NORTH CENTRAL VICTORIA – CLIMATE CHANGE AND LAND-USE: POTENTIALS FOR THIRD CENTURY IN A TIMELESS LAND

Ian Mansergh

Hon. Research Fellow, Department of Agricultural Sciences, La Trobe University, Victoria 3086.
Email: ian.mansergh@gmail.com

Mansergh, I., 2010. North central Victoria - climate change and land-use: potentials for third century in a timeless land. *Proceedings of the Royal Society of Victoria* 122(2): 161-183. ISSN 0035-9211.

For the 21st century, scenarios of future climate under global warming suggest that Bassian-Eyrean bioclimatic region of northern Victoria, centred on the North Central Catchment Management Authority (NCCMA), will become markedly warmer and drier. Significant climate change is a real possibility mid-century and some basic bio-physical attributes underpinning the current ecology, land-use and management will be altered. Societal adaptation to climate change will include enhancing landscape resilience and changes to the mix of inter-related ecosystem services. The increasing understanding of these inter-relationships will allow for the creation of a more holistic quantification and production of landscape services. In combination, these challenge the past land-use paradigm on the driest, inhabited continent. Following the mid-19th century gold rushes, land-use in the NCCMA represented the epitome of the colonial land-use paradigm through clearing for agriculture and pastoralism. Victoria has long had the highest percentage private land of any Australian state. The NCCMA catchment is the most denuded of native vegetation, with the smallest percentage of public land and conservation reserves, and is now the centre of a continental concentration of bioregions under high environmental stress. The original primacy of agriculture was fulfilled, sometimes under adverse circumstances, but resultant landscape legacies persist within the relative economic decline of Australian agriculture. The amelioration of these within a future land stewardship that is water-stressed, carbon constrained and prone to extreme weather events is a major challenge. Exploring landscape adaptation, the simple questions arise: From what? To what? This contribution examines broad land-use in the NCCMA in the long term context of climate change and adaptation, land-use and the perceived valuation of ecosystem services from the landscape. The increasing realisation of the interconnectedness of these phenomena and the necessity for ecologically sustainable agriculture provide enhanced drivers for the evolution of new landscape meanings in the context of an inter-generational equity and climate change response.

Key words: northern Victoria, land-use change, climate change in south east Australia, land-use history

IN Australia, over 40,000 years of Aboriginal habitation was abruptly altered by European arrival. After the Victorian gold rushes of the 1850s, the resulting population surge was resolved by massive land alienation for agriculture using novel biota, technologies and a colonial landscape paradigm. These values transposed European landscape visions onto an old, dry and nutrient deficient land with little understanding of the continental climate, soils, vegetation, fire and native biota or their interactions. The millenia of human knowledge contained within the Aboriginal cosmology was devalued and ignored as settlement focused on food and fibre for export to the empire. This paradigm dominated land-use and management for well over a century (Smith 2002; Weaver 2003). Now, the majority of national agricultural productivity and wealth is derived from a very small percentage of land that was originally allocated for this purpose (NLWA 2001a,c; Hamblin 2009). Society, the economy and our understanding of the environment and climate have all evolved. This awareness and the climatic challenges of this century offer opportunities for re-imaging future landscapes. The NCCMA will not be immune from these changes and early societal adaptation to climate change is viewed as not only conveying economic advantages but also as a necessity (e.g. Stern 2007; Australian Government 2010).

At the national scale, this paradigm of agricultural settlement is being challenged from several perspectives, with observable differences in the rate of change from south to north across eastern Australia, the heartland of the Australian wheat sheep belt. The relative economic importance of agriculture has declined in Australia over the last five decades and the demographics of rural Australia and Victoria are changing, with long-term depopulation in many regions. Other regions trend toward amenity landscapes, which are viewed differently, offering new opportunities to

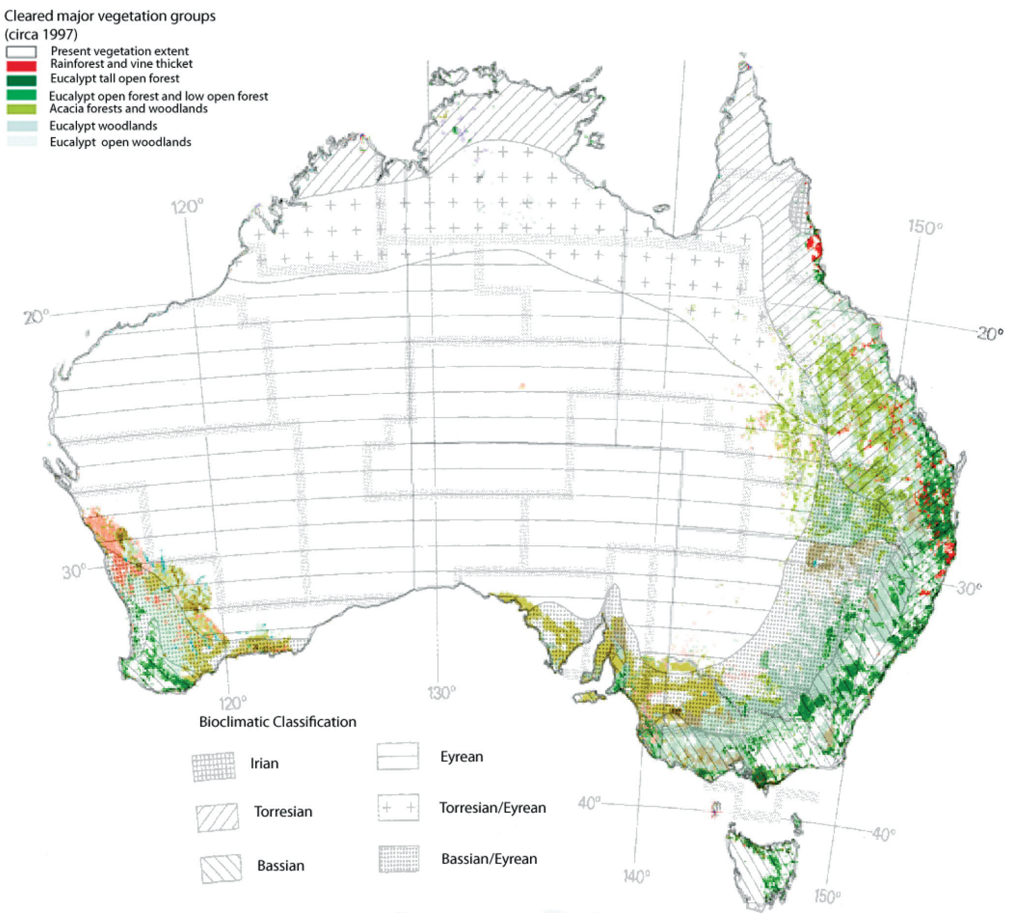


Fig. 1. Broad vegetation groups cleared in Australia (up to 1997) overlaid with the bio-climatic zones: uncleared (white); woodland (grey) and forest (green). Note extensive clearing in Bassian and Eyrean-Bassian bio-climatic zones of eastern Australia. Source: Mansergh et al. 2008a.

realign the mix ecosystem services produced that includes biodiversity conservation. This evolving social licence for including ecology derives in part from a maturing sense of place, where natural environments are valued more for their own sake, and for the increasing recognition of their diverse and interconnected range of ecosystem services.

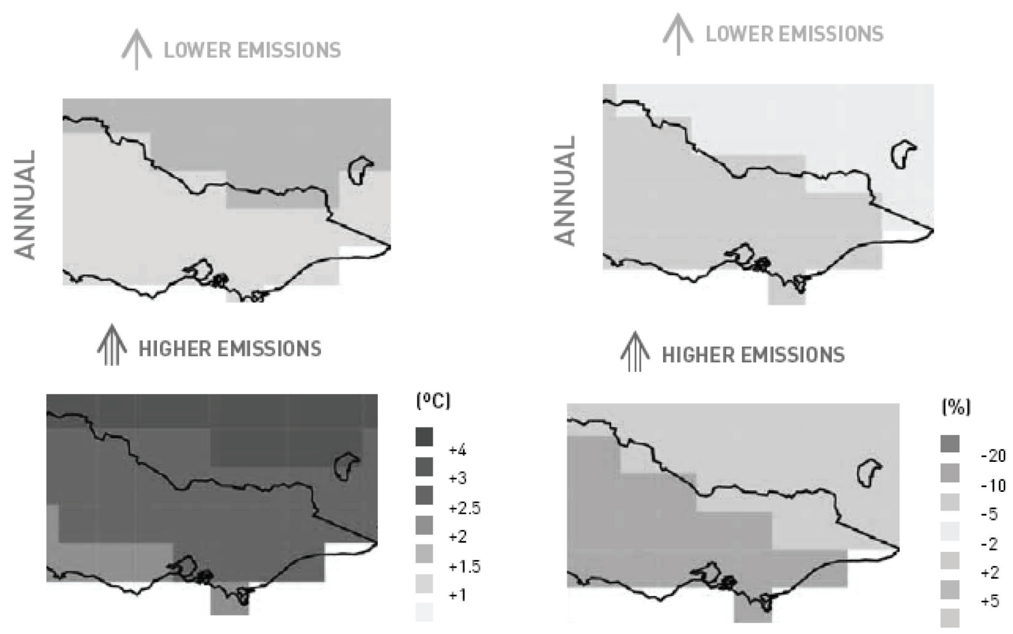
From many perspectives, the state of ecosystems within the NCCMA represent the epitome of the colonial landscape meaning and resultant adverse landscape legacies are now evident. This agricultural region, in the state with the highest percentage of land alienation in Australia, is the most denuded of native vegetation, has relative small percentage of public land, low percentage area of public reserves and is the centre of a continental (and state) concentration of bioregions under high environmental stress (Fig.1). Dams and other engineering works along the Murray River were built to drought proof the region and although irrigated land provides more agricultural wealth per unit area (NCCMA 2003) it still remains vulnerable to drought and climate change (MDBA 2008; Jones 2010).

Major socio-economic drivers of land-use for both Victoria and the NCCMA were gold from the mid 19th century and agriculture from late 19th to mid 20th century. While the State's economy progressively diversified through industrialisation, manufacturing and most recently services, the NCCMA has remained traditionally agricultural.

The rhetorical conference theme: have the ecosystems in the NCCMA changed forever? - can be answered with a qualified yes. However, whether this change continues to be adverse to such critical ecological elements and basic processes, such as biodiversity and soils, will be determined by human endeavour. Human responses to climate change will necessitate a re-evaluation of landscapes and the ecosystem services provided.

CLIMATE CHANGE AND EFFECTS ON BIOTA AND ECOSYSTEMS

The Inter Governmental Panel on Climate Change (IPPC) (2007) has led science and the global community to a deeper understanding of recent climate change, future climates and potential impacts. The IPCC (2007) attributes around 35% of the greenhouse gasses (GHG) stored in the atmosphere to past deforestation, and about 18% of annual global emissions as a result of continuing deforestation. The planet is now committed to an increase in temperature – the magnitude of which will be determined by human emissions (CO_2 e) and responses (Fig. 2). Globally, climate change will spatially affect basic Net Primary Productivity (NPP) with changes already observed (Nemani et al. 2003). Mass extinctions have been predicted based on meta analysis of global change due to factors such as: changes in ecosystem/species distribution and abundances; habitat contraction/elimination (e.g. polar regions) and inhibition of re-colonisation over fragmented landscapes; changes in phenology and synchronicity of biological events (Hughes 2003; Root et al. 2003; Thomas et al. 2004; Umina et al. 2005). The resilience and thresholds of the functionality of natural systems remain critical, even if quantification remains uncertain, under future climates (Steffen 2009). In Australia, biodiversity is recognised as one of the most vulnerable sectors (Steffen et al. 2009). Changes in the mean global temperature are not equivalent to smooth transition to new regional climates. Relative abrupt changes in a range of parameters may occur (IPCC 2007) where thresholds or 'tipping points' may irrevocably change ecosystems into an altered, perhaps vanishing form (Smith et al. 2009; Steffen 2009).



Temperature Change **Rainfall change** **Figure**

Fig. 2. Temperature and rainfall changes in Victoria under future climate scenarios for 2070. Source: Victorian Government 2008a.

SOUTH-EAST AUSTRALIAN BIOCLIMATIC, ECOLOGICAL AND LAND-USE ZONES

The dryness north of the Great Dividing Range (NCCMA) puts the region in a different global climatic zone to that of southern Victoria (Thorndyke 1931 in Davidson 1965). Ecologically, the NCCMA is currently on the southern edge of the Bassian-Eyrean bio-climatic zone, transitional between the hot-dry interior and the cool moist region of the coastal fringe (Fig. 1). The zone supports a distinctive flora, fauna and ecosystem configuration within the sheep-wheat belt of the Murray-Darling Basin which is part of the most extensively cleared area of the continent (Wadham et al. 1957; Blakers et al. 1984; Emison 1983; Fig. 1). Climatic modelling suggests a southward migration of this zone with a resultant shrinkage of the Bassian zone (Brereton et al. 1995; Newell et al. 2009). The pressure of such changes relating to effective growing season and available moisture will also affect current distribution of agricultural pursuits (Stokes & Howden 2010).

CLIMATE CHANGE IN VICTORIA, NCCMA AND NATURAL RESOURCE USE

Global warming is a current and future problem with Australia warming about 0.9^{O} C over the last decades. Future climate projections under various emission scenarios are available and are periodically updated for Victoria and the Catchment Management Authorities (CMA) regions (Figs 2, 3, Victorian Government 2009). There is ongoing research investigating the drivers of climate change and variability to provide assessments of regional vulnerability and risks. For example, the South Eastern Australian Climate Initiative (SEACI) found that the trend towards a warmer, drier climate is strongly linked to the intensification of the sub-tropical ridge (SEACI 2008). Climatologists place higher confidence in temperature projections than those for rainfall.

The NCCMA, in common with other regions north of the Great Dividing Range, faces a drier and warmer future with increased frequency of extreme weather events (fire, flood) and declining water runoff in all rivers and streams under all scenarios (Hennessey et al. 2005; Jones & Durack, 2005; Fig. 2). By 2070, runoff into the Campaspe, Loddon and Avoca Rivers is expected to decrease by 5 to >50% (Jones & Durack 2005). Indeed, over the next 20 years catchments in the NCCMA (Eastern Mt Lofty, Loddon-Avoca and Campaspe) are projected to have the highest percentage runoff decline (>15%) of all MDB catchments except the Wimmera (CSIRO 2008). At a continental scale analysis suggests the entire NCCMA is in a high risk zone for water and agriculture (Jones 2010), rainfall of the last decade (pre 2009) is less than the worst case 2030 scenario. Recent analysis of the scientific evidence suggests that dangerous climate change may arrive sooner than the most recent global assessment of the IPCC (2007) (SEACI 2008; Steffen 2009; Fig. 3). Climatic parameters will change within the region, driving other biophysical changes, but it is also important to recognise that the socio-ecological relativities between regions will also change. The vulnerability of regions dependent on external resources that may themselves be stressed, e.g. water, may be further increased. Significantly, land use change is seen as appropriate natural resource management response to climate change at levels from the national economic mitigation (Garnaut, 2008; Wentworth Group 2009) to northern Victoria (Jones et al. 2007; Walker et al. 2009). Australian agriculture adaptation to climate

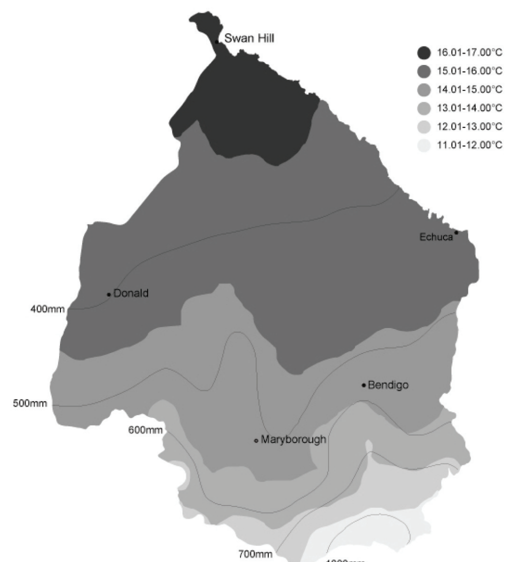


Fig. 3. North Central Catchment Management Authority: current annual temperature (OC- shaded) and rainfall isohyets (mm - lines). Moister areas are limited to the higher altitudes in the south. Source data: http://www.climatechange.vic.gov.au/CA256F310024B628/0/60371A89A1AB810ACA25747400102F55/$File/North+Central_WEB.pdf.

change may involve adjustments to altered land capability distributions across many sectors (Stokes & Howden 2010). Current decisions, including those relating to land-use, will affect Australia's future vulnerability to climate change (Australian Government 2010).

HISTORICAL LAND AND WATER USE IN NORTH CENTRAL VICTORIA

This paper does not cover pre-European settlement; however, the rich cosmological land management of the 11 Aboriginal language groups that inhabited the catchment was part of a culture that has the longest continuous occupation of any continent on the globe. European settlement brought brutal changes to Aboriginal society and imposed a European view of land ownership, use and management (Christie 1979; Weaver 2003). The legal, cultural and socio-psychological ramifications of the Mabo decision in 1992 undermined a fundamental pillar of the colonial land-use paradigm, that of *terra nullius*, ramifications of which are being incorporated into new understandings of landscapes and the humans within it (Reynolds 1994, 1998; Russell 2006). In the NCCMA, the Yorta Yorta Co-operative Management Agreement (2004) was the first Victorian agreement reached outside the native title process that allowed Indigenous people to be involved formally in the management of their traditional lands and waters (ALR 2002).

In 1835, Governor Burke declared Australia *terra nullius* and the next year Mitchell (1838) explored through the NCCMA and wrote of *Australia Felix*. Squatters quickly invaded with sheep – the northern plains grassland and Murray River were particularly favoured for pasture. Victoria's climatic advantages for settlement, better watered and more temperate climate, were magnified by the discovery of gold at Bendigo that initiated a gold rush of global scale. Some of the greatly expanded population base was induced to stay by the lure of land ownership. Victoria, which became a separate colony in 1851, enacted a series of land Acts in the 1860s to promote small farmer freehold property. Indeed, the privatisation was so rapid and extensive that the reservation of public stream side reserves, was too late to be effective over large areas of the NCCMA (Cabena 1983; Elkner 2007; Table 1). Almost all land suitable for agriculture as practised at the time was alienated. The natural flooding of the Red Gum forest and the durable timbers used for mining and infrastructure of the Box-Ironbark forests probably protected them from initial clearing (VEAC 2006; Lawrence & Bellette 2010). Alienation often required 'improvement' and clearing the land of native vegetation. By 1870, Echuca had the only Victorian inland railhead and longest rail line. Within 20 years four rail lines traversed the region (generally NW-SE) to transport agriculture product, predominantly grain, to Melbourne (Waugh 2000; Mansergh *et al*. 2006)

The adoption of the Torrens title system facilitated transfer of rights in real property, but with no legal link to social or environmental responsibilities of ownership as did its Hansatic precursor, which evolved to have such connections in the German constitution (Raff 1998 2004). Thus the legal, economic and demographic framework reflecting the colonial paradigm was in place very early in Victoria's history (Weaver 2003). This was well before there was adequate knowledge of climate, soils, hydrology, biodiversity and their interactions with land. Other colonies, under the same paradigm, adopted similar systems, although much larger areas were maintained as leasehold, predominantly in more arid zones (Table 2). Even when environmental constraints and social risks were better known, the populating of agricultural Australia continued under the Solider Settlement Schemes of World Wars I and II, with varying success and many social and environmental disasters, including drought, across marginal landscapes (McKernan 2005). Unfettered by official environmental or social constraints, individual farmers used the land to produce the best economic return. Collectively this created the wheat-sheep belt, where both could be grown, technology and market forces determined the regional landscape character over time, as in the NCCMA.

Overcoming many difficulties, including climate, these farmers fulfilled the then 'social licence' (Wadham et al. 1957; Smith 2002; Gunningham et al. 2004; McKernan 2005). The extent and condition of native vegetation and related environmental attributes declined (Figs. 1, 4, Tables 1, 2). The net result of this early settlement, in contrast to other states, produced a Victoria that was over two-thirds private land and about one third public (Table 2). The NCCMA region was predominantly cleared and settled for agriculture, with grazing in the east and cropping in the west, and irrigation along floodplains of the Murray River leaving a relatively small area left as public land (NL&WA 2001b; NCCMA 2003; Elkner 2007; Table 1).

Table 1. Percentage areas of selected rural land-uses in North Central and North-east CMAs compared to Australia and Victoria. Source * http://www.ga.gov.au/education/geoscience-basics/land-tenure.jsp - 1993 data, and NLWA 2001b & c; # 42.1% crown land leasehold, treated as private; Data from NECMA (2003), NCCMA (2003); + 1997 data - http://www.anra.gov.au/topics/irrigation/overview/index.html, (NCCMA 2003 – 2001 data).

	Total Area (000 Km^2)*	Public land* (%)	Parks and reserves (%) *	Native vegetation cover (%)	Intensive agricultural and cleared land - 000 km^2	
					Irrigated +	Cleared land
Australia	7682.3	23.0 #	9.83	Intensive zone * 68	2. 1	Intensive zone * 926
Victoria	227.6	34	c.17	c. 34	0. 55	14.3
NECMA +	1.98	55	22	>65	-	?
NCCMA *	3.0	<13	4.8	12.2	0.26	2.6

Table 2. Comparative statistics on land-use, biodiversity policy and climate change for the eastern states of Australia over time.

Theme	Date	Victoria Area = 22.8 (000 Km^2)*	New South Wales Area = 801.6 (000 Km^2)	Queensland Area = 1727.2 (000 Km^2)	Source
Parks and	1970	c. 1	< 1	< 1	Hardy (2001),
reserves (% state)	1993	14.3	6.8	3.8	DSE data bases (Victoria)
Land tenure (%)	1993				Queensland
- Public		34	11.2	24.6	Government
- Freehold		65	55	8.7	(1998, 2009)
- Leasehold		0.1	38.5	66.7	http://www. ga.gov.au/education/geoscience-basics/land-tenure.jsp
- Traditional		-	0.2	2.4	
Land cleared (%)	1997	63	33	28	NLWA (2001b)
First Vegetation Clearance regulations		1989	2005	2006	
First biodiversity Strategy		1992 / 1997	1999	2005	
Kyoto reporting Land-use change	1990	Source (4th highest)	Source	Source (highest)	Australia Government (2007),
(Carbon sink or source)	2005	Sink (highest and only)	Source	Source (2nd highest)	Fig. 9

Climate - Water - irrigation

The NCCMA was within the transition zone between the arid interior and the wetter south. Irrigation was perceived as the answer in the Murray-Darling Basin. The first major water impoundment in the Basin was in the NCCMA at Coliban, begun in 1858 for the goldfields. The NCCMA was also amongst the first regions to use extensive irrigation for settlement (McKay & Eastman 1990). Despite early problems, such as salination around Barr Creek, irrigation was seen as the panacea. Droughts occurred in 1882, 1901, 1914, 1927, 1938, 1940-41, with the current south eastern Australian drought the worst drought on record. The Federation drought in 1901 and the River Murray Waters Agreement of 1915 eventually lead to the establishment of the Hume Weir in the 1930s, giving the longest river on the continent large-scale regulation and massively changed flow regimes (Jacobs 1990). The Hume Weir supplied water to existing and additional irrigation schemes across northern Victoria. Irrigation based on the Murray River was set to overcome natural water deficits caused by existing climate.

A large proportion of NCCMA was in the irrigation zone around the zenith of agricultural planning in the 1960s (Fig. 5). In 1997, Victoria estimated that it could supply 100% of the farmers allocated water

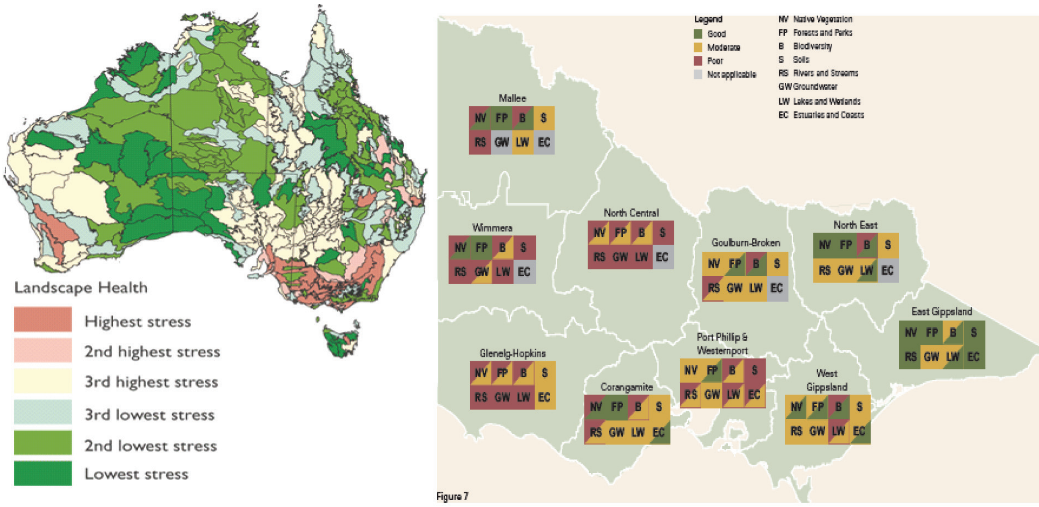


Fig. 4. Landscape health by Australian bioregions (left) and most recent catchment condition report (right). Note that the NCCMA is central to bioregions under high environmental stress and has amongst, if not the, poorest report on environmental condition. Sources: NLWA (2001c), VCMC (2007).

rights in 96 years out of 100 (DNRE 1997, in Cooke 2006). By 2005, about 10% of the region was irrigated and produced around 50% of the Gross Agricultural Value (NCCMA 2003). By 2009, water strategies for the region indicated that climate change would be the biggest factor affecting future water availability with the most severe climate change scenario projected to require significant adjustment for the environment, irrigation sector and communities (SEACI 2008; Victorian Government 2009c). Inflows into the Murray-Darling system show a marked decline over the last decade which cannot be explained by natural variation alone (Cal & Cowan 2008a, b; Australian Government 2010). Some groundwater resources were also declining in the NCCMA by 2007, but their inter-connection to surface water is now recognised by policy (DSE 2008; Victorian Government 2009b). Current areas of Victorian irrigation are part of a modernisation program along the Murray River that, in part, facilitates water use to the highest agricultural value. In 2010, irrigators around Rochester voted overwhelmingly to sell their water rights, and to leave the irrigation system (Ker 2010). Under future climate changes, the exact future extent and spatial configuration of the irrigated area remains unknown.

We now perceive a water stressed future with water availability, variability and climate change within the Murray-Darling Basin as a major national and regional issue (MDBA 2008). In a drier future, adaptive risk management of an individual farming enterprise may include increased water security through larger dams on the property or by using ground water in pivot irrigation (Garnaut 2008). However, such individual risk management multiplied over many enterprises may increase the vulnerability of ecosystem function and services over the region, such as environmental flows and keystone remnant vegetation (Maron & Fitzsimmons 2007). In adaptation across landscapes, particularly those with a large percentage of private property, as in the NCCMA, individual risk mitigation action must be balanced with long-term landscape and social vulnerability and resilience (e,g, Ker 2010). The evolving social licence for land and water use and avoidance of maladaptive responses under climate change are important in this arbitration.

Current environmental effects of past land-use

What happened in multiple paddocks altered ecosystem functionality at all scales from micro-climate and evapo-transpiration, soil health, tree decline to regional hydrology, biodiversity and, perhaps rainfall (see below) (Kile et al. 1980; VCMC 2002, 2007). The ramifications of past land use have left the NC-

Type	Existing	Under Construction	Planned
Irrigation Areas and Districts		(Under Development)	

Fig. 5. Conservation of surface water from the 1959 Atlas of National Resources. At this time, some infrastructure was already decades old in some parts of NCCMA (orange boundary), the Snowy River Scheme was yet to be completed and the concept of environmental flows unknown. In the 1990s, environmental flows in the Snowy River became a major national controversy. Source: Commonwealth of Australia (1959).

CMA with environmental legacies and on-going stresses that are significantly poor at the continental scale and from all perspectives measured by the Victorian Catchment Management Council (VCMC 2007) (Fig. 4). Many of these major threatening processes have strategies and plans in place, e.g. salinity, nutrient management, river health and native vegetation (NCCMA 2003). Re-occurring themes in these documents are the interconnectedness of ecological processes; the need for changed land-use and management regimes for co-ordinated action across the landscape. Collectively, these catchment degradations represent the tangible results of the colonial land-use paradigm. In essence over estimation of land use capacity, dramatic over clearing and irrigation have been the major causes of the poor environmental outcomes in northern Victoria (Cooke 2006; VCMC 2007; Barr & Cary 1992).

CHANGING SOCIO-ECONOMIC LANDSCAPE AND LAND-USE TRAJECTORIES

There were some very positive economic ramifications from the initial land-use/agriculture paradigm. Australians achieved a relative high standard of living, good diet availability and acquired valuable foreign exchange. However, since the 1990's, the national sheep herd has halved (ABS 2008b) perhaps symbolically reflecting the long-term decline of the economic dominance of agriculture (Campbell 1994). De-population is occurring and projected in many agricultural regions (including part of the NCCMA (Fig. 6). At the national level the sector was: 92% of export earnings (29% of GNP) in 1951 declining to 22% (3% of GNP) in 2005; providing 28% of employment in 1931 but only 4% in 2005. Land and Water (NLWA 2001a, b) found 26% of agricultural product came from irrigated land, i.e. 1% of the agricultural land, 80% of profits came from 2% of the land and 10% of farm establishments produced 40-50% of Gross Agricultural Product. Greater productivity has been achieved with fewer producers but more intensity of use (e.g. Barr & Cary 1992). Hamblin (2009: 1196) calls the primacy of agriculture 'the land-use paradox' and observes that although Australia has about 3% of the global arable land, produce feeds only 0.02% of the world's population. Over the last decade, Victorian primary agriculture contributed about 25-30% to national agricultural exports but accounted for about 2-4 % of the Victorian Gross State Product (ABS 2008a, and Rochester ABS, pers. comm.).

Adverse terms of trade (cost vs. income) in an increasingly capitalised and industrialised sector have eroded the socio-economic viability of small and medium sized farms which is particularly relevant to the historically smaller farms in Victoria, but also evident in the Bassian-Eyrean zone up through to Queensland (Barr & Karunaratne 2002; Barr 2004). In recent decades the socio-economic trajectories of land-use in Victoria have been changing with over 50% of the private landscapes moving away from traditional agriculture to amenity and transitional landscapes (Barr 2008). Those remaining in traditional broad acre production landscapes are often associated with de-population (Fig. 8).

The NCCMA has the full mix of the land-use trajectories in production (including irrigation), transitional and amenity landscapes (Barr 2008). Amenity zones are associated with proximity to Melbourne or Bendigo and have higher rainfall, less extreme temperatures, elevated terrain and increasing population. In the production zone, aggregation of farms means continued depopulation of the western part of the NCCMA where drier, warmer conditions are projected (Figs 2, 8; Barr 2004, 2008). As these landscapes and their residents adapt to climate change, different opportunities and constraints will manifest.

There have also been changing policy perspectives of future land-use perhaps in recognition of land and water use capabilities, economics and climatic realities. By 2020, the Department of Primary Industry envisaged agriculture as using 30% less land and 20% less water (Kefford 2002; ORL 2002) whilst the VCMC (2002) has called for 40% of catchments to be re-vegetated. The NCCMA (2003) envisaged raising the cover of native vegetation from 13% to 20%

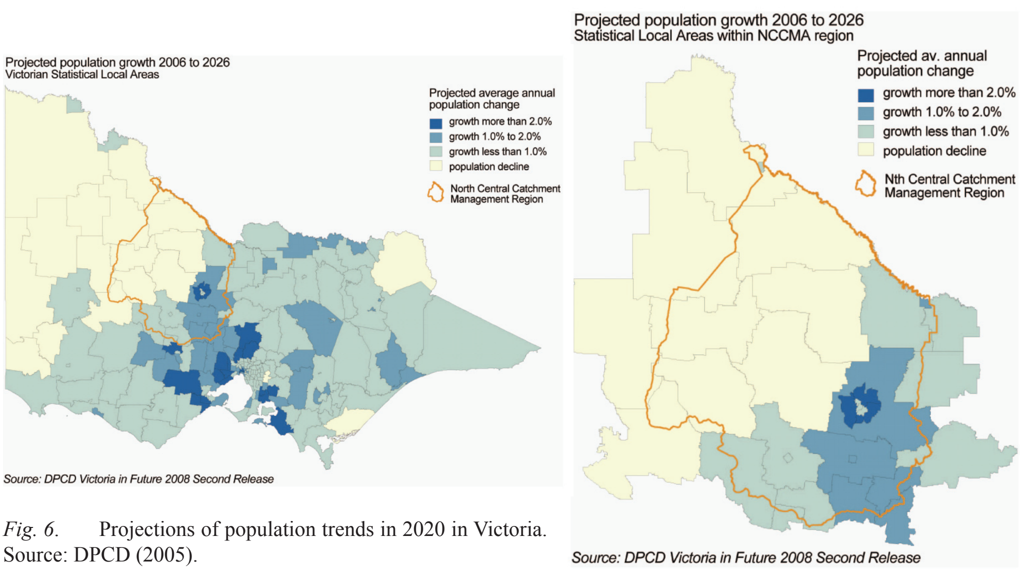


Fig. 6. Projections of population trends in 2020 in Victoria. Source: DPCD (2005).

of the catchment by 2020. Each of these perspectives explicitly means new uses for private land that was used in the past for agriculture. Amidst these policy directions, climate change is projected to have further profound implications for current agriculture (DPI 2009). Garnaut (2008:13) observed that 'the most effective responses in agriculture to climate change will sometimes require fundamental changes in attitudes, policies and institutions'. Different land-uses and landscapes can be envisaged.

CHANGING VIEWS OF LANDSCAPES

Science, ecology and socio-ecology

Science investigates the prevailing societal questions put to it, thus science, particularly of agronomy, and engineering, including water, serviced the colonial land-use paradigm. The initial work on native pasture was abandoned when it was discovered that the addition of phosphates and N-fixing plants could make many Australian soils more productive for agriculture and alleviate some soil erosion problems (Smith 2002; Mansergh et al. 2006). The Victorian extent of native pastures, i.e. grasslands, grassy woodlands, plummeted from the 1940s (Barr & Cary 1992; Smith 2002; Mansergh et al. 2006). Over the last four decades there has been a dramatic increase in ecological research focused on natural environment. This conservation oriented science highlighted the importance of native grasslands and re-awakened some of the side benefits for production, which included drought resistance. The Western Basalt Plains grasslands of Victoria became the most endangered ecosystem in Australia with the Northern Plains grasslands of the NCCMA also massively depleted. When a property at Terrick Terrick which remained unimproved and only lightly grazed by sheep for generations, was discovered as a highly significant remnant grassland it was incorporated into the reserve system in 1999. In the 1980s the official state-wide vegetation mapping, which was structurally based from the forestry viewpoint, showed the NCCMA supported eight vegetation types, but two decades later the same source recorded over 180 Ecological Vegetation Classes (EVCs). Our view of native vegetation in the landscape has become more sophisticated, nuanced and more respectful of diversity. Now we 'see' landscape differently.

New concepts arising from ecology and natural resource management are emerging into the field of socio-ecology. These are becoming integral to the debates around climate change (Holling & Meffe 1995; Steffen 2009; Steffen et al. 2009; Walker et al. 2009). Using these concepts in a modelling analysis of the adjacent Goulburn-Broken CMA, it was concluded that large-scale revegetation may be important to increase the overall social ecological resilience of a transformed region where on-going agriculture is required. Building ecosystem resilience is the first goal of three for Victoria's policy on land and biodiversity under changing climate (Victorian Government 2009b). Alternative landscape futures can be constructed and quantified in virtual reality to show trajectories of current and future land-use change at all scales (Mansergh et al. 2008b; Figure 8). .

NEW LANDSCAPE PARADIGM EMERGING SOCIO-ECOLOGY

Sense of place

The 'sense of place' in the Australian culture is evolving from the colonial paradigm of the supremacy of agriculture to embrace respect for endemic environments. This manifests in changing land use and management. Victoria is now at the forefront in fundamental changes in land use and management on both public and private land (Table 2, Campbell 1994; Mansergh et al. 2008a). Victoria had already commissioned its last major dams (Blue Rock and Thomson – 1981) by the time the Franklin dam issue in Tasmania was resolved after the national election of 1982 and provided a symbolic national watershed for public land and water use.

In the public estate, there has been a dramatic change of land-use and management from timber production to conservation through the Victorian initiative of the Land Conservation Council (LCC) (Clode 2006). In Victoria, National Parks (Table 2) now constitute about 17% of the State (50% of all public land) from < 3% in 1970 (Robin 1998; Clode 2006). Following lengthy public-political debates, public land grazing – part of the social licence of the past, was gradually removed from new parks (Mallee in the 1980s, alpine 2002). Changes in the use of public land are often accompanied by vigorous public debate and anxieties in affected communities (Clode 2006; VEAC 2006). Some of the infrastructure that supported pastoralism is finding new uses for biodiversity conservation, Victorian crown land stream sides and the travelling stock routes of NSW and Queensland (Mansergh et al. 2006; Queensland Government 2009).

These changes reflect the cultural-ethical evolution of Victorian society regarding landscape. From a stronger valuing of the natural environment this new sense of place has evolved to incorporate more utilitarian views such as ecosystem services. The initial mix of drivers for the establishment of National Parks may have been predominantly ethical but once established they become valued as part of some regional economies. This can be seen in the different arguments and data used for determining public land use in the NCCMA over time (LCC 1983; VEAC 2006). Due to past land allocation, use and management, land-use change in the NCCMA has not benefited as much as other CMA regions (Table 1 and 2).

In the private estate, traditional agriculture dominates, however, concepts such as ecological sustainability, biodiversity conservation and landscape restoration have driven major national and State initiatives in public funding and catchment management, e.g. Natural Heritage Trust 1 and 2. Land stewardship has becomes a widely used term. Organisations and programs such as the Land for Wildlife, Potter Foundation, Land Care, Trust for Nature and the first existence and persistence rights legislation *Flora and Fauna Guarantee Act 1988* for all native species were all developed in Victoria. A more holistic and landscape view, including biodiversity conservation and group action, is evolving. Indeed, Land Care is premised on the actions of local groups, rather than individual landholders, and these tend to include a local sense of place (Campbell 1994; Williams 2004).

New institutional players in traditional agricultural landscapes place a higher value on the natural environment and ecological sustainability. Trust for Nature and Bush Heritage (Australia) purchase private property for long-term conservation. However, properties in the NCCMA do not feature large in their portfolios. In contrast, a large superannuation fund, is making substantial investment in the sustainability of land and related water resources of northern Victoria, including NCCMA (25 000 ha and 30 GL of high security water) (VicSuper 2008).

Apart from institutional changes, broad attitudinal changes evolving from earlier land-use paradigms have also been observed within residents and land owners, across rural Australia (Barr & Cary 1992). These changes suggestive of evolving world views, reflect re-evaluation of their histories which often incorporate a deeper respect for the original inhabitants and examination of current and future landscapes under climate change (Williams 2004; Bunbury 2009). These vary across sectors and regions. A detailed analysis of the Genaren Hill Land Care group (NSW) observed that some individual sheep and wheat producers grew to perceive that protecting and enhancing native vegetation enhanced their own working environment and added a new dimension to their enterprise (Williams 2004). Barr & Cary (1992) showed that Victorian pastoralists in the 1980s were more receptive to the useful function of trees in the landscape than crop growers. However, in some dry-land cropping regions of WA affected by salinity, research is investigating deep-rooted perennials such as eucalypts in alley farming to combat dry-land salinity (Clarke et al. 2002). Even in agri-industrial regions, more mosaiced landscapes become conceivable.

Talking amongst ourselves

The systematic introduction of about 30% of Australia's weed complement remained hidden from analyses within the colonial land-use paradigm until identified by Cook & Dias (2007; see also Mansergh 2010) New descriptors and terminology are emerging from processes and activities within the landscape. The concept of environmental flows for rivers was inconceivable in the water conservation of earlier periods but is now part of sustainable river management. Increasing understanding of climate and climate change has meant that exceptional circumstances in a beyond seasonal, beyond reasonable, drought have become expected. Farmers and graziers are now frequently referred to as agri-businesses and landholders. In the same landscapes, remnant vegetation is becoming referred to as reservoir vegetation for future landscape restoration through the emerging land-use and climate change debate (Mansergh et al. 2008a).

Valuation of ecosystem services over time

Humans modify landscapes inherited from the past to reflect meaning for a future (Schama 1998; Mansergh et al. 2008a) as reflection of the underlying land-use paradigm (Bayliss-Smith 1982). River Red Gums *Eucalyptus camaldulensis* are a ubiquitous feature of the NCCMA floodplains, however, society's perception of the forest and the services related to the species,

Table 3. Indicative societal valuation of ecosystem services provided by trees in the landscape over time. Rating: - = not considered, irrelevant, ○ = minor, emerging ◖ = partial ● = major value or considered part thereof, ●● = dominant driver. # Kibblewhite et al. (2009), ## Victoria Government (1997), Yen et al. (2002) – a single River Red Gum may support over 700 morph-species of invertebrate; * McAlpine et al. (2007), ** Wentworth Group (2009); Mansergh (2008a).

Ecosystem service of native tree / vegetation		Past societal perception of value		Future
Anthropocentric	19th century	Early- mid 20th century	Late 20th century	Future under climate change
Inhibitor of primary land-use	●	●	◖	-
Wood product				
- building,	●	●	●	● plantation ?
- infrastructure	●●	●	◖	-
Fence post	●	●	◖	○ plantation
Fuel	●	●	◖	○ plantation
Wood chips			●	○ plantation
Fire risk	●	●	●	●
Amenity	-	◖	●	●●
- shade/shelter (pastoral)	◖	◖	◖	◖
- landscape		○	○	●
- tourism	-	-		●
Bio-physical				
Hydrological	-	○	◖	●●
deep water pump	-	◖	○	●
soil penetration		-	◖	●
flood mitigation	-	-	◖	●
Soil health #		○	◖	●●
stability	-	◖	●	●
water penetration	-	-	○	●
micro climate	-	-	-	●
C-sequestration	-	-	-	●
Biodiversity ##	-	-	●	●●
inherent	-	○	○	●
landscape	-	○	◖	●
Climate regulation *	-	-	-	●
- micro climate			○	●
Carbon sequestration **	-	-	○	●
- inherent	-	-	◖	●
- part of soil/vegetation	-	-	○	●

changes over time (Table 3, Figs 7, 8). The original reservation of the Red Gum forest was to provide fuel for Murray River steam-boats, a mode of transport that was eliminated when low railway bridges were built across the river. Over time, forests of Red Gum and Box-Ironbark in the catchment have been important sources of various fuels (including charcoal in WW2); durable timbers for infrastructure; fencing for agriculture, mining structures, railway sleepers, bridges, road bases etc. (LCC 1983; VEAC 2006; Fig.8). *In situ*, these ecosystems can recover with change of management however, some are dominated by large-scale *ex-situ* factors, in the case of River Red Gums, by changing water regimes (VEAC 2006).

Societal perception of the relativities of the ecosystem services of 'a tree' has changed over time and will evolve in future (Table 3). The bio-physical services provided by 'the tree' can be modified by land-use and management but the basic bio-physical potential does not change – our valuation does. Thus the return of eucalypts in alley farming to ameliorate salinity (Clarke et al. 2002). Our perception of

Fig. 7. Different landscape uses of the River Red Gum *Eucalyptus camaldulensis*. Left: Relatively young regrowth along Murray River (timber, soil stability, amenity); - Centre: Provision of shade and amenity (Dunkeld with plantation in background); Right: Cattle in riparian zone of pastoral landscape. Many old trees in 'pastoral' landscapes are senescing with future declines and landscape change projected. Photos C&R Alex Lau DSE, L -Adrian Martins, NCCMA.

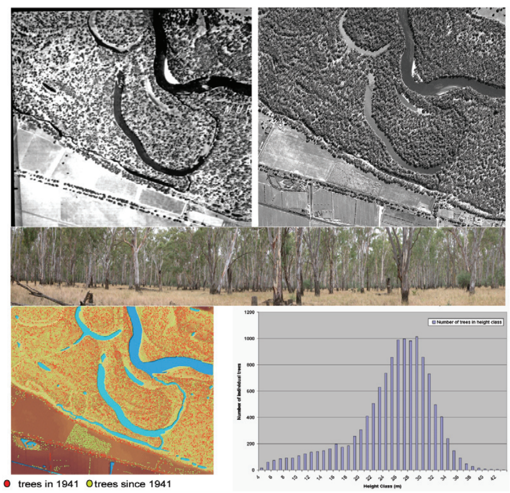


Fig. 8. Technology allows accurate measurement of landscape attributes. Aerial photography and remote sensed imagery centred on River Red Gum *Eucalyptus camaldulensis* forest (409 ha) – Murray River - 10 km se of Cobram, immediately west of NCCMA. Top left: 1941 aerial photograph. Top right: Aerial photograph (2005) enhanced by DEM, satellite imagery and lasar telemetry shows increased tree density and bank stabilisation. Centre: panorama at site. Bottom left: Regrowth between 1941 and 2005. Bottom right: Lasar telemetry allows accurate measurement of tree height distribution in 2005. (courtesy A Lau, DSE, see Mansergh et al. 2008b).

climate change and the need for a response to a carbon constrained and water stressed future is a new, perhaps profound, perceptual driver in evaluation of ecosystem services. Roadside eucalypts and the soils beneath them, so typical of the pastoral box woodland of eastern Australia, have recently been examined for their carbon content (Eldrigde & Wilson 2002).

In 2005, Australia reported on Kyoto Protocol under CO_2 emissions categories, although not a signatory to the Treaty at the time. The national (1990) and Victorian (2005) contributions reveal important elements of land-use (Fig. 9). Agriculture is the second largest contributor to national GHG emissions and the third in Victoria (12.5% in 2005) (Australian Government 2007; Garnaut 2008). Land-use change in Victoria went from a source to a sink in the 15-year period but in NSW and Queensland it remained a significant source, reflecting a stronger influence of the colonial paradigm (Table 2). The changing value of ecosystem services, including international reporting requirements, have economic and land-use implications (Fig. 9) These changes in societal valuations may also affect vulnerabilities and risks in adaptation to changing climates and become significant at different scales and different attributes. At the macro-scale reducing CO_2 emissions has crystallised the ecosystem service of bio-sequestration, hence the introduction of requirements to measure bio-sequestration and land-use change (Fig. 9, Australian Government 2010).

RE-CARBONISING THE LANDSCAPE AS A RESPONSE TO CLIMATE CHANGE

De-forestation (landscape de-carbonisation) and burning of fossil fuels have been the main contributors to global atmospheric CO_2 with Australia's past and present land clearing contributing (IPCC 2003; Spittlehouse & Stewart 2003; IPCC 2007; CSIRO 2009, Fig. 9). Australia has an embedded carbon debt from historic land-use. Land clearing saw the NCCMA landscapes radically de-carbonised with consequent environmental legacies (Attiwell & Leeper 1987, Table 1, Fig. 4). Reducing atmospheric emissions CO_2 is the major global response to climate change. Agriculture and land-use change are the only Kyoto categories that can have negative emissions, i.e. extract atmospheric CO_2 through bio-sequestration of carbon with land-use change an important component of Australia's emissions (Fig. 7). From an economic perspective, Garnaut (2008, 2009) viewed large scale revegetation and bio-sequestration as having huge economic potential, with particular potential in the heavily cleared woodland environments of eastern Australia, including the NCCMA with massive revegetation within the Murray-Darling as an option. The Wentworth Group (2009) also see re-carbonising the landscape as important economically but linked this to incorporation of beneficial environmental outcomes (see also Victorian Government 2009b, c). According to these studies a relatively modest carbon price could facilitate massive land-use change through revegetation and plantations and modification of agricultural practice (Garnaut 2008). Advancing laser technologies and remote sensing are being used in environmental and agricultural management and can underpin monitoring and accounting of carbon and other related environmental attributes that can inform investment decisions (e.g. Fig. 7; Stoneham et al. 2009; EnSym 2010). Virtual reality technolgies now available allow visualisations of alternative environmental future (Mansergh et al. 2008b; Fig. 8)

Potential bio-sequestration of carbon and agriculture are both related to Net Primary Productivity (NPP) which is spatially changing under currently observed climate change (Nemani et al. 2003). NPP is reliant on water availability so may decline in some drier areas of Australia and native vegetation restoration also will be slower in drier areas. The drought-fire-flood cycle, an environmental driver of south eastern Australian landscapes, will change, probably accelerating. Some observers suggest that fire would inevitably eliminate any carbon sequestration. However, this does not consider that about 50% of carbon is stored in soils (Lal 2004; Kibblewhite et al. 2009), immune from the immediate effects of fire but not longer-term changes in NPP and vegetation change. Further, examination of the differential resilience of pine plantation, persisting and revegetated native vegetation (both direct seeding and tube stock) five years after major fires around Canberra in 2003, found that the native vegetation had recovered. All parameters of soil health measured also had recovered with exotic weeds temporarily providing soil stabilisation (Freudenberg 2009; Mansergh 2010). In contrast, the pine trees were killed and the soil condition was poorer than under native vegetation. Thus, even over a relative short period, fire may not be detrimental to long-term carbon sequestration in restored woodland and dry forest environments such as the NCCMA.

Related to large-scale revegetation is its effect on water availability and catchment hydrology (Wentworth Group 2008, 2009). Through modelling, clearing of native vegetation has been associated with observed rainfall decline in Western Australia (Pitman & Narisma 2004) and in the Murray-Darling Basin (Mc Alpine et al. 2007). Although these studies are still being debated, recent evidence, from basic atmospheric physics and global forest distribution, indicates that forests may act as a 'pump' bringing water over 2000 km inland, conversely clearing of forest dramatically reduces inland rainfall (Makarieva et al. 2009). It may be argued that this may not apply to arid inland Australia, however, it may be of significance to the large Bassian-Eyrean transition zone (Fig. 1), including the NCCMA.

Although critically important, re-carbonising the landscape should not become a single landscape focus. Rather it should be seen as a key component of a more holistic view of landscapes that produce a wide variety of ecosystem services based on long-term land capability (including resilience), the regional social-ecology and avoiding irreversible loss (Mansergh et al. 2008; Wentworth Group 2008, 2009; Walker et al. 2009,). Landscape revegetation appears to have several key components of adaptation planning: no-regret, reversibility and incorporating safety margins and may be important in increasing the robustness of productive agricultural areas to vulnerabilities of climate change (Hallegate 2009; Walker et al. 2009; Mansergh 2010). Re-vegetation, including the removal of ungulate grazers, appears an obvious option

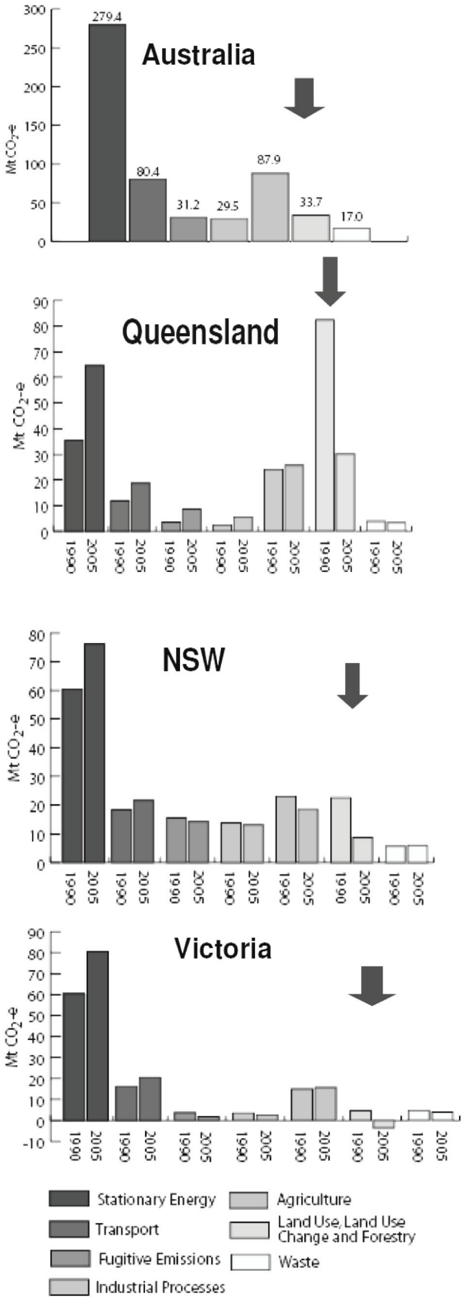


Fig. 9. Australia's report of CO_2e emissions under Kyoto Protocol categories showing national contribution (2005 only) and eastern states (1990 and 2005). Significance of land-use change emissions increases in states north of Victoria which converted this category of CO_2 emission from a source to a sink over the period.

in marginal lands or those that may become marginal under climate change.

Many world leaders have identified that our responses to climate change, including adaptation, involve ethical issues. These issues are broad and multi-faceted, but would appear to include how and where societies curtail and off-set emissions and re-carbonise landscapes.

In the NCCMA, forestry CO_2 sequestration has been estimated to be medium-low (10 t/ha p.a.) in the drier north and medium-high in the south (13 t/ha p.a.) and carbon sequestration, biodiversity and water quality outcomes were optimised in revegetation of riparian landscapes (Jones et al. 2007; Fig. 8). Re-carbonising the NCCMA will likely take different forms in amenity, production and transitional landscapes and will depend not only on the price of carbon, but also upon the quantum and mechanisms for pricing the restoration and maintenance of ecosystem services, e.g. individual initiative, planning, incentives, market mechanisms. These are underpinned by the evolving social licence for land-use and management.

BIOLINKS

'Biolink zone' was first coined in 1992 to encapsulate a new land-use resulting from research on vertebrate fauna of south eastern Australia and their prospective responses to climate change (Bennett et al. 1992; Brereton et al. 1995). The research was among the first attempts to unify the themes of the Earth Summit (1992) - both biodiversity and climate change - into an adaptation response for land-use change at the regional and sub-continental level and is now in general usage (e.g. Victorian Government 2009b). Biolink zones are consistent with calls for restoration of connectivity to overcome past and current issues of ecological connectivity in Australia (Soule et al. 2004). They are equivalent to the bold connectivity zones proposed by Opdam & Wascher (2004) and by Hilty et al. (2006) who in a global review of wildlife corridors, viewed them as the only realistic alternative for resolution of climate change impacts. Land-use change incorporating resilience to climate change is also being considered by US legislature.

Biolink zones are identified parts of the landscape where the functional ecological connectivity for native flora and fauna is enhanced and/or restored to provide space for species (and consequently ecological communities) to self-adapt their distributions and abundances through natural processes that include:

dispersal; re-colonisation; regeneration; plasticity of species genetic response (Mansergh & Cheal 2007; Mansergh 2008). In fragmented landscapes, biolink zones are established between large areas of remaining native vegetation and potential climatic refugia with landscapes that should be managed to support 30% to >50% of high quality native vegetation and habitats (Mansergh et al. 2008a). Persisting public infrastructure networks of the past, such as roadsides (including unused roads), stream-sides and travelling stock routes, provided a skeletal framework. More recently, their establishment has been seen as compatible with carbon sequestration in soils and vegetation and improved landscape health as a more holistic adaptation response to climate change emerges (Mansergh et al. 2008a).

Biolinks as new land-use in the NCCMA

Biolink zones are one of three key policy directions of State Government for land management under future climates and substantial areas occur in the NCCMA which are probably the most significant in the Bassian-Eyrean zone in Victoria (Victorian Government 2009c) (Figs 1, 10). The biotic mix of this transition zone may bestow some natural advantage in adaptation as the species and genetic diversity already present includes those from warm and drier zones (Emison 1983; Mansergh et al. 2008a). The variable historic land use and tenure and configuration of public land (Table 1, NCCMA 2003); environmental depletion and degradation (Figs 1, 4); land use and demographic trajectories (Fig. 6) suggest that different mechanisms informed by ecology will be required in implementing biolinks (Yates et al. 2000; Mansergh et al. 2008a; Newell et al. 2009). Past land-use of cropping and fertiliser use adversely affects the resilience of native vegetation whereas unimproved pasture has much higher resilience (Yates et al. 2000; Dorrough et al. 2006). Indeed, in northern Victorian grazing land even where much depleted of eucalypts (< 3%), 40% of the total area has a high probability of supporting natural regeneration in the absence of grazing but this is reduced to 18% if no action is taken over the next 30 years. Decline and senescence of isolated trees across these landscapes is a sub-continental issue of major significance (Vesk & Mac Nally 2006). Natural regeneration is a prudent and efficient climate change adaptation for biodiversity as natural selection will establish the most suitable genetic stock from existing reservoirs (Mansergh & Cheal 2007; Mansergh et al. 2008a) and soil seed store (Lindsay 2008).

Dryland landscapes in the NCCMA support about 240 000 ha of reservoir vegetation of which approximately 50% is EVC currently endangered or presumed endangered (NCCMA 2003). Across the NCCMA good years for regeneration and the interval between them will vary so a long term plan is essential and should be informed by ecology to exploit these opportunities across the catchment particularly in grazing lands. Pastoral landscapes with as little as 3% persisting eucalypt cover retain capacity for natural regeneration over 40% of the area if grazing pressure was to be reduced but this resilience rapidly declines over the next three decades under business as usual (Dorrough & Moxham 2005; Dorrough et al. 2006).The limited extent of public land and the extensive area of long-term cropping presents challenges for re-establishment of native vegetation. Allowing persisting reservoir vegetation, including isolated trees and roadsides, the space to regenerate and recolonise would be a significant start in the establishment of biolink zones and carbon sequestration (Eldridge & Wilson 2002). Victoria's unique system of colonial crown land river frontages could form the skeletal landscape web of biolink zones, however, the NCCMA is not well endowed with this asset (Cabena 1983; Mansergh & Cheal 2007; PLC 2008).

FUTURE DIRECTIONS

Have the ecosystems in the NCCMA changed forever? The biotic component of these systems will adapt and change to altered environmental and climatic conditions using available populations, genetic capacity and space. How humans attribute meaning to landscape is the critical question for the future of those ecosystems, e.g extent of available space. Historical land and water use of the NCCMA has depleted and degraded that space and functionality. However, the old land-use paradigm has been challenged and corroded: Australia was never *terra nullius*; agriculture has declined in relative economic importance and vast regions are depopulating (Figs 1, 4, 6). From almost every viewpoint, economic, ecological and agricultural 'over shoot' of the old paradigm is recognised (SEAC 1996; Kefford 2002; VCMC 2007; Barr 2008).

Climate change will be relatively more pronounced than in southern Victoria. Potential vulnerabilities and futures for water and agriculture show

Fig. 10. Biolinks and flagship conservation areas in Victorian policy (Victorian Government (2009c) for science see Mansergh et al. (2008a).

a future of change (MDBA 2008; DPI 2009; Fig. 7). Business will not be 'as usual' and where traditional uses intersect with land and water capability thresholds of change can be expected. In terms of ecosystems, large scale new uses are active in the public debate around response to climate change (e.g. Mansergh et al. 2008a; Victorian Government 2009b; Wentworth Group 2009). There are feasible potentials for increasing the resilience of natural ecosystems to cater for the re-valuation of ecosystems services and new sense of place.

The future of the ecosystems within the NCCMA will be based on human actions over land and water use and many will be committed or omitted over the next decade (see Australian Government 2010). Under climate change bleak or optimistic futures could be portrayed (Figs. 3, 5). The above analysis suggests that the environmental future of the NCCMA will be determined by the intersection and manifestation of the following drivers.

Adaptive landscape responses to a projected water stressed, carbon constrained and extreme weather event prone future in south eastern Australia need to:

- Place a premium on reducing atmospheric GHGs (such as CO_2) and increasingly recognise the importance of landscapes, through bio-sequestration (soils, vegetation restoration) as part of the solution. How this is achieved economically is still being debated. Victorian landscapes have been configured to move from a carbon source to carbon sink in the recent past (Australia Government 2007; Garnaut 2008; Wentworth Group 2009; Fig. 9);
- Appropriate landscape planning for extreme weather events (drought, heatwave, fire, frost, flood and hailstorm);
- Recognise the interconnectedness of the range of ecosystem services from landscapes and the sophisticated technologies available to monitor and account for this diversity in the economy (Table 3, Fig. 9, Stoneham et al. 2009; Victorian Government 2009b; Ensym 2010). This will include the diverse services of native vegetation at all scales (e.g. Wentworth Group 2009);
- Avoid mal-adaptation and irreversible loss, particularly to broad-scale ecosystem function;
- Recognise that integrated catchment management which incorporates restoration of large areas of native vegetation may decrease the overall vulnerability of regions and sectors to climate change (e.g. Walker et al. 2009).
- Take a long-term, holistic catchment management approach that incorporates a new social licence for land-use in the inter-generational landscape equity debate.

Large-scale improvement of the depleted ecosystems of the NCCMA in the 21st century will depend on how the current assets, potentials and persisting resilience manifest. As part of a bio-climatic transition zone the biotic complement *may* have more diverse adaptive capacity compared to a homogeneous zone (Fig. 1) and there is an active and recognised indigenous culture that is included in land-uses of public land (Yorta Yorta 2004) in the catchment. Large areas of grazing land may retain a resilience capacity for restoration of native vegetation and about ¼ million ha of reservoir vegetation remains across the catchment. Much of this is within transitional and amenity landscapes that appears to have a diversifying economic and social base (Thwaites et al. 2008) that may be more supportive of land-uses that include enhanced environmental protection and restoration.

The areas within key biolink zones provide a framework for re-dreaming 'post agricultural' land-uses (Fig.10). These zones may facilitate new targeted interest of government programs (e.g. market based), land management NGOs, bio-diverse carbon sequestration and evolution of new compatible land-uses. The NCCMA has a a novel, long-term institutional investor in sustainable landscapes (superannuation fund) and has attracted an innovative research base around climate change response (e.g. Jones et al. 2007; Newell et al. 2009). With the uncertainties recognised, it is time to hasten re-dreaming the landscape to adapt to future changes.

ACKNOWLEDGEMENTS

Many people provided advice and honing of the contribution: John Cooke, Karyn Bosomworth, Alan McPherson, Alex Lau (photographic images), Peter Johnson (LfW data), (all DSE staff), Peter Rochester (Australian Bureau of Statistics), Fiona McKenzie and Elissa Waters (DPCD, figures), Adrian Matins (NCCMA – photograph), Keith McDougall (NSW DCC). Denis Saunders provided assistance with the conclusions. This contribution is dedicated to Bill Borthwick, who made such a far-sighted contribution to Victorian intergenerational landscape equity and Lil and Bess – may *Burramys*, biolinks, Barmah and the Box-Ironbark still be flourishing into their respective futures for you and other global citizens.

REFERENCES

Attiwill, P.M. & Leeper, G.W., 1987. *Forest Soils and Nutrient Cycles*. Melbourne University Press, Carlton.

Australian Bureau of Statistics, 2008a. 5220.0: Australian National Accounts: State Accounts, 2007-08, Australian Bureau of Statistics. Table 1 Gross State Product. & Table 11 Agricultural Income:, all states: Current prices. Commonwealth of Australia, Canberra.

Australian Bureau of Statistics, 2008b. *7124.0-Historical Selected Agriculture Commodities, by State (1861 to Present)*. ABS, Canberra.

Australian Government, 2007. *National Inventory Report 2005 (Revised) The Australian Government Submission to the UN Framework Convention on Climate Change, 2007*. Department of Climate Change, Canberra.

Australian Government, 2010. *Adapting to Climate Change in Australia. An Australian Government Position Paper*. Department of Climate Change, Canberra.

Australian Law Reports (ALR), 2002. Members of the Yorta Yorta Aboriginal Community v Victoria and others (2002). *Australian Law Reports* 194: 538.

Barr, N.F., 2004. The micro-dynamics of change in Australian agriculture: 1976-2001. Australian Bureau of Statistics, Canberra. http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/2055.0

Barr, N.F., 2008. Social landscapes in Victoria. In *Landscape Analysis and Visualisation,* C. Pettit, W. Cartwright, I. Bishop, K. Lowell, D. Pullar & D. Duncan, eds. Springer, Berlin.

Barr, N.F. & Cary, J.W., 1992. *Greening a brown land: An Australian search for sustainable land-use*. McMillan, Melbourne.

Barr, N. & Karunaratne, K., 2002. Victoria's small farms, CLPR Research Report 10. Natural Resources and Environment, Melbourne.

Bayliss-Smith, T.P., 1982. *The ecology of agricultural systems*. Cambridge UP, Cambridge UK.

Bennett, S., Brereton, R. & Mansergh, I., 1992. Enhanced greenhouse and the wildlife of south-eastern Australia. Arthur Rylah Institute Technical Report 127**.**

Blakers, M., Davies, S. & Reilly, P.N., 1984. *The Atlas of Australian Birds*. RAOU and Melbourne University Press, Melbourne.

Brereton, R., Bennett, S. & Mansergh, I., 1995. Enhanced greenhouse climate change and its potential effect on selected fauna of south-eastern Australia: a trend analysis. *Biological Conservation* 72: 339–54.

Bunbury, B., 2009. Taking down the Fences – Encounter 4 October 2009. (ABC Radio, Canberra). http://www.abc.net.au/rn/encounter/stories/2009/2698072.htm.

Cabena, P.B., 1983. *Victorian Water Frontage Reserves: an historical review and resource appreciation*. Department of Crown Lands and Survey, Melbourne.

Cal, W. & Cowan, T., 2008a. Dynamics of late autumn rainfall over south-eastern Australia. *Geophysical Research Letters 35* L09708, doi:10.1029/2008GL033727.

Cal, W. & Cowan, T., 2008b. Evidence of impacts from rising temperature on inflows to the Murray-Darling Basin. *Geophysical Research Letters 35* L07701, doi:10.1029/2008GL033390.

Campbell, A., 1994. *Landcare*. Allen and Unwin, Sydney.

Christie, M.F., 1979. *Aborigines in colonial Victoria: 1835-86.* University of Sydney Press, Sydney.

Clarke, C.J., George, R.J., Bell, R.W. & Hatton, T.J., 2002. Dryland salinity in south-western Australia: its origins, remedies, and future research directions. *Australian Journal of Soil Research* 40: 90-113.

Clode, D., 2006. *As if for a Thousand Years: a History of Victoria's Land Conservation and Environment Conservation Councils.* Victorian Environmental Assessment Council, Melbourne.

Commonwealth of Australia, 1959. *Atlas of Australia Resources*. Department of National Development, Canberra.

Cook, G.D. & Dias, L. 2007. It was no accident: deliberate plant introductions by Australian government agencies during the 20th century. *Australian Journal of Botany* 54: 601–625.

Cooke, J., 2006. European settlement in the Victorian Mallee a brief overview. *Proceedings of the Royal Society of Victoria* 118(2): 295-303.

CSIRO, 2008. *Water availability in the Murray-Darling Basin. A Report to the Australia Government from the CSIRO Murray-Darling Basin Sustainable Yields Project.* CSIRO, Melbourne.

CSIRO, 2009. *An analysis of Greenhouse gas mitigation and carbon bio-sequestration in rural land-use*. CSIRO, Melbourne.

Davidson, B.R., 1965. *The northern myth*. 2nd ed. Melbourne University Press, Melbourne.

Department of Planning and Community Development, 2005. Regional Matters: 2005. DPCD, Melbourne.

Department of Primary Industries, Victoria, 2009. *Climate and Agriculture.* http://www.dpi.vic.gov.au/DPI/nrenfa.nsf/childdocs/-

Dorrough, J. & Moxham, C., 2005. Eucalypt establishment in agricultural landscapes and the implications for landscape scale restoration, *Biological Conservation* 123: 56–66.

Dorrough, J., Moxham, C., Turner, V. & Sutter, G., 2006. Soil phosphorus and tree cover modify the effects of livestock grazing on plant species richness in Australia's grassy woodlands. *Biological Conservation* 130: 394–405.

Eldridge, D.J. & Wilson, B.R., 2002. Carbon storage in soils and vegetation in paired roadside sites in the box woodlands of eastern Australia. *Australian Forestry* 65**(**4): 268-272.

Elkner, C., 2007. Putting Colonial Victoria on the Map: The 1862 Land Act and its 'big map'. *Journal of Public Record Office Victoria.* Number 6. URL://www.prov.vic.gov.au/provenance/no6/ColonialVictoriaPrint.asp

Emison, W.B., 1983. Wildlife. In *Atlas of Victoria,* J.S. Duncan, ed. Victorian Government Printer, Melbourne, pp 57-72.

EnSym, 2010. See www.dse.vic.gov.au

Freudenberg, D., 2009. Landscapes under fire: the resilience of restored communities near Canberra to large-scale disturbance by fire. *Thinking Bush* 9: 10-13. http://lwa.gov.au/products/pn30144

Garnaut, R., 2008. *The Garnaut Climate Change Review.* Cambridge University Press, Melbourne. Also at www.garnautreview.org.au

Garnaut, R., 2009. *Climate change and the Australian agricultural and land use industries*, Melbourne School of Land and the Environment, Dean Lecture Series, The University of Melbourne.

Gunningham, N,, Kagan, R.A. & Thorton, D., 2004. Social licence and environmental protection: why businesses go beyond compliance. In *Law and Social Enquiry,* American Bar Association, pp. 307-341.

Hallegatte, S., 2009. Strategies to adapt to an uncertain climate future . *Global Environmental Change* 19: 240-247.

Hamblin, A., 2009. Policy directions for agricultural land use in Australia and other post-industrial countries. *Land use policy* 26: 1195–1204.

Hennessy, K., Lucas, C., Bathols, J., Nicholls, N., Suppiah, R. & Ricketts, J., 2005. *Climate change impacts on the fire weather in se Australia.* CSIRO and Bureau of Meteorology, Melbourne.

Hilty, J.A., Lidicker, W.Z. & Merenlender, A.M., 2006. *Corridor Ecology: The science and practice of linking landscapes for biodiversity conservation.* Island Press, Washington, pp. 323.

Holling, C.S. & Meffe, G.K., 1995. Command and control and the pathology of natural resource management. *Conservation Biology* 10: 328-337

Hughes, L., 2003. Climate change and Australia: Trends, projections and impacts. *Austral Ecology* 28**:** 423–43.

Intergovernmental Panel on Climate Change (IPCC), 2003. IPCC Third Assessment Report, Working Group II : Adaptation to climate change in the context of sustainable development and equity. *Climate Change 2001: impacts, adaptation and vulnerabilty.* Cambridge University Press, Cambridge.

IPCC, 2007. IPCC Fourth Assessment Report, Working Group II Report: Impacts, Adaptation and Vulnerability. Geneva, Intergovernmental Panel on Climate Change. Cambridge

University Press, Cambridge.

Jacobs, T., 1990. River Regulation. In *The Murray*, N. Mackay & D. Eastburn, eds. Murray Darling Basin Commission, Canberra, pp.39-60.

Jones, R.N., 2010. Water Resources. In *Adapting agriculture to climate change; Preparing Australia agriculture, forestry and fisheries for the future,* C. Stokes and M. Howden, eds. CSIRO, Melbourne, pp. 187-204.

Jones, R.N., Dettman, P., Park, G., Rogers, M. & White, T., 2007. The relationship between adaptation and mitigation in managing climate change risks: a regional response for north central Victoria, Australia, *Mitigation and Adaptation Strategies for Global Change* 12**:** 685–712.

Jones, R. & Durack, P., 2005. *Estimating the impacts of climate change on Victoria's runoff using hydrological sensitivity model.* CSIRO and DSE, Melbourne.

Kefford, B., 2002. Discussion Paper: Victoria's Food and Agriculture Sector on 2020. Paper delivered by Governor of Victoria, John Landy, as part of a discussion on the future of the food and agriculture industry. Department of Natural Resources and Environment, East Melbourne.

Ker, P., 2010. Luck runs dry. *The Age*. 5/4/10, p. 7.

Kibblewhite, M.G., Ritz, K. & Swift, M.J., 2009. Soil health in agricultural systems, *Philosphical Transactions of the Royal Society* 36: 685–701, 533–44.

Kile, G., Greig, P. & Edgar, J., 1980. *Tree decline in rural Victoria.* Institute of Foresters, Melbourne.

Lal, R., 2004. Soil carbon sequestration impacts on global climate change and food security. *Science* 304: 1623–1627.

Land Conservation Council, 1983. *Report on the Murray Valley area*. LCC, Melbourne.

Lawrence, R.E. & Bellette, M.P., 2010. Gold, timber, war and parks: a history ogf the Rushworth Forest in central Victoria. *Proceedings of the Royal Society of Victoria* 122(2): 130-146.

Lindsay, E., 2008. The soil seed bank of woodland remnants: a resource for restoration in weed infested woodlands. *Thinking Bush* 8: 12-13.

McAlpine, C.A., Syktus, J., Deo, R.C., Lawrence, P.J., McGowan, H.A., Watterson, I.G. & Phinn, S.R., 2007. Modeling the impact of historical land cover change on Australia's regional climate. *Geophysical Research Letters* 34: L22711, doi:10.1029/2007GL031524, 6.

McKay, N. & Eastman, D., eds., 1990. *The Murray.* Murray Darling Basin Commission, Canberra.

McKerrnan, M., 2005. *Drought: the red marauder*. Allen and Unwin, Australia.

Makarieva, A.M., Gorshov, V.G. & Bai-Lian, L., 2009. Precipitation on land versus distance from the ocean: evidence for a forest pump of atmospheric moisture. *Ecological Complexity* 6: 302-307.

Mansergh, I., 2008**.** Connecting the dots… adaptation to climate change, biodiversity and land use in se Australia. GEC3 2008-09. McGill University, Montreal. Webcast: http://www.geog.mcgill.ca/gec3/index.php/events/webcasts/#section4

Mansergh, I., 2010. Perceptions of weeds in changing contexts. Land-use change, landscape value change and climate change in se Australia: adaptation to change in the third century of the timeless land. *Plant Protection Quarterly* 25(4): 173-185.

Mansergh, I., Anderson, H. & Amos, N., 2006. Victoria's living natural capital – decline and replenishment: 1880–2050 (Parts 1 and 2). *The Victorian Naturalist* 123: 4–28, 288–323.

Mansergh, I. & Cheal, D., 2007. Protected area planning and management for eastern Australian temperate forests and woodland ecosystems under climate change – a landscape approach. In *Protected areas: buffering against climate change,* M. Taylor & P. Figgis, eds. Proceedings of a WWF and IUCN World Commission on Protected Areas symposium, Canberra. WWF Australia, Sydney.

Mansergh, I., Cheal, D. & Fitzsimons, J.A., 2008a. Future landscapes in south-eastern Australia: the role of protected areas and biolinks in adaptation to climate change. *Biodiversity* 9:59-70.

Mansergh, I., Lau, A. & Anderson, R., 2008b. Geographic landscape visualisation in planning adaptation to climate change in Victoria, Australia, In *Landscape Analysis and Visualisation,* C. Pettit, W. William Cartwright, I. Bishop, K. Lowell, D. Pullar & D. Duncan, eds. Springer, Berlin, pp. 59–70. http://www.springerlink.com/content/978-3-540-69167-

9?sortorder=asc&p_o=20 4.

Maron, M. & Fitzsimmons, J.A., 2007. Agricultural intensification and loss of matrix habitat over 23 years in the west Wimera, south-eastern Australia. *Biological Conservation* 134: 587-593.

Mitchell, T.L., 1838. Three expeditions into the interior of eastern Australia with descriptions of the recently explored region of Australia Felix, and of the present colony of New South Wales. 2 vols, T. & W. Bone, Melbourne.

Murray– Darling Basin Authority, 2008. Annual report 2007-08 (MBA, Canberra). www.mdbc.gov.au/subs/annual_reports/AR_2007-08/objectives2_s2_1.htm.

National Land and Water Audit, 2001a. *Australian Agriculture Assessment – 2001* vol. 2. National Land and Water Resources Audit, Canberra.

National Land and Water Audit, 2001b. *Australia's native vegetation.* National Land and Water Resources Audit: Canberra. http://lwa.gov.au/files/products/national-land-and-water-resources-audit/pr020284/pr020284_0.pdf.

National Land and Water Audit, 2001c. *Landscape Health in Australia*. National Land and Water Resources Audit, Canberra.

Nemani, R., Keeling, C., Hashimoto, H., Jolly, W., Piper, S., Tucker, C., Myneni, R. & Running, S., 2003. Climate-driven increases in global terrestrial net primary production from 1982 to 1999, *Science* 300: 1560–1563.

Newell, G., White, M. & Griffioen, P., 2009. Ecosystem Risk Project Potential impacts of a changing climate on selected terrestrial ecosystems of Northern Victoria. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg, Victoria.

NCCMA, 2003. North Central Catchment Strategy – 2003-2007. North Central Catchment Management Authority, Bendigo.

NECMA, 2003. North-east Catchment Strategy – 2003-2007. North East Catchment Management Authority, Wangaratta.

Opdam, P. & Wascher, P., 2004. Climate change meets habitat fragmentation: linking landscape and biogeographical scale levels in research and conservation. *Biological Conservation* 117: 285–297.

ORL, 2002. Our Rural Landscape – Farming for a Sustainable Future. A Discussion Paper. Department of Natural Resources and Environment, East Melbourne.

Pitman, A.J. & Narisma, G.T., 2004. Impact of land cover change on the climate of southwest Western Australia. *Journal of Geophysical Research* 109: D18109,doi:10.1029/2003JD004347.

Public Land Consultancy, 2008. A review of the management of riparian land; report to the Department of Sustainability and Environment, Melbourne.

Queensland Government, 1998. A guide to land tenure in Queensland. Brisbane.

Queensland Government, 2009. *Enhancing biodiversity hotspots along western Queeensland stock routes.* http://www.derm.qld.gov.au/land/stockroutes/.

Raff, M., 1998. Environmental obligation of the Western Liberal property concept. *Melbourne University Law Review* 22: 657-692.

Raff, M., 2004. Private property and environmental responsibility – a comparative study of German Real Property Law. Kluwer International, The Hague.

Reynolds, H., 1994. History. In *Australian Civilisation,* R. Nile, ed. Oxford University Press, Melbourne, pp. 24-40.

Reynolds, H., 1998. *This Whispering in Our Hearts.* Allen & Unwin, Crowsnest, NSW.

Robin, L., 1998. *Defending the Little Desert: the rise of ecological consciousness in Australia*. Melbourne University Press, Melbourne.

Root, T.L., Price, J.T., Hall, K.R., Schneider, S.H., Rosenzweig, C. & Pounds, J.A., 2003. Fingerprints of global warming on wild animals and plants. *Nature* 421: 57–59.

Russell, P., 2006. Recognising Aboriginal title: the Mabo case and indigenous resistance to English-settler colonialism. UNSW press, Sydney .

Schama, S., 1998. *Landscape and memory*. Vintage Publications, New York.

Smith, D.F., 2002. *Natural gain: in the grazing lands of southern Australia.* University of New South Wales, Sydney.

Smith, J.L., Schneider, S.H., Oppenheimer, M., Yohe, G.W., Hare, W., Manstrandrea, M.D., Patwardhan, A., Burton, I., Corfee-Morlot, J., Magadza, C.H.D., Fussel, H., Pittock, A.B., Rahman, A., Suarez, A. & van Ypersele, J.

2009. Assessing dangerous climate change through an update of International Panel on Climate Change (IPCC) ‘reasons for concern’. *PNAS* **106** (11): 4133–7. http://www.pnas.org/content/106/11/4133.abstract.

Soule, M.E., Mackey, B.G., Recher, H.F., Williams, J.E., Woinarski, J.C.Z., Driscoll, D., Dennison, W.G. & Jones, M.E., 2004. The role of connectivity in Australian conservation. *Pacific Conservation Biology* 10: 266-79.

South Eastern Australian Climate Initiative (SEACI), 2008. *Characterisation and Attribution of Current Climate* http://www2.mdbc.gov.au/subs/seaci/docs/factsheets/SEACI-factsheet_Theme1_Summary.pdf.

Spittlehouse, D.L. & Stewart, B.C., 2003. Adaptation of forests and people to climate change. *Journal of Ecosystems & Management*. 4 (1). Available at http://www.forrex.org/jem/2003/vol4/no1/art1.pdf.

State of the Environment Advisory Council (SEAC), 1996. *State of the Environment: Australia.* CSIRO, Melbourne.

Steffen, W., 2009. *Climate Change 2009. Faster change and more serious risks.* Australian Government Department of Climate Change, Canberra. Available at http://www.anu.edu.au/climatechange/wp-content/uploads/2009/07/climate-change-faster-change-and-more-serious-risks-final.pdf.

Steffen, W., Burbidge, A., Hughes, L., Kitching, K., Lindenmayer, D., Musgrave, W., Stafford Smith, M. & Werner, P., 2009. *Australia’s Biodiversity and climate change.* CSIRO, Melbourne.

Stern, N., 2007. *The Stern Review: the economics of climate change.* Cambridge University Press, UK.

Stoneham, G., Eigenraam, M. & Bain, D., 2009. Creating environmental accounts for diffuse-source environmental problems. Paper prepared for the London Group on Environmental Accounting Workshop, May, 2009, Canberra, Australia.

Stokes, C. & Howden, M. eds., 2010. *Adapting agriculture to climate change; Preparing Australia agriculture, forestry and fisheries for the future*. CSIRO, Melbourne.

Thomas, C., Cameron, A., Green, R., Bakkenes, M., Beaumont, L., Collingham, Y., Erasmus, B., de Siqueira, M., Gralnger, A., Hannah, L., Hughes, L., Huntley, B., van Jaasvel, A., Midgley, G., Miles, L., Ortega-Huerta, M., Peterson, A., Phillips, O. & Williams, S., 2004. Extinction risk from climate change. *Nature* 427:145–148.

Thorndyke, C.W., 1931. The climate of North America according to a new classification. *Geographical Review* 21: 633-655.

Thwaites, R., Curtis, N., Mazur, N., & Race, D., 2008. Understanding rural landholder response to climate change. Report No. 48. Institute for Land, Water and Society Charles Sturt University, Albury-Wodonga.

Umina, P.A., Weeks, A.R., Kearney, M., McKechnie, S.W. & Hoffmann, A.A., 2005. A rapid shift in a classic clinal pattern in *Drosophila* reflecting climate change. *Science* 308: 691–3.

Vesk, P.A. & Mac Nally, R., 2006. The clock is ticking. Revegetation and habitat for birds and arboreal mammals in rural landscapes of southern Australia. *Agriculture, Economics and Environment* 112: 356–366.

VicSuper, 2008. Future Farming Landscapes. http://www.nwf.org.au/lectures/Forster%20Wettenhall.pd and, http://www.vicsuper.com.au/www/html/2280-future-farming-landscapes.asp?intSiteID=1.

VCMC, 2002. *The health of our catchments: a Victorian report card 2002*. Victorian Catchment Management Council, Melbourne.

VCMC, 2007. *Catchment condition report: 2007.* VCMC, Melbourne.

Victorian Environmental Assessment Council (VEAC), 2006. *River Red Gum Forests investigation.* VEAC, Melbourne.

Victorian Government, 1997. *Victoria’s Biodiversity Strategy*. Department of Natural Resources and Environment, Melbourne.

Victorian Government, 2008a. *Climate Change in Victoria: 2008 Summary.* Melbourne.

Victorian Government, 2008b. *Land and biodiversity in times of climate change: Green Paper* Melbourne. Available at: http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/2270213701D9AE6DCA2574350015F8F9554FC9C681B6CAB6CA2572C600036DB1#gp.

Victorian Government, 2009a. *Climate change in the North Central Region*. Melbourne. http://www.climatechange.vic.gov.au/CA256F310024B628/0/60371A89A1AB810ACA25747400102F55/$File/North+Central_WEB.pdf

Victorian Government, 2009b. *Securing our Natural Future:* a *White Paper for Land and Biodiversity in times of climate change.* Department of Sustainability and Environment, Melbourne.

Victorian Government, 2009c. *Final Northern Regional sustainable water strategy*. Melbourne. http://www.ourwater.vic.gov.au/programs/sws/northern/final.

Wadham, S., Wilson, R.K. & Wood, J., 1957. *Land Utilisation in Australia*. 3rd ed. Melbourne University Press, Carlton, Victoria.

Walker, B., Abel, N., Anderies, J.M. & Ryan, P., 2009. Resilience, adaptability and transformability in the Goulburn–Broken catchment, Australia. *Ecology and Society* 14 (1). Available at http://www.ecologyandsociety.org/vol14/iss1/art12/.

Waugh, A., 2000. *Historical railway maps of Victoria.* Author, West Macleod. http://www.vrhistory.com/VRMaps/index.htm.

Weaver, J.C., 2003. *The Great Land Rush and the Making of the Modern World, 1650-1900*. McGill University Press, Montreal.

Wentworth Group, 2008. *Accounting for Nature: A model for building the national environmental accounts of Australia* Canberra.

Wentworth Group, 2009. *Optimising carbon in the Australian landscape.* Sydney.

Williams, C.C., 2004. *Old land new landscapes: a story of farmers, conservation and the Landcare movement.* Melbourne University Press, Carlton, Victoria.

Yates, C.J., Norton, D.A. & Hobbs, R.J., 2000. Grazing effects on plant cover, soil and microclimate in fragmented woodlands in south-western Australia: implications for restoration. *Austral Ecology* 25: 36–47.

Yen, A.L., Hinkley, S., Lillywhite, P., Wainer, J. & Walker, K., 2002. A preliminary survey of the aboreal invertebrate fauna of two River Red Gum trees (*Eucalyptus camaldulensis*) near the Murray River, Victoria. *The Victorian Naturalist* 119: 180-185.

Yorta Yorta, 2004. Yorta Yorta Co-operative Management Agreement with the State Government of Victoria.