governments' preferred direction for natural resource management in northern Australia is towards negotiated and consensual management by multiple stakeholders and decision makers (Brown 1995). Initiatives such as Property Management Planning, Landcare and the Integrated Catchment Management (ICM) program in Queensland are prominent examples of this ethos.

The participants in these initiatives have become major clients for research in rural north Queensland. However, in order to meet their needs, the processes themselves must be understood. What is required in, for example, understanding ICM as a decision making context?

In October 1991, an Integrated Catchment Management Strategy for Queensland was released by the State Government. The Strategy is intended to provide a framework for fostering cooperation and coordination between landholders and other resource users, community groups and government agencies involved in the use and management of natural resources. It is dependent on landholders, the community in general and government having a sound understanding of the interactions between natural resources and the need for a coordinated catchment-wide approach for addressing issues affecting these resources.

To understand the implications of this initiative, we need to evaluate the process of implementation of ICM: to identify social, economic and institutional factors that facilitate or hinder this process, to evaluate the impacts in terms of attitude and behaviour and the tractability and severity of resource use conflicts and, thereby assess the specific technical and related information needs for effective ICM in a wet tropical environment. This demands consideration of the resource use and social history of a catchment, the legislative and institutional context of resource use, community and stakeholder attitudes and, of course, the nature, availability, distribution and use of current knowledge about relevant biophysical processes. A current multi-disciplinary project over five years is undertaking precisely this type of evaluation in the Herbert catchment of north Queensland.

Understanding and facilitating analysis and synthesis in natural resource management

If research providers can be criticised for failing to understand the context of application, they can also be criticised for failing to facilitate the uptake of existing knowledge. While there is much research relevant to catchment scale natural resource management in northern Australia that needs to be done, there is a lot that has been done already. This includes both formal research results and the vastly greater pool of experience of landholders, natural resource management professionals and the broader community. Much of this knowledge is, for one reason or another, inaccessible to those involved in the natural resource management decision making process. Research providers should be able to re-package it to make it accessible, or provide the necessary tools to access and use it in its present form.
In 1995 a series of interviews were held with advisers from three state government agencies and industry working in the Herbert catchment of north Queensland. These interviews sought to characterise natural resource management tasks undertaken by these individuals at that time (see Walker and Johnson 1996) and to obtain a broader perspective of the needs they had and constraints under which they operated in providing advice on natural resource management issues to decision makers such as local government. Some of the constraints and opportunities that they identified are described below under five headings that characterise steps in the process.

Step 1 – Problem formulation
The activities of the advisers interviewed involved comparatively little routine work, but advisers were often faced with questions on quite new issues. As a result, one of the first problems faced by many advisers in addressing a new situation was – what is important here? What should I be considering? Addressing these questions demands a systems level view of biophysical issues, which is rarely effectively provided by research agencies. The challenge for research providers is how best to provide the information that advisers need to decide the issues that merit consideration in any particular context.

Step 2 – Task analysis
Having decided on a range of issues that merit consideration, the adviser must decide how to address them. This requires an understanding of the level of accuracy and precision required, but also an understanding of the data resources and analytical tools available for use in analysis, and the limitations associated with these resources. Where does this information come from and who should provide it?

Step 3 – Data analysis
Data analysis may take a number of forms. In many instances experience may be enough. In other instances accessing and interpreting data about a site may suffice. However, there will be instances where informed advice demands a more sophisticated analysis. Researchers can make a large contribution to the accessibility of data resources, both by expanding the natural resource data that is available and by developing means of allowing potential users to find and interpret those data effectively. When advisers need to perform structured

analyses, they are generally applying generic analytical tools that are research outputs to their particular instance. Researchers are accomplished at providing generic tools but less so when it comes to providing guidance in the application of those tools to site specific contexts. For example, any analytical tool will be based on a set of assumptions. These may be implicit or explicit but either way are often not effectively communicated to potential users.

Step 4 – Synthesis
A response to a request for advice on a complex natural resource management issue will often require the synthesis of a range of analyses and arguments. A typical issue here was how best to integrate local knowledge and experience with more formal analyses of data, how to interpret the former in terms of the latter or *vice versa*. Research advances in systems perspectives on resource use are not easily accessible to practitioners.

Step 5 – Presentation
The politics of natural resource management, particularly where contentious, put pressure on advisers for unambiguous answers. However, these will often not be available. Appropriate presentation of what is available and what it means is, therefore, very important (Funtowicz and Ravetz 1990). Advice must be accessible and defendable. It must be presented at an appropriate levels of abstraction, for example predicting trends and presenting scenarios, rather than providing precise but quite possibly incorrect predictions. Uncertainties and assumptions must be clearly stated without undermining the advice. The data/knowledge must be plausible – particularly where using predictions as evidence.

Given the above requirements, the task of the professional natural resource manager is challenging. There are, however, many opportunities for research contributions. For example, the above analysis has underpinned the development of an advanced decision support environment for natural resource management called NRM Tools (Walker and Johnson in press). The toolkit is designed to provide the flexibility of application demanded by users (Walker and Johnson 1996) in combining and recombining analytical functionality to meet the demands of particular tasks. As such, NRM Tools is a powerful environment in which to package and deliver research outputs. NRM Tools provides a mechanism whereby decision makers can make use of quantitative models. It also provides means of delivering qualitative or semi-quantitative knowledge and guidelines produced by research by developing knowledge-based systems (most familiar in the form of expert systems) that can be integrated into decision-support tools. NRM Tools not only provides a means of making this analytical functionality more readily available to users, it also provides means of facilitating their use. In particular, modules are currently under development that *support* problem formulation ('I've been asked to comment on this change in resource management – what possible implications should I be considering?') and task analysis and tool construction ('I want to assess the implications of this land use change on water quality and flooding risks – what data and analytical tools do I have to help me do this?').

Facilitating the uptake of research outputs

Research initiatives such as the development of NRM Tools add value to biophysical research in making it available to managers. However, this is only true where the technologies upon which such outputs are based are themselves accessible. They may often not be. Here again, there are opportunities for researchers.

The Herbert Resource Information Centre (the HRIC) was established because many such decision makers in the Herbert River catchment did not have adequate access to basic information about the catchment. The HRIC is a community-based and collaborative joint-venture which integrates a large range of high quality data about the Herbert catchment into a GIS (Geographic Information System). The partners to the HRIC are the Hinchinbrook Shire Council, CSR (the sugar milling company in the catchment), the Herbert Productivity Board, the Queensland Department of Natural Resources and CSIRO. Two Centre staff manage the data sets and undertake advanced analyses as required. Much routine analysis is undertaken directly by staff in the participating organisations.

As well as introducing GIS to the catchment, and thereby providing much more effective access to the range of data available about the catchment than was previously available, the HRIC provides both the technical requirements and ethos required for the use of NRM

Tools by managers within the catchment. CSIRO's involvement in this project has, therefore, both been of benefit in establishing a resource that is useful in its own right and has fostered a context for uptake of research outputs, in this case NRM Tools.
The HRIC provides a context in which data, scientific knowledge and method can be better integrated into local political processes by local people. The collaborative nature of the centre can be expected to have an impact on the flow of information and the course of debate in the catchment.

CONCLUSIONS

The creation of new knowledge usually involves institutions that are different from those concerned with its application and dissemination. However, what is clearly increasingly required is that the former better understand the latter if they intend to justify their existence in terms of impact on natural resource management rather than advancement of knowledge *per se*. Boehmer-Christiansen (1994) identified seven ways that experts can further their own interests in policy development. The first three of these are: emphasise uncertainty and incompleteness of knowledge; emphasise complexity and difficulty; emphasise threats that can be tackled with more science and technology. We would suggest that the reality of natural resource management in the 1990s means that these strategies are a fast-track to irrelevance. We suggest it is far better to invest effort in exploring techniques by which scientific expertise can be transformed into information relevant to natural resource management.

Science is often more comfortable in providing advice on what ought to be done and why, rather than practical advice on how it might be achieved (Boehmer-Christiansen 1994). Initiatives such as the NRM Tools and HRIC are designed to provide practitioners with access to scientific resources which they can then apply to the 'how' problem. Our vision is one in which data, knowledge and scientific judgements of that data/knowledge can all be made available for integration into a negotiation process that attempts to deal with inherent uncertainty. Therefore, there is a considerable focus on communication of the principles, values and assumptions underlying analyses. Ideally initiatives such as NRM Tools and HRIC should ultimately lead to co-design of research in which researchers and local stakeholders interact to explore the extent to which applied science can make a contribution to effective and sustainable natural resource management.

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