Understanding Alternative Landscape Design Options for Planning more Sustainable Regions (LWA UNE 54)

A REVIEW of the LITERATURE*

***as at February 2008, compiled by David Brunckhorst, Phil Morley, Karl Bock and Scott Bassett**

1.0 General Introduction

Landscapes, across the globe have faced pressures of change from human activity over millennia. Agricultural development and land use has contributed to major alteration of small islands to large regions in most parts of the world (Power 1996; Diamond 2005). Landscape change due to agricultural land uses in particular, has produced environmental externalities with expansive spatial reach (e.g. salinity and loss of production in the Murray-Darling Basin). Since the Industrial revolution, the rate of landscape change has increased due to both agricultural development and urban development, with concurrent demands for provision of water and infrastructure for human settlements (Platt 1996; Dovers 2000; Gray and Lawrence 2001). Urban development, intensified land use, consumption and waste management issues are increasing change pressures on landscapes and their environmental services.

Rapid and large-scale regional change is especially prevalent along the coastal zones of continents where climates tend to be milder and attract greater population (Woodward 2000). In Australia, more than 70 per cent of the population lives along a relatively narrow coastal fringe and most of this is on the eastern and south-eastern coastline (ASoEC 2001). Consequently, social, economic and environmental pressures of change are now producing large-scale alteration of ecological functions, loss of productive agricultural land on coastal floodplains and progressively more limited space available for coexistence of ecosystem functions and new human settlements. Communities must decide how much landscape change, loss of amenity and losses of ecosystems and ecological services such as water quality and quantity is acceptable for the future that they have in mind for their children (e.g. Brunckhorst and Bridgewater 1995; Brunckhorst 2002; Stewart et al. 2004).

In recent decades, the rate of change along Australia's east coast has been accelerating (ASoEC 2001; Graymore et al. 2002). The recently coined 'sea change' phenomenon refers to shifts of population from city and metropolitan suburbia to smaller coastal settlements for lifestyle benefits and opportunities (Murphy 2002; Burnley and Murphy 2004; Gurran et al. 2005a or 2005b). There are enormous economic pressures on local governments and policy makers for further planning for land release and housing development. Part of the dilemma for future sustainability of coastal regions is not only population growth, but the expectations for quality of life that lead to high rates of consumption, waste production and amenity loss. At the same time, local and state governments and professional planners and policy makers have begun to struggle with the critical need for more integrated planning for local to regional scale, ecological sustainability (Westcott 2004). These questions include, not only how to plan for sustainability through integrating landscape scale ecosystem health and function, but how to go about re-designing regions to improve prospects for ecological and social sustainability (Young 1995; Johnson and Hill 2001; Terkenli 2005).

What directions, decisions and spatial configurations are now available for future sustainability? Studying the distribution patterns of human communities, local economies, policy and planning applications, together with knowledge of the distribution patterns of ecological systems and processes, and the products of social-ecological systems interactions, are critically important to trying to understand societies' progressively limited options and directions towards sustainability (Slocombe 1983; Brunckhorst 2000, 2005; Field et al. 2003; Batabyal and Nijkamp 2004). Over the past decade, advances in the integration of remote imagery and spatial analysis technologies have started to provide regional landscape approaches that are practical and economic for monitoring environmental change and providing relevant knowledge for improved policy and planning (e.g. Graham et al. 1991; Mouat et al. 1993; O'Neill et al. 1997; Jones et al. 2001; Kepner and Edmonds 2002; Turner 2003). Alternative landscape futures assessment provides a framework for understanding and visualising future landscapes leading to more effective and well informed planning and decision-making for governments and communities at local to regional scales (e.g. Steinitz et al. 2003;

Dunlop et al. 2002).

Landscapes are in one sense a human construct because of the way we view the environment in which we live. As such, landscapes provide a valuable framing for guiding and assessing our expectations for how we wish our environment to appear now and in the future (Cantrill and Senechah 2001; Lindley and McEvoy 2002; Field et al. 2003; Stewart et al. 2004; Dortmans 2005). Landscapes are also defined by the function of interacting ecological processes that produce patterns that are observable in different ways (Forman and Godron 1986; Hansen and DiCastri 1992; Forman, 1995; Turner et al. 2001). Human activities including social and policy choices have shaped past landscapes and are shaping the future of landscapes at local and regional scales (Norton and Ulanowicz 1992; Power 1996). Indeed, the interaction of social and ecological systems, produces new properties, which might include for example, the creation of local economies (through eco-tourism or servicing agriculture) and towns, but also may produce decreasing water quality and land degradation or loss of amenity (Johnson et al. 1999; Brunckhorst 2000, 2005).

Landscape composition and patterns affect key ecological processes that govern the movement and flow of energy, nutrients, water and biota overtime and, which operate at many scales (Forman and Godron 1986; O'Neill et al. 1997). Hierarchy theory provides for the understanding and integrating of multiple scales of information and interactions of ecological systems and human systems (O'Neill et al. 1986). In simple terms, it considers landscapes and many social systems to be organised into subsidiary patterns within a hierarchy of spatial, temporal and operational scales.

Change is normal for all systems, but the type, extent and rate of change can vary and subsequently over-stress systems (Herce et al. 2003; Gunderson and Holling 2001; Brunckhorst 2005). Human and natural change or disturbance occurs across a range of spatial and temporal scales, which serve to either maintain landscape patterns and ecological processes or initiate transitions into other conditions and patterns (Reeve 1997; Rollings and Brunckhorst 1999; Gunderson et al. 1995; Gunderson and Holling 2001; Brunckhorst 2002). For example cumulative effects of a local decline in biodiversity and, or composition of the physical environment (e.g. erosion) can lead to

broader scale impacts on ecological services and reduce environmental resilience to disturbance, which in turn causes changes in spatial patterns and landscape composition and processes (Hansen and DiCastri 1992; ONeill et al. 1997; Johnson et al. 1999; Turner et al. 2001). Hence a regional landscape approach provides for the integration of many interacting social and ecological elements for the study of spatial patterns (Slocombe 1983; Forman 1995; Brunckhorst 2000), and the influence of these patterns on the sustainability of regional development and land use (Brand and de Bruijn 1999; Irwin and Geoghegan 2001; von Malmborg 2004; Batabyal and Nijkamp 2004).

A regional landscape framework therefore provides the context to:

1. investigate changes in composition pattern, distribution and process function;
2. understand and analyse cumulative sources of land use change over time;
3. compare conditions within a region or across mixed landscapes; and,
4. consider spatial arrangements to enhance social-ecological systems interactions for sustainability in the design of future change in a particular regional context.

The fourth step in this process leads to possibilities for the design or redesign of landscape elements for future sustainability. A variety of regional planning designs might exist for more or less sustainable futures; some possible, others probable, and a few practical and plausible. This project adapts such an approach to trial, for the first time in Australia, an alternative landscape futures design and analysis study on the rapidly changing coastal region of the Northern Rivers of NSW.

2.0 Urban and regional planning and growth in coast areas

2.1 Urban and regional planning systems in developed countries

A key function of urban and regional planning systems is to resolve the inherent conflicts which arise over the qualities of places and regions. This can be achieved by promoting the proper use of land by using spatial planning (land use planning) systems (Hall 1982; Farthing 1997; Vigar et al. 2000). Spatial planning systems are a form of public policy

that focuses on the spatial organisation of places and regions, and the allocation of rights to use and develop land (Hall 1982; Vigar et al. 2000). Spatial planning sorts out potential conflicts over the use and development of land and the spatial arrangement of activities which arise because qualities of land, of spaces and places are not evenly spread around. Complications and conflict arise in deciding the allocation of priority attributes to socially valued qualities (Campbell and Fainstein 1996). Development of a parcel of land has multiple impacts on neighbouring people and places. The more society is urbanised and the more people have to live within already developed areas, the more complex the conflicts over access to space and development opportunity are likely to be (Campbell and Fainstein 1996; Vigar et al. 2000). As spatial planning is concerned with the way in which land is allocated to certain land uses and how such uses interact with neighbouring land uses it is able to achieve some purpose of environmental management, social welfare, cultural conservation or economic development (Fabos 1985; Guttenberg 1993). Therefore, the primary focus of spatial planning is to match land types and land uses in the most rational way possible, so as to maximise sustainable production and satisfy the diverse needs of society while at the same time conserving fragile ecosystems (Fabos 1985; Farthing 1997; Conacher and Conacher 2000).

There are two broad spatial planning approaches that are evident within many developed countries for dealing with land use conflicts. One approach is to focus on the regulation of development impacts (Hall 1982; Ramsey and Rowe 1995; Dollery and Marshall 1997). This involves the preparation of regulations that aim to minimise conflict between neighbours, that is, between those who seek to develop and those who will be affected by the development. The second approach involves promoting strategic public interests (Hall 1982; Ramsey and Rowe 1995; Dollery and Marshall 1997). This approach can have multiple objectives; including, to promote particular qualities of specific places (e.g. amenity), to achieve some quality of life purpose, to promote economic objectives or, to maintain particular environmental qualities and services. In most planning systems these two approaches are related. For instance, strategic public interest purposes define the objectives which act as criteria for detailed regulation. This

regulation then becomes both a sorting out of conflicts among neighbours, as well as, a mechanism to secure the wider long-term public interests in the use and development of land.

Any planning and policy system aimed at promoting and regulating development needs to have a strong local focus (Pearson 1994; Gleeson and Low 2000). Local responsibility is a feature of most planning systems. But even minor developments may raise issues of concern to stakeholders elsewhere or questions of policy at regional, state, national or international levels (Dollery and Marshall 1997). The distribution of formal responsibilities within planning systems provides structure to planning practices, specifying in legal terms who has the power to use the different planning tools, to change and to oversee others in their use (Cullingworth 1988; Ramsey and Rowe 1995). The patterns of responsibilities usually involve more than one level of government, and sometimes other public and private agencies. There are very significant variations between countries in the pattern of distribution of responsibilities. For instance, in Australia and the United States the national government merely provides enabling legislation or adjudication, allowing local or regional level governments to develop their own approaches (Vigar et al. 2000). On the other hand, the British national government can keep tight control over the development of the planning system and its practices (Vigar et al. 2000). Most European planning systems achieve a balance between the British system and that of the United States and Australia (Vigar et al. 2000).

Difficulties arise when trying to describe a planning system, partly because all systems are deeply embedded in nationally specific constitutional and legal arrangements and in the historical politics of the power relations over land and property. Although approaches of planning systems may be similar, the aims and objectives of planning policies may differ significantly between countries. For instance, in Australia the emphasis in the late 1940s and 1950s was focusing attention on post-war development, planning for full employment and the general welfare of the Australian people. This involved planning for the development of resources, the growth of population, decentralisation of population and economic activity, and the correspondence between water supplies and population concentration (Beer 2000). During the mid 1970s there

was an emphasis on selective decentralisation which encouraged population growth of selected regional towns and fringe urban centres (Beer et al. 2003). There was also an emphasis on housing, public transport, overcrowding in the capital city centres, conservation, the environment and land use. Various decentralisation policies continued till the mid 1980s. Throughout the 1980s policies pursued economic restructuring via industry policies and addressed social disadvantage and spatial population imbalances (Rainnie and Grobbelaar 2005). During the 1990s the focus moved to a more integrated approach that aimed to deliver better regional services, strengthen regional economic development with local governments having a more inclusive role, strengthening social opportunities and sustaining natural resources and the environment (Rainnie and Grobbelaar 2005). Whereas, in Britain the emphasis in the 1940s and 1950s was on providing better town centres and improving the provision and quality of housing and infrastructure. During the 1960s the emphasis turned to accommodating growth within the constraints of landscape protection policies and in the 1970s there was more concern with urban regeneration and countryside management. The major changes that occurred during the 1980s and 1990s were the rise of a more ecological approach to environmental quality and the prioritisation of economic consideration (Vigar et al. 2000).

Although the emphasis of planning policies vary between countries, what has become apparent towards the end of the twentieth century in Australia and other developed countries across Europe and North America has been the rediscovery of the significance of locality, place and territory as foci for policy attention (Vigar et al. 2000; Wallis 2002). This has resulted from a developing awareness that quality of life is intertwined with qualities of place. The rediscovery of place and territory is linked to the evolution of the global economy, the diminished role of the welfare state as a model for service delivery and the focus towards the concept of environmental sustainability (Vigar et al. 2000; Wallis 2002). As such, the evolution of the global economy has seen the role of the nation state (federal or state government) as a focus of business attention and economic policy development, replaced with an emphasis on the quality of locales as sites for economic activity. Secondly, the diminishing role of the welfare state as a

model for service delivery reduces the significance of nationally organised public services, focusing attention on individual and localised forms of provision. Thirdly, the concept of environmental sustainability (that was initially articulated in the Brundtland Report 1987) embraced the view that development must be seen as sustainable if it meets the needs of the present without compromising the ability of future generations to meet their own needs.

Consequently, within developed nations the policy spotlight turns to regional and local governance, and their capacity to mould diverse governance elements, scattered among state, economy and civil institutions, into strategic directions which can foster economic health, environmental quality and quality of life, in sustainable ways, in places and regions (Vigar et al. 2000; Wallis 2002). The shift to regional and local governance is supported by Haughton who suggests that regional planning is a 'process that is fundamental to future place-making activities, providing a forum for deciding what types of future settlement patterns society wishes to see' (Haughton and Counsell 2004, p135). Katz (2000) also identifies the increasing importance of regional and local level planning as people are increasingly living their lives regionally. For instance, Katz states that people are more likely, than in the past, to live in one community, work in another, and also shop in another region where the price or selection is right. However, Katz also states that people identify themselves locally; focusing on how different they are from their near neighbours.

The greater focus on regional and local governance can be described by what is known as the 'new regionalism'. Wheeler (2002) notes that observers in North America and the United Kingdom have associated the emergence of a 'new regionalism' with a dramatic resurgence of interest in regional planning as matters such as growth management, environmental protection, equity, and the quality of life are now seen as most appropriately dealt with at the level of regional strategies. Wheeler argues that in contrast to much regionalism during the second half of the 20th century, 'new regionalism':

- focuses on specific territories and spatial planning;

- tries to address problems created by the growth and fragmentation of postmodern metropolitan regions;
- takes a more holistic approach to planning that often integrates planning specialities such as transportation and land use as well as environmental, equity and economic goals;
- emphasises physical planning, urban design, and a sense of place as well as social and economic planning; and
- often attempts a normative or activist stance.

Wallis (2002) identifies the motivating forces behind the renewed interest in regionalism as emerging from a number of sources. Firstly, globalisation of the economy has lead to reduced economic competitiveness on a country-by-country basis, and increased competitiveness on a region-by-region basis. Secondly, meeting the challenge of achieving sustainable development requires the balance of economic growth with environmental preservation and social equity. Part of the solution requires acting regionally, as ecological processes such as water catchments and commuter patterns are regional issues. Thirdly, in the United States and several other countries, more of the policy making and service delivery functions mandated by federal and state governments are being directed to the local level. These include issues such as transportation, air and water quality planning, and an increasing amount of social services planning are required to be carried out on a regional basis.

Wallis describes how the new regionalism contrasts to the old regionalism[1]. Wallis identifies six contrasting characteristics that help to define and distinguish new regionalism from the old regionalism. The following summarises these contrasting characteristics as described by Wallis (2002, p 2):

- *governance versus government.* The old regionalism was basically about government, specifically about how to insert a new layer in the hierarchy of

[1] Old regionalism generally refers to a varied body of theory and practice spanning the period from the 1880s to the 1980s.

state-local relations. Whereas, the new regionalism is about governance, that is, establishing vision and goals, and setting policy to achieve them. This requires involvement of private, non-profit and public interests. Emphasis on governance recognises that ensuring the future quality of life and competitiveness of a region is a shared responsibility of all sectors.

- *process versus structure*. The old regionalism dealt with structural alternatives such as city/country consolidations, creation of urban counties, the formulation of special purpose and multi-purpose authorities. With new regionalism its main focus is on processes such as visioning, strategic planning, resolving conflict and building consensus.

- *open versus closed*. The old regionalism was concerned with defining boundaries and jurisdictions. Hence, it wanted to clearly identify the region in terms of issues such as boundaries of growth, service delivery, job markets and pollution sheds. As such, the region was closed, with you being in it or outside of it. The new regionalism accepts that boundaries are open, fuzzy or elastic. What defines the extent of the region varies with the issue being addressed or the characteristic being considered.

- *collaboration versus coordination*. The old regionalism focused on coordination (typically hierarchical) including land use, infrastructure development and services. In contrast, the new regionalism focuses on collaboration and voluntary agreement among equals.

- *trust versus accountability*. The old regionalism's emphasis on coordination was often accompanied by demand for accountability. The new regionalism is more inclined to talk about trust as a binding element in relations among regional interests. Part of the discussion about trust relates to the idea of employing regional social capital and civic infrastructure.

- *empowerment versus power*. The old regionalism was perceived as drawing its power from units of government above or below it. The new regionalism gains power by empowering. This may involve the empowerment of neighbourhoods

and communities, with the objective of getting them constructively engaged in regional decision making. Empowerment also consists of engaging non-profits and for-profits in governance decisions that were once treated as the domain of the public sector alone.

Evidence of the new regionalism can be found in the United States (see, Soja 2000; Wallis 2002; Wheeler 2002) and Europe (see, Tomaney and Ward 2000; Wheeler 2002; Morgan 2004). Australia is also experiencing a shift towards the new regionalism (see, ALGA 2001; Beer et al. 2003; Rainnie and Grobbelaar 2005) with its approaches to regional planning displaying many of the characteristics of the new regionalism paradigm.

2.2 Urban and regional planning in Australia

Australia has a federal system of government, having been formed by the federation of six self-governing British colonies in 1901. Most of the tax revenue is collected at the federal level, of which a substantial part is distributed to the States and Territories as per capita general revenue payments. Although this gives the national government considerable power over the States, the national government has limited direct powers in the development of regions, non-capital cities or other geographically-defined units (Beer et al. 1994; Walmsley and Sorenson 1993). However, the national government may influence the development of regions and non-metropolitan cities and towns indirectly through urban development and regional development policies and its more general economic policies that shape economic growth and quality of life in Australia. State governments are central to the development of non-metropolitan areas as they are a key provider of services and infrastructure, play an important part in local economic development initiatives and establish the framework for planning and the regulation of urban development. The States are responsible for the provision of a wide range of infrastructure and services including social services, education, construction of major roads, policing and health services. Local governments are a creation of State governments. They emerged in non-metropolitan areas in the 1850s to enable local communities to levy rates to build local roads and in some areas to tackle heath and housing issues (Beer, et al. 1994). Local government in Australia are financially weak and

responsible for a narrower range of functions than in many European countries (Worthington and Dollery 2000).

Australia's government has traditionally been highly centralised with a strongly developed welfare state, organised into policy sectors for the delivery of specific functions (Walmsley and Sorenson 1993). As such, state agencies were providers of services, while citizens and firms were receivers of benefits. Since the 1970s this structure has been remoulded through neoliberal strategies of deregulation and privatisation (Maude 2004). As a consequence, planning at the regional and local level has become more important for encouraging and managing regional growth of non-metropolitan areas of Australia.

Traditionally local government planning has been responsible for the role of town planning. Town planning aims to ensure orderly land use and the provision of infrastructure and services (SRMCS 1993; Alexandra 1994; Dollery and Marshall 1997). This is achieved at the local government level by means of town planning schemes and other regulations. Town planning schemes are statutory planning instruments which provide a comprehensive basis for both 'forward planning' and 'development control'. The main 'forward planning' components are strategic plans and development control plans; and the main 'development control' components are zoning maps and scheme provisions which allocate land use rights in each zone; and subdivision controls which determine allotment sizes and related matters (Pearson 1994; Ramsey and Rowe 1995; Dollery and Marshall 1997).

In recent years, local government authorities have become responsible for implementing various laws for governing environmental matters. Of particular importance is the Rio Declaration known as Agenda 21 that was adopted by Australia in 1992. Agenda 21, *Climate Change and Biodiversity, and Declaration of Forest Principles*, is an Action Plan that directs countries to develop policies which include national, state and local ecologically sustainable development policies and State of the Environment Reports. Agenda 21 covers a wide range of issues, including: protection of fresh water resources; land degradation and desertification, and conservation of biological diversity (UNCED 1992).

Local governments have also become more involved in social planning and local economic development in recent decades. As such, local governments have increasingly been involved in social and community planning, which is concerned with investigating and responding to the needs and aspirations of people and communities with the aim of developing better communities and quality of life. For instance, in New South Wales local governments are required to develop Social Plans every five years to examine social issues within their local government area, examining issues such as equity and fairness in the distribution of resources, employment opportunities, and accessibility of resources and social services (NSW Government 2000). In terms of encouraging local economic development, local governments have needed to develop economic development policies and strategies to boost local economies and improve employment opportunities. Increasingly, local governments are working with neighbouring local governments and regional agencies to improve local and regional economies. Evidence of this can be found in the increasing number of Voluntary Regional Organisations of Councils (VROCs) established during the1980s and the establishment of Regional Development Organisations (RDOs) during the mid 1990s (Dollery and Marshall 1997).

As many environmental, social and economic issues extend beyond individual local government boundaries, local governments have started to deal with these issues using a collaborative approach with neighbouring local governments, regional agencies and private sector interest groups to deal with these issues appropriately. This collaborative approach is a characteristic of the new regionalism paradigm. According to the Australian Local Government Association (ALGA) State of the Regions Report (2001) there are five elements to the new regionalism development paradigm evident in Australia:

- a transition to a knowledge economy where this is not already based on high technology industries and in which all regions, industries, organisations, households and individuals must participate;
- clusters, where successful regions form or strengthen clusters or dense networks of firms, research or educational institutions and regional agencies to produce an innovative milieu;

- global firms embedded in regional networks where they gain access to the tacit knowledge found therein;
- the state at the local and national level playing an important role in promoting business and community networks as well as developing new visions;
- a need to address the disparities between core and peripheral regions through pro-active strategies that enable regions to attain their knowledge based potential.

In all Australian States and Territories there is a myriad of institutions and agencies undertaking various regional planning activities (Beer and Maude 1997). Regional institutions and agencies are often narrowly focused and concerned with either: regional development; provision of regionally significant infrastructure (e.g. highways, water supply, health services); biodiversity conservation; or natural resource management. Such institutions and agencies are often supported by local government, a community group, a federal government department or operate as a State agency. Examples include business enterprise centres, a regional development board, an Area Consultative Committee or a Catchment Management Group.

Australia's approach to regional planning is a complex and at times confusing field of endeavour. This can be attributed to Australia's federal system of government. Traditionally, the federal government has distanced itself from regional planning and development, stating that it is the responsibility of each of the States (Maude 2004). Although the federal government does not have a direct role in regional planning it can influence regional development by providing funding for programs such as the *Sustainable Regions Programme*. At the State level, there is no single approach to regional planning amongst the States. Thus, each State pursues regional planning in its own unique fashion. What is common amongst the States is the many institutions and agencies undertaking various regional planning activities that are narrowly focused. Consequently, any one region may be covered by multiple agencies (federal or state), all of which are working at a variety of scales and in response to the priorities of different

stakeholders. This inevitably leads to the fragmentation of regional planning approaches in Australia.

Over the last decade regional development has attracted renewed policy interest in Australia. As such, regional development has come to represent something new and quite different when compared with policy debates and programs of two decades ago (Beer 2000). Over the last decade there has been a proliferation of regional and local economic development programs and policies that have been attributed to a shift from Fordist approaches to post-Fordist approaches that place a greater emphasis on the culture of entrepreneurialism and engagement with global economies (Beer 2000).

The more recent flurry of activity in regional policies and new approaches to promoting the growth of regions has not necessarily resulted in better quality of life for regional communities (Beer 2000). Beer suggests that non-metropolitan regions are facing even greater pressures than in the past, through the withdrawal and restructuring of public services, the decline in the terms of trade for many agricultural commodities, employment loss from manufacturing sector and persistently high levels of unemployment (Beer 2000). Further to this, Lyne (2005) suggests that Australian regional development policies are inadequate, partial and unintegrated. They often lack regional vision and few means by which policy intention within one portfolio are implemented in policy or practice in other relevant portfolio area.

The lack of interdisciplinary integration of regional planning approaches also becomes evident when examining regional management and policies concerning natural resources and biodiversity conservation. Examples include Catchment Blueprints and other TCM approaches in which there appears to be a mis-match of institutional scale and design, local social systems and civic engagement and environmental attributes of the resource and land-use base; most of which, do not relate to the catchment boundaries at all (Brunckhorst 2000; Brunckhorst et al. 2004). Increasingly there has been a greater emphasis on managing and protecting natural resources and biodiversity in more environmental sustainable ways, however, the development of plans, policies and strategies often neglect the socio-economic influences and implications associated with

the management and protection of natural resources and biodiversity conservation. This further exemplifies the fragmentation of regional planning approaches in Australia.

One particular area of concern in the urban and regional planning arena in recent years in Australia has been the planning of high growth areas along Australia's coast line. This growth has primarily been driven by internal migration patterns within Australia. The growth of coastal areas is causing many planning dilemmas as it is placing pressures on coastal environments, existing infrastructure and services and existing community cohesion. Thus, the approaches to urban and regional planning within these areas are being relied upon to guarantee the sustainability of high growth coastal areas.

2.3 Factors influencing internal population movements over recent decades — an Australian and International perspective

Research on internal migration is concerned with a number of issues. Cushing and Poot (2004) distinguish between studies that are concerned with people and studies that are concerned with places. Studies concerned with people are interested in the migration decisions, motives of migrants, and the socio-economic characteristics of people or places. While, studies that are concerned with places are interested in migration as a mechanism that connects places and looks only at the overall number of migrants and pattern of migration between localities within a country. Brown and Neuberger (1977), Burnley (1996) and Hugo (2002) identify four main patterns of population redistribution generated through internal migration as:

(i) interstate migration, movements between the states of a country;

(ii) counter-urbanisation, involving movements away from large cities to nearby rural areas, small towns and coastal locations;

(iii) urbanisation, involving movements from large rural areas and small towns to large cities; and

(iv) suburbanisation, comprising shifts of population away from the inner and middle suburbs of the cities to the metropolitan fringe.

Australia's internal migration trends resemble that of other Western countries such as the United Kingdom (Boyle and Halfacree 1998), North America (Fuguitt and Beale 1996), and European countries (Champion 1989). However, the characteristics of the internal migration processes vary considerably between nations.

Since the 1970s Australia has experienced fluctuations in the pace and volume of population movement from metropolitan to non-metropolitan localities, as has occurred in other developed nations. However, Australia has experienced less decentralisation of its national population away from its major cities (Sydney and Melbourne) and their immediate hinterlands when compared to many developed countries (Hugo 2002).

The primary factors that have influenced metropolitan to non-metropolitan population movements in Australia differ from that of other developed countries. Metropolitan to non-metropolitan population movements in Australia have been primarily influenced by environmental and lifestyle factors (Hugo and Smailes 1985; Sant and Simons 1993; Burnley and Murphy 2002) and to a lesser extent welfare-led migration (Burnley 1996; Hugo and Bell 1998). Whereas, the metropolitan to non-metropolitan population movements of other developed countries have been primarily driven by demographic change and growing affluence. For instance, in North America metropolitan to non-metropolitan has been primarily influenced by the de-concentration of manufacturing and other employment activities away from metropolitan heartlands (Vining and Kontuly 1978). In Britain, a primary influence for counter-urbanisation has been the search by city dwellers for a rural idyll on the metropolitan fringes, at rural inland localities and some coastal areas (Vigar et al. 2000). While, in European countries where population densities are much higher than that of Australia and North America, small urban centres that are in close proximity to large cities have experienced substantial growth from internal migration processes (Vining and Kontuly 1978; Burnley and Murphy 2002).

2.3.1 Migration within Australia over the last few decades

Recent internal migration patterns in Australia have had significant impacts on the distribution of Australia's population. For instance, the number of non-metropolitan

localities has increased from 450 in 1966 to 728 in 1996 (Hugo 2002). This has led to non-metropolitan localities increasing their share of the national population from 20.5 per cent in 1966 to 23.7 per cent in 1996 (Hugo 2002). This equates to almost a quarter of Australians living in country and coastal towns and regional centres, although some of the country and coastal towns are located in close proximity to metropolitan localities.

Since the 1970s internal migration trends in Australia have been primarily influenced by environmental and lifestyle factors. However, these factors are not the only influences controlling internal migration trends. Stimson and Minnery (1998) state that the motivation for moving can come from a combination of 'push and pull factors', those that encourage people to leave a region and those that attract people to a region. Some of the factors that are driving present internal migration processes include: globalisation, disparities in international terms of trade for key industries (e.g. primary industries, tertiary and quaternary industries), increasing transport technology, lifestyle factors such as seeking a better climate, leaving the congestion of city living, wanting a more pleasant environment, wanting to live close to family and friends, rising personal aspirations and the means to pursue them, seeking more affordable housing and looking for work or retiring from work (Stimson and Minnery 1998). Thus, it becomes evident that many complex factors and personal reasons may interact to motivate a person or family to move from one location to another location.

Over that last few decades, patterns of internal migration in Australia have displayed the 'Sea Change' migration phenomenon, however, the mainstream of mobility has been intra-urban, dominated by suburbanisation within the large metropolitan cities (Burnley and Murphy 2004). Outside the metropolitan cities, there have been cyclical increases and decreases in migration flows to coastal areas since the 1970s. Growth intensified in many coastal areas in the early 1980s, before moderating in the 1990s. Although there has been an overall slowing in the rate of migration to the coast, population growth in coastal areas remains high in proportional and numerical terms (Burnley and Murphy 2004). For instance, the rate of growth in many coastal local government areas is equivalent to or higher than that of metropolitan areas (Trewin 2004). It is also

important to note that there are strong regional and State variations in this growth. Non-metropolitan coastal areas of New South Wales, Queensland and Western Australia had particularly rapid population growth between 1991 and 1996, while coastal areas in South Australia and Victoria largely experienced an acceleration of growth between 1996 and 2001 (Gurran et al. 2005a or 2005b).

Salt (2004) observes that the shift to the coast is occurring on such a scale that some coastal areas, such as the Gold Coast and the Sunshine Coast in Queensland, are now emerging as major population centres. In 2004, the Gold Coast had become a larger population base than Canberra and the Sunshine Coast had replaced Hobart as the tenth largest urban centre in Australia (Salt 2004). Rapid population growth is also evident on the northern, central and southern coast of New South Wales, the southern coast of Victoria and South Australia, the eastern coast of Tasmania and the coastline north and south of Perth, in Western Australia (NRMMC 2003).

Over the coming decades population growth and pressures along coastal areas of Australia are likely to continue. Hugo (2002) suggests that Australia could experience a greater overall change in population distribution than that experienced in the past. Considerations that might promote this include the following. First, the continued development of information technology, which will tie people and industry less to locations in major urban areas than in the past. Second, the ongoing shift in employment from manufacturing and agriculture towards service industries. Third, increasing differentials in the costs of housing, land and infrastructure between different parts of Australia. And finally, growing evidence of environmental stress in heavily populated areas such as Sydney.

Past, current and future internal migration patterns and trends are important as they represent both partial cause and effect of processes of social, environmental and economic change (Hugo 1996; Burnley and Murphy 2004; Gurran et al. 2005a or 2005b). The ongoing movement, and gradual redistribution, of the Australian population to coastal areas is having dramatic short-term and long-term consequences for the social and economic fabric of coastal towns and contributing to the decline of environmental

attributes (Hugo 2002). Consequently, these issues are raising many planning dilemmas for governments and agencies involved in the planning for growth and declining regions.

2.3.2 The 'sea change' phenomenon

The beach holds an iconic status in Australian culture. Coastal locations have long been a favourite place for Australians to take their holidays and relax. Approximately four million people live in Australian coastal areas outside the capital cities (Trewin 2004). It is estimated that the rate of population growth in these coastal areas is 50 per cent higher than the national average. In the year to June 2003, 69,000 people moved to coastal areas, an increase of 7 per cent on the previous year (NSCT 2004). These figures indicate that the movement of population to the coast continues to gather momentum. This is further supported by Salt (2004) who predicted that the coastal population will increase by a further million people over the next 15 years.

People moving to sea change localities are motivated by a range of 'push' and 'pull' factors, particularly housing costs, the amenity of coastal areas and employment circumstances (Trewin 2004). Additionally, a combination of personal circumstances (particularly social networks) and cultural factors (perceptions about a particular place and sense of connection to 'reference groups' within it) influence decisions to migrate to coastal areas (Stimson and Minnery 1998). Traditionally, sea changers have been motivated by the ideal of an alternative lifestyle in rural areas, particularly in the coastal hinterlands of northern New South Wales (Burnley and Murphy 2004). Increasingly the high cost of housing in metropolitan centres is contributing to the 'sea change' phenomenon. This may occur in a number of ways. Firstly, more affluent sea changers release high capital gains from city housing and 'down size' in lifestyle destinations. Secondly, other sea changers often seek more affordable housing in small coastal towns. For instance, Burnley and Murphy (2002) identifies housing affordability as the main factor affecting the decisions of lower income and income support recipients (the unemployed, single parent households, disabled and aged pensioners) to move to coastal areas. Employment opportunities may also influence 'sea change' population movements as jobs and business opportunities follow population growth. However, the nature of

demand in sea change localities leads primarily to growth at the low-end of the service economy such as tourism related industries, some modest export-oriented manufacturing, and culture industry growth in areas such as the far north coast of NSW (Gibson 2002). Improvements in transport and communication technology may increase employment opportunities in coastal areas. For instance, transport and communication improvements may increase the number of workers that can use the internet as well as contract or outsource their services without the need to be permanently based in the city (Burnley and Murphy 2002).

Until recently, it was believed the shift to the coast is being led by the 'baby boomer' generation and included a high proportion of people aged over 50. However, Trewin (2004) suggests that this may not be the case. Twain's report reveals that 'sea changers' are in fact younger than previously thought. Twain identifies that 79 per cent of people who moved to high growth coastal regions in the year prior to 2001 were aged less than 50 years old. As a whole, young adults in their twenties accounted for 22 per cent of new residents, and those in their thirties and forties accounted for 17 per cent and 12 per cent, respectively. While, those younger than twenty accounted for 28 per cent of new residents. Further to this, Trewin (2004) identifies areas that the sea changers are moving from and found that 78 per cent of people moving to coastal areas moved to the coast within their state or territory, while the remainder had moved from interstate. Twain also found that 42 per cent of people moving to coastal areas had moved from a Large Population Centre, 31 per cent of people had moved from a capital city, with the remaining 27 per cent moving from a Country Area. Of the new residents that are of working age (25–54 years), they were most likely to have come from Large Population Centres (43 per cent) and least likely to have come from Country Areas (25 per cent). Of the new residents aged 55–64 years (the ages associated with early retirement) they were most likely to have come from Capital Cities (44 per cent) and least likely to have come from Country Areas (24 per cent).

2.4 Coastal systems and the coastal zone

We still tend to think the marine environment can look after itself and often cannot see the problems and pressures across the coastal-marine interface. Marine policy makers and managers have tended to argue that because the marine environment is different it must be considered and managed separately from the adjacent land (despite clear evidence to the contrary, creating further institutional impediments; see Brunckhorst and Bridgewater 1994, 1995; Viles and Spencer 1995; Peterson and Lubchenco 1997). The greater uncertainty of how marine systems operate has tended to encourage this tyranny of isolated management and fragmented decision-making (Odum 1982; Lawrence et al. 2001; Kingdon 2003). Scientific involvement in management or policy making has generally been limited to episodic cases of reactive, crisis management (Walker and Crowley 1999; Westcott 2004). Coastal management tends to be extremely fragmented between a multitude of organisations and laws, often at odds with one another.

Globally, there is undoubtedly enormous pressure and degradation on coastal-marine environments and resources — far greater than on any other ecological system. The coastal-marine interface is perhaps the most significant ecotone on which humanity's survival depends (Hansen and DiCastri 1992; Hinrichsen 1998; H.John Heinz III Center 2000). Land/sea systems are essentially four-dimensional, where the ocean 'atmosphere' physically supports marine life through time, and the inhabitants, species and species assemblages vary markedly in the environmental attributes on which they depend (Brunckhorst and Bridgewater 1994, 1995; Peterson and Lubchenco 1997). Oceans and inshore environments are far from homologous (Ray and Hayden 1992), however, circulation of water in the ocean and the atmosphere on land (and over water) in the coastal zone do have similarities (Peterson and Lubchenco 1997). For example, convergence is a circulation pattern common to both, though organisms (or their propogules) in the atmosphere are usually temporary residents whereas a marine convergence can be a very concentrated area of biological activity over longer periods of time (Steele 1991). While some species and species assemblages may require relatively discrete areas amenable to protection through reservation, others utilise a range of space and resources through time and therefore require larger scale or

land/seascape linkages to maintain viable populations (Steele 1991; Palmer et al. 1996). Some marine managers (e.g. Kenchington and Kelleher 1995; Ottesen and Kenchington 1995) incorrectly argue the latter signifies a major difference between land and sea systems, and that terrestrial and marine systems should be managed separately. Such linkages are as true for terrestrial systems as they are for marine, and they certainly occur across the coastal-marine interface (e.g. the fisheries of most countries are inshore and reliant on terrestrial coastal processes to sustain them; Talbot 1994). Clearly there is a critical need for holistic, integrated management across the coastal marine interface.

Increasingly, therefore, scientists and managers are advocating the coastal zone be described and managed in the following context (Dyer and Holland 1991; Ray and Hayden 1992; Price and Humphrey 1993; Dutton et al. 1994; Brunckhorst and Bridgewater 1994, 1995; Brunckhorst 2000):

> *The **coastal-marine interface** or **coastal zone** extends from the coastal faces of mountain ranges, their watersheds through to the waters of the continental shelf.*

In examining alternative landscape futures for coastal regions, we need to consider the coast as a terrestrial-marine interface zone, not stopping at high water mark, but as the dynamic interactions between atmosphere, land, sea, biota and human activity (Ray and Hayden 1992; Talbot 1994; Dutton and Saenger 1994; Viles and Spencer 1995; Smyth 1995; Brunckhorst 2000). Across this coastal interface, major movements of sediments and nutrients are powered by waves, tides, currents (in water and air). These movements shape the coastal profile, contributing erosional and depositional landforms. The terrestrial component is not placid, as rivers bring sediments, nutrients and freshwater to the coast and inshore waters (Viles and Spencer 1995). As well as providing the base for extensive human settlement, the coast is home to some of the worlds most productive and diverse ecosystems (e.g. mangroves, coral reefs, salt marshes). Biologically, the coastal zone is mega-diverse, with beaches being the only ecosystem on Earth containing representatives from every phyla (see Ray 1991; Wilson 1992). The members of coastal biodiversity are also active in forming reefs, accretions,

and aiding sedimentation in addition to providing important buffering and filtering capacities (Peterson and Lubchenco 1997).

From a social and cultural perspective, indigenous peoples and the citizens of the high-density communities now living on the coast generally identify with the environment across the coastal-marine interface as defined above (Castaneda 1993, Smyth 1995, Wells and White 1995). They identify with the lower end of the catchments running into estuaries (often where townships are located and where ocean access by boat is possible), with the coastal plains for agriculture and other uses, with the beach and sea for recreation and gathering of marine resources (Dutton et al. 1994; Brunckhorst and Bridgewater 1994, 1995; Wescott 2004). The identity and 'sense of place' attachment to coastal areas by resident communities and the expectations for resource use, accommodation types and amenity by tourists and resident businesses alike will frame expectations for the future of a region (Cantrill and Senechah 2001; Lindley and McEvoy 2002; Field et al. 2003; Stewart et al. 2004; Dortmans 2005).

The coast offers amenity, quality of life in recreational pursuits and generally, a mild climate. It is not surprising that population settlement trends continue to be coastal. The enormous challenge is in dealing with huge pressures of change brought about by the interactions of social-ecological systems across the terrestrial-marine interface. Future planning and spatial redesign of new settlements must incorporate knowledge of landscape ecology, including coastal zone processes (see for example, Steinitz 1997), into assessing plausible and sustainable future scenarios for the Australian coastline.

2.5 Expanding population and development in coastal areas

There is good reason to be particularly concerned about our burgeoning issues of the coastal zone, many of which relate directly to pressures of human settlement and activity. Coastal areas of Australia consist of a wide range of climatic, geological and oceanographic regimes and support an interacting mix of terrestrial, estuarine and marine ecosystems that support a wealth of biodiversity. It is these attributes that provide the unique coastal environments that attract people to coastal areas and are

consequently under threat by coastal growth and tourism. As coastal areas grow they have to accommodate major economic, industrial and social activity that place greater pressure on coastal resources and present significant resource use challenges, some of which emerge beyond the local scale. As such, coastal areas are forced to support a broad range of commercial and non-commercial activities that are dependant on healthy coastal environments. Such activities include commercial and recreational fishing, tourism and recreation, urban development, aquaculture, shipping and transportation, coastal agriculture, mining, manufacturing and trade. Equally coastal areas have important social, cultural and indigenous values, including coastal landscapes and amenity (NRMMC 2003).

The pressures associated with population growth in coastal areas result in many environmental, social and economic consequences. The consequences of 'sea change' growth are not just an Australian phenomenon. Ames (1997) reports that in the United States 'sea changers' from California have been descending on small coastal townships in Oregon in such numbers they have destroyed the original community character that attracted them, and then moved on in search of another town with an appealing coastal ambience.

Managing the pressures of change in coastal areas becomes a very challenging task. Unlike growth corridors in outer metropolitan areas, coastal areas have not often been planned with the objective of accommodating high growth rates. Consequently, planning authorities in coastal areas are faced with significant challenges in dealing with the social, environmental and economic issues related to rapid growth.

Coastal population growth brings with it both social and economic changes. Residential and tourism development associated with the 'sea change' phenomenon does not necessarily lead to sustainable economic growth or improved socio-economic outcomes for local communities. Increasing populations may lead to a continuing demand for infrastructure, such as roads, mains water supply, sewerage, and power. High growth coastal communities also experience a lack of essential services, such as public transport, health care, emergency services and education facilities (NRMMC 2003). In spite of new population growth, many non-metropolitan coastal communities are

characterised by high levels of unemployment, lower than average household incomes, and greater levels of socio-economic disadvantage along with higher numbers of seniors than other parts of Australia (Vinson 1999; NRMMC 2003). Consequently, social cleavages are occurring between existing residents and newcomers and between wealthier, usually retiree, sea changers and those lower income groups who have been pushed out of expensive metropolitan areas (Gurran et al. 2005a or 2005b). Although growth in sea change areas stimulates employment opportunities, the new jobs are usually in lower paid occupational sectors such as retail, restaurants, tourism, and care-giving. These types of jobs are frequently part time and subject to seasonal fluctuations (Stimson et al. 2003). Various social problems also result from retirees moving into 'sea change' localities. As a consequence, retirees find themselves separated from family and friends when they are heading into a stage of their life cycle when they are most likely to need support from friends and relatives. Further problems arise in the transition to specialised retirement accommodation where such facilities are not available locally.

Not only are coastal communities attempting to cope with high population growth, they are also facing a dramatic increase in the level of international and domestic tourism, which is forecast to become Australia's major export earner by the year 2007 (NRMMC 2003). Although tourism provides a number of economic benefits, tourism may have a number of social impacts on local communities, including antisocial behaviour, extra pressures on existing infrastructure and increased traffic congestion. Increases in the level of international and domestic tourism may also have a number of environmental impacts on coastal areas, including impacts on coastal environments and processes, greater reliance on natural resources such as water for supplying domestic activities and greater demand for land to accommodate tourists and tourist activities. Consequently, pressures associated with tourism further exacerbate impacts associated with population growth in coastal areas.

The environmental implications of 'sea change' migration are also profound. Development pressures associated with rapid population growth offer opportunities for 'sea changers' in the form of high quality open space but at the same time these opportunities pose threats to sensitive coastal processes and environments, including

coastal waters, dunes, wetlands, and distinctive landscapes. Furthermore, many coastal communities are surrounded by environments of national and international heritage importance, such as national parks, world heritage areas, and marine protected areas. These places are particularly vulnerable to inappropriate development which threatens biodiversity, cultural heritage sites, recreational and tourism values (Gurran et al. 2005a or 2005b). The expansion of coastal urban development and increased exploitation of natural resources to accommodate growth has placed increasing pressure on the natural environment through problems such as habitat loss and fragmentation due to urban development and tourism, loss and degradation of coastal wetlands, change in hydrological systems and marine habitats, the introduction of exotic species, erosion and pollution (Hamilton and Cocks 1993). In addition, global climate change, particularly sea level rise, is likely to impact coastal environments in the near future.

2.6 Integrated coastal management

The current international benchmark for coastal zone management is the concept of 'integrated coastal management' (Cicin-Sain and Knecht 1998; Wescott 2000). Integrated coastal management (ICM) has become increasingly popular among the international scene since the early 1990s. ICM is now internationally recognised as the most successful and appropriate way to manage coastal and marine ecosystems (Cicin-Sain and Knecht 1998; Olsen and Christie 2000; Morcom 2002); and a key for achieving sustainable development (Olsen 2000). ICM has become the umbrella term for the various names including: 'coastal zone management', 'integrated coastal zone planning and/or management', 'coastal area planning and/or management', and 'integrated coastal resources planning and/or management'.

ICM is a multi-disciplinary process that unites levels of government and the community, science and management, sectoral and public interests, in preparing and implementing a program for the protection and sustainable development of coastal resources and environments. The process is designed to overcome the fragmentation inherent in single-sector management approaches (e.g. fishing operations, coastal development, biodiversity conservation), in the splits in jurisdiction among different levels of

government, and in the land-water interface. The ICM process provides a means by which concerns at local, regional and national levels are discussed and future directions are negotiated (GESAMP 1996). The key factors that appear to be consistent with successful ICM are: legislation, zoning, strategic or management plan, education and public participation and coordination and integration of agencies and government (Morcom 2002).

The overall goal of ICM is to improve the quality of life of the communities that depend on coastal resources as well as providing for needed development (particularly coastal-dependent development) while maintaining the biological diversity and productivity of coastal ecosystems (Christie 2005). This objective is pursued to achieve and maintain desired functional and/or quality levels of coastal systems, as well as to reduce the costs associated with coastal hazards to acceptable levels (Morcom 2002).

ICM can include the planning and management of just the coastal lands or just marine side of the coastal zone. Whereas, integrated coastal zone management (ICZM) requires that the planning and management area must include a zone comprised of coastal and estuarine waters, the adjoining and complete inter-tidal areas, and the supra-littoral coastal lands (Thom and Harvey 2000). The coastal lands should extend inland to at least the maximum highest tide and include directly connected coastal environments such as wetlands and dune systems.

Thom and Harvey (2000: p275) suggest four triggers which have stimulated reform of coastal management in Australia and the shift towards ICZM. These triggers include: global environmental change; adoption of the principles of sustainable development; application of strategic planning principles as a result of pressure for a more holistic or integrated approach to resource management; and greater community awareness of management issues and greater community participation in decision making. An example of the move towards ICZM in Australia is the development of the *Framework for a National Cooperative Approach to Integrated Coastal Zone Management*. Implementation of the Framework is managed through the Intergovernmental Coastal Advisory Group (ICAG). This group is made up of representatives of the Australian Government, each state government and the Northern Territory, and the Australian

Local Government Association (ALGA). The representatives are from the key coastal policy areas of government agencies.

2.6 Coastal planning and management in Australia

In Australia the three tiers of government share responsibility for management of the coastal zone, its resources and the offshore waters. The legislative basis for planning and management of the land area of the coastal zone is primarily provided by the States. Local government is generally responsible for the day-to-day decision making. The Commonwealth and the States both have responsibilities in the offshore area. The States are responsible for management of coastal areas within three nautical miles of the territorial sea baselines and have concurrent legislative power within the same area. The Commonwealth has primary responsibility from three nautical miles to 12 nautical miles in the territorial sea and beyond to the 200 nautical mile Exclusive Economic Zone and the edge of the continental shelf (under the *Offshore Constitutional Settlement*).

This shared responsibility of coastal zone management is complex because all tiers of government have legitimate interests and responsibilities in the coastal zone. All tiers of government are under increasing pressure from coastal communities to deal with coastal issues and no single level of government can manage the coastal zone on its own. Thus, cooperative approaches that share solutions and resources for dealing with coastal management can provide a more effective means of managing coastal areas. Management responses at the local and regional level would provide a more effective means given that coastal management needs to take into account site-specific needs and local community values. A lack of integration across sectoral interests within government has repeatedly been identified as a cause for great concern about the effectiveness of coastal management. The number of agencies with sectoral management responsibilities that affect the coast and the unclear boundaries of responsibility contribute to this lack of integration. This becomes evident when examining the role of each level of government in coastal management (for details see the *Offshore Constitutional Settlement*).

Coastal management and activities relevant to the Commonwealth government include those with respect to interstate and overseas trade and commerce, fisheries in Australian waters beyond territorial limits, taxation, defence, lighthouses, quarantine, corporations, petroleum and minerals beyond three nautical miles, Aboriginal and Torres Strait Islander affairs, territories, and external affairs (in relation to matters physically external to Australia and in relation to giving effect to Australia's international obligations). The Commonwealth may also influence coastal zone activities by its power to grant financial assistance to the States natural resource management programs, such as the Ocean Rescue 2000 Program.

With the exception of the Great Barrier Reef Marine Park, the Commonwealth's responsibilities for marine conservation in Commonwealth waters are prescribed in three Acts administered by the Australian Nature Conservation Agency: The National Parks and Wildlife Conservation Act 1975; The Whale Protection Act 1980; and The Endangered Species Protection Act 1992. The Commonwealth also has responsibilities under the Australian Heritage Commission Act 1975. In addition to this, Australia is party to a number of international treaties and conventions that have implications on coastal management. Examples of obligations include: maritime pollution, shipping operations, oceanic oil pollution, environmental data collection and service provision, coastal navigation, preservation of flora and fauna (including whales, dolphins, seals and migratory birds) and their habitats, and the conservation of World Heritage properties.

The Commonwealth government also has a broader concern with the overall national economic, social and environmental outcomes, including coastal zone outcomes. As such, the Commonwealth is an active player in the coastal zone in a number of capacities as identified by DEH (1995):

- as a coastal landowner, it possesses substantial coastal landholdings for maritime and defence purposes;
- as a coastal manager, for example, regionally through the Great Barrier Reef Marine Park Authority and nationally through the Australian Nature Conservation Agency (ANCA) and the Australian Fisheries Management Authority (AFMA);

- as an initiator and sponsor of marine and coastal research, through, for example, CSIRO, the Australian Institute of Marine Sciences, the Australian Geological Survey Organisation, the Bureau of Resource Sciences, the Great Barrier Reef Marine Park Authority and ANCA;
- as a party to international agreements and conventions;
- as a regulator for maritime safety and shipping, World Heritage properties, sea dumping, and offshore resource exploration and development;
- as a source of funds for coastal projects carried out by other tiers of government and the community;
- as the authority responsible for immigration policy, taxation policy and investment in major infrastructure, all of which affect urban coastal development.

The underlying goal of the Commonwealth Coastal Policy is ecologically sustainable use of the coastal zone. This means that through policy the Commonwealth aims to ensure that development of the coastal zone improves Australian's total quality of life, now and in the future, in a way that maintains the ecological processes on which life depends. To achieve this goal, the activities of Commonwealth agencies and authorities in the coastal zone are guided by a number of specific principles, which aim to provide a common focus for Commonwealth actions. The Commonwealths guiding principles for the management of coastal resources are based on the recommendations of the Resource Assessment Commission report *Final Report of the Resource Assessment Commission's Coastal Zone Inquiry (1993)* and they are consistent with the principles of the National Strategy for Ecologically Sustainable Development. The guiding principles are based on three themes: Sustainable Resource Use; Public Participation; and Knowledge and Understanding (RAC 1993).

As already mentioned, the legislative basis for planning and management of the land area of the coastal zone is primarily provided by the States. The States are also responsible for management of coastal areas within three nautical miles of the territorial sea baselines. Each State and Territory has their own coastal zone management legislation and programs. In addition, local governments develop their own bi-laws and policies.

Over recent years most states have revised their coastal management legislation and adopting elements of ICM and incorporating the principles of Ecologically Sustainable Development (ESD). Victoria, New South Wales and Queensland have all recently revised their coastal management legislation (e.g. Victoria: *Coastal Management Act 1995*; New South Wales: *Coastal Protection Act 1998* and Queensland: *Coastal Protection and Management Act 1995*). On the other hand, South Australia has not kept pace with changes in coastal management. South Australia has gone from having one of the first pieces of coastal protection legislation (*Coast Protection Act 1972*), not having revised its 30-year-old coastal legislation (Morcom and Harvey 2002). Tasmania, Western Australia and the Northern Territory are still without any form of coastal legislation.

In terms of statutory coastal policy documents Victoria, Tasmania, Queensland, Western Australia, New South Wales and the Northern Territory have developed separate statutory coastal policy documents (i.e. Victoria: *Victorian Coastal Strategy 2002*; Tasmania: *Tasmanian State Coastal Policy 1996*: Queensland: *State Coastal Management Plan 2002*; Western Australia: *State Coastal Planning Policy 2003*; New South Wales: *NSW Coastal Policy 1997* and Northern Territory: NT Coastal Management Policy 1999). South Australia does not have a statutory coastal policy document. In South Australia, the *Coast Protection Board Policy on Coast Protection and New Coastal Development (1998)* leaves coastal protection and land use planning to local government, with State technical and planning assistance and planning overview (Ramsey and Rowe 1995).

Currently coastal planning activities differ between each of the States. Tasmania is reviewing their state coastal policy. Victoria is currently reviewing its planning activities through the Coastal Spaces project. New South Wales is undertaking a number of regional planning activities in coastal areas and will shortly be undertaking a targeted review of their coastal policy. South Australia is updating their coastal development plans and has undertaken a coastal landscape assessment. The Northern Territory is undertaking a review of environment legislation. Queensland has recently released the South East Queensland Regional Plan 2005-2026. Western Australia continues its coastal planning program across the State and is currently preparing a Perth Coastal Planning Strategy. Although there have been moves by some State governments to

develop integrated regional coastal plans and strategies, there is still a general lack of coastal zone management been undertaken at the regional level.

In Australia, local government plays a significant role in coastal zone management. Councils are a major land manager of reserves, parkland and beaches. Councils are often responsible for the management of estuaries, which can be vast systems in some shires, placing a significant burden on council resources. Councils are responsible for vegetation management and biodiversity conservation on public areas. As such, they may be responsible for implementing state legislation or their own council bi-laws to manage vegetation and biodiversity.

Many local councils have developed a number of planning documents and strategies to address the pressures they are facing. Councils are using their land use planning and statutory responsibilities to achieve more sustainable outcomes and some councils are trying to forge improved partnerships with other spheres of government and the regional NRM organisations. Councils across Australia have recently established the *National Sea Change Taskforce.* The Taskforce comprises of member councils and aims to assist local councils with dealing with the impact of changes such as rapid population and tourism growth. The Taskforce aims to work collaboratively with State and Federal Governments to develop national and state policies that will establish sustainable limits to growth, help to protect the coastal environment and address funding issues.

Planning issues within coastal local government areas have become more challenging in recent years. Council resources are increasingly under significant pressure due to the rapid pace of growth affecting many coastal areas. Coastal councils are attempting to keep pace with growth in demand within severe limitations. Councils are a large provider of infrastructure which can have a significant impact on the quality of the natural resource base, social issues in the area, and traffic congestion. Local councils typically are left to provide support services with inadequate resources to do so. Consequently, coastal councils do not have the resources to meet the continuing demand for infrastructure, such as roads, mains water supply, sewerage, and power. In addition, high growth coastal communities also experience a lack of essential services,

such as public transport, health care, emergency services and education facilities (NRMMC 2003).

A recent survey of coastal councils across Australia conducted by the Australian Local Governments Association during 2004 identified the five highest priority environmental issues nominated by councils (ALGA 2005a, p11). These issues include:

i. *planning,* the rapid pace of growth affecting coastal areas in recent years has placed significant pressure on council resources. Given this, the capacity of councils to undertake strategic planning is currently constrained. There is a shortage of planning staff, the need for strategic planning is enormous and there is limited funding to implement strategic plans. In addition, there is a lack of co-ordination between strategic planning being undertaken at the local, regional and state levels.

ii. *water supply,* the consistent supply of good quality water was identified as the biggest environmental concern. Finding a solution is made more difficult through a lack of coordination in providing infrastructure for water provision and treatment. This in turn influences the quality of water and the ability for towns to expand and generate economic growth.

iii. *biodiversity conservation,* it was identified that biodiversity continues to be lost along the coastline and this is a significant issue, as once lost it is often impossible to regain. Managing this issue requires councils to undertake work in this area, regional NRM organisations to address biodiversity decline in their regional strategies and compliance with state and Australian government legislation.

iv. *climate change,* climate change is occurring and it is feared that the longer it takes governments to respond to climate change, the greater the cost of undertaking mitigation activities.

v. *infrastructure provision,* infrastructure provision in coastal areas is severely lacking and there is a need to undertake maintenance of much of the existing infrastructure. It was identified that this problem would require a whole of government approach.

The social, economic and environmental issues associated with population growth in coastal areas raises many planning dilemmas for both local and regional planning authorities. Although coastal zone management in Australia has seen a shift towards integrated coastal zone management, there has been little work been undertaken in regards to integrated regional approaches to coastal zone management. This is further supported by Gurran et al. (2005a or 2005b) who suggests that Australia's local, State and Federal governments need to work much more collaboratively to ensure that coastal development occurs in a sustainable way (see also Resource Assessment Commission 1993). The report found this to be necessary as many local and regional planning instruments related to land use planning, tourism development, and social and economic development are not well articulated or integrated within coastal policy and planning frameworks.

Policy reviews (e.g., RAC 1993, Westcott 2004; Gurran et al. 2005a or 2005b) have also called for the development of coordinated regional plans by State Governments that would provide greater certainty about the extent and rate of growth in coastal communities. This suggests that effective regional planning is widely regarded by representatives of coastal communities to be critical to the management of growth and change in coastal growth areas. Many coastal communities report that existing regional plans lack weight, are not consistently applied, or are out of date. Gurran et al. (2005a or 2005b) points out there are no mechanisms within Australia to fund regional infrastructure, extremely limited funding to protect and enhance the natural environment and a lack of effective coordination between the three levels of government, which is critical to addressing coastal growth.

3.0 Social-Ecological Systems, Hierarchies, Landscapes and Integration

The laws that govern the processes of natural systems are fixed, but those of human social systems for governance[2] of natural resources and ecosystem services are not. Opportunities to significantly improve resource management outcomes will therefore rely on our ability to modify our social systems to better serve our long-term interest in the natural world. In practice however, social change often seems difficult to achieve. Nevertheless, society[3] and its institutions[4] must become more capable of substantial transitions over shorter time scales to adapt to pressures of change including social ramifications of reduced resource capacity or alternative ecosystem uses and restoration. Such transformations might require novel approaches if humanity is to find realistic solutions to social and environmental sustainability issues that provide long-term resilience so that communities can adapt with matching civic skills and knowledge (Gunderson et al. 1995; Holling and Meffe 1996; Johnson et al. 1999; Brunckhorst 1998, 2001; Bailey 2002).

The highest priority may now be an improved integration of ecology and resource governance, bringing together the economics, sociology, institutional arrangements and politics of the required transitions and timing towards an adaptive 'sustainability' that provides resilience. The term integration as used herein refers to a holistic understanding of complex interacting social-ecological systems, rather than approaches that attempt to reassemble separately studied components to elucidate meaning. A whole view of, and immersion in real, though complex, interacting systems will elucidate understanding of unique properties that materialise from systems interactions, and is likely to provide more realistic and practical solutions for natural resource management, planning and human needs (Brunckhorst 2005).

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[2] 'Governance is the capacity of self-organizing systems to govern themselves, and includes not only formal government authorities and agencies, but also an array of private sector and non-governmental organisations as well as communities. Stewardship is the expression of this capacity in the form of "responsible custody" of human ecosystems, and therefore requires competence, vigilance, and ethics of responsibility and accountability for the sustainability of human ecosystems' (Francis and Shannon, in Shannon 2000). See also Singleton 1998; Johnson et al. 1999.

[3] A social system refers to any group of people who interact long enough to create a shared set of understandings, norms, or routines to integrate action and established patterns of dominance and resource allocation.

[4] The term 'institutions' refers to sets of formal and informal rules and norms that shape interactions of humans with others, and with nature. See Ostrom 1990; Goodin 1996.

There has been a tendency in both science and policy to consider 'integration' as reassembling conclusions from individually studied parts. In this paper, 'integrated' means 'holistic' and refers to a whole system of interacting elements. The interaction of ecosystems, social systems and economic systems of landscapes and regions clearly exhibit characteristics of complex, networked, cross-scale systems giving rise to a broad range of other conditions and properties influencing one another (Costanza 1993; Gunderson and Holling 2001). Novel (holistic) integrative systems research into the ecological and social processes that occur and interact at various scales across landscapes requires a multi-theoretical basis (Gunderson et al. 1995; Gunderson and Holling 2001; Brunckhorst 2001).

In systems theory, complex systems are characterised by non-linear interactions and continual feedbacks, which makes causal resolution extremely difficult. Systems are generally non-additive due to the existence of diverse hierarchies, (i.e. the whole is not simply a sum of parts, but much more; von Bertalanffy 1968), but display self-organising and emergent properties. Complex systems produce new properties or synergistic influences, referred to as emergent properties, produced by interactions and interdependency; higher level combinations can affect a variety of other states or products, in turn facilitating new interactions or dependencies. Emergent properties cannot be observed when individual components are studied or re-aggregated. Local economies, rural towns and communities are emergent properties of social-ecological systems interactions in a 'place'. Systems interactions also produce self-organising properties which are crucial for adjustment, repair and maintenance of system functions, and capacities to adjust to pressures of change and adapt to new circumstances.

Classical (reductionist) science aims to find linear causalities, and basic 'elements' which directly add-up. The properties of complex social-ecological systems important to responsive adaptation towards sustainability will not be well understood using the methods of classical science. Reductionism is of limited use in dealing with the requirements for sustainability. To minimise complexity, but retain the reality of interactions, systems researchers look for boundaries where there are much reduced interactions between system elements or other systems. In this way hierarchies or

scaled nestings of interactions can be identified. This capacity can, to some extent, be provided through a place-based, 'regional landscape' approach grounded in landscape ecology theory (Kim and Weaver 1994; Brandenburg and Carroll 1995; Forman 1995; Platt 1996; Cantrill 1998; Odum 1998; Brunckhorst 1998, 2000, 2002; Cheng et al. 2003). Regional case studies and 'on-ground' experimental models are also valuable in contributing holistic integration, understanding and synthesis (e.g. Ostrom 1990; Gunderson et al. 1995; Brunckhorst et al. 1997; Berkes and Folke 1998; Johnson et al. 1999).

3.1 Regional landscape as a context for integration of policy and Planning

The actions and choices of human communities interacting locally with the ecological systems of a landscape shape a 'place' and give rise to its social identity (Shannon 1992, 1998). The social system of a 'place' shapes that landscape through institutional interactions with perceptions of resources and land use practice. The local to regional scale of similar ecological landscape, land use and, concurrent human attachment to 'place' and, local social interactions has been referred to as a bio-cultural region or bioregion (Slocombe 1993; Platt 1996, Folke et al. 1996; Goble and Hirt 1999; Johnson et al. 1999; Brunckhorst 2000, 2001; Brunckhorst et al. 2004, 2005; Cheng et al. 2003).

> *The human region … is a complex of geographic, economic and cultural elements. Not found as a finished product in nature, not solely the creation of human will … the region, … is a collective work of art* (Mumford, 1938: 367).

Mumford (1938) characterised the entwined processes of social-ecological systems producing a distinctively patterned and functioning regional landscape. However, the interacting and interdependent activities of natural resource use, local government and regional development need to be compatible with the dynamics of the ecological services and resources, and with the social and institutional characteristics of the communities to which resource users belong. Actions to sustain ecological systems, flows and function can then be integrated across the entwined human and ecological dimensions of regional landscapes (Gunderson et al. 1995; Hanna et al. 1996; McKean

1996; Berkes and Folke 1998; Brunckhorst et al. 1997; Zhu and Dale 2000; Shannon 2000; Brunckhorst 2000, 2001; Cantrill and Senecah 2001).

Definitions of the term landscape vary considerably among planners, researchers and other professionals. Landscape ecologists consider a landscape to be a heterogeneous area of land that is generally hierarchically structured. (e.g. Forman and Godron 1986; O'Neill et al. 1986, 1997; Turner 1989; Hansen and DiCastri 1992; Forman 1995; Brunckhorst 2000; Turner et al. 2001; Liu and Taylor 2002). The local interaction of structure and function give rise to patterns and processes that are also embedded in broader contexts. The term landscape ecology seems to have been coined when aerial photography made it apparent that there were identifiable spatial patterns where biological communities interacted with the physical environment (McHarg 1962 in McHarg 1992; Troll 1968).

In summarising the foundations and theory of landscape ecology, Forman (1995) lists 12 key principles of landscape and regional ecology which are important in understanding change and more integrated planning for future sustainability. These principles are summarised below (after Forman 1995, pp. 514-516).

1. *Landscapes and Regions*. Local ecosystem and land use types are repeated over an area forming a landscape, which is the basic component of a region — the next broader scale of a non-repetitive, coarse-grained pattern of landscapes.
2. *Patch, Corridor, Matrix*. The pattern and arrangement of patches, corridor linkages and the collective matrix that constitutes a landscape is the major influence on biodiversity movement, functional flows and change across the landscape (see also Turner 1989; O'Neill et al. 1997).
3. *Large areas of natural vegetation*. Large vegetation patches are often the only structures in a landscape that maintain and protect surface and ground water; and, interconnected streams and rivers.
4. *Shape*. An ecologically optimum patch shape should maximise area and minimise boundary or edge effects. It will probably also have an optimum orientation and may require lobes or branches for linkages across the landscape matrix.

5. *Ecosystem interaction*. All ecosystems across a landscape and region are interrelated and interdependent to varying degrees.
6. *Species metapopulation dynamics*. Local extinction rates of sub-populations decreases with greater habitat quality, patch size and connectivity (short inter-patch distances) across the matrix.
7. *Landscape resistance*. The arrangement of spatial elements (proximity, barriers, conduits or corridors) creates or influences functional flows and movement, including species, energy, disturbance and material over a landscape.
8. *Grain size*. Fine-grained patches making up a coarse-grained landscape are usually best for large scale ecological and resource benefits for maintaining biodiversity including humans, and environmental health.
9. *Landscape change*. Landscape transformation occurs through spatial processes such as perforation, attrition, fragmentation and isolation which in turn have various effects on ecological processes and patterns.
10. *Mosaic sequence.* Transformation of land to less suitable habitat for biodiversity occurs to a small number of repeated mosaics (sequences). The ecologically optimal is considered to be progressive parallel strips from an edge (see principles 4,7,8; Dramstad et al. 1996).
11. *Aggregate outliers.* Ecologically optimum spatial pattern in human dominated landscapes is best arranged by aggregating land uses, while maintaining small patches, corridors or other forms of linkage throughout developed areas, including outliers of human activity (e.g. along major boundaries such as roads).
12. *Indispensible patterns.* Provide highest priority for protection to unrepeated, non-replaceable, patches of high ecological benefit. Priority patches of this category being the largest, most connected patches (see principles 4,6,7).

Dramstad et al. (1996) provide a detailed, illustrated guide to the application of Forman's principles in landscape planning and design. McHarg (1992, reprint of 1962 edition of *Design with Nature*) and Lyle's *Design for Human Ecosystems* (1999) are the

most comprehensive guides for urban and regional planning and design incorporating landscape ecology principles. With increasing use of GIS tools in regional analysis and planning applications, new approaches are using combinations of the above principles with McHarg's and Lyle's design approaches (for example, Steinitz 1993, Steinitz 1997; Liverman et al. 1998; Kepner and Edmonds 2002; Johnson and Hill 2001; Steinitz et al. 2003; Terkenli 2005). Other applications of landscape ecology in design for urban and regional planning are provided by Mackenzie (1996), Van der Ryn and Cowan (1996) and Bailey (2002).

Enduring ecological, social and economic sustainability requires integrated planning and management of natural resources, ecological functions and primary production across anthropogenic landscapes (Kim and Weaver 1994; Forman 1995; Lyle 1999; Liu and Taylor 2002). While landscapes might also be considered a social construct, they are inherently diverse, embodying a multitude of values for their inhabitants. These values also influence planning and landscape change. Rural landscapes include people and communities, resource production and related industries, social networks, economies and political institutions, biodiversity and ecological systems (Figure 1). These components operate at various scales (Pattee 1973; O'Neill et al. 1986) and interact also at a variety of organisational levels (Ostrom 1990; Goodin 1996). A policy and environmental history has resulted in the landscapes we have to work with and care for today (Figure 1). Constant change however, is the normal state with changing policies, decisions and resource management applications. These pressures of change on economies, ecological services and resources, and towns and communities appear to be increasing — indeed, across many rural landscapes, all components are collectively struggling for ecological and economic survival. Various forms of planning often fall short of considering the spatial configuration of ecological processes and land use intensities, resulting in configurations that can lead to undesirable effects on society and ecosystems (Conacher 1980; Tjallingii 2000; Hersperger 2006). Single issue or narrowly focused approaches to solutions are unlikely to have lasting benefits.

Though society and its economies are derived from interactions with the environment, human activity is a major change force shaping landscapes (Figure 1). There is no point

'winding back the clock'. Past change has provided us with our present starting point. Forward looking responses are required to alter the course of unsustainable practices degrading the environment and the future. The lessons learnt and new knowledge available must become more influential in facilitating recognition and action to change direction towards future sustainable landscapes and compatible rural industries (Brunckhorst 2001, 2002). This should be the aim of 'integration' – both for applied interdisciplinary research, improved 'learning-by-doing' (adaptive management) and innovative policy implementation across social-ecological landscapes (Walters 1986; Walters and Holling 1990; Gunderson et al. 1995). Genuine attempts at integration will require changes to the way governments and their organisations view regional administrative frameworks, and adaptation or redesign of various organisational forms and institutional arrangements. The landscape scale is the main scale of human interaction with the environment (Lyle 1985; Forman 1995; Platt 1996; Knight and Landres 1998). A regional landscape scale of analysis allows effective understanding of emergent and self-organising properties for 'holistic' integration and innovative redesign of human institutions and activities, and their influences, across landscapes (Noss 1983; Lyle 1985; Urban et al. 1987; Takeuchi and Lee 1989; Saunders 1990; Johnson et al. 1999; Tjallingii 2000; Johnson and Hill, 2001; Brunckhorst 2000, 2002).

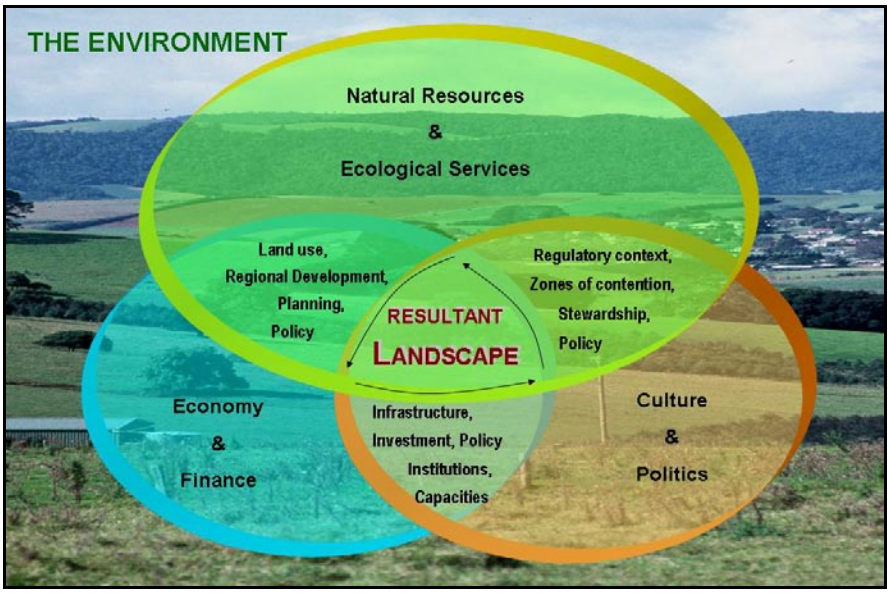

Figure 1. The Environment underpins natural resources, ecological services and society including the economy, culture and politics. Regional landscapes are continually shaped by complex interacting cultural, institutional and physical processes reflecting human values, identity and interactions with that region (after Brunckhorst 2002).

4.0 Remote sensing and related spatial analysis

Increasingly Geographic Information Systems (GIS) can be a useful synthesis and analysis tool in assessing the impacts human activities have on social-ecological systems. Combining GIS with remotely sensed imagery data and landscape ecology theory, hierarchy theory and planning theory provides a powerful basis for interdisciplinary studies to monitor and assess regional scale social-ecological systems interactions (Liverman et al. 1998; O'Neill et al. 1999; Alberti and Waddell 2000; Liu and Taylor 2002). This section briefly reviews the principles and uses of tools for spatial and temporal analysis of remote sensed image data, such as aerial photography or satellite imagery.

The surfaces of all living and non-living objects reflect, absorb, or transmit 100 per cent of incident light. Different materials reflect and absorb different amounts and wavelengths of light along the electromagnetic spectrum (EMS). The wavelengths that

are reflected can be recorded by distant sensors and this becomes the basis for identifying surface components from remote sensing. Digital sensors, such as most satellite-based sensors, can collect multiple wavelengths or bands of light in regions of the EMS not possible with standard analogue photography. It is possible to manipulate and statistically analyse these wavelengths of light to determine unique characteristics of the landscape and ground surface. These characteristics can be turned into information such as land cover.

Digital raster images are analogous to matrices or spreadsheets. The cells or pixels are packed with observations (in this case digital values representing the intensity of band-width of light reflected from surface materials). It is possible to statistically analyse digital imagery to determine land cover. The reflective characteristics of each cell are compared and clumped together to form spectral signatures. In a perfect world, each spectral signature would represent a unique landscape component. This is rarely the case; therefore, many processes and applications have been designed to extract information from digital imagery (Turner 1990; O'Neill et al. 1999; Corry and Nassauer 2005). Remote sensing (RS), the science of deciphering imagery combined with spatial analysis of the Earth's surface, both aerial and satellite, is becoming an integral part of today's desktop PC mapping systems. Spatial technologies and GIS have advanced enormously in both user interface and analytical capacities in recent years. The Leica Imagine and ESRI GIS software (e.g., ArcView® Image Analysis extension) have become the tools most commonly used in image analysis, land cover and change analysis (Kepner and Edmonds 2002; Liu and Taylor 2002). These programs can take full advantage of the wide range of digital image data that is available today or planned for in the near future, such as aerial photography and digital orthoimagery of all types, as well as current and future small to large scale satellite data (Turner 1990; Environmental Systems Research Institute 1997).

Computer software expedites spatial differentiation and analysis. Each satellite scene is individually classified, focusing first on separating major categories (e.g., water, vegetation, grazing or farmland, urban development) using standard supervised and unsupervised classification techniques (Legendre and Legendre 1998; Turner 1990, 2003;

Liu and Taylor 2002). Fieldwork, often referred to as 'ground-truthing', at this stage of classification is important for orientation to the environment and to provide numerous individual areas as training sites for correct differentiation in the land cover classification. The mean and covariance statistics for these training areas are passed to an isodata classification algorithm which assigns every unknown pixel to the class in which it has the highest probability of being a member (see for example, O'Neill et al. 1999; Turner 2003). Iterative unsupervised classifications are then undertaken on each major category individually by masking out all other major categories. By masking out all data but a single major category, the spectral variance is greatly reduced, thus decreasing classification errors. After several classification iterations of the masked data, final classification labels are assigned to the spectral clusters. In small areas where land cover class confusion cannot be separated spectrally, human observation based, pattern recognition can be used to recode the data, however a range of other statistical techniques are constantly being developed (Hunsaker et al. 1994; Legendre and Legendre 1998; Turner 1990; Dale 1999; Liu and Taylor 2002; Lewis and Brabec 2005).

4.1 Land cover and landscape change analysis

Sun-synchronous satellites return to the same point on the face of the Earth at a regular time each day. Multiple images of the same location can be compared to each other to statistically isolate changes. When images are compared over different seasons or time lapse periods, it is possible to extract human and natural landscape pattern changes. Temporal changes can therefore be mapped for a range of purposes and intervals.

Change detection is usually accomplished by subtracting the images or performing correlation analysis to determine differences. The individual cells or pixels in the matrix contain numbers which can be subtracted, divided, or otherwise manipulated. By subtracting two images, the areas of change can be highlighted. It should be noted that there are several ways of highlighting areas of change, or creating change masks, ranging from very simple to very complex processes involving correlation analysis (Legendre and Legendre 1998; Verburg et al. 1999; O'Neill et al. 1999). Usually, a land cover change analysis will proceed initially with a baseline interpretation or classification for the most

recent time period. The development of an accurate change mask is critical for an accurate change detection analysis (Apan et al. N.D.; Baker 1989; Turner 1990, 2003; Corry and Nassauer 2005). With a good baseline, only the pixels in images for the previous time period that have changed spectrally are necessary to reclassify. The assumption is that anything that did not change significantly spectrally, did not change in the landscape. These pixels (representing no change) are simply replaced with the previous time period image classification. Digital image change analysis is limited to analysing time slices (discrete observations in time).

The analyst really only knows how a pixel was classified from one image to the next, and can only make inferences on the processes at work in between. However, many of the processes are readily apparent in the field, such as the transformation of forest and agriculture to development, and logging. Because we are analysing discrete time slices, landscape change is reported as from-to information in a change matrix which is set up with 'From' and 'To' designations; each pixel has a 'from' value (i.e. forest) and a 'to' value (i.e. development).

For a relatively long time-series analysis of change, rates of landscape or land use change can be estimated. As noted earlier, landscape ecology incorporates hierarchy theory in explaining spatial and temporal changes in pattern and structure over time and across patches, landscapes and regions (e.g. Forman 1995; Dale 1999). A procedure therefore, to delineate specific image objects and identify them, or 'track' them as they change through spatial scale over time is a valuable tool for integrating social-ecological elements for integrated resource management and planning (Liverman et al. 1998; Irwin and Geoghegan 2001; Liu and Taylor 2002; Hall and Hay 2003).

It is also possible to identify the amount of change between two images by image differencing the same band-width, if the two images have previously been rectified to a common base map and normalised. Image differencing involves subtracting the imagery of one date from that of another. The subtraction results in positive and negative values in areas of radiance change and zero values in areas of no change in the derived image of new change (e.g., Pan et al. 1999; Jones et al. 2001; Weng 2002; Alphan 2003; Vogt et al. 2006).

The change image produced using image differencing usually yields a brightness value distribution approximately Gaussian in nature, where pixels of no brightness value change are distributed around the mean and pixels of change are found in the tails of the distribution. A threshold value is carefully chosen to identify spectral 'change' and 'no-change' pixels in the change image. A 'change/no-change' mask is derived by performing image differencing on TM band 4 (Near Infrared), Normalized Difference Vegetation Index (NDVI), a Principle Components Analysis (PCA), or a combination of the three on the two dates of imagery recoded into a binary mask file (Legendre and Legendre 1998; Dale 1999; O'Neill et al. 1999; Pan et al. 1999; Jones et al. 2001; Kepner and Edmonds 2002). The change/no-change mask is then overlayed onto the earlier date of imagery and only those pixels that are detected as having spectrally changed are viewed as candidate pixels for categorical change. These candidate pixels are classified in the same manner as the baseline land cover analysis for consistency.

The two land cover classifications from different time periods are compared on a pixel by pixel basis using a change detection matrix. This traditional post-classification comparison yields 'from'-land-cover-class and 'to'-land-cover-class change information (Legendre and Legendre 1998; Dale 1999; O'Neill et al. 1999; Jones et al. 2001). Many pixels with sufficient change to be included in the mask of candidate pixels in the spectral change process did not qualify as categorical land cover change. This method may reduce change detection errors (omission and commission) and provides detailed 'from-to' change class information (see Apan et al. N.D.; Turner 1990; O'Neill et al. 1999; Corry and Nassauer 2005). The technique reduces effort by allowing researchers to focus on the small amount of area that has changed between dates.

A Change Matrix is a N x N table of all possible landscape changes where N is the number of thematic land cover classes in a study. The matrix is useful for quantitative interpretation of tabulated results measuring change between classes, such as Forest type 'Z' being cleared and becoming Bare Soil 'Y'. These tables show the exact amount of change, what the pixel was, and what it became. This matrix is critical to see the entire change analysis in one view and can be a powerful tool for examining landscape change (e.g. Jones et al. 2001; Jackson et al. 2004).

Methods for computer aided (GIS) identification of landscape patterns and change have quickly expanded in the last two decades to underpin the planning and management of landscapes and natural resources. There are numerous examples in which data containing information available from the visible (electro-magnetic) portion of the spectrum (e.g. aerial photography and satellite imagery) are combined with other data, such as biophysical (e.g. soil type, geology, climate, elevation) to increase our understanding of landscapes and provide the basis for resource management decisions (for examples, see Liverman et al. 1998; Legendre and Legendre 1998; Dale 1999; Jones et al. 2001; Kepner and Edmonds 2002; Turner 2003; Thackway et al. 2005). As water resources and water quality are likely to be major issues for natural resource managers in the future, it is notable that GIS/RS based analysis of land cover change can be linked to water resource degradation and other hydrological responses (Matheussen et al. 2000; VanShaar et al. 2002; Baker 2003).

In understanding trajectories of land cover change for alternative landscape futures analysis, an interval of around 4-8 years over several decades is preferable; however this will vary depending on the main parameters of interest, sampling scale and rate of change (Turner 1990; Mouat et al. 1993; Steinitz 1993; Steinitz et al. 2003). Remote imagery derived, landscape metrics of regional land cover provides a useful comparative baseline on the state and condition of the region at a given time. In terms of the alternative futures this baseline is usually the present. It provides the first step for scenario analysis by fulfilling the need to describe the landscape in terms of content, boundaries, space and time (Steinitz 1993; Steinitz et al. 2003; Brunckhorst and Mouat 2000; Kepner and Edmonds 2002). The measurements of pattern across the landscape provide a predictive inference (a change model) for measuring and assessing change, which provides insights to questions about how the landscape might be changes by current trends (producing future trajectories). Finally the combination of RS landscape change metrics combined with spatial data layers of other social, economic, planning and ecological attributes contribute to a comparative evaluation of alternative courses of planning, design and policy action (i.e. the alternative futures scenarios) that lead to the

decision model (Steinitz 1993; Steinitz et al. 2003; Brunckhorst and Mouat 2000; Kepner and Edmonds 2002).

5 Key drivers of change in social-ecological systems

Different processes of land cover change have taken place in different parts of the world in the last two decades (for example, there have been decreases in cropland in temperate regions and increases in the tropics), and have different impacts (Lambin 2005). Land cover changes may result from various actions including forest cover changes causes by selective logging, fires and insect damage; drainage or other alterations to wetlands; soil degradation in cropping lands; changes in extent and productive capacity of pastoral lands; dryland degradation; changes related to urban infrastructure; and lifestyle-driven changes (Lepers et al. 2005)

Australian landscapes have changed significantly since the beginning of European settlement and they will continue to do so into the future. The exploitation of natural resources may bring many economic and social benefits, however, this often comes at an environmental cost, such as alteration to ecological processes across the landscape. For instance, past agricultural developments in Australia have brought profit to many, sustained vibrant rural communities and contributed significantly to national economic growth. However, such agricultural practices have led to increased clearing of land and extraction of water for agriculture, resulting in negative impacts on land resources, river health, biodiversity, rural infrastructure and other sectors of the economy (Dunlop et al. 2002). However, such adverse impacts may be minimised by undertaking a long-term planning perspective that recognises the physical environmental, ecological, economic, social, cultural, and decision processes that characterise and control land use and land cover systems.

5.1 Understanding causes and drivers of land cover and land use change

Land use change is always caused by multiple interacting factors originating from different levels of organisation of coupled social-ecological systems. The mix of driving

forces of land use change varies in time and space, according to specific social-ecological conditions. At the time scale of a few decades, migration is the most important demographic factor causing land use change. While, at decadal time scales, land use changes mostly result from individual and social responses to changing economic conditions, which are mediated by institutional factors. Opportunities and constraints for new land uses are created by markets and policies and are increasingly influenced by global factors (Lambin et al. 2001). New technologies can lead to rapid shifts in land use practices. Institutions (political, legal, economic and traditional) at various scales, and their interactions with individual attitudes, values and knowledge systems, have a major impact on land use change. Globalisation can either amplify or attenuate the effect of driving forces of land use change.

Land use changes have multiple impacts on ecosystem goods and services at a variety of spatial and temporal scales. There are trade-offs between immediate human needs satisfied by land use, and maintaining the capacity of the biosphere to provide goods and services in the long term. Adopting a long-term view of land use change history in a given region is essential to understanding current changes and to predicting future ones as legacies of past land use changes.

Understanding the diversity of causes and drivers of landscape change is an important step in developing policy for managing our landscapes. Drivers of landscape change can be slow (climate change) or relatively fast (commodity prices); they can originate from within our landscapes (altered hydrology) or externally to them (national or state economic policies); and they can be physical, economic or societal. Over the last decade there has been an improved understanding of the complex dynamic processes underlying land use change, which has lead to more reliable projections and more realistic scenarios of future change. A wide range of land use change models are now available for different scales and research questions and are based on a variety of approaches. Different models of land use change address different questions, for example, location of change versus quantity of change. The use of land use change models to understand past and current causes and drivers of landscape change provides the first step in investigating alternative future landscape scenarios.

5.2 Socio-economic and demographic change analysis

In a world of fast-moving fashion and identity construction, lifestyles and, material and aesthetic consumption, socio-economic geographies have become increasingly complex (Dobers and Strannegård 2005). Much of the above review has already introduced many of the variables and drivers in socio-economic and demographic change, which is occurring at an increasing rate at the beginning of this new millennium. This has been exemplified in the media in recent times highlighting not only 'sea change' and 'tree change' migration, but also spatial shifts in other socio-economic variables such as jobs, incomes, lifestyle farming and the political landscape (e.g. *The Weekend Australian,* August 20-21, 2005, Feature pp.6-7; *The Australian*, February 30, 2007 p.13). All have significant implications for urban and regional planning and future environmental sustainability.

Apart from records of general trends in population demographics (e.g. Australian Bureau of Statistics CData 2003), mapping and spatial change analysis of socio-economic data has tended to focus on transport routes, migration and employment and 'catchment' areas for retail shopping centres (e.g., Burnley and Murphy 2002; Smailes 1999; Conley and Topa 2002; Hugo 2002; Frank et al. 2001). The way past census data has been collected presents challenges and limitations for spatial analysis, including; scaling, the shape and size of collector districts as well as uneven distributions in space for census variables (see Liverman et al. 1998; Voas and Williamson 2000; Blake et al. 2000; Frank et al. 2001; Hugo et al. 2001; Brunckhorst et al. 2005).

Less progress has been made towards spatial integration of socio-economic and ecological data for more sustainable natural resource management and planning (see Liverman et al. 1998; Turner 1999; Frank et al. 2001; Lindh 2003). Turner (1999) reviewed integration of social and environmental data and modelling for coastal zone planning and management. A 'pressure-state-response' framework was suggested focusing on links between ecosystem processes, functions and outputs of goods and services deemed to be 'valuable' to society (Turner 1999). In the Netherlands, a modelling system was developed to assist integrated assessment of socio-economic factors with environmental policies at three hierarchical levels from National to 40

‘economic regions’ to local ‘cellular’ levels represented by 25ha pixels (Engelen et al. 2003). Brunckhorst and co-workers derived ‘eco-civic’ regions for New South Wales by developing a modelling approach by using common trends of mapped primary survey data with census data, to examine areas of civic interest to local community residents. The width and extent of ‘valleys’ in the derived ‘social topography’ of communities of common interest provided flexibility to an optimisation for the best placement of a hierarchy of nested, regional boundaries representing both multiple environmental attributes (i.e. ecoregions) and areas of greatest interest to local communities (Brunckhorst et al. 2004; Brunckhorst et al. 2005). ‘Ecocivic’ regions might provide a more appropriate regional framework (c.f. political or agency administrative regions) within which to develop and assess alternative landscape futures. The present case study however restricts itself to the NSW Northern Rivers region of adjacent local government boundaries in accord with the areas that current plans, regional development and other strategies and census data aligns.

In examining causal and possible future trends and alternative scenarios it will be useful to be able to map and analysis socio-economic change in a similar way to land cover change as suggested by Geoghegan et al. (in Liverman et al. 1998: 51-69). Overlays of landscape change and socio-economic change could provide insights into drivers and future directions, as a method to assess scenarios, and to help understand probable socio-economic change which might occur under various alternative landscape futures scenarios.

6 Redesigning Future Change: Planning for Alternative Futures

Regional communities are in their current situation and place due to past policies, socio-economic drivers and ecological change — an altered landscape with various possibilities for the future. A variety of regional planning designs might exist for more or less sustainable futures; some possible, others probable, and a few practical and plausible. This project adapts such an approach to trial, for the first time in Australia, an alternative landscape futures design and analysis study on the rapidly changing coastal region of the Northern Rivers of NSW. The objectives of this study are to improve on

this approach and related methodologies within it and, to demonstrate its use through application (to the northern NSW case study region), so that the techniques might be further adapted for use elsewhere in Australia. In the first instance however, the regional context of a social-ecological system has multiple pasts and a converging present (drivers of change), which will shape options for alternative futures.

There are often multiple views of the past reflecting different directions influences on landscape pattern and use have come from. These are not isolated states but elements of a continuum of interdependency that affects one of several potential futures (List 2004; MacKay and McKiernan 2004; Dortmans 2005). Local to regional community identities can also play a substantial role in determining (more sustainable) visions for landscape change and desired futures (Stewart et al. 2004; Dobers and Stannegård 2005). This 'sense of self-in-place' can be used directly in a spatial context for integrated environmental policy making and planning (Cantrill and Senecah 2001). The future is also an iterative continuum of interdependent changes, which span the gap between the present, projected changes and alternative futures. Therefore an additional challenge for plausible, aspirational and sustainable future landscape scenarios is to provide an effective and efficient process for transition with present and future communities (van Notten et al. 2003; Nassauer and Corry 2004; Dortmans 2005; Dobers and Strannegård 2005).

6.1 Scenarios and planning

Scenario and alternate futures analysis uses integrated models to direct analysis on the best available range of spatial and temporal data. Integrated modelling uses a suite of models and associated data representing different social, economic, and environmental processes such as transportation, land use allocation, hydrology, soil erosion, wildlife viability, and so forth. Models could be connected in different combinations to address different environmental problems. A modelling capability needs to be spatially explicit and able to deal with several different spatial scales. A key characteristic is an ability to analyse historic conditions and to forecast future conditions, as well as to assess current conditions (O'Neill et al. 1986, 1997; Turner 1989, 1990, 2003; Hansen and DiCastri

1992; Legendre and Legendre 1998; Turner et al. 2001; Kepner and Edmonds 2002; Liu and Taylor 2002). In addressing 'real-world' problems, the modelling capacity should ideally have appropriate user interfaces for different kinds of audiences, be they municipal planners, or national or sub-national agency resource managers, or policy analysts.

There are a number of dimensions of attributes along which any model might be placed. Starting with space-time context, it is obvious that any model can be either solely applied to a single time or place, or to multiple times and places. The current project considers a single study area and the time sequence of events and spatial structure of the area. Related to the temporal structure of a model is the specific capability for retrospective or prospective modelling, in other words, an ability to cast backwards to an historical state or forwards to possible future states. Models also differ in their level of dynamism from strictly statistical associations of empirical data to time dynamic simulation of environmental, economic, or social processes (O'Neill et al. 1986, 1997; Turner 1989, 1990, 2003; Hansen and DiCastri 1992; Legendre and Legendre 1998; Turner et al. 2001; Kepner and Edmonds 2002; Liu and Taylor 2002).

The development and analysis of scenarios can take various styles depending on the predictability of key variables, the role of controllable and uncontrollable drivers, and the purpose of the exercise (Dunlop et al. 2001). Three typical uses of scenarios are: for choosing between alternative futures (Which of these scenarios do we want to make happen?); strategies for testing new equipment or machines (Is our strategy robust to these different possible futures?); and, to help predictions (What factors might give an early indication that one or other of these scenarios is going to unfold?).

Scenarios move away from ordinary predictions about the distant future by investigating what a desirable future would be and then try to figure out how to make it feasible. As such, a set of scenarios can be used to help test the possible long-term consequences of a specific decision in each of the scenarios, or what policies might be required to achieve, or prevent, a specific long-term outcome in each scenario? In this way it would be possible to determine whether a single policy would be robust to uncertainty in the

future, or whether a portfolio of policies might be more appropriate to cover different contingencies (Dunlop et al. 2001).

The discipline of scenario planning has evolved to help planners and policy makers cope with uncertainty in the future. Scenarios of land use change help to explore possible futures under a set of simple conditions by summing up current knowledge in the form of consistent, conditional statements about the future. Scenario planning is based on the premise that the future is not 'knowable'. As such scenarios are hypothetical possible futures that may or may not be realised. Hence, scenarios are not predictions or forecasts. Scenarios should be rich and multidimensional, and a set of scenarios should not be based simply on high, medium and low values of a single dimension nor simply provide a pessimistic and an optimistic outlook (O'Brien 2000).

The strengths of scenario planning derive from it being a fundamentally integrative approach to thinking about the future. Participating in the development of scenarios that are an inclusive view of a possible version of the future integrates social, biophysical, economic, technological, cultural and demographic dimensions in a way that more reductionist planning processes cannot (Bennett et al. 2003).

Scenario building can involve policy makers and stakeholders to define and negotiate relevant scenarios. An important step in this process is the visioning of desirable futures. Visioning can be effective means to involve the community in planning for their future. The visioning process identifies challenges and issues facing the community and courses of action required to bring about a desired future. Visioning can answer some questions about the future of communities. Thus, it can increase public involvement in planning for the future, and it can build awareness of what can be done to enhance a community's quality of life.

Scenarios provide insights into possible consequences of change for social and ecological systems and the interaction of these systems, and facilitating improved decision making for management of land and of systems in which land dynamics play an active role, such as ecosystems, and water and carbon cycles (Aspinall and Justice 2003). Thus, scenarios allow decision makers to anticipate their reactions to different future possibilities, to anticipate time-frames beyond the immediate future, and to make choices (Peterson et

al. 2003). They should include a description of the present situation, a number of alternative futures, and possible pathways connecting the present with images of the future. Alternative futures than can be evaluated and compared (Steinitz et al. 2003).

Scenario planning requires knowledge of the region, the local and world forces or drivers shaping it, and how these drivers might possibly combine into scenarios. This requires an examination of past and possible future trends. Scenario planning involves testing the robustness of current and emerging strategies and policies, public and private, against the set of scenarios that strategic thinkers, investors and community members develop. The process of designing and developing scenarios is as important as the final scenarios themselves. The process helps deconstruct biases and preconceptions about the future, provides active learning about future opportunities and threats, and engenders future-oriented, proactive strategy rather than reactive decision making (Bennett et al. 2003). This results in decision makers being better prepared to make better policy and take strategic action (Dunlop et al. 2002).

6.2 Alternative landscape futures design scenarios

In landscape planning, 'scenario' refers to the different possible stories, or alternative assumptions, that underlie landscape change (e.g. policy); the landcover pattern and functional consequences that may be an outcome of the scenario is referred to as a 'future' (Steinitz et al. 2003). For landscape scenarios, the alternative futures are explicit, spatially-specific representations of landcover patterns: maps, digital imaging simulations, or even drawings, rather than only quantitative outcomes (Nassauer and Corry 2004). This has implications for policy: allowing decision makers and the broader public to literally visualise the alternatives.

Scenario approaches have been suggested as a means of integrating the science of landscape ecology with landscape planning (Ahern 2001), and a wide array of scenario approaches is being used by landscape ecologists (Johnson et al. 1999; Steinitz and MacDowell 2001; Tress and Tress 2003). More broadly, scenarios have been used to anticipate environmental and human effects of trade, agricultural, forestry, and land use

policy — including climate change and biodiversity loss (Bennett et al. 2003; Cocks 1992; Peterson et al. 2003).

The science of landscape ecology is particularly apt as a basis for developing scenarios because it allows scenario designers to experiment with inventing land cover patterns that are expected to have selected ecological functions that society values (Swetnam et al. 1998; Ahern 2001). Thus, allowing for long-term perspectives that recognise the slow ecological processes underpinning landscapes. For landscape ecology, images of the future have an additional advantage: they depict landscape patterns that can be generated and tested by interdisciplinary thinking. Maps encoded as appropriately scaled and classified coverages in geographical information systems (GIS) allow experts from different disciplines to make inferences from a single landscape pattern to a wide array of ecological, economic and cultural functions.

Scenarios that embody stakeholder values and choices about landscape patterns can be very helpful in pointing out the implications of potential decisions about particular landscapes. Developing scenarios can engage stakeholders in articulating their values, building consensus, or understanding a problem (Ahern 2001; Peterson et al. 2003). For example, a scenario developed by stakeholders might engage citizens in envisioning alternative locations for residential development in a rural area, and the habitat effect of the alternative futures could then be measured (Nassauer and Corry 2004).

A number of alternative future scenario projects have been conducted in different parts of the world. High profile examples of various scale uses of scenarios include the following.

1. Alternative landscape futures in the Netherlands, where the Dutch Government has generated spatial scenarios describing possible future urban and rural environments in the Netherlands as a means of initiating a conversation with the community about preferred spatial future. The scenarios therefore, were used as a means of engaging the community in the Netherlands at regional level about the sort of spatial planning policy that the community wanted.

2. Alternative future scenarios for two watersheds in Iowa, USA, where spatially-explicit models were develop to evaluate the potential consequences of changes in farmland management. This project developed alternatives intended to improve the understanding of landscape ecology in agricultural ecosystems and to inform agricultural policy. Scenarios generated were used to assess the impacts of land use change on water quality, social and economic goals, and native flora and fauna (Santelmann et al. 2004).

3. Alternative landscape futures for the Upper San Pedro river basin in Arizona and Sonora, where the scenarios generated in the research assessed the potential future impacts in terms of land use development, hydrology, vegetation, landscape ecology, species and habitats, and visual preferences (Steinitz et al. 2003).

6.3 Outline of approach to alternative landscape futures techniques

Alternative Landscape Futures (ALF) scenario approaches can be adopted as a regional planning and community-based approach to the design and evaluation of future sustainable landscapes, incorporating the biophysical, social and economic constraints, or trade-offs, and potential emerging new industries and integrated regional development. ALF scenarios will often challenge governments, community leaders and the local people to decide for themselves if they want to implement action towards a desired future (time +). If they do, over the course of time that landscape will become a present landscape, and eventually a past landscape (time –). The cycle of observation, analysis (with new information), development of future scenarios, reflection on a preferred future, and adaptive change should continue as illustrated in Figure 2 (Brunckhorst 2002).

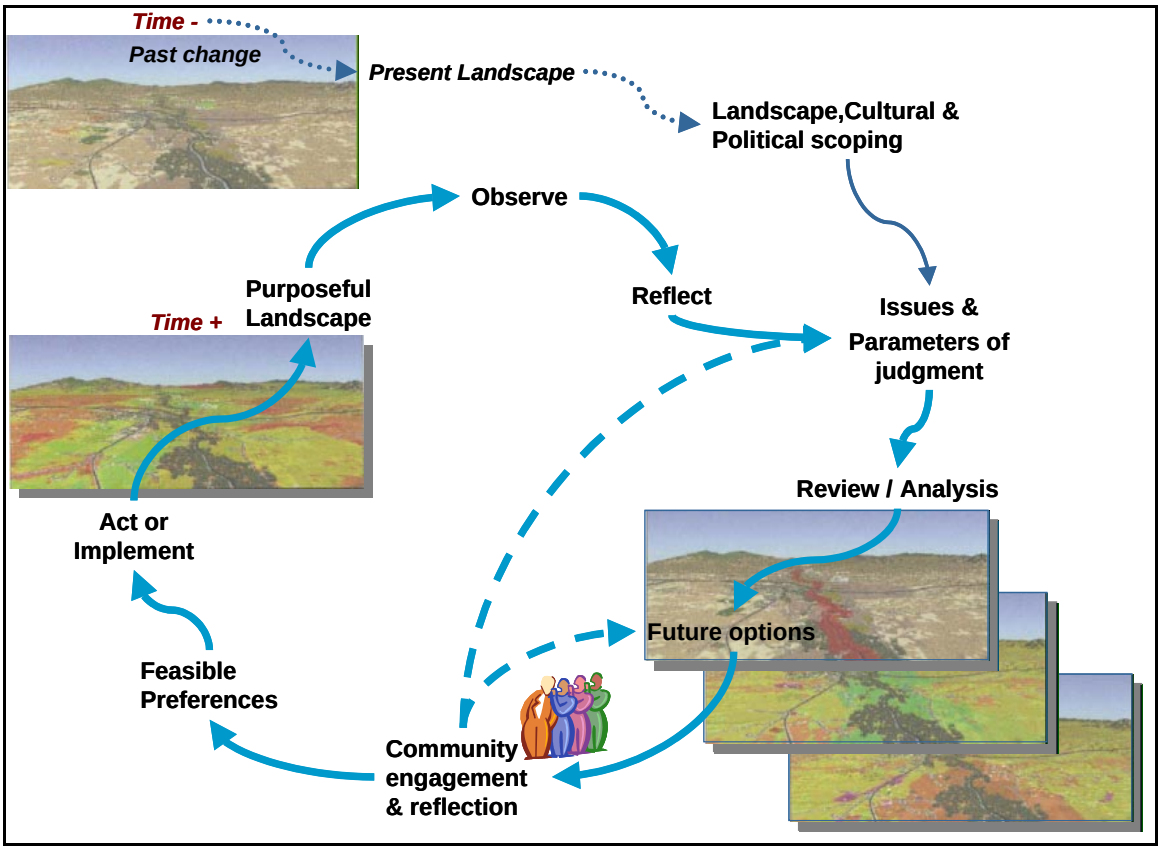

Figure 2. Cycles of adaptive implementation of ALF scenarios by local to regional communities and policy makers (after Brunckhorst 2002, 2005).

6.3.1 The Steintz alternative landscape futures analytical framework

Professor Carl Steinitz (Harvard University) developed the alternative landscape futures scenario analysis and design approach. The Steinitz research framework (Figure 3) is the primary methodological driver of the ALF process (including community and stakeholder engagement) providing a clear direction (path), while allowing flexibility to deal with case-study specific context and issues that will inevitably arise. The framework for design analysis identifies several different questions; each is related to a theory-driven modelling type (Figure 3 boxes).

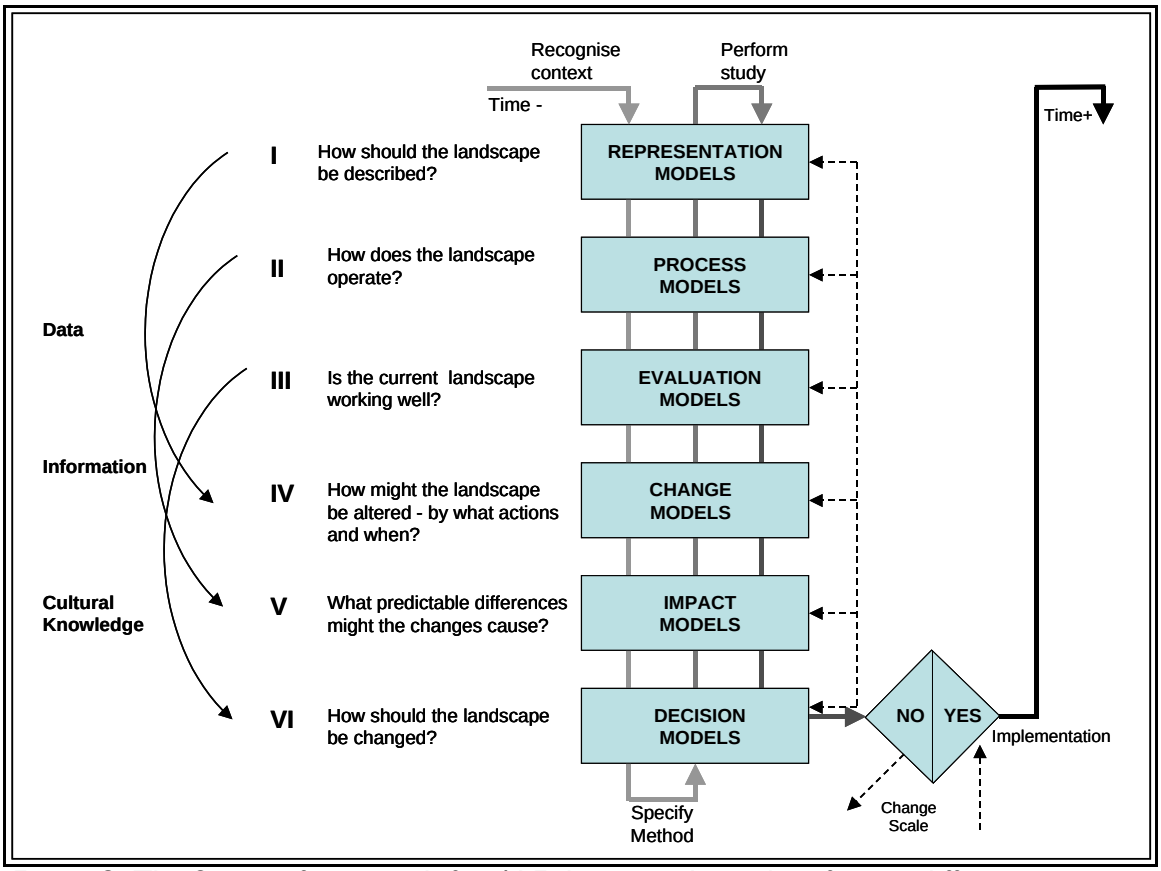

Figure 3. The Steinitz framework for ALF design analysis identifies six different questions, each related to theory-driven modelling or analysis (Steinitz 1990, 1993; Steinitz et al. 2003).

The procedural path initially starts from the top passing down through each series of questions required of each model. This 'first pass' specifies the context, content and scope and defines specific questions (within each of six major questions) specific to the context of the study area.

1. How should the state of the landscape be described in terms of components, boundaries, space and time (e.g. might include prior and projected landscape change)? This group of questions leads to Representation models.

2. How (generally) does the landscape operate? What are the main structural and functional relationships amongst components? This gives rise to Process models.

3. Is the current landscape functioning well? And what are the parameters of judgement (e.g. ecosystem health, community health, aesthetics, water supply, production, economies)? This leads to Evaluation models.

4. How might the landscape be altered? And by what actions, where and when? This line of inquiry relates to the first modelling type and gives rise to Change models (this level will have multiple elements, including community values and visions; what actions, where; types of change projected and preferred). At least two important types of change will be considered: change by current projected trends, and change by feasible design elements (such as plans, investments, regulations, synergies of industry placement, land use and infrastructure development).

5. What predictable differences might the changes cause? This set of inquiry is related to the second modelling type as both are based on information and predictive theory. This leads to Impact models in which Process models are used to simulate change.

6. Should the landscape be changed (comparative evaluation)? How should evaluation and comparison of the impacts of alternative changes (future landscape scenarios) be made? These questions relate to the third modelling level in that both are based on knowledge and cultural values (providing preferences on reflection). This final level of inquiry leads to Decision models (Which is/are the preferred future/s options?).

After recognising and describing the context and scope of purposeful landscape change, decision makers and stakeholders need a means of deciding on whether or what to change and a way to compare alternatives. Deciding how to answer the questions, what data is needed, and how it might be examined or synthesised is the next part of the process. Therefore the path reverses to travel upwards to define data needs and specific methodologies of assessment. These strategic elements (type of data, methods for analysis, mapping and design) required to undertake the design analysis are specified and organised by proceeding upward through the levels of inquiry. Each level defines its

necessary contributing products from the models next above in the framework as follows (Steinitz 1990, 1993; Steinitz et al. 2003):

Decision:	To be able to decide to propose or to make a change (or not) a process for comparing alternatives is required.
Impact:	To be able to compare alternatives one needs to predict their impacts from having simulated changes.
Change:	To be able to simulate change, one needs to specify (or design) the changes to be simulated.
Evaluation:	To be able to specify potential changes (if any), one needs to evaluate the current conditions.
Process:	To be able to evaluate the landscape, one needs to understand how it works.
Representation:	To understand how it works, one needs representational schema to describe it.

Then, in order to be effective and efficient, a landscape futures design and planning project should progress downward at least once through each level of inquiry, applying the appropriate modelling types:

1. Representation
2. Process
3. Evaluation
4. Change
5. Impact
6. Decision.

While implementation might be considered a further level, this applied research framework considers implementation action as a forward-in-time (time +) feedback to the first level (the creation of the changed representation model — a purposeful landscape; see Figures 2 and 3 above). The time-scale relationships assume that the

design and (community) implementation actions were preceded by similar considerations, and that they will in the future, be reconsidered.

The ALF framework allows communities, local government and other stakeholders to envision and develop various scenarios of how they see their region and its landscapes, land use, industry and infrastructure development and living space in the future. To build potentially real and applied futures scenarios and design their layout 'on-the-ground' (mapped onto a landscape) these elements will need to be worked through several times iteratively (beginning with the 'first pass scoping') to work towards a decision model for a redesign outcome or plan.

Visualisation, analysis and evaluation is accomplished using GIS techniques and iteration with alternatives and stakeholder's increasing understanding of multiple issues as they are identified. Alternative landscape futures scenarios are assessed and several identified to be discarded. Others are identified for further design alternatives and assessment. At the extreme, two decisions present themselves: ' no' and 'yes'. A 'no' implies a backward feedback loop and the need to alter a prior level. All six levels can be the focus of feedback; hence, 'redesign' is a frequently applied feedback response. Through assessment of the communities/stakeholders 'preferred' futures, it is expected that several alternative future patterns of land uses and development might be identified. The resultant impacts that 'preferred' scenarios might have on patterns of ecological resource issues, regional development and socio-economic factors can be assessed and options reconfigured to elaborate the 'best' alternative scenarios — ones that might be acceptable for implementation.

6.3.2 Variations to Steinitz' alternative landscape futures approach

In a particular landscape context there may be one or a few ecological attributes which are the primary limiting factor/s and driver/s of any plausible future. For example, in the Steinitz et al. (2003) ALF study of the Upper San Pedro river basin in Arizona and Sonora, hydrology, and ground water in particular, was the most important influence on current and future land uses.

We noted at the beginning of this section that Dunlop et al. (2001) considered scenarios that were distant to ordinary predictions worth investigating to assess what a desirable future would be and then how to make it feasible. This approach opens a wide range of possibilities for novel change by being unconstrained by the current 'state' or description of a landscape and pressures of change. However, deciphering a plausible and practical future capable of being implemented becomes a greater challenge.

Socially maintained norms and values drive interpretations and interests of those involved or consulted in scenario building and analysis (Van Wynsberghe et al. 2003; van Notten et al. 2003; Nassauer and Corry 2004). In their review, van Notten et al. (2003) distinguished between descriptive scenarios that explore possible futures (sometimes referred to as baseline or reference scenarios), and normative scenarios that describe probable or preferable futures. Normative landscape scenarios for regional policy and planning create the potential for a science – community – policy engagement that provides realistic means of producing more sustainable (simulated) futures for change that can be implemented (Nassauer and Corry 2004).

A study of scenarios for land use change in central Europe (Prieler et al. 1998) was developed to assess potential effects of accumulated heavy metal pollution in a region incorporating south-western Germany, northwest Poland and the northern part of the Czech Republic. The study was part of the Regional Material Balance Approaches to Long-Term Environmental Policy Planning at the International Institute for Applied Systems Analysis. Land use and land management have a major influence on the fate and impact of heavy metals. Some land management practices also effect soil characteristics that determine accumulation of heavy metals and release of toxins. Future land use in this region is highly uncertain; therefore Prieler and colleagues (1998) developed three very different scenarios, of which all were possible but not equally probable. In this study past change and policies were considered to be less useful in predicting future trends because of enormous uncertainty of a range of factors, including a higher probability of radically different future policies. Major social disruption, due to agricultural production decrease and labour outflow, was accepted as unavoidable.

The Metro Quest and Envision suite of modelling and visualisation tools were developed through the University of British Columbia (Canada) by Dave Biggs, Mike Walsh and Jeff Carmichael. The focus of these programs is for facilitating community dialogue in envisioning a future and as user friendly decision support tools via the exploration of scenarios and consequences for sustainable futures. The futures study of the Georgia Basin of British Columbia (Dale and Hill 2001; Van Wynsberghe et al. 2003), involved a wide range of stakeholder engagement in a modelling process facilitated by previously identified alternative futures scenarios. An iterative process was used with local communities and stakeholders to assess and adapt 'quasi-valid' landscape futures options. There were considerable challenges to balancing local expert participation in dampening a wider ranging, flexible and innovative envisioning that community participants were willing to engage in (Van Wynsberghe et al. 2003).

Integration of environmental considerations into all areas of policy for sustainability is one of the European Union's primary objectives. In England, major policy changes relating to regional development and governance in the late 1990s created new opportunities to consider alternative futures across urban and rural landscapes at a regional level. In the north-west of England, six defining characteristics effecting the future became the main drivers and variables in examining alternative scenarios. These were: the largely urbanised population; significant rural areas; the multi-centred nature of the region; the industrial age legacy, which includes derelict mines and pollution; and, a long coastline (Lindley and McEvoy 2002; Puglisi and Marvin 2002). A '4-sight' model that focuses on resource flows auditing for sustainable resource management was used to guide development of a spatial atlas and future scenarios. This approach was considered a useful contribution of data and tools to underpin decision making and further policy development (Lindley and McEvoy 2002).

The Pacific Northwest of North America, in particular in Oregon, has been the subject of several studies in regional planning for social-ecological sustainability (Johnson et al. 1999; Johnson and Campbell 1999; Baker et al. 2004). Public and community involvement has been a feature of these studies and alternative futures assessments including implementation (for example, using economic development as an ecosystem

restoration and management strategy; Johnson and Campbell 1999). The alternative futures 2050 study of the Willamette Valley of Oregon (using a modified Steinitz approach) examined scenarios based on current trends, development and conservation (Baker et al. 2004).

In the course of our work in adapting and using Carl Steinitz' general framework, other models will be incorporated where useful. We will also be contributing additional analyses including; a visualisation of trajectories with an understanding of the (trend based) rate of future landscape change; development of a demographic socio-economic change analysis spatially and temporally comparable to the landscape change analysis; limits imposed by key resources or ecological attributes and their spatial arrangements (e.g. habitat, water, agriculturally productive land); and, community aspirations, visions and values. Our procedure for Alternative Landscape Futures analysis will combine a trend/trajectory approach (e.g. Baker et al. 2004; Hulse et al. 2004) with scenario development and evaluation (e.g. Steinitz et al. 2003). Our approach includes baseline or reference scenarios from trajectories of past change, but our focus is to provide plausible and practical scenarios for sustainable futures, therefore aiming to produce normative landscape scenarios (see Nassauer and Corry 2004; Hulse et al. 2004). The outputs of our process will provide a generalised understanding of the major landscape interactions influencing future landscapes, as well as spatially explicit evaluations of several trend and alternative landscape futures scenarios for the northern New South Wales coast.

7.0 Description and Literature relating to north-eastern NSW case study region

Located in the north-east corner of New South Wales, the Northern Rivers is a rapidly growing region of over 250,206 people, covering an area of approximately 20,896 sq km (NRRSS 2005a, b, c). The region is bounded by the Queensland border to the north, the NSW coastal line to the east and the Great Dividing Range to the west that extends from the Queensland border through to just south of Grafton (Figure 4). The region

includes the local government areas of Tweed, Byron, Ballina, Lismore, Kyogle, Richmond Valley and Clarence Valley (Figure 4).

The region experiences a warm subtropical climate that provides a wide range of lifestyle opportunities in rural, urban, forested and coastal areas. The region is located within the Macleay-Macpherson overlap, this is an overlay between tropical and temperate ecosystems which comprises the southern-most limit for many tropical species and the northern-most limit for many temperate organisms (Ladiges et al. 2003; Benson 1991). Consequently, the climatic conditions and geographical location of the region means that the region has the second highest level of biodiversity in Australia, supporting species and habitats of local, regional and international significance (Ladiges et al. 2003; Benson 1991).

The region is characterised by three river valleys; the Tweed Valley, Richmond Valley and Clarence Valley; a scenic coastal escarpment with World Heritage rainforests, fertile farm land and its broad coastline. The Northern Rivers has a strong sense of identity around its environmental and lifestyle attributes. The region has a predominantly rural character and is widely recognised for its unique environment, diverse communities and village communities. The regional landscape is dominated by agriculture land uses (20 per cent), forestry (50 per cent) and land for environmental conservation purposes (30 per cent) (NRRSS 2005a, b). Until the late 1970s, dairy farming was a predominant agricultural land use within the region, but this has declined over the last 30 years (DOTARS 2003). Sugar cane has also been a significant industry, however, this has also experienced declines across the region. At present, macadamia nuts, bananas, avocados and beef are typical products of the region (DPI 2004).

Figure 4. Northern Rivers Region

Scattered throughout the regional landscape are the region's 300 cities, towns, villages and smaller communities or localities (NRRS 2001). Historical factors have influenced the current settlement patterns within the region, with initial European settlements being linked to early transport routes and land use practices for economic development. Consequently, the economic base of the region originally developed around its natural resources, stimulating the growth of agricultural and forestry industries. It was not until the 1960s that the settlement patterns started to be influenced by other factors. During the 1960s lifestyle reasons resulted in greater population concentrations in the coastal zone and then in the 1970s there was an emphasis on rural residential development (Cuming et al. 1996). The result has been the current settlement pattern that consists of agricultural holdings and dispersed rural subdivision, interspersed among a general distribution of village and smaller settlements with a focus on the region's larger towns and cities.

In the thirty years from the end of World War II to 1976, the Northern Rivers experienced relatively modest population growth, rising from 75,000 to 92,000 persons NRACC (2004). However, during the period 1976 to 2005 rapid population growth was experienced as the population more than doubled from 92,000 to nearly 278,000 (DIPNR 2004a, b, c). This growth tended to be concentrated in the coastal parts of the region. Consequently, 43 per cent of the region's population is concentrated along the coastal fringe with the remaining 57 per cent of the population scattered throughout the inland cities, towns, villages and smaller communities. At present the Northern Rivers is among the top ten fastest growing regions in Australia and population projections suggest that the region's population will reach 348,880 by 2031, this equates to 1.8 per cent of Australia's projected population (DIPNR 2004a).

7.1 Planning challenges facing the Northern Rivers region

The Northern Rivers region is undergoing substantial social and economic change due to the effects of population shifts, global competition and industry restructuring. The rapid increase in the region's population, together with changing land use is impacting on the Northern Rivers' natural environment, natural resources and on major

infrastructure requirements of the region. These pressures provide a serious threat to the unique features of the region (such as the rural and natural landscapes, rural activities, and diverse cultural and lifestyle opportunities) that are currently highly valued by residents and visitors.

There are a number of key planning challenges that face the Northern Rivers region as identified by NRRS (2005a, b), DIPNR (2004b. c) and NRACC (2004). The following lists the key planning challenges that have direct implications on the regional landscape:

- Managing high population growth, particularly growth in the coastal areas. This will require protecting fragile coastal environments and minimising urban expansion into coastal habitat areas and areas that are of importance from a landscape ecological perspective.
- Boosting the economy and promoting growth of inland towns and villages that are experiencing little to no growth. This will need to be achieved without compromising environmental values, while preserving regional heritage such as village characteristics, agricultural landscapes and natural landscapes.
- Approaching regional planning for infrastructure in a strategic and integrated. manner. Such that the maintenance, upgrading and new development of major infrastructure such as roads, seaports, dams and airports minimises impacts on the regional landscape while being located in areas that generate economic efficiencies and provide positive social outcomes.
- Protecting the natural resources on which industries (particularly tourism and agriculture) depend while providing for the growing population.
- Maintaining and enhancing the region's natural assets, particularly in areas where environmental quality is currently declining. This is important for maintaining ecological functionality of the region and for preserving natural landscapes that form an important component of the region's identity and regional heritage.
- Minimising the loss of farming potential due to industry restructuring, competition for housing on good agricultural lands and viability of current

agricultural activities. Particularly, focusing on the issues associated with the fragmentation of rural lots.

7.3 Key regional planning strategies and plans for the Northern Rivers

Since the late 1980s a number of regionally focused plans and strategies have been developed to address the pressures of change faced by the Northern Rivers region. These regional plans and strategies have primarily focused on dealing with the social, economic and environmental issues resulting from significant population growth and land uses changes across the region. The following summaries are of the key regional planning strategies and plans that are currently relevant to planning decisions for the Northern Rivers region:

i. North Coast Urban Planning Strategy

The North Coast Urban Planning Strategy was developed in 1995. This strategy covers the area from the Queensland border south to Port Macquarie and it identifies the areas that can accommodate more people and development while maintaining and protecting the region's environmental quality. The strategy nominates specific centres that are best able to grow. This strategy was developed to assist government decision makers, developers and the local community when dealing with urban expansion issues.

ii. North Coast Regional Environmental Plan

The North Coast Regional Environmental Plan 1988 plan covers all the North Coast local government areas except Greater Taree. It identifies environmental features that are important to the region and provides a basis for new urban and rural development. With an emphasis on careful assessment, the plan sets requirements for, and guides, the preparation and processing of local environmental plans and some forms of development.

iii. Northern Rivers Regional Strategy

The Northern Rivers Regional Strategy commenced in 1996. The strategy is the result of a partnership between the Northern Rivers Regional Economic Development Organisation, the Northern Rivers Regional Organisation of Councils and the Department of Infrastructure, Planning and Natural Resources. It was developed in consultation with interest groups and the community. The strategy is based on the principles of sustainable development and builds on the findings of the North Coast Urban Planning Strategy. It integrates land use planning, economic development and environmental management in a framework for managing sustainable growth and development in the Northern Rivers region. The strategy has produced many plans, policies and reviews that can assist organisations, such as government agencies, development and industry groups, and community and environmental organisations, that are involved in planning and developing the Northern Rivers region.

iv. Clarence Valley Settlement Strategy

The Clarence Valley Settlement Strategy was produced in 1999 and is part of the Northern Rivers Regional Strategy. This Strategy involved the then local councils within the Clarence Valley region (in 2005 these councils were all amalgamated into the Clarence Valley Council) adopting a valley-wide strategic approach to future planning. The strategy focuses on how the Clarence Valley can grow sustainably over the next 20 years up until 2020, in particular by aiming to locate population growth in areas that will have the least costs in environmental, social and economic terms. By dealing with urban and rural issues on a cooperative valley-wide basis, the aim is to preserve the unique values of the Clarence Valley while allowing a range of settlement opportunities.

v. Northern Rivers (Sustainable) Investment Plan

The Northern Rivers (Sustainable) Investment Plan presents a framework to manage the region's growth and development at the local government level in a way that integrates land use, social and economic planning and maintains the quality of life and environmental integrity of the Northern Rivers region. The plan integrates Commonwealth, State, regional and local planning requirements and considerations into

a single document with clear outcomes and policy directions. The intention of the plan is for it to be viewed as a useful resource for future planning in all areas of land use planning, natural resource management, economic and social/community development.

vi. Regional Industry and Economic Plan for the Northern Rivers

The Regional Industry and Economic Plan for the Northern Rivers was completed during 2005. This plan was facilitated by the Northern Rivers Region Development Board to provide a framework for all organisations and individuals involved in economic development. The plan has been prepared to provide guidance to the region's stakeholders regarding strategies and actions that can be implemented in order to develop a sustainable and robust regional economy which responds to emerging global economic forces and capitalises upon existing and emerging opportunities that are specific to the Northern Rivers. The plan is not intended to replace or override local economic development facilitation efforts. Rather the intent of the plan is to provide guidance and direction to assist all stakeholders in the region with an interest in realising sustainable business and employment growth.

vii. Integrated catchment management plans

Catchment Blueprints have been developed for the 21 catchments of New South Wales. There are two catchment Blueprints that are relevant to the Northern Rivers region. These blueprints are the *Integrated catchment management plan for the Northern Rivers catchment 2002* and the *Integrated catchment management plan for the Upper North Coast catchment 2002 (collated in NRCMA 2005)*. These plans have been developed in consultation with government agencies, community groups and landholders concerned with the management of the region's land, vegetation and water resources. These Blueprints for the region share a common vision of the management of natural resources underpinning ongoing access to cultural, economic, environmental and social benefits. The Blueprints have set ten-year targets for natural resource management activities to be undertaken in the region including but not limited to: (i) establishing conservation agreements over regionally significant ecosystems; (ii) re-establishing native vegetation in wildife corridors and riparian zones; and (iii) installing riparian fencing and

associated works including provision of off-stream watering and shade and rehabilitation of native vegetation (NRCMA 2005).

7.4 Visioning for the Northern Rivers region

Between 1996 and 2003 the Northern Rivers Regional Strategy (NRRS) undertook comprehensive future visioning programs with participants from State, Regional and Local Governments, interest groups and the community. In 1998 participants in the NRRS endorsed the following regional vision:

> *A healthy, prosperous and sustainable future for the communities of the Northern Rivers region.*

This vision can be further broken down into its main components as is documented in NRRS (2003) and are as follows:

i. *Healthy, Prosperous* means:

The NRRS is aiming to ensure that the people and natural environments of the Northern Rivers region are healthy, with high levels of mutual trust, co-operation and support within the region's communities, and there is sufficient material wealth to satisfy basic needs and wants (acknowledging that some people aspire to higher levels of material wealth than others).

ii. *Sustainable Future* means:

Recognising the links between the region's economy, environment and quality of life, now and in the future. Acknowledging that ecologically sustainable development and economically and socially sustainable development are synonymous. By striving for a sustainable future, the NRRS is aiming to achieve a balance between economic, environmental and social goals.

iii. *Communities of the Northern Rivers region* means:

Recognising the people in the region do not form a homogenous group. Communities can be defined by spatial boundaries, such as the Tweed, Richmond

and Clarence Valleys, or by particular characteristics, such as people adopting differing lifestyles.

This regional vision represents the ideal state that the people of the region are aiming to achieve within the region. It gives the people of the region something to aim and aspire for over the long term.

During 2003 the NRRS expanded on the regional vision to develop Desired Future Character Statement for the Northern Rivers. Again, this process involved participation from State, Regional and Local governments, interest groups and the community. A set of forward vision action statements or outcomes was subsequently developed. These statements and outcomes are documented in NRRS (2003). The Desired Future Character Statement and a summary of actions and outcomes for the Northern Rivers region are listed below.

The Northern Rivers region Desired Future Character Statement NRRS (2003):

> *'Vibrant, inter-connected villages; expansion through innovative learning, lifestyle and the three sectors of agriculture, tourism and knowledge-based industries; a mosaic of farms, forests, pristine wilderness and human settlements.'*

The following summaries the actions and outcomes that are believed to be necessary to keep the Northern Rivers special:

- **Keeping our strong identity as a region of diverse villages.** Not only do we share a common identity, but we recognise and celebrate the diversity and unique character of individual villages and places.
- **Reviving small town and village centres** and developing local employment opportunities to keep the Northern Rivers as a region of villages, each with its own distinctive sense of place and community.
- **Designing and providing services that encourage social interaction** and build social capital.

- **Protecting special resources** such as agricultural land, mining and forestry, and identifying 'no go' areas for human settlement, to keep the rural outlook of the area and prevent urban sprawl.
- **Improving the region's natural beauty** through programs to care for the land.
- **Establishing a formal reserve system** that protects all native animal and plant types and communities and passes on this biodiversity to future generations. This is very important, as the region is located in the Macleay-McPherson overlap and is the second highest area of biodiversity in Australia.
- **Recognising the region's World Heritage areas as critical assets** for biodiversity, tourism and recreation.
- **Leading the way in regional planning activities** to integrate between all levels of government in achieving the region's goals, and maintain local control over the region's future.
- **Investing significantly in new approaches to learning and innovation** to develop new job opportunities and contribute towards keeping young people in the region after they finish school.
- **Developing employment in the knowledge-based industries** to provide opportunities for groups (such as Aboriginals and Torres Strait Islanders, young people) that are vulnerable in the regional labour market.
- **Developing health care and home care related industries** to service the region's aging population and strengthen its economic base.
- **Leading development in clean and green industry** to protect the natural features which are a strong part of the feel and essence of the Northern Rivers, and a source of resources and inspiration for economic activities.
- **Maintaining the region's reputation** for a strong and personal connection between genuine, reliable and quality products or services and the people who wish to purchase them.

- **Recognising the importance of healing and spirituality to community well being.**
- **Expressing social and cultural diversity and creative energy** at markets, in arts and crafts, in the multi-media industry and in festivals and celebrations.

The intention of these statements is to expand on the Regional Vision in a more meaningful way, which details outcomes for the region's natural, social and economic capital by the year 2026. Each outcome is categorised in terms of its contribution to economic viability, natural resource management or community well being. The concept behind this approach was to ensure that the outcomes aim to achieve a balance between economic, social and environmental outcomes. The Alternative Landscape Futures project will endeavour to contribute design and planning elements to scenarios to guide community decision making to consider current trends and alternative pathways to these desired futures.
