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Developing Knowledge-Action Systems for Integrated Water Management in New Zealand

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DEVELOPING KNOWLEDGE-ACTION SYSTEMS FOR INTEGRATED WATER MANAGEMENT IN NEW ZEALAND

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Abstract:

The development of agricultural productivity and the management of water along sustainable ecological, economic and social trajectories require an integrated approach. Integrated water management is knowledge intensive across multiple scales. As New Zealand moves to set limits on water quantity and quality and respond to changing environmental values, both of which have implications for agricultural productivity, it has become apparent that the links between knowledge, policy and on-ground action are often missing. As a potential means of reconnecting these missing connections, this paper outlines the theory and practice of knowledge-action systems and their potential role in the coproduction of knowledge and policy across organisational, knowledge and institutional boundaries.

Introduction:

As New Zealand moves to set limits on water quantity and quality and respond to changing environmental values, both of which have implications for agricultural productivity, it has become apparent that the links between knowledge, policy and on-ground action are often missing (Clark and Holliday 2006; McDonnell 2008; Buhrs 2009; Regeer and Bunders 2009). To contribute to addressing the need to reconnect these missing connections, this paper outlines the theory and practice of knowledge-action systems and their potential role in the coproduction of knowledge and policy across organisational, knowledge and institutional boundaries. As such, the purpose of this paper is to open a conversation about knowledge – the knowledge on which we currently rely for making resource policy and management decisions, and the knowledge we might seek to produce in the future. It will be argued that *how* knowledge is produced can influence *what* knowledge is produced and, thereby, the willingness and capacity of policymakers and/or end-users to put that knowledge into on-ground action (Cash et al. 2006; Duncan 2011).

I address three questions. First, in general terms, what is the *status quo* in terms of the relationship between knowledge production and policy development and its limitations? I will argue that knowledge/policy interactions as they currently are configured can obstruct the management of our complex social-ecological issues and our capacity to address wicked problems (Batie and Schweikhardt 2010). My second question is what sort of knowledge do we need? I will argue that we need issue-based rather than discipline-based knowledge, and that this knowledge needs to be coproduced by scientists, policymakers and stakeholders (Roux et al. 2006; Cash et al. 20006; Regeer and Bunders 2009; Wallington et al. 2010). I will further argue that the knowledge we need should have scientific credibility as well as social legitimacy and relevance (Cash et al. 2006; Duncan 2011). My final question is what new institutional spaces could be created to produce the knowledge and policy that we need? I will argue that the knowledge-action systems framework holds considerable promise for opening up new knowledge spaces, spaces we might have thought not possible because we have been constrained in our thinking by conventional wisdom about the *status quo* relationship between knowledge production and policy development.

What is the *status quo*?

What is the *status quo* relationship between knowledge production and policy development? The first observation to make is that much of the knowledge used in social-ecological decision-making is required to be technical, scientific and quantitative. It is these attributes that engender authority and credibility (Bohme 1997; Porter, 1992). Given that our decisions are usually preventive

in intent, this technical, scientific and quantitative knowledge has to be predictive and, as such, is usually purpose-built (Wynne 1992; Duncan 2008). Whether for a consent to dispose of effluent into a waterway or to build a dam on a river, predictive models are indispensible for this purpose as they give decision-makers an approximation of what might happen to a river and a community without first having to pollute the waterway or build the dam (Duncan 2006, 2008).

Crucially, the *status quo* knowledge/policy relationship is configured as a linear 'science in/policy out' mode of interaction (Jasanoff and Wynne 1998; Batie and Schweikhardt 2010), which encourages the assumption that if sufficient disciplinary knowledge goes in the front end, good policy will come out the other (Cash et al. 2006; Wallington et al. 2010). For example, when a development is to be assessed for its potential effects or a policy change is developed to address a particular issue, standard procedure is to convert the issue into a set of, usually biophysical, scientific questions to be evaluated by the separate disciplines. Hence, the body of knowledge used to address an issue will be discipline-based. For example, hydrologists, geomorphologists, ecologists, economists and sociologists would convey separate understandings of what might happen to a river and a community if a dam was built. This is not to suggest that discipline-based knowledge is dispensable. On the contrary, disciplinary scholarship provides the depth of knowledge needed to address complex issues which otherwise would be unattainable.

What is the problem with the *status quo*?

What is problematic here is that each of the above disciplines would provide their individual perspectives in separate unrelated reports. The outcome for decision-makers is a very fragmented picture. When it comes to public input, individuals and communities are left bewildered when asked to comment on an issue they thought was of concern to them but which has been carved up and drawn out across, often, hundreds and hundreds of pages of reports (Duncan 2004). What is missing is an integrative framework to draw the best, collectively, from these individual disciplines (Buhrs 2009).

Integrative frameworks are obstructed by the persistence of the linear 'science in/policy out' model and its imperative to keep facts and values separate. Facts are deemed to be the realm of science while values are the realm of politics (Gieryn 1983). Keeping facts and values apart serves to uphold the authority and credibility of technical, scientific and quantitative knowledge. Importantly, this bifurcation serves to legitimise consequent political decisions (Gieryn 1983; Jasanoff 1990).

It needs to be recognised, however, that in the preventive context the authority and credibility of technical, scientific and quantitative knowledge cannot be derived from having revealed scientific reality because this purpose-built knowledge can only ever provide an approximation of what could or should happen in the future via predictive means. Already the legitimacy and credibility of a predictive model and its outputs are in question from the perspective of lay people and project opponents (Duncan 2004). It is well known by lay people that partisan judgments favouring a proponent or reflecting best case rather than worst case scenarios become embedded in the knowledge relied on for decision-making (De Jongh 1988; Wachs 1990; Irwin and Wynne 1996; Flyvbjerg 2003; Duncan 2003, 2004, 2006, 2008). The neglect of frameworks to negotiate problem definition before studies are commissioned to identify effects further erodes confidence. When resource conflicts get to the courts lay people's concerns are confirmed when it becomes clear that values permeate the so-called facts. Essential for running predictive models, assumptions and extrapolations that embed these values are easy targets to draw scientific conclusions and policy decisions into question (Jasanoff 1987, 1990).

Given that one predictive model can be as contingent as another, plaintiffs and defendants have to navigate the same knowledge/policy terrain. The result is interminable debates over technical issues that are unresolvable by the facts (Jasanoff 1990), especially given the complex nature of contemporary social-ecological issues. It is well known that legal controversies drain too much time and money for questionable gains. Ironically, the ultimate outcome can be the imposition of the values of a judiciary who end up arbitrating on the science of resource use decisions, thus further infusing values through the so-called facts of the matter.

If we consider the origins of the 'science in/policy out' model and compare its historic purpose with the contemporary context in which we are trying to apply it, we can see that conventional practice is likely to be constraining our capacity to manage social-ecological issues in a collaborative manner. For example, the use and abuse of technical, scientific and quantitative knowledge for political purposes goes back to the highly contested regulation by the U.S. Environmental Protection Agency in the 1970s of health risks from the use and disposal of chemicals (Jasanoff 1990; Wynne 1996).

What these circumstances demonstrate is that facts and values cannot be separated (Jasanoff 1990). They also demonstrate that in contemporary social-ecological contexts, the science/policy model that purports to separate facts and values, and which validates a 'set, notify and defend' *modus operandi*, proliferates fragmentation, contestability and confusion. It can also undermine the legitimacy and credibility of the knowledge and policy decisions derived therefrom in the eyes of communities and publics. Given that this model has demonstrated its capacity to inflame and perpetuate

disputes rather than ameliorating them, I would argue that it is time to consider a new knowledge governance model that more appropriately aligns with the new collaborative paradigm that has been adopted in New Zealand and internationally (Folke et al. 2005; de Loë et al. 2009; Duncan 2011).

Turning these insights to evaluating the implementation of the Canterbury Water Management Strategy, my preliminary observations from meeting minutes, direct observation and observer reports of the Hurunui-Waiau zone and regional committee proceedings are that the *status quo* 'science in/policy out' model is firmly in place in New Zealand. The knowledge that has been used to inform the Hurunui-Waiau zone and regional committee deliberations has been fragmented, contested and difficult for committee members to align and integrate. What this means in terms of the knowledge/policy relationship is that moves to a new collaborative paradigm, with the laudable intention of taking resource use issues out of the courts, have not been matched with moves to collaborate on knowledge production. Hence, it appears that the new paradigm relies on an out-dated and unreliable mode of knowledge/policy interaction. The question that remains to be answered is whether decisions derived collaboratively will unravel due to knowledge politics during the implementation stage.

What knowledge do we need?

Having described the *status quo* and its limitations, I now address my second question – what sort of knowledge do we need for the management of social-ecological systems? Returning to the hypothetical proposal of building a dam, issue-based rather than discipline-based knowledge would require an integrated, adaptive and collaborative approach to knowledge production and policy development (Wallington et al. 2010). Such an approach has the potential to bring together the ecological, social and economic dimensions of an issue to create a coherent integrated picture rather than many disconnected snapshots of the effects of a proposal. The crucial missing element is an integrative framework that can facilitate interactions between multiple actors across disciplinary, organisational and knowledge boundaries (Wallington et al. 2010).

Cash et al. (2006) maintain that to successfully link knowledge to action, knowledge needs to be salient, credible and legitimate to a range of audiences. Salience is about relevance and is important to end-users. Does the knowledge answer the right questions and is it in a form and provided at a time that is useful? Credibility is about technical adequacy. Have appropriate methods been used? How was data obtained? What sort of analysis has been applied? These issues are important to the scientific community but also end-users. Legitimacy is about fairness. Was the knowledge production process fair and open? Are there mechanisms to

facilitate the expression and resolution of conflicts? These issues are important for end-users and the wider community (Clark and Dickson 1999; Cash et al. 2006). Crucially, the attributes of salience, credibility and legitimacy are interdependent – a shift in one can shift another. Cash et al. (2006, 468) argue that "threshold levels of salience, credibility, and legitimacy" need to be maintained "while managing tradeoffs between them".

With an integrated framework, it is possible for complementarities and trade-offs between the ecological, social and economic aspects of a development to be identified and negotiated (Horwitz and Carter 2011). If knowledge is conceived as a "process of relating" between science, policy and stakeholder actors, rather than something to be transferred (Roux et al. 2006, np), we can see that an integrative framework could be useful for facilitating the production of knowledge and policy as well as building the credibility, legitimacy and salience of the knowledge base that underpins policy decisions (Cash et al. 2006; Duncan 2011).

It is on this basis that the theory of knowledge-action systems calls for the coproduction of knowledge and policy. This is in stark contrast to the conventional linear model that constitutes the domains of science and politics, or knowledge producers and knowledge users, as mutually exclusive (Jasanoff and Wynne 1998; Owens 2006). I will argue that knowledge-action systems have the potential to open up new knowledge spaces, spaces we might not have thought possible because we have been constrained in our thinking by conventional wisdom about the *status quo* relationship between knowledge production and policy development and the false dichotomy of fact and values.

What might be beyond the *status quo*?

My third question is what institutional spaces or capacity could be created to coproduce the knowledge and policy that we need? As discussed, knowledge-action systems seek to facilitate the coproduction of knowledge and policy (Cash et al. 2006). An important difference between the *status quo* that I have described and what is envisaged with knowledge-action systems is that the values and interests of those involved are made explicit in the process of coproduction. Conceived this way, knowledge takes on a new perspective – it becomes a means to an end rather than an end itself. As stated, a fundamental proposition of this coproduction knowledge governance model is that *how* knowledge is produced can influence *what* knowledge is produced and, thereby, the willingness and capacity of policymakers and/or end-users to put that knowledge into on-ground action (Cash et al. 2006; Duncan 2011).

Two useful concepts from the field of science and technology studies that have been identified as useful in the theory and practice of knowledge-action systems are boundary objects and boundary organisations (Cash et al. 2003). Conceived as a means, amongst others, to build institutional capacity these boundary entities have been shown to play a crucial role in encouraging the collaboration of knowledge producers and knowledge users to build stronger links between knowledge, policy and practice (Cash et al. 2003; Cash et al. 2006; Kelly et al. 2006; Wallington et al. 2010).

Boundary Objects

As explained by Duncan (2011), according to Star and Griesemer, the "boundary object" (1989, 409) is a means by which people from "distinct social worlds" (1989, 388) with different worldviews and values can co-operate. The boundary object is a concept or something more material that brings together and accommodates divergent social worlds. They can be "abstract or concrete" but "plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain common identity across sites" (1989, 393). Boundary objects can be maps, computer models, management plans, forecasts, policies and treaties, to name a few. A boundary object is "an object which lives in multiple social worlds and which has different identities in each" (Star and Griesemer 1989, 409).

The scope for multiple interpretations is an important characteristic of a boundary object. If appropriately chosen and deployed, boundary objects can facilitate cooperation, coherence and credibility across knowledge and institutional boundaries (Star and Griesemer 1989; Cash et al. 2006; Clark and Holliday 2006). Notably, boundary objects are not intended to generate consensus (Star and Griesemer 1989). Rather, they mediate the alignment of mutual interests by allowing those involved to retain their variant perspectives while also contributing to build common ground. In short, boundary objects can be a means of mobilising conflicting viewpoints for mutual outcomes. Hence, success in using boundary objects is determined by the multiple interests they align and how they are deployed. For several summarised case studies of the use of boundary objects see Wallington et al. (2010).

Boundary organisations

Duncan (2011) explains that boundary organisations, like boundary objects, are used to bridge divergent social worlds, but they play a broader role by facilitating, if not institutionalising, the use of boundary objects. Boundary organisations, as formal institutions or informal institutional collectives, can serve to translate ideas, vocabularies, practices and worldviews across knowledge and institutional boundaries that ordinarily serve to isolate science and policy communities (Cash et al. 2006). Guston (1999, 93) identifies three essentials for boundary organisations. They need to: 1. facilitate and

validate the use of boundary objects 2. bring together science and policy actors as well as professional mediators to enable co-production 3. embody arrangements that ensure accountability on both sides of a boundary.

According to Guston (1999), boundary organisations need to be strategically positioned between divergent social worlds and accountable to each of them. Guston (2001, 402) argues that rather than insulating itself from external political forces, the boundary organisation's success is determined by it "being accountable and responsive to opposing, external authorities". In other words, boundary organisations need to engender trust and goodwill both internally and externally. This means that boundary organisations can serve as conduits – they encourage dialogue, information and ideas to flow. They mediate and translate across knowledge and policy boundaries, across institutions and organisations. Importantly, this flow has to be moving in two directions, not just one. It is in this respect that seeing knowledge as a "process of relating" rather than something to be transferred is so important (Roux et al. 2006, np).

Knowledge-action systems in practice

To provide an example of how a knowledge-action system has worked in practice using a boundary object and a boundary organisation, Cash (2001) examines water management for irrigated agriculture on the Great Plains of the United States (see also Duncan 2011). Cash (2001) examines the role of the agricultural extension system as a boundary organisation in helping farmers to manage their irrigation practices with a depleting groundwater resource. He found that county extension agents and specialists using socio-economic, hydrogeologic and cropping computer models involved farmers in model development and refinement as well as data collection. The following, from an interview conducted by Cash with a county extension agent, illustrates the sort of facilitation, negotiation and mediation work the agents were involved in as boundary operators:

> There was a question of a policy [regulatory] change from the Ground Water Management District, and the producers [farmers] were questioning whether the policy was going to affect them adversely or not. And so it was a producer-driven need for an answer, to give them some credible knowledge to make a decision on whether or not they wanted that [new] policy in place. And so, as the agents, we contacted the university to find who was doing the study…. We got the department heads out there… the head of economics…and a couple of others. And we sat down with the members of the water board. … We sent letters to producers and got a group of producers together, and all of us sat down and hashed out what we would like to see done here. And the

> university went back and set up the model, and started working on the model, and then we started putting the baseline data together. … And it was a back and forth thing for several years getting it done because it was a rather involved model (Cash 2001, 441 [brackets in original]).

This extract illustrates how the coproduction of knowledge worked with the use of a boundary object facilitated by a boundary organisation. The knowledge users, the farmers, were actively involved with knowledge producers, the modellers, to produce knowledge and develop policy options that were robust in the eyes of the farmers, the modellers and the water utility. A crucial contribution to achieve this outcome was the farmers' participation, which gave modellers insight into on-ground issues and conditions. Access to local data and on-ground knowledge contributed to the modellers' ability to identify appropriate model parameters. This access gave them an opportunity to explain their model and its limitations to farmers and decision-makers. This interactive and iterative process gave the model and its outputs credibility for all involved. Importantly, this process allowed the modellers to produce a policy-relevant decision-making tool.

Contributing to the social credibility, legitimacy and salience (Clark and Dickson 1999) of the Great Plains groundwater model and its outputs was the extent to which farmers and water managers were able to contribute to the development and refinement of the model and its data inputs. The process built trust between actors around the model, its scenarios and its outputs because farmers had been involved throughout the process. In their role as mediators of disparate social worlds, the county extension agents brought together a broad range of actors and translated their needs and goals across knowledge, policy, organisational and institutional boundaries that otherwise would have isolated farmers, modellers and the water board. Cash (2001, 441) concludes that "neither community could have produced a model that was relevant and perceived as being scientifically sound without the other's participation. The county agent, in this case, acted as facilitator across the boundary between these two groups." Hence, the coproduction of knowledge and policy was facilitated by the use of a predictive model – a boundary object – and the county extension system – a boundary organisation.

Discussion

This Great Plains case shows that boundary objects and boundary organisations can accommodate divergent worldviews and facilitate coproduction. The county extension system, as a boundary organisation, was positioned between knowledge producers and knowledge users and it was accountable to both in terms of funding and mandated outcomes. The

problem to be addressed was co-defined while the knowledge and policy needed to address the problem were coproduced. The boundary object facilitated the flow of communication and information by creating a bridge between farmers, government agencies, scientists and modellers. The boundary object built a two-way bridge to allow the flow of communication, information and negotiation across knowledge, institutional and organisation boundaries. The predictive model that simulated water depletion scenarios on the Great Plains – the boundary object – introduced a common focus, and with all parties involved in its development, refinement and use, it had legitimacy collectively and individually.

Notably, we saw that the roles of farmers and modellers became interchangeable in terms of who was producing knowledge and who was using it (Duncan 2011). For example, with their local knowledge and essential data inputs, the farmers became knowledge producers and the modellers took on the role of knowledge users (MacKenzie 1990, Shackley and Wynne 1995, Duncan 2008). This interchangeability of roles enhanced the salience and legitimacy of the coproduction process and the knowledge/policy outcomes without compromising credibility.

According to Cash et al. (2006), the attributes of credibility, legitimacy and salience can be managed by boundary organisations with appropriate levels of convening, translation, collaboration, and mediation. Convening involves bringing knowledge producers and end-users together face-to-face to facilitate dialogue and build trust. Translation involves communication, assisted by boundary organisation intermediaries, to literally translate language, jargon, assumptions, methods, worldviews and practices to facilitate the breaking down of barriers and the flow of information and ideas. Collaboration means putting actors from different social worlds to work on a boundary object, for example, a model or a forecast. Mediation is about resolving conflicts that arise when issues or divergent ideas, values or interests collide. It involves open evaluation and mediation by people that are respected and trusted by those involved (Cash et al. 2006).

The Great Plains case demonstrates the importance of managing the salience and legitimacy of knowledge if there is an expectation for it to be applied on the ground by end-users. Cash et al. (2006) maintain that the institutional functions of convening, translating, collaborating and mediating are crucial for balancing salience, credibility and legitimacy and, consequently, linking knowledge, policy and practice. Importantly, with this framework, scientists would not relinquish their scientific credibility to accommodate end-users in the production of policy-relevant knowledge. Recognition of the need to balance the knowledge attributes goes some way towards addressing this tension. It does so not by dispensing with the need for establishing credibility but by enhancing it by building institutional capacity to engender salience

and legitimacy. Indeed, it would appear that with coproduction, scientific credibility could be substantially bolstered.

Conclusions

I have argued that conventional practice in terms of knowledge production and policy development is a constraint on managing social-ecological issues and addressing wicked problems. The tendency of existing knowledge/policy practice to generate fragmented and contestable knowledge for decision-makers, and proliferate confusion for stakeholders and publics undermines its utility in the contemporary context. In terms of the development and implementation of the Canterbury Water Management Strategy, the *status quo* risks undermining collaboratively-derived decisions and their implementation.

I have argued that the knowledge we need for the management of social-ecological systems should be issue-based rather than discipline-based, and that conceiving knowledge as a "process of relating" represents an important shift from treating knowledge as an end in itself to seeing it as a means to an end. The knowledge we need should be coproduced by scientists, policymakers and stakeholders (Roux et al. 2006). In this way, policy-relevant knowledge gains not only technical credibility but also social legitimacy and salience (Cash 2006). I have described the concepts of boundary objects and boundary organisations as important aspects of knowledge-action systems that represent opportunities for the creation of new institutional spaces to coproduce the knowledge and policy that we need. Importantly, the attributes of credibility, legitimacy and salience can be managed by boundary organisations with appropriate levels of convening, translation, collaboration, and mediation.

From a knowledge-action system perspective, the question we need to be asking is how do we collaborate to move from contested knowledge to negotiated knowledge? As a researcher who has focused predominantly on knowledge politics, I caution that this proposition is a little like asking a politician to 'stop playing politics' – an impossibility. Owens (2006, 636) cautions that coproduced knowledge could become "crudely instrumental" (Owens 2006, 636). This is a valid argument that could be raised against developing knowledge-action systems and partaking in the coproduction of knowledge and policy. However, having demonstrated that the separation of facts and values is a false dichotomy and described how boundary objects, in particular, can be utilised to facilitate dialogue and coproduction and, potentially, provide a means to move past conflict, it is reasonable to argue that knowledge-action systems have promise. There is a growing body of evidence in support of various knowledge-action systems formats in theory and practice (for example, see Wallington et al. 2010; Regeer and Bunders

2009). A negative aspect is that the development and implementation of knowledge-action systems can require considerable financial resources, time and effort. This is a drawback (Wallington et al. 2010). However, this does not have to be the case. Much can be done with existing resources and informal arrangements. What is required, in my view, is a focus on opening up new knowledge spaces, spaces we might have thought not possible because we have been constrained in our thinking by conventional wisdom about the *status quo* relationship between knowledge production and policy development.

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