



Adaptive management intentions with a reality of evaluation: Getting science back into policy



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ABSTRACT

In Australia's Murray-Darling Basin water reform has been contentious as government attempts to reconcile historical over allocation of water to irrigation with the use of water for environmental outcomes. However, in many aspects, scientific knowledge of the environment is either imperfect, incomplete or environmental responses are unpredictable, with this uncertainty preventing definitive policy and closure of political arguments. In response to uncertainty and knowledge gaps, adaptive management has been written into the legislation, along with provisions for periodic evaluation.

This research ascertains how adaptive management is understood by policy makers, with this indicative of future implementation of adaptive management. The way in which adaptive management is constructed by policy makers is determined through legislation, public speeches, government reports and semi-structured interviews. The findings demonstrate that adaptive management has been subsumed by evaluation. The loss of adaptive management as a distinct concept is seen as a loss of science and discovery from the policy process, with the dominance of evaluation discussed as limiting innovation and reinforcing a 'muddling through' of policy.

1. Introduction

The complexity of the environment and ongoing, often unpredictable environmental and social responses to policy means that policy becomes continual experimentation with limited repeatability and replication (Folke et al., 2005; Pahl-Wostl, 2009). In response, the integration of knowledge from different sources and types is often advocated (see Nursey-Bray et al., 2014; Raymond et al., 2010; van der Molen et al., 2016 as recent examples), as is ongoing learning (see Folke et al., 2005; Pahl-Wostl, 2009). Adaptive management, with its participatory processes and knowledge discovery focus, is now widely accepted as a necessity in environmental management (Allan, 2009; Pahl-Wostl, 2009; Pahl-Wostl et al., 2013). Adaptive management gathers knowledge from across an environment's stakeholders to plan for experimentation as part of policy development (Walters and Holling, 1990); applying a paradigm of scientific problem solving within the policy process.

Despite widespread support for adaptive management, examples of successful adaptive management have remained scarce (Eberhard et al., 2009; Wilhere, 2002; Allen and Gunderson, 2011). Challenges with stakeholder engagement and acceptance of results, the complexity of the science and resourcing issues, both time and funding have been noted elsewhere (Allen and Gunderson, 2011). It has been suggested that legislated prescription of adaptive management is needed to

overcome these challenges and ensure it actually occurs (Lee, 1993).

In 2012 adaptive management became a defined term in Australian water legislation in the Murray-Darling Basin Plan (Commonwealth of Australia, 2012), providing a fit case to test these arguments for prescription in legislation. First, a brief literature review of adaptive management and evaluation is provided, followed by a description of the method used and an introduction to the case. Legislation, policy documentation and semi-structured interviews are analysed to determine the social construction of adaptive management by government. The results demonstrate that the true barrier to adaptive management is not the absence of legal requirement, but conflation of adaptive management with evaluation. The implications to water reform and more broadly, the role of science in policy are discussed.

2. Literature review

Regardless of its source (local or scientific) or type (tacit or implicit), the integration of knowledge in the policy decision making process remains at a tricky juncture with politics. Others have looked at this from the perspective of epistemology (Sanderson, 2002), discourse (Nursey-Bray et al., 2014) and communication barriers between scientists and policy makers (Laing and Wallis, 2016). The role of science in adaptive management, and policy making more broadly, introduces debate on the relationship between science and societal outcomes. To

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some there is an ‘inherently intractable’ problem with the unpredictable utility of research findings, whilst others assert that ‘contingency, complexity and non-linearity (i.e., in the relations between science policy decisions and societal outcomes) are obstacles to accurate predictions, but they need not prevent decision-making’ (Sarewitz and Pielke, 2007, p 6).

This research considers adaptive management and evaluation as two forums in which knowledge holders can seek an audience. These are opportune times in the policy process when new knowledge can come to the fore and be considered. Adaptive management, as initially conceived (see Holling, 1978), provides an opportunity for science to be integrated at policy planning, with the design of experiments to address uncertainties and gain new knowledge across a social and ecological system. This includes a wide array of scientific disciplines, from ecology and hydrology through to economics and sociology. In comparison, evaluation as a reflective process offers potential for knowledge gains on the response to policy to come to light and for this to iteratively improve policy. However, it remains the interpretation of adaptive management and evaluation by policy makers that affects how in practice, each provides potential for knowledge integration in the policy decision making process.

2.1. Adaptive management

The meaning of adaptive management has been debated over time, with adaptive management referred to as ‘experimental management’ (Walters, 1997), ‘learning by doing’ (for example, see Schreiber et al., 2004) and ‘structured decision making’ (Allen and Gunderson, 2011; Gunderson and Light, 2006). Across these views, there remains a consistent tenet of embedding research into policy at the time of policy development, so that policy includes experimentation that can resolve uncertainties and subsequently improve policy. Forms or types of adaptive management distinguish between active adaptive management, with multiple hypothesis testing, statistically designed experimentation and technical modelling; and passive adaptive management that monitors the response to single treatments (Hasselman, 2017; Lee, 1999; Walters and Holling, 1990).

Active and passive adaptive management both emphasise systematic and planned hypothesis testing, involve stakeholders working across knowledge disciplines, and remain strongly motivated by the need to gain knowledge of ecosystem function and address uncertainty (Hasselman, 2017). However, there are three broadly recognised types of uncertainty and the differences between them have important implications. This includes uncertainty that results from imperfect knowledge (undiscovered science), incomplete knowledge (knowledge that cannot be held individually but is collectively held across stakeholders), and unpredictability (unforeseeable futures with unknown society and environmental responses) (Brugnach et al., 2011, 2008; Pahl-Wostl, 2007). In addition to these three types of uncertainty, Pagan and Crase (2005) also note unforeseen changes to community preferences and government objectives over time.

Active adaptive management seeks to reduce imperfect knowledge with experimentation to discover new knowledge and determine the optimal solution (Walters and Holling, 1990), viewing knowledge as absolute and uncertainty as something to remove. In comparison, passive adaptive management seeks responsiveness to unpredictability. Each policy is seen as a single experiment accepting unpredictability as unresolvable, with this necessitating a responsiveness and ongoing adjustment of policy (Berkes, 2007; Brugnach et al., 2008; Huitema et al., 2009).

The context to which adaptive management is applied is important; particularly the types of uncertainty that are present in each specific case. There may also be unspoken differences in underlying epistemology that affects its interpretation (Hasselman, 2017). In this case, adaptive management is considered as a science-based activity that increases collectively held knowledge (imperfect and incomplete) and

experience (unpredictability), in order to make better management decisions. The ability to change decisions based on new information is just as critical to adaptive management as the ability to gain new knowledge or bring together knowledge.

2.2. Evaluation

Evaluation also plays a significant role in policy implementation and development, supporting evidenced based policy making (Sanderson, 2002). Evaluation involves evidence collection, often referred to as monitoring, and a process of applying judgement to an evaluand; or the subject of the evaluation. As such, evaluation has been described as an appraisal or systematic assessment of merit and/or worth (Guba and Lincoln, 2001). It has variably been seen as providing for performance improvement, organisational learning, accountability for results, learning about persistent social problems and how to address them, informed decision making and democratised decision making (Alkin, 2013; Greene, 2013; Sanderson, 2002). Scriven (2013, p 169, original italics) argues that a widely held misunderstanding is “that the difference between evaluation and research is that *research* is aimed at the acquisition of new knowledge whereas *evaluation* is aimed at developing information for decision making.” Scriven (2013) also draws a distinction between evaluative research and non-evaluative research, based on the distinction of value judgements that are used in evaluation to assess merit.

In Australia, evaluation has been shaped by public administration reforms in the 1980s, including the 1988 Evaluation Strategy (Rogers and Davidson, 2013). Australian evaluations have been described as concentrated to ongoing management of programs, commonly using theory driven approaches such as program theory or program logic, with emphasis on stakeholder participation (Rogers and Davidson, 2013). These program theory and logic approaches use causal pathways that articulate how policy and program activities lead to achievement of desired outcomes, with these in turn leading to achievement of objectives (Funnell, 2000). Assumptions underpinning the causal relationships may be stated, with monitoring and evaluation seeking to confirm these assumptions. In the confirmation of assumptions, causal pathways are also confirmed, achievement or contribution to achievement of outcomes is deduced, and eventually objectives are reasoned as being met. Evaluation most commonly occurs after a policy has been implemented, to test the achievement of policy (Rogers and Davidson, 2013).

In 2014 the Murray-Darling Basin Authority (MDBA) published a framework for the evaluation of the Basin Plan in which evaluation is defined as “a systematic process in which the particular objectives and outcomes being sought guide the development of a series of evaluation questions to be asked. In this case, what will we need to know to assess if the Basin Plan is on track?” (Murray-Darling Basin Authority, 2016 p. 6). This definition upholds a performance improvement and accountability view of evaluation, with evaluation serving a political and managerial mandate; demonstration of the intended outcomes provides accountability and validates the use of public resources.

In this context Scriven’s (2013) distinction between evaluation and research is particularly pertinent as it relates to the types of uncertainty that may be resolved or identified. The main purpose of a performance and management oriented evaluation is to assess progress, through a causal pathway of outcomes, towards stated objectives. This essentially narrows the scope of investigation to testing environmental and social response to policy, or unpredictability. In this way, policy and programs remain a sequential testing of single hypothesis and evaluation is aligned with passive adaptive management. The relationships between adaptive management, uncertainty and evaluation are shown in Fig. 1.

<p>Adaptive management</p>	<p>Passive adaptive management</p> <p>Monitoring the unpredictable response to policy and adjustment to remain on track to desired outcomes.</p> <p>Also known as ‘learning by doing’ and ‘structured decision making’</p>	<p>Active adaptive management</p> <p>Experimentation to test policy alternatives, addressing imperfect knowledge</p> <p>Also known as ‘experimental management’</p>
<p>Uncertainty</p>	<p style="text-align: center;">Incomplete knowledge</p> <p style="text-align: center;">Acknowledges that full system knowledge is collectively held by stakeholders, not by any individual party. Includes local knowledge. Active and passive adaptive management can include stakeholders in planning and implementation.</p> <p>Unpredictability</p> <p>The response to policy are unknown, with unexpected changes</p> <p style="text-align: right;">Imperfect knowledge</p> <p style="text-align: right;">There are limits to knowledge with gaps in the science.</p>	
<p>Evaluation</p>	<p>Effectiveness and impact evaluation</p> <p>Questions have the intended outcomes been achieved and is the evaluand of merit?</p>	

Fig. 1. Relationships between adaptive management, uncertainty and evaluation.

3. Method

3.1. Case study – the Murray-Darling basin

Water reform has been contentious as government attempts to reconcile historical over allocation of water to irrigation and balance the use of water for environmental, social and economic outcomes (Commonwealth of Australia, 2016). Water reform can be broadly contextualised to the National Water Initiative (see Grafton and Horne, 2014), however it was in 2012 that adaptive management became a defined term in Australian legislation with the passing of the Murray-Darling Basin Plan (Basin Plan), and subsequently, for this research, the Basin Plan has been determined as the appropriate unit of analysis. The following overview of the Murray-Darling Basin is brief and focused to key points necessary for this paper. Others have published more detailed accounts of the governance history, ecological and social challenges and conflict (see Guest, 2017; Connell, 2015).

Currently water governance is done by six jurisdictions, being each of the four States and the Territory that the Murray-Darling Basin spans and the Commonwealth (see Fig. 2). The Basin Plan determines the maximum volume of water that can be sustainably extracted for urban, industrial and agricultural use (Sustainable Diversion Limits), provides the latest reform on water trading rules and sets a planning hierarchy for the use of licenced water for the environment.

The State and Territory governments administer water licences that provide irrigators with a share of the water resource (also called entitlement), with the actual volume determined (allocation) based on seasonal conditions (Commonwealth of Australia, 2016). Water use and trade is governed through rules established in regional scale Water Resource Plans, as developed and legislated by State governments. These Water Resource Plans must align with the Sustainable Diversion Limits set by the Basin Plan and require accreditation by the Commonwealth (Commonwealth of Australia, 2012). State and Commonwealth governments also hold water licences, as purchased directly from the market or acquired through infrastructure grants. This licenced water is used for specific environmental outcomes, with actions such as watering wetlands or river flows for fish breeding.

The Basin Plan is said to be based on the “best available science”,

and the heavy reliance on science such as hydrologic modelling in setting the Sustainable Diversion Limits at the time of policy development led to criticism of the Basin Plan as technocratic (Daniell, 2011). “Best available science” also recognises that in parts of the Murray-Darling Basin, scientific knowledge of the system is either imperfect, incomplete or system responses are unpredictable. In particular, the ecological, social and economic responses to the Basin Plan are uncertain, and remain points of contention and debate (Commonwealth of Australia, 2016).

3.2. Data collection and analysis

The beliefs and actions of individuals shape policy, with the social construction of a practice arising “through the ability of individuals to create and act on meanings” (Wagenaar, 2012; see also Bevir and Rhodes, 2005). As such, the understanding of adaptive management by leaders within the development and implementation of the Basin Plan will determine how it will be implemented. It is worth noting that the first five year review of the Basin Plan is anticipated in 2018, and it is expected that this will further evidence this translation of meaning into action. Qualitative research, using document analysis and interviews, has been conducted to understand the current social construction of adaptive management.

Document analysis included legislation, planning documents, published reports, policy statements and speeches. Interviews were conducted with 16 Commonwealth, ten NSW policy makers and implementers and four regional stakeholders with roles in developing and implementing the Basin Plan and associated State planning instruments. The sample covered different aspects of water reform within the Murray-Darling Basin (water resource planning, environmental water planning, river operations) and included public servants and individuals appointed to representative or leadership roles. These interviews sought to determine how adaptive management is socially constructed, under the framework set by the Basin Plan and associated governance arrangements. The interviewees included past government employees involved in the development of the Basin Plan and those currently involved in its implementation. The research purposefully targeted those in leadership positions, such as Authority members,

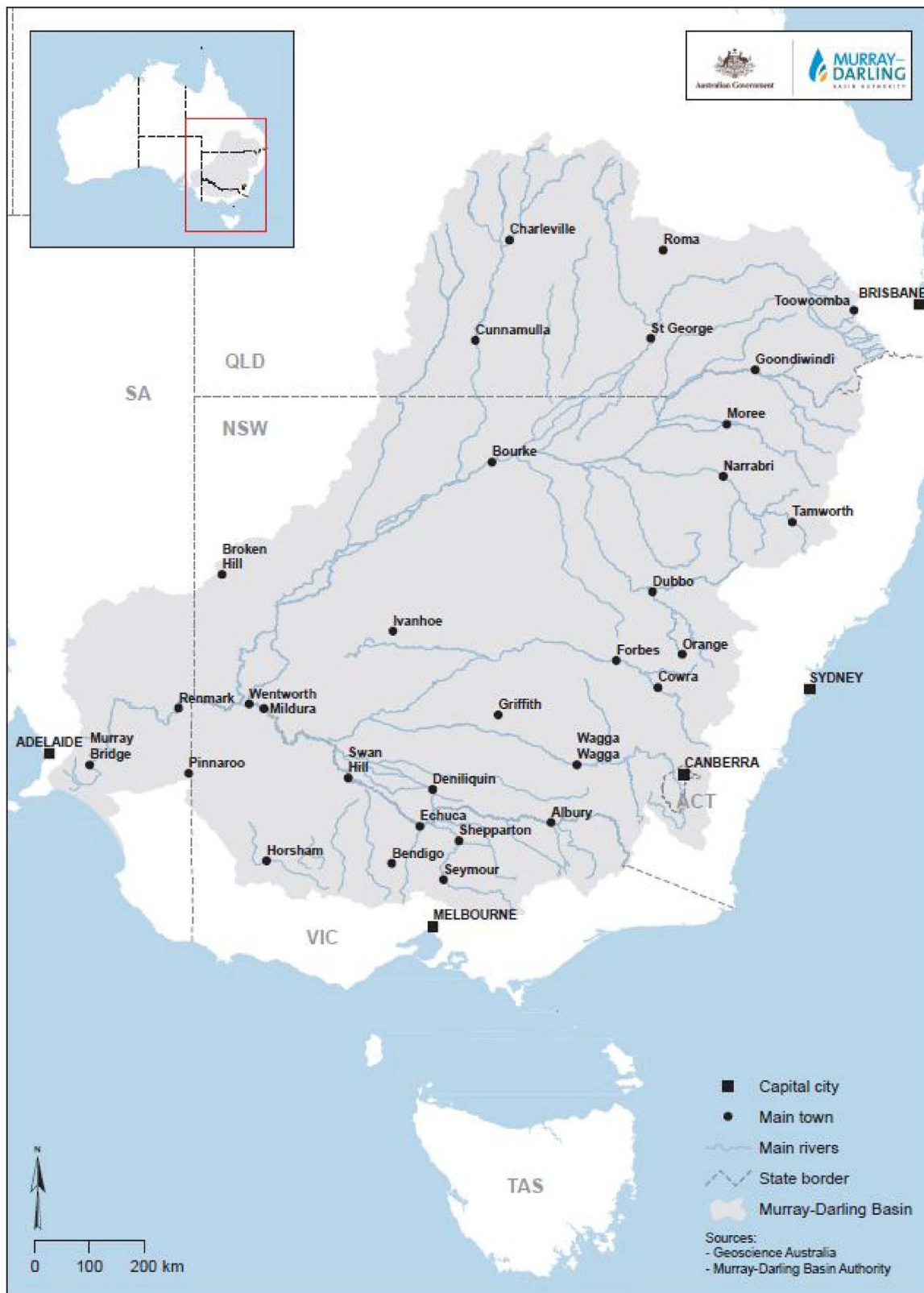


Fig. 2. The Murray-Darling Basin, Australia.

Source http://www.mdba.gov.au/sites/default/files/cartographicmapping/8_Murray-Darling_Basin_Boundary.pdf (accessed 31.05.16)

executive and senior level staff, as these individuals have greater influence in setting policy directions. In respecting the anonymity of the interviewees, quotes are attributed to Commonwealth, State or Regional.

Saturation point was reached, when no new themes were emerging (see Glaser and Strauss, 1966). The interviews were semi-structured and explored views and experiences of adaptive management. The interviews included questions on the definitions of adaptive management,

example cases of adaptive management in practice and challenges to adaptive management. The interviews were transcribed before being thematically coded using Nvivo software.

In summary, this research sought to understand how adaptive management is socially constructed by policy makers, in light of it being stipulated in legislation. The possible implications for policy are then discussed.

4. Results

4.1. The documented meaning of adaptive management

The meaning of adaptive management has been determined from government documentation, including the Basin Plan, reports published by the Murray-Darling Basin Authority, and public speeches by the Chair of the Murray-Darling Basin Authority. With the passing of the Basin Plan, adaptive management became a defined term in legislation for the first time in Australia.¹ In Section 1.07 of the Basin Plan “adaptive management is taken to include the following steps:

- (a) setting clear objectives;
- (b) linking knowledge (including local knowledge), management, evaluation and feedback over a period of time;
- (c) identifying and testing uncertainties;
- (d) using management as a tool to learn about the relevant system and change its management;
- (e) improving knowledge;
- (f) having regard to the social, economic and technical aspects of management. (Commonwealth of Australia, 2012)

With respect to the differences between active and passive adaptive management, the Basin Plan positions management as a learning tool and relates adaptive management to evaluation and feedback in a context of set objectives, uncertainties that need to be identified and with regard to social, economic and technical ‘aspects’. The definition makes no reference to modelling or experimentation; it states objectives rather than hypotheses and evaluation rather than science or research; and with specific mention of local knowledge. While it can be argued that in doing several of the steps a) to f) experimentation and other active adaptive management processes can be used, it is not required by the definition. While there is some ambiguity, the definition is taken here as suggesting passive forms of adaptive management, due to its neglect of research and sympathies to responsiveness.

This interpretation as passive is confirmed in looking at how the term adaptive management is applied in the Basin Plan. Adaptive management as a defined term is used nine times throughout the Basin Plan. Across these references, adaptive management is intended to contribute to decision making, evaluation is to contribute to adaptive management, and adaptive management will be evaluated. A relationship between science and adaptive management is not apparent, instead, monitoring and evaluation of the Basin Plan is seen to both contribute to adaptive management and to improving knowledge. Adaptive management is about responding to triggers and applying a management process, and therefore confirms the passive interpretation. A performance paradigm dominates, with both adaptive management and evaluation linked to policy effectiveness and responsiveness.

In a speech to the United Nations, the Chair of the MDBA described

¹ Other legislation, such as the NSW Water Management Act 2000 ambiguously refers to the “principles of adaptive management” (Section 5 Water Management Act 2000 No 92 Chapter 2 Water management planning Part 1 General Division 1 Water management principles), “objectives of adaptive management” (NSW Water Sharing Plans made under the Water Management Act 2000) or “an adaptive management framework” (Murray-Darling Basin Amendment Act 2002–Schedule 1 http://www.austlii.edu.au/cgi-bin/sinodisp/au/legis/qld/bill_en/waolab2010362/waolab2010362.html?stem=0&synonyms=0&query=%22adaptive%20management%20%22)

the Basin plan and its implementation as “based on adaptive management” because “it’s meant to be a flexible plan because in nature, things change. As we discover better ways to do things, we need to respond. Equally, we need to be ready to adjust to things like seasonal and climate changes.” In this speech the Chair also stated “but, it’s not just a ‘science experiment’...the plan recognises the need to make judgements and decisions based on social and economic impacts” (Murray-Darling Basin Authority, 2013). This managerial and passive view of adaptive management is repeated in other public speeches and corporate documents, such as annual reports and in the evaluation framework published by the MDBA. For example, the evaluation framework states “adaptive management is a systematic process for continually improving management practices through learning from the outcomes of previous management” (Murray-Darling Basin Authority, 2014 p 28). The organisation and leadership has provided a strong rhetoric of adaptive management as necessary, and that adaptive management is responsive policy implementation in the face of unpredictability.

4.2. Social construction of adaptive management

In interviews, adaptive management was espoused as necessary and important by all interviewees. The reasons included demonstrating the success of the plan, improving implementation and to provide accountability. Statements of importance and support included “It’s really important, it’s expensive to collect, but it would be just irresponsible not to do it” (State 1) and “You obviously have to do it, and you have to do it as well as you possibly can. It’s part of the accountability” (Commonwealth 13).

However, in questioning the definitions of adaptive management, the interviews confirmed a lack of clear meaning. Adaptive management was described as “more of a buzz word and an ideal rather than reality” (Regional 17) and “It’s a bit of an overused term, and I don’t think we do it particularly well. I guess it’s so overused I’m a bit over it to be honest.” (State 21) One interviewee even stated “the difficulty is though it’s very, very, very hard to define. Nearly everybody you talk to, and you will probably find this, has got a different idea of what it is.” (Commonwealth 19) The definitions provided by interviewees commonly referred to learning by doing, checking progress to objectives, monitoring, review and management. One interviewee used the word hypothesis, but explained adaptive management as passive with response and adjustment, stating “adaptive management is about coming up with probably a hypothesis, and then putting things in place to review that and adapt accordingly.” (Regional 11) In this, there was no discussion on putting experiments in place to test any hypotheses or resolve imperfect knowledge. A few interviewees acknowledged the difficulties of implementing large scale, replicated experiments in a varied landscape noting “when you start talking about social-ecological systems, it becomes much more difficult, and you can’t avoid your approach to adaptive management being more passive.” (Commonwealth 19) Despite the interview not questioning evaluation, the word itself occurred in 22 interviews, a total of 147 times. Evaluation language featured strongly, with some specifically noting efficiency and effectiveness with a typical definition of adaptive management provided by the interviewees being “implementing on the ground an outcome, and then considering or evaluating how what was actually achieved”. (Commonwealth 25)

Adaptive management, despite its definition and prescription in legislation remains an enigma. There is an overriding use of monitoring and evaluation language, a dominance of passive forms of adaptive management, as connected to evaluation, and a loss of experimentation to gain scientific knowledge. For example, contrary to the legislated definition, it is not possible to find a list of identified uncertainties or the research that is underway. While there has been an Advisory Committee on Social, Economic and Environmental Sciences (ACSEES) established and “the committee’s role is to provide strategic advice on science and knowledge to underpin the implementation of an adaptive Basin Plan,” it has a single page on the MDBA website, with no links to further information, details of its meetings, work or publications (Murray-

Darling Basin Authority, 2016). The prevailing construction of adaptive management by those implementing the Basin Plan is as part of or following an evaluation. Adaptive management is about achieving the policy's objectives, not changing or testing objectives with new knowledge on environmental functions; *“Adaptive management works on the basis of seeking to achieve the outcomes that were originally set, and having a robust and transparent process in place to make adjustments along the way, if needed to achieve those outcomes.”* (Commonwealth 12)

4.2.1. Implementation challenges and limits to adaptive management

To further test perspectives and understanding of adaptive management, the interviewees were asked for good examples of adaptive management. Several responded that they could not think of a good example of adaptive management and the same example of localised trial and error was mentioned by a number of interviewees, confirming a lack of adaptive management in practice. Some interviewees noted the Sustainable Diversion Limit adjustment process as a good example. In seeking explanation for the limited availability of good examples, the challenges to adaptive management were questioned.

The challenges identified by interviewees largely confirmed the literature on evaluation barriers. The ‘usual suspects’ of cost, unclear responsibilities, lack of information, organisational culture, time, data complexity, landscape differences and scale of implementation were identified (see Carter and Ross, 2013). For example, landscape differences and scale were seen to limit replication and transferability, with statements such as *“There are rivers where we are relaxing constraints, but we're not setting up an experiment. Could you compare, say, the Lachlan to the Gwydir? I just don't know if you could do it effectively”* (Commonwealth 19) and *“The bigger the area, the more the people, the less active it can be and the more you move into a passive.”* (Commonwealth 15)

In describing challenges to adaptive management, evaluation featured strongly in the responses. For example, cost was identified on the basis that *“in a tight fiscal environment, the monitoring and evaluation programs are the ones that tend to get dropped off, unfortunately.”* (State 14) Similarly, challenges associated with data complexity and quality of information was described as *“Having good data and information that's feeding into that. You've got to have a good monitoring program on the ground. You've got to be able to have an effective way of evaluating the outcomes from that.”* (Commonwealth 25) In these cases, evaluation is seen as adaptive management, in line with the above noted merging of the concepts.

In addition to the usual suspects, politics and conflict were also raised. These challenges surfaced as public support for decisions and cross jurisdiction politics and accountabilities. For example, public support for decisions were seen as changing over time, creating a time limit or lifespan on legitimacy, *“even if you can accurately reflect community values and take them broadly into SDLs [Sustainable Diversion Limits] and you put it in, even if you could get that right, the following day you would be wrong, because community values are always changing”* (Commonwealth 15) and *“some of the information maybe comes from the scientists then you've got to translate that information into a way that can win the public and bring the public along. We shouldn't underestimate the role of that, I don't think, in adaptive management in the long term will be successful because ultimately you don't do anything unless you get the social licence to do it.”* (Commonwealth 30)

Conflict over water use was also identified as restricting adaptive management, particularly when specific details, such as a volume for Sustainable Diversion Limits is negotiated and then legislated. For example, *“I think it's [adaptive management] also at odds with our political process and also what the community expect when they want finite outcomes to be clearly defined and delivered.”* (Regional 16) In this context, adaptive management becomes limited and any change to policy is a point of conflict; *“anytime those policies, particularly the ones that are legislated, that they need to be changed there's always going to be conflict.”* (Commonwealth 13) and *“There are too many people, too many vested interests who don't want to change things and they always take longer,*

hugely longer than you expect.” (Commonwealth 18)

Cross jurisdiction governance and accountabilities was another way in which politics surfaced as a challenge to adaptive management. The closure of the independent National Water Commission and shift in the responsibility for external review and audit of Basin Plan implementation was described by one interviewee as reducing the imperative for the State's to respond and change, *“there's nothing to oblige the State's to actually make changes as a consequence of the Productivity Commission's reporting.”* (State 12) Here, a weakening of political will to change, through a loss of accountability, is seen as curtailing adaptive management. It is also possible that the conflict in setting the Basin Plan has contributed to a rigid adherence to past political agreement; however this was not noted by any of the interviewees.

In returning to the documentation, there were also limits evident here. For example, the Basin Plan itself can be viewed as limiting adaptive management in regards to the legislated process for adjusting the Sustainable Diversion Limits. The Basin Plan acknowledges that the figures used to determine the Sustainable Diversion Limits were based on river management infrastructure expected to be in place and *“the level of scientific understanding of the Basin hydrology and ecology at that time”* (Commonwealth of Australia, 2012 p 36) and Chapter 7 outlines an adjustment process for the Sustainable Diversion Limits. However, for surface water the Basin Plan only permits adjustment on the basis of improved efficiency and supply of water. There are no provisions for new information on river systems, ecology or unpredicted negative impacts (social, economic or environmental). In addition, any experiential learning gained by river operators and Basin Plan implementers is not recognised as cause for change. The final limitation on adaptive management of the Sustainable Diversion Limits is that the net adjustment, Basin wide cannot be greater than 5%.²

Lastly, and possibly most significantly, the coupling of adaptive management and evaluation in the Basin Plan is also limiting. Chapter 13 of the Basin Plan describes adaptive management as making a change as a result of an evaluation, effectively limiting adaptive management to occurring with the scheduled five and ten year reviews or by request of a State Minister. Changing the Basin Plan requires an amendment to the legislation, or as one interviewee bluntly stated *“the bloody Act of course has to go through Parliament so it's not a trivial manner to change the Basin Plan.”* (Commonwealth 18)

5. Discussion

The definition of adaptive management provided by the Basin Plan connects adaptive management to evaluation, with this echoed by the interviews. The sample of 30 interviews was restricted to only NSW and Commonwealth governments due to resource constraints. However, the prevalence of adaptive management as passive, initially in the legislated definition and with such consistency in interpretation by policy makers gives weight to the finding that adaptive management has been redefined as evaluation. This social construction of adaptive management as evaluation has implications to future water reform and the role of science in policy.

5.1. Adaptive management and evaluation in the Basin Plan

The social construction of adaptive management as evaluation is consistent with the Basin Plan's definition, and the MDBA's evaluation framework. Adaptive management has been interpreted to just one form, passive adaptive management, occurring as the results of policy are monitored and periodically evaluated for progress against policy objectives. This is problematic on two fronts, firstly it narrows

² See Section 7.19 “Note: This section allows a supply contribution or an efficiency contribution of more than 5% of total surface water SDL to each be given full effect in an adjustment, provided that the net effect across the Basin is within the 5% limit” (Commonwealth of Australia, 2012).

knowledge discovery and in doing so there is a loss of explicit attempts to resolve imperfect and incomplete knowledge, and secondly the use of value judgements.

The role and emphasis on knowledge discovery in adaptive management and evaluation differs significantly. The adaptive management ideals of scientific discovery to address uncertainties, particularly those arising from incomplete and imperfect knowledge, remain largely incongruent with evaluation. Evaluation is not regarded as generating new knowledge on how ecosystems or natural resources function, but rather checks if they respond to policy as intended, seeking to confirm or refute the results of policy or program with respect to its objectives. The policy or program itself becomes the single hypothesis that is being tested, with correcting management responses to deviations from policy objectives. In evaluation, science and local knowledge is limited to confirming an assumption underlying a causal pathway, or detecting a change at the outcome level, for example, in resource condition. Furthermore, the performance orientation and use of evaluation to provide accountability for the use of public resources fosters a confirmation bias. This finding aligns with the views of Sanderson (2002) who questions the self-fulfilling design of pilot programs and consequent (in)ability to evaluate potential policy transferability to other contexts. One interviewee put this into perspective in stating, “*The assumptions that we have behind them are generally well established. The science doesn't come back and tell you an awful lot about those assumptions. You wouldn't have done it if there wasn't some science to support it.*” (State 10)

The second problem is the differing role of value judgements in adaptive management and evaluation. Adaptive management, taken as a way to improve policy by increasing knowledge does not involve passing judgement or assessing merit. In stark contrast, and as noted by Scriven (2013), a key distinction between research and evaluation, is that value judgements are used in evaluation to assess the merit or worth of a policy or program. One interviewee noted this difference in evaluation and the scientific discovery of adaptive management, stating “*Data can kind of provide some of the script for the thinking about those choices, but the choices are so inherently a value choice. To suggest that its adaptive management gives it a scientism which I think isn't there*” (Commonwealth 13). A few interviewees specifically spoke about the role of science, recollected development of the plan as “*No one wants to hear about experiments and research. Part of the culture here was, 'Do not talk about research. Do not talk about experiments. Do not mention science explicitly.' ... but people are more comfortable with the passive end*” (Commonwealth 19).

To these interviewees politics and science were not compatible, it remains the role of politics to apply value judgements and as a result only certain forms or applications of adaptive management are palatable. This finding is particularly pertinent to other studies of the science-policy interface and the role of scientists in policy making.

The first five year evaluation of the Basin Plan is due in 2018 and this will provide more conclusive evidence, and demonstrate if the social construction of adaptive management as evaluation has indeed resulted in a loss of scientific discovery to address imperfect and incomplete knowledge. While the outcomes of the Basin Plan may take time to develop, an evaluation that questions effectiveness against intended outcomes does not entail a search for alternative approaches or test the appropriateness of policy.

5.2. Implications to water reform

Essentially the Basin Plan hypothesises that reducing the volume of water extracted for consumptive use and using licenced environmental water to water rivers and wetlands will improve the environmental conditions. Evaluation ensures that progress within this pathway is monitored and judged. Monitoring and research is designed to confirm the hypothesis, with responsive incremental refinements along the set pathway, or single loop learning that seeks to essentially do the same

thing better (Pahl-Wostl, 2009). Reinforcing this restraint on change, the interviewees noted that the legislation itself limits the extent of change and adaptive management. This is supported by the document analysis of the Basin Plan, for example with its specified constraints on adjustments to the Sustainable Diversion Limits. Change is only possible within the pathway of adjusting volumes, as set by the plan.

Exploration of alternative hypothesis remains missing. To illustrate, European carp represents 90% of the fish biomass in the Murray-Darling Basin (PestSmart Connect, 2016) and carp negatively impact on water quality and native fish populations (Department of Agriculture and Water Resources, 2016). Recently government has committed \$15 million to reducing European carp from the Murray-Darling Basin, with the Deputy Prime Minister, The Hon. Barnaby Joyce stating in his media release, “*The Coalition Government has long supported an adaptive approach to environmental management in the Murray-Darling Basin that goes beyond looking solely at water in and water out.*” (The Hon. Barnaby Joyce, 2016) This posits an alternative reason for declining environmental health. It could be hypothesised that a number of stressors, including European carp, have weakened the system. In this weakened system, volumes of water previously extracted are no longer adequate to maintain environmental sustainability. Testing a hypothesis that environmental stressors are reducing the ‘safe’ volume of water extraction provides for new knowledge on the problem itself, and may entail a significantly different policy package. Another untested hypothesis is that water delivery and extraction can be done in more environmentally compatible ways, with slower delivery to reduce rapid rises and falls in river levels.

The redefining of adaptive management to evaluation limits the testing of such alternatives, with imperfect and incomplete knowledge remaining largely ignored. Evaluation reinforces a path dependency, in this case an engineering paradigm of reducing extraction volumes and applying water for environmental outcomes. Future evaluation of the Basin Plan will test how implementing this single hypothesis has improved environmental condition, without exploring alternatives. As a result, policy will remain an incremental muddling through along a set pathway.

5.3. Implications to the role of science in policy

Adaptive management and evaluation both seek to learn, with the ultimate purpose being to gain improved outcomes for society. However, adaptive management looks to address imperfect knowledge, incomplete knowledge and unpredictability with research planned as part of policy, while evaluation uses the experience gained resulting from implementation to identify performance improvements. In evaluation, and arguably also in passive forms of adaptive management, monitoring checks existing understanding of system operation, to fine tune actions in response to unpredictability. Rather than exploring alternatives, it is structured to a confirmation bias. The reinterpretation of adaptive management to evaluation, effectively redirects adaptive management to a performance management concept, as a managerial tool. The evaluation forum is open to those who can confirm, or less likely, refute, causal pathways within the program theory, with learning resulting in reinforcement rather than change (Weible et al., 2011). It means an incremental improvement of policy towards its stated objectives, or as asserted by Marshall and Alexandra (2016), institutional path dependence in the Murray-Darling Basin.

Adaptive management reinterpreted as evaluation, means a weakening of scientific inquiry through focusing knowledge discovery to unpredictability, omitting or redirecting away from imperfect and incomplete knowledge. Developing collective understanding of the problem itself or testing of alternative hypothesis remains outside of scope of evaluations on the effectiveness of policy. The scope of evaluation is bounded by the policy hypothesis and objective, with ‘supply’ and ‘demand’ for science limited accordingly (Sarewitz and Pielke, 2007). In effect, the result is a ‘blinkering’ of science to single loop affirmation,

with new knowledge, or the deeper questioning of second loop learning marginalised from the policy making process. Where others have found that “room for experimentation is an important factor in improving environmental governance,” (van der Molen et al., 2016), here it is clear that the scope for experimentation is limited to monitoring unpredictability.

Whether or not this is intentional, accidental, through ignorance or because the Basin Plan as a policy is not amenable to such a task remains debateable. Based on the challenges identified in the interviews, it could be argued that the logistics associated with adaptive management have steered it towards evaluation. It could also be argued that the conflict and political challenges have made evaluation a much more attractive prospect; the risk associated with science providing proof of poor or incorrect decision making by government may be too great.

A fuller approach to adaptive management that systematically seeks to address more than just unpredictability is needed or policy development will be limited to incrementalism, or first loop learning. The scientific testing associated with adaptive management that seeks to experiment to discover new knowledge and deliberative processes to engage multiple perspectives in decision making pushes towards, questioning objectives and values. In the absence of science, exploration and innovation with alternative solutions is limited.

6. Recommendation and conclusion

Adaptive management and evaluation are two distinct concepts and practices. However, ambiguities within the legislated definition have enabled policy makers to interpret adaptive management as evaluation. The common step of changing policy or making decisions based on findings is not an adequate reason to merge these concepts; that management may change or in other words, adapt, on the basis of findings, merely draws attention to the poor and ambiguous naming of the concept of adaptive management.

The merging of the two concepts means that adaptive management is no longer able to meet its intended purpose, and no longer provides a platform for imperfect and incomplete knowledge to be included in policy. The dominance of evaluation and its paradigm of performance improvement designed to test the achievement of set objectives, acts to confirm policy choices and contributes to decision accretion. It fails to test alternative hypotheses and overlooks questioning the underlying values that contributed to initial decision making. Over time, it leads to a narrowing of choices, with incremental muddling through.

A number of logistical challenges may have contributed to the merging of adaptive management and evaluation, but it is proposed here that the underlying causes are conflict and politics, with this proposition requiring further testing. However, it does appear in the case study, that adaptive management poses a political risk, with science having the potential to question the wisdom of past decisions, challenging accountability. There remains a strong political need to remain accountable to highly negotiated and specific outcomes. Instead evaluation offers a validation of objectives, confirmation of policy choices and sense of accountability.

Despite the challenges, scientific problem solving and performance improvement are both essential to governance of natural resources, and the problem of bringing together research in policy remains. As a start, clear statement of uncertainties and hypothesis at the outset of policy design is required, as originally provided for in the Basin Plan's definition of adaptive management. A fuller solution is to embrace the temporal distinction between adaptive management and evaluation, and use this to create a clear separation between each practice with a stepwise approach to each type of uncertainty. This would firstly entail seeking to resolve incomplete knowledge by gathering local knowledge and using this to identify alternate hypotheses. Suitable research to test these hypotheses can then be designed and incorporated into a package of policies, with this focused to resolving imperfect knowledge. In some cases a geographical division to the application of policy experiments

may be needed to limit compounding causes and effects. Lastly, evaluation of the policies can be used to identify outcomes and achievement of objectives, testing and responding to unpredictability. There is also potential for this stepwise approach to the implementation of adaptive management and evaluation to provide a process to test alternative views and forum to debate the science, with increased roles for different knowledge holders and bring a sense of collegiality to water reform.

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