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Analysis of operating environments: A diagnostic model for linking science, society and policy for sustainability

Peat Leith [a,b,*], *Kevin O'Toole* [c], *Marcus Haward* [a], *Brian Coffey* [d], *Chris Rees* [a], *Emily Ogier* [a]

[a] *Institute for Marine and Antarctic Studies, University of Tasmania, Hobart 7001, Tasmania, Australia*
[b] *Tasmanian Institute of Agriculture, University of Tasmania, Private Bag 98, Hobart, Tasmania, Australia*
[c] *School of Humanities and Social Sciences, Deakin University, Warrnambool, Victoria, Australia*
[d] *Alfred Deakin Research Institute, Deakin University, Burwood, Victoria, Australia*

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ABSTRACT

Through analysis of the dynamics between science and decision-making, we argue that diagnosing fit-for purpose approaches to linking science and decision-making may be possible. Such diagnosis should enable identification of appropriate processes, institutions, objects (e.g. tools, information products) and relationships that can facilitate outcomes. We begin the paper by unsettling the traditional constructions that science must distance itself from debates about values and what is at stake, and so from policy making. Then, drawing from mixed methods case studies in coastal South-eastern Australia, we describe how scientific research has had a bearing on decisions affecting society and the environment. These analyses suggest that the willingness and capacity of research organisations, programmes or projects to actively reflect on and participate in the evolution of the 'operating environment' for their research is integral to their ability to inform outcomes through science.

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1. Introduction

A fundamental challenge for sustainability stems from long-standing tensions between the domains in which knowledge is made and applied in contemporary society. Jasanoff (2003: 235) sums the challenge up well: "how to institutionalize polycentric, interactive, and multipartite processes of knowledge making within institutions that have worked for decades at keeping expert knowledge away from the vagaries of populism and politics". Traditional narratives in science and policy organisations tend to treat science, policy and politics as three separate spheres. Yet empirical research on the demarcation of roles and responsibilities across these domains indicates that their boundaries are blurred and continually renegotiated (Jasanoff, 1987; Wynne, 1994; Guston, 2000). Approaches to addressing the interactions between science and decision-making have tended to be normative rather than diagnostic. For example, boundary organisations that operate between science and decision-making

* *Corresponding author at*: Tasmanian Institute of Agriculture, University of Tasmania, Private Bag 98, Hobart, Tasmania, Australia. Tel.: +61 3 6226 2650; fax: +61 3 6226 7444.
E-mail addresses: Peat.Leith@utas.edu.au (P. Leith), kevin.otoole@deakin.edu.au (K. O'Toole), Marcus.Haward@utas.edu.au (M. Haward), brian.coffey@deakin.edu.au (B. Coffey), Chris.Rees@utas.edu.au (C. Rees), Emily.Ogier@utas.edu.au (E. Ogier).
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organisations and are accountable to both spheres (Guston, 2001) tend to be presented as a generic institutional and structural means of mediating and translating science for decision-making (Cash et al., 2003; McNie, 2007). Alternately, a focus on improving information products has drawn on psychological research (e.g. Kahneman and Tversky, 1996) to tactically refine scientific messages to improve 'science impact'.

In this paper we draw on relevant literature and a synopsis of five case studies of science integration for South-eastern Australia. We argue that this empirical and theoretical work provides grounds for a diagnostic approach to developing context appropriate interventions into the interactions between science and decision-making, in what we term the operating environment. We define the operating environment for sciences as the dynamic and cumulative interactions between actors, values, stakes, and the institutions, processes, discourses and objects that mediate such interactions. Our diagnostic model is proposed as an approach for analysing and re-configuring operating environments for science in specific problem contexts.

2. Trends in making useful science for environmental management

Empirical research on the effectiveness of science in environmental governance demonstrates that the linear model of science and its application to decisions (Wynne, 1994) is rarely effective in creating outcomes (McNie, 2007; Nelson et al., 2008; Leith, 2011). Analyses of practice have detailed how scientists and policy-makers frame problems in partial ways, between diverse values and interests, and negotiate the credibility and meaning of knowledge in relation to such framing (Jasanoff, 1987; Wynne, 1994; Guston, 2000, 2001). A more public concern for science has been the associations between sciences and specific interests, undermining the legitimacy of scientists, science agencies, or the scientific enterprise as a whole (Oreskes, 2004). Claims by scientists may also be perceived as illegitimate when they are made in isolation from local knowledge, through their apparent finality and purported authority (Wynne, 1992a,b).

The metaphor of boundaries has become an influential framing of the interactions between science and decision-makers. Boundary work has moved beyond its origins as a methodology for analysing 'credibility contests' among scientists (Gieryn, 1983; Gilbert and Mulkay, 1984). Scholars have adapted the concept of boundaries to analyse a variety of situations where science intersects with lay and policy domains. Jasanoff's (1987) seminal work on science-policy boundaries highlighted the complex negotiation of boundaries around responsibility and authority. Star and Griesemer (1989) detailed how 'boundary objects' (such as graphs, maps, and report cards) can be used to mediate knowledge between actors. Guston (2001) suggested that the creation of science-for-policy and policy-for science are two sides of a principal-agent problem that can be resolved through setting up 'boundary organisations' which sit between science and decision-makers and are accountable to both. For Cash et al. (2003) boundary spanning includes processes of convening, translating and mediating to create knowledge for decision-making in which synergies and trade-offs between the salience, credibility and legitimacy of that knowledge are negotiated. In all these forms of boundary spanning 'what we know' and 'who we are' are linked together (Jasanoff, 2004). Knowledge production and governance become a single system (Whatmore, 2009) in which the supply of scientific information meets the well-developed demands of decision-makers (McNie, 2007; Sarewitz and Pielke, 2007). There are multiple dimensions to problem definition that could help to guide focussed application of boundary spanning. However, two frames of reference – systems uncertainty and stake – have consistently been at the centre of debates about how to link science with decision-making (Funtowicz and Ravetz, 1993). Below we draw on two recent framings of these broad issues.

Firstly, Allenby and Sarewitz (2011) suggest that sciences and technologies can be thought of as having effects on three levels depending on the system complexity and uncertainty. The direct 'level one' effects are the usual goals of the application of a technology. 'Level two' interactions are the less immediate consequences that emerge from the interaction of human and biophysical systems at a local and regional level. At 'level three', these second level interactions are extended through interactions with global drivers to create even less predictable or manageable consequences. These three levels of interactions are reflected in inter- and trans-disciplinary research as means to better understand complex systems problems (Holling et al., 1998). Such research underpins adaptive governance, where policy creates experiments and research plays a key role in their evaluation (e.g. Holling et al., 1998; Innes and Booher, 2004; Cash and Buizer, 2005; Nelson et al., 2008; Hallegatte, 2009). The three levels of complexity and system uncertainty provide a useful lens for considering and defining system boundaries and therefore contexts for learning, policy review, and the scope of enabling research.

Secondly, stakes and the politics that arise from them are crucial to the structuring of problems. By stakes we mean the degree of interest or concern that individuals or groups have regarding particular issues, and the degree of associated value consensus or divergence. Stakes may be based on pecuniary, instrumental, non-instrumental, intrinsic, or any other values. Authors such as Hoppe (2011) and Turnhout et al. (2008) argue that politics structures problem situations in different ways depending on what is at stake for whom. Turnhout et al. (2008) develop a typology of problem structuring across which the role of scientists, policy processes and the forms of useable knowledge all vary substantially (Table 1). First, well-structured problems are those for which converging values and/or low stakes make a problem amenable to direct application of technical information. Second, moderately structured problems exist where there is a possibility of a majority reaching agreed goals, and relatively high certainty about science. Third, poorly structured problems are typified by dilemmas such that an outcome that is considered positive will create another that is considered negative, often depending on the divergent values and stakes. Finally, for unstructured problems, divergent perspectives exist about what the issue actually is, and

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