Ocean & Coastal Management 84 (2013) 107–118

Contents lists available at ScienceDirect

Ocean & Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

# Exploring the science–policy interface for Integrated Coastal Management in New Zealand

Scott Bremer [a,*], Bruce Glavovic [b]

[a] Ecological Economics Research New Zealand Massey University, Private Bag 11222, Palmerston North, New Zealand
[b] Resource and Environmental Planning Programme School of People, Environment and Planning Massey University, Private Bag 11222, Palmerston North, New Zealand

ARTICLE INFO

*Article history:*
Available online 2 September 2013

ABSTRACT

Integrated Coastal Management has seen an on-going debate on the best way of integrating knowledge with political decision-making across the so-called 'science–policy interface'. This paper engages with this debate by presenting an empirical study into practice at the science–policy interface supporting coastal management in New Zealand. The research takes as its point of departure a notional dichotomy in the Integrated Coastal Management literature between two broad traditions; one espousing a 'science-based interface', the other a 'participatory interface'. Structured according to this conceptual framework, the research describes and analyses the diverse ways in which these two traditions have found practical expression across New Zealand, both at the national scale and according to a comprehensive survey of coastal managers across all 16 regional councils. The analysis extends to the relationship between these two traditions, and how this relationship has determined the evolution of the science–policy interface.

This paper describes the traditional dominance of science-based coastal management in New Zealand, but highlights an important paradox; while science is valorised as the most robust knowledge for decision-making under the statutory decision-making process, there are pervasive financial, procedural and institutional barriers to its collection, meaning that many decisions are made under significant uncertainty. Against the background of this paradox, local government has increasingly departed from the statutory process, according to a philosophy of co-management. This extends to new strategies for mobilising knowledge, both through knowledge partnerships to generate more science, and participatory approaches to mobilise other forms of traditional and local knowledge. These participatory interfaces take many forms, but typically see scientists engaged alongside other knowledge holders within an inclusive decision-making process. All knowledge systems form a common pool of evidence on which to base decisions, and science is used strategically to fill knowledge gaps identified by a participatory process. Therefore, while science-based coastal management remains dominant in New Zealand, it is increasingly couched within a participatory tradition that valorises other knowledge systems as well.



## 1. Introduction

The field of Integrated Coastal Management (ICM) has emerged from a realisation of the unique values of the coastal marine commons and the distinctive challenges it poses to natural resource management. From its inception, ICM has placed a central emphasis on providing coastal communities with the highest quality knowledge available to support collective decision-making. This integration of knowledge with political decision-making has traditionally been discussed relative to a notional 'science–policy interface' (Cicin-Sain and Knecht, 1998), though there is on-going debate on the ideal form this interface should take. This debate finds scholarly expression in the ICM literature and practical expression in the field, with ICM practitioners worldwide engaged in a balancing act at the boundary between scientific and political communities. As a reflexive field, ICM has always evolved according to a dialogue between theory and practice, and it is against this background that this paper aims to make an empirical contribution to this science–policy interface debate. Using a lens constructed in the scholarship of ICM, it seeks to describe and analyse the diverse approaches to mobilising knowledge in support of coastal management in New Zealand.

* Corresponding author. Present address: Centre for the Study of the Sciences and the Humanities, The University of Bergen Postboks, 7805 5020 Bergen, Norway. Tel.: +47 555 82985; fax: +47 555 89664.
*E-mail addresses:* scott.bremer@svt.uib.no, bremer.scott@gmail.com (S. Bremer).

0964-5691/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ocecoaman.2013.08.008

This paper takes as its point of entry into this debate the work of Bremer and Glavovic (2013), who draw a loose dichotomy between two broad traditions at the ICM science–policy interface (see Section 3). They discern one group of ICM authors (see e.g. Forst (2009), McFadden (2007) and Turner (2000)) espousing a 'science-based interface', concerned with how best to generate science and transform it into policy. This tradition is underpinned by an assumption that the quality of decision-making is contingent on the quantity of science used to support it, such that more science results in better decisions. As ICM has evolved so have the demands placed on the coastal and marine sciences, which are today expected to be *ecosystem-based* and *interdisciplinary* in their enquiries, according an iterative *adaptive management* process (Bennett et al., 2005; Espinosa-Romero et al., 2011; Korfmacher, 2002). The other broad tradition embraces a 'participatory interface' that encourages dialogue across multiple knowledge systems; voicing local and traditional knowledge alongside science for instance. Authors espousing this tradition (see e.g. Knol (2010), Runhaar & van Nieuwaal (2010), and Tobey and Volk (2002)) argue that there already exists enough knowledge to support wise decisions but that this knowledge is disintegrated, and needs to be brought together. Bremer and Glavovic note that this dichotomy is often blurred in ICM practice, with coastal management initiatives drawing on approaches from both traditions.

This paper presents empirical research that employed the conceptual framework of Bremer and Glavovic (2013) to structure a description and analysis of the diverse forms the science–policy interface takes in support of coastal management in New Zealand. The research was undertaken between 2008 and 2010, and traversed 'vertical' boundaries between national and local scale governance through a desktop study of published material, and 'horizontal' boundaries, by interviewing coastal managers across all 16 regional councils that make up the primary domain of local-scale coastal management in New Zealand. It explores how elements from these two traditions have found practical expression for different issues and at different scales across the New Zealand context, and why. It also looks at how the changing relationship between these two traditions over time – the waxing and waning influence of each tradition – has seen the evolution of the science–policy interface.

Section 2 begins by describing the New Zealand context in terms of the coastal pressures and the current management response. Section 3 introduces the conceptual framework as the particular theoretical lens focussing this study, and presents an account of the empirical method. Section 4 presents a discussion of the results, before Section 5 draws some conclusions on the evolving form of the science–policy interface for coastal management in New Zealand.

## 2. Context: the pressures facing New Zealand's coast, and its management response

### 2.1. The pressures on New Zealand's coastal marine area

As an island nation, New Zealand is characterised by 15,000 km of coastline and the fourth largest Exclusive Economic Zone in the world (Department of Conservation, 2005). New Zealand's marine jurisdiction spans 30 degrees of latitude, encompassing both subtropical and sub-Antarctic waters, in the path of the 'Roaring Forties' prevailing westerly weather systems. New Zealand is therefore subject to particularly dynamic coastal processes, which combined with a tectonically active coastline, gives rise to a diversity of coastlines, habitats and species. Indeed, so rich is this biodiversity, some estimate New Zealand's EEZ may contain up to 10% of the world's marine life (Department of Conservation, 2005) – between 23,000 and 75,000 species – many of which are endemic (WWF – New Zealand, 2004). However, with such dynamism and diversity comes a significant degree of complexity and uncertainty, with it lamented that more is known about the surface of the moon than the seafloor around New Zealand (Wood, 2006).Fig. 1

New Zealanders are a coastal people; all 4.4 million living within 130 km of the coast (Oceans Policy Secretariat, 2001) and more than 65% living within 5 km of the coast (Statistics New Zealand, 2006), sharing 250,000 recreational vessels, and one in five of them going fishing each year, mainly along the coast (Peart, 2006). This attachment to the coast has most recently been illustrated with a 'human tide' of migration to coastal townships, where house prices sky-rocketed 200% from 2000 to 2005 (University of Otago, 2005). As a result, New Zealand's coastal commons is subject to fierce competition amongst a diversity of values, debated within a political arena fraught with conflict (New Zealand Office of the Parliamentary Commissioner for the Environment, 1999; Oceans Policy Secretariat, 2001). These values are as multitudinous as there are New Zealanders, however the Oceans Policy Secretariat was able to distil six key values at the core of coastal conflict, including: (i) market values; (ii) ecosystem services values; (iii) public access values; (iv) recreational values; (v) spiritual values, or a sense of self/identity; and (vi) cultural values for Maori, as the indigenous people of New Zealand.

### 2.2. New Zealand's coastal management response

Since at least 1991, New Zealand has been steered by a coastal management regime that gives effect to the ICM approach. In 1991, a new environmental management regime was established centred

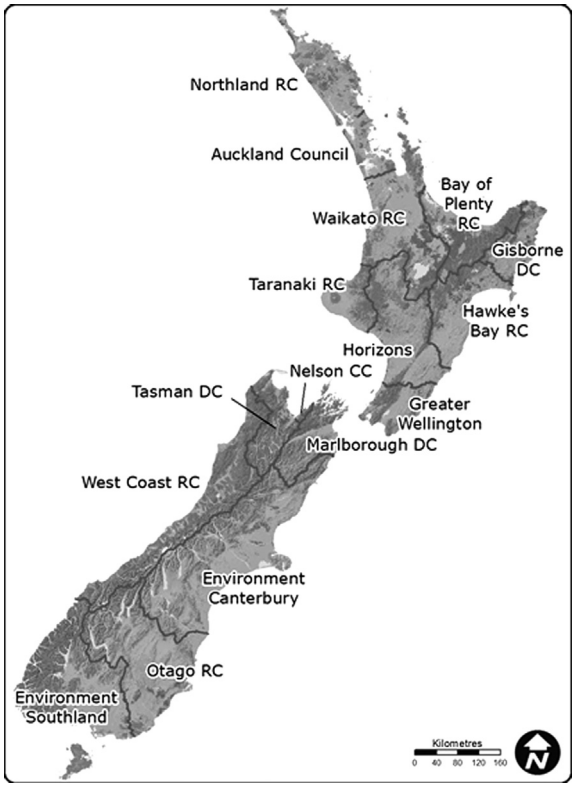


**Fig. 1.** Map of the New Zealand coastline, including regional council boundaries (Produced by the New Zealand Ministry for the Environment – http://www.mfe.govt.nz/environmental-reporting/air/air-quality/pm10/nes/).

on the Resource Management Act, which while never formally described as an exercise in ICM, nonetheless gave regard to its principles, institutions, methods and tools. By 1992 New Zealand had ratified Chapter 17 of Agenda 21, which endorses the ICM approach, and submitted its new coastal management regime as proof of this commitment. Subsequently, New Zealand has been subject to at least two international ICM reviews by the Scottish Executive (2001), and the OECD (1997). Whilst the RMA does not define integration, the Act is deemed to exemplify ICM legislation and is considered a model for implementing ICM in developed countries (Makgill and Rennie, 2012). Therefore, within the context of this paper, it is appropriate to discuss New Zealand's coastal management within the framework of ICM.

New Zealand's coastal and oceans management is spread over more than 25 different statutes, and administered by at least 14 different agencies across seven different spatial jurisdictions. That noted, local government is the lead agency in coastal management, with devolved governance powers and responsibilities under the Resource Management Act 1991 (RMA) and Local Government Act 2002 (LGA). The RMA is an 'effects-based' statute that allows for the integrated allocation and management of all natural resources along the coast (with the exception of fisheries and minerals) by broadly stipulating the form of local government policy documents and processes. Both the RMA and the LGA recognise 'sustainability' as the steering purpose of local government, though the RMA is more environment-centred and regulatory, and the LGA more socioeconomic-centred and strategic in focus. With significant devolved power comes significant accountability, with local government required to be transparent, and follow a 'special consultative process'. This process dictates the statutory minimum public consultation to precede decision-making by local government representatives (councillors), and allows for these decisions to be appealed by any member of the public, to the 'Environment Court.'

At the local government scale, coastal management under the RMA is divided between 'regional councils' and 'territorial authorities'. Territorial authorities (as typified by district and city councils) have jurisdiction of the management of land-use to the high tide mark, as defined within their 'District Plan.' They are also charged with the more common operational duties related to roads and waste management for example. Regional councils have a much broader spatial jurisdiction based broadly on catchment boundaries, and extending to the edge of the territorial sea (12 nm) (see Fig. 2).

Regional councils have jurisdiction over the use of all other resources, including allocation of space below the high tide mark, meaning they are usually the lead agency for coastal management. These resources are managed within the Regional Coastal Plan, which must give effect to the guiding principles of the RMA and the objectives and policies of the New Zealand Coastal Policy Statement (see below). These Coastal Plans are required to be reviewed and amended every ten years, with most regional councils today working under a 'second generation' plan. Coastal Plans primarily fulfil a regulatory role, indicating where people are able to take or use a resource by right, or whether they need to apply for 'resource consent.' Any application for resource consent must be accompanied by an 'assessment of environmental effects' outlining any actual or potential effects of their proposal on the environment or others in the community, and how they propose to remedy, avoid, or mitigate these effects. The regulatory measures of the Coastal Plan are balanced by the non-regulatory measures encompassed within both the Coastal Plan and a region's Long Term Plan (as required under the LGA) which detail a community's long-term goals and spending priorities; from coastal education to sea-walls.

With coastal management highly devolved to the local level, the RMA has introduced the national-scale New Zealand Coastal Policy Statement (NZCPS) to harmonise coastal management, and ensure consistency across the regions. The Department of Conservation is responsible for the NZCPS, and the first NZCPS was released in 1994, after a long consultation process. A second generation NZCPS took effect on 3 December 2010 when the 1994 version was updated and

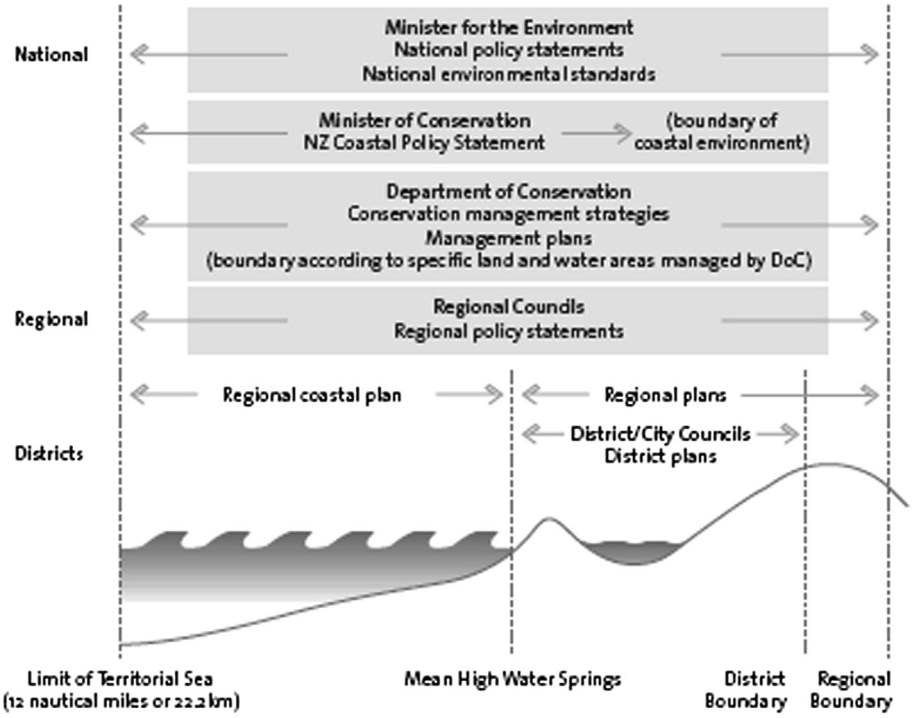


**Fig. 2.** Jurisdictional boundaries for coastal management in New Zealand (Produced by the New Zealand Ministry for the Environment – http://www.mfe.govt.nz/publications/rma/rma-guide-aug06/html/page3.html).

revoked. The NZCPS sits high within the RMA policy hierarchy, to ensure that local-scale coastal policy shares a common regard for a set of collectively agreed principles of good process, and guiding values of national importance. These principles are closely aligned with those of ICM, particularly the procedural principles of participation and precaution. The NZCPS is reviewed every 10 years, with a third generation NZCPS due in 2020.

The Conservation Act 1987, the Fisheries Act 1996, and the Marine and Coastal Area (Takutai Moana) Act 2011[1] are the other three key statutes governing the New Zealand coastline. The Conservation Act creates the Department of Conservation (DOC) to both manage public conservation estate (including the foreshore and seabed), and act as an advocate for conservation of natural and cultural heritage. DOC itself is a central government department with a local presence through 12 conservancy offices. The Fisheries Act allocates and manages the marine fishery and is guided by a resource use imperative through a quota management system. It is highly centralised in its implementation within the recently formed Ministry for Primary Industries (MPI), with relatively few local officers. The Marine and Coastal Area Act was recently introduced to guarantee free public access to the common marine and coastal area, while also preserving recreational fishing rights, navigation rights and all other existing uses.

Finally, it remains to note the integrative influence of the Ministry for the Environment (MfE) within New Zealand's coastal management regime. The MfE was created by the Environment Act 1986 to provide tools of inquiry, monitoring and advice across all state agencies (including local government) on the best means of resource and environmental management.[2] In effect they give national expression to the RMA, in parallel with the Ministry of Conservation.

## 3. The conceptual framework and method of research

### *3.1. The conceptual framework as a lens for exploring the science–policy interface*

In the field of ICM, the linking of knowledge with public decision-making has traditionally been described in terms of a 'science–policy interface', however this paper broadens this focus beyond scientific knowledge alone, and beyond the formal policy-process. The science–policy interface ('the interface') here refers to the multitude of ways in which knowledge, in all its forms, is used in support of public decisions. It can be thought about as the *relationships* between knowledge-holders, like the scientific community, and decision-makers. It can equally be thought about as the formal or informal *institutions* that frame the relationship between knowledge and public decision-making; the way coastal managers might convene an expert panel or public meeting for instance. Or it can refer to the *process* by which knowledge is drawn on for decisions, which GESAMP (1996) and other ICM scholars have described in a step-wise fashion. So framed, the interface encompasses a broad spectrum of relationships, institutions and processes, presenting a rich field of study for philosophers of science (see e.g. Funtowicz and Strand (2006)), scholars of Science and Technology Studies (see e.g. Jasanoff (1987) and Sarewitz (2004)) and policy-scientists (see e.g. Ozawa (2006) and Weible (2008)) alike. This paper limits itself to the debate around the interface in the particular field of ICM, and takes as its conceptual framework a broad dichotomy in the literature between one tradition espousing a 'science-based interface', and another espousing a 'participatory interface', as discussed by Bremer and Glavovic (2013). Fig. 3 heuristically illustrates this dichotomy relative to two simplified spectrums for characterising approaches at the science–policy interface.

The science–policy interface can be considered relative to how participatory it is; who is permitted to voice their knowledge, and how do participants interact with each other? Fig. 3 represents these highly political questions on a scale combining headings from Arnstein's (1969) ladder and the International Association for Public Participation's IAP2 public participation spectrum (see http://www.iap2.org.au). At the left end of this scale we can envision a 'closed' interface which favours one group of knowledge-holders – the scientific community – to the exclusion of all others; typically manifest in a demarcation model of science. Where science has been deemed the most powerful form of knowledge, the scientific community has often been insulated from the politics of decision-making to continue their 'pure' enquiries. Within such science-based management models, interaction can be limited to scientists 'informing' decision-makers. This mechanistic notion of transforming supposedly 'objective' and 'disinterested' science into policy belies the highly political nature of knowledge, and the way that actors can use scientific facts to 'manipulate' a decision-making process. If we move right along the scale, we can envisage a more 'open' interface where all knowledge-holders are equally 'empowered' to contribute their perspectives, such that we see science voiced alongside traditional and local knowledge for instance. Necessarily, opening the interface demands greater dialogue, both across knowledge systems and between knowledge-holders and decision-makers. Indeed, an open interface brings the political nature of knowledge to the fore, with knowledge employed as evidence in support of underlying values; where knowledge and values are negotiated side by side (Boesch, 1999; Fritz, 2010).

The science–policy interface can also be considered relative to how knowledge is defined as being of high quality for decision-making. This is non-trivial given the conflicting norms of knowledge quality across knowledge systems, or indeed within knowledge systems (Fuller, 2007). Compare, for example, the norms of

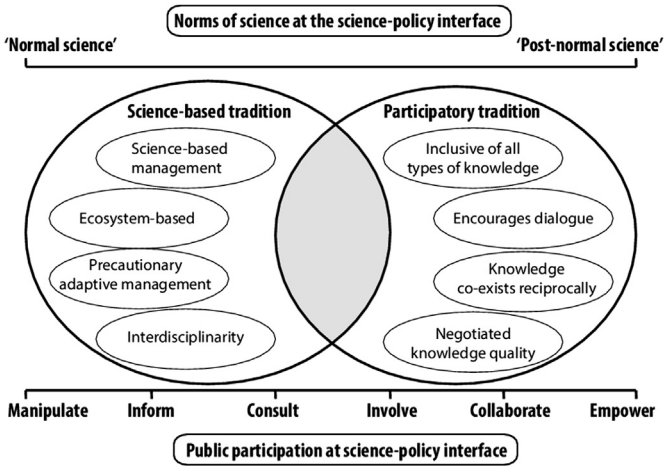


**Fig. 3.** Mapping the conceptual framework for the empirical research.

[1] The Marine and Coastal Area Act 2011 supplements the existing Foreshore and Seabed Act 2004, which preserves the public foreshore and seabed as the common heritage of all New Zealanders, to enable its protection by the Crown and ensure general rights of public access, and the recognition and protection of customary rights and interests.

[2] Latterly MfE has also been enabled with regulatory powers under an amendment to the RMA allowing them to impose National Environmental Standards, which can have wide-reaching influences on local government policy. At this stage no such standards exist for coastal management.

'formal' scientific knowledge that conforms to universally-accepted rules of rigor and is 'explicitly' communicated in written form, with the norms of an 'informal' orally-transmitted traditional knowledge system where much of the knowledge is 'tacit' to tribal elders and its quality derived from the integrity of these elders (see Fabricus et al. (2006)). Indeed, 'science' itself cannot be considered a homogenous set; though scholars have tried to distil universal characteristics of science quality (see e.g. the four norms of Merton (1973)). As we move between different scientific disciplines we see different institutional and procedural norms for what counts as knowledge. The diversity and contingency of science can see conflicting scientific interpretations of the same phenomenon, and arguably open science to 'non-sciences' or 'pseudo-sciences' like cosmology (ISCU Study Group on Science and Traditional Knowledge, 2002), or the manipulation of science towards political ends (Oreskes and Conway, 2010).

Fig. 3 simplifies the complex norms of knowledge onto a spectrum, ranging from settings where knowledge is defined relative to one strict framework of 'normal science' (Kuhn, 1962), to settings where all different norms of knowledge are extended legitimacy, represented by Funtowicz and Ravetz' (1993) 'post-normal science'. In a normal interface, the quality of knowledge is measured relative to its conformity to strict scientific norms derived from some dominant scientific disciplines, and evaluated by peer review within these disciplines. This may see other knowledge systems 'cleaned-up', 'scientised' and incorporated into scientific models, thus losing their intrinsic value (Mosse, 2002). Within a post-normal interface, knowledge quality is negotiated across the multitude of knowledge systems and their respective frameworks of norms; no one framework is dominant and all are allowed to co-exist. The quality of knowledge relates to how well it supports decision-making, or its 'fitness for function', as appraised by an 'extended peer community' that extends to all knowledge-holders. This may see knowledge quality measured according to a conglomerate of heterogeneous indicators.

The ICM literature engages with the full spectrum of different approaches at the science–policy interface shown in Fig. 3, but against this background, Bremer and Glavovic (2013) distinguished a broad dichotomy between two traditions. The *science-based tradition* draws on a long history of *science-based management* for ICM (Cicin-Sain and Knecht, 1998), according to an assumption that the collection of more science will render more certainty and result in better decisions (see e.g. Cheong (2008) or Turner (2000)). It reflects a tendency towards a 'closed' interface governed according to the strict norms of 'normal science', with knowledge production an individual endeavour. This can be seen, for example, in the applied disciplinary science of a university or government research institute, or even through the disciplinary reports of a consultant. However, as ICM has evolved, so have notions of science-based management. As ICM is increasingly described in terms of *ecosystem-based management*, this has implications for the representation of the coast as a complex and dynamic social–ecological system (Forst, 2009), demanding *interdisciplinary* science that reflects this reality (Cicin-Sain and Knecht, 1998). Recognising the complexity of social–ecological systems also implies recognising the significant uncertainties inherent in managing such a system; necessitating an *adaptive* approach to science and management, steered by the principle of 'precaution' (Botsford et al., 1997). Therefore science-based management is today closely linked with this cluster of principles.

The *participatory tradition* emerged in the ICM literature in the 1980s in recognition that the complexity and uncertainty inherent to many coastal issues challenged the dominance of science, and lent legitimacy to other knowledge systems (Vallega, 1997). Proponents of the participatory tradition argue for bringing together different knowledge perspectives in deliberation at the science–policy interface to 'co-construct' a more comprehensive picture of issues (Glavovic, 2013; Tobey and Volk, 2002). This reflects a tendency towards an 'open' interface that allows all knowledge systems to co-exist according to a 'post-normal' approach to knowledge quality within an 'extended peer community', with knowledge production a communal endeavour. Examples may be government-convened 'advisory groups' comprising 'experts' from across different knowledge systems, or other participatory techniques like 'citizen juries' or 'consensus conferences'. Bremer and Glavovic (2013) note how this participatory tradition has come to characterise the science–policy interface as a 'governance setting' (see example Boesch (1999), Cicin-Sain and Knecht (1998), Costanza et al. (1999), Knol (2010) and Norgaard et al. (2009)) according to principles; prescribed as *inclusive* and encouraging of *dialogue*, while reciprocally recognising the *co-existence of diverse knowledge* perspectives, and emphasising the negotiated *quality* of knowledge for decision-making. Importantly though, it must be noted that participatory initiatives do not always guarantee that all knowledge-holders are 'empowered'. They can be an arena for one knowledge-holder to exert power and manipulate others.

The way in which knowledge is mobilised for decision-making is contingent on the particular context of ICM, and the nature of the issues faced. Presented with a spectrum of issues, from manageable well-structured problems to unstructured 'wicked' problems (Rittel and Weber, 1973), it is unrealistic and potentially dangerous to adhere dogmatically to any one tradition, whether it be science-based or participatory. To use the taxonomy of Funtowicz and Ravetz (1993), the degree of uncertainty and controversy associated with an issue dictates the way we approach the science–policy interface. Where an issue exhibits few uncertainties and remains uncontroversial, for example better understanding the reproductive cycle of a particular organism, then a disciplinary science-based approach may be entirely appropriate. On the other hand, where an issue is clouded by significant uncertainty and represents high stakes, such as through the construction of an artificial reef, then a more participatory approach engaging stakeholders may be more appropriate. Another consideration is the scale at which knowledge is collected on an issue. While recognising that many coastal issues span scales, the scale at which we study them implicates different knowledge systems. As Reid and others (Reid et al., 2006) note, addressing issues at a local scale often implicates a participatory endeavour mobilising local stakeholders' knowledge of experiencing the issue daily, while investigating issues at a national or global scale typically lends itself to a more scientific endeavour, as seen in the Intergovernmental Panel on Climate Change for example.

Successful ICM engages approaches across the full science–policy interface spectrum, from both science-based and participatory traditions, and tailor these approaches to their own context and issues. Indeed, it should be recognised that for many ICM scholars and practitioners the dichotomy posed by these two parallel traditions will be artificial given the complex and contingent configurations of influences that determine ICM initiatives, in most cases drawing on elements from both 'traditions' and working within the 'grey area' in Fig. 3. Nonetheless, this research adopted the dichotomy of Bremer and Glavovic as the conceptual framework to steer the empirical description and analysis of the science–policy interface for ICM in New Zealand. The two traditions, and their constituent 'principles', present an interesting lens to examine which approaches have been favoured for mobilising knowledge, how they have found practical expression, and why? It permits an analysis of the relationship between the two traditions; Do they co-exist, or are they in competition? Is one tradition dominant, and if so, why?

**Table 1**
Interview framework themes and sub-themes.

| |
|---|
| 1) The coastal management framework of the Regional Council |
| • Coastal management policy and its integration |
| • The policy-process |
| • In-house capacity for coastal management |
| • Coordination with other coastal management organisations |
| 2) Stakeholder participation in coastal management |
| • Identifying stakeholders for coastal management |
| • Mechanisms for engaging stakeholders |
| • Stakeholders' reaction to participation |
| 3) Knowledge used in support of coastal management |
| • Studies completed on the state of the coast |
| • Modes of improving knowledge and understanding of the coast |
| • Monitoring |
| • Use of non-scientific (local or traditional) knowledge |
| • Bringing together disparate knowledge systems |
| 4) Key barriers and possible solutions for coastal management in New Zealand. |

### 3.2. Research method

Data collection for this research was structured according to the conceptual framework and progressed in two stages; from early 2008 until early-2010. The first stage began with a 'desktop study' of New Zealand's coastal management regime, and the place of the science–policy interface within this regime. It drew on a diversity of resources, including (i) the legislation; (ii) reports by government agencies such as the Department of Conservation, and the Parliamentary Commissioner for the Environment (1999); (iii) central government policy-making processes including the preparation of an 'Oceans Policy' in 2000; (iv) the review of the first generation NZCPS by Rosier (2004); and (v) published literature on New Zealand's coastal management (Peart, 2005, 2007). During this first stage it became apparent that New Zealand's highly devolved coastal management and the diversity across regions demanded exploration of approaches at the science–policy interface across the regions.

The second stage of the research involved face-to-face interviews with coastal managers at all of the 16 regional councils in New Zealand. Regional councils were chosen instead of territorial authorities given their greater statutory responsibility for coastal management, as embodied within their Coastal Plans and spatial jurisdiction.[3] The research targeted those 'coastal managers' most knowledgeable about coastal management in their region, which ranged from natural resource planning staff to in-house scientific experts, depending on the region. In all but two regions, interviews were conducted by a single interviewer with a single interviewee; the two exceptions including a group of 4–5 interviewees within the same room. The semi-structured interview framework (see Table 1) was designed in accordance with the conceptual framework and structured around broad themes as open questions, followed up by a list of sub-themes or prompts. Interviews lasted between one and 2 h and were recorded, with notes taken from these recordings and sent to the interviewees for confirmation. These notes were then coded in accordance with the conceptual framework for analysis. Some of the results from this study also contributed to a separate evaluation of New Zealand's coastal management regime (Bremer, 2009; Bremer and Glavovic, 2009).

There are three main restrictions to the above research method. Firstly, by undertaking interviews with only one representative from each region, only one perspective is presented when a diversity of perspectives prevails. This can be a significant limitation given that a regional council can extend to hundreds of staff engaged in a multi-faceted coastal management regime, and rarely does any one individual have a comprehensive knowledge of all facets. Secondly, the majority of respondents had a background in natural resource planning, as did the interviewer, such that the research was apt to be oriented towards this professional perspective. Thirdly, given the length and nature of the interviews, notes were taken from recordings rather than a full transcript. This can prejudice the research according to the perspective of the note-taker; who inevitably imposes their perspective on the recorded data. Finally it must be noted that this research attempted to distil the diversity of experiences at the science–policy interface across New Zealand into a meaningful discussion of 'common' experiences, both as a function of the formal coastal management regime and widespread practice. Necessarily this paper must be read with caution that some of the generalisations employed may not do full justice to the diversity of coastal management within and across the regions.

## 4. The science–policy interface for New Zealand's coastal management: findings and discussion

The lack of knowledge on New Zealand's coastal and marine environment is one of the most significant barriers to management of these areas. National reviews of the coastal management framework since the 1990s have outlined significant gaps in New Zealand's coastal knowledge and encouraged the mobilisation of 'knowledge capital' to enable sustainable development (Hooper and Chong, 2006); with this same message echoed by regional coastal managers in this study. Indeed, much of the discussion focussed on the quality of knowledge for New Zealand's coastal management. Taking up this debate, this section describes and analyses the science–policy interface according to the two rival traditions introduced in Section 3 above.

### 4.1. Elements of a science-based tradition

#### 4.1.1. Coastal management as science-based management

The research found New Zealand's coastal management, consistent with its broader environmental management, is dominated by a bias towards science-based management, giving science the principle role at the science–policy interface (see e.g. the Ministry of Research, Science and Technology (MoRST) (2001, 2004, 2007), and the Parliamentary Commissioner for the Environment (2001, 2003, 2004)). This is confirmed by both national-scale evaluations and indeed by coastal managers at all 16 regional councils, who reported that they most drew on science to inform coastal management. As such, attempts to mobilise knowledge for coastal management, at both the national and local scale, usually begin with a discussion on how best to mobilise 'more science'.

The three key coastal management agencies – regional councils, DOC and the MPI – are responsible for collecting the science necessary to undertake their roles, with MfE undertaking research that spans all three jurisdictions. For instance, while not one of their formal roles, MfE produces a national State of the Environment report every 10 years. However, a number of published evaluations of New Zealand's coastal management have levelled criticism against this institutionalised approach to mobilising science, for at least five reasons. First there is a lack of in-house

[3] With reference to Section 2.2, we can distinguish between 'national government' and 'local authorities', before making a further distinction at the local authority level between 'regional councils' and 'territorial authorities', where territorial authorities refer to city and district councils. New Zealand also has several 'unitary authorities' that combine the responsibilities of both regional councils and territorial authorities.

scientific capacity and resources to spend on commissioned science across all three agencies, with this worsened by the prohibitive costs of science below the high tide mark (Parliamentary Commissioner for the Environment, 2007). Second, owing to the disparate governance imperatives of the three main agencies and their poorly coordinated roles and responsibilities, science collection is often siloed, resulting in a disintegrated and patchy knowledge base (Parliamentary Commissioner for the Environment, 2007). Third, there is an inadequate national State of the Environment monitoring framework – with only three indicators of coastal health, which are arguably not the most important, namely: (i) marine protected areas; (ii) recreational water quality; and (iii) fishing activity relative to the health of fish stocks, and the area 'swept' by trawling[4] (Parliamentary Commissioner for the Environment, 2007). Fourth, the MPI devolves almost all science collection related to fish stocks to private fishery quota holders; however experience has shown that quota holders are not sufficiently motivated by their property rights to invest in research (McKay, 2006). And fifth, the science that does exist is poorly disseminated. It is often in an unusable form, has been lost through poor information management, or is held guardedly by private organisations and research institutes (Ministry for the Environment, 2005).

Perhaps the most significant of the challenges facing the current coastal management regime is the lack of in-house scientific capacity, at all levels of government and especially in Local Authorities. Since the restructuring of New Zealand's state agencies according to principles of New Public Management in the mid-1980's, science-based coastal management is a luxury that not all regional councils can afford. Many coastal managers described a lack of in-house scientific expertise and a small science budget as two important shortcomings in their coastal management capacity. This confirmed a MoRST (2004) report which found that only three regional councils had significant in-house science capacity (scientists) and a good engagement with the science, with variable capacity across the other 13 councils owing mainly to variable rating and asset bases. Moreover, this lack of in-house science capacity means that policy- and decision-makers struggle to engage with science to support decision-making (State Services Commission, 1999; as cited in, Parliamentary Commissioner for the Environment, 2007), as evidenced by a large number of 'first generation' coastal plans that incorporated relatively little science. One typical comment from a coastal manager was, "We're not too hot on our science – most of our spend is on planning policy" (Respondent A). This introduces the interesting paradox of coastal managers who place a priority on science-based decision-making, within a coastal management regime that limits their access to science.

The science used to support coastal management at the regional-scale can be broadly divided into three streams, which found variable utility across the 16 regional councils. The first is the on-going 'State of the Environment' (SOE) monitoring, which only six regions felt made a significant contribution to their decision-making. For most regional councils there is insufficient scientific capacity in-house to allow them to monitor a large number of indicators over a long time series, such that they are only able to measure a few, fragmented indicators. This, combined with a complaint that the truly important indicators like coastal amenity are immeasurable, meant that for most respondents SOE monitoring was poorly linked to policy preparation. The second stream of science is 'resource consent-based research,' associated with the preparation of an assessment of environmental effects (AEE) for a particular proposal, and with monitoring afterwards. Only six regions felt that resource consent-based research constituted a significant contribution to their decision-making. In general, these regions did not have significant in-house scientific capacity, or a significant budget to commission science, and therefore relied on resource consent applications to incrementally build up a picture of their coastline. To this end, three regions reported the assembly of a database within which the individual AEE form a piece of a growing puzzle.

The third stream of science is 'issue-based' research, which a majority of respondents (9) felt contributed meaningfully to coastal management. Issue-based research is usually conducted in response to political pressure from the community who perceive an issue threatening their coast, though sometimes it is collected to fill knowledge gaps that become evident through a policy/decision-making process. Due to their focussed and specialised nature, issue-based reports are most often commissioned from consultants. Respondents favoured issue-based science for a number of reasons, including; (a) the limited scope of their SOE programme; (b) issue-based reports have a specific policy-purpose, and are therefore more efficient than maintaining expensive in-house capacity; (c) issue-based research, when done in partnership with other agencies, means the council budget can be more effectively used; and (d) scientific resources are allocated on the basis of political pressure.

Important innovations over the past ten years have attempted to address the shortfalls in science mobilisation under the current coastal management regime. At a regional scale, this research found a growing number of examples where agencies, such as a regional council and DOC, have cooperated in commissioning and carrying out scientific research, to both better coordinate the research and to share the cost burden. At a central government level, the 'Envirolink' fund was created, which allows regional councils to apply for supplementary funding to commission science. Similarly central government has strategically prioritised research itself, with the NZ Biodiversity Strategy seeking an improved knowledge of coastal and marine biodiversity through cross-agency, interdisciplinary initiatives, including the Oceans 20/20 project. More recently, in June 2013, central government highlighted its National Science Challenges as 12 priority areas for research, including the coastal marine area titled 'Life in a Changing Ocean'. It focuses on developing knowledge on how best to exploit coastal and marine resources within environmental and biological constraints, and in that respect reflects the current government's focus on efficient economic development. The National Science Challenges also reveal a persistent priority on science-based management at the national scale. Finally, at the time of writing, the RMA Reform Bill 2012 is open for public consultation, but if passed it would allow regulations to be drafted standardising how SOE monitoring would be undertaken, and establishing nationally consistent monitoring.

#### 4.1.2. Ecosystem-based management

While New Zealand's coastal management regime under the RMA is labelled ecosystem-focussed, neither the national- nor regional-scale research found that the mobilisation of science is sympathetic to this approach. Perhaps most fundamentally, the artificial division between the three key agencies of coastal management has led to fragmented and siloed science collection that does not serve an ecosystem-based perspective. In particular, the gap between the collection of science for fisheries management under the Fisheries Act and coastal ecosystem management under the RMA leaves any scientific understanding partial at best. Furthermore, regional coastal managers reported that SOE monitoring was often limited to just three or four indicators, which were

[4] It must be recognised though that the other State of the Environment indicators have relevance also to coastal management, including measures of fresh water quality, or soil erosion for example.

historically derived rather than based on ecosystem-management. Only seven respondents reported undertaking any socio-economic monitoring, demonstrating a bias towards natural science, and disinclination toward linking socio-economic and natural systems. Similarly, resource consent and issue-based research was widely described as *ad hoc*; undertaken in a fragmented way according to an urgent issue, or for a specific project. This, respondents noted, does not allow for an integrated understanding of an ecosystem or an appreciation of the cumulative effects of coastal activities on 'thresholds,' or tipping points.

Having noted this shortcoming, there have been a number of central-government funded research projects under the Biodiversity Strategy, which have led to a more ecosystem-based understanding of the oceans and coasts, including: the National Aquatic Biodiversity Information System (NABIS); the Marine Environment Classification System (MEC); and most notably the Oceans 20/20 initiative, which aims to map New Zealand's marine territory, with a focus on regions that experience high use. Similarly, the 'Life in a Changing Ocean' strategy adopts an ecosystem-based framework. These projects are interagency and interdisciplinary in nature; demonstrating the links between social–ecological systems, and have been welcomed by regional councils. As one respondent noted, "I would dearly like to have a much more thorough information base with an accurate, if that was possible, geo-spatial framework, in maps, attached to the policy documents and to a policy framework" (Respondent E).

#### 4.1.3. Precaution and adaptive management

Increasingly the science–policy interface is characterised by the need to proceed in the face of significant uncertainties. To this end, the precautionary principle and associated notions of risk have become a basis for coastal management in New Zealand (Ministry of Research Science and Technology, 2001). It is explicit in a number of pieces of legislation, such as the Fisheries Act or the RMA, where environmental effects are evaluated according to the probability of their occurring and their scale. Peart (2007), in her analysis of three coastal plans, found that all were influenced by a precautionary approach that restricted the use of the marine area on the basis of poor knowledge. That is, where significant uncertainties existed the regional council would be precautionary by imposing strict restrictions, until they knew better. This reflects the political urgency associated with producing a policy document that provides for procedural and development certainty, while not providing time for the research required to address uncertainty (MoRST, 1998; as cited in, Parliamentary Commissioner for the Environment, 2004). In addition, five regional coastal managers described exercising the precautionary principle through the resource consent process, by requiring applicants to supply a comprehensive AEE, and granting short-term consents with stringent monitoring conditions.

However, while having good regard for principles of precaution, New Zealand's coastal management regime is poorly able to adapt in response to new information; to implement 'adaptive management.' The first reason for this is the lack of emphasis placed on monitoring. As noted above, most regions do not have the capacity to monitor a large number of SOE indicators, and not one region reported mobilising resource consent monitoring results in a form able to support decision-making. The second reason for this lack of adaptability is the inflexibility of the policy documents, stemming from the political inertia within a decision-making process that regularly results in policy changes being delayed by appeals that can take years in the Environment Court.

#### 4.1.4. Interdisciplinarity

At the national-scale interdisciplinary science is rarely given effect, mainly due to a framework which encourages fragmented and *ad hoc* science collection. However, as noted, a number of interdisciplinary projects have been developed at a national, interagency scale, including NABIS and Oceans 2020 for example. Regional coastal managers were also asked whether their science was interdisciplinary. For the majority of councils, science remains very much siloed, with two restrictions to interdisciplinarity being: (a) a coastal management framework that collects science incrementally, 'as required'; and (b) the prohibitive cost. Only six councils reported undertaking any science that was interdisciplinary. Three of these six councils were very well resourced councils that were able to collect science from multiple disciplines to build complex models of the issues. The other three ran a less costly process that allowed for interaction between scientists, which they recognised as interdisciplinary. Four respondents felt that 'coastal managers' acted in an interdisciplinary role, by bringing multiple disciplines together within the context of a policy or resource consent process. Two other respondents described their in-house scientists as adequately knowledgeable to facilitate the bringing together of multiple disciplines. Three regions made special mention of the Oceans 2020 interdisciplinary project, and how valuable this science was for coastal management.

### 4.2. Elements of a participatory tradition

The research discovered that within many regional councils the science–policy interface is being re-defined to encourage a wider dialogue between different knowledge systems. This follows recognition that all stakeholder groups – whether from the state, the private sector, civil society or the scientific community – are possessing of valuable knowledge perspectives, which can be mobilised in support of decision-making through dialogue: "You can't separate knowing your district and managing it" (Respondent C). While not phasing out the traditional interaction between scientists and policy-makers, many regions were found to complement this interface with methods for mobilising other forms of knowledge, and facilitating dialogue across the different forms of knowledge. This normally signalled a departure from the statutory process, and was influenced by a growing philosophy of co-management: "They're as much institutions in the community as we are" (Respondent N). However it should be noted that this trend toward increased participation is far from being the norm, with the majority of public participation at the local government scale limited to the statutory minimum, which amounts to a tokenistic consultation via individually written submissions.

The different knowledge systems engaged by councils is highly contingent to the regions, and indeed to the different coastal issues addressed in each region. This much noted, the research was able to distinguish two broad knowledge systems, besides science, that were of importance across most regions. 'Traditional knowledge' is associated with the indigenous Maori population, and represents a cumulative body of knowledge, practices and representations maintained by tribes (or iwi) with histories of interaction with their territory (or turangawaewae). This knowledge is part of wider Maori culture that encompasses language, naming, resource-use, spirituality and worldview (see e.g. the discussion of the ISCU (2002)). 'Local knowledge' similarly represents the experience of local communities' interaction with their natural environment over time, but is distinguishable from traditional knowledge as less tightly bound to a community's culture. It is seen in the long memories of residents, who have walked and fished their local coastline for decades, and observed changes over time. Local knowledge is also associated with the private sector, with primary sector enterprises that rely closely on a particular natural resource, for example a forestry company with extensive knowledge of their forest.

*4.2.1. Inclusive of multiple forms of knowledge*

This research found five ways in which regional councils complemented their science–policy interface with methods for including other knowledge perspectives, listed below in order of least-to-most 'participatory':

(i) *Education programmes*: All respondents reported education programmes as forming part of their coastal management regime, and many had staff devoted solely to education. Where these education programmes found expression through forums or travelling 'road shows' there were often opportunities for stakeholders to contribute their perspective.

(ii) *Consultation with the wider public*: At least 12 respondents reported undertaking some form of non-statutory consultation as a means of accessing the community's diverse perspectives on an up-coming policy document or plan. Most regions released a draft document for public comment prior to entering into the statutory 'special consultative process', with this document accompanied by a combination of public meetings, travelling road shows, newspaper surveys, postal surveys, and the use of other media such as radio or internet. Indeed, many regional council respondents saw this wider engagement as democratically important, because other participatory initiatives often acted to limit the power within a tight network of 'stakeholders'.

(iii) *Cross-agency coordination around an issue*: All respondents reported being able to pick up the phone and initiate as-required coordination with stakeholders from other state agencies on an issue according to principles of openness: "honesty and transparency are the big ones" (Respondent J). Eight regions reported some kind of formal inter-agency knowledge mobilisation for key issues.

(iv) *Preparing non-statutory strategic policy*: At least nine regions created strategic, non-statutory policy documents for the coast, with the preparation of these involving the creative mobilisation of knowledge across different knowledge systems: "…it's a pretty useful exercise, and it's certainly one that territorial authorities and regional councils find easier to do because we're fundamentally not research bodies" (Respondent M). Where these non-statutory processes were led by regional councils, they tended to start from a science-based management paradigm. Community stakeholders are invited to contribute their perspective at well-defined entry points in a highly structured and formal process, with a clear boundary between the knowledge provided by scientists and other stakeholders. Conversely, where these projects were led by the community, they started from community knowledge, with council and scientific knowledge invited to fulfil a supporting role. Community processes are more inclusive and less structured, with less of a boundary between state, scientific and community actors.

(v) *Knowledge partnerships with stakeholder groups*: All respondents reported entering into partnerships with stakeholders that transcend the state agencies, though for many of them, the mobilisation of knowledge was only one facet of a multi-faceted relationship: "More and more community groups are raising their heads and wanting to get involved in the planning side of things" (Respondent B). There were four broad forms of partnership discussed. A 'planning partnership' saw a small group of stakeholders presented with all available knowledge, including science, and asked to deliberate on its credibility, salience and legitimacy for supporting 'planning' or policy-making. A 'research partnership' saw two or more partners undertake research on a particular issue of interest. There is no defined policy outcome; rather it is a knowledge gathering exercise. An 'operational partnership' was built around a concrete project or piece of infrastructure, such as a rehabilitation project, coastcare programme, or the operation of a port for instance. This partnership meets regularly to discuss any emerging issues, and to aid in the evolution of knowledge on this resource. And finally, the 'on-going forum' is a forum comprising all categories of stakeholders, which meets regularly to discuss emerging issues across a defined area, with a strategic focus.

*4.2.2. Opportunities for dialogue across different knowledge systems*

As noted, an increasing number of regional councils are creating opportunities for dialogue between knowledge perspectives, from across the full spectrum of stakeholders. Particularly through community-led 'non-statutory policy processes' and 'knowledge partnerships,' regional councils have created a more inclusive science–policy interface to allow for the mobilisation of previously inaccessible knowledge perspectives, and the co-construction of new knowledge relative to an issue. Such settings allow for the negotiation of what constitutes the 'facts' within the context of strongly-held value positions, making clear the politics and power present in coastal management: "Trying to get that communication going back and forth, so that we all reach a place of a reasonably common understanding, and a lot of the misconceptions from the science side and from the community side are eroded" (Respondent O). As one respondent noted, these processes of dialogue have the potential to make the scientific community feel uncomfortable: "The scientists hate it, but at the end the community holds them up and tells them they've done a good job" (Respondent G). While the scientists may see the process of dialogue as science-poor, the fact that the community has taken ownership legitimises the process.

Outside of the settings specifically designed to facilitate dialogue between knowledge systems, coastal managers were asked to characterise the interaction between science and other knowledge perspectives, with three broad views put forward. Three respondents viewed the resource planners, and the RMA process, as the principle means of encouraging interaction between knowledge systems. For four respondents, the community was invaluable in their role as "…the eyes and the ears of the Council" (Respondent I); observing changes in the environment which were then further investigated by the council: "Then you go back to the science to measure these perceptions" (Respondent A). Finally, for two respondents the community was useful in helping science to establish the cause of different scientifically observed changes: "I think there's a lot of room for the observations of the ordinary bloke, and science, to come together to resolve an issue" (Respondent C).

*4.2.3. Knowledge reconciled according to principles of reciprocity and co-existence*

Regional coastal managers were asked to what degree disparate knowledge systems were able to be 'reconciled' or brought together according to principles of reciprocity and co-existence. A number of respondents felt that science and other knowledge systems were not able to co-exist, or that they may be equally accepted as legitimate until they conflict with each other, and then the dialogue becomes adversarial. For two respondents there was a fundamental and irreducible rift between the science-based perspective and the 'cultural-ethical' perspective characterised by other knowledge systems: "Really, really hard to balance the rational science with the cultural ethical paradigms…they're talking past each other" (Respondent G). This rift was seen to stem largely from the transparency (or lack thereof) of the values underpinning both forms of knowledge; with science professing to 'objective knowledge' while other knowledge systems have a more explicit link between their

values and their knowledge perspective. Indeed it is this perceived 'objectivity' that has elevated science to the most legally defensible form of knowledge, such that one respondent noted that where these sources of knowledge clash, regional council staff (policy-makers) often turn directly to science. However, for regional council politicians (councillors) this choice is not so evident. Five respondents noted how the choice of which knowledge to give precedence to is a political decision; for politicians the most credible source of knowledge is that which strengthens their cause. Therefore if the science fails to support the cause, it will be construed as 'narrow', 'short-term' or even just 'bad' science; while other forms of knowledge will be dismissed as 'anecdotal' if it is counter to a politician's line. In this way, one respondent emphasised that while the RMA is often defined as science-based, in reality almost all decisions are political, which greatly dilutes the potency of the science.

Finally, for two respondents, the dialogue between science and other knowledge systems had been beneficial in bridging the rift between the two; resulting in 'social learning' across both fact and value dimensions, and eroding misconceptions on both sides. For example, one group of respondents described how dialogue between local coastal inhabitants and ecologists had eroded the polarised positions on the worth of mangroves. The ecologists came to realise the barrier mangroves pose to the effective use of the coast, while the locals came to realise their ecological value; such that the two knowledge systems arrived at mutual recognition of the other's worth, and their ability to co-exist.

#### *4.2.4. Attention to negotiated knowledge quality*

Coastal managers across all of the regions described the dominance of 'experimental' science as the most high quality form of knowledge used to inform coastal management, particularly given it is legally defensible within a litigious RMA decision-making process. Many made the point that other forms of 'experiential' knowledge, local or traditional for example, held less credibility under legal scrutiny due in large part to the difficulties in validating their truthfulness, and a perception that they were more fallible in terms of false memory, value-bias, and broad unqualified statements. Given the importance of legal defensibility in a decision-making process that is regularly decided in the Environment Court, scientific criteria have become the universal measure of knowledge quality. That is, the quality of knowledge perspectives for supporting decision-making is evaluated on the degree to which it satisfies scientific measures of objectivity. Given the dominance of scientific measures, a number of respondents felt it was impossible for science to sit alongside other knowledge systems in a cross-validation role. However, as noted above, this is not to forget the measure of quality decided according to political power. As long as decision-making is political, knowledge will be appropriated to the degree it supports specific value positions.

## 5. Conclusions: nurturing strong science within a strong participatory setting

ICM has long debated the ideal form of the 'science–policy interface' for coastal management, which originally described the communication between scientists and policy-makers, but has since expanded as a term to describe any number of mechanisms for bringing together knowledge in support of collective decision-making. Within ICM, the science–policy interface debate can be depicted according to a loose dichotomy between science-based and participatory traditions. This paper used this conceptual framework to structure an exploration of the diverse forms that the science–policy interface takes for coastal management in New Zealand. The research found that across New Zealand the science–policy interface is comprised of elements from both broad traditions, with a rich diversity of experiences across the regions. This makes it very difficult to make observations that are universally true across the coastal management regime, and in all practice. Similarly, the influences that are shaping New Zealand's coastal management institutions are multiple, complex and dynamic; confounding attempts to focus on the evolution of the science–policy interface in isolation. However, this noted, we can endeavour to make some broad observations that appear meaningful in terms of a 'widespread' practice.

While New Zealand's science–policy interface comprises elements of both traditions, the research found the science-based management to be dominant. Indeed, science has proven a powerful source of knowledge to support coastal management in the past, with many coastal managers emphasising the improved predictability offered by science, and better informed decisions. In this regard, they pointed to the benefits derived from large interdisciplinary projects like Oceans 20/20, and the significant scientific research surrounding aquaculture. However there are also a number of significant barriers to the effective mobilisation of science. These barriers are many and diverse, but echoing the findings of the Parliamentary Commissioner, stem primarily from a lack of resources to invest in science, resulting in reduced in-house scientific capacity and poor engagement between policy and science. This has adverse spin-off effects in terms of siloed science collection, a poor emphasis on long-term monitoring, poor information management, and a short-term focus on *ad hoc* consultant reports.

Therefore we can, in a very real way, discuss a paradox within the science–policy interface. On one hand, there is a reliance on science as the most robust and powerful form of knowledge to push back the bounds of uncertainty and render a clear picture of coastal issues. On the other hand, there is a coastal management regime that seriously hinders the mobilisation of science, such that there is persistent and significant uncertainty. Moreover, there are elements of the coast important to New Zealanders that are immeasurable by science such as amenity and cultural value, which frustrates a decision-making process reliant on 'hard' and unequivocal scientific measures. Indeed, for many coastal managers, science-based management is an illusion given that most of the most important decisions are made by local politicians, who are accused of manipulating science according to political ends. Therefore, it must be recognised that while science remains a central pillar of efficient and effective coastal development (to echo 'Life in a Changing Ocean'), it is not sufficient on its own, and not well provided for in the current statutory framework. This has seen coastal managers in the regions engage creative new strategies for generating more science, through knowledge partnerships with other state agencies for example.

In contrast to the dominant science-based tradition, coastal management in New Zealand is increasingly supported by attempts to mobilise a participatory science–policy interface. The research found this at least represents the influence of (a) an increasing experience and maturity relative to the coastal management regime and the restrictions of the statutory decision-making process, leading to more creativity beyond core functions; (b) an emphasis on co-management in some regions; (c) recognition of the impediments to mobilising science; and (d) an increasing tendency to base decisions in a fuller understanding, that extends to evidence from other knowledge systems. However, it must be re-emphasised that participatory initiatives are far from constituting normal practice for local government, with most consultation with the wider community still limited to the statutory minimum.

The introduction of a more participatory science–policy interface mechanism therefore signalled willingness in many regions to invest in both greater participation, and more science, to better

support decision-making. This is evidenced by the processes preceding the emerging 'second generation' coastal plans, and the raft of non-statutory plans, which have attempted to combine strong participation with a strong science-basis. Importantly, participation through the inclusion of a wider array of knowledge perspectives is not seen as an alternative to science. On the contrary, science retains an essential role as a powerful knowledge system. But science becomes couched within the context of a participatory process; one which integrates the science–policy interface and decision-making arenas. Science becomes more targeted to gaps identified in the participatory process, and in that way can incorporate more long-term monitoring efforts – often comprising other non-scientific monitoring – within a more strategic knowledge forum. These participatory interfaces have taken many forms, ranging from inter-agency knowledge sharing fora, to community-led non-statutory policy processes, to knowledge partnerships and on-going community fora.

## Declaration

We the authors declare that this manuscript has not been published before, and it has not been submitted simultaneously for publication anywhere other than within the journal 'Ocean and Coastal Management.'

## Contribution

Both authors have materially participated in the research described in this paper, and to the preparation of the paper itself. Bremer undertook this research as part of his PhD, but was significantly helped by Glavovic in designing the research approach, and interpreting the results. Bremer led the writing of this paper, with Glavovic making material contributions to the format of the paper and in co-writing sections of the paper. Both authors have approved the final paper.

## Acknowledgements

The author would like to acknowledge Charlotte Drury at the Hawke's Bay Regional Council for her help making sense of the fast-changing coastal management legislative framework in New Zealand. Acknowledgement must also go to the Ryochi Sasakawa Young Leaders Fellowship and to the Eiffel Scholarship for their financial support of doctoral study, within the auspices of which this research was undertaken.

## References

Arnstein, S.R., 1969. A ladder of citizen participation. Journal of the American Institute of Planners 35, 216–224.
Bennett, J., Lawrence, P., Johnstone, R., Shaw, R., 2005. Adaptive management and its role in managing Great Barrier Reef water quality. Marine Pollution Bulletin 51, 70–75.
Boesch, D.F., 1999. The role of science in ocean governance. Ecological Economics 31, 189–198.
Botsford, L.W., Castilla, J.C., Peterson, C.H., 1997. The management of fisheries and marine ecosystems. Science 277, 509–514.
Bremer, S., 2009. Evaluating the State of New Zealand's Coastal Management: Application of Integrated Coastal Management Indicators at the National and Local Scale. NZCEE, Palmerston North.
Bremer, S., Glavovic, B.C., 2009. Evaluating the State of New Zealand's Coastal Management. Coasts and Ports '09 Conference, Wellington.
Bremer, S., Glavovic, B.C., 2013. Mobilizing knowledge for coastal governance: re-framing the science–policy interface for integrated coastal management. Coastal Management 41, 39–56.
Cheong, S.-M., 2008. A new direction in coastal management. Marine Policy 32, 1090–1093.
Cicin-Sain, B., Knecht, R.W., 1998. Integrated Coastal and Ocean Management: Concepts and Practices. Island Press, Washington, D.C.
Costanza, R., Andrade, F., Antunes, P., van den Belt, M., Boesch, D., Boersma, D., Catarino, F., Hanna, S., Limburg, K., Low, B., Molitor, M., Pereira, J.G., Rayner, S., Santos, R., Wilson, J., Young, M., 1999. Ecological economics and sustainable governance of the oceans. Ecological Economics 31, 171–187.
Department of Conservation, 2005. Protecting Our Seas: An Overview of New Zealand's Marine Biodiversity Conservation and the Role of Marine Protected Areas = Tiakina a Tangaroa. Marine Conservation Unit Dept. of Conservation, Wellington, N.Z.
Espinosa-Romero, M.J., Kai, M.A.C., McDaniels, T., Dalmer, D.M., 2011. Structuring decision-making for ecosystem-based management. Marine Policy 35, 575–583.
Fabricus, C., Scholes, R., Cundill, G., 2006. Mobilizing knowledge for integrated ecosystem assessments. In: Reid, W.V., Berkes, F., Wilbanks, T.J., Capistrano, D. (Eds.), Bridging Scales and Knowledge Systems: Concepts and Applications in Ecosystem Assessment. Island Publishing, Washington.
Forst, M.F., 2009. The convergence of Integrated Coastal Zone Management and the ecosystems approach. Ocean & Coastal Management 52, 294–306.
Fritz, J.-S., 2010. Towards a 'new form of governance' in science-policy relations in the European Maritime Policy. Marine Policy 34, 1–6.
Fuller, S., 2007. The Knowledge Book. Acumen Publishing Limited, Stocksfield.
Funtowicz, S.O., Ravetz, J.R., 1993. Science for the post-normal age. Futures 25, 739–755.
Funtowicz, S.O., Strand, R., 2006. Models of science and policy. In: Traavik, T., Lim, L.C. (Eds.), Biosafety First: Holistic Approaches to Risk and Uncertainty in Genetic Engineering and Genetically Modified Organisms. Tapir Academic Press, Trondheim, pp. 263–278.
GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection), 1996. The Contributions of Science to Integrated Coastal Management. GESAMP Reports and Studies.
Glavovic, B.C., 2013. Coastal innovation imperative. Sustainability 5, 934–954.
Hooper, R.J., Chong, K., 2006. Developing the NZ marine infrastructure. In: Royal Society of New Zealand Conference: New Zealand's Oceans and Its Future: Knowledge, Opportunities and Management, Auckland.
ISCU Study Group on Science and Traditional Knowledge, 2002. Science and Traditional Knowledge. International Council for Science, Paris.
Jasanoff, S., 1987. Contested boundaries in policy-relevant science. Social Studies of Science 10, 195–230.
Knol, M., 2010. Scientific advice in integrated ocean management: the process towards the Barents Sea plan. Marine Policy 34, 252–260.
Korfmacher, K.S., 2002. Science and ecosystem management in the Albemarle–Pamlico Estuarine study. Ocean & Coastal Management 45, 277–300.
Kuhn, T., 1962. The Structure of Scientific Revolutions, third ed. University of Chicago Press, Chicago.
Makgill, R.A., Rennie, H.G., 2012. A Model for Integrated Coastal Management Legislation: a principled analysis of New Zealand's resource management act 1991. The International Journal of Marine and Coastal Law 27, 135–165.
McFadden, L., 2007. Governing coastal spaces: the case of disappearing science in Integrated Coastal Zone Management. Coastal Management 35, 429–443.
McKay, J., 2006. Fisheries resource management, knowledge and opportunities: has the emperor got no clothes?. In: Royal Society of New Zealand Conference: New Zealand's Oceans and Its Future: Knowledge, Opportunities and Management, Auckland.
Merton, R.K., 1973. The normative structure of science. In: Merton, R.K. (Ed.), The Sociology of Science: Theoretical and Empirical Investigations. The Unversity of Chicago Press, Chicago, p. 267.
Ministry for the Environment, 2005. Getting Our Priorities Right: The Role of Information in Setting Priorities for Management of New Zealand's Ocean. Ministry for the Environment, Wellington, N.Z.
Ministry of Research Science and Technology, 2001. Science and Society: a Policy Perspective Background. Ministry of Research Science and Technology, Wellington.
Ministry of Research Science and Technology, 2004. Evaluation of the Environmental Output Class. MoRST, Wellington.
Ministry of Research Science and Technology, 2007. Roadmaps for Science: Environment Research. MoRST, Wellington.
Mosse, D., 2002. 'People's knowledge', participation and patronage: operations and representations in rural development. In: Cooke, B., Kothari, U. (Eds.), Participation: the New Tyranny? Zed Books Ltd, London and New York, pp. 16–35.
New Zealand Office of the Parliamentary Commissioner for the Environment, 1999. Setting Course for a Sustainable Future: The Management of New Zealand's Marine Environment. Parliamentary Commissioner for the Environment, Wellington N.Z.
Norgaard, R.B., Kallis, G., Kiparsky, M., 2009. Collectively engaging complex socio-ecological systems: re-envisioning science, governance, and the California delta. Environmental Science & Policy 12, 644–652.
Oceans Policy Secretariat, 30 September 2001. Healthy Sea, Healthy Society: Towards an Oceans Policy for New Zealand: Report on Consultation Undertaken by the Ministerial Advisory Committee on Oceans Policy. Oceans Policy, Wellington N.Z.
Oreskes, N., Conway, E.M., 2010. Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming. Bloomsbury Press, New York.
Ozawa, C.P., 2006. Science and Intractable Conflict. Conflict Resolution Quarterly 24, 197–205.

Parliamentary Commissioner for the Environment, 2001. Key Lessons from the History of Science and Technology: Knowns and Unknowns, Breakthroughs and Cautions. Parliamentary Commissioner for the Environment, Wellington.
Parliamentary Commissioner for the Environment, 2003. Illuminated or Blinded by Science? a Discussion Paper on the Role of Science in Environmental Policy and Decision-making. Parliamentary Commissioner for the Environment, Wellington.
Parliamentary Commissioner for the Environment, 2004. Missing Links: Connecting Science with Environmental Policy. Parliamentary Commissioner for the Environment, Wellington.
Parliamentary Commissioner for the Environment, 2007. Outcome Evaluation: Missing Links: Connecting Science with Environmental Policy. Parliamentary Commisioner for the Environment, Wellington.
Peart, R., 2005. Looking Out to Sea: New Zealand as a Model for Ocean Governance. Environmental Defence Society, Auckland, N.Z.
Peart, R., 2006. Managing New Zealand's Coastal Development: the Role of National Policy Coast to Coast 2006 Conference, Melbourne.
Peart, R., 2007. Beyond the Tide: Integrating the Management of New Zealand's Coasts. Environmental Defence Society Incorporated, Auckland.
Reid, W.V., Berkes, F., Wilbanks, T.J., Capistrano, D., 2006. Introduction. In: Reid, W.V., Berkes, F., Wilbanks, T.J., Capistrano, D. (Eds.), Bridging Scales and Knowledge Systems: Concepts and Applications in Ecosystem Assessment. Island Publishing, Washington, pp. 1–17.
Rijsberman, F.R., 1997. Integrated Coastal Zone Management: Review of Progress in Selected OECD Countries. OECD, Paris.
Rittel, H.W., Weber, M.M., 1973. Dilemmas in a general theory of planning. Policy Sciences 4, 155–169.
Rosier, J., 2004. Independent Review of the New Zealand Coastal Policy Statement: A Report for the Minister of Conservation. School of People Environment and Planning Massey University, Palmerston North, N.Z.
Runhaar, H., van Nieuwaal, K., 2010. Understanding the use of science in decision-making on cockle fisheries and gas mining in the Dutch Wadden Sea: putting the science–policy interface in a wider perspective. Environmental Science & Policy 13.
Sarewitz, D., 2004. How science makes environmental controversies worse. Environmental Science & Policy 7, 385–403.
Scottish Executive Central Research Unit, 2001. Indicators to Monitor the Progress of Integrated Coastal Zone Management: a Review of Worldwide Practice. Scottish Executive, Edinburch.
Statistics New Zealand, 2006. Are New Zealanders Living Closer to the Coast?.
Tobey, J., Volk, R., 2002. Learning frontiers in the practice of Integrated Coastal Management. Coastal Management 30, 285–298.
Turner, R.K., 2000. Integrating natural and socio-economic science in coastal management. Journal of Marine Systems 25, 447–460.
University of Otago, 2005. The Impact of Rising Property Prices on Coastal Settlement Communities. Dept. of Geography University of Otago, Dunedin.
Vallega, A., 1997. Fundamentals of Integrated Coastal Management. Kluwer Academic Publishers, Dordrecht.
Weible, C.M., 2008. Expert-based information and policy subsystems: a review and synthesis. The Policy Studies Journal 36, 615–635.
Wood, R.S., 2006. The 96% solution: resources on and beneath the ocean floor. In: Royal Society of New Zealand Conference: New Zealand's Oceans and Its Future: Knowledge, Opportunities and Management, Auckland.
WWF New Zealand, 2004. In: Shining a Spotlight on the Biodiversity of New Zealand's Marine Ecoregion: Experts Workshop on Marine Biodiversity, 27–28 May 2003, Wellington, New Zealand. WWF-New Zealand, Wellington, N.Z.