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Risks, Uncertainty and Climate Confusion in the Murray–Darling Basin Reforms

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Risks and uncertainties arising from climate change are increasingly recognized as significant challenges for water governance. To support adaptive approaches, critical examinations of water policy practices and rationalities are needed. This paper focuses on the treatment of climate change in Australia's Murray–Darling Basin (MDB) reforms over the past decade. While the MDB faces potentially significant drying trends due to climate change no reductions in future water availability due to climate change were formalized in the 2012 Basin Plan — a regulatory instrument agreed to by Australia's National Parliament. The background, key dimensions and possible reasons for this decision are examined. Possible reasons for not formally reducing water deemed available in the future include the complexity and uncertainty of climate science, the cultural construction of "climate normal" based on long-term averages, and institutional settings that reinforce dominant "hydro-logical" approaches and rationalities. Minimizing the political, legal and financial consequences of attributing reductions in water allocations to climate change are also potential reasons. The case of the MDB, as outlined in this paper, demonstrates some of the ways climate change is causing systemic challenges for adaptive water governance, and that innovative approaches need to be embraced, including better processes for institutionalizing science/policy integration.

Keywords: Climate risk; climate normal; adaptative governance; water reform; Murray–Darling Basin.

1. Introduction

The science and the popular understanding of climate change may be fundamentally shifting policy debates and policy choices, altering the conceptual, political and physical geographies of water. With the "death of stationarity" undermining the foundations of hydrology, the past is being rendered a less reliable guide to the future (Milly *et al.* 2008).

Climate change introduces profound risks and dynamic uncertainties driving more severe droughts in the mid-latitudes and the intensification of tropical monsoons (IPCC 2012). In response, more innovative and adaptive approaches to water governance are required (Pahl-Wostl 2007) with investigation into what constitutes these approaches requiring critical examinations of policy practices, paradigms and rationalities.

This paper focuses on recent water reforms in Australia's Murray–Darling Basin (MDB). These provide a useful microcosm of the challenges of incorporating climate change risks into water policies and basin scale plans. While Australia's water and natural resources governance regimes have evolved under a highly variable climate, including recurrent, severe, decadal droughts (Kiem and Verdon-Kidd 2013), these are being further challenged by climate change (Alexandra 2012; Horne 2013).

During the Millennium drought, against a backdrop of escalating concerns about climate vulnerability, Australia's national science organisation, CSIRO (2008, 2010) warned emphatically that it is prudent to plan for hotter and drier futures in South Eastern Australia. Water (in)security was used to justify subsidizing water saving irrigation infrastructure (Crase 2009) and "climate-resilient" desalination plants (Elmahdi and Hardy 2015) built at great expense to urban water users (Ferguson 2014). Australia also implemented major water policy reforms (COAG 2004) introducing a new national Water Act (Commonwealth of Australia 2009; Hart 2015a,b).

When the Commonwealth Water Act Amendment was introduced into Parliament, two policy challenges were offered as the rationale for these reforms — rebalancing over allocations to provide water for the environment and preparing for climate change (Wong 2008).

The Water Act (Commonwealth of Australia 2007) ushered in a new regime of planning for the MDB, requiring a Basin Plan based on the best available scientific and socio-economic assessments, refined through formal consultations with communities and Basin governments. Key policy intentions and outcomes are summarized in Section 2.

During the preparation of the Basin Plan, from 2009 to 2012, formalizing the volume of extractive water rights to be recovered for environmental water and setting a sustainable diversion limit (SDL) became the central focus of water policy debates. However, the 2012 Basin Plan does not factor in any specific adjustment for the reductions in water availability due to climate change (Commonwealth of Australia 2012; Horne 2014) because climate change impacts were deemed to be too uncertain (Commonwealth of Australia 2012). Section 3 provides a summary of the scientific advice provided on climate change impacts, note that incorporating scientific advice into policy processes is neither simple nor straightforward (Miller 2001) with contestation of major policy reforms inevitably involving judgement calls, trade-offs and political adjudication (Sarewitz 2004).

Questions of risk and certainty are central to planning in a changing climate. Climate change might be game a changer for those who depend on historic numbers, including in the sphere of water resources planning. The concept of climate change depends on a baseline of ‘climate normal’, the cultural construction of which is explored in Section 4. Section 5 examines some possible reasons why the climate science was deemed to be too uncertain, exploring how incorporating climate science into water policies is a subset of the wider challenges of policy-science integration (Miller 2001; Sarewitz 2004).

Finally, because planning for the future cannot be reduced to climate (Hulme 2011), the concluding section briefly considers some ideas about how we might more actively embrace climate, induced risk and uncertainty in the adaptive governance of natural resources.

2. Climate Change and the MDB Plan

2.1. *Policy intentions*

The Water Act (Commonwealth of Australia 2007) ushered in substantial reforms, establishing the MDBA as a Commonwealth agency with new powers and functions, including responsibilities for preparing the Basin Plan. The objectives of the Act include giving effect to international agreements, managing risks including climate risks, conserving biodiversity and riverine ecosystems and optimizing social, economic and environmental outcomes. It mandates a Basin Plan that specifies limits on water extracted (a ‘sustainable’ diversion limit or SDL) and the preparation of environmental watering plans. In the Australian Parliament, Senator Wong (2008) articulated that the MDB Plan “*enables the national interest to be put first by providing new SDLs on water use, taking account of future climate change and addressing a legacy of past overallocation in the basin. For the first time ever,* *we will have enforceable, scientifically informed limits on the amount of water that can be taken out of our rivers...It is extremely important (a) that the science is, for the first time, actually going to drive the SDLs; and (b) that the authority's approach will reflect the recognition by this government...that we have to confront the future of climate change and the challenge of climate change not only as a nation but also in the particular context of the MDB. It is also important that we recognise the legacy of overallocation...*"

This statement makes it clear that the intention of the Basin Plan, particularly the SDL would be to prepare for climate change and deal with the legacy of over allocation.

2.2. *Climate adaptive policy outcomes*

The recent water reforms in Australia's MDB have resulted in the most significant reallocation of extractive water rights to environmental uses in Australia's history (Hart 2015a,b). The 2012 Basin Plan established a legislated environmental water recovery target of about 20% of historic use or 2,750 million m^3 of which 1,954 million m^3 (approximately 70%) had been recovered by November 2015 (Commonwealth of Australia 2015). This substantive rebalancing between extractive and environmental rights will provide more water to riverine ecosystems (Hart 2015a,b; Horne 2014). However, the Basin Plan makes no specific adjustment for anticipated reductions in total water availability due to climate change raising some significant, unresolved issues (Horne 2014; Pittock *et al.* 2015). In particular, given climate forecasts, there are substantive risks that under drier climate sequences, many water rights holders will have significantly reduced water allocations, as occurred in the Millennium drought. Regardless as to whether they are intended for extractive or environmental uses, future climates may render these water rights 'drier' and of less value to either irrigators or environmental holders.

In addition to the substantial reallocation of extractive rights to the environment, other adaptive responses have been adopted. These include the adaptive planning and management framework that enables incorporation of emerging climate knowledge in the future and water market reforms (Alexandra and Donaldson 2012; Neave *et al.* 2015). Water market reforms are climate adaptive because water markets support dynamic adjustment. Water market activity in the Millennium drought demonstrates that these markets enable more flexible risk management allowing water rights holders to be responsive to variable climate and water availability conditions (Alexandra and Donaldson 2012; Alexandra 2014).

2.3. *Defining water available in the future*

Both the Water Act (Commonwealth of Australia 2007) and the Basin Plan (Commonwealth of Australia 2012) honour existing state-based water plans, requiring these statutory water plans be consistent with the Basin Plan when these are renewed, mostly after 2019 (Commonwealth of Australia 2012). With water plans typically in force for 10–15 years, the first Basin Plan is likely to influence water policy for two decades from when it was gazetted in 2012. With this time frame, defining climatic conditions and water availability out to beyond 2030 were central questions for Basin planning.

The Water Act (2009) is explicit that the Plan must assess and manage the risks of climate change. Defining the water resources available and limits on extraction are also legislative requirements. Determining climate change's impacts on water resources over the planning period while of fundamental importance to the Plan was not straightforward.

Water resources in Australia have historically been managed separately by State Governments. State-based water administrations, licencing, and planning frameworks evolved separately in each jurisdiction, due to Australia's colonial history, with intergovernmental coordination mechanisms for the River Murray, evolving since Federation (Connell 2011).

Recognizing the need for basin wide information, the Commonwealth Government commissioned the national science organisation, CSIRO, to model water availability under a range of climate scenarios. CSIRO (2008) concluded that while the impacts of climate change remain uncertain, by 2030 the median likely reduction in surface water availability would be 11% across the entire MDB and 13% in the southern Basin.

In 2010, in The Guide to the Plan (MDBA 2010) the Authority proposed a 3% reduction in consumptive water due to climate change impacts (Pittock *et al.* 2015). However, whilst acknowledging the significant risk posed by climate change, the Authority subsequently stated that "*there is considerable uncertainty regarding the potential effects of climate change, and that more knowledge is needed to make robust water planning and policy decisions that include some quantified allowance for climate change. Until there was greater certainty MDBA considered that the historical climate record remains the most useful climate benchmark for planning purposes*" (MDBA 2012c: p. 123).

Reliance on historic records was justified on the argument that "forecasts of possible climate change impacts fall within this observed range of natural variability" experienced over the 114 years of the instrumental record from 1895 to 2009 (Commonwealth of Australia 2012; MDBA 2012b). This historic climate sequence demonstrates the wide variation in water availability from "around 117,907 million m^3 in 1956 to a low of around 6,740 million m^3 in 2006" and includes "the millennium drought, when inflows were 40% below the long-term average" (Commonwealth of Australia 2012).

The MDBA based it's modelling for basin planning on the instrumental record. It modelled four flow regimes for comparative purposes — pre-development (without water resources development), baseline extractions (without Basin Plan) and two reductions in water extractions, with the 2800 GL/y the key one. No scenarios or "*forecast of what might happen under a future climatic regime*" were used (MDBA 2012b). By using the instrumental climate record as the basis of this modelling (MDBA 2012b) the MDBA choose not to use a range of climate scenarios as recommended by CSIRO. In response to a request for formal advice on how to handle climate change in the planning process the MDBA was advised that: "*water resources planning should consider a range of possible scenarios to assess system robustness and resilience to historical droughts as well as future climate projections*" (Chiew *et al.* 2009).

At the time of preparation of the Basin Plan, incorporating climate scenarios into water planning was becoming an accepted practice (CSIRO 2008; DSE 2009) in Australia. For example, in 2008, the Victorian Government developed the Northern Sustainable Water Strategy, in which the prospect of climate change was treated as a serious threat to future water supplies (DSE 2009). The Strategy aimed to develop water policies and plans effective under a range of future conditions using three climate change scenarios, and one based on the drought of the previous decade to test the robustness of proposed strategies. With the then current Millennium Drought resulting in runoff approximately 40% lower than mean and the persistent reduction in cool season rain, (Chiew *et al.* 2009) had also advised the MDBA to use one scenario based on a continuation of recent past, noting that longer droughts can be found in the paleo-climate record.

The 2012 Basin Plan clearly identifies climate change as a significant risk and a matter of central importance for future revisions. It requires reviews to have "regard to the management of climate change risks and include an up-to-date assessment of those risks" considering all relevant knowledge (Commonwealth of Australia 2012). These reviews provide opportunities for revisions of the Plan to incorporate new knowledge of climate and over successive planning cycles this enables an adaptive approach (Alexandra and Donaldson 2012; Commonwealth of Australia 2012). However, there may not be the political will to tackle further reform in the future, and like all legislative arrangements, the planning framework enabled by the Water Act may be altered by legislative changes. For example, the Commonwealth amended the "*Water Act 2007 to impose a duty on the*

Commonwealth not to exceed the 1500 gigalitre limit on surface water purchases in the MDB at the time of entering into a water purchase contract" (Commonwealth of Australia 2015). This places an upper limit on water rights that can be purchased by the Commonwealth for environmental purposes (Commonwealth of Australia 2015).

2.4. *Policy risks*

Despite explicitly acknowledging the risks to water availability posed by a changing climate, the 2012 Basin Plan defines the total water resources available as unchanged by climate change with the SDLs based on averages of the historic flows and climatic conditions (Commonwealth of Australia 2012). Adopting this approach emphasizes the sharing or rebalancing of water between extractive users and the environment, but generally not on how to handle reduced amounts of water that are possible as a result of a drying climate. (Note the one key exception is a revised drought reserve with risks based on climate forecasts (Commonwealth of Australia 2012).

Whilst the substantial increase in water rights held as environmental water is likely to increase the resilience of water-dependent ecosystems (Commonwealth of Australia 2012) if extreme dry climate sequences eventuate, water available to be allocated to both extractive and environmental water rights will be severely reduced. For example, under some extreme dry scenarios, outflows from the Murray River system could be reduced by 69% (Pittock *et al.* 2015). If this eventuates, substantially less water will be available for holders of either extractive or environmental water rights, with extreme impacts on riverine ecosystems and irrigation dependent industries, as occurred during the Millennium Drought.

These risks were identified in many submissions on the Proposed Basin Plan that expressed concern about the treatment of climate change (MDBA 2012c). For example, the Wentworth Group (2012) articulated several fundamental concerns including that

(1) The SDL had been set on the assumption that there is no risk from climate change despite CSIRO predicting significant reductions in rainfall and runoff;
(2) The impacts of climate change in reducing environmental flows were ignored in setting the 2,750 million m^3 water recovery figure; and
(3) A drying climate puts river health and environmental water at risk because extractive rights are generally given priority over non-entitlement water, with the latter representing over 70% of all 'environmental' water.

Other submissions argued that by failing to account the impacts of climate change, the proposed Basin Plan ignored the best available scientific evidence with assumptions that reductions in stream flows will be within the bounds of normal variation dubious. For example, the Victorian Environment Defenders Office (EDO 2012) argued that the use historical inflow data to set baselines for the SDLs, rather than the 2030 climate projections, ignores the Water Act requirement to adopt the precautionary principle that "*lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation*" (EDO 2012).

Pittock *et al.* (2015) raise concerns about the implications of delaying efforts to adjust to the impacts of climate change. These include eroding the confidence of water users and river managers in the reliability of the Plan and the potentially poor targeting of public investment in infrastructure, claiming that even moderate climate change could make some irrigation or environmental infrastructure redundant, suboptimal and mal-adaptive (Pittock *et al.* 2015). Horne (2013) also warns that if drier climates sequences eventuate, further adjustments to extractive water use may be required but that Governments may defer these to the environment's detriment.

3. Scientific Advice Climate Risks and Impacts

Uncertainty about future climates requires systemic risk assessments able to anticipate the potential for catastrophic shifts and transformations in ecosystems (Scheffer *et al.* 2001). With the many complex feedbacks, improved ways of assessing and incorporating the risks and uncertainties driven by climate change are needed in contemporary water planning. Recognising the potential significance and the nature of these risks, the MDBA commissioned reviews of climate science and climate risks (see for example Low 2009; Donohue *et al.* 2011; Roderick 2011; Kiem and Verdon-Kidd 2009; Schofield 2011).

The climate beyond the instrumental record confirms that dramatic swings through wetter and drier phases are typical of the MDB (Gallant and Gergis 2011) and that the probabilities of drought or floods occurring changes dramatically due to the powerful influences of the oceans surrounding Australia (CSIRO 2010 and 2012; Kiem and Verdon-Kidd 2013).

Changes in temperature and precipitation will drive dynamic ecosystem responses and influence the dynamics of large-scale eco-hydrological processes, such as forest water use with consequential impacts on the water yield of streams (Donohue *et al.* 2011). An increased frequency of forest fires, succession in vegetation communities, and fundamental changes in the processes that determine plant water use have the potential to alter water balance at the basin scale (Donohue *et al.* 2011). Climate change is likely to favor pests, diseases and feral plants and animals (Low 2009) and increased heat could result in relocation of irrigated crops.

For the MDB over the longer term, Donohue *et al.* (2011) estimated that 94% of precipitation (P) is returned to atmosphere via evapotranspiration (ET) with 6% forming all the streams, wetlands and recharge and only about 2% flowing out the Murray mouth before irrigation development. Runoff and stream flows are sensitive to change in the driving variables of P and ET and therefore could change dramatically as a result of climate change if one or more variables change — e.g., ET increases, or P is reduced — especially in the 12% of the MDB that generates 66% of the stream flow because in "these high yield catchments runoff is most sensitive to changes in climatic conditions" (Donohue *et al.* 2011).

To determine future surface water availability (CSIRO 2008) combined climate and hydrological models, modeling water availability under a range of climate scenarios. After the most comprehensive hydro-climatic modeling to date, CSIRO (2008: p. 8) concluded that despite considerable uncertainty, a pronounced drying trend was anticipated due to climate change. Importantly, CSIRO (2008) warned that the greatest reduction would occur in the south east of the MDB where the majority of the runoff is generated. This includes the mountainous areas that generate the runoff supplying the major water storages in the southern Basin. Only 6.5% of the MDB contributes more than 50% of the runoff and because "this area is predominately forested, changes in vegetation water-use in these high water yielding catchments driven by hydro-climatic change and ecohydrological functioning change are important for long-term planning of water resources". Yet, there is significant uncertainty about how higher CO2, temperatures and changes in seasonality of rainfall will impact on stream flows (Donohue *et al.* 2011). The non-stationarity of forest water use may compound predicted reductions in precipitation in these areas that generate significant runoff (Donohue *et al.* 2011).

The South Eastern Australian Climate Initiative (SEACI) a major research program focused on the MDB's hydro-climatic systems confirmed CSIRO's (2008) findings regarding drying trends. Two synthesis reports intended for policy audiences summarize the key findings (CSIRO 2010, 2012). SEACI Phase 1 emphasized that the majority of climate models used by the CSIRO predict drier futures and therefore it is prudent to plan for conditions drier than the long-term historical conditions (CSIRO 2010). The drying trend is likely to be particularly acute in the southern Basin, resulting in reduced runoff, including in the Murray headwaters where reduction in stream flow of up to 40% is possible (CSIRO 2010).

SEACI 2 concluded that with the strong probability of a significant underlying drying trend "water resource managers need to ensure their planning and management processes are robust and adaptive across a wide range of future climate and stream flow scenarios" (CSIRO 2012).

Importantly, the causes of declining cool season rainfall were identified. SEACI found multiple lines of evidence that the tropics are expanding southward, exerting drying influences on the climates of South-eastern Australia (CSIRO 2012). Long-term reductions in cool season rainfall and reduced stream flows are associated with changes in the global atmospheric circulation via an expansion of the tropics, with the Hadley cell circulation expanding at the rate of 0.5° of latitude (approximately 50 km) per decade (CSIRO 2012). Combined with the pole-ward contraction of the southern storm tracks that historically brought cool season rains, these changes in global circulation patterns provide an explanation for the drying trend, indicating a future climate characterized by below average autumn, winter and spring rainfall (CSIRO 2012). As a result, the traditional dam 'filling seasons' for Southern Australia is unlikely to be as reliable in the future as it has been in the past. Reductions in rainfall account for most of the reduction in runoff with rainfall declines amplified fourfold in runoff reductions but changes to the seasonality of rain also contributes to reduced runoff (CSIRO 2012).

In summary, climate research consistently indicates that a reduction in water availability in the Basin in the future is highly likely and that ecosystem processes at the catchment scale contribute further uncertainty.

4. The Cultural Construction of Climate Normal

4.1. *Droughts, floods and averages — the cultural construction of climate*

Climate change is a "quintessentially modern problem" defined by the scientific method, requiring reframing of both problems and solutions in ways that do not "run the risk of unwittingly buttressing reactionary skeptics and a range of vested interests" (Head and Gibson 2012).

Both climate change and climate normal are culturally constructed (Hulme *et al.* 2008). The concept of climate change can only be conceived of by some explicit or implicit reference to climate normal, which itself has been constructed via a cooperative global scientific effort and the statistical manipulations needed to arrive at climate averages (Hulme *et al.* 2008). This claim is not intended to buttress reactionary skeptics or climate change deniers, but to clarify ideas about how underlying concepts of climate and climate change became widely established and used.

All numbers about water, rivers and climate, whether simple statistics or sophisticated models are abstractions (Linton 2010), representations of nature like a map, a painting or an essay (Castree 2014). As abstracted representation, they can neither be neutral in a political sense, nor devoid of cultural framings or bias inherent in all culturally constructed representations of nature (Descola 2012) because scientific representations embed normative framings and institutional settings (Sarewitz 2004; Miller 2001).

Therefore, water policy debates are rich in cultural and scientific representations and political symbolism with struggles about water, being struggles over power, symbolic representations and natural resources (Archarya 2015: p. 379) in which non-human forces like weather events, like droughts and floods, are key influences (Head and Gibson 2012). Major Australian reforms were triggered during and in response to droughts with the Bureau of Meteorology established in response to the Federation Drought and the Commonwealth Water Act of 2007 introduced during the Millennium drought.

In describing climatic conditions, reference is made to the 'average' with deviations from it, frequently called 'anomalies' implying the abnormality of the non-average conditions, but conditions coincidently conforming to the "average" are unusual due to fundamental drivers of Australia's climate with it, dramatic wet or dry phases (Kiem and Verdon-Kidd 2013). Australia's highly variable rivers are functionally different, depending on the wet or dry climate phases which alter them in almost every respect, including flood frequencies (Kiem and Verdon-Kidd 2013) but their average flows are a result of combining all flow data, including episodic floods and drought flows sequences. Reconstructions of the hydro-climate beyond the instrumental records demonstrate that recurrent droughts punctuated by floods typify longer-term patterns, while conditions that imitate the statistical averages are rare (Gallant and Gergis 2011).

Averages as statistical representation disguise significant spatial and temporal variations. "Averaged" water can never satisfy thirst or irrigate crops the way "wet" water can. A mission to locate blue lines on maps delineating rivers like the Darling, Paroo or Warrego may find floods kilometers wide or vast, dry clay pans.

Long-term average water availability and stream flow averages are drawn statistically by combining large floods flows with lower flows during extended droughts divided by the number of years and are therefore rarely reflective of actual conditions. Yet, the MDBA decided that the SDL would be based on "long-term averages" as the unit of measure (Commonwealth of Australia 2012), although the Water Act was not prescriptive, providing the MDBA with options for the use of formulas, averages or measured units (Commonwealth of Australia 2009).

Consideration of how to use formulas that incorporate and reflect the deeply variable climate is worthy of further research. Given the inherent variability of

Australia's climate, it is important that our plans, policies, attitudes and understanding are based on accepting and working with the inherent climate variation that drives Australian hydrological systems (Kiem and Verdon-Kidd 2013).

This construction of normal using averages and the embedding of these into water plans in a country characterized by high variability exemplifies the social constructions of normal climate (Hulme *et al.* 2008). In Australia's variable climate "all averages are lies" (Cullen pers com) distorting the fluctuating phases of water scarcity and abundance that drive "boom-bust" ecosystems. While irrigation development has been successful at providing more reliable water supplies, the use of averages for water planning may reflect a culturally engrained yearning for a sense of a 'normality' that seeks to deny or overcome the highly variable nature of Australian climatic and riverine systems. Ideas of 'normal' conditions embedded in Australia's water policy may be driven by the perceived unreliability and scarcity of water relative to the wet country origins of early English colonists (Cathcart 2009) that resulted in a prevailing view that this dry, disappointing country demanded drought-proofing (Arthur 2003). The stark contrast between England and the 'default' country (Arthur 2003) resulted in obsessive "water dreaming" after 1778 (Cathcart 2009) with the aspiration for securing reliable water supplies, both a deeply symbolic and practical challenge for Australia in financial and material terms (Larsen *et al.* 2014). The building of vast irrigation schemes resulted in politically powerful constituencies and institutions that have grown to dominate water policy (Crase *et al.* 2009; Connell 2011; Marshall and Alexandra 2016). It is therefore feasible that the difficulty of more fully incorporating climate change impacts into the MDB reforms may be the legacy of ingrained cultural perspectives, literally and metaphorically concreted into the physical and cultural landscape, in the form of large dams and irrigation schemes and the institutions and professions that have evolved to operate them, (Marshall and Alexandra 2016) with embedded rationalities that emphasize reliable water supply and a yearning for a more reliable and 'normal' climate.

5. Reflections on Risks and Rationale

5.1. *Assigning and minimizing risks*

There are a number of plausible reasons why estimates of future water availability were not reduced to allow for the anticipated impacts of climate change in the Basin Plan.

First, there is the uncertainty inherent in climate science predictions, especially in comparison with the 'facts' of the hydrological and climate records. In determining future water availability, greater trust was placed in the 'facts' established by hydrological science, then climatological science, reflecting Sarewitz's (2004) observation that in environmental controversies, uncertainty arises from incoherence amongst competing scientific understandings based on different disciplines, because each has embedded values, established institutional linkages and normative frameworks.

Second, the government may have decided that it did not want water reforms embroiled in the politically hostile climate debate occurring. Embroiling water reforms in this political debate would have inflamed the already heated debates, but largely separate about water and climate change. Tony Abbot, who led Australia's Conservative Opposition, was a vocal opponent of climate change policies (Manning 2015) during the Plan's development (2009–2012). Richard Davis, former science advisor to the National Water Commission, believes that the MDBA chose to minimize opposition to the reforms "*because they had enough on their plates fighting the argument for returning water to the environment and they didn't want to open another front with all the climate change sceptics. I don't think they wanted radio shock jocks on their tail over climate change*" (ABC 2015).

Finally, another potential reason is an attempt to minimize adverse reactions to the triggering of the risk assignment clauses (46 and 50) in the National Water Initiative (COAG 2004) that states that water access entitlement holders bear the risk of climate change. The National Water Initiative (COAG 2004) is a water policy reform agreement between Australia governments (Crase *et al.* 2009; COAG 2004). Clause 46 assigns climate risks to entitlement holders who "*bear the risks of any reduction or less reliable water allocation, under their water access entitlements, arising from reductions to the consumptive pool as a result of*:

1. (i) *seasonal or long-term changes in climate*; *and*
2. (ii) *periodic natural events such as bushfires and drought.*"

In contrast, clause 50 assigns Governments the responsibility for bearing the "*risks of any reduction. . .arising from changes in government policy (for example, new environmental objectives). In such cases, governments may recover this water in accordance with the principles for assessing the most efficient and cost effective measures for water recovery*" (COAG 2004).

In accordance with the NWI principles of risk assignment, if reductions in consumptive water mandated through the Basin Plan were based on climate change then water entitlement holders would bear the risk (COAG 2004). By not triggering clause 46, the costs of planned reductions were borne by taxpayers. This would have been more acceptable to water entitlement holders, the majority of whom were irrigators. Irrigators publicly demonstrated their displeasure about the reforms with staged managed protests, burning the Guide to Plan in 2010 to maximize media coverage of their opposition. It may be that these groups did not want the NWI climate risk clause (46) activated because it clearly assigns risks from climate change to water entitlement holders. This risk may have been neutralized by minimizing any reductions in water availability attributed to climate change.

5.2. *Contested policies and complex truths*

Water reform occurs within a complex assemblage of historical, cultural, political and economic relationships (Allen 2011; Dittmer 2013) with water policy debates deeply contested because their outcomes affect the distribution of resources, status, wealth and power whilst reinforcing or assaulting established ideologies (Allouche *et al.* 2015).

In water policy debates, across multiple scales, multiple actors form policy coalitions attempting to steer choices and directions through processes that inevitably involve discourse, debate, contestation, politics and power relations (Dore *et al.* 2012). Discourse coalitions refashion concepts to suit specific political ideologies (Hajer 1996) with competing interests using multiple strategies to influence outcomes. For example, there were well-orchestrated protests against the MDB Plan, particularly in regions where irrigation is economically significant. Irrigation accounts for about 70% of all water used in Australia, mostly within the MDB, producing half the profit in Australian agriculture & horticulture, (NLWRA 2001) establishing powerful vested interests that are effective at politicking and political lobbying (Marshall and Alexandra 2016). Pro irrigation groups staged excellent, media savvy protests that included highly symbolic book burning designed to gain maximum media coverage and political leverage.

The MDB reforms, like the National Water Initiative (NWI) before them, are complex, multilayered policies containing fundamental tensions in terms of conflicting values, rationalities and imperatives (Hussey and Dovers 2006). Crase *et al.* (2009) claim that the politicized processes for resolving these tensions enabled powerful vested interests to alter the trajectories of reform, while the multi-billion dollar subsidies that flowed to the irrigation sector demonstrate the irrigation lobby's ability to influence politicized processes and capture resources through subsequent stages of reform (Marshall and Alexandra 2016).

Governing is dynamic and relational, involving multiple actors from governments, business and civil society with rich and complex feedbacks (Dore *et al.* 2012). Through practice, governance evolves, drawing on ideas, information and knowledge (Ison *et al.* 2014). Folded into the present are shifting senses of history, and implicit and explicit visions of the future, with public policies contests over preferred futures (Appaduri 2013). Nature-society relationships are shaped through debates involving fundamental beliefs (Hajer 2005; Dryzek 2005) causing controversies which science tends to amplify, but cannot resolve without comprehensive political adjudication (Sarewitz 2004) such as occurred with the 2012 Basin Plan.

Science is unavoidably politicized in the value-based disputes underlying environmental controversies (Sarewitz 2004). Uncertainty about climate change and its impacts in the MDB can be usefully understood "*not as a lack of scientific understanding but as the lack of coherence among competing scientific understandings, amplified by the various political, cultural, and institutional contexts within which science is carried out*" (Sarewitz 2004: p. 385). This incoherence arises in part from the differences between the disciplinary practices and frameworks of hydrology and climate science and institutional settings in which they have evolved.

As reforms unfold, choices are made about which 'facts' are legitimized and which science is trusted and used as the basis of policy and which is discounted as too uncertain (Miller 2001). Due to their history and institutional linkages, certain disciplines are more relied upon and trusted while others are considered less relevant (Sarewitz 2004). The MDBA relied more on hydrology, then climatology with instrumental measurements of climatic conditions and stream flows providing greater certainty (Commonwealth of Australia 2012a,b&c), then predicted climate futures with their intrinsic uncertainty. The historical and institutional linkages between water resources and hydrology are well established. Linton and Budd (2014) argue that engineering and hydrology became the dominant discipline for water resource management because of their historical alignments with state power in an era focused on controlling rivers to serve economic development objectives. The resulting hydro-bureaucracies with their "hydro-logical" rationalities have risen to dominate water globally (Molle *et al.* 2009) including in Australia.

While science is critical to understanding large-scale systems like climate (Hulme 2008; Head and Gibson 2012), the policy choices made about which science is trusted depends on underlying perspectives and value-based positions (Miller 2001; Sarewitz 2004). Recognizing the social production of knowledge justifies looking critically at how power relations legitimize facts (Miller 2001) and to question these in terms of their social construction and political purpose (Allouche *et al.* 2015). Science and policy should not be conceived of as separate domains of human endeavor because they have a dynamic relationship in actively structuring knowledge. The way knowledge is constructed and legitimized inevitably involves questions of framing, power and social ordering (Miller 2001).

6. Enhancing Water Governance Under Climate Confusion

With the end of stationarity (Milly *et al.* 2008), the past may be an inadequate guide to the future. Planning for hotter and drier conditions is both judicious and pragmatic because overall, there is consistent scientific advice about the high likelihoods of a significant drying trend in the MDB (CSIRO 2008, 2010, 2012).

Australia's capabilities in water management result from experience operating in a highly variable climate combined with the dynamic interplay between culture, knowledge, and the functionality of governance arrangements (policies, laws, rules, social norms) with responsiveness to new challenges, circumstances and knowledge central to adaptive capacity (Alexandra 2012). Climate change and reforming water policy in the MDB have both been described as complex, multifaceted or 'wicked' problems that require systemic responses (APSC 2007).

Complex sustainability challenges, like these, require institutional innovations that support more deliberative governance (Dovers 2001). Meeting the aspiration of future water resource plans to be based on the best available science requires concurrent commitments to investing in robust science in a dynamically changing climate (Alexandra 2012) and ensuring that key agencies have capabilities for science policy-integration (Campbell 2005). Better integration of science and policy (Miller 2001) can be fostered by innovative institutional arrangements. For example, a recent review of the Australian Public Service identified that long-term partnerships between policy and science agencies can assist in building greater capability for strategic policy development (APSC 2010).

Empowering communities and industries through partnerships to co-produce reform pathways is also critically important to building increased capacity to manage rivers and their catchments for multiple outcomes and to ensure long-standing support and commitment to natural resource reforms by affected parties (Campbell 2010; Alston and Whittenbury 2011). Scenario planning methods, incorporating much more than climate, may be useful to support adaptation to different futures by empowering people to conceive of and prepare for different futures (Rickards *et al.* 2014; Vervoort *et al.* 2015).

To support anticipatory policy in the face of the potential scale and magnitude of climate change increased investment in climate and ecological sciences are needed. However, the MDB reforms also demonstrate the complex and dynamic interplay between science and policy practices and the importance of capacity for dealing with complex choices, tradeoffs and risks. The skilful governing of dynamic social, economic and ecological systems requires the critical questioning of institutionalized settings and dominant rationalities and innovative practices that embrace complex change processes involving risk, change and uncertainty.

References

ABC (2015). Climate review promised after dispute with top water scientists, Available at http://www.abc.net.au/radionational/programs/breakfast/climate-review-promised-after-dispute-with-top-water-scientists/6547394 [19 April 2016].

Acharya, A (2015). The cultural politics of waterscapes. In Bryant, RL (ed.), *The International Handbook of Political Ecology*. Chettenham: Edward Elgar, pp. 373–386.

Alexandra, J and J Donaldson (2012). Climate change and water — knowledge, scarcity and innovation [online]. *Proceedings of the 2nd Practical Responses to Climate Change Conference, Water and Climate: Policy Implementation Challenges*, Katherine A Daniell (ed.), Barton, ACT, Engineers Australia, pp. 494–501. Canberra: Australia.

Alexandra, J (2012). Australia's landscapes in a changing climate — caution, hope, inspiration, and transformation CSIRO publishing. *Crop & Pasture Science*, 63, 215–231, http://dx.doi.org/10.1071/CP11189.

Alexandra, J (2014). Difficult transitions — Australia's MDB reforms — adaptive watershed and water governance?. Resilient Water Governance Workshop University of Melbourne 2014, Available at http://www.law.unimelb.edu.au/files/dmfile/AlexandraDifficulttransitions-watergovernanceandtheMDB-CREEL2.pdf.

Allen, J (2011). Powerful assemblages?. *Area*, 43(2), 154–157.

Allouche, J, C Middleton and D Gyawali (2015). Technical veil, hidden politics: Interrogating the power linkages behind the nexus. *Water Alternatives*, 8(1), 610–626.

Alston, M and K Whittenbury (2011). Climate change and water policy in Australia's irrigation areas: A lost opportunity for a partnership model of governance. *Environmental Politics*, 20(6), 899–917.

Appaduri, A (2013). *Future as Cultural Fact — Essays on the Global Condition*. London: Verso Books.

APSC Australian Public Service Commission (2007). *Tackling Wicked Problems: A Public Policy Perspective*. Canberra: APSC.

APSC Australian public Service Commission (2010). *Ahead of the Game: Blueprint for the Reform of Australian Government Administration*. Canberra: APSC.

Arthur, JM (2003). *The Default Country: A Lexical Cartography of Twentieth-Century Australia*. Sydney: UNSW Press. ISBN 0 86840 542 6.

Campbell, A (2005). Knowledge for Managing Australian Landscapes Land and Water Australia. Canberra: Australia.

Campbell, A (2010). Murray Murmurings: Rethinking the Basin Plan *CRIKEY* | NOV 16, 2010 12:06PM, http://blogs.crikey.com.au/rooted/2010/11/16/murray-murmurings-rethinking-the-basin-plan/ [19 April 2016].

Castree, N (2014). *Making Sense of Nature*. Oxford: Routledge.

Cathcart, M (2009). *The Water Dreamers — The Remarkable History of our Dry Continent*. Melbourne: Text.

Chiew, F, W Cai and I Smith (2009). Advice on defining climate scenarios for use in Murray–Darling Basin Authority Basin Plan modelling, CSIRO report for the Murray–Darling Basin Authority.

COAG (Council of Australian Governments) (2004). *Intergovernmental Agreement on a National Water Initiative 25 June 2004 Communiqué*, Available at http://www.environment.gov.au/system/files/resources/6caa5879-8ebc-46ab-8f97-4219b8ffdd98/files/policyframework.pdf.

Commonwealth of Australia (2009). Water Act 2007, Canberra, Available at www.Commonwealth of Australia.au [12 December 2015].

Commonwealth of Australia (2012). *The Basin Plan 2012, and The 2012 Basin Plan Explanatory Statement* Federal Register of Legislation, Available at https://www.legislation.gov.au/Details/F2012L02240/Explanatory%20Statement/Text Commonwealth of Australia [19 April 2016].

Commonwealth of Australia (2015). Water Act Amendment 2015, Available at https://www.legislation.gov.au/Details/C2015A00133 Commonwealth of Australia [19 April 2016].

Connell, D (2014). *Time to regroup and reassess in the Murray–Darling* http://www.globalwaterforum.org/wp-content/uploads/2014/01/Daniel-Connell-FINAL.pdf.

Connell, D (2011). Water Reform and the Federal System in the Murray–Darling Basin. *Water Resources Management*, 25(15), 3993–4003.

Crase, LR, SM O'Keefe and BE Dollery (2009). The fluctuating political appeal of water engineering in Australia. *Water Alternatives*, 2(3), 441–447.

CSIRO (2008). Water availability in the Murray–Darling Basin. A report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project, Available at https://publications.csiro.au/rpr/download?pid=legacy:530&dsid=DS1 [12 December 2015].

CSIRO (2010). Climate change and variability in SE Australia — A synthesis of Phase 1 of SEACI CSIRO.

CSIRO (2012). SEACI Phase 2 Synthesis Report, Climate and water availability in south-eastern Australia, Available at http://www.seaci.org/publications/documents/SEACI-2Reports/SEACI_Phase2_SynthesisReport.pdf [12 December 2015].

Descola, P (2012). *Beyond Nature and Culture*. Chicago: University of Chicago Press.

Dittmer, J (2013). Geopolitical assemblages and complexity. *Progress in Human Geography*, DOI: 10.1177/0309132513501405.

Donohue, RJ, ML Roderick and TR McVicar (2011). Assessing the differences in sensitivities of runoff to changes in climatic conditions across a large basin. *Journal of Hydrology*, 406(3–4), 234–244, doi: 10.1016/j.jhydrol.2011.07.003.

Dore, J, L Lebel and F Molle (2012). A framework for analysing transboundary water governance complexes illustrated in the Mekong Region. *Journal of Hydrology*, 446–463.

Dovers, S (2001). *Institutions for Sustainability*. Melbourne: Australian Conservation Foundation.

Dryzek, J (2005). *The Politics of the Earth*. Oxford: Oxford University Press.

DSE (2009). *Northern Region Sustainable Water Strategy*, Available at http://www.depi.vic.gov.au/__data/assets/pdf_file/0005/188744/Northern-Region-SWS-Part1.pdf [12 December 2015].

EDO (2012). *Legal Analysis of the Proposed Murray–Darling Basin Plan*. Environment Defenders Office (Victoria).

Elmahdi, A and M Hardy (2015). The role of water in Australia's uncertain future, Available at http://theconversation.com/the-role-of-water-in-australias-uncertain-future-45366 [30 November 2015].

Ferguson, J (2014). Billions in desalination costs for not a drop of water, Available at http://www.theaustralian.com.au/national-affairs/state-politics/billions-in-desalination-costs-for-not-a-drop-of-water/story-e6frgczx-1227094416376?sv=127c70f7ae41111d448ae3ffaca5f058.

Gallant, AJE and J Gergis (2011). An experimental streamflow reconstruction for the River Murray, Australia, 1783–1988. *Water Resources Research*, 47, W00G04, doi: 10.1029/2010WR009832.

Hajer, M (1996). Ecological modernisation as cultural politics in *Risk, Environment and Modernity: Towards a New Ecology,* S Lash, B Szerszynski and B Wynne (eds.), London: Sage.

Hajer, MA (2005). *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process*. Oxford: Oxford University Press.

Hart, BT (2015a). The Australian Murray–Darling Basin Plan: Challenges in its implementation (Part 1). *International Journal of Water Resources Development*, http://dx.doi.org/10.1080/07900627.2015.1084494.

Hart, BT (2015b). The Australian Murray–Darling Basin Plan: Challenges in its implementation (Part 2). *International Journal of Water Resources Development*, http://dx.doi.org/10.1080/07900627.2015.1083847.

Head, L and C Gibson (2012). Becoming differently modern geographic contributions to a generative climate politics. *Progress in Human Geography*, 36(6), 699–714.

Horne, J (2013). Australian water policy in a climate change context: Some reflections. *International Journal of Water Resources Development*, 29, 137–151.

Horne, J (2014). The 2012 Murray–Darling Basin Plan — issues to watch. *International Journal of Water Resources Development*, 30, 152–163.

Hulme, M (2011). Reducing the future to climate — a story of climate determinism and reductionism. *OSIRIS*, 26, 245–266.

Hulme, M, S Dessai, I Lorenzoni, R Donald and DR Nelson (2008). Unstable climates: Exploring the statistical and social constructions of 'normal' climate. *Geoforum*, 40 (2009), 197–206.

Hussey, K and S Dovers (2006). Trajectories in Australian water policy. *Journal of Contemporary Water Research & Education*, 135, 36–50, doi: 10.1111/j.1936-704X.2006.mp135001005.x.

IPCC (2012). Intergovernmental Panel on Climate Change, Summary for policy makers: Managing the risks of extreme events and disasters to advance climate adaptation, www.ipcc.org

Ison, R, A Grant and R Bawden (2014). Scenario praxis for systemic governance: A critical framework. *Environment & Planning C: Government & Policy*, 32(4), 623–640, http://dx.doi.org/10.1068/c11327.

Kiem, AS and DC Verdon-Kidd (2013). The importance of understanding drivers of hydroclimatic variability for robust flood risk planning in the coastal zone. *Australian Journal of Water Resources*, 17(2), 126–134.

Larsen, J, D Gibbes and J Quiggin (2014). Dam hard: Water storage is a historic headache for Australia, Available at http://theconversation.com/dam-hard-water-storage-is-a-historic-headache-for-australia-33397

Linton, J (2010). *What is Water — the History of Modern Abstraction*. Vancouver: UBC Press.

Linton, J and J Budds (2014). The hydrosocial cycle: Defining and mobilizing a relational-dialectical approach to water. *Geoforum*, 57, 170–180.

Low, T (2009). Climate Change, Weeds & Pests in the Murray–Darling Basin Murray–Darling Basin Authority, Canberra, Available at http://www.mdba.gov.au/kid/files/2264-ClimateChangeWeedsPestsMDB1.pdf [12 December 2015].

Manning, P (2015). *Born to Rule, the Unauthorised Biography of Malcolm Turnbull*. Melbourne: Melbourne University Press.

Marshall, G and J Alexandra (2016). Institutional Path Dependence And The Political Economy Of Environmental Water Recovery In The Murray-Darling Basin. *Water Alternatives*, 9(3), 679–703.

MDBA (2010). *The Guide to the Proposed Basin Plan* MDBA Canberra, Available at http://www.mdba.gov.au/kid/guide/

MDBA (2012a). *The Proposed Basin Plan*, Murray–Darling Basin Authority, Canberra.

MDBA (2012b). Hydrologic modelling to inform the proposed Basin Plan — methods and results, MDBA publication no: 17/12, Murray–Darling Basin Authority, Canberra.

MDBA (2012c). Proposed Basin Plan Consultation Report, MDBA publication no: 59/12 Murray–Darling Basin Authority, Canberra, Available at http://www.mdba.gov.au/sites/default/files/archived/revised-BP/PBP_Consultation_report.pdf.

Milly, PCD, J Betancourt and M Falkenmark (2008). *Climate Change: Stationarity Is Dead: Whither Water Management? Science*, 319(5863), 573–574.

Miller, C (2001). Hybrid management: Boundary organizations, science policy, and environmental governance in the climate regime. *Science, Technology & Human Values*, 26(4), 478–500. Retrieved from http://www.jstor.org/stable/690165.

Molle, F, P Mollinga and P Wester (2009). Hydraulic Bureaucracies and the Hydraulic Mission: Flows of Water, Flows of Power. *Water Alternatives*, 2(3), 328–349.

Neave, I, A McLeod, G Raisin and J Swirepik (2015). Managing water in the Murray–Darling Basin under a variable and changing climate. *Water: Journal of the Australian Water Association*, 42(2), 102–107.

NLWRA (2001). Australian Agricultural Assessment Land and Water, Australia, Canberra.

Pahl-Wostl, C (2007). Transitions towards adaptive management of water facing climate and global change. *Water Resources Management*, doi: 10.1007/s11269-006-9040-4.

Pittock, J, RQ Grafton and J Williams (2015). The Murray–Darling Basin Plan fails to deal adequately with climate change. *Water*, 42(6), 28–34. https://www.researchgate.net/publication/282636368_The_Murray-Darling_Basin_Plan_fails_to_deal_adequately_with_climate_change.

Rickards, L, R Ison, H Fünfgeld and J Wiseman (2014). Opening and closing the future: Climate change, adaptation, and scenario planning. *Environment and Planning C: Government and Policy*, 32(4), 587–602.

Roderick, ML (2011). Introduction to special section on Water Resources in the Murray–Darling Basin: Past, present, and future. *Water Resources Research*, 47, W00G01, doi: 10.1029/2011WR010991.

Sarewitz, D (2004). How science makes environmental controversies worse. *Environmental Science & Policy*, 7(5), 385–403.

Scheffer, M, S Carpenter, A Jonathan Foley, C Folkes and B Walker (2001). Catastrophic shifts in ecosystems. *Nature*, 413, 591–596.

Vervoort, JM, R Bendor, A Kelliher, O Strik and AE Helfgott (2015). Scenarios and the art of worldmaking. *Futures*, 74, 62–70, http://dx.doi.org/10.1016/j.futures.2015.08.009.

Wong, P (2008). Second reading speech Water Act amendments, Available at http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22chamber%2Fhansards%2F2008-11-25%2F0110%22 [30 November 2015].