RESEARCH TO SUPPORT SUSTAINABLE ALTERNATIVES TO THE PRODUCTIVIST PARADIGM IN AN ERA OF CLIMATIC RISK

SUPPORTING SUSTAINABLE ALTERNATIVES IN AN ERA OF CLIMATIC RISK

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Abstract — The paper describes research approaches applied to support alternative viewpoints and practices regarding risk management and resilience within agro-ecosystems. A regional social learning approach was undertaken to guide adaptation to climate change in the Adelaide and Mount Lofty Ranges of South Australia. It involved working closely with stakeholders to critically examine management systems according to future climate change risk. An integrated analysis of the vulnerability of natural resource management sectors to projected climate change was undertaken. Subsequently, a series of case studies applied approaches that could be used to develop context specific adaptation responses. The research also involved an examination of perceptions of climate change and associated impacts on regional systems. The potential scope of regional responses to new risks facing farmers and their agro-ecosystems is constrained by the dominant neoliberal approach to agricultural development.

Key words : climate change; risk; adaptation; agriculture; land use planning; South Australia

Résumé — L'article décrit des approches de recherche appliquées au soutien de points de vue et de pratiques alternatives en matière de la gestion de risque et de la résilience dans les agroécosystèmes. Une approche régionale à l'apprentissage social a été adoptée pour soutenir l'adaptation au changement climatique à Adelaide et dans les Mount Lofty Ranges de l'Australie du Sud. Cette approche a impliqué un travail étroitement lié aux participants de façon à examiner critiquement les systèmes de gestion selon le risque futur de changement climatique. Une analyse intégrée de la vulnérabilité des secteurs de gestion de ressources naturelles au changement climatique projeté a été entreprise. Plus tard, les approches qui pourraient être employées pour

soutenir des réponses d'adaptation à un contexte spécifique ont été appliquées à travers une série d'études de cas. La recherche à également impliqué un examen des perceptions du changement climatique et des impacts associés sur les systèmes régionaux. La portée potentielle des réponses aux nouveaux risques faisant face aux agriculteurs et à leurs agroécosystèmes est limitée par l'approche néolibérale dominante au sein du développement agricole.

Mots clés : changement climatique; risque; adaptation; agriculture; aménagement du territoire; Australie du Sud

1. INTRODUCTION

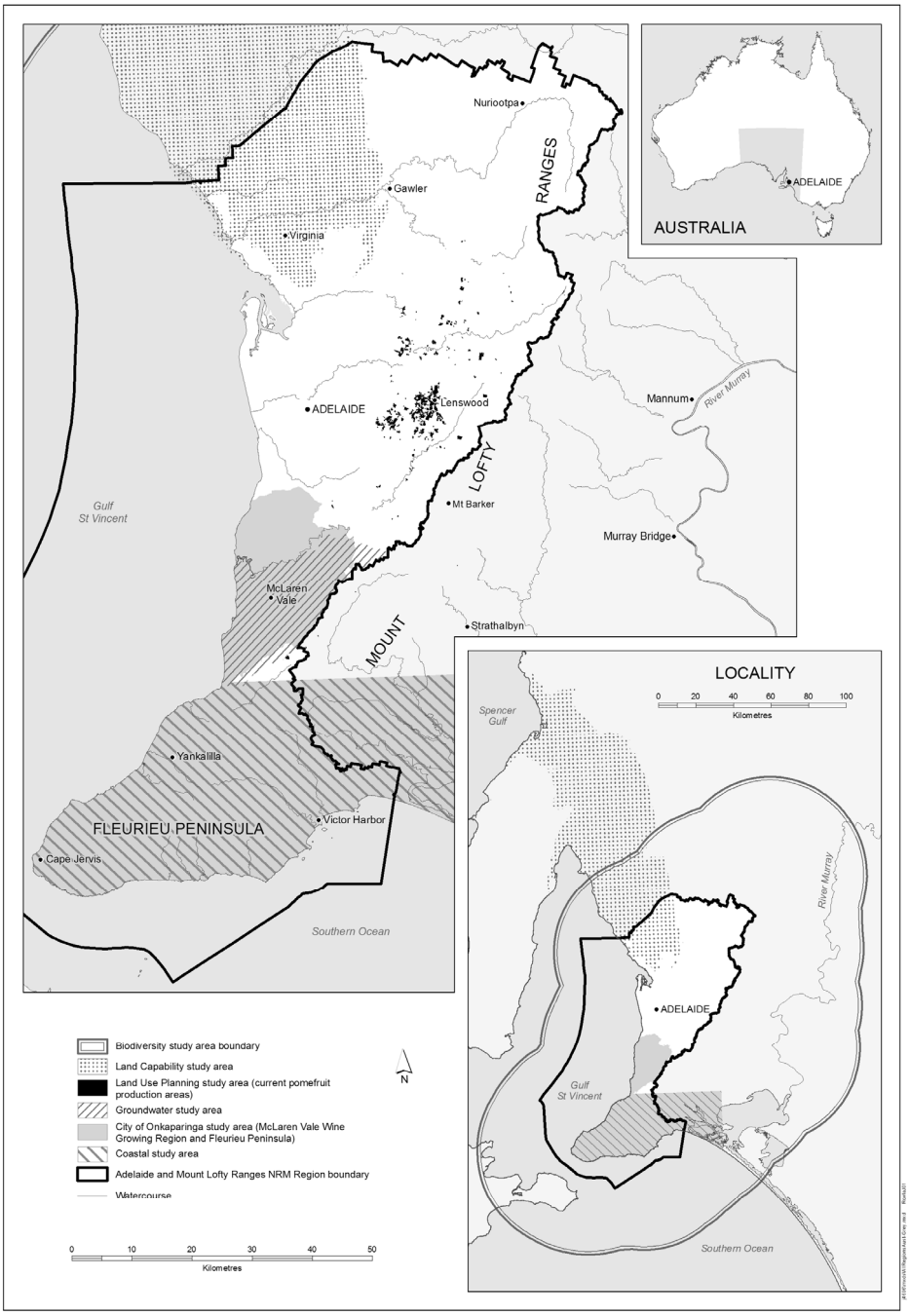
The level of environmental risk that many Mediterranean climatic regions are facing is very difficult to fully conceptualise, plan for or manage. Nevertheless, there is a need to advance research approaches to develop and implement appropriate adaptation responses to climate change (Adger *et al.* 2009; Beck 2009). The paper describes research to assist the development of climatic risk adaptation approaches within the Adelaide Mt Lofty Ranges (AMLR), a peri-urban region of South Australia (SA). The discussion here describes work with regional and local decision makers to analyse natural resource management (NRM) systemic vulnerabilities to climate change, which led to an argument that land use planning must be more formally utilised an adaptation response within the region.

The AMLR NRM Region is one of eight NRM regions in SA that have recently been defined under the *SA Natural Resources Management Act 2004* (SA Government 2004; AMLR NRM Board 2007a). The AMLR region covers a land area of approximately 3,880 square kilometres, and a similar area of marine and estuarine environments and contains the city of Adelaide with 1.1 million people (see Figure 1) (SA Government 2006). The area is one of the most productive in the state for agriculture with viticulture, horticulture, vegetable market gardens and livestock production being some of the major industries within the mixed-use region (AMLR NRM Board 2008a). On average, 60% of Adelaide's water comes from local catchments, with the remainder coming from the River Murray (AMLR NRM Board 2008a). Although only 13% of its original terrestrial native vegetation remains, the AMLR also contains 50% of SA's native plant species and 75% of the native bird species (Paton *et al.* 2004).

The AMLR is part of a Mediterranean climatic region projected to dry due to anthropogenic climate change (Houghton *et al.* 2001; Dünkeloh and Jacobeit 2003). Projections to 2030 suggests that there could be ongoing warming, with shorter growing seasons limited by moisture availability and an increased risk of drought (McInnes *et al.* 2003; Suppiah *et al.* 2006). While average rainfall is projected to decline along with average overland flows, the intensity of rainfall events is projected to increase. Simultaneously, projections of global sea-level rise range from 0.09 to 0.88m, with a median of 0.48m, by 2100 will challenge urban planning (Houghton *et al.* 2001; Walsh *et al.* 2004). The research here was based on the understanding that adaptation responses to the scope and scale of such climatic risks must be holistic to have a realistic chance of success. The work aimed to develop mechanisms to assist regional stakeholders to learn to adapt to change, following several important steps including:

I) undertaking an integrated climate change vulnerability assessment for regional NRM;
II) researching community perceptions of climate change impacts;
III) developing and demonstrating methods to assist natural resource managers to address climate change risk and develop adaptation responses in vulnerable sectors;
IV) creating arguments for the need for a stronger planned response across the region to deal with the increasing levels of resource conflict and climatic risk.

Figure 1. Map of the Adelaide Mt Lofty Ranges Natural Resource Management region showing the case study areas



Source: Bardsley and Sweeney 2008

The vulnerability of NRM systems in the AMLR to 2030 was analysed by examining the exposure and sensitivity to climate change to indicate the potential level of future impacts, against the capacity for the systems to adapt successfully to those changes (Table 1) (The Allen Consulting Group 2005; Füssel and Klein 2006). The scope and scale of the required adaptation responses will challenge local and regional capacities (Bardsley 2006). The most vulnerable systems were assessed to be those that have long management response timeframes, namely perennial horticulture, coastal and bushfire management or those under less human control such as biodiversity conservation. Other systems, particularly water and land management, will require significant intervention to reduce their vulnerability.

Table 1 Summary of vulnerability analyses for natural resource management in the Adelaide Mt Lofty Ranges Natural Resource Management Region

	Exposure	Sensitivity	Potential impact	Adaptive capacity	Vulnerability
Riparian flood management				–	
Surface water				XXX	
Groundwater				XXX	
Coasts: flooding				X	
Coasts: beaches				X	
Biodiversity: terrestrial				X	
Biodiversity: freshwater				–	
Invasive species				X	
Parks & Gardens				XXX	
Revegetation				XXX	
Agriculture: annual cropping				XXX	
Agriculture: horticulture				X	
Agriculture: livestock				XXX	
Land management				XXX	
Bushfires				X	
Air quality				XXX	

Colour Key for Exposure, Sensitivity, Potential impact & Vulnerability (not Adaptive capacity)

Low *Low-Medium* *Medium* *Medium-High* *High*

Key for Adaptive capacity

Limited	*Medium*	*Significant*
–	X	XXX

Source : Bardsley 2006

Perceptions of climate change on regional systems were examined using three methods: small group workshop discussions to assist respondents to critically analyse the vulnerabilities of their own systems; responses to a survey questionnaire after the workshops; and, targeted interviews with key stakeholders (Bardsley and Bardsley 2007; Bardsley and Liddicoat 2008; Bardsley and Sweeney 2008). The assessed vulnerabilities were discussed and critiqued by groups throughout the region. By working closely with stakeholders to review management systems according to their analyses of future climate change risk, a regional social learning approach to assist local and regional adaptation to climate change emerged (Keen *et al.* 2005).

A series of case studies applied approaches to support context specific adaptation responses across the major areas of NRM interest, namely water, soil, biodiversity, coastal, and land use management and planning (see Bardsley and Sweeney 2008; 2010). Projects were developed with stakeholders across the diverse region (Figure 1), to ensure valid, relevant questions were examined. The different case study approaches represent a spectrum, from those that rely strongly on empirical science-led analyses through to stakeholder-led participatory research: Scenario modelling; Applied participatory Geographic Information Systems modelling; Environmental risk analysis; and Participatory action learning (Table 2).

Table 2. The application of four key approaches to guide decision-making and development of climate change adaptation responses in the case studies

Adaptation approach	Scenario modelling	Applied and participatory GIS modelling	Environmental risk analysis	Participatory action learning
Case Study	Land Capability (DWLBC 2008) Ground Water (Waclawik 2007)	Biodiversity (Crossman *et al.* 2008) Land Use Planning (Houston and Rowland 2008)	Perennial Horticulture (James and Liddicoat 2008)	Coastal (Raymond 2008)
Case study process	Adjust resource condition assessments according to climate scenarios to raise awareness of potential impacts and develop responses.	Maximise engagement with stakeholders and natural resource managers as modelling is developed, so that key vulnerabilities can be further highlighted and responses discussed.	Conduct a formal risk assessment with impact and likelihood components to guide stakeholders through an analysis of their systems	Assist stakeholders to identify and analyse local vulnerabilities to climate change, in absence of detailed external information.
Where approach could be used in future studies	When seeking specific guidance to better understand natural resource vulnerability, when good background data is available concerning the issue, but specific climate change implications are uncertain.	When seeking specific guidance to better understand natural resource vulnerability. Also when the development of good background data concerning the NRM issue requires stakeholder input.	When trying to involve stakeholders in a process of analysing risk. Ideally supported with empirical data to inform planning outcomes. Best outcomes if likelihoods and consequences are well understood.	When community support needs to be generated and/or articulated to support difficult decision making. Particularly to generate greater awareness of climate change risks.
Targeted scale	State-region	State-local	Local-sectoral	Local-individual
Key limitations of approach	Data availability and lack of knowledge of current systems. Validity and applicability for local management questioned.	Data availability and validity of modelling given uncertain futures. Requires further knowledge input & support from external decision-makers.	Applies incomplete knowledge to analysis. Depth or breadth of risk analysis insufficient.	Lack of full integration of scientific data. Expensive. Validity of local perceptions questioned.

Source: Developed from Bardsley and Sweeney 2010

3. HOW HAS CLIMATE CHANGE INFLUENCED AGRICULTURAL PLANNING IN THE ADELAIDE MT LOFTY RANGES?

Primary to this work was the development of ownership of the issue by stakeholders, so that risks are incorporated into strategic planning, rather than simply being responded to in an ad hoc manner in the future. The breadth of uptake of the work at both the local and regional levels (Table 3) is, we assume, indicative of the strength of developing project partnerships with the AMLR NRM Board, sectoral and regional organisations (Bardsley and Liddicoat 2008; Bardsley and Rogers 2011). These groups have been able to interact with their own networks to advocate for the use of appropriate vulnerability analyses and re-conceptualisations of risk. The research aim was only partially achieved however, because there is a lack of explicit uptake by agricultural industry bodies. There is no reason why our particular study should focus on agricultural climate change planning because there have been several other reviews undertaken for agriculture in SA (see for example Rebbeck *et al.* 2007). Yet it begs the question – how is agriculture planning for climate change in the AMLR?

Table 3. Use of the Adelaide Mt Lofty Ranges climate change vulnerability analysis (Bardsley 2006) for adaptation planning in South Australia

Level of Governance	Sector	Use of work in strategic planning documents
Local	Biodiversity Conservation	City of Port Adelaide Enfield developing their conservation strategy to allow for future climate change (City of Port Adelaide Enfield 2007, 2009).
Local	Biodiversity Conservation	The Department for Environment and Heritage (2010) outline the climate change component to reserve management and their revegetation strategy (Oke 2009).
Local	Catchment Management	Adelaide Hills Council (2008) developing plans for management of flood waters incorporated future climatic projections.
Local	Catchment Management	Estuary Management plans for river systems on the southern Fleurieu Coast (Sinclair Knight Merz 2010a, b).
Local	Coastal Management	City of Onkaparinga argue for a more detailed study of local vulnerabilities (Caton 2007).
Local	Coastal Management	The Environmental Impact Statement for the Buckland Park urban development in the City of Playford used the work to note that there is a risk of coastal inundation (REM 2008).
Local	Multiple	City of Onkaparinga (2007) develop arguments for adaptation and mitigation measures to be put in place.
Regional	Catchment management	Creating arguments for stricter dam development in the Mt Lofty Ranges (AMLR NRM 2007b)
Regional	Multiple	Review articles on relevant climate change information for Local Councils and environmental management practitioners (AMLR NRM Board 2007a)
Regional	Multiple	The Eyre Peninsula NRM Board (2009), Northern and Yorke Natural Resources Management Board (2009) and SA Murray-Darling Basin Natural Resources Management Board (2009) highlight climate change risks such as the likelihood that areas which experience a Mediterranean climate are likely to experience more change.
Regional	Multiple	The Kangaroo Island Natural Resources Management Board (2007) argue for a targeted review of impacts and vulnerabilities to be undertaken for Kangaroo Island.
Regional	Tourism	The Fleurieu Peninsula Tourism Development Plan acknowledges the risks of climate change for tourism in the region (Urban & Regional Planning Solutions 2007; Department of Planning & Local Government 2007)
Regional	Multiple	The AMLR NRM Board (2008a, b, c, d) detail specific climate change adaptation response plans and investments.

Climate change risk is discounted in SA agricultural plans for beef and dairy cattle, pigs, poultry, sheep and vegetable industries, which all fail to even mention the issue as being significant for the industries (Dairy Industry Development Board 2002; PIRSA 2004a, b, c; 2005; Rural Solutions SA 2004). A more recent review of horticulture on the northern Adelaide Plains, which is a vital area for vegetable production, does outline the key climate change risks to 2030, but goes on to state that "it is unlikely climate change may have a significant impact on the Adelaide Plains within the given timeframe" (The Lucas Group 2007 p.38). Even the powerful viticulture industry does not strongly emphasise the importance of planning for climate change risk, with an aim to "Support information flow between Industry and environmental groups such as the Climate Change Council, to grow industry knowledge and facilitate adaptation and mitigation in the face of climate change" (SAWIC 2010 p.9). The strongest AMLR agricultural planning response is by the apple, pear and cherry industries, which aim to "Develop a better understanding of climate change and assist in the establishment of programs that assist growers to adapt to climate change" (PIRSA 2007). The SA Horticultural strategic plan also calls for government to "Secure water and land availability with relevant authorities", and "Link existing policy programs with climate change objectives" (PIRSA 2008 p.29). Unless climatic risk is incorporated into agricultural planning documents and future adaptation needs are understood by government and the general public, there will be insufficient focus on the importance of sustaining agricultural spaces in the landscape for future agricultural adaptation requirements. Perhaps the problem is that a more formal recognition of the need for more prescriptive land use planning would challenge the dominant neo-liberal approach to both agricultural development and land management.

Many regional businesses and agro-ecosystems are already stressed by the extreme economic pressures resulting from deregulation and the need to maximise efficiencies of resource exploitation (Higgins *et al.* 2008; Hamblin 2009). The majority of the risk in the neo-liberal policy environment has been carried by farmers, with state involvement only to ensure social welfare outcomes or to provide disaster assistance. That minimalist contribution has been brought into question by the perceived failure of "Exceptional Circumstances" policy during the 2000s, which saw government provide widespread drought relief across most agricultural areas of Australia (Nelson *et al.* 2008): the National Farmers Federation (2009) has suggested that the policy draws people deeper into debt; while others note that it targets assistance for the least resilient farm businesses, therefore sending out the wrong policy message (Heathcote 2002). Just as risks are building for family farming, "South Australia aspires to become world-renowned for being clean, green and sustainable" (SA Government 2007 p.15). However, to achieve such a goal, SA must become representative of the best available approaches to environmental planning. The type of complex mix of adaptation alternatives required will only develop if the extreme socio-economic pressures applied to the highly geared agricultural systems are reduced, which would involve the state assuming a more significant component of future risk in the agricultural sector (Bardsley 2008).

Few of the adaptation responses developed during this research could incorporate the full scope of the risks of climate change in the particularly sectoral context. Suddenly, with climate change, the water supplies are vulnerable (SA Government 2007); the biodiversity may have to adjust to changing bioclimatic envelopes (Department for Environment and Heritage 2009; Bardsley 2010); the climate restricted agricultural spaces become smaller - and these are just in one of Australia's more "favourable regions" (Bunker and Houston 2003 p. 5). These islands of favourability are going to become increasingly contested not only because Australia's cities are reaching the frontiers of expansion for comfortable regular commuting, but also because climate change will limit the resources available within such spaces in the future. Governance of climate change within peri-urban spaces will require considerable humility to allow for the physical, systemic and conceptual "space" for social learning and an ongoing evolution of approaches to management and policy (Houston and Rowland 2008; Opdam *et al.* 2009; Bardsley and Sweeney 2010). To be effective, land use planning must now provide for or define vital multifunctional spaces to support or develop crucibles of socio-ecological complexity and resilience, irrespective of the dominant neo-liberal socio-economic system (Bardsley 2003; 2008).

There has been a weak land use planning tradition on the peri-urban fringe of Australia's cities (Australian Urban & Regional Development Review 1995; Bunker and Houston 2003). Apart from the Hills Face Zone, which limits urban land use on the westerly slopes of the Mt Lofty Ranges, and the Parklands that surround the Adelaide Central Business District, Adelaide has largely been able to expand linearly in all directions constrained only by the natural boundaries of the St Vincent Gulf to the west and the Mt Lofty Ranges to the east (Garnaut 2008). However key planning documents for the AMLR such as the 30-year Plan for Greater Adelaide (SA Government 2009) and the Outer Metropolitan Planning Strategy (SA Government 2007), are beginning to detail planning mechanisms to ensure that peri-urban agriculture is sustained. To achieve the goal of constraining urban sprawl, an Urban Boundary was formalised in 2002 with the aim of delineating "the outer limit of desired town growth" (SA Government 2007 p.23). Even though Local Government Development plans are assessed by the SA Government, the constraints on urban expansion and definition of designated areas of primary production significance remain largely dependent on the discretion of a particular Local Council (SA Government 2007, The Lucas Group 2007). Climate change presents new threats to the value of the Adelaide peri-urban landscape and planning will need to explicitly value, define and protect the unique multifunctional peri-urban space as new tensions develop in the urban-rural dynamic. What might such crucibles of rural complexity look like?

There is a range of alternative agricultural policy ideas that could act to support complexity in different contexts via stronger meta-classification for the entire region, or at least the agricultural systems within the AMLR. The regional integration of previously separate issues of water, land, biodiversity and invasive species management within the rare landscapes of the AMLR, has created an opportunity to establish integrated governance frameworks for sustainable NRM (AMLR NRM Board 2008a, b, c, d). One idea would be to classify the peri-urban space in a manner that would increase land use regulatory power, while supporting those farmers who wish to establish improved risk management systems. Some potential land use classifications are already applied in the Australian context, including green belts (eg. CPRE and Natural England 2010; Garnaut 2008); World Heritage Listing (eg. Attwater and Merson 2007); or Biosphere reserves (eg. Pfueller 2008). Important rural spaces could be more specifically defined from international land classification ideas such as those emerging from policies to support multifunctionality in Europe, including regional parks (eg. Hamin 2002) or the French/EU landscape classifications “Trame Verte et Bleue” or Natura2000 (eg. Fortier 2009). Another alternative might be to not define multifunctional landscapes as much as the production systems themselves, such as the European Union and Switzerland have implemented for integrated systems since the 1990s (Curry and Stucki 1997; OECD 1998; Bardsley and Thomas 2004). Such mechanisms recognise the multifunctional values of agriculture and buffer risk implicitly by providing an assured income irrespective of production levels. Why couldn’t policy define areas of great agricultural value that are at risk, such as the AMLR, or highly vulnerable, marginal production areas (see Bardsley 2003), and direct support for alternative systems based on risk avoidance, resilience and flexibility within such spaces? Such a mechanism would withdraw the state from comprehensive Exceptional Circumstances assistance to have a responsibility to assist only those farming businesses that have been willing to respond to increased risk.

4. CONCLUSION

By embedding responses to climate change into local and regional planning activities, climate change adaptation and risk management in general extends beyond the limited, piece-meal activities that have typified risk management and planning. Integrated research has assisted decision-makers to adjust systems within their own biophysical and socio-cultural contexts. By working to create a broader understanding and legitimisation of the importance of climate change vulnerabilities to NRM planning, this work also assisted the region’s planners to “own” future risk. However, future risk is of such a magnitude that it will be very difficult to manage in a sustainable manner via current weak planning guidelines, especially in the highly contested landscapes of the peri-urban fringe. The research enabled a critical review of agricultural planning within those same landscapes to expose the current limits of policy and planning. As resource conditions are constrained by climate change there will be increasing competition for space and resources on the peri-urban fringe. Land use planning mechanisms will need to take increasing account of long term projections of change and ensure that the conceptual space and the physical resources are available to allow for future adaptation. The only way to achieve that would be to implement comprehensive and integrated agricultural and land use planning to support complexity and resilience on the peri-urban fringe.

REFERENCES

ADELAIDE HILLS COUNCIL, 2008. *Adelaide Hills Council development plan: Flood management. Draft development plan amendment by Adelaide Hills Council, January 2008* available from http://www.ahc.sa.gov.au/webdata/resources/files/Draft_AHC_Flood_Management_DPA_ Version_7.pdf, accessed online 3 June, 2009:

ADGER, W.N., DESSAI, S., GOULDEN, M., HULME, M., LORENZONI, I., NELSON, D., NAESS, L., WOLF, J., WREFORD, A., 2009. Are there limits to social adaptation to climate change? *Climate Change*, vol. 93, pp. 335-354.

AMLR NRM (ADELAIDE AND MT LOFTY RANGES NATURAL RESOURCE MANAGEMENT) BOARD, 2007a. *Climate change in the Adelaide and Mt Lofty Ranges region*, Adelaide, SA Government.

AMLR NRM BOARD, 2007b. Discussion Paper 4: Permits for New Dams, available from http://www.amlrnrm.sa.gov.au/Portals/1/Our_Plans/Docs/WAP/WesternMtLofty/DP_4.pdf , accessed 7 April 2010.

AMLR NRM BOARD, 2008a. *Creating a sustainable future: a natural resources management plan for the Adelaide and Mount Lofty Ranges Region. Volume A – state of the region report*, Adelaide, SA Government.

AMLR NRM BOARD, 2008b. *Creating a sustainable future: a natural resources management plan for the Adelaide and Mount Lofty Ranges Region. Volume B – ten year plan for the region*, Adelaide, SA Government.

AMLR NRM BOARD, 2008c. *Creating a sustainable future: a natural resources management plan for the Adelaide and Mount Lofty Ranges Region. Volume C – the board's investment plan 2008/09-2010/11*, Adelaide, SA Government.

AMLR NRM BOARD, 2008d. *Creating a sustainable future: A natural resources management plan for the Adelaide and Mount Lofty Ranges Region. Volume D – regulatory and policy framework*, Adelaide, SA Government.

ATTWATER R., MERSON J., 2007. Resilience of agri-industries neighbouring the Blue Mountains World Heritage Area, *Systems Research and Behavioural Science*, vol. 24, pp. 249-252.

AUSTRALIAN URBAN AND REGIONAL DEVELOPMENT REVIEW, 1995. *Urban Australia: Trends and prospects*, Canberra, Commonwealth of Australia.

BARDSLEY D., 2003. Risk alleviation via in situ agrobiodiversity conservation: drawing from experiences in Switzerland, Turkey and Nepal, *Agriculture, Ecosystems & Environment*, vol. 99, pp. 149-157.

BARDSLEY D., 2006. *There's a change on the way: An initial integrated assessment of projected climate change impacts and adaptation options for natural resource management in the Adelaide and Mt Lofty Ranges region*. DWLBC Technical Report 2006/06, Adelaide, SA Government.

BARDSLEY D.K., 2008. Building resilience into marginal agroecosystems: A global priority for socio-ecological sustainability. Berlin conference on the human dimensions of global environmental change: long-term policies. International Conference of the Socio-Ecological Research Programme, 22-23 Feb. 2008, Berlin, Germany, available at http://web.fu-berlin.de/ffu/akumwelt/bc2008/papers/bc2008_195_ Bardsley.pdf, accessed 23 July 2009.

BARDSLEY D.K., 2010 NatureLinks: A critical response to climate change impacts on biodiversity in South Australia. *SA Geographer* n° April 2010.

BARDSLEY D.K., BARDSLEY A., 2007. A constructivist approach to climate change teaching and learning. *Geographical Research*, vol. 45, pp. 329-339

BARDSLEY D.K., LIDDICOAT C., 2008. *Community perceptions of climate change impacts on natural resource management in the Adelaide and Mount Lofty Ranges*. DWLBC Report 2008/14, Adelaide, SA Government.

BARDSLEY D.K., ROGERS G., 2011. Prioritising engagement for sustainable adaptation to climate change: An example from natural resource management in South Australia, *Society and Natural Resources*, vol. 24, In Press, DOI: 10.1080/08941920802287163.

BARDSLEY D.K., SWEENEY S., 2008. *A regional climate change decision framework for natural resource management*. DWLBC Report 2008/21, Adelaide, SA Government.

BARDSLEY D.K., SWEENEY S.M., 2010. Guiding climate change adaptation within vulnerable natural resource management systems, *Environmental Management*, vol. 45, pp. 1127-1141.

BARDSLEY D., THOMAS I., 2004. In situ agrobiodiversity conservation in the Swiss inner alpine zone. *GeoJournal*, vol. 60, pp. 99-109.

BECK U., 2009. *World at risk*, Cambridge, Polity Press.

BUNKER R., HOUSTON P., 2003. Prospects for the rural-urban fringe in Australia: Observations from a brief history of the landscapes around Sydney and Adelaide, *Australian Geographical Studies*, vol. 41, pp. 303-323.

CATON B., 2007. *The impact of climate change on the coastal lands of the City of Onkaparinga*. Report for the City of Onkaparinga 18 July 2007, available at http://www.onkaparingacity.com/web/binaries?img=15099&stypen=html, accessed 23 July 2009.

CITY OF ONKAPARINGA, 2007. *Addressing climate change: Strategic directions 2020*, Discussion paper 2, June 2007, City of Onkaparinga, available at http://www.onkaparingacity.com/ web /binaries ?img=9442&stypen=html, accessed 26 May, 2009.

CITY OF PORT ADELAIDE ENFIELD, 2007. *State of environment report June 2007*, City of Port Adelaide Enfield, available at http://www.portenf.sa.gov.au/site/page.cfm?u=1160, accessed 23 July 2009.

CITY OF PORT ADELAIDE ENFIELD, 2009. *Biodiversity management plan 2009-2014.* City of Port Adelaide Enfield, available at http://www.portenf.sa.gov.au/webdata/resources/ files/ Biodiversity_Managment_Plan_2008_endorsed_14, accessed 7 April 2010.

CPRE(CAMPAIGN TO PROTECT RURAL ENGLAND), NATURAL ENGLAND, 2010. *Green belts: A greener future*, London/Sheffield, CPRE/Natural England.

CROSSMAN N., BRYAN B., BARDSLEY D., 2008. *Modelling native and exotic flora distributions under climate change*. CSIRO Land and Water Science Report 01/08, Adelaide, CSIRO.

CURRY N., STUCKI E., 1997. Swiss agricultural policy and the environment: an example for the rest of Europe to follow? *Journal of Environmental Planning and Management*, vol. 40, pp. 465–482.

DAIRY INDUSTRY DEVELOPMENT BOARD, 2002. *South Australian dairy industry: Strategic plan for 2010*. Adelaide, SA Government.

DEPARTMENT FOR ENVIRONMENT AND HERITAGE, 2009. *NatureLinks, a*vailable at http://www.environment.sa.gov.au/naturelinks, accessed 4 February 2010.

DEPARTMENT FOR ENVIRONMENT AND HERITAGE, 2010. *Hallett Cove and Marino conservation parks (including Sandison Reserve): Management plan 2010*, SA Government, available at http://www.environment.sa.gov.au/parks/pdfs/PARKS_PDFS_HALLETT_COVE_AND_ MARINO_CONSERVATION, accessed 7 April 2010.

DEPARTMENT OF PLANNING AND LOCAL GOVERNMENT, 2007. *South Coast master plan*: *Draft for consultation.* SA Government, available at http://www.planning.sa.gov.au/download.cfm? DownloadFile=839F367E-F203-0D46-A35ED0ED2DF868B3, accessed 7 April 2010.

DÜNKELOH A., JACOBEIT J., 2003. Circulation dynamics of Mediterranean precipitation variability 1948-98, *International Journal of Climatology*, vol. 23, pp. 1843-1866.

DWLBC (DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION), 2008. *Climate change and the potential for wind erosion: A model for the Adelaide and Mt Lofty Ranges NRM region*. Adelaide, SA Government.

EYRE PENINSULA NRM BOARD, 2009. *State of our resources: Recognising the state of natural resources of the Eyre Peninsula*, Adelaide, SA Government.

FORTIER A., 2009. La conservation de la biodiversité: Vers la constitution de nouveaux territoires, *Etudes Rurales* vol. 183, pp. 129-142.

FÜSSEL H.-M., KLEIN R.J.T., 2006. Climate change vulnerability assessments: An evolution of conceptual thinking, *Climatic Change* vol. 75, pp. 301-329.

GARNAUT C., 2008. « The Adelaide Parklands and the endurance of the green belt idea in South Australia », in AMATI M., *Urban green belts in the twenty-first century*. Aldershot, UK, Ashgate, pp. 107-128.

HAMBLIN A., 2009. Policy directions for agricultural land use in Australia and other post-industrial economies. *Land Use Policy*, vol. 26, pp. 1195-1204.

HAMIN E.M., 2002. Western European approaches to landscape protection: A review of the literature. *Journal of Planning Literature*, *vol.* 16, pp. 339.

HEATHCOTE R.L., 2002. *Braving the bull of heaven: Drought management strategies, past, present and future.* Brisbane, RGSQld.

HIGGINS V., DIBDEN, J., AND COCKLIN, C., 2008. Neoliberalism and natural resource management: Agri-environmental standards and the governing of farming practices. *Geoforum*, vol. 39, pp. 1776-1785.

HOUGHTON J.T., DING Y., GRIGGS D.J., NOGUER M., VAN DER LINDEN P.J., DAI X., MASKELL K., JOHNSON, C.A., 2001. *Climate change 2001: The scientific basis. Contribution of working group I to the third assessment report of the Intergovernmental Panel on Climate Change*, Cambridge, Cambridge University Press.

HOUSTON P., ROWLAND J., 2008. *Room to move: Towards a strategy to assist the Adelaide Hills apple industry adapt to climate change in a contested peri-urban environment*, DWLBC Report 2008/20, Adelaide, SA Government.

JAMES J., LIDDICOAT C., 2008. *Developing industry climate change adaptation strategies: A case study for the McLaren Vale viticulture and Fleurieu Peninsula oliveculture industries*, DWLBC Report 2008/11, Adelaide, SA Government.

KANGAROO ISLAND NATURAL RESOURCES MANAGEMENT BOARD, 2007. *Here to stay: An investment strategy for Kangaroo Island's future 2007-1010.* Adelaide, Australian Government/SA Government.

KEEN M., BROWN V.A., DYBALL R., 2005. *Social learning in environmental management: Towards a sustainable future*, London, Earthscan.

MCINNES K.L., SUPPIAH R., WHETTON P.H., HENNESSY K.J., JONES R.N., 2003. *Climate change in South Australia*, Melbourne, CSIRO Atmospheric Research.

NATIONAL FARMERS FEDERATION, 2009. *Inquiry into the role of government in assisting Australian farmers to adapt to the impacts of climate change: NFF submission March 2009*, available at http://www.aph.gov.au/house/committee/pir/australianfarmers/subs/sub017.pdf, accessed 15 April 2010.

NELSON R., HOWDEN M., STAFFORD SMITH M., 2008. Using adaptive governance to rethink the way science supports Australian drought policy, *Environmental Science and Policy, vol.* 11, pp. 588-601.

NORTHERN AND YORKE NATURAL RESOURCES MANAGEMENT BOARD, 2009. *Northern and Yorke regional NRM plan. Volume A: State of the region report 2008*. Adelaide, SA Government.

OECD (ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT), 1998. *Agricultural policy reform and the rural economy in OECD countries*, Paris, OECD.

OKE R., 2009. *Tackling climate change: SA urban forests – million trees program*, available at http://www.conservationvolunteers.com.au/shellecovolunteers/documents/CVA ClimateChangeforumNov09Ross, accessed April 7 2010.

OPDAM P., LUQUE S., JONES K.B., 2009. Changing landscapes to accommodate for climate change impacts: A call for landscape ecology, *Landscape Ecology*, vol. 24, pp. 715-721.

PATON D.C., ROGERS D.J., HARRIS W., 2004. « Birdscaping the environment: Restoring the woodland systems of the Mt Lofty Region, South Australia », in: LUNNEY D., *Conservation of Australia's forest fauna*, Mosmon, NSW, Royal Zoological Society of NSW, pp. 331-358

PFUELLER S.L., 2008. Role of bioregionalism in Bookmark Biosphere Reserve, Australia, *Environmental Conversation*, vol. 35, pp. 173-186.

PIRSA (PRIMARY INDUSTRIES AND RESOURCES SA), 2004a. *Beef industry strategy: Directions for South Australia 2005-2015*. Adelaide, SA Government.

PIRSA, 2004b. *South Australian sheep industry 10 year strategic plan*, Adelaide, SA Government.

PIRSA, 2004c. *The South Australian pork industry's strategic plan for 2010*, Adelaide, SA Government.
PIRSA, 2005. *Poultry meat in South Australia: Strategic directions 2005-2015*. Adelaide, SA Government.
PIRSA, 2007. *South Australian apple, pear and cherry industry: Strategic plan 2006-2011*, Adelaide, SA Government.
PIRSA, 2008. *Horticulture development in South Australia 2008-2014*. Adelaide, SA Government.
RAYMOND C., 2008. *Mapping landscape values and perceived climate change risks for natural resources management: a study of the Southern Fleurieu Peninsula region, SA,* DWLBC Report 2008/07, Adelaide, SA Government.
REBBECK M., DWYER E., BARTETZKO M., WILLIAMS A., 2007. *A guide to climate change and adaption in agriculture in South Australia*, Adelaide, SARDI, PIRSA and Rural Solutions SA.
REM (RESOURCE AND ENVIRONMENTAL MANAGEMENT), 2008. *Buckland Park EIS: Groundwater investigations*, available at http://www.planning.sa.gov.au/download.cfm? DownloadFile= 08F81969-F203-0D46-A3BCD106C50CC435, accessed 8 April 2010.
RURAL SOLUTIONS SA, 2004. *Strategic Plan for the South Australian vegetable industry*, Adelaide, SA Government.
SA (SOUTH AUSTRALIAN) GOVERNMENT, 2004. *South Australia natural resources management act 2004*, Adelaide, SA Government.
SA GOVERNMENT, 2006. *Planning strategy for metropolitan Adelaide*. Adelaide, SA Government.
SA GOVERNMENT, 2007. *Planning Strategy for the Outer Metropolitan Adelaide Region*. Adelaide, SA Government.
SA GOVERNMENT, 2009. *Planning the Adelaide we all want: Progressing the 30-year plan for greater Adelaide*. Adelaide, SA Government.
SA MURRAY-DARLING BASIN NATURAL RESOURCES MANAGEMENT BOARD, 2009. *Regional NRM plan. Volume 2: State of the region*, Adelaide, SA Government.
SAWIC (SOUTH AUSTRALIAN WINE INDUSTRY COUNCIL), 2010. *Wine: A partnership 2010-2015*, Adelaide, SA Government.
SINCLAIR KNIGHT MERZ, 2010a. Hindmarsh River estuary action plan: Draft report for community comment. Adelaide, AMLR NRM Board.
SINCLAIR KNIGHT MERZ, 2010b. *Inman River estuary action plan: Draft report for community comment*, Adelaide, AMLR NRM Board.
SUPPIAH R., PRESTON B., WHETTON P.H., MCINNES K.L., JONES R.N., MACADAM I., BATHOLS J., KIRONO D., 2006. *Climate change under enhanced greenhouse conditions in South Australia*, Aspendale, Victoria, CSIRO.
THE ALLEN CONSULTING GROUP, 2005. *Climate change risk and vulnerability: Promoting an efficient adaptation response in Australia*, Canberra, Commonwealth of Australia.
THE LUCAS GROUP, 2007. *Development of horticulture industries on the Adelaide Plains: A blueprint for 2030*. Adelaide, SA Government.
URBAN & REGIONAL PLANNING SOLUTIONS, 2007. *Fleurieu Peninsula Region Integrated Strategic Tourism Plan 2007 – 2012*, Adelaide, SA Government.
WACLAWIK V., 2007. *Discussion paper on the potential impact of climate change on the groundwater resources of the McLaren Vale prescribed wells area*, Adelaide, SA Government.
WALSH K.J.E., BETTS H., CHURCH J., PITTOCK A.B., MCLNNES K.L., JACKETT D.R., MCDOUGALL T.J., 2004. Using sea level rise projections for urban planning in Australia, *Journal of Coastal Research*, vol. 20, pp. 586-598.