



# To what extent do they sway Australian water management decision making?

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**Abstract.** At a time when the reliability of freshwater resources has become highly unpredictable, as a result of climate change and increased droughts frequency, the role of scientific evidence in forecasting the availability of seasonal water has become more critical. Australia is one of the driest inhabited continents. Its freshwater availability is highly variable, which poses unique problems for the management of the nation's water resources. Under Australia's federal system, water management challenges have been progressively dealt with through political institutions that rely on best available science to inform policy development. However, it could be argued that evidenced-based policy making is an impossible aim in a highly complex and uncertain political environment: that such a rational approach would be defeated by competing values and vested interests across stakeholders. This article demonstrates that, while science has a fundamental role to play in effective water resource management, the reality *on the ground* often diverges from the intended aim and does not always reflect efforts at reform. This article briefly reviews the *Water Act 2007* (Cth) and comments on why policy makers need to manage rather than try to eliminate uncertainty to promote change.

## 1 Introduction

Decision making in water resource management in Australia has long been driven by the need to adapt to changes in water availability and to respond to increasing water scarcity. Australia is regarded as the world's driest continent, much of it flat, and with a legacy of high levels of salinity buried deep within it (Cullen et al., 2012). Salinity is an inherent feature of the Australian landscape, which if left unmanaged, has serious implications for water quality, biodiversity, land productivity and the supply of water generally (Thompson, 2014). Similarly, a flat continent suggests very low or no mountain ranges, with no permanent snow or glaciers, and therefore, no freshwater source other than rivers and aquifers (i.e. receptacles for groundwater). To compound the problem, Australia's weather is influenced by a highly variable climate with an annual cycle of wet and dry periods (Bureau of Meteorology, 2013). It could be argued that given these factors, science – based decision-making would improve sustainable water management practices. When the Federal *Water Act*

*2007* (Cth)<sup>1</sup> was introduced in response to Australia's millennium drought (2001–2009) (van Dijk et al., 2013), and in an attempt to prevent the further decline of water resources in the Murray Darling Basin (MDB) (also referred to as the Basin), one of the key reform measures was to prepare a Basin Plan to cap water extractions to levels that scientific evidence indicated would be sustainable. In short, the Act was in response to a severe drought period, unprecedented in the instrumental record, and called on water management policy to recognise the impact of climate change. However, the Basin-wide hydrological modelling required determining the level of water extraction from the environment, which was vigorously contested (explained further in Sect. 3) and proved challenging to guiding management decisions. This suggests that science-based knowledge had a limited role in stakeholder engagement outcomes. To demonstrate this point, the article proceeds in three sections. The first provides a very brief overview of the geography and manage-

<sup>1</sup>Cth refers to Commonwealth indicating that the Act is valid Australia wide.

ment framework in the MDB, the second section critically evaluates a key objective of the *Water Act 2007*. The final section explores the role of science in policy formulation and its effect on decision making relating to water resources more generally. This article concludes that although science is key to policy formulation, it is not in itself sufficient to reconcile competing stakeholder interests or to decide which objectives should be achieved and at what cost.

## 2 Background overview: brief geography and governance of the MDB

Located in south eastern Australia, the MDB is considered one of the flattest catchments in the world largely comprised of vast low-lying dry plains (Murray-Darling Basin Authority, 2012a). Although the MDB average annual rainfall supplies is in excess of 530 000 GL of freshwater, 90 % evaporates or transpires back into the atmosphere, leaving less than 10 % to drain as run off into rivers, lakes, streams and into groundwater aquifers (MDBA, 2012b). Despite these challenges, the MDB is Australia's agricultural heartland, producing one-third of the nation's food supply. It also plays an important role in ecological diversity and supports a wide range of animals, plants and ecosystems. The MDB covers an area of more than one million square kilometres (about 14 % of Australia's land mass) (MDBA, 2012c) and spans four states (Queensland, New South Wales, Victoria and South Australia) and the Australian Capital Territory. Good governance and reliable seasonal predictions of water availability for effective use of water is paramount for the MDB.

Historically, a co-operative framework governed water sharing in the MDB (whereby states and Commonwealth governments had to reach consensus, to manage the Basin resources), rather than a constitutional framework to ensure a right of supply (Connell and Grafton, 2011). This co-operative framework was fundamental and crucial to the MDB because it required federal and state governments to agree on an overall plan, with each jurisdiction responsible for its implementation (Connell, 2007). Yet, in the last twenty years, concerns about over-allocated water and the continuing decline of water resources in the river system remains a serious issue, severely affecting not just environment quality but also the security of water entitlements for consumptive users (Scanlon, 2006; Papas, 2007; Connell, 2011). These problems have arisen despite a number of management programmes and joint initiatives between states and the Commonwealth – namely, the National Water Initiative and the Living Murray – that had been implemented expressly to address the highly variable water conditions that characterise the MDB (Papas, 2007, p. 90). These reforms were implemented to ensure the ecological system is restored to good health and retains an optimum level of productivity. However, for these measures to work effectively, inter-jurisdictional arrangements require that each govern-

ment maintain a shared responsibility as to how the water is managed and allocated (Papas, 2007). This is especially true of Australia's federal system of government, because primary responsibility for water and environmental management rests with state governments (Kildea and Williams, 2010).

Australia's most recent water reform, the *Water Act 2007*, was introduced in the context of the most devastating drought in recorded history (Skinner and Langford, 2013, p. 871). The reform occurred within an existing mix of institutional arrangements, which inherently suggests that reforms have to adapt to a set of constraints (Skinner and Langford, 2013, p. 872). Yet, the principles of governance that underpin the *Water Act 2007*, marked a renewed approach to environmental protection and the way scientific knowledge was used to arbitrate the final outcome. Some of the issues are explored below.

## 3 A new governance framework: the *Water Act 2007*

The *Water Act 2007* established a new governance structure, whereby the MDB was brought under Commonwealth management for the first time since Federation (Kildea and Williams, 2011). The passing of the Act represented a widespread consensus that ongoing unsustainable levels of water extractions in the Basin needed to be seriously tackled through a central statutory planning process that could provide clear guidance in the matter (Fisher et al., 2010). In effect, the Act imposes a national interest in the management of the MDB system, rather than leaving its management at the state level.

The Act also established an independent Murray-Darling Basin Authority (MDBA), an agency of the federal government, to prepare a Basin Plan (MDBA, 2007). The aim of this Basin Plan was to apply best available science to define an environmentally sustainable level of take and to reduce over-allocated water entitlements that threatened water security (Skinner and Langford, 2013). That is, the Basin Plan was to set enforceable limits on the quantity of water (both surface and groundwater) – known as sustainable diversion limits (SDLs) – that could be extracted from the Basin as a whole, without compromising key environmental assets and ecosystem functions. This is the amount of water, expressed as the long-term average annual volume, that may be taken from a given river or aquifer (Hamstead and O'Keefe, 2008). These limits are central to the Basin Plan in securing the long-term health of the MDB, and come into effect in 2019 (MDBA, 2014).

Hydrologic modelling was used to determine SDL across the Basin (MDBA, 2012a). However, the diversion limits that were initially proposed were systematically contested and provoked considerable community anger. Some academics argue that one of the main issues to provoke strong opposition from water users was whether in developing the Basin

Plan, the MDBA was prepared to give future environmental considerations precedence over current social and economic factors (Kildea and Williams, 2011). Their concerns were valid given that in previous decades, water needs for the environment and for irrigation were often treated as mutually exclusive, and served the political purposes of particular interest groups (e.g. Musgrave, 2008; Skinner and Langford, 2013, p. 890). Similarly, the distinctive “battle line” between irrigators and regulators to engage farmers with water regulation was fundamentally weak; the decision-making process was fraught and highly politicised, and this resulted in little progress (Holley and Sinclair, 2012; Doremus and Tarlock, 2008). Consequently, some academics have questioned the reliance of scientific evidence to best inform water resources regulation and facilitate management decision making about socio-economic effects (Liu et al., 2008). Others maintain that given the prevalence of the role of modelling in natural resources and environmental regulation in other countries, policy makers should engage critically with these scientific tools and not neglect their effect as the realm of scientific expertise (Fisher et al., 2010).

### 3.1 The role of science

Science is considered an essential discipline used to promote policy formulation and political decision making (Davis et al., 2015, p. 1). As Frewer and Salter (2002, p. 138) explain, the role of science as an aid to policy development and to guide complex decision making is based on two assumptions:

... first, that the advice and, in particular, its predictive content is accurate and, second, that the public sees the advice as authoritative and the decisions and policy flowing from that advice as legitimate.

Despite this, it could be argued that the context in which specialist advice is sought, plays a role in the interpretation of scientific knowledge. As we saw above, science was used to frame the objectives of the SDLs, and thus to formulate policy. However, there was considerable reluctance from particular interest groups to comply with the proposed limits. Their reluctance, besides their concerns about the primacy the Water Act gives environmental needs in decision making (e.g. Godden, 2011), also stemmed from their expressed concern about the MDBA’s failure to engage local experts in the hydrological modelling content of the Basin Plan (Parliament of the Commonwealth of Australia, 2011). Pileke (2007) argues that this undermined both the reputation of scientific knowledge to guide policy development and its effectiveness as a regulatory tool to inform decision making. In contrast, other commentators suggest that complex public policy problems, including those faced by catchment water managers, must be made in the best interest of the public, which represents a broad cross-section of views and opinions (Heazle, 2010, p. 6; Skinner and Langford, 2013, p. 873). In this context,

while scientific advice was desirable, it remained subsidiary to community participation in decision making.

Another issue worth considering when seeking scientific advice is the notion of uncertainty. Some observers assert that scientists use statements of uncertainty to characterise information that is by nature never “black and white”, or to indicate what they do not yet know (Gibbs et al., 2013). In short, uncertainty is normal in scientific research (Gibbs et al., 2013). However, it could be argued that uncertainty has an adverse impact on complex decision making. For example, uncertainty can play a key role when policy makers attempt to justify one policy over another, particularly when both the level of uncertainty and the political stakes are high (Heazle, 2010, p. 135). Heazle (2010, p. 135) notes that uncertainty strips our ability to proclaim the best course of action on the basis of evidenced-based knowledge alone, while simultaneously granting license to speculate on various policy alternatives for those seeking to frame policy issues. Scientific findings are not exact. Therefore, policy makers like to draw their decisions based on various scenarios (or findings) to guide their policy options. Still, this suggests that the scope for scientific uncertainty is a valid factor that influences decision making. Similarly, Skinner and Langford (2013, p. 888) believes that the effect on constituents, ideological perspective and socio-economic implications also actively contribute to what happens on the ground.

More recently, predictions by Australia’s Bureau of Meteorology (BoM) of a “substantial” El Niño event in 2015 for the first time in five years (BoM, 2015) points to the need to adapt to worsening conditions. El Niño periods in Australia are generally associated with warmer temperatures across much of the country, below average rainfall and higher risk of bush fires (The Guardian, 2015). Under such extreme forecasts, the reliability of seasonal water is likely to be even less predictable, further undermining efforts to manage water resources sustainably.

### 3.2 The way forward

The Basin Plan, which received final approval from Australia’s Federal Minister in 2012, allows the MDBA to amend SDLs up or down within defined parameters (see *Water Act 2007* (s23a) through the SDL mechanisms by 2015 (Murray-Darling Basin Authority, 2015). These mechanisms were implemented to ensure sufficient flexibility in adapting to Australia’s highly variable weather conditions and were based on best available scientific knowledge in the context of climate change (Murray-Darling Basin Authority, 2015). This suggests that the potential effect of climate change in the reduction of precipitations and run offs (overland flow) are considered in government policy. However, Pittcock (2013) argues that the 2012 Basin Plan makes no specific provision for managing the risks posed by climate change, which raises important questions in terms of compliance and regulatory decision making, by both water users and their community.

The *Water Act 2007* (s22, item 8) states that the Basin Plan must include a mechanism for determining whether there has been compliance with SDLs but provides no clear requirements about the methods the MDBA must adopt to include this mechanism (Environment Defenders Office, 2012). Basin state governments are required to implement the SDLs through their own water resources management plans, which typically operate at the scale of river catchment (Foster, 2014, p. 264). Therefore, it is reasonable to assume, that a lack of clear guidelines for compliance means that water users may choose to exceed their limits, which would compromise the sustainability of water extractions across the Basin and its states (particularly downstream users) (Gardner et al., 2014, p. 4; see also Holley and Sinclair, 2012, p. 179). Further, the MDBA expounds on its adaptive management approach to addressing the effects of climate change on water resources, but does not suggest that adaptive responses may require a reduction of water entitlements (Gardner et al., 2014, p. 4).

In dry periods, it is conceivable that the attitudes of water users and the community to further reducing their entitlements may well result in wilful non-compliance with the SDLs, and a lack of cooperation. Indeed, governments have been found to struggle to provide an effective and comprehensive compliance and enforcement regime for water (Holley and Sinclair, 2012, p. 149). In addition, the national policy in relation to the risks and costs of future reductions in water entitlements is currently assigned to water-entitlement holders, which means that a reduction of water availability as a result of climate change will not be compensated by the Australian Government (Gardner et al., 2014, p. 5). Gardner argues that this policy is significantly unjust, and suggests that economic and environmental losses from reduced water entitlements could be calculated in pecuniary terms, for the purpose of determining compensation to water holders who suffer such losses (Gardner et al., 2014, p. 5). Nonetheless, the Australian Government has demonstrated some level of engagement with and commitment to enforcing standards, with the introduction of the *National Framework for Compliance and Enforcement Systems for Water Resource Management* in 2012 (Department of the Environment, 2012). This initiative creates a prospect for a great deal of improvement in water management in Australia, and it might be necessary to enforce compliance through financial concessions or more stringent enforcement mechanisms (or both) to promote change.

This discussion leads to a question about the long-term implications for scientific research generally and best science advice more specifically. It points to two major issues: first, while science-based knowledge can provide best available hydrological modelling, and the most accurate data, there are clearly inconsistencies between efforts at reform and on-the-ground outcomes when mechanisms to monitor compliance are poorly enforced. These inconsistencies are a major concern given that the Basin Plan outlines legally binding ex-

traction limits on all Basin states, and that ultimately, the effectiveness of these overarching SDLs is vital to the management regime of the MDB under the Federal Government. Secondly, the former Prime Minister Tony Abbott's<sup>2</sup> decision not to have a dedicated science minister in his government, until a recent cabinet reshuffle, raises an important question about the Coalition Government's attitude to the discipline of science (The Guardian, 2013). Similarly, the 2014-15 cuts in the Federal Budget to science programs and research grants has left many observers deeply concerned about Australia's future prosperity in the sciences (Australian Academic of Science, 2014)<sup>3</sup>.

At a time when changing weather patterns due to climate change are predicted to affect the hydrological cycle across various regions more than ever, it is important to recognise the value of research efforts that provide the scientific knowledge necessary to drive future preparedness. Australia is about to face the adverse impacts of another El Niño event, which will be compounded by the effects of climate change. In this context, the federal government of Australia should take the long-term view that policy informed by science-based knowledge must transcend both political lines and stakeholders' interests. A good first step in this direction would be to bring science under a single responsible minister and the policy impetus to encourage science to do what it does best – that is, develop sound methodologies for water resource assessments to inform sustainable water management practices.

#### 4 Conclusions

The role of science in policy making demonstrates that specialist knowledge may or may not influence complex decision making. Despite the idea that governments and organisations across the world consider evidence-based policy a key factor to making sound policy, the reality tends to fall short of this idea. This article has demonstrated that the treatment of uncertainty in specialist advice largely determines how well the advice fits with, or contradicts the policy goals dominated by the political and stakeholder interests. In Australia, as elsewhere, the role of science remains vital in formulating the evidence and forecasting necessary to prepare against unprecedented changes to our climate and our water ways. More than ever, water managers and decision makers need to be well informed about the consequences of poor policy implementation and the dangers of climate change on

<sup>2</sup>The Coalition Government led by the Prime Minister Tony Abbott was ousted in a dramatic party coup on 14 September 2015. Malcolm Turnbull won the prime ministership from Tony Abbott and has been sworn in as Australia's new Prime Minister.

<sup>3</sup>Prime Minister Malcolm Turnbull recently announced that science will have a more predominant role in his government (see Department of Industry, Innovation and Science <http://www.industry.gov.au/science/Pages/default.aspx>).



water resources. The prospect of an El Niño event in Australia suggests that the future of water management will need to adapt to highly variable seasonal precipitations. Science can help prepare for such anticipated changes but decision makers have to be motivated to act accordingly.

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## References

- Australian Academy of Science: 2014-15 Federal Budget Analysis of Measures Relating to Science, Research and Innovation, From the Australian Academy of Science, <https://www.science.org.au/files/userfiles/support/submissions/2014/2014-15-federal-budget-initial-analysis.pdf>, 2014.
- BoM: Mature El Nino in the Tropical Pacific Region, <http://www.bom.gov.au/climate/enso/#tabs=Overview>, 2015.
- Bureau of Meteorology (BoM): Australian Water Resources: Assessment 2012, <http://www.bom.gov.au/water/awra/2012/documents/summary-hr.pdf> (last access: 1 August 2016), 2013.
- Connell, D.: Water Politics in the Murray-Darling Basin, The Federation Press, Sydney, 2007.
- Connell, D. and Grafton, Q. R.: Water Reform in the Murray-Darling Basin, *Water Resour. Res.*, 47, W00G03, doi:10.1029/2010WR009820, 2011.
- Cullen, P., Flannery, T., Harding, R., Morton, S., Possingham, H., Saunders, D., Thom, B., Williams, J., Young, M., Cosier, P., and Bouilly, L: Blueprint for a Living Continent: A Way Forward from the Wentworth Group of Concerned Scientists (1 November 2002), <http://wentworthgroup.org/publications/>, 2012.
- Davis, K. E., Kingsbury, B., and Merry, S. E.: The Local-Global Life of Indicators: Law, Power, and Resistance, in: *The Quiet Power of Indicators: Measuring Governance, Corruption and the Rule of Law*, Cambridge Studies in Law and Society, edited by: Merry, S. E., Davies, K. E., and Kingsbury, B., CUP, 2015.
- Doremus, H. and Tarlock, A. D.: *Water War in the Klamath Basin: Macho Law Combat Biology and Dirty Politics*, Island Press, Washington, DC, 2008.
- Environment Defenders Office: Legal analysis of the Proposed Murray-Darling Basin Plan, Environment Defenders office (Victoria), [https://envirojustice.org.au/downloads/files/law-reform/EDO\\_legal\\_analysis\\_of\\_draft\\_MD\\_Basin\\_Plan.pdf](https://envirojustice.org.au/downloads/files/law-reform/EDO_legal_analysis_of_draft_MD_Basin_Plan.pdf) (last access: 1 August 2016), 2012.
- Fisher, E., Pascual, P., and Wagner, W: Understanding environmental models in their legal and regulatory context, *J. Environ. Law*, 22, p. 251, 2010.
- Foerster, A: Water law: adapting to climate change in South-eastern Australia, in: *Water and the Law: Towards Sustainability*, edited by: Kidd, M., Feris, L., Forombo, T., and Iza, A., The IUCN Academy of Environmental Law, Edward Elgar Publishing Limited, 2014.
- Frewer, L. and Salter, B.: Public attitudes, scientific advice and the politics of regulatory policy: The case of BSE, *Science and Public Policy*, 29, p. 138, 2002.
- Gardner, A., Blaskers, R., and Hartley, M.: Legal Scenarios for Integrated Modelling, *Australasian Journal of Natural Resources Policy and Law*, 17, p. 4, 2014.
- Gibbs, P., Hanlon, M., Hardaker, P., Hawkins, E., McDonald, A., Maskell, K., Mayfield, H., Mclean, A., Morris, E., Mylne, K., Naylor, M., Palmer, T., Rawlins, M., Roysse, K., Smith, L., So, E., Spiegelhalter, D., Stainforth, D., Stewart, I., Tyler, C., De Fotch, F., Brown T., and Innocent, T.: *Making Sense of Uncertainty: Why uncertainty is part of science, Sense about Science*, p. 3, London, UK, available at: [http://www.senseaboutscience.org/data/files/resources/127/SAS012\\_MSU\\_reprint\\_compressed.pdf](http://www.senseaboutscience.org/data/files/resources/127/SAS012_MSU_reprint_compressed.pdf), 2013.
- Godden, L.: Submission to the Inquiry into the Provisions of the *Water Act 2007*. The Senate Standing Committee on Legal and Constitutional Affairs, Canberra, Australia, 2011.
- Hamstead, M., Baldwin, C., and O'Keefe, V.: Water Allocation Planning in Australia – current practices and lessons learned *Waterlines No 6*, National Water Commission, Canberra, [http://archive.nwc.gov.au/\\_data/assets/pdf\\_file/0011/11018/Waterlines\\_no\\_6.pdf](http://archive.nwc.gov.au/_data/assets/pdf_file/0011/11018/Waterlines_no_6.pdf), 2008.
- Heazle, M.: *Uncertainty in Policy Making: Values and Evidence in Complex Decisions*, Earthscan, 2010.
- Holley, C. and Sinclair, D.: Compliance and enforcement of water licenses in NSW: Limitations in law, policy and Institutions, *Australasian Journal of Natural Resources Policy and Law*, 15, 149–189, 2012.
- Kildea, P. and Williams, G.: The Constitution and the management of water in Australia's rivers, *Sydney Law Review*, 32, 595–616, 2010.
- Kildea, P. and Williams, G.: Journal Excerpt: The Water Act and the Murray-Darling Basin Plan, *Public Law Review*, 9, 2011.
- Liu, Y., Gupta, H., Springer, E., and Wagener, T.: Linking science with environmental decision making: Experiences from an integrated modelling approach to supporting sustainable water resources management, *Environ. Model. Softw.*, 23, 846–858, 2008.
- Murray-Darling Basin Authority (MDBA): The Water Act, <http://www.mdba.gov.au/about-us/governance/water-act> (last access: 1 August 2016), 2007.
- Murray-Darling Basin Authority (MDBA): Hydrological modelling, <http://www.mdba.gov.au/managing-water/hydrological-modelling> (last access: 1 August 2016), 2012a.
- Murray-Darling Basin Authority (MDBA): About the Basin, [http://www.mdba.gov.au/sites/default/files/archived/proposed/Hydro\\_Modelling\\_Report.pdf](http://www.mdba.gov.au/sites/default/files/archived/proposed/Hydro_Modelling_Report.pdf) (last access: 1 August 2016), 2012b.
- Murray-Darling Basin Authority (MDBA): SDL Adjustment Ecological Elements Methods Development Report Review of Final Project Report by the Independent Review Panel, <http://www.mdba.gov.au/publications/independent-reports/sdl-adjustment-ecological-elements-method-development-report-review> (last accessed: 1 August 2016), 2014.
- Murray-Darling Basin Authority (MDBA): Geography, <http://www.mdba.gov.au/discover-basin/landscape/geography> (last accessed 1 August 2016), 2012c.

- Murray-Darling Basin Authority (MDBA): The SDL adjustment assessment framework for supply measures, <http://www.mdba.gov.au/publications/mdba-reports/sdl-adjustment-assessment-framework-supply-measures> (last accessed: 1 August 2016), 2015.
- Musgrave, W.: Historical development of water resources in Australia, in: *Water Policy in Australia: The Impact of Change and Uncertainty*, edited by: Crase, L., Resource for the Future, 2008.
- Papas, M.: The Proposed Governance Framework for the Murray-Darling Basin, *Macquarie Journal of International and Comparative Environmental Law*, 4, 77–90, 2007.
- Parliament of the Commonwealth of Australia: House of Representatives Standing Committee on Regional Australia, Of Drought and Flooding Rains: Inquiry into the Impact of the Guide to the Murray-Darling Basin Plan, 2011.
- Pileke, R.: *The Honest Broker: Making Sense of Science in Policy and Politics*, Cambridge University Press, Cambridge, 2007.
- Pittock, J.: Lessons from adaptation to sustain freshwater environments in the Murray-Darling Basin, Australia, *Wiley Interdisciplinary Reviews: Climate Change*, 4, 429–438, 2013.
- Scanlon, J.: A hundred years of negotiations with no end in sight: Where is the Murray-Darling Basin Initiative leading us?, *Environmental & Planning Law Journal*, p. 386, 2006.
- Skinner, D. and Langford, J.: Legislating for sustainable basin management: the story of Australia's Water Act (2007), *Water Policy*, 15, 871–894, 2013.
- The Guardian: Australia, where is your science Minister?, 17 September 2013.
- The Guardian: El Nino on its way to Australia, says Bureau of Meteorology, 12 May 2015.
- Thompson, A.: Soil – salinity, Soil salinity, dryland and salinity, <http://www.natsoc.org.au/our-projects/biosensitivefutures/part-4-facts-and-principles/ecological-issues/soils-salinity> (last access: 1 August 2016), 2014.
- van Dijk, A. I. J. M., Beck, H. E., Crosbie, R. S., Jeu, R. A. M., Liu, Y. Y., Podger, G. M., Timbal, B., and Viney, N. R.: The millennium drought in Southeast Australia (2001–2009): natural and human causes and implications for water resources, ecosystems, economy and society, *Water Resour. Res.*, 49, 1040–1057, 2013.