



# Multiple and sequential land use: A national policy for Australia?

James J Walcott

21 Jelbart St Mawson, ACT 2607, Australia



## ARTICLE INFO

### Keywords:

Multiple land use  
Sequential land use  
Natural resource information  
Land use policy

## ABSTRACT

The closest the Australian Government has come to a national land use policy was for multiple and sequential use that was proposed in 1992 as one pathway to sustainable development of land in Australia over space and time. Under this national strategy governments in Australia's federalist system would undertake several actions but it was never resourced. In 2013 the Multiple Land Use Framework (MLUF) was developed but still has little promotion by governments and has not noticeably reduced disputes on land use developments. Trial programs that support multiple uses, especially nature conservation, on privately operated land have been moderately successful but limited in scope. Sequential land use, largely applicable to post-mining recovery, appears limited so far, but may succeed in facilitating alternative land uses as the mining industry moves to life-of-mine planning. Some possible reasons for this lack of government response are discussed.

## 1. Introduction

Australia, being a continent that is managed by a single nation, should be able to plan its land use policies so as to adequately manage the needs of conservation, indigenous peoples and industries. This is not always so, with land use policy and planning in Australia recently described as in disarray, lacking focus, determination, coordination and leadership (Thackway, 2018a). Disagreements and conflicts over present or proposed uses for a piece of land are not unusual in Australia (Cocks, 1992) and more recently evidenced by the issue of a proposed coal mine in the Galilee Basin in Queensland during the election of May 2019. A recent publication honouring the career of a former colleague (Thackway, 2018c) highlights some progress and issues relating to land use in Australia and stimulated this opinion essay.

The many unique flora and fauna assemblages in Australia applies a special responsibility upon Australian citizens, represented by its various governments, to manage and conserve its natural resources (White, 1994). Aboriginals, who began arriving about 60,000 years ago, were the first to use the land, modifying the land cover of Australia and arrive at uses that were sustainable albeit for a low population density (Barr and Cary, 1992; Gammage, 2011). Since the arrival of largely European settlers from 1788 there have been much greater changes to land use over the continent (Attwood and Burns, 2012) through intensification. I refer the reader to some brief descriptions of Australia's unique position given in other articles (Hobday and McDonald, 2014; Williams and Walcott, 1998) to avoid repeating them here.

Land use issues often arise from three broader concerns of "who gets the land, how they manage it and what they do to others in the process"

(Manning, 1986). Following the publication of *Our common future* in 1987 (World Commission on Environment and Development, 1987) sustainable development has provided a broad conceptual basis for national land use policies to deal with these issues. The latest iteration, the 2030 Agenda for Sustainable Development, which was adopted by all UN member states in 2015 (United Nations, 2015), indicates its continuing relevance to land use policies (Scoones, 2016). Its sustainable development goal 15 is to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss".

Multiple land use delivers multiple goods or services from a piece of land but has a broad application depending on its source (in forestry, agriculture and nature management) and applies at different spatial and temporal scales (Havel, 1989; Londo et al., 2004; Nair, 1983). This opinion article presents my thoughts on a little studied aspect of using multiple and/or sequential land use as the basis for policies in Australia's federalist system.

## 2. A national land use policy?

Like other similar federalist nations with an extensive area and dependence on natural resources, such as Canada and the United States of America (USA), the responsibility in Australia for land use policy and planning primarily resides at the sub-national level (Bray, 1979; Hueglin and Fenna, 2006) except for national controlled lands (such as military bases). But unlike Canada (Government of Canada, 1981), whose land use policy is primarily about the effective use of federal

E-mail address: [jwalcott@bigpond.net.au](mailto:jwalcott@bigpond.net.au).

<https://doi.org/10.1016/j.landusepol.2019.104160>

Received 26 December 2018; Received in revised form 3 August 2019; Accepted 7 August 2019

Available online 20 August 2019

0264-8377/ © 2019 Elsevier Ltd. All rights reserved.

policies and programs, Australia does not have a national policy on land use.

There were at least 16 inquiries that called for an national land-use policy between 1972 and 1992 (Cocks, 1992). The most important was the Senate Standing Committee on Science, Technology and the Environment (SSCSTE, 1984) which identified many reasons for a national policy, the major ones being:

- Addressing issues and problems of national significance, such as soil, water and vegetation resources, salinity, Aboriginal lands and foreign ownership;
- Issues that cross State borders, such as the Murray-Darling Basin;
- Reduce uncertainty for miners, foresters, developers and land-holders; and
- To complement and assist State and Territory governments in their land use problems through consistent data, research and negotiating national targets for various land uses.

The closest Australian governments have come to an overarching national land use policy was as part of the National Strategy for Ecologically Sustainable Development (ESD) (Council of Australian Governments, 1992) under objective 13.1 as Multiple and Sequential Land Use. This objective arose from the sector reports of agriculture, forestry and mining in the ESD process. Specifically, it was “to encourage environmental and economic land use decision making which takes full account of all relevant and resource values (including downstream aquatic resources) and to establish and operate systems of land use decision making and dispute resolution. Governments will [inter alia]:

- continue efforts to clarify, rationalise and publicise policies and legislation for access to land, including the nation’s conservation and heritage estate and
- promote multiple and sequential land use.
- continue efforts to improve levels of understanding of Australia’s natural resource base, and work towards land use planning and decision making processes which take those resource values into account.”

Multiple and sequential land use embodies the notion that a given area of land can accommodate several uses at the same time and/or can first be used for one purpose and then later used for another purpose (BRS, 1997). I consider the two as covering land use in space (multiple) and time (sequential).

Although compiled under a moderately liberal Labor government, multiple and sequential land use was endorsed by the incoming more conservative Coalition government in 1996. However, this was a strategy with only the lightest of touches – it had no legislative teeth, was given no resources, provided with little definition or explanation and did not assign roles and responsibilities.

After some twenty years a government panel produced a Multiple Land Use Framework (MLUF), primarily for mining industries but with applicability to others (Standing Council on Energy and Resources, 2013). It is intended to influence the way in which land use planning and policy are imposed by governments but it still provides mostly aspirational policy ideas (Taylor, 2017). It still has little promotion or resources from government to implement it although it does encompass some principles desirable in a land use policy.

In practice, Australian governments have almost universally chosen to address these issues singly (Thackway, 2018a), subject to changes in emphases between policies over time depending on the priority of issue and political persuasion (Burns et al., 2016). The national government, if it has the political will to do so, has several avenues to influence the management of an issue through the national environmental legislation (often tied to international agreements) similar to other federalist countries (OECD, 2006, 2012, 2017, 2019). It also often influences

large development proposals through the use of environmental assessments (Silva and Acheampong, 2015) and through direct tied grants to sub-national governments. For instance programs such as National Heritage Trust (1999–2008), National Action Plan for Salinity and Water Quality (2000–2008), Landcare (1990 – continuing) and Caring for our Country (2008–2013) as noted by Salt et al. (2016).

Changes in land-use and land-cover have many biophysical impacts – on the processes that influence climate, carbon storage, biodiversity, and ecosystem services (Attwood and Burns, 2012; Lambin et al., 2003) including by the soil (Nielsen et al., 2015). These unintended consequences develop over time and require attention to alleviate their impacts. Hamblin (2009) asked for a general policy rationale to consider whether an intervention will provide environmental sustainability under any intended land use. Indeed, a robust and comprehensive assessments of major land use projects should explicitly acknowledge and assess uncertainty (Pannell et al., 2012). One of the guiding principles in the MLUF asks for decision making to take a “risk-based approach in the assessment of land use capability, including the benefits and consequences”.

### 3. Multiple land use

Multiple use of agricultural lands, though deemed important, has had little impetus (Hamblin, 2009) from governments so far. In part, it depends upon how to deliver a desired range of ecosystem services, such as the provisioning, regulating, cultural, and supportive functions (van Noordwijk et al., 2012). In Australia, environmental services are commonly considered using a land-sparing attitude that allows for trade-offs between production uses and the quantity of services the land may otherwise provide (van Noordwijk et al., 2012). This implies intensification for more production from an area of land specialisation of the existing or potential land uses thus allowing for multiple uses over space.

Alternatively, environmental services can be considered as adopt a land sharing attitude (often called multifunctional) while trying to optimise the total land productivity. This implies reducing or diversifying land uses (Stafford Smith, 2000). While this can be supported in European countries when cross-subsidised through tourism, it has much less scope in Australia (Hamblin, 2009). However, Renwick and Schellhorn (2016) argue that land sharing/land sparing concepts could be considered as finding the most efficient allocation of land while improving productivity and stemming further biodiversity losses and impacts. This is a pragmatic approach given the challenges posed by the continuing intensification of agriculture and mining driven by industry needs for increased efficiencies and productivity.

Pastoral leases in the rangelands are moving to multiple uses to encompass a wider range of interests including Aboriginal land rights, sustainable management, biodiversity preservation, and tourism especially in South Australia and Western Australia (Holmes, 2014; Stafford Smith, 2000; van Etten, 2013). Nevertheless, despite nearly 40 years of Landcare (an Australian Government program with farmer groups) underpinning the restoration of degraded land, the actions are fragmented and often not sustained (Campbell et al., 2017). Some multiple uses contributing to the conservation of native biodiversity have persisted without formal recognition, for instance, in road corridors, travelling stock reserves (Forman and Alexander, 1998; Lentini et al., 2011; O’Loughlin et al., 2017) and railway verges - although this is little studied (Popp and Boyle, 2017).

The Australian government has given AU\$6.5 billion in funding since 1990 to 2013 for a range of natural resource management strategies (Salt et al., 2016). This sounds a lot of money but not compared to the approximately AU\$10b given in drought assistance to farmers by the Australian government between 2002-03 and 2007-08 (Productivity Commission, 2009). The funding has been delivered in various ways including direct grants, competitive tenders and market based instruments. There have been criticisms because of cost-shifting between and

within governments and government agencies, and a push from recent governments to shift responsibilities from governments to communities and individuals (Salt et al., 2016). The Australian Government has undertaken two programs using market based instruments to enhance conservation of biodiversity on private land (Zammit, 2013). They are the Forest Conservation Fund operated in Tasmania to conserve high value forests, and the Environmental Stewardship Program to conserve nationally endangered ecological communities. Zammit assessed them as providing reasonable ecological and social benefits in a relatively efficient and cost-effective manner. Despite this success and planned improvements and extended range the government did not undertake further funding rounds or support of these longer term projects from 2012 and will wind it up in 2026/27 (Burns, et al., 2016).

#### 4. Sequential land use

Sequential land use is a much less common approach and mainly sponsored by the mining industry in Australia. Despite mining occupying a very small proportion of Australia's land, there is potential for serious offsite damage such as from acid and metalliferous drainage remaining after mine closure (McCullough et al., 2018). For instance, there are estimated to be some 1800 abandoned pits left after open-cut mining in Western Australia (McCullough and Lund, 2006) while some shaft mines enter an indefinite 'care and maintenance' phase (Ashby et al., 2016). Moreover, there is general concern about the quality of mine restoration (Lamb et al., 2015) both for numbers and for quality (Cristescu et al., 2012). Hopefully, moves by the industry and government to promote life-of-mine planning that includes other potential land uses after mine closure (McCullough, et al., 2018) and is consistent with the MLUF will improve matters.

These disagreements are at least partly due to the variations between individual States in their land use regulation and planning. In Australia, mineral resources are the property of the state, who issue permits to miners for a temporary right to exploit them (Mant and Nielson, 1975; McCullough, et al., 2018). But such permits may easily impinge upon existing land use rights. So mining in ever larger open-cut systems and if new proposals encroach further on aboriginal cultural heritage sites could make it harder to recover and deliver sequential land change.

However, land uses that are highly path dependent could also be considered as sequential. For instance the possible recovery of some areas to the wilderness level on the protected area spectrum and whether mining, grazing, tourism and cultural activities should be allowed or managed (Irving, 2018). For some land use changes, such as urbanisation, a one-way single-use conversion is often appropriate but will have significant impacts on the natural landscape and present policy problems for conservation (Liu and Robinson, 2016).

#### 5. Improve understanding of Australia's natural resources

Most inquiries into land use have recommended that up to date data and information were needed for improved decision making and to inform the public of developments in the quality of their environment and use of their taxes. For instance the eighth of the guiding principles of the recent MLUF is to 'have easy access to accurate information regarding land capabilities, and examples of multiple and sequential land uses'.

Fortunately, there has been considerable progress in the underlying knowledge of natural resources of Australia since 1992 (Thackway, 2018c). A very comprehensive data collection, analysis and review on Australia's land and water resources was conducted at the turn of the millennium (NLWRA, 2005), which provided an impetus for the Australian Collaborative Land Use and Management Program (Hicks, 2018; Leslie et al., 2006; McKenzie, 2018). There are also four yearly State of Environment reports on land, and the latest notes some overall but inconsistent improvements (Metcalfe and Bui, 2017).

As a consequence of improved information, there has been more success dealing with individual issues such as wilderness in South Australia (Irving, 2018), biodiversity conservation (Neldner, 2018), and general conservation programs (Howling and Pulsford, 2018). Less successful have been efforts to deal with larger complex issues like climate change despite an abundance of information and analyses (Mackey, 2018).

The ability to use data and information to aid decisions has advanced recently with the development of decision analysis tools such as LUPIS (Cocks, 1992), MCASS (Hill et al., 2006), INFERR (Pannell, et al., 2012) and a scientific workflow approach (Clancy et al., 2018). It is likely that more information is an easy task to adopt – it is relatively cheap, non controversial and can be used as an excuse to defer difficult decisions. Even so, the use of scientific information to help resolve environmental conflict requires careful use to support dialogue rather than deepening divisions (Schirmer, 2018) and incorporating into wider contexts. This could fall under the guiding principle of MLUF for "open and constructive debate and analysis of different multiple land use options".

#### 6. Discussion

In theory, developing a national policy on land use should aid effective and efficient decisions to balance the delivery of public goods and services with those of private sector. But until such a policy is developed and enacted it is hard to tell if it will improve matters. As argued elsewhere (Thackway, 2018b; Williams and Walcott, 1998), under the principle of subsidiarity (whereby responsibility should not be assumed by a larger entity than necessary), ideally the roles and responsibility for land use management should be appropriately recognised, accepted and resourced. Multiple and sequential land use offers good principles for such a policy and often appear to have been adopted in part even if not acknowledged.

However, in practice the national government in Australia of all political persuasions has favoured addressing single issues over any comprehensive land use policy. Yet many efforts are piecemeal, uncoordinated or left unfinished (Campbell, et al., 2017). It may be overly optimistic to consider that better allocating roles and responsibilities could be adopted here.

There are implicit differences between policy development and its implementation through programs and projects that sometimes lead to considerable differences between original expectations of a policy and its delivery. It can become contested at policy implementation between differing interpretations such as neoliberalism (focus on natural resource), ecological modernization (focus on pollution and ecosystem services) and transformative change (focus on interconnected ecosystems) (Coffey and Marston, 2013). Also with the time lapses between policy development and its implementation conditions can change; in budget, the economy and prolonged rainfall deficiencies impeding community participation and recovery of natural systems. Hence, there is a need for risk management to be incorporated into the policies and their implementation.

So why not develop such a policy? It is possible that governments deem it to be unnecessary, but the plethora of ongoing serious environmental issues in Australia associated with land use (Hobday and McDonald, 2014) and the many inquiries (Cocks, 1992) indicates that it should be required (Mackey, 2018). The reluctance to attempt any formal national land use policy may have many underlying reasons. It is apparent that ministers, politicians and senior bureaucrats want to put their own stamp on their roles and to be recognised for it. It may also be due to either a concern about government controls, a means of maintaining some flexibility for decisions and freedom to undertake certain work, or reluctance on the part of the states to cede any further power to the national government. Since 1996 Australian politics has been largely dominated by neoliberal philosophies that emphasise capitalism and property rights. This may reinforce existing extractive, exploitative

relations and fail to deliver sustainability (Scoones, 2016). Yet, the practice and politics are far from rational and often not well informed (Dovers et al., 1995, Dovers, 2018) even from a strict neoliberal viewpoint.

Looking forwards, it could be helpful to undertake a comparative study looking at the adoption of multiple and sequence land use issues in similar countries such as Canada, USA, and Argentina similar to that conducted by Han and Go (2019) to help identify robust approaches. I also think it is about time to undertake another National Land and Water Resources Audit to review progress in last 20+ years and to identify major neglected areas and issues. But this time, unlike the first that concentrated on using existing datasets, it should also include developing a capacity to initiate longer-term monitoring sites.

The author, scientist, bureaucrat and politician C.P Snow observed (Snow, 1969) that “it is in the nature of politics that the short-term duties come first” and consequently “the duty of the rest of us, and perhaps most of all the generations which are going to live in what is now the future, to keep before the world its long-term fate”. Progress will involve unruly political alliances, diverse knowledge, and collective organization (Scoones, 2016).

## 7. Conclusions

While there has been no formal national land use policy despite many calls for one, the strategy involving multiple and sequential land use has come closest. However, in practice the national government in Australia of all political persuasions has favoured addressing single issues over any comprehensive policy. The major influence of multiple and sequential land use is likely to have been through its informal, cohesive overview that has led to arrangements that work in a fashion. With current indifference at the national level, policies and actions take place at state (Hicks, 2018), industry (MLUF), community and individual levels (Thackway, Brown et al., 2018). On balance, I think applying the concept of multiple and sequential land use is better than middle-through, laissez-faire, single issue approaches particularly as land use pressures increase as population expands and as climate change impacts worsen. But it will need considerably more coordination, resources and promotion from governments to make a difference.

## Acknowledgements

I was a former colleague of both the late Dr Robert Lesslie (the focus) and Dr Richard Thackway (the editor) of the recent book “Land use in Australia: past, present and future”.

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

I acknowledge the contribution by my late colleague Dr Jon East in commencing this topic.

Dr Ann Hamblin provided some stimulating comments and useful suggestions to an early draft. Two anonymous referees stimulated critical revisions. Ms Jessica Cross helped with the abstract. But any errors remain my own.

## References

- Ashby, A.D., van Etten, E.J.B., Lund, M.A., 2016. Pitfalls of gold mine sites in care and maintenance. Paper Presented at the Proceedings of the 11th International Conference on Mine Closure. [https://papers.acg.uwa.edu.au/p/1608\\_22\\_Ashby/](https://papers.acg.uwa.edu.au/p/1608_22_Ashby/).
- Attwood, S.J., Burns, E., 2012. Managing biodiversity in agricultural landscapes: perspectives from a research-policy interface. In: Lindenmayer, D., Cunningham, S., Young, A. (Eds.), *Land Use Intensification: Effects on Agriculture, Biodiversity and Ecological Processes*. CSIRO Publishing, Collingwood, Victoria, pp. 17–26.
- Barr, N., Cary, J., 1992. *Greening a Brown Land: the Australian Search for Sustainable Land Use*. Macmillan Education Australia, Pty. Ltd, South Melbourne, Victoria.
- Bray, C.E., 1979. *Canadian Land Use*. Dept. of Agriculture, Economics, Statistics, and Cooperatives Service, Washington, D.C.
- BRS, 1997. *Multiple and Sequential Land Use Technical Symposium*. Bureau of Rural Sciences., Canberra.
- Burns, E., Zammit, C., Attwood, S.J., Lindenmayer, D., 2016. The environmental

- stewardship program: lessons on creating long-term agri-environment schemes. In: Ansell, D., Gibson, F., Salt, D. (Eds.), *Learning from Agri-Environmental Schemes in Australia: Investing in Biodiversity and Other Ecosystem Services on Farms*. ANU Press, Canberra, pp. 33–51.
- Campbell, A., Alexandra, J., Curtis, D., 2017. Reflections on four decades of land restoration in Australia. *Rangel. J.* 39 (6), 405–416. <https://doi.org/10.1071/RJ17056>.
- Clancy, T., Bryan, B.A., Guru, S.M., 2018. The future for land use mapping: national e-infrastructure, modelling analytics, synthesis and securing institutional capacity. In: Thackway, R. (Ed.), *Land Use in Australia: Past, Present and Future*. ANU eView., Canberra, pp. 253–262.
- Cocks, D., 1992. *Use With Care: Managing Australia's Natural Resources in the Twenty First Century*. New South Wales University Press, Kensington, NSW.
- Coffey, B., Marston, G., 2013. How neoliberalism and ecological modernization shaped environmental policy in Australia. *J. Environ. Policy Plan.* 15 (2), 179–199. <https://doi.org/10.1080/1523908X.2012.746868>.
- Council of Australian Governments, 1992. *National Strategy for Ecologically Sustainable Development*. Australian Government Publishing Service, Canberra, ACT.
- Cristescu, R.H., Frere, C., Banks, P.B., 2012. A review of fauna in mine rehabilitation in Australia: current state and future directions. *Biol. Conserv.* 149, 60–72. <https://doi.org/10.1016/j.biocon.2012.02.003>.
- Dovers, S., 1995. Risk, uncertainty and ignorance: policy process and institutional issues. *Risk and Uncertainty in Environmental Management: Proceedings of the 1995 Australian Academy of Science Fenner Conference on the Environment* 14–32.
- Dovers, S., 2018. Does public policy obey data, information and maps? In: Thackway, R. (Ed.), *Land Use in Australia: Past, Present and Future*. ANU eView., Canberra, pp. 59–68.
- Forman, R.T.T., Alexander, L.E., 1998. Roads and their major ecological effects. *Annu. Rev. Ecol. Syst.* 29, 207–231.
- Gammage, B., 2011. *The Biggest Estate on Earth: How Aborigines Made Australia*. Allen & Unwin., Sydney.
- Government of Canada, 1981. *Federal Policy on Land Use*. Minister of Supply and Services, Ottawa, Ontario.
- Hamblin, A., 2009. Policy directions for agricultural land use in Australia and other post-industrial economies. *Land Use Policy* 26, 1195–1204. <https://doi.org/10.1016/j.landusepol.2009.01.002>.
- Han, A.T., Go, M.H., 2019. Explaining the national variation of land use: a cross-national analysis of greenbelt policy in five countries. *Land Use Policy* 81, 644–656.
- Havel, J.J., 1989. Land use conflicts and the emergence of multiple land use. In: Dell, B., Havel, J.J., Malajczuk, N. (Eds.), *The Jarrah Forest: A Complex Mediterranean Ecosystem*. Springer Netherlands, Dordrecht, pp. 281–314.
- Hicks, R.W., 2018. Responding to land use pressures: a state and territory perspective. In: Thackway, R. (Ed.), *Land Use in Australia: Past, Present and Future*. ANU eView., Canberra, pp. 85–106.
- Hill, M.J., Lesslie, R., Donohue, R., Houlder, P., Holloway, J., Smith, J., et al., 2006. Multi-criteria assessment of tensions in resource use at continental scale: a proof of concept with Australian rangelands. *Environ. Manage.* 37 (5), 712–731. <https://doi.org/10.1007/s00267-004-0390-5>.
- Hobday, A.J., McDonald, J., 2014. Environmental issues in Australia. *Annual Review of Energy and Environment* 39, 1–28. <https://doi.org/10.1146/annurev-environ-012113-111451>.
- Holmes, J., 2014. Explorations in Australian legal geography: the evolution of lease tenures as policy instruments. *Geogr. Res.* 52 (4), 411–429. <https://doi.org/10.1111/1745-5871.12083>.
- Howling, G., Pulsford, J.S., 2018. The role and importance of coordinated land information to support landscape connectivity initiatives. In: Thackway, R. (Ed.), *Land Use in Australia: Past, Present and Future*. ANU eView., Canberra, pp. 181–202.
- Hueglin, T.O., Fenna, A., 2006. *Comparative Federalism: a Systematic Inquiry*. Broadview Press, Peterborough, Ontario.
- Irving, J., 2018. Balancing land use trade-offs: the role of wilderness in nature conservation. In: Thackway, R. (Ed.), *Land Use in Australia: Past, Present and Future*. ANU eView, Canberra, pp. 107–113.
- Lamb, D., Erskine, P.D., Fletcher, A., 2015. Widening gap between expectations and practice in Australian minesite rehabilitation. *Ecol. Manag. Restor.* 16 (3), 186–195. <https://doi.org/10.1111/emr.12179>.
- Lambin, E.F., Geist, H.J., Lepers, E., 2003. Dynamics of land-use and land-cover change in tropical regions. *Annu. Rev. Environ. Resour.* 28, 205–241. <https://doi.org/10.1146/annurev.energy.28.050302.105459>.
- Lentini, P.E., Fischer, J., Gibbons, P., Lindenmayer, D.B., Martin, T.G., 2011. Australia's stock route network: 1. A review of its values and implications for future management. *Ecol. Manag. Restor.* 12 (2), 119–127. <https://doi.org/10.1111/j.1442-8903.2011.00591.x>.
- Lesslie, R., Barson, M.M., Smith, J., 2006. Land use information for integrated natural resources management - a coordinated national mapping program for Australia. *J. Land Use Sci.* 1 (1), 45–62. <https://doi.org/10.1080/17474230600605244>.
- Liu, Z., Robinson, G.M., 2016. Residential development in the peri-urban fringe: the example of Adelaide, South Australia. *Land Use Policy* 57, 179–192. <https://doi.org/10.1016/j.landusepol.2016.05.026>.
- Londo, M., Roose, M., Dekker, J., de Graaf, H., 2004. Willow short-rotation coppice in multiple land-use systems: evaluation of four combination options in the Dutch context. *Biomass Bioenergy* 27 (3), 205–221. <https://doi.org/10.1016/j.biombioe.2004.01.008>.
- Mackey, B., 2018. Elephants in the kitchen: responding to the challenge of rapidly changing climate and land use. In: Thackway, R. (Ed.), *Land Use in Australia: Past, Present and Future*. ANU eView, Canberra, pp. 241–250.
- Manning, E.W., 1986. *Towards sustainable land use: a strategy*. Canada-China Bilateral Symposium on Territorial Development and Management. Beijing, China (Vol.

- Working Paper No. 47. Ottawa: Lands Directorate, Environment Canada, pp. 53.
- Mant, J.H., Nielson, L., 1975. Land use issues in Australia. *Aust. Q.* 47 (4), 20–27. <https://doi.org/10.2307/20634811>.
- McCullough, C.D., Harvey, B., Unger, C.J., Winchester, S., McCarthy, B., Coetzee, J., 2018. From start to finish - a perspective on improving sustainable development aspects of life-of-mine practices. *From Start to Finish: a Life-of-mine Perspective*. AusIMM, Carlton South, pp. 395–400.
- McCullough, C.D., Lund, M.A., 2006. Opportunities for sustainable mining pit lakes in Australia. *Mine Water Environ.* 25 (4), 220–226. <https://doi.org/10.1007/s10230-006-0136-0>.
- McKenzie, N., 2018. Understanding soil change: institutional requirements to ensure Australia's national preparedness. In: Thackway, R. (Ed.), *Land Use in Australia: Past, Present and Future*. ANU eView, Canberra, pp. 145–165.
- Metcalfe, D.J., Bui, E.N., 2017. *Australia State of Environment 2016*: Land. Australian Department of the Environment and Energy, Canberra, pp. 162.
- Nair, P.K.R., 1983. Multiple land-use and agroforestry. In: Nugent, J., O'Connor, M. (Eds.), *Better Crops for Food*. Symposium on Better Crops for Food. Pitman Books, London, pp. 101–115.
- Neldner, J., 2018. The impacts of land use change on biodiversity in Australia. In: Thackway, R. (Ed.), *Land Use in Australia: Past, Present and Future*. ANU eView, Canberra, pp. 115–125.
- Nielsen, U.N., Wall, D.H., Six, J., 2015. Soil biodiversity and the environment. *Annu. Rev. Environ. Resour.* 40, 63–90. <https://doi.org/10.1146/annurev-environ-102014-021257>.
- NLWRA, 2005. *National Land and Water Resource Audit: an Initiative of the National Heritage Trust: Final Reports*. pp. 1997–2002.
- O'Loughlin, T., O'Loughlin, L.S., Michael, D.R., Wood, J.T., Waudby, H.P., Falcke, P., et al., 2017. The importance of travelling stock reserves for maintaining high-quality threatened temperate woodlands. *Aust. J. Bot.* 65, 507–516. <https://doi.org/10.1071/BT17114>.
- OECD, 2006. *OECD Environmental Performance Reviews: United States 2005*. OECD Publishing, Paris.
- OECD, 2012. *OECD Environmental Performance Reviews: Germany 2012*. OECD Publishing, Paris.
- OECD, 2017. *OECD Environmental Performance Reviews: Canada 2017*. OECD Publishing, Paris.
- OECD, 2019. *OECD Environmental Performance Reviews: Australia 2019*. OECD Publishing, Paris.
- Pannell, D.J., Roberts, A.M., Park, G., Alexander, J., Curatolo, A., Marsh, S.P., 2012. Integrated assessment of public investment in land-use change to protect environmental assets in Australia. *Land Use Policy* 29 (2), 377–387. <https://doi.org/10.1016/j.landusepol.2011.08.002>.
- Popp, J.N., Boyle, S.P., 2017. Railway ecology: underrepresented in science? *Basic Appl. Ecol.* 19 (1), 84–93. <https://doi.org/10.1016/j.baae.2016.11.006>.
- Productivity Commission, 2009. *Government Drought Support Report No. 46, Final Inquiry Report*. Retrieved from. pp. 431. [www.pc.gov.au](http://www.pc.gov.au).
- Renwick, A., Schellhorn, N., 2016. A perspective on land sparing versus land sharing. In: Ansell, D., Gibson, F., Salt, D. (Eds.), *Learning from Agri-Environmental Schemes in Australia: Investing in Biodiversity and Other Ecosystem Services on Farms*. ANU Press, Canberra, pp. 117–125.
- Salt, D., 2016. A brief history of agri-environment policy in Australia: from community-based NRM to market-based instruments. In: Ansell, D., Gibson, F., Salt, D. (Eds.), *Learning from Agri-Environment Schemes in Australia: Investing in Biodiversity and Other Ecosystem Services on Farms*. ANU Press, Canberra, pp. 91–104.
- Schirmer, J., 2018. Environmental conflict: engaging with scientific information and community activism. In: Thackway, R. (Ed.), *Land Use in Australia: Past, Present and Future*. ANU eView, Canberra, pp. 169–179.
- Scoones, I., 2016. The politics of sustainability and development. *Annual Review of Energy and Environment* 41, 293–319. <https://doi.org/10.1146/annurev-environ-110615-090039>.
- Silva, E., Acheampong, R., 2015. Developing an Inventory and Typology of Land-use Planning Systems and Policy Instruments in OECD Countries OECD Environment Working Papers No 94 (Vol. 94). OECD Publishing, Paris.
- Snow, C.P., 1969. *The State of Siege*. Charles Scribner's Sons, New York.
- SSCSTE, 1984. *Land Use Policy in Australia*. Senate Standing Committee on Science, Technology and the Environment. Canberra AGPS.
- Stafford Smith, M., 2000. *Grazing half of Australia: risks and returns to regional futures*. Paper Presented at the Emerging Technologies in Agriculture: from Ideas to Adoption. Proceedings of a Conference, 25–26 July 2000.
- Standing Council on Energy and Resources, 2013. *Multiple Land Use Framework*. Council of Australian Governments Energy Council, Canberra. Retrieved from <http://www.coenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/Multiple%20Land%20Use%20Framework%20-%20Dec%202013.pdf>.
- Taylor, M., 2017. Trends in current Australian agricultural policy and land resource management. *Legal Studies Research Paper 17/52, 16* Retrieved from. [ssrn.com/abstract=2997776](http://ssrn.com/abstract=2997776).
- Thackway, R., 2018a. Introduction. In: Thackway, R. (Ed.), *Land Use in Australia: Past, Present and Future*. ANU eView, Canberra, pp. 1–8.
- Thackway, R., 2018b. National coordination of data and information to inform land use policies and programs: the recent past, the present and ideas for the future. In: Thackway, R. (Ed.), *Land Use in Australia: Past, Present and Future*. ANU eView, Canberra, pp. 129–143.
- Thackway, R. (Ed.), 2018. *Land Use in Australia: Past, Present and Future*. ANU eView, Canberra.
- Thackway, R., Brown, V.A., Marsh, D., Harris, J.A., 2018. Land use planning as a collective learning spiral: the case of regenerative landscape policy and practice. In: Thackway, R. (Ed.), *Land Use in Australia: Past, Present and Future*. ANU eView, Canberra, pp. 263–278.
- United Nations, 2015. *Transforming Our World: the 2030 Agenda for Sustainable Development*. A/RES/70/1. United Nations Sustainable Development, New York. Retrieved from <https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>.
- van Etten, E.J.B., 2013. Changes to land tenure and pastoral lease ownership in Western Australia's central rangelands: implications for co-operative, landscape-scale management. *Rangel. J.* 35 (1), 37–46. <https://doi.org/10.1071/RJ11088>.
- van Noordwijk, M., Leimona, B., Jindal, R., Villamor, G.B., Vardhan, M., Namirembe, S., et al., 2012. Payments for environmental services: evolution toward efficient and fair incentives for multifunctional landscapes. *Annu. Rev. Environ. Resour.* 37, 389–420. <https://doi.org/10.1146/annurev-environ-042511-150526>.
- White, M.E., 1994. *After the Greening: the Browning of Australia*. Kangaroo Press, Kenthurst, N.S.W.
- Williams, R.T., Walcott, J.J., 1998. Environmental benchmarks for agriculture? Clarifying the framework in a federal system - Australia. *Land Use Policy* 15 (2), 149–163. [https://doi.org/10.1016/S0264-8377\(97\)00042-2](https://doi.org/10.1016/S0264-8377(97)00042-2).
- World Commission on Environment and Development, 1987. *Our Common Future*. Oxford. Oxford University Press.
- Zammit, C., 2013. Landowners and conservation markets: social benefits from two Australian programs. *Land Use Policy* 31 (1), 11–16. <https://doi.org/10.1016/j.landusepol.2012.01.011>.