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To cite this article: Christopher B. Daniels & Kym Good (2015) Building resilience to natural, climate and anthropocentric change in the Adelaide and Mount Lofty Ranges region: a natural resources management board perspective, Transactions of the Royal Society of South Australia, 139:1, 83-96, DOI: [10.1080/03721426.2015.1035218](https://doi.org/10.1080/03721426.2015.1035218)

To link to this article: <http://dx.doi.org/10.1080/03721426.2015.1035218>



Published online: 09 Jun 2015.



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Building resilience to natural, climate and anthropocentric change in the Adelaide and Mount Lofty Ranges region: a natural resources management board perspective

Christopher B. Daniels^{a,b*} and Kym Good^b

^aBarbara Hardy Institute University of South Australia Mawson Lakes Campus, Adelaide, Australia; ^bAdelaide and Mt Lofty Ranges Natural Resources Management Board, Eastwood, Australia

The Adelaide and Mt Lofty Ranges region is one of the areas of Australia most at risk from, natural, climate or human-induced environmental change. This region is effectively a green island surrounded by ocean and arid zones. Whilst this region is home for 1.3 million people it is also a biodiversity hot spot (one of 15 in Australia) and provides 17% of the agricultural production of the State. The region is at risk because significant parts of the flood plain are barely above sea level, it is heavily reliant on River Murray water, and is highly susceptible to severe natural events including drought, flood, fire and earthquake. This paper will examine how the Natural Resource Management approach to managing the regional environment is aimed to increase resilience of the ecosystems and communities of this area. The regional Natural Resources Management (NRM) Board was created under the Natural Resources Management Act 2004 (NRM Act), and raises a levy to spend on environmental improvement activities in the region. These activities are articulated in the NRM Plan for the region and are designed to achieve an improvement in the condition of our natural resources quantified by 13 targets 20-year regional targets. The NRM planning approach adopted by the Board involves understanding and applying the concepts of resilience and systems thinking and understanding and interpreting transition states. We will illustrate the resilience approach by describing the Adelaide and Mt Lofty NRM planning methodology and provide examples of the Board's on ground activities.

Keywords: natural resource management; climate; Adelaide

1. Introduction

The Adelaide and Mt Lofty Ranges region is an amazing place. A green and fertile island surrounded, and isolated by arid-lands and ocean. This region is the heart of South Australia. Our Natural Resources Management region is quite small compared to many of the others but it is so distinctive in so many ways. The region is 11,208 km² (or 1.12M Hectares), of which 59% is terrestrial, and 41% marine. The area contains 1.3 million people – 80% of the SA population with 1.1 million living within the Adelaide metropolitan area. Our NRM region contains 26 Local Councils, four Indigenous Nations (Kaurna, Peramangk, Ngadjuri, and Ngarrindjeri), over 500 Schools and 250 active volunteer community groups.

*Corresponding author. Email: Chris.Daniels@unisa.edu.au

The region also provides extensive water assets including: 9300 km of watercourses: Significant water catchments including eight reservoirs yielding on average 60% of Adelaide's water supply: Prescribed water resources (surface and groundwater) including the Western Mount Lofty Ranges, Barossa, McLaren Vale, Northern Adelaide Plains, and Central Adelaide: Water assets in metropolitan Adelaide including Torrens Lake, Patawalonga Lake infrastructure, and a network of Gross Pollutant Traps: and of course over 15,000 private dams and 2000 water allocation licenses in the Western Mount Lofty Ranges alone.

The region's terrestrial assets include almost 87% (574,000 Ha) of the land area which is rural of which 53% is used for primary production by producing more than \$788 million (17% of South Australia's total agricultural production). The region has a diverse range of commercial, industrial, residential and primary production land-uses including mining, cropping, grazing and horticulture. Grazing or livestock production represents 39% of total production value whilst wine grape production represents 37% of total production value. Only 8% of the original native vegetation remains (70% of which is on private land). The region has a relatively small amount of public land which comprises a network of 70 parks and reserves totalling 21,384 Ha and there is an additional 6638 Ha of crown land. However, this parks network is important and involves the management of \$39 million of park and visitor infrastructure assets which support 67% of park visitations state wide (4 million of the total 6 million visitors). Finally the region's marine parks and reserves include significant areas of Encounter, and Upper Gulf St Vincent Marine Parks, and the Adelaide Dolphin Sanctuary. The region includes a \$7.6 million commercial fishing industry, and is home to 47% of state's recreational fishing vessels.

The net result is that this green island has a very large and dynamic pool of diverse land-managers in need of support to deliver NRM outcomes. And this is where the Board come in. The Adelaide and Mt Lofty Ranges NRM Board is expected to support and deliver positive environmental change by supporting and enhancing, fresh water, terrestrial and marine biodiversity, whilst simultaneously supporting sustainable agriculture, multiple water users (including the environment) and educating and facilitating community engagement (Mex, 2010). It therefore involves the Board commanding the 6 'C's' of NRM.

Complicated

The Board needs to understand, respond to and mitigate a host of external and internal influences on our region. These include variations in land practice, climate change adaptation, policy development and a host of international, national and state influences. It must continually consider the constantly changing mosaic that is our regional environment (in terms of the land, the people and the policies).

Communication

The Board's primary role is to communicate, educate and empower our communities and land holders. NRM is really a community activity and staff, Board members, committees and community groups fulfil a vital role in connecting landholders with NRM values.

Capacity

The Board focuses on building both capacity and resilience. Resilience is the capacity of an ecosystem to respond to a large-scale challenge (Walker & Salt, 2006). The Board views the landscape through the lens of 'systems thinking' which involves understanding the regional ecosystems and the external drivers that can perturb those systems (Walker & Salt, 2006). This task is enormous, even overwhelming considering the extent and complexity of the issues faced by the region. Nevertheless each day the community becomes a little more connected.

Create

To construct, contribute and champion 'The Plan' (Adelaide and Mt Lofty Natural Resources Strategic Plan 2013). This plan provides the philosophy for the regional NRM organisation, and provides a fair, robust and transparent mechanism to invest the levy and undertake the work. It presents the 13 long-term targets for improving the region's natural resources. It also establishes the goals of the organisation and the mechanism for achieving the strategic objectives, which including viewing the area as a set of connected subregions and developing conceptual models of how the systems inherent in the region work.

Collaborate:

The Board works with a huge range of organisations, all levels of government, Non-Government Organisations (NGO's), industry and many others. By partnering the Board can both increase the scope of works and more than double the extent of the investment into the region.

Confusion

There remains some confusion in the community about the roles of the Board and the other organisations engaged in environmental improvement. The Board is a relatively new organisation created out of the combination and amalgamation of the older Catchment Water Management Boards with the Pest Animal and Plant Control Boards and the Soil Conservation Boards in the region. Recently (2012) the NRM Board management structure (staff) was integrated into the Department of Environment, Water and Natural Resources (DEWNR). However, the Board (membership) still retains its independence under the NRM Act 2004 and funds its regional activities through the NRM levy. The NRM Board is not the reincarnation of past pest and soil boards but is a new organisation, with new expanded and integrated functions. The Board has developed a new way of examining both conservation and natural resource management actions, by taking both a landscape and a community-based approach (Mex, 2010). The landscape view enables work across both public and private lands. However, most importantly it focuses on people, from individuals, communities, organisations to agencies. It is the people involved that make the difference. As the Board has continued to engage communities, its role confusion has and will continue to decline.

Natural Resources Management is a foundation philosophy for the community. It puts citizens at the centre of decision making and action and by linking across multiple agencies it supports and illustrates the concept of *Joined Up Government*. The Board

also has very specific roles and responsibilities. The roles are described in the NRM Act (2004) and inform what the Board does and does not do. In a nutshell the Board facilitates, organises and supports land owners to better manage their land. It also informs, advises and connects all the communities and stakeholders with the specific issues relating to the natural resources of the region. The on ground activities and philosophy of Natural Resources Management are all delivered through the region's NRM plan.

2. The region's NRM plan

Under the NRM Act (2004) funding for NRM-based activities involving freshwater, coast and marine, and terrestrial biodiversity management (pests, native species, weeds and native vegetation), sustainable agriculture, soils and community education and engagement, must be spent against a Regional NRM Plan. By 2008 the first NRM plan, with a set of 13 major 20-year regional targets, was completed. This plan set ambitious challenges for the Board but it provides direction and focus for NRM in the region. Within this planning process the

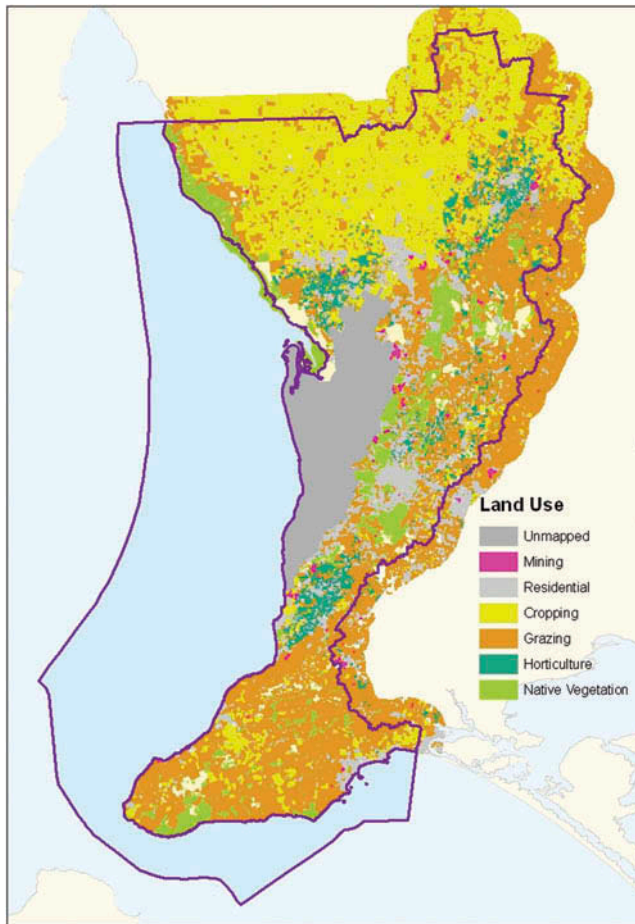


Figure 1. Land use in the Adelaide and Mt Lofty Ranges NRM Board region.

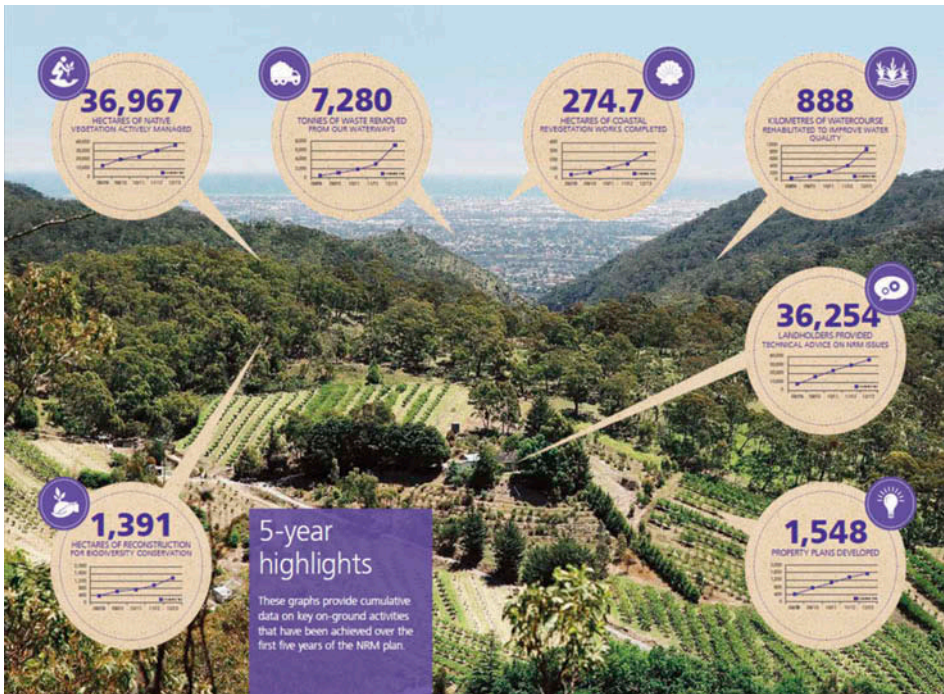


Figure 2. Achievements in the first 5 years of the Adelaide and Mt Lofty Natural Resources Management Board Plan (2008–2012).

long-term view was reduced to shorter term, 3 and 5-year intermediate targets supported by 3-year business plans (which in turn are reviewed annually). The first NRM Plan commenced in July 2008 and achieved stunning results towards those ambitious targets. Some of these achievements are described in Figures 1, 2.

Since the first NRM plan was developed, our understanding of the region and ecological knowledge has grown and matured. We now know that we must see ecosystems within a social context and we must look and act at a landscape scale if we are to be effective. We can have the greatest effect on resource management not by identifying a species or particular creek that needs conserving, or by simply replanting degraded grassland. We conserve more species, repair degraded land and polluted water, and reinvigorate agricultural services by identifying the ecosystems that best service the region, its communities and industry. If we conserve those ecosystems, at a landscape level, then many other beneficial actions will follow (Walker & Salt, 2006; Rosnas, Louter, Orre-Gordon, & Weinstein, 2011). Hence the Board developed over the years 2011–2013 (with significant community involvement) a new approach to NRM. This new NRM plan uses resilience thinking and takes a systems-based approach to develop a landscape level response to environmental challenges (Walker & Salt, 2006). The new plan also divided the region into seven connected sub regions (Adelaide and Mt Lofty Natural Resources Strategic Plan 2013). We believe this will allow the Board and others to direct resources to be most effective in the management of the region's natural resources.

By taking a systems (resilience) approach to NRM we now consider the region as a network of linked systems, rather than individual natural resources assets (e.g. water, soil, biodiversity). We recognise complexity, uncertainty and natural variability. We identify



Figure 3. The conceptual models.

the drivers that may cause a system to shift to a less desirable state and identify the way in which those drivers may act on a system and the thresholds that may exist between states. Hence we can target effort towards where it can make the greatest difference to prevent systems approaching or crossing thresholds (Walker & Salt, 2006). These thresholds delineate the conceptual environmental and social systems that are in transition from good to intermediate then to a poor condition (Figure 3). The current state of a system and the thresholds between systems are important when determining where and when to make investments. It is not possible to repair all the damaged systems or to conserve everything. So the conceptual models help determine where investments will provide the best and most effective outcomes (Figure 3).

Figure 3 shows the conceptual models. There are seven large-scale conceptual models around ecosystem services used in the Adelaide Mount Lofty Ranges Regional Concept Modelling. The high-level drivers are usually external to local control and include climate change and economic forces. Regional threats are local activities contributing to the decline of a system. Management responses are most efficient if they allow a system to cross a threshold into a better state or stop a system moving to a less desirable state.

The plan is based on the best science and methodological approaches currently available. Resilience thinking is increasingly being applied to NRM planning across NRM regions nationwide. The actions proposed in the plan are tested, and the outcomes continually analysed through state of the art monitoring and robust evaluation techniques. The benefits of the Regional Plan’s approach, methods and targets, are continually



Figure 4. Schematic of the Philosophy of the Adelaide and Mt Lofty Ranges Natural Resources Management Plan 2013–2018.

reviewed by the Board and actively discussed with the Board's community network. This continual review is fed into the Regional NRM Plan through the review process and helps to shape changes to the next strategic plan (10-yearly plan review). Life is learning and the plan is a living document that encourages learning as well as action. This new plan also places community at the centre and will enable the Board and its partners, in particular the Department of Environment, Water and Natural Resources to take a landscape scale approach to natural resources management and focus our resources where most needed (Figure 4).

Figure 4 shows the Schematic of the Philosophy of the Adelaide and Mt Lofty Ranges Natural Resources Management Plan 2013–2018. The first plan (2008–2013) provided the vision and goals, the long-term targets, the strategic directions and the guiding principles. The 2013–2018 plan adds the seven conceptual models and the sub regional approach which enables investments to be undertaken using a whole of landscape and socio-ecological systems (and resilience) approach.

2.1. Systems thinking

Systems thinking and understanding resilience differs from simply targeting individual activities. In the first plan the Board focused on individual farms or small-scale units

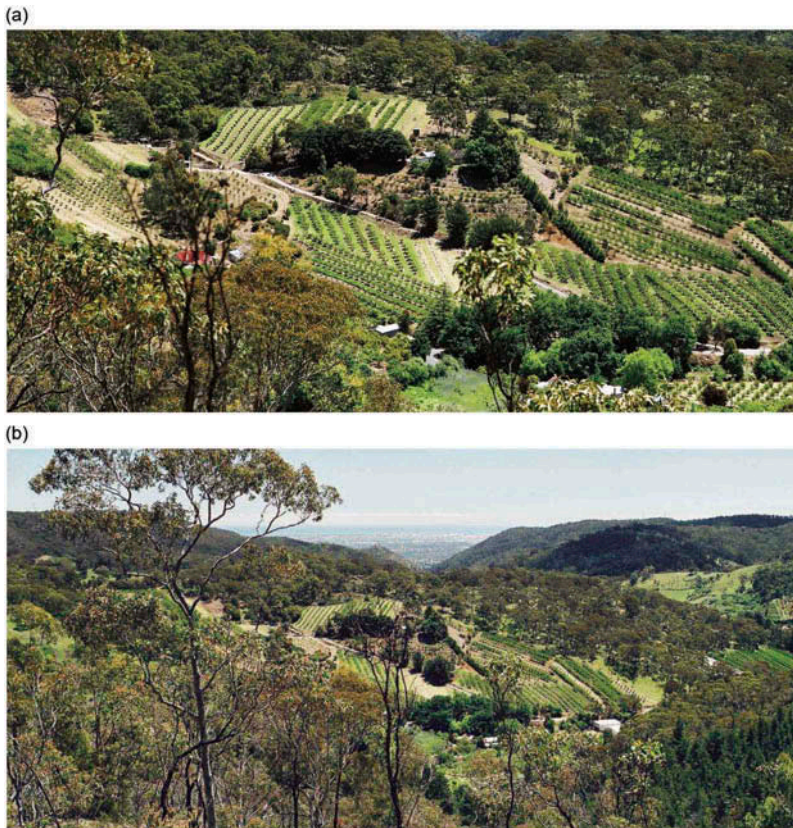


Figure 5. (a) Farm scale, (b) Landscape scale.

(Figure 5a). It traditionally worked to improve water quality, soil health, reduce weeds and do other on ground works. However, now in the new NRM plan (2013–2018) the Board takes a more ‘landscape’ view. (Figure 5b) This view recognises that any local land use impacts (e.g. soil impacting on water quality) will be transmitted downstream through catchments, potentially across the metropolitan area impacting on the ecosystems and natural resources along the way and the coast and marine environment where they maybe finally be deposited. Likewise, the market and economic situation in the city (or further afield) affects the values put on items coming off productive land, so forestry, grazing and horticulture might all, at various times, be impacted by changing social trends. There are virtually no ecosystems that are not shaped by people and no people without the need for ecosystems and the services they provide. The Mt Lofty Ranges are a complex region with a significant population. ‘Systems thinking’ therefore also allows the Board to incorporate social and economic factors into Natural Resources Management planning. ‘Systems thinking’ recognises that many serious recurring problems in Natural Resources Management stem from a lack of recognition that ecosystems and social systems are dynamic and inextricably linked.

2.2. *Sub regions*

To deliver the systems approach, the Board views the region as composed of seven connected subregions. The subregions are areas with generally (although not exclusively) consistent social and ecological characteristics. The areas identified share more in common compared with adjacent areas. The plan identifies future priorities for each subregion and includes information about assets and issues in each subregion presented under the headings landscapes, livelihoods, and lifestyles. Landscapes details the physical attributes such as vegetation, biodiversity and water resources. Lifestyles details some of the social aspects of the subregion, while livelihoods identifies significant contributors to the economic output of the subregion, mainly agricultural for many of them (Figure 6).

2.3. *Conceptual models*

The second significant difference in the 2013–2018 NRM plan from its predecessor is the use of regional concept models (Figure 4). These seven models help us to document our current understanding of some of the key dynamics operating across the region. The models are:

- terrestrial landscape health
- marine health
- aquatic (freshwater) health
- community support for NRM
- building capacity of natural resource managers
- sustainable primary production
- adapting to a changing climate.

The models also describe the range of alternative states that a system can exist in (Figure 4). The idea of systems in our region existing in different states has led to the identification of key systems that are important across the whole region. The regional conceptual models identify broadly the attributes of the system in a desired, transition and

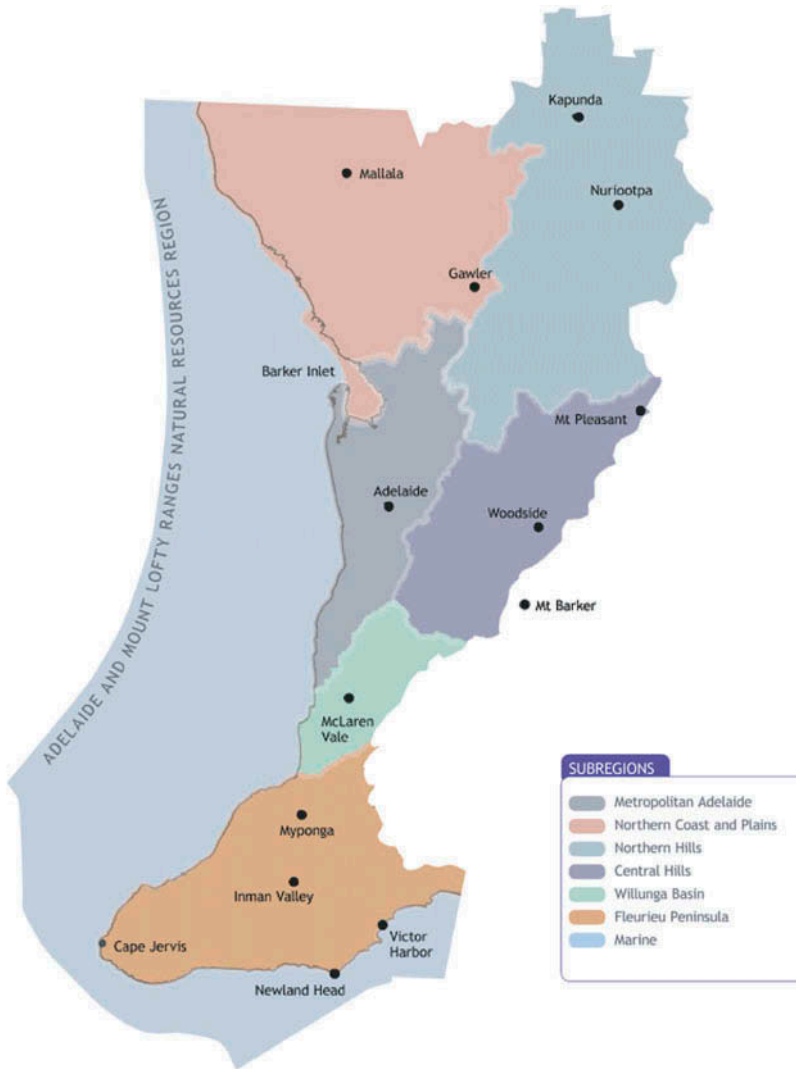


Figure 6. The subregions of the Adelaide and Mt Lofty Ranges NRM Board.

undesired state – these attributes can be economic, social or environmental in nature and can also be qualitative or quantitative. They show the threats that can move a system from a desired to transition to undesired state, and the management actions that can move a system back in a positive direction (Figure 4). The key external drivers and shocks that can influence systems are also identified – these things are often beyond the ability of land managers to control but potentially have a significant impact on the system and may require higher-level collaboration and partnerships to minimise their influence. Over time these models will be refined, as we gather further information about the ecosystems of the region, the thresholds between states and the effects of the primary challenges including climate change.

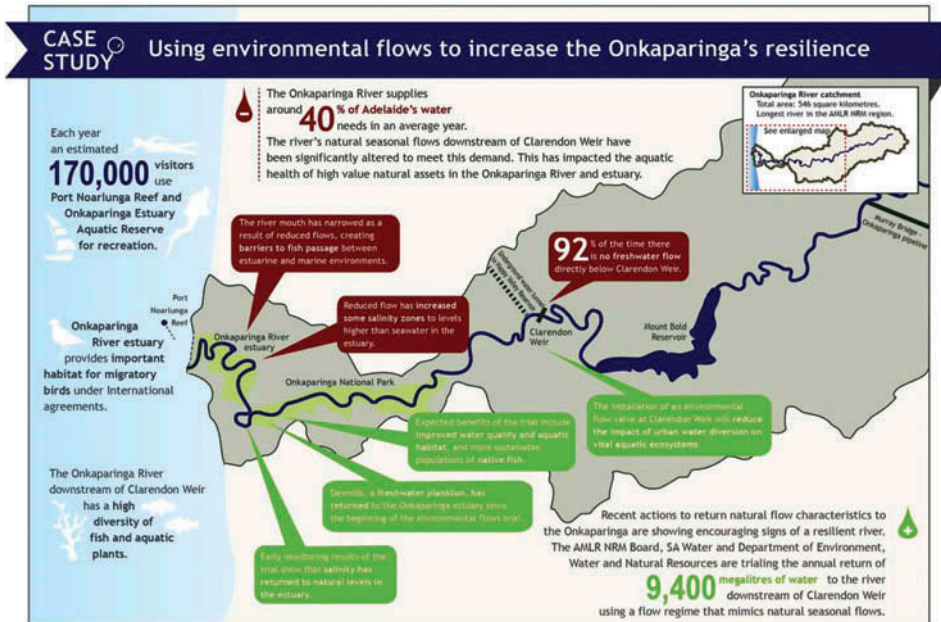


Figure 7. The environmental flows in the Onkaparinga System.

The conceptual models are a mechanism to test knowledge. By continually monitoring and evaluating and including new information as it becomes available, the models will develop and improve our understanding of how the socio-ecological systems work and respond to (even absorb) change. This process is termed adaptive management and allows the Board to modify the plan when new information fundamentally changes our understanding of a system and therefore changes the interventions, programs or projects associated with maintaining (or returning) that system in/to a desired state. An example of an ecosystem transitioned from a poor state to a good state, is the introduction of Environmental flows into the Onkaparinga River. The conditions creating ecosystem damage were identified as were the community values for the region. A plan to release water from Mt Bold Reservoir via the Clarendon Weir in specific flow regimes which mimic the natural flow patterns at different times of



Figure 8. (a) Typical reach of Onkaparinga River pre-environmental flows, (b). Onkaparinga River with environmental 'fresh' flow (30 ML/day), (c) Southern pouched lamprey – not been seen in the river for more than 100 years, was found during monitoring to test the effectiveness of the Environmental Flows Trial which began in 2012.

the year demonstrated that providing flow below reservoirs can improve health (Figures 7, 8a, b, c).

Figure 7 shows the environmental flows in the Onkaparinga System transitions this ecosystem from a poor condition towards a much better state. Note the system values (in blue) determine the high quality of this system and how the management responses are tailored to address specific threats (in brown) to deliver the environmental outcomes (in green). Figure 8 demonstrates the improvement in the Onkaparinga river condition which led to the return of the pouched lamprey, a species that had disappeared from the system.

3. The Western Mt Lofty Ranges Water Allocation Plan

The Western Mt Lofty Ranges (WMLR) Water Allocation Plan (WAP), completed in 2013, is one of a suite of large-scale environmental management plans (WAPs) used by the Board to specifically manage the allocation and sustainable use of water resources within the region. The WMLR WAP represents a major step towards securing sustainable water supplies for the community, industry and the environment for future generations. It endeavours to determine the right balance between, and be able to respond to, the needs of different water users under different environmental conditions. This WAP was developed through the substantial involvement of industry and the community and took almost a decade to complete. This careful approach was essential given the WMLR dual role as a food bowl and as a major catchment area for Adelaide's water supply. By making sure water is used sustainably and a balance is achieved between the needs of water users and the environment, the WAP will ensure both the long-term economic viability of the region and Adelaide's future water supplies.

As with the Regional NRM plan the WAP takes into account the needs of a wide range of water users, while still protecting a portion of water for the health of the environment. This WAP also articulated directly with water management plans in adjacent regions, such as the Eastern Mt Lofty Ranges (in the South Australian Murray Darling Basin NRM Board region), the Northern Plains, the Barossa and the McLaren Vale Water Allocation Plans. The best available science and research was used during the development of the WAP to understand and predict water usage and develop an equitable allocation system. The WAP delivers clarity and security around the water entitlements for primary producers and other water users. Ongoing monitoring will continually assess the condition of the region's water. The WAP was delayed until a staged roll-out of water licences to more than 2000 water users in the region was completed. The Minister adopted the plan in September 2013, to uniformly high support from the community.

4. Raising revenue to undertake environmental and sustainable agricultural activities

The Board obtains funding from a variety of sources including an important contribution from the Australian Government. The primary income stream however, is the NRM levy collected by local government based on property value. In 2013/2014 just over \$30 million was spent in the region on projects aimed to improve the condition of the natural resources of region and build resilience within its socio-ecological systems. This expenditure breakdown is provided in Figure 9. A significant amount of resources are invested in planning and evaluation. A vital part of the Board approach to delivering on ground change is to continually monitor and evaluate the effects of the projects,

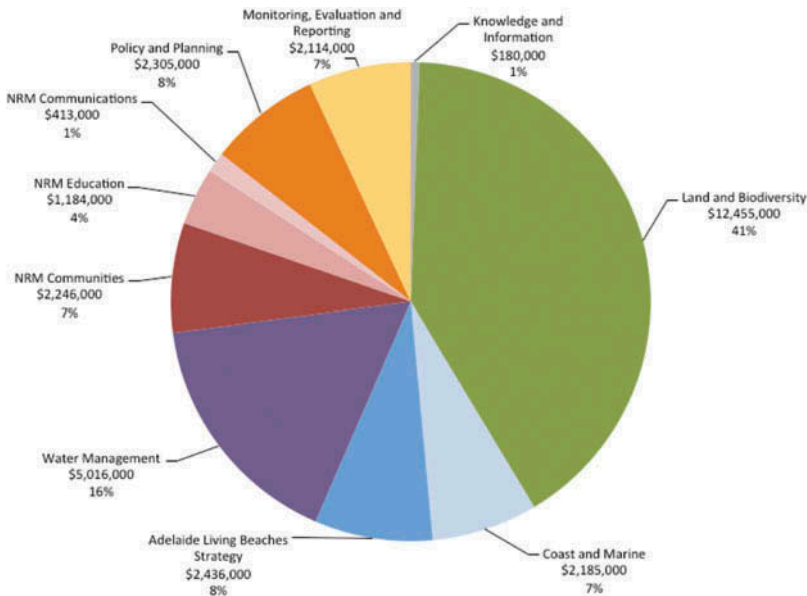


Figure 9. The Adelaide and Mount Lofty Ranges NRM Board expenditure allocation for 2013/14.

and feed that knowledge into future planning. The plans therefore both drive the decision making and implementation but also are adaptive and responsive to the science of the region.

The investment of Board resources also attracts additional funding and in-kind support from government, industry, and many community organisations and individuals who invest their time and resources into NRM projects. By investing with our partners the Board leveraged an additional \$47.3 million (2012–13) which was directed towards delivering NRM plan targets. This emphasises the importance of partnerships and additional funding sources play in supporting the environmental activities in the region.

5. Natural resources centres

As previously stated, NRM is really a community activity and it is vitally important for the Board to connect landowners with NRM values and knowledge. There are six well-established community-run Natural Resource Centres in the Adelaide and Mount Lofty Ranges Region, located in Gawler, Mount Pleasant, Norton Summit, Willunga, Normanville and Victor Harbor and a seventh centre has recently been established in the Barossa Valley. Some of these NRC's have supported the activities of the Board since its inception in 2004 by providing a wide range of free information and resources for landholders and community members keen to protect and manage the environment.

In 2013 they were complemented by four DEWNR natural resources centres at Gawler, Lobethal, Eastwood and Willunga. These DEWNR Resource centres represent the South Australian Government's initiative of inter-agency '*Integration at work*' by providing a one-stop-shop for advice and information about the local environment, planning and educational activities, workshops, field days and so much more. These

four DEWNR resource centres represent the ‘face’ of environmental management. As the landscape approach continues to develop and the relationship between DEWNR, the Boards, and other agencies such as the EPA, SA Water and PIRSA and also community groups including farming groups and Environmental NGO’s progress, these centres will become increasingly important as the core for community engagement and *Community at the Centre*.

6. Water programs

Urban and regional water programs have provided outstanding results in 2013. Large-scale environmental water quality and amenity flow trials such as Torrens Lake and the environmental flows for the Torrens, Onkaparinga and Para rivers are delivering tangible benefits. The environmental flows program in particular has breathed new life into our rivers. Whilst the Torrens amenity flow trial has reduced the number, onset, duration and severity of algal blooms, there is still a long way to go to eliminate them entirely from the water way. Stormwater harvesting programs including the Oaklands Park and First Creek (Adelaide Botanical Gardens) wetlands continue to be expanded to meet both the Board’s and the ‘Water for Good’ stormwater targets. These two wetlands are now completed. In all there are eight large wetland projects under development in metropolitan Adelaide and many more smaller-scale creek revegetation and improvement activities across the region. In the south work continues around protecting the Fleurieu swamps and decreasing hard rubbish and chemical pollution outflows into the gulf.

7. Public engagement

The vital ingredient to making NRM work is engaging the public. The Board knows it must explain what NRM is, why it is vital, and how everyone can help. The Board has undertaken these tasks through involvement in a raft of Open Days, events, and activities. It encourages participation by running workshops and short courses in everything from sustainable farming to rabbit baiting, and from fencing to clay delving. The Board also worked hard to explain both the Regional NRM plan and the WAP – often one-on-one – to farmers and communities to gain support. This information sharing also occurred, through lectures and practical demonstrations and by providing a host of prepared materials, both paper and electronic, including video (YouTube).

The NRM education teams have supported sustainability programs through some 300 schools and engaged thousands of kids, it now supports large-scale programs like **Nature Play**, *Education for Sustainability* and many others. The Board also organises and supports over 250 groups of volunteers, working at a wide range of scales and on a wide range of issues across the region. Without these really high-level organisational skills and the collective ability of all those connected to NRM to work so enthusiastically and knowledgeably with community, engagement would be a shallow and meaningless action.

If NRM is all about people, then it is the community who make the most difference. The community committees and networks that support the Board not only guide on ground actions, working with staff and also local government, but they have particularly positively participated in creating and recreating a role for the community at the centre of NRM. The Board simply could not progress without its community support network.

8. Conclusion

The Adelaide and Mt Lofty Ranges region is the heartland of South Australia. However, it faces a large number of environmental threats, including human induced and from climate change. However, the NRM Board is capable of responding to these threats but introducing landscape scale management programs using a systems approach to direct its investment. The Board has proved that the community-based approach will work and has made great progress with large and small projects alike. However, the work of the Board is not done.

The Board still needs to establish a clearer alignment between the NRM plan, the sub regions, and community governance and regional structures. The Board still needs to determine how its investments will be driven by socio-ecological systems analysis. It still needs to get greater community support, incorporate public lands management into subregional planning and continue the process of revising the governance structures. In particular the Board needs to enhance Aboriginal engagement. Aboriginal engagement in the region is a complex issue because although there is a large aboriginal population from all parts of South Australia and beyond and there is almost no land co-managed by aboriginal people. The Board also needs to continue the strengthening of Local Government partnerships and collaboration and to strengthen relationships with the Agriculture sector.

There is so much to do. But we must remember why we do it. Engaging communities in proactively participating in natural resources management, revitalising the environment, conserving biodiversity and sustainably managing the productivity of the region is the only mechanism to survive the man-made and climate change-induced threats to our livelihood. If we stop there will be a poor legacy for our children.

Acknowledgement

The authors would like to acknowledge the communities that live and work in the Adelaide and Mt Lofty Ranges NRM region. The community and our many other partners, as well as the staff of DEWNR working on Board funded programs make a tremendous contribution to protecting and restoring our environment for conservation, social and production outcomes. A special acknowledgement goes to the staff who contributed to the development of the new Regional NRM Plan (2013–2018) and its innovative methodology. Thanks also to the individuals and networks leading the development of systems and resilience thinking in NRM that informed our plan.

Disclosure statement

No potential conflict of interest was reported by the authors.

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