

Towards an Improved Understanding of Knowledge Dynamics in Integrated Coastal Zone Management: A Knowledge Systems Framework

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Abstract

Integrated coastal zone management (ICZM) is a complex undertaking that draws on a range of biophysical and social science disciplines, and involves a wide range of stakeholders operating through multiple processes, and crossing various levels. Conceptually, this means that ICZM represents a significant challenge in terms of improving the way in which different disciplinary 'knowledges' and different forms of knowledge (scientific, managerial, lay, and indigenous) inform decision making. Depending upon the circumstances, ICZM may be constrained by different knowledge deficits, including: uncertainty; science - policy gaps; and the 'filtering' of particular forms of knowledge relative to others. As a means for making sense of these knowledge dynamics, this paper considers the concept of knowledge systems and its potential for improving understanding of coastal management processes. The potential insights that can be gained from four analytical approaches (stakeholder, institutional, network, and discourse analysis) are then discussed, and used to develop an analytical framework for investigating coastal knowledge dynamics, which is based upon a generic coastal knowledge system and associated research questions. Finally, the utility of this framework is illustrated using a case study that examines the knowledge dynamics associated with debates about the establishment of marine protected areas in Victoria, Australia.

Keywords: knowledge systems, integrated coastal zone management, stakeholder analysis, social network analysis, institutions, discourse analysis

INTRODUCTION: THE CHALLENGE OF INTEGRATED COASTAL ZONE MANAGEMENT

This paper provides an analytical framework which can be used to investigate the knowledge dynamics associated with integrated coastal zone management (ICZM) (Fletcher and Potts 2008). The importance of ICZM is clearly demonstrated by Harvey and Caton (2003) who highlight that most of the world's population lives around the coast, humans are

dependent on the coast, and the coast is being subjected to increasing development-related impacts. Available evidence also indicates that coastal areas are not being managed in ways that avoid or minimise environmental degradation, with coastal ecosystems considered to be "amongst the most productive yet highly threatened systems in the world" (Agardy and Alder 2005: 515).

At least part of the explanation for the challenges facing coastal areas is the nature of the coast and the complexity of arrangements pursued to manage it. Coastal processes are diverse and complex, involving biophysical processes that occur over a range of time frames (and scales) as well as being at the intersection of marine and land based biophysical processes (Harvey and Caton 2003; Cicin-Sain and Belfiore 2005; Stojanovic and Barker 2008). Coastal areas are also subject to multiple threats, including overfishing, infrastructure development, population growth and urbanisation, pollution, mining, tourism, introduction of exotic species, and climate

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change (Beeton et al. 2006; Commissioner for Environmental Sustainability 2008). The uncertainty associated with current understandings of coastal systems and processes and the impacts of human activities in the face of climate change compounds the challenges faced (Tribbia and Moser 2008).

Managing coastal areas is also administratively complex, occurring across multiple jurisdictional boundaries and scales, and involving multiple management authorities. It is further complicated by the diverse viewpoints and values of people, which can result in conflict over current and future uses of the coast (Mercer 1999; Thompson 2007; Stocker and Kennedy 2009; Powell et al. 2009).

Coastal management is therefore concerned with complex processes, uncertain understandings, multiple threats, multiple jurisdictions and scales, and multiple stakeholders and perspectives. This means that considerable attention needs to be devoted towards improving the way in which the diverse challenges and inputs to ICZM are understood, investigated and mediated. Given this, there is considerable merit in the view of Raymond et al. (2010: 1766) that “to manage the scope, complexity and uncertainty of global environmental problems it is important to take account of different types and sources of knowledge.” However, taking account of different types and sources of knowledge is a considerable challenge, theoretically and practically.

The aim of this paper therefore is to develop an analytical framework that is useful for exploring knowledge dynamics in ICZM. We begin by outlining the concept of knowledge systems and discussing its relevance for the study of ICZM. We then consider what four approaches to policy oriented research (stakeholder, institutional, network, and discourse analysis) may contribute to the analysis of coastal knowledge systems, concluding that a mixed methods approach is likely to offer the best prospects. We then propose an analytical framework for exploring the dynamic relationships between the multiple forms of knowledge that inform ICZM, which is based on a generic coastal knowledge system and series of indicative research questions derived from the approaches reviewed. The utility of the analytical framework is then illustrated using a case study of the debates associated with the consideration of marine protected areas (MPAs) in Victoria, Australia. In broad terms, the framework presented provides a structured yet flexible approach to exploring knowledge dynamics that is able to incorporate insights from a variety of analytical approaches. While our focus is on ICZM, the ideas and framework presented may be of relevance to other areas of environmental management as well.

KNOWLEDGE SYSTEMS AND THEIR RELEVANCE TO INTEGRATED COASTAL ZONE MANAGEMENT

There is value in exploring how the concept of knowledge systems may contribute to understanding knowledge relations in ICZM, given the emerging interest it has attracted in a number of areas including: agricultural extension (Roling 1985, 1992); natural resource management (Campbell 2006;

Ojha et al. 2008); sustainable development (Cash et al. 2003); biodiversity management (Kelsey 2003); public health (Van Kerkoff and Szlezak 2006); indigenous knowledge (Verran 1998; Mauro and Hardison 2000; King 2004; Houde 2007); business (Tsoukas and Mylonopolous 2004); innovation (Howells and Roberts 2000); knowledge management in firms (Lee and Van den Steen 2010); and information technology (Stefik 1995). In broad terms, our argument is that the concept of knowledge systems provides a means for re-conceptualising coastal knowledge relations as dynamic and interactive, which improves how ICZM may be understood, by highlighting the ways in which different forms of knowledge inform it. The following discussion considers: 1) how knowledge systems may be conceptualised; 2) the way in which different studies frame the types of knowledge system dynamics to be investigated; and 3) how the relationships between different knowledge systems are addressed.

How knowledge systems may be conceptualised

Authors vary in the emphasis they direct to social actors or ideational aspects of knowledge systems, which has implications for how knowledge systems may be understood and investigated. For example, drawing on Feyerabend (1987), Erickson and Woodley emphasise the ideational aspects of knowledge systems, viewing them as “A body of propositions actually adhered to, whether formal or otherwise, which are routinely used to claim truth” (2005: 89). This emphasis can be seen in studies of traditional ecological knowledge (Kelsey 2003; Houde 2007). By contrast, Van Kerkoff and Szlezak view knowledge systems as “A network of actors connected by social relationships, either formal or informal, who dynamically combine knowing, doing, and learning to bring about specific actions for sustainable development” (2006: 63). This approach places greater emphasis upon the social networks and interrelationship aspects of knowledge systems and offers the prospect that interventions can be made to alter the way in which knowledge systems operate. It has parallels with social learning (Blackmore 2007; Ison et al. 2007; Steyaert and Jiggins 2007) and other conceptual frameworks including adaptive management, organisational learning, and deliberative processes (Ojha et al. 2008).

A similar concern with social networks and inter-organisational relations is evident in Campbell’s (2006) evaluation of Australia’s natural resource management knowledge system. Campbell’s work highlights the fluid boundaries and characteristics of knowledge systems and how such boundaries and characteristics may be influenced by changes in their components: people, institutions, and networks (Campbell 2006). The value of networked oriented approaches is that they highlight the influence of informal processes, the interplay across organisational boundaries, and the possibilities for intervening to improve the way in which knowledge systems may operate for a defined purpose.

The approach of Roling and Jiggins (1998), who view knowledge systems as both relatively stable networks of

actors and a coherent set of cognitions, cosmologies, and practices, provides a suitable starting point for considering how knowledge systems are conceptualised. They conceptualise knowledge systems as 'a mental construct' made up of seven elements, namely: an epistemology; ecology (belief about the way in which people interact with their biophysical environment); a set of practices (for managing agro-ecosystems); ways of learning (about agro-ecosystems); ways of facilitating and supporting such learning; supportive institutional frameworks and actor networks; and conducive policy context. They argue that taken together, these seven elements occur in unique internally coherent combinations, which help to determine a particular type of knowledge system. The value of such an approach is that it has a dual focus rather than giving emphasis to social networks or ideational aspects of knowledge systems.

Different ways that knowledge systems are analysed

In addition to articulating the characteristics of a particular knowledge system, such as an indigenous knowledge system, two other areas of focus in the study of knowledge systems are evident: analysis of contrasting knowledge systems; and analysis of multiple knowledge systems. The work of Roling and Jiggins (1998) illustrates the first type, where they contrast a traditional approach to agricultural extension with a 'soft system' oriented approach, which they label as 'the ecological knowledge system'. In summary, core features of the traditional, and dominant, approach include a linear and sequential approach where knowledge is generated by researchers, which is then transferred to farmers, such that science is seen as the major source of new ideas and technologies (Roling 1992). According to Roling (1992: 3), key weaknesses of this approach are that "it implies that there is a science based fix for all societal problems: a promise that inhibits the search for other survival strategies" and that there are "strong incentives and political dynamics [which] keep it alive." By contrast, for Roling, under a knowledge systems perspective, all participants are involved in knowledge generation, dissemination and uptake.

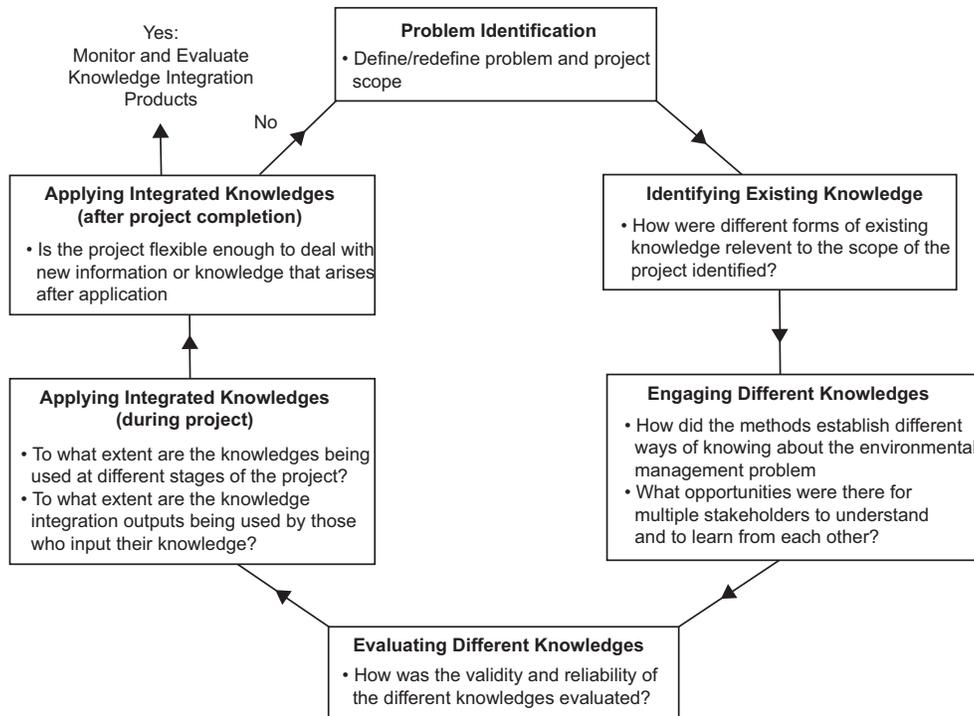
A broadly similar approach is taken by Kelsey (2003) in the area of biodiversity management. Kelsey's terminology for the traditional approach is the science-first model, with this approach assuming a hierarchical relationship in which scientific knowledge is elevated above other knowledge systems. In Kelsey's explanation, the public is expected to respond to environmental problems, initially and accurately described by scientists, with solutions informed by science, negotiated by politicians, and enacted by the public through various means of persuasion and regulation. For Kelsey, the problems with this model are that in privileging "expert information", it "marginalises public knowledge", and "restricts the ability of the public to participate", as well as having the potential to "undermine the public's own belief in the value of their knowledge and participation" (Kelsey 2003: 382). By contrast, in Kelsey's view, there needs to be

"a willingness to adopt decision making processes, timelines and organisational structures that reflect the different values upon which alternative knowledge systems are based" (Kelsey 2003: 384). She also highlights the importance of recognising that "knowledge is not transferred directly from one knower to another, but [instead] is actively built up by the learner" (Kelsey 2003: 389).

The second types of studies focus on the interactions between multiple knowledge systems (Erickson and Woodley 2005; Ojha et al. 2008). Ojha and colleagues (2008: 3) identify "at least four different but overlapping systems of knowledge operating within the natural resource management sector in Nepal", which they consider have consolidated around techno-bureaucratic organisations, development agencies, politicians, and civil society. They argue that "in the processes of political interaction and deliberation over issues of natural resource governance, we see that these four systems of knowledge underpin the constitution of the four categories of social and political agents" (Ojha et al. 2008: 3). Erickson and Woodley (2005) document the challenges and benefits associated with using multiple knowledge systems in the development of the Millennium Ecosystem Assessment (MEA). For them, the benefits of using multiple knowledge systems (such as scientific, indigenous, traditional ecological, local, and practitioner knowledge) are evident in terms of: the benefit that the insights provided from such knowledge systems add to the assessment process; the benefits associated with using participation as a means for empowering local resource users (and the challenges and tradeoffs involved in using such processes); and, the value of using multiple knowledges for improving the relevance, credibility, and legitimacy of the results generated. The value of recognising multiple knowledge systems is that it provides a richer understanding of the complex dynamics associated with the debates encountered in pursuing ICZM. It also provides a means for highlighting how the understandings associated with particular knowledge systems, whether individually or contrasting, play out in debates.

How the relationships between different knowledge systems are addressed

Importantly, while recognising the benefits and challenges of using multiple knowledge systems in environmental assessment, the MEA was less helpful in suggesting practical mechanisms or processes for integrating multiple knowledge systems. By contrast, the work of Raymond et al. (2010) explicitly engages with the challenge of integrating different forms of knowledge. Raymond et al. (2010) discuss the ontological, epistemological, and applied challenges associated with integrating different types of knowledge before outlining a framework to assist with the consideration and subsequent addressing of such challenges, and trialing it in three case studies which used different approaches to integration. In summary, the Raymond et al. (2010) approach involves the asking of seven questions within four themes (see Figure 1).



Source: Raymond et al. 2010: 1771

Figure 1
Questions to be asked when integrating different types of knowledge for environmental management

Based on the insights gained from the application of the framework to the three case studies, they conclude that “there is no single optimum approach for integrating local and scientific knowledge and encourage a shift in science from the development of knowledge integration products to the development of knowledge integration processes” (Raymond et al. 2010: 1775). The work of Raymond et al. (2010) is very useful for a number of reasons: firstly, it highlights the diverse ontological and epistemological perspectives which inform the integration of knowledge in environmental management; secondly, it provides a useful framework for considering the integration of different ‘knowledges’ in environmental management projects; and thirdly, it highlights a useful avenue for future research—the development of knowledge integration processes. Their point that questions of power and equality are key challenges to be addressed in promoting more integrated environmental management is also well made (Raymond et al. 2010). However, their focus on projects and their view of problems as being ‘identifiable’, constrains the focus and types of issues that can be explored. For example, focusing on projects means that broader strategic and structural issues may be overlooked, and viewing problems as ‘identifiable’ overlooks the importance of contests over problem representation that is highlighted in discourse theory (Bacchi 1999). In addition, achieving integration of different knowledge systems is likely to represent a considerable, if not insurmountable, challenge. Given this, while the integration of various knowledge systems may be

desirable, it remains necessary to focus on the interactions between different knowledge systems. Such an approach is consistent with that of Ojha et al. (2008), which highlights the interactions between different knowledge systems, in the way in which natural resource governance practices are mediated, while also emphasising the potential of more deliberative processes. This approach reflects a stronger focus on political mediation and negotiation, rather than any inherent resolution of the differences between specific knowledge systems.

The preceding discussion highlights the need to conceptualise coastal knowledge relations in ways that are dynamic and multi-directional, and which recognise the multiple roles played by different stakeholders. Put simply, in place of a linear and unidirectional transfer of coastal knowledge from researchers to extension officers to clients, coastal knowledge relations need to be reconceptualised, such that they are dynamic exchanges, whereby participants often have multiple roles in relation to knowledge generation, dissemination, and use, and different forms of knowledge are given due recognition. Given this, it is useful to consider coastal management and knowledge relations as encompassing dynamic networks of multiple (intersecting) knowledge sub-systems (each of which reflects a diverse set of values, worldviews, and practices), and which are advocated to varying degrees by different individuals and organisations. Clearly, such an approach is warranted given the challenges of ICZM as discussed above.

APPROACHES TO STUDYING COASTAL KNOWLEDGE SYSTEMS

Having discussed knowledge systems and their relevance to coastal management, this section discusses how such systems might be investigated, focusing on four approaches to policy oriented social research, namely: stakeholder analysis, network analysis, institutional analysis, and discourse analysis. Stakeholder and network analysis were selected on the grounds that they provide a focus on the interplay between stakeholders, while institutional analysis and discourse analysis enable a focus on contextual and structuring processes, within which interpersonal and inter-organisational dynamics may be played out.

Stakeholder analysis and mapping

Given the diversity of stakeholders with an interest in coasts (Rockloff and Lockie 2004; Wescott and Fitzsimons 2010), stakeholder analysis provides a means for exploring their views and contribution to coastal management. For Bryson (2004), stakeholder analysis is becoming more important because (as the world is becoming more connected) all issues or problems encompass or affect numerous people, groups and organisations. Rockloff and Lockie (2004: 83) define stakeholders as “those individuals, groups, organisations and communities involved in or affected by decision made to plan and manage coastal resources.” More tangibly, Billgren and Holmén (2008: 552) consider that the aims of stakeholder analyses are to: identify and categorise stakeholders that may influence and perhaps transform an organisation or system; develop an understanding of why changes occur; establish who can make changes happen; and, discern how to best manage natural resources. Further, since stakeholder analysis allows for the collection of knowledge and information from a wide range of sources, it is a valuable way to identify the conflicting knowledge bases and the values that underlie them (Varvasovszky and Brugha 2000; Rockloff and Lockie 2006). It has also been used to identify, explain, and find ways to overcome conflicts in coastal resource management (Rockloff and Lockie 2004).

While the specific stakeholders of relevance will be influenced by the issue being investigated, useful starting points can be found in the categories provided by Beach et al. (2010) which include: interest groups; universities; unions; industry groups; community and citizens; peak bodies and lobby groups; and government departments. Further, decisions about which stakeholders to involve are complicated by the broad spectrum of actors and groups who may have, or believe they have, a legitimate claim to participate (Beach et al. 2010: 35). Importantly, Rockloff and Lockie (2004) indicate that processes of exclusion are not always consciously deliberate. However, stakeholder analysis can tend to overlook various contextual influences which may shape a stakeholder's perspective.

There is value in using stakeholder analysis in tandem

with other techniques, such as social mapping. For example, Rockloff and Lockie (2004: 84) used social mapping “to show visually the relationships between different stakeholders” and subsequently used these ‘social maps’ with stakeholders to begin to identify “strategies to address areas of social conflict”.

Network analysis

Network analysis is a social research technique for understanding the relationships between people in social systems (Scott 1991; Wasserman and Faust 1994), with there being a range of approaches to defining and investigating networks (Selman 2000). Reflecting its diversity, the level of quantification of network relationships varies considerably in different approaches to network analysis. For example, Baggio et al. (2010) review quantitative approaches to network analysis in tourism, while Mikkelsen (2006) emphasises the value of simple approaches as a means for voluntary organisations to improve their understanding of the opportunities and constraints they face.

In simple terms, the analysis of social networks seeks to unearth structural patterns that exist among stakeholders, in order to examine the relations between them, how they are positioned, and how relations are structured into overall network patterns (Prell et al. 2009). These relationships can be analysed in terms of the way that individuals, groups, and organisations utilise these networks either to transmit, receive, or generate knowledge. More formally, the characteristics of networks are often discussed in terms of network density (the number and intensity of connections); network cohesion (the number of separate network components); network centralisation (the closeness of ties between core actors); and connectivity (to other networks) (Kratke 2010). Practically, such concepts are useful for exploring issues such as the structure of networks and relative influence of various individuals (Lewis 2009), and potentially, the way in which knowledge is exchanged and translated. Network analysis also offers the opportunity to explore the way in which knowledge may be exchanged informally (Kratke 2010).

Importantly, Lewis (2009) acknowledges that influence may be determined by the position held, or by the reputation of the actor, while Schenkel (2002) highlights the potential for network management, which offers the potential for designing interventions to alter the way in which the networks that make up the coastal knowledge system operate. However, Hajer's (1995) concept of discourse coalitions highlights a limitation of network analysis, as policy actors can embrace the same discourse despite never having met. Notwithstanding this limitation, analysing networks provides opportunities for exploring the structure, operation, and evolution of social networks, and the ways in which they may operate to include or exclude different forms of knowledge.

Institutional analysis

Institutional analysis is predicated upon the idea that

institutions matter, in the sense that institutions such as family, church, government, and legal systems can be relatively stable over time, and exert an influence over the ways interests may be structured and the processes by which issues may be responded to (March and Olsen 1983, 1996; Rhodes 1995; Ostrom 1999; Lowndes 2002; Young 2002). Further, in contrast to economically and behaviourally inspired approaches to policy analysis, institutional analysis is informed by views that “institutions are more than simple mirrors of social forces” and that “institutions affect the distribution of resources, which in turn affects the power of political actors, and thereby affects political institutions” (March and Olsen 1983: 739). Under such a perspective “interests and cleavages are seen as created by institutional arrangements and maintained by institutional processes of socialisation and co-optation” such that “institutions shape the definition of alternatives and influence the perception and construction of reality within which action takes place” (March and Olsen 1996: 142). What this means is that institutionalised rules, duties, rights, and roles define acts as appropriate (normal, natural, right, good) or inappropriate (uncharacteristic, unnatural, wrong, bad) (March and Olsen 1996).

Institutional analysis therefore, provides a useful means for considering the way in which interests are characterised, and institutions and formal decision making processes structure the way in which science and other forms of knowledge may inform ICZM. For example, it can be used to explore questions such as how do existing institutional and organisational arrangements and decision making processes enhance or inhibit the consideration of science and other forms of knowledge in ICZM? And, how might institutional and organisational reform influence ICZM decision making and what kinds of knowledge are used? It can also be useful for identifying veto points, where reforms can be blocked or enabled (Wimmer et al. 2002). More practically, it can also be used to explore how key organisations and processes operate, or should operate: for example, does the charter of particular coastal management organisations effectively serve to exclude particular forms of knowledge. A practical limitation of focusing on organisational arrangements, however, is that there is potential for too much emphasis to be directed towards the ‘formal’ arrangements, relative to more informal processes and networks. This point is well made by Van Kerkoff and Szlezak (2006) in relation to the limitations of the Global Fund to Fight Aids, Tuberculosis and Malaria.

Discourse analysis

The way in which we think, write, and talk about coasts has important implications for the way in which they are understood and subsequently governed. While language may be thought of as mere semantics, discourse theory draws attention to the way that language constructs and organises social reality, rather than merely reflecting it (Fairclough 1992; Hajer 1995; Mill 1997; Howarth 2000). The importance of this is illustrated in the view that:

It makes no sense to consider the ‘objects’ or targets of policy as existing independently of the way in which they are spoken about or represented either in political debate or policy proposals. Any description of an issue or a ‘problem’ is an interpretation, and interpretations involve judgment and choices (Bacchi 1999: 1).

This does not mean that words are the only things that matter. Instead, language is the way in which humans make sense of the world, as illustrated in the view that while real problems exist, our interaction with them can only ever be through culturally constructed lens—meaning that we can never know nature except through the interpretive mechanism of culture, which means that all perspectives are partial and contestable (Dryzek 1997).

More conceptually, discourse is concerned with power/knowledge relations, such that a discourse can be thought of as a form of social knowledge (Foucault 1980). In relation to coasts, discourse analysis could highlight the configurations of meaning and power associated with terms like ‘the coast’ and ‘coastal management’, such that it would be possible to explore what forms of knowledge function as dominant, or legitimate, understandings. Importantly, discourses do not float in the ether, but can be advocated and resisted to varying degrees by different actors. For Hajer (1995: 65), discourses get their social power through discourse coalitions, defined as “the ensemble of: a set of storylines; the actors who utter these storylines; and, the practices in which this discursive activity is based.” The importance of discourse here is the inter-relationship between ideas, values, and practices. Importantly, discourse coalitions differ from traditional political coalitions or alliances, in that it is the embrace of a shared discourse that unites members of a discourse coalition, rather than any direct interpersonal contact or communication between them. Analysing texts (written, spoken, visual) and practices therefore provides a means for examining knowledge relations, dealing with issues such as the representation of reality, relationships, and identities in relation to the coast, and how the diffusion and uptake of concepts and practices occurs. Ebbin’s (2011) analysis of the way in which the issue of salmon management was contested illustrates how discourse analysis can inform coastal research, as does the problem structuring approach of Turnhout et al. (2008).

From the preceding discussion, it is clear that each of the four approaches considered provides useful insights into particular aspects of coastal knowledge dynamics, even though none provides a comprehensive understanding. Given this, there is merit in seeking to collectively harness the analytical strengths of the various approaches.

ANALYSING COASTAL KNOWLEDGE SYSTEMS

Drawing on the preceding discussion of the potential insights from different analytical approaches, this section proposes an analytical framework based on a generic coastal knowledge system, and series of associated research questions, which can

be used to orientate investigations into different issues and at different scales (site, project, programme policy, strategic direction). This analytical framework is then illustrated through brief discussion of the knowledge dynamics associated with the consideration of the establishment of a system of marine protected areas (MPAs) in Victoria, Australia.

Analytical framework

Drawing on the different forms of knowledge identified by Tovey and Mooney (2006) and the multiple knowledge systems identified by Ojha et al. (2008), we represent the coastal knowledge system as a dynamic intersecting network of multiple separate knowledge systems, each of which represents diverse values and world views, and which are advocated to varying degrees by different organisations and individuals. In this process, there are some key features that need to be noted: an area of focus (ICZM); various forms of knowledge which are advocated to greater or lesser degrees by different stakeholders (scientific, managerial, indigenous, and lay/local knowledge); the interactions between these forms of knowledge by stakeholders operating through formal and informal processes; and, barriers or filters which mediate the influence of various forms of knowledge on ICZM.

In terms of the *area of focus*, any number of specific ICZM issues could be considered, such as flooding (McFadden et al. 2009), sea level rise (Abel et al. 2011), estuary management (Hoare 2002), fisheries (Hill et al. 2010; Ebbin 2011), and marine conservation and protected area planning (Gray and Campbell 2008; Osmond et al. 2010; Ritchie and Ellis 2010). Obviously, the types of knowledge which inform the consideration of different cases will vary by location and time.

While recognising that there are many *different forms of knowledge*, and that the forms of knowledge relevant to a particular situation can be differentiated, the knowledge forms encountered will be influenced by the research questions asked and the specific circumstances. We suggest that it is useful to consider four separate forms of knowledge (scientific, managerial, lay, and indigenous) as a starting point, because it serves to highlight some of the diverse forms of knowledge likely to be present in ICZM issues. Since scientific knowledge is understood as coherent theoretical constructions that have a concern to formulate universalistic understandings within a disciplinary framework, it is treated as expert, where "expert knowledge is primarily derived from verifiable investigations and experiments based on peer accepted methodologies" (Harding et al. 2009: 142). According to Tovey and Mooney (2006), managerial knowledge can also be treated as a form of 'expert' knowledge that can be framed both by past experience in management practice as well as by formal managerial education. Managerial knowledge is often placed between the adoption of 'expert' advice and the necessity to translate the results into an instrumental form for political and community consumption. Lay knowledge is often grounded in an array of components that include empirical perceptions of practical experience and tacit understanding of "how things work"

(Tovey and Mooney 2006: 97). What separates indigenous knowledge out as a separate category is the way that moral and ethical considerations combine nature and culture into one process, unlike western scientific and managerial approaches that make it a sharp division (Berkes 1999; Pierotti and Wildcat 2000).

While we also recognise that different forms of knowledge are often given effect by particular stakeholders, we present the forms of knowledge rather than specify possible stakeholders, in order to avoid preconceptions about what types of actors will embrace what forms of knowledge. It may be the case that at any one time, different stakeholders may in fact use a collation of knowledge forms. For example, stakeholders may draw on a mix of expert and lay knowledge in advocating their interests.

The third element of our generic coastal knowledge system is the *interactions and relationships between the various forms of knowledge and associated stakeholders* who embrace them in responding to particular coastal management issues. In presenting these relationships, our intention is to highlight that such interactions occur in relation to ICZM as well as other broader issues.

Our generic coastal knowledge system also includes *barriers and/or filters* which serve to enable or constrain the contribution of particular forms of knowledge to ICZM. In considering barriers and filters, it is important to consider the potentially pervasive ways in which some forms of knowledge are privileged and others marginalised. For example, western legal systems define property rights in ways that may not recognise the mechanisms used to govern access to, and use of, resources in indigenous knowledge systems (King 2004). Further, it is also important to consider questions of the legitimacy of different forms of knowledge (Erickson and Woodley 2005). Finally, having considered barriers, it is also useful to consider nodes and other means for improving, or enabling, the uptake of different forms of knowledge in ICZM. Such *enablers* may involve removing, or reducing the effects of barriers and filters, or enhancing the capacities of particular forms of knowledge, or strengthening the interrelationships between different forms of knowledge in ICZM.

The analytical value of this approach will be enhanced by considering some specific mechanisms about the dynamics involved in particular aspects of coastal management. To that end, drawing on the strengths and weaknesses of the analytical approaches discussed above, we propose a series of initial research questions which can be used to guide research into the knowledge dynamics associated with particular aspects of coastal management:

1. What is the issue of interest, and how is it represented?
2. Who are the stakeholders with an interest in the issue?
3. What administrative processes and institutions do these stakeholders work through?
4. In doing so, what forms of knowledge are drawn on, in what ways, and for what purposes?
5. How have, might, and should these forms of knowledge influence(ed) ICZM?
6. What barriers, filters, constraints, and enablers influence

the in/exclusion of different forms of knowledge, and with what effect?

7. How might these be addressed or encouraged?

The first question is concerned with providing a focus for the research and identifying whether or not there are widely divergent views as to the nature of the problem, or whether the issue is actually viewed as a concern by relevant stakeholders. The second question focuses on identifying those with an interest in the issue and exploring the nature of their views. Institutional analysis and social network analysis may be useful for gaining insights into the processes and institutional frameworks that stakeholders work through in relation to particular coastal management issues (question 3). This highlights the position and relative influence of different stakeholders, and whether or not institutional arrangements enhance or hinder the expression of different perspectives. Various frameworks for the identification of barriers and filters have been developed in various aspects of environmental management (Painuly 2001; Weichselgartner and Kasperson 2010), as well as coastal management (Powell et al. 2009), and these may be used to guide investigations in questions 4 and 5. Insights into questions 6 and 7 are expected to emerge from the investigation of the preceding questions, although it is acknowledged that the merit of such insights is likely to be contested, given the diverse interests at stake. Insights into the potential solutions available is also likely to be found within the extensive literature on ICZM that is emerging, including, but not limited to: continual engagement models (Reid et al. 2009); boundary objects (Lejano and Ingram 2009); collaborative knowledge production (Weichselgartner and Kasperson 2010); sustainability science (Cummins and McKenna 2010); and, knowledge brokering (Michaels 2009), to name but a few possibilities.

Importantly, we consider that there is considerable merit in approaching the questions posed in an iterative manner, and that there is considerable merit in making use of participatory and consultative approaches to undertaking research. We also consider that there is merit in approaching research in ways that are informed by the post-normal science criteria of: 1) explicitly addressing uncertainty and risk; 2) recognising that values underpin science; and 3) being participatory (Funtowicz and Ravetz 1993), and the guiding principles of sustainability science, which aim to: 1) resolve sustainable development issues by a problem-driven agenda; 2) co-produce knowledge in collaboration with stakeholder groups; 3) implement an interdisciplinary approach; 4) address earth system complexity; 5) focus communication and research activities at the local level; and, 6) provide a process of social learning rather than providing definitive answers (Cummins and McKenna 2010).

Knowledge dynamics in marine protected area processes in Victoria, Australia

What is the integrated coastal zone management issue of interest, and how is it represented?

The establishment of MPAs is an area of ICZM that attracts

considerable debate (Gray 2010; Osmond et al. 2010), no more so than in the Australian state of Victoria, where there has been a prolonged period of public debate and formal investigation into the merits or otherwise of establishing and maintaining a Comprehensive, Adequate and Representative (CAR) system of marine reserves, including highly protected 'no take' Marine National Parks, marine sanctuaries, and other reserves (Clode 2006; Wescott 2006). As part of these debates, concerted efforts were made to present the marine environment and MPAs in ways that were familiar to people, including in the naming of marine environments using terms such as 'forests', 'gardens', and 'meadows' (Wescott 2006: 914). Central elements in these ongoing debates are how marine and coastal areas should be managed, the role of MPAs, the nature of MPAs ('no take' versus 'multiple use'), and the boundaries of any protected areas established. In working through these issues, effective consideration of governance issues, planning processes and public input, and scientific input can be considered central to success (Osmond et al. 2010).

Who are the stakeholders with an interest in the issue?

Similar to other areas of ICZM and marine conservation planning (Wescott and Fitzsimons 2010), the consideration of MPAs in Victoria attracted significant and sustained input from a diverse and changing range of stakeholders. Key stakeholders involved included: conservation groups (national, state, and local groups); fishing organisations (commercial and recreational); other interest groups (tourism operators and diving groups); political parties; and public servants (Wescott 2006). While conservation organisations actively campaigned for the establishment of a CAR system of MPAs, commercial and recreational fishing organisations strongly opposed MPAs (particularly 'no take' MPAs as opposed to 'multiple use' MPAs), and tourism operators and dive groups tended to be neutral, although over time became "mild supporters of the CAR system" (Wescott 2006: 911). Further, major political parties actively debated the merits of MPAs, with the two major political parties both eventually coming to support the concept of 'no take', while a third, smaller, rural focused, political party continued to maintain its opposition. Finally, Wescott (2006) considered that senior public servants in particular Divisions of the state government environment department were "influential in maintaining the momentum behind the debates", while the establishment, and subsequent activities, of an 'independent' statutory coastal advisory body, the Victoria Coastal Council, was viewed as "lending strong credibility" to the establishment of a CAR system of MPAs (Wescott 2006: 911).

What administrative processes and institutions do these stakeholders work through?

The principle arenas in which MPAs were debated included Victoria's Environment Conservation Council (ECC) process and Victorian Parliamentary processes, as well as the media. The ECC is an independent statutory body responsible for undertaking strategic environmental assessments on public land, which (in one form or another) has been in place

for over 40 years (Coffey et al. 2010). Between 1991 and 2000, the ECC and its predecessor organisation conducted a Marine, Coastal and Estuarine Inquiry (ECC 2000). ECC investigation processes involve five main steps: 1) initiation of investigations; 2) preparation of descriptive reports; 3) preparation of draft options; 4) preparation of final recommendations; and 5) preparation of a government response (with steps 1 and 5 undertaken by the government and not the Council) (Coffey et al. 2011: 309). In the Marine, Coastal and Estuarine Investigation, there were six formal periods for public comment, ongoing consultation with a wide range of stakeholders, and technical support provided by an advisory group. In addition, social and economic assessments were commissioned, and a separate process established to facilitate and coordinate the input of aboriginal people (ECC 2000: xii). An indication of the controversy surrounding the investigation is evident from the fact that 2,500 written submissions were received following the release of draft recommendations (ECC 2000).

Following the release of its final report, the focus of attention shifted to the Victorian Parliamentary processes. Initial legislation to establish a series of MPAs was withdrawn from parliament by the minority government, in the face of considerable opposition, and almost certain failure for the bill. Following further negotiations and the development of “a substantial compensation package for people adversely affected” by the proposed MPA (Wescott 2006: 910), legislation was re-introduced a year later, and subsequently passed with the support of the minority Government, major opposition party, and independent members of parliament (Wescott 2006).

In doing so, what forms of knowledge are drawn on, in what ways, and for what purposes?

Throughout this process, many and varied forms of knowledge were drawn upon. Firstly, available technical information on Victoria's marine, coastal, and estuarine environments was assembled in various background reports. Secondly, socio-economic information on the values derived from making use of Victoria's marine, coastal, and estuarine environments was collated from a range of sources, including the fishing industry, and the socio-economic impacts of recommendations considered. More informal forms of knowledge (lay and indigenous) were also considered through the widespread consultation processes deployed (including public meetings where ECC members met with members of the community), and the commissioning of a separate consultation process “to facilitate and coordinate the input of aboriginal people” (ECC 2000: xii). In summary, extensive opportunities for written and verbal input were made available, which provided for the consideration of various forms of knowledge—scientific, managerial, lay, and indigenous. However, it is not apparent whether experiential processes (e.g., site visits) were used to gain insights into the views of different stakeholders.

How have, might, and should these forms of knowledge influence(ed) integrated coastal zone management?

In terms of the relative influence of the various types of knowledge, and how they were considered in decision making, the following points are apparent. While the underlying foundation for the ECC is rational and managerial and centred on the compilation of technical information on the biophysical environment, it also had clear requirements for consideration of economic, social, and environmental objectives. These requirements provided the justification for considering information about: ecosystems; human uses of marine, coastal, and estuarine environments; the impacts of these activities: and, the associated social and economic values, effects, and implications. The legislative requirements for public consultation also provided the means for at least some consideration of lay and indigenous forms of knowledge. However, it is unclear how the various forms of knowledge were considered in decision making—for example, it is not clear how the relative numbers of submissions for and against the establishment of MPAs were weighed up against each other, and the technical information assembled. Further, indigenous perspectives appeared to have relatively limited influence in shaping the recommendations (subsequent investigations have given greater attention to consulting with indigenous stakeholders which culminated in joint-management arrangements for particular areas) (VEAC 2008).

What barriers, filters, constraints, and enablers influence the inclusion/exclusion of different forms of knowledge and with what effect?

In terms of the constraints on use of different forms of knowledge, the most significant factor was the competing viewpoints embraced by different stakeholders, who embraced markedly different visions of the value of marine, coastal, and estuarine environments and how they should be used and managed. This meant that ‘facts’ were interpreted through different frames (Rein and Schon 1993). More practically, other barriers and filters included: scientific uncertainties associated with understanding of the marine environment; lack of public awareness about the marine environment; the difficulties associated with interpreting information produced at different scales (for example, how to assess the impact of park boundaries on fishing incomes); and the lack of transparency in terms of how different forms of knowledge were considered. There is little explanation by the ECC of their approach on these matters.

How might these be addressed or encouraged?

Earlier consideration of structural adjustment and compensation packages, or at least a process for dealing with such concerns, may also have been useful, as a means for giving greater acknowledgement of those whose livelihoods may have been affected (Macintosh et al. 2010), as this was an area of considerable controversy until “decision makers were able to define the MPA boundaries to minimise impacts on financially important fisheries” (Wescott 2006: 913). By contrast, the presence of the ECC as an independent,

transparent, structured, and respected process (Coffey et al. 2011) enabled the many controversies associated with the sustainable management of the marine, coastal, and estuarine environment in Victoria to be thoroughly worked through, even if they were not necessarily conclusively resolved. Finally, there would be merit in greater consideration having been given to the difficult task of articulating and explaining the way in which diverse forms of knowledge were considered in decision making (Erickson and Woodley 2005; Raymond et al. 2010).

CONCLUSION

This paper contributes to an enhanced understanding of the knowledge dynamics associated with ICZM. It has considered the potential of the concept of knowledge systems and proposed an associated analytical framework for improving understandings of the ways in which different forms of knowledge may or may not inform coastal management. Such understandings are important, and necessary, because of the nature of ICZM, with its inherent complexities, uncertainties, and conflicts. It is also important for characterising coastal knowledge relations as dynamic and multi-directional rather than being linear.

In the section “Knowledge systems and their relevance to integrated coastal zone management”, we identified how the literature on knowledge systems varied and how it could be understood. Firstly, while some authors emphasised the network aspects of the concept, others emphasised the ideational aspects. Secondly, some authors were concerned to identify the characteristics of particular forms of knowledge (such as indigenous knowledge systems), whereas others contrasted knowledge systems or emphasised the presence of multiple knowledge systems. Further, whereas some authors sought to integrate different ‘knowledges’, others focused on the dynamic interplay between different forms of knowledge. This highlights the point that consideration of coastal management encompasses dynamic networks of multiple knowledge sub-systems that are advocated to varying degrees by different individuals and organisations. Consequently, the analytical value of the concept of ‘knowledge systems’ is integral to an enhanced understanding of ICZM.

However, we consider that there is a need to develop a more integrated approach and in the section “Approaches to studying coastal knowledge systems”, we considered how such knowledge systems may be investigated empirically. We reviewed four approaches to policy oriented research (stakeholder, network, institutional, and discourse analysis) some of which (stakeholder and network analysis) have been used to study various aspects of knowledge dynamics. Based on this review, we consider that each of the four approaches was useful for illustrating different aspects of the issues at stake, without any being completely adequate on its own. For this reason, we proposed a mixed methods approach that allows the researcher to draw on the strengths of different methods to provide a richer understanding of ICZM. Furthermore, we

believe that discourse analysis is a particularly useful addition to the analytical toolkit, because it significantly enhances the way in which knowledge systems can be understood, particularly in relation to problem framing and the implications that flow from this. To date, it would appear that discourse analysis has attracted relatively limited attention within the knowledge systems literature.

Based upon this mixed methods approach, we developed an analytical framework comprising a generic model of coastal knowledge systems that included a series of orienting research questions used for teasing out the interrelationships between various forms of knowledge. In proposing such a framework, we recognise that like all models, it is prudent to always take note of the dynamism that exists between different aspects contained therein. A useful feature of the analytical framework outlined is that it provides a relatively structured yet flexible means for making use of a variety of methods, as well as organising the vast amounts of empirical data into one coherent framework.

To illustrate our analytical framework, we used the debates surrounding the consideration and subsequent establishment of a system of MPAs in Victoria, Australia. In so doing, we were able to highlight the processes deployed in Victoria as a means for articulating, considering, and to some extent mediating, various knowledge claims. More conceptually, the analytical framework used provided a structured yet flexible means for arranging and considering the way in which the diverse forms of knowledge concerning MPAs were debated in Victoria. Such an analytical framework offers richer insights into the processes of coastal knowledge dynamics than could be obtained using a single method.

In conclusion, this article has clarified understandings of the concept of knowledge systems, highlighted its value for the study of coastal knowledge dynamics, and considered how such systems could be investigated. It has also provided a structured yet flexible analytical framework for undertaking empirically focused research that explores the ways in which diverse forms of knowledge intersect within the challenging and contested domain that is ICZM.

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