Australian Universities, Government Research and the Application of Climate Change Knowledge in Australian Coastal Zone Management

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a. Introduction

This chapter reports on a recent Australian research initiative to improve the national and local policy application of climate change and sustainability science, through three types of research engagement. First, we analyse the opportunities presented to both Universities and to the Commonwealth Scientific and Industrial Research Organisation (CSIRO) by their 'Flagship' program, featuring a partnership approach to research. Second, we focus on the existing and potential interactions and linkages between social and natural science and explore the benefits of interdisciplinary encounters between the two epistemic communities. Third, we critically examine the engagement of the research community with policy makers and other stakeholders.. We present the conceptual framework for an innovative CSIRO Flagship project which partners the CSIRO with seven universities across Australia. On its completion, project will produce a fully developed model for improved engagement of climate change research with current Australian coastal planning and policy initiatives and affected communities. The key organising concepts of the CSIRO project are trans- and inter-disciplinarity, reflexive governance, post-normal science, social networks and adaptive learning.

b. Flagship program

Australia's national science agency is the Commonwealth Scientific and Industrial Research Organisation (CSIRO). In 2003 the National Research Flagships program was launched as part of the Commonwealth Government's allocation to CSIRO. The

Collaboration Fund provides $97 million over seven years to the National Research Flagships.[1]

Flagships are designed to respond to national priorities such as energy transformation, water supplies, food, health, minerals, metals and manufacturing. Relevant to the project discussed here are the Wealth from Oceans Flagship and the Climate Change Adaptation Flagship. Flagships are large-scale, multi-disciplinary and collaborative in nature, linking CSIRO to industry, NGOs, government and universities. The total investment of partners to 2010-2011 will be approximately A$1.5 billion, a very substantial research enterprise for Australia. The Flagship program has brought benefits to universities in terms of opportunities for funding and research partnerships. It could be argued that the program has meant a 'leakage' of funds out of CSIRO to its research partners; however, research partners are required to provide in-kind funding at a ratio of approximately 70 (Partner):30(CSIRO collaboration fund), so in this way intellectual resources also flow back to CSIRO. The Flagships meet their research goals by funding 'Clusters' which are large-scale research activities, with an emphasis on people and partnerships, and which are collaborations between CSIRO, industry, universities and other publicly funded research agencies.[2]

There are now 11 clusters established from the first three rounds of funding proposals and nine more are being established from the 2008 funding round. The three clusters relevant to climate change adaptation were all funded in the 2008 round. The Clusters relevant to climate change include two from the Climate Change Adaptation Flagship: Human health and climate change adaptation (led by Professor Anthony Capon, ANU), and Regional adaptation to climate change - a case study in SE Queensland (led by Professor Jan McDonald, Griffith University). A third Cluster working on Climate change adaptation is in the Wealth from Oceans Flagship. Its long title is "Clearing the path for science uptake: identifying and overcoming the social and institutional barriers to effective and integrated management of Australia's coastal zone in the face of future change". This is the Cluster whose work is described in the current chapter. "Future change" clearly includes climate change although there is growing evidence that climate change is already having an impact on social-ecological systems. The Cluster is led by Professor David Wood, Curtin University of Technology and includes seven universities across Australia.

The majority of CSIRO Clusters are focused on the natural and physical sciences although there is increasing recognition in the broader scientific community that trans-disciplinary and inter-disciplinary knowledge, specifically including social sciences and humanities' disciplines, is fundamental to finding pathways through

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[1] http://www.csiro.au/partnerships/Flagship-Partnering.html

[2] http://www.csiro.au/org/Flagship-Cluster-Applications.html

complex, real-world issues like climate change and coastal adaptation. As was argued in the recent Copenhagen Climate Change Synthesis Report,

> The research required to inform and support a major societal transformation lies primarily in the domains of the humanities and social sciences, which have been much less prominent in the climate change discourse than natural sciences and economics. Nevertheless, their insights into human cultures, behaviours and organisation are crucial to meeting the climate change challenge (Richardson et al., 2009).

The Cluster described in this chapter is social-science based and includes a range of disciplines. The question remains, how can this cross-discipline research be achieved in relation to coastal adaptation to climate change?

c. Benefits of interdisciplinarity and transdisciplinarity

This section explores the existing and potential interactions and linkages between social and natural science and explores the benefits of interdisciplinary encounters between the two epistemic communities. Central to improving the human understanding of the problems posed by climate change is the need for greater cooperation across disciplinary boundaries, particularly between the human and natural sciences. Such cooperation is necessary for several reasons. The problem of climate change and its impact on coastal development is a human-induced problem with an environmental dimension. The development of policies to bring about a more sustainable relationship between human activity, climate and coastal development requires a re-thinking of humans' relationship to the natural world. To bring about a change in that relationship, it is important to shift away from the traditional ontological dichotomy which sees human 'nature' as a different order of being from non-human nature. It is this dichotomous thinking, and its institutionalization into a hierarchy of sciences dominated by certain disciplines, that underpinned much policy-making in the 20th century.

During the 19th and early 20th centuries intellectuals and academics divided the world into three spheres of life organized around the concepts of society, economy and nature. These three spheres became scientifically and professionally differentiated as separate ontological spaces or basic categories of being, leading to the growth of specific disciplines with their own specific subject matters, epistemologies and epistemic communities. As a result, the technical expert, particularly in natural sciences and, latterly, economics, was elevated to a position of considerable intellectual and decision-making power in public policy. Such a view led people to believe it the task of specific sciences in alliance with government to define the problem to be solved, develop the instruments necessary to bring about a solution to the problem, and to evaluate the success or otherwise of the approach taken. The general public was accorded the role of grateful beneficiary of expert advice and expected to accept whatever policy and planning decisions were made

on its behalf. In its more radical forms, this 'rule of the expert' was based on the idea that the only true knowledge was scientific knowledge. All else was superstition, pre-scientific, and non-rational.

In recent years there have been moves away, at least in western liberal democracies and some other parts of the world, from a largely authoritarian model of science with its 'top-down' approach to policy-making and planning to one in which science is considered as one component or node in a network of relations, which include policy makers, managers, NGOs, members of the public and others. In the world of science itself, a key development has been the blurring of the traditional disciplinary boundaries and the search for new ways for scientists of different intellectual and disciplinary backgrounds to work together on academic and policy-related issues and questions. Within the social sciences this development can be seen in the emergence of new hybrid conceptual frameworks such as ecological economics, environmental anthropology, economic sociology, and political ecology. The natural sciences have seen the growth of sustainability science with its focus on the interaction between human and natural systems[3]. A related development is that of the Earth System Governance Project defined as:

> …the interrelated and increasingly integrated system of formal and informal rules, rule-making systems, and actor-networks at all levels of human society (from local to global) that are set up to steer societies towards preventing, mitigating, and adapting to global and local environmental change and, in particular, earth system transformation, within the normative context of sustainable development (Biermann et al., 2009: 4).

These initiatives, including the one described here, seek to bring together a diverse range of researchers and policy makers to develop a field of inquiry '…defined by the problems it addresses rather than by the disciplines it employs' (Clarke, 2007: 1737).

Cooperation across disciplinary boundaries can take many forms ranging from multi-disciplinary to trans-disciplinary approaches (Eigenbrode et al., 2007). Whatever form taken, the underlying reason for such cooperation is to draw on the creativity of intellectual diverse approaches in understanding and offering solutions to the problems posed by climate change, environmental degradation and the creation of sustainable livelihoods.

d. Engagement of science with policy: adaptive learning in Australia's coastal zone

Australia's coastal zone includes a complex interaction of biophysical and socio-cultural dimensions. Humans have inhabited the coast for tens of thousands of years

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[3] See the new journal 'Sustainability Science' published under the auspices of the Proceedings of the National Academy of Sciences of the United States of America.
http://www.pnas.org/site/misc/sustainability.shtml

and have affected, and been affected by, its ecology. Many coastal Indigenous peoples dwelt as clans whose livelihoods had several common features. They used marine resources for subsistence, ritual activities and exchange; they viewed saltwater or sea country as inseparable from the land; this connection found expression in stories describing features of sea country, names and sacred sites; and clan identities were closely related to the sea. Clans managed their estates through cultural ceremonies such as song and dance, and traditionally restricted access to the sea according to season, status of clan member, totem and presence of sacred sites (Smyth, 1997).

Since European colonization, human uses of and impacts on the coastal zone have increased. Pressures arise from rapid coastal population growth and development; catchment land and water use; marine industries (shipping, tourism, aquaculture, oil and gas extraction, tourism and fishing); pollution; exotic species; coastal infrastructure development; and climate change and extreme weather events[4]. The coastal zone is now characterised by multiple jurisdictions, differing views on what constitutes appropriate coastal zone management; lack of integrated management tools and continuing controversy on major developments (Kellert, 2003; Stocker & Kennedy, 2009).

It is the aim of our new Cluster to contribute to an academic and policy integration of the understandings and activities of the wide range of coastal users and to develop conceptual and adaptive approaches that will link improved science to the models of governance , which contribute to a more resilient and sustainable coastal zone. Below, we describe the conceptual framework for the Cluster. The key research questions are:

- What are the key social and institutional obstacles to adaptive management in the coastal zone?
- How do these obstacles inhibit the incorporation of science into the governance process?
- How can obstacles to better environmental and social governance be reduced?
- What approaches can be taken to enhance science uptake in coastal zone management in the face of these particular challenges?
- To what extent have such improvements occurred in existing Flagship projects?

The key Cluster outcomes will be:

- enhanced pathways for on-going science implementation in the coastal zone
- the use of coastal science to enhance uptake of adaptation options to generate economic, social and environmental wellbeing for Australia.
- systemic improvements to the management of the coastal zone in Australia.

The Cluster is composed of five themes studied across seven universities (Curtin, Adelaide, Deakin, Flinders, Sunshine Coast, Tasmania and Wollongong). This is the largest number of universities in any such collaboration in Australia. The themes

[4] http://www.csiro.au/science/ManagingCoastalWaters.html

are: governance, socio-cultural context, knowledge systems, and adaptive learning. The various themes are brought together by a keystone Theme whose role is integration, analysis and synthesis. The universities will interact on a regular basis with the relevant CSIRO scientists and their research programs to ensure a two-way exchange of ideas and findings.

Cluster Themes

A schematic diagram, showing the key Cluster Themes, their relationships and key research questions, is given below (Figure 1). It depicts the biophysical context as an external envelope; changes in this context are a driver for this project but we do not research them directly. Within this is the socio-cultural context, which in turn contains the spheres of governance and knowledge systems in dialogue via the process of adaptive learning. In fact, all aspects of the system are mutually constitutive. Core concepts are detailed below.

Biophysical context

The coastal zone of mainland Australia is over 36 000 km long and includes tropical and temperate climates, ancient and recent geological formations, and a variety of onshore and offshore currents. These physical factors interact to support high levels of biological diversity among and within the terrestrial, estuarine, and marine systems that characterise our coastal zone, including dunal systems, coastal heathlands and forests, sandy shores, rocky shores, coastal wetlands, mangroves, coral reefs, temperate reefs, sea-grass meadows, sponge gardens and island systems. Many of these habitats include endangered and vulnerable species.

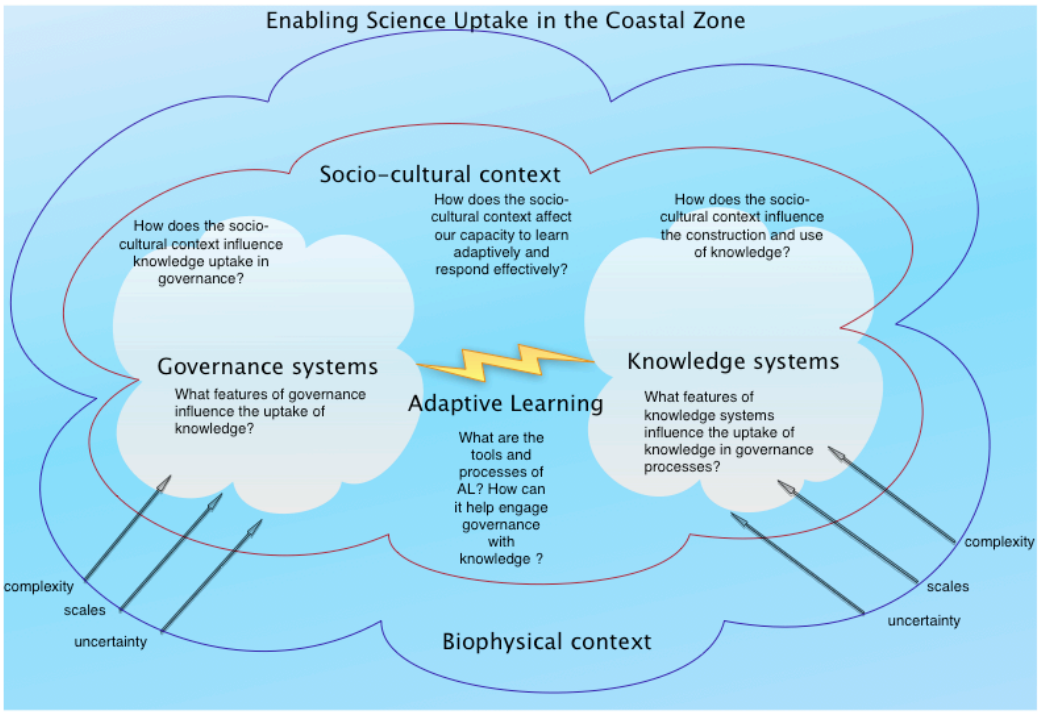

Figure 1: Enabling science uptake in Australia's coastal zone: The Cluster Themes and their broad research questions.

Socio-cultural context

The socio-cultural context of the coastal zone is comprised of networks and communities of actors who operate within and among formal structures and informal systems, and whose worldviews and values differ widely. The socio-cultural context is the formative milieu in which human activity is generated and mediated. It interacts continually with the biophysical context within which human activity is embedded, creating a socio-ecological system. In relation to coastal adaptation, this interaction is characterised by multiple scales, complexity and uncertainty.

The socio-cultural context of the coastal zone strongly influences its adaptive management. Specifically, the socio-cultural context influences: the politics and practice of knowledge generation, dissemination and use; the process of governance; and actors' ability to learn and respond adaptively. The Socio-cultural Context Theme thus provides an envelope in which the other Cluster Themes are located conceptually and are mutually constitutive (See Fig 1). All Cluster Themes and the underlying conceptual elements are mutually constitutive.

The Socio-cultural Context Theme (2) of the Cluster specifically investigates the informal and formal relations among community, industry, universities and government in relation to knowledge formation, its use in decision-making, and the identification of obstacles to and opportunities for to adaptive coastal management.

Non-technical barriers to effective coastal zone management can arise from structural or systemic features of the socio-cultural context, including formal institutional and governance arrangements (see Theme 1). Non-technical barriers to coastal adaptation can also arise from informal aspects of social function including those driven by culture, psychology, politics, and those arising from social processes such as short-term decision-making and vested interests. In Theme 2, these aspects are researched in terms of the influence on decision-making in the coastal zone of divergent socio-cultural perspectives; the understandings, concerns and behaviours of actors; and the social and other relationships among actors.

The degree and substance of this influence is assessed in Theme 2 by analysing the bases of significant past decisions, using detailed interviews and documents. These results can in turn inform governance processes (Theme 1), knowledge generation and communication (Theme 3), and learning approaches (Theme 4).

Governance

Governance is an aspect of socio-cultural context and refers to the patterns that derive from actual managerial and governing practices; the complex interactions among state and non-state actors; and the stretching of governance systems across temporal and spatial scales (Adger and Jordan, 2009). In order for knowledge to be

incorporated into governance systems, knowledge needs to be accessible and the governance process receptive to such knowledge. This two-way dialogue can be greatly enhanced, especially in the complex and uncertain domain of coastal management, by adaptive learning. The Governance Theme (1) of this Cluster addresses what kinds of governance arrangements are most likely to enable uptake of knowledge about coastal adaptation and generate on-ground solutions.

Governance of the coastal zone in Australia includes the institutional authorities, processes, and procedures used for guiding strategic and key operational decisions about the coastal zone. It comprises not only complexly interacting levels of formal government (Federal, State and Local) but also development commissions, NGOs, Indigenous Native Title holders and other stakeholders. The influence of a changing socio-cultural context in Western democracies since the 1970s has meant a gradual shift from strong central government as the key decision-maker to a system of governance that includes the fragmentation and sharing of responsibility and power; the decentralization and 'agentization' of policy formulation and implementation; an increasing reliance on partnerships and networks; and new deliberative ways of consultation and dialogue about policy (Peters & Pierre, 1998; de Loe, 2009). These changes create complexities in the way knowledge can be understood, communicated and implemented. In the coastal zone, making the transition from government to governance typically demands a change in thinking about who is responsible for what, how decisions should be made, what kinds of knowledge should be used for the decisions, who is accountable, and how social and ecological systems are interconnected (de Loe, 2009). The contemporary emphasis on reflexive governance takes this trend even further and emphasises that governance is itself part of the dynamic system that is governed, and is therefore oriented towards continued learning and modulating ongoing developments, rather than towards perfect knowledge and maximising control (Kemp et al., 2005). Through these processes, structural and institutional obstacles to knowledge uptake can be identified, and pathways to a better knowledge-governance partnership developed.

Theme 1 researches the kinds of governance arrangements that are most likely to enable uptake of knowledge about coastal adaptation and generate adaptive solutions, by drawing on practices of transition management such as visualisation exercises, transdisciplinary research, deliberative workshops and trials in governance (Kemp et al., 2005), including the City of Bunbury.

Knowledge systems

CSIRO have generated a substantial body of scientific data and models about likely impacts (e.g., for coastal climate change impacts see Church et al., 2006) from which decision-makers and stakeholders should be able to act to improve governance of the coast. Specific initiatives include, *inter alia*:

- the Derwent-Huon region in Tasmania and the INFORMD project based on this region

- south East Queensland Healthy Waterways Partnership
- Ningaloo Collaboration Cluster
- North-West Shelf Project.

Lay and traditional knowledge systems also report evidence of, for example, climate change. However, while some progress has been made in managing these changes, decision-makers and stakeholders have generally been slow to develop and implement policies and management strategies. Slowness in adapting to climate change on the coast is by no means limited to Australia (Tribbia & Moser, 2008). At its core lies the persistent phenomenon referred to as the science-policy divide (May, 2002; Reid, 2004; Saner, 2007), which has particular characteristics in the coastal zone.

The Knowledge Systems Theme (3) of this Cluster analyses this process of knowledge diffusion as it presently affects coastal zone management. It addresses both obstacles to uptake, and how the different forms of knowledge – scientific, managerial, lay and indigenous – can better influence the decision-making process and outcomes for end users of that knowledge.

The current impact of science on the policy process can be analysed according to Figure 2. Figure 2, hereafter referred to as the 'De la Mare model', shows a flow from science to political decision. As decisions move into the policy development/political decision phase the level of active science input declines. De La Mare's model demonstrates the existence of feedback loops and indirect links although they are weak or absent. These loops and links are often absent from the standard account of uptake (e.g. May, 2002).

A more sophisticated representation of an improved pathway is represented in Figure 3, which shows much stronger feedback from the policy and political domain in terms of defining information needs and policy impact. In addition there are stronger forward links such as the effect of scientific research on properties of policy options. Rather than being a simple linear process, a complex set of engagements and relationships can develop over time (Vogel et al., 2007).

Thus, a current model of the interface between science, policy and practice suggests a complex terrain that is a multi-level system of governance and knowledge production among a range of actors engaged in understanding and managing environment–society interactions (Vogel et al., 2007). This model is relevant to the dynamic, complex socio-ecological system that makes up the coastal zone.

The political domain is potentially able to improve the usability and relevance of science through feedback loops (what policy-makers and planners want to know and in what form), but without actually dictating science outcomes.

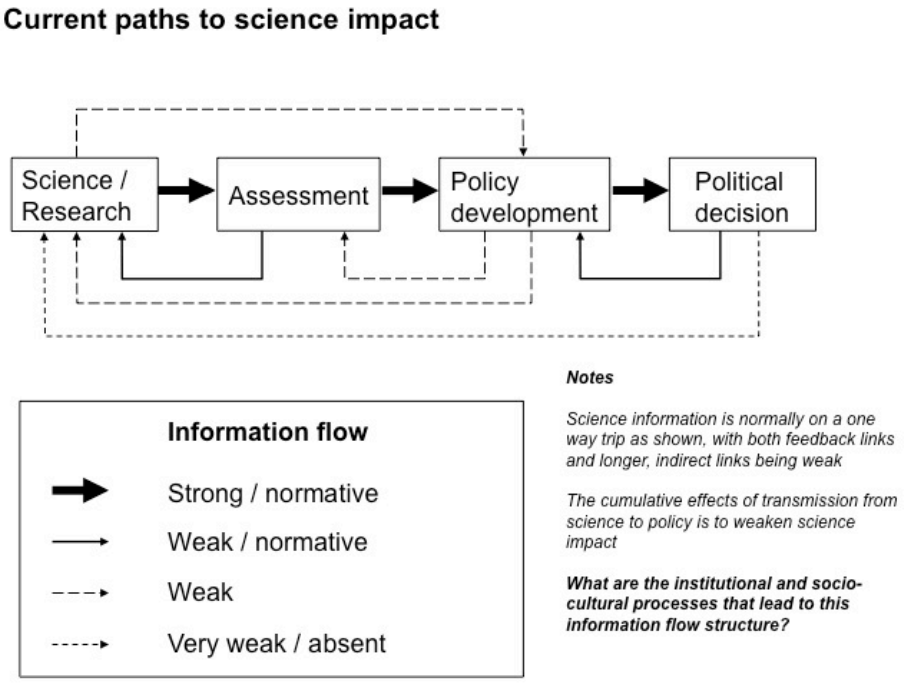

Figure 2. Current paths to uptake (Source: Bill De La Mare, pers. comm.)

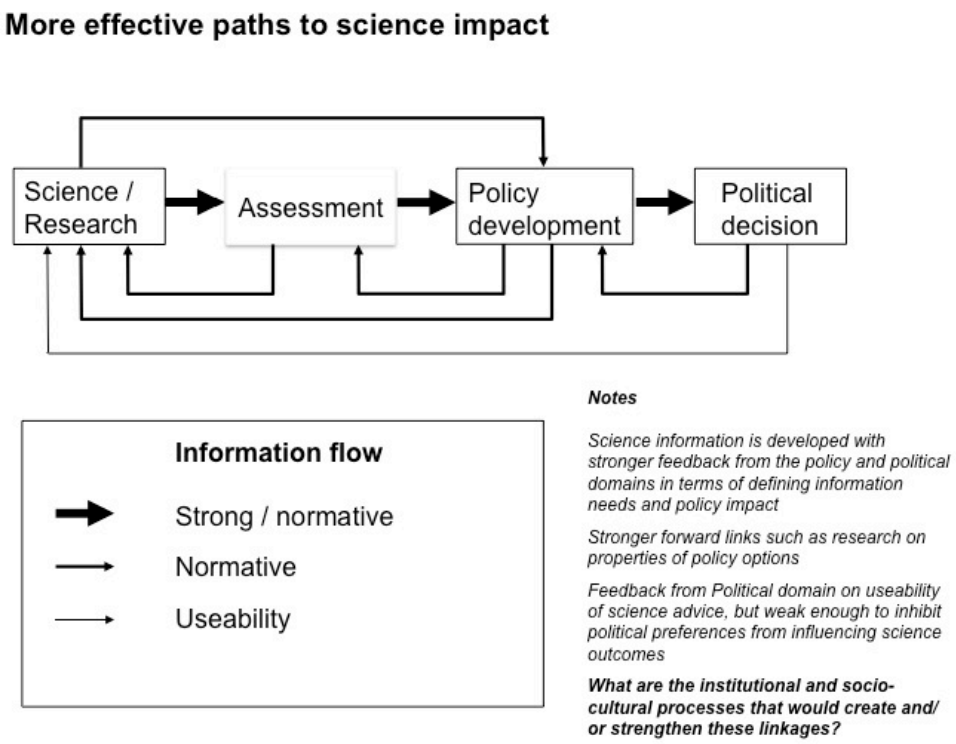

Figure 3. More effective paths to uptake (Source: Bill De La Mare, pers. comm.)

Currently there are perceived obstacles to science uptake in the model represented in Figure 3, or at least differences in perspective between scientists, planners and politicians about the role and value of science relative to other influential factors. There is a particular challenge posed by the analysis/advocacy dichotomy where valuable science inputs can be diminished through interventions in the decision-making process. Policy-makers, planners and politicians may have different attitudes from scientists in relation to the relative importance of:

- scale, uncertainty and complexity
- economism, power, interest groups and legal issues in the policy space (May, 2002)
- constituencies, party platforms, federal/state/local relations, caucus, cabinet, parliament, public opinion and media focus in the political space (May, 2002).

A lack of communicative engagement between knowledge and governance systems about these issues threatens the legitimacy, accountability and efficacy of the systems. It also produces gaps between knowledge, governance and on-ground change. That is, there is an implementation gap (Scherr & Barnhizer, 1997) between the knowledge of the need for changing practices to achieve sustainable coastal management on one hand, and actual effective on-coast adaptation on the other. Such an implementation gap will lead to lack of resilience and to unsustainability in coastal communities (Beatley, 2009). An implementation gap suggests there are

opportunities to improve knowledge and governance (Howlett, 2001) systems, and their interaction, in order to achieve resilience and sustainability in the coastal zone (Adger et al., 2005).

Notwotny et al. (2001) propose what they refer to as 'socially robust knowledge', which involves the contextualization of knowledge as the key to producing science for public policy and practice purposes. They propose adopting forms of knowledge that gain strength from their embeddedness in society. The problem is how to isinstitutionalize polycentric, interactive, and multipartite processes of knowledge-making within institutions that have worked for decades at keeping expert knowledge away from the policy and politics (Vogel et al., 2007).

Contemporary experience and theory suggest the need for greater reflexivity, by which is meant the need to recognise how governance shapes, and is shaped by, knowledge systems and broader societal loops and contexts, as well as by its own workings; and the need to challenge the foundations of systems, find alternatives and change shapes (Voβ et al., 2006).

In order to move to a preferred uptake pathway in which there are stronger and more constructive feedback loops and links, there is a requirement for different institutional and socio-cultural processes that enable better dialogue between knowledge in public policy. For example, substantial interest has grown in 'boundary organisations' that can form a communication link and provide information brokering services between knowledge and governance systems (Vogel et al., 2007). In addition, new processes are needed to engage the decision-makers and stakeholders in scientific data and models that relate to building resilient communities and sustainably managing the coastal zone.

Features of these new processes are likely to include:

- units of analysis which are strongly coupled, jointly determined, nonlinear, complex socio-ecological systems
- integrated research which is transdisciplinary and interdisciplinary as well as disciplinary
- a focus on integration as well as analysis in seeking 'truth'
- inclusion of qualitative values, rigorously treated
- explicit treatment of uncertainty with reflexive, iterative and adaptive approaches
- incorporation of non-scientific knowledges
- inter-paradigmatic dialogues and adaptive learning
- stakeholder involvement
- dealing with multiple scales

(Sources: Dovers, 2005; Modvar & Gallopin, 2005; Guimarães Pereira & Funtowicz, 2006).

Theme 3 applies many of the above-listed methodological processes to generate a picture of the existing 'complex terrain' of science uptake in coastal zone

management and to produce recommendations for enabling pathways to knowledge uptake.

Adaptive learning

Complexity, uncertainty and high decision-stakes are typical characteristics of many coastal systems (Smith, in press). Adaptive management is an important paradigm for responding to these characteristics within coastal systems, yet little attention has been focused on mechanisms crucial to its success (Smith & Smith, 2006). Adaptive learning drives the adaptive management process by facilitating connections between science and management processes – and thereby maximises pathways to science uptake. Adaptive learning supports reflexive governance and deliberative approaches in handling pervasive uncertainty and conflict resolution among competing interests. It also supports knowledge makers to learn from and respond to the requirements of governance. The Adaptive Learning Theme (4) analyses how a more communicative relationship between knowledge-makers and decision-makers could be enabled for the coastal zone, and how learning can be better institutionalised within coastal management organisations. It also helps inform the process of integration among the various themes of the Cluster.

Integration, Analysis and Synthesis

Theme 5, Integration, Analysis and Synthesis plays an active role in bringing the other themes together, but it generates insights and analyses that are greater than the sum of individual Themes. The products of each of the other four Themes, along with selected existing CSIRO knowledge and experience, are collated, synthesised and analysed on an ongoing basis during the life of the Cluster. Integrating, distilling and testing common lessons, and understanding why significant divergences may occur, are a key outcome of this Theme. The role is both conceptual and procedural.

Conceptual integration, analysis and synthesis involve refining and developing the model presented in this research plan, based on Theme results. This process draws on localised research findings from the individual themes to develop collective general theory and models, as distinct from a set of individual case studies. Our conceptual process also produces innovative high-level methodological analyses. One key example is exploring the conceptual relationship between actor-based and systems-based methodologies employed by Cluster researchers. The methodology of adaptation is primarily based on an actor-centred understanding of the world. It focuses on the agency of social actors to respond to specific environmental stimuli, and emphasises the reduction of vulnerabilities (Nelson et al., 2007). However, a complex systems methodology takes a more dynamic view, and might see adaptive capacity as a core feature of resilient social-ecological systems (Nelson et al., 2007). Thus, one important and innovative research task of Theme 5 is to show how actor-based and systems-based methodologies can converge and synergise in improving science uptake in the coastal zone.

Procedurally, a key factor in the effectiveness of the Cluster is the requirement for close collaboration between the Cluster teams, and between the Cluster participants and key CSIRO leaders and staff. Procedurally, an actor-based approach involving

intensive deliberative Cluster workshops and adaptive learning strategies are used to enable research integration. A systems-based approach is also used to develop a big picture analysis of how the Cluster themes interact.

In summary, the Cluster features an integration of actor-based and systems-based epistemologies in analysing knowledge uptake and governance in the coastal zone. It is oriented towards long-term sustainability goals and visions for the Australian coastal zone; it aims to change the ways in which systems operating within this zone are organised; it acknowledges socio-cultural normative concerns for the coast; it is highly participatory; and it is based on continual learning using available evidence about coastal systems, and so is reflexive, iterative and adaptive. (Rotmans et al., 2001; Kemp et al., 2005; van de Kerkhof & Wieczorek, 2005; Loorbach & Rotmans, 2006). Specifically, our Cluster engages the researchers themselves in integrative, deliberative discussions (Bammer et al., 2007).

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