Land

Author:

Tony Gleeson, Synapse Research & Consulting

Alex Dalley, Ministry of Agriculture Fisheries and Forestry, Dili, East Timor

Peer reviewers:
Craig Pearson, Dean & Professor of Agricultural Policy, OAC, University of Guelph

John Taylor, Director Rangelands, Australia

Citation:

Gleeson, T and Dalley, A 2006, 'Land', theme commentary prepared for the 2006 Australia State of the Environment Committee, Department of Environment and Heritage, Canberra, <http://www.deh.gov.au/ soe/2006/commentaries/land/index.html>.

Links to data:
In the following text, there are hyperlinks to indicator documents which informed the particular statement or comment to which they are linked. It should be noted that, at different points in the commentary, different words might trigger links to the same indicator document. The links are entirely context dependent. In some cases, hyperlinks are made to indicator documents which are now populated but for which data were unavailable to the commentary authors at the time of writing the commentaries.

Overview

Purpose

This is a commentary on trends in the condition of the land resource, the pressures on the land resource and the effectiveness of responses to those pressures since the publication of *Australian State of the Environment 2001* (*SoE2001*). The commentary is based almost exclusively on the data provided for this purpose and it is severely constrained by the lack of comparable trend datasets.

Condition of the land resource

There are few data to show an improvement in the condition of the land resource, those showing a reduction in the presence of chemical residues in foodstuffs and an increase in the extent of regrowth of woody vegetation in the intensive landuse zone being exceptions.

On the other hand, there are indications that the condition of the land resource continues to be threatened or is deteriorating, including:

- continued high proportion of threatened ecosystems
- continued decline in the extent of woody vegetation and inferred increasing age of remnant eucalyptus, especially in Southern Australia
- continued unsustainable rates of soil erosion
- no significant increase in vegetated stream length
- expected doubling over the next ten years of land affected by soil acidification
- significant levels of ammonia pollution from intensive animal production.

Pressures on the land resource

Pressures on land primarily arise from human settlements (see Newton 2006) and from agriculture.

There are no data to conclusively show an increase or a decrease in the pressures on land from agriculture since *SoE2001*, but the long-term trend of continuing substantial increases in the volume of agricultural production and more recently in irrigation are likely to be placing increased pressure on land.

Responses to pressures on the land resource

There are no data to indicate significant changes in the effectiveness of the responses to the pressures on the condition of land. Consequently, given that the condition of the land resource continues to be threatened or is deteriorating we conclude that either the pressures on the land resource need to be reduced or that new or additional response efforts will be required to ameliorate the impacts of those pressures.

The pressures on the land resource and the responses to those pressures come primarily from land managers and the public sector respectively. The responses from land managers are crucial simply because of the size of their investment in land management and because they are the people who make the land management decisions.

Institutional drivers of pressures on the land resource

Agricultural mindsets dominate institutional arrangements for rural Australia and, in turn, the beliefs and values that underpin agricultural activities are reinforced by the institutional arrangements they spawn. This reinforcing loop leads to institutional paralysis and a consequential maintenance of agriculturally generated pressures on the land resource.

Institutional challenges

The need for institutional change in relation to land management is as great in private sector organisations representing farmers as it is in the public sector. Almost without exception these organisations have been reluctant to develop strong and genuine land management partnerships with governments, catchment agencies and community groups such as Landcare. Unless this changes, the effectiveness of efforts to protect and improve land condition will be severely constrained, to the detriment of landholders and the community more broadly.

As a first step towards improving institutional arrangements all parties need to recognise and accept the multifunctionality of landscapes. Other requirements include:

- a fundamental re-conceptualisation of the role and nature of environmental legislation concerning land condition
- more sustained and holistically based forms of support for improving land management, forms of support that build on landholder motivations and capabilities, that are less transient, have lower transaction costs and which are well supported by environmental monitoring and evaluation
- arrangements for supporting innovation, which recognise the conditions necessary to enable creativity, the essential multifunctionality of landscapes, the multi-industry nature of most Australian farms and the need to support systemic and revolutionary innovations as well as incremental innovations directed towards the needs of existing operators in existing businesses.

Challenges—monitoring condition, pressures and responses

Effective national state of the environment reporting on land condition is now not possible because of the paucity of relevant time-series datasets.

There needs to be a more realistic assessment of what data can be collected by individuals and organisations responsible for environmental management at all spatial scales, from the individual land management scale through to subcatchment, catchment, regional and national scales. There is also a need for greater coordination between state of the environment reporting processes and national data collation projects.

Given the paucity of trend datasets for key biophysical parameters, it might be counterproductive to propose collection of additional datasets. Nevertheless monitoring arrangements that focus only on the condition of the land will not inform us of the beliefs and values that should govern the design and operation of institutional arrangements that impact both on the pressures on the land resource and on the responses to those pressures. Additionally there is a need for independent evidence-based assessments of changes in the effectiveness of institutional arrangements in relation to land condition. For instance, it would be possible through case studies to quantitatively assess the impact of regulation related to native vegetation.

Introduction

The purpose of this commentary is to discuss the implications of the data available for *Australian State of the Environment 2006* (*SoE2006*) to inform the Australian community about trends in the condition of the land resource, the pressures on the land resource and the effectiveness of responses to those pressures since the publication of *SoE2001*.

A commentary on data is both a reflection of the data and a reflection of the lenses through which the data are viewed.

The data provided for this commentary to identify these trends since the publication of *SoE2001* are very limited. This may be because the data are not available or because approaches used to assemble the data are not effective.

The extent to which the availability of trend data limits the usefulness of the commentary depends largely on the expectation or otherwise of discernible changes in key land condition indicators over what is, in the context of environmental trends, a short five years between state of the environment reports.

The commentary is based primarily on continental-scale data. The broad scale nature of these data obscures positive and negative trends that may be occurring in particular parts of the continent or in relation to particular landuses.

We viewed the data through two predominately rural lenses, one older and experienced in rural and environmental policy analysis and in land management, and the other younger and experienced in environmental management, communication and community development.

These lenses have concentrated our attention on agriculture, which is the principal landuse activity across much of Australia. We acknowledge however that impacts on landscapes arise also from other landuses, such as from human settlements and national parks.

A further limitation is that the scope of the commentary is limited primarily to the pressures and impacts on land arising from the activities of land managers. Reflecting a lack of data, there is little direct focus on the pressures and impacts arising from policies affecting consumption patterns for land-based products. For example, policies affecting the transport and retailing of food products affect the location and form of production, and hence land condition, as do policies promoting the industrial use of land based products, for instance for the production of ethanol. Nevertheless, this commentary does include an examination of the drivers of the pressures on the land resource. This examination raises the question as to whether or not these drivers support or retard the ecologically sustainable management of the land resource.

The particular issues dealt with in this commentary are:

- vegetation

- soil
- salinity and acidity
- species introduction
- pollution to and from the land.

Vegetation

Interpreting the data on Australian vegetation requires an understanding of the difference between native and non-native vegetation and between woody and non-woody vegetation.

For the purposes of this commentary, native vegetation is broadly defined as plant life present in Australia prior to European settlement. Non-native is plant life, such as cereal crops, many garden plants and introduced pasture species that have been introduced since European settlement. It is generally accepted that native vegetation is more likely to provide a better habitat for native fauna and flora, and that native species are likely to be better adapted to local conditions.

The status of native vegetation is a function of:

- initial vegetation
- vegetation loss
- vegetation gain from growth and thickening of existing plants, from unassisted growth of new plants and from plantings.

(Vegetation loss can be a result of fire, flood, drought, natural competition and native grazing, from clearing—broadscale, selective or thinning—or harvesting, from ground or nutrient disturbance including erosion, harvesting of biomass, and salinity, for example as a result of grazing pressure, from other ecosystem disturbance—such as loss of predatory or pollinating insects or invasion by introduced species—and, potentially, from poisoning as a result of pollution.)

The Australian Terrestrial Biodiversity Assessment, carried out in 2002 as part of the National Land and Water Resources Audit, assessed the condition of ecosystems and species in bioregions across Australia. Each state and territory was asked to identify threatened ecosystems, which were described as 'integrated units of vegetation including the dominant species in the principal stratum and structural formation, geology or soils and landform' (NLWRA 2002). The results show more than a third of Australian bioregions (39 per cent) have more than 30 per cent of their ecosystems threatened. Of these, the most dominant types of threatened ecosystems are eucalypt forests and woodlands. Vegetation data for *SoE2006* are primarily derived from remote sensing of woody vegetation. Woody vegetation is defined (in the National Carbon Accounting System dataset) as vegetation, native or non-native that

can grow at least two metres high and has 20 per cent canopy cover. Non-woody vegetation includes most introduced annual crops, as well as both native and introduced grasses, low shrubs and heath vegetation.

Despite woody vegetation potentially being a mix of native and introduced species it does play an important role. Woody vegetation generally provides better habitat and it is perennial, which also means it provides this habitat for the entire year. It is also high in biomass, providing good greenhouse sink value, and deep-rooted, with benefits for the maintenance of surface water absorption and groundwater levels.

The extent of woody vegetative cover in the Intensive Landuse Zone (ILZ) is still decreasing. In 2002 the extent of woody vegetation in the ILZ in Queensland was approximately 36 million hectares. This is almost half of the woody (perennial) vegetation cover in Australia. This was significantly reduced from the 1995 level of almost 38.5 million hectares (NLWRA 2001a).

The impacts of all modes of native vegetation loss are both immediate and long term. The impacts of high intensity pressures, such as broadscale clearing, are more visible and more easily quantified than are the impacts of less intensive pressures such as grazing of livestock, intentional clearing of dead wood by fire and firewood collection, increasing soil acidity, changed fire regimes and selective timber removal. Grazing pressure, for instance, is known to select against delicate palatable native species, whilst changing fire regimes can result in less frequent, hotter burning bushfires that favour quickly establishing invasive weed species. Such negative impacts could be further exacerbated if palatability declines and woody species growth increases as an outcome of greenhouse gas increases.

Regardless of the intensity of the various pressures, Australian native vegetation species and communities continue to decline in their distribution and diversity and, in many cases, introduced vegetation has extensively replaced native vegetation; for instance, temperate pasture and cropping species in southern Australia and Buffel Grass (*Genus spp.*) in the Queensland brigalow woodlands.

Whatever the value of native vegetation *versus* that of non-native vegetation, the reality is that non-native vegetation is now an integral part of many Australian ecosystems. Given this mix of native and non-native components, vegetation is increasingly likely to be measured and assigned values according to the objectives of vegetation management, for example greenhouse gas abatement, protection of endangered species, protection of biodiversity, protection of surface water catchments for human water supply, protection of groundwater to prevent salinity, protection of soil from water or wind erosion, exclusion of non-native species, or any combination of these. Good examples of this are the use of more productive non-native species for the production of food and fibre and the use of particular introduced species to colonise bare burnt ground precisely because they recolonise more quickly than native species, thereby protecting and restoring the soil to the point where native plants can also recolonise.

Remote sensing data do not distinguish between native and non-native vegetation or provide a measure of the condition of the vegetation in biodiversity terms. Consequently, as the criteria used to assess the status of vegetation may vary considerably according to the objectives of vegetation management, it is necessary to interpret remote sensing data together with data on species composition, landuse and land management practices at lower spatial scales. In fact, given the increased focus on catchment level planning and monitoring it may well be timely to consider intergovernmental, catchment-level state of the environment reporting.

Broadscale clearing of native trees is the most visible and controversial aspect of ecosystem modification and hence it attracts considerable attention; but the potential impact of broadscale and selective tree clearing is not evenly distributed between ecosystems. In regions where past tree clearing has dramatically reduced the level of native vegetation, particularly in southern Australia, the most critical factor influencing future vegetation status will be the management of remnant trees to allow for and even encourage regeneration of more sustainable lots of woody vegetation.

There are many drivers of broadscale tree clearing and or the prevention of regeneration of woody vegetation including financial, aesthetic and social factors and their relative importance varies between places and over time.

Broad scale clearing of woody vegetation is prevented principally by legislation, whereas in areas already largely cleared, regeneration of woody vegetation is supported by financial incentives of varying forms. These different policy instruments have markedly different impacts on landholders, particularly as there is a clear financial benefit in many areas from the clearing of woody vegetation. A 2002 report by CSIRO found that restricting access to cleared riparian areas on four farms in Queensland reduced net profit by between 29 and 77 per cent across the four farms (Pyper 2002).

A prime driver of the destruction of many communities of native species, particularly communities of non-woody native species and of measures to prevent regeneration of these communities, is the belief, rightly or wrongly, that native species are less agriculturally productive than introduced species. At the margin this belief is being increasingly questioned as more effort is being directed towards designing agricultural systems that more closely mimic natural systems. For instance, native eucalyptus species now dominate forestry plantings and there is an increasing interest in mixed species plantations which may provide better habitat than monocultures of, for instance, *Eucalyptus globulus* (DAFF 2001).

This new way of looking at the value of native vegetation will assist in the prevention of clearing of woody vegetation and in the enabling of regeneration of woody vegetation. In fact, the amount of regrowth in the ILZ has been increasing (AGO 2004). Nevertheless, the political conditions and policies governing the status of woody vegetation are broadly unstable.

We conclude that further and more effective responses will be required to arrest the decline in the extent and diversity of Australian native vegetation species and communities.

Soil

As identified in previous state of the environment reports, soil loss and soil movement are important determinants of land condition because they create negative feed back loops through reducing the organic matter and nutrients available to sustain vegetative growth, and hence ground cover. Nevertheless, soil related trend datasets have not been made available for this commentary.

The data presented in *SoE2001* show that annual soil loss is commonly greater than one tonne per hectare across most of Australia. This is approximately twice the rate that Loughran, et al. (2004) cite as the agreed rate (adjusted for location and seasonality) at which soil is replaced by organic decomposition.

Soil loss is principally due to water and wind erosion, both heightened by practices that reduce surface cover. An in-depth description of the process of soil loss can be found in *State of the Environment Report Tasmania 2003* (RPDC 2003).

The National Land and Water Resources Audit (NLWRA 2001a) shows that, in the ILZ, erosion on native pastures accounts for 76 per cent of total soil erosion (5.7 t/ha/year), with a further eight per cent (4.7t/ha/year) and six per cent (8.9 t/ha/year) being accounted for by erosion in unmanaged woodlands and national parks respectively. The Audit concludes that 'the biggest total contribution to soil erosion in Australia is from the vast semi-arid woodlands and grazing lands in northern regions'.

In their nationwide study of rates of soil loss, Loughran et al. (2004) measured annual rates of erosion of 5.5 tonnes per hectare in rangelands sites around Australia. The Audit data show also relatively high rates of erosion on sugar cane (37.2 t/ha/year) and cotton (7.0 t/ha/year) lands but together those lands account for only 1.7 per cent of total erosion in the ILZ.

The overall picture is that over 70 per cent of the ILZ has erosion rates ten times greater than the estimated average natural rate of erosion. The effects of this erosion over time are, at best, cumulative resulting in continued deterioration of the condition of land.

The net flow of soil nutrients reflects the balance between nutrient export through erosion and agricultural production, and nutrient import through soil formation and applied nutrients.

Particulate (sediment-bound) phosphorus and nitrogen flows arise from hillslopes, gullies and river banks with hillslope erosion being the greatest contributor (approximately 65 per cent) of particulate phosphorus and nitrogen flows; with nutrient flows into the Burdekin (nitrogen only), Fitzroy and Murray-Darling river systems being of particular quantitative importance (NLWRA 2001a). Urban point-source discharges can also be a substantial source of nutrient

discharges into waterways, representing, for instance, 31 per cent of the total phosphorus load in the Moreton Bay region in Queensland (NLWRA 2001a).

There are both local and distant impacts of these soil related nutrient flows, with great variation between river systems in the proportion of nutrient loads being discharged at river mouths.

The environmental and human impacts of discharges vary greatly, depending on the location of the discharge, with particular sensitivity being assigned to nutrient discharges in close proximity to human settlements and to the Great Barrier Reef. It is reasonable to presume a causal relationship between grazing and cropping and soil erosion given that agricultural activities dominate much of the ILZ and the patterns of erosion according to land types and landuses as described above. However the high rates of soil erosion in national parks signal a need for caution in attributing high erosion rates simply to agricultural causes and further analysis of the extent and causes of erosion in national parks appears warranted. Furthermore, the NLWRA (2001a) concluded that an assessment of the impact of landuse practice on erosion rates could not be undertaken due to a lack of spatial information.

The need to address soil erosion has been evident for at least 50 years and agricultural management practices to do this, generally having the intermediate impact of maintaining adequate ground cover, are well known. They include retention of native vegetation, not undertaking agricultural activities on areas particularly susceptible to erosion, adjusting grazing pressure from both domestic and wild species, modifying grazing strategies (as distinct to grazing pressure), minimum tillage, soil conservation works and stubble retention.

In the absence of a long-term land care ethos or interventions to encourage adoption, increasing productivity rather than the prevention of soil erosion is likely to be the primary driver for most of the practices listed above. Perhaps it is not surprising then that there has been no significant reduction in the amount of soil lost from grazing lands (the largest contributor to soil loss) across this time (Loughran et al. 2004). Additionally, erosion rates from cultivated lands remain high notwithstanding the widespread introduction of no till and minimum till cropping practices.

Over the span of the last 50 years or so, public sector responses to the problems of soil erosion and nutrient loss have included establishing public sector soil conservation and natural resource management agencies with charters related to soil condition. These agencies have generally not been well integrated with agencies promoting strategies to enhance agricultural productivity. In many instances these agricultural productivity strategies have had an adverse impact on the natural resource base, for instance the introduction, particularly into northern Australia, of *Bos Indicus* breeds of cattle that are highly adapted to exploiting available vegetation, and, more recently, the use of supplementary feeding regimes that enable livestock to remain on native pastures having low levels of retained dry matter.

Greater leverage of private sector inputs, including information, knowledge and wisdom, remains the key to reducing soil erosion. Strategies to achieve this object need to be well integrated with overall property management activities rather than, as is more common, taking the form of prescribed discrete additions to routine practices, such as those covered by favourable taxation arrangements for certain conservation related activities.

Lastly it needs to be recognised that the compositional and functional features of soil biota are fundamentally important to conservation, biodiversity and agricultural production. Hence the crucial issue of soil health requires consideration of the state of the soil biota in addition to considerations of, for instance, soil erosion, compaction, loss of nutrients and pH balance (see the section on salinity and acidity). Nevertheless, no data were provided in relation to soil biota.

Salinity and acidity

Salinity occurs naturally, even in healthy catchment areas. Salt borne from the sea by wind and rain is deposited across the landscape. Naturally occurring salts are leached downwards into groundwater where they are concentrated by the transpiration of plants. This naturally-occurring salinity is known as primary salinity.

Secondary salinity is the salinisation of land and water resources due to the impacts of human activities (NLWRA 2000a). Secondary salinity takes the form of irrigated salinity due to rises in groundwater resulting from irrigation, and dryland salinity caused by the removal of vegetation that otherwise keeps saline groundwater at levels below the root zone.

Of particular concern is the condition of riparian vegetation, which is severely affected as it occupies the lowest parts of the landscape where much of the saline groundwater is released to the surface; but there has been no significant increase in vegetated stream length since 1989. This is of major concern as riparian vegetation plays a key function in stopping the movement of salt through river systems.

In *SoE2001,* salinity was described as a keystone indicator that could inform about disturbances to hydrological and nutrient balances. The importance of accurate and publicly accepted information about salinity hazard is clear when considering the broad range of impacts that it may have on human societies. At the farm level, salinity will result in the loss of production and income. Other effects include the decline in capital value of land, damage to infrastructure, salinisation of water storages, loss of farm flora and fauna, and loss of shelter and shade. These effects are magnified at the regional scale. Salinity will have a substantial impact on resources such as biodiversity, water supplies and infrastructure (DEH 2005).

Despite acceptance of the importance of salinity hazard as an indicator, no new data on salinity hazard have been collected since the *Australian Dryland Salinity Assessment 2000*. The maps of areas forecast to contain land of high hazard risk of dryland salinity in 2050

(NLWRA 2000a) that caused much contention in regional Australia have not been updated. Nor have these data been combined with other datasets, such as the area of land under perennial vegetation, overall land cover change, or area of land under high to medium grazing pressure. The timeframe of five-year reporting, in the context of salinity, is a short one and responses need not be constrained by this lack of data.

In 2003–04 the National Action Plan for Salinity and Water Quality (NAP) and the regional component of the Natural Heritage Trust (NHT) invested $33 million in actions that have a major focus on land salinity. The majority of these funds were disbursed in New South Wales, Victoria and South Australia, primarily for on ground activities.

Whilst salinity problems have a high profile, soil acidity currently affects eight to nine times more land than that affected by dryland salinity. Approximately 50 million hectares of agricultural land (around half the total area) has a surface soil pH value less than 5.5 (NLWRA 2001b). In the next ten years this is expected to increase to a total of 99 million hectares with a pH value of 5.5 or lower. Acidic soils are those with a pH less than 5.5 and they are usually found in areas of high rainfall. Acid soils are toxic to plants because they can release toxic levels of aluminium and other mineral elements. Acid soil conditions also restrict the availability of nutrients and trace elements vital to plant growth. It is estimated that acidity affects half of all agricultural land in NSW (NSW Agriculture 1999). The four main causes of soil acidity are:

- removal of product from the farm
- leaching of nitrogen below the plant root zone
- inappropriate use of nitrogenous fertilisers
- build-up in organic matter (NSW Agriculture 1999).

Soil acidity is a particular problem in many of Australia's low-lying coastal regions, especially in areas where mangrove swamps have been cleared for agriculture or urban development. The exposure of coastal acid sulphate soils (pH less than 3.5) to the atmosphere results in the manufacturing of huge quantities of sulphuric acid, which reduces water quality in rivers and estuaries and can result in fish kills.

To raise the pH of all soils in Australia to 5.5, it is estimated that Australia would need to apply a one-off application of 66 million tonnes of lime to its acidic soils (NLWRA 2001b). The Audit estimates current agricultural lime use is nearly two million tonnes of lime per year (NLWRA 2001b). This is clearly insufficient to deal with existing acidity problems let alone take into account continuing soil acidification.

There are alternative management options open to land managers wishing to deal with acid soils without using lime. For instance, timing fertiliser applications to match plant demand, avoiding long fallows, and retaining crop residues rather than burning. Data describing the

national-scale extent and effectiveness of these responses are unavailable for this commentary.

Some $9.5 million of funding has been supplied through NAP and NHT for major activities to improve soil condition. Despite the magnitude of the soil acidity problem, it seems to receive little attention compared with the attention given to the problem of salinity.

Introduced species

Introduced species are those that have arrived accidentally or been introduced to Australia intentionally since European settlement.

Some species, for instance rabbits, cane toads and many plant species have escaped or been abandoned and survive to establish wild populations with limited, if any net benefit. Once an introduced species establishes a self-sustaining population in the wild it is known as a naturalised species. Other introduced species, such as domesticated livestock, plant crop species, poultry, dogs and cats, are intentionally maintained because they provide economic or social benefits.

The pressures on the land resource from intentionally maintained species and responses to those pressures are dealt with indirectly in those parts of this commentary dealing with the impacts of agriculture.

Introduced species (wild or domesticated) can affect land condition, either because of the nature of their being or because they are not managed according to the requirements of the Australian environment. Especially in landscapes that have been anthropogenically altered to favour them (for example through urbanisation or the introduction of European-style agriculture), naturalised species have the potential to impact on land condition in several ways, with unpredictable consequences for ecosystems. They can outcompete resident species for food and habitat; they can prey on them at a rate that is unsustainable when compounded with other natural and anthropogenic pressures; or, in the case of grazing animals, they can contribute to land degradation.

Pollution to and from land

Reporting on solid waste and land pollution is plagued by a lack of national datasets.

Landfill

Australia's per capita waste disposal rate is estimated to be 1.1 tonnes per year, which is the second highest in OECD countries, behind the United States of America (OECD 1999).

Unfortunately there is no national data collection for the volume of waste disposed in landfill nor is there national data collection for the area of land that landfill sites take up. This information is collected by local governments with no standardising of data collection.

Pollutants

Since 1998 the National Pollutant Inventory (NPI) has measured emissions of substances to air, land or water. The NPI is an Internet database that displays information about the emissions from industrial facilities and diffuse sources of 90 different substances. The NPI is legislated for in every state and territory and all facilities or businesses that exceed NPI chemical use thresholds are required to report on their use annually, although not all do so (see the NPI website <http://www.npi.gov.au>).

Certain industries, including all facilities involved in agricultural production except for intensive livestock raising facilities, are excluded from the NPI, even though they may 'trip' the reporting thresholds. As a result the NPI does not keep information on the total amounts of phosphorus fertiliser applied to the land.

Ammonia is the most common pollutant to land as a result of agricultural practice . In 2003-04, ammonia emissions to land accounted for 48 per cent of the total emissions of NPI substances to land.

The main producers reporting ammonia emissions are intensive animal production facilities. Of these, on the basis of the reported data, beef feedlots would seem to be by far the largest. In 2003–04, intensive beef production facilities (feedlots) reported emitting approximately 40 million kilograms of the total 55 million kilograms of ammonia. In comparison, the reported contributions from intensive poultry and pig production were negligible. However, as yet, only a relatively small proportion of poultry and pig establishments are reporting emissions to the NPI.

Because all other agricultural facilities are excluded from the NPI, the real emission of ammonia to the land through animal production is likely to be much greater than that reported. This is further supported by data on the nutrient loads of rivers in the Murray–Darling Basin. Nutrient loads were found to be greater than natural levels for over 90 per cent of river length in the basin (NLWRA 2001b).

Residues

Agricultural or industrial chemicals and their breakdown products are known as residues. Unless care is taken, these residues can find their way into the foods we eat and export.

The National Residue Survey monitors the chemical residue levels of agricultural products and records when chemicals occur in greater concentrations than limits established for trade (domestic, export and import) or human health reasons.

National Residue Survey data for January 1998 through to July 2004 suggest a slight downward trend in the number of residues and metals found in foodstuffs in excess of permitted levels. This may be due to improvements in the handling of chemicals through programmes such as DrumMuster or through an increase in the numbers of land managers undergoing training in chemical handling and use.

Chemical residues would directly hamper both domestic and international trade and presumably this is a major driver for both the collection of relevant data and for improvement against the chosen indicator. Clearly, when there is a strong economic imperative to do so, we can act on a national level to address an impact of our activities. The situation for chemical residues illustrates the importance of using indicators for environmental performance against which progress can be monitored reasonably simply and that have both direct environmental and economic significance.

Pressures on the land resource

Pressures on the land resource in the ILZ come principally from human settlements and agriculture. Pressures from human settlement are comprehensively explored in (Newton 2006).

Pressures on the land resource from agriculture relate primarily to the magnitude of agricultural production and to the nature of agricultural production practices, both mediated to some extent by climatic conditions.

Since European settlement, farmers have transformed much of the Australian rural landscape for agricultural production. Farmers now occupy virtually all of the ILZ, the focus for this commentary.

There has been a sustained and substantial growth in agricultural production over the past 40 to 50 years, notwithstanding large between-year fluctuations that are principally due to variable weather conditions. For instance, the Productivity Commission (2005) calculated the growth in agricultural output to have averaged 2.4 per cent between 1963–64 and 2003–04 and Gleeson and Piper (2002) reported an increase in the volume of agricultural production of about 100 per cent between 1981 and 2001.

These increases in agricultural production have occurred notwithstanding the proportion of the Australian landmass used for agriculture remaining reasonably constant at about 60 per cent. Farmers also utilise about 70 per cent of all water allocated for irrigation, domestic, recreational and industrial use and much of this water has been made available only over the past four to five decades (Synapse Research & Consulting and Bob Hudson Consulting 2005).

These factors and others combine to increase the pressure from agriculture on the land resource, pressures ameliorated to some extent by crop and livestock genetic improvement

and by improved management practices, in particular the widespread use of no and minimum tillage and improved livestock grazing strategies.

Responses to pressures on the land resource

One of the purposes of this paper is to comment on the responses to the pressures on the land resource.

Although agricultural activity dominates landscapes throughout the ILZ, there are substantial regional differences in the physical manifestations or symptoms of that domination.

For instance, broad scale clearing of woody vegetation has been extensive in southern Australia but less so in northern Australia. This differential in the extent of vegetation clearing has resulted in almost half of the remaining woody vegetation now being located in Queensland.

Irrigated agriculture is a key activity in some regions, for instance in the Murray–Darling Basin. The Basin accounts for some 60 per cent of total national water use with about 80 per cent of the Murray–Darling River annual flows being diverted, 95 per cent of which is diverted for irrigated agriculture (Yencken and Wilkinson 2000). These differences in the physical manifestations or symptoms of agriculture influence the nature of responses as is illustrated, for instance, by the establishment of programmes focused on particular symptoms such as on salinity and deteriorating water quality.

The pressures on the land resource and the responses to those pressures come primarily from land managers and from the public sector, with the community sector playing a minor supportive role.

The importance of the responses from land managers is crucial for several reasons:

- the majority of the investment in land management comes from land owners and managers who have approximately $100 billion invested in farm assets (Gleeson and Piper 2002)
- land managers are in a position to make and implement decisions that can have both immediate and long-lasting impacts on the condition of the land, both positive and negative
- land managers are in a relatively strong position to accumulate knowledge and wisdom that, given the motivation and capability, enable them to deal with the ecological complexity and heterogeneity that pervades the business of land management.

Notwithstanding the importance of the responses of land managers to the condition of land, virtually no data were available for this commentary to enable an assessment of the effects of

those responses on the condition of the land, or in fact on the pressures affecting the condition of the land.

Public sector responses have been focused largely on the impacts of the pressures rather than on the pressures themselves. These responses generally take the form of:

- increased regulatory control, such as now applies universally to broadscale clearing and to the use of veterinary and agricultural chemicals
- the provision of financial incentives to promote and support environmentally related activities
- the strengthening of catchment-based organisational and process arrangements
- support for innovation and education and training.

It is an open question as to whether or not recently introduced changes to these responses, specifically to land clearing legislation, to financial incentives and to catchment based organisational and process arrangements, will result in a lessening of the rate of deterioration of the land resource.

Many past and present public policies and programmes, including the advocacy of land clearing and intensive grazing systems, certain forms of drought assistance and land tenure arrangements, promote or enable practices that impact adversely on the natural resource base. Furthermore a wide range of macro-economic, competition and other generic policy settings affect land management practices and, consequently, the condition of land. Although not covered specifically by this commentary, it needs to be recognised that these policies do affect the condition of land in very substantial ways.

Responses to date to the pressures on the land resource have not been sufficient to prevent a continued deterioration in the state of the land resource or, at best, to remove the threat of a continued deterioration in the condition of the resource. Hence, unless one postulates that non-anthropogenic factors will counterbalance the impacts of human activities, an unlikely scenario, then the deterioration is likely to continue unless there are changes in the pressures on the resource or in the responses to those pressures.

Institutional paralysis

Human pressures on the land resource and the responses to those pressures should reflect community beliefs (symbolic statements about reality) and values (symbolic statements about what is right and important), including the beliefs and values of landholders (drawn from Rogers et al 1988; see also Gleeson et al. in press). These beliefs and values are mediated through institutions including the traditions, norms and practices of groups, the organisations formed by government, industries and communities and their policies and programmes, including laws, regulations, codes of practice, and the operation of markets (Ball 1996).

The policy positions and actions of governments (and of many farmers) lead us to accept, for the purpose of this commentary, that there is support in the community for actions to improve the condition of land, or at least to arrest deterioration in the condition of land; that this is not happening points to the need to change institutional arrangements driving the pressures on the land resource and the responses to those pressures.

The meaning and significance of landscapes cannot be divorced from human experience and culture. Hence it is not surprising that agricultural considerations have had a substantive influence on how we value and relate to rural land, and on the institutions operating in the ILZ.

By the mid-nineteenth century, the domination of rural landscapes by agriculture had lead to the establishment of an extensive array of institutional arrangements governing agriculture. These arrangements have remained largely unchanged since that time. They are underpinned by valuing the 'development' of our natural resources, in part for the sake of economic prosperity and in part by the desire to 'tame our landscapes'.

Agricultural mindsets dominate institutional arrangements for rural Australia and, in turn, the beliefs and values that underpin agricultural activities are reinforced by the institutional arrangements they spawn. This reinforcing loop, leading to institutional paralysis, can be illustrated in several ways.

Firstly, the reinforcing loop between agriculture and institutional arrangements is illustrated by our common misuse of the term 'rural'. Rural is a place term, yet agricultural interests frequently capture it, such as in the naming of the rural research and development corporations. Although termed 'rural', the charter and activities of these organisations are almost exclusively agricultural. They rarely deal with the wider rural domain.

Secondly, the productivist nature of agriculture leads to private and public organisations and policies, again such as occurs with the rural research and development corporations, to serve single or closely-related agricultural industries. This industry-by-industry approach does not take account of the fact that more than 70 per cent of agricultural production is produced on farms operating more than one agricultural industry (Gleeson et al. in press). Furthermore it does not reflect the strong spatial dimension of environmental management requiring whole of farm, catchment linked institutional arrangements. Hence, whilst industry-by-industry institutional arrangements might well suit various product chain related requirements, they are not well aligned to meeting the requirements of good land management.

The third illustration of how beliefs and values are reinforced by the institutional arrangements they spawn lies in the portrayal of the results of much of the analysis of the financial performance of the agricultural sector. In simple terms, much of the portrayal of these analyses seeks to establish a 'high' ground for agriculture, a platform built upon more favourable understandings of financial performance than is the reality.

In 2005 the Productivity Commission reported that ' … in real terms, the value of agricultural output increased two and a half times over the four decades to 2003–04', but this conclusion appears not to have accounted for lower product prices. Similarly ABARE (ABARE 1999) favourably portrayed the growth in the value of farm production as follows: 'Between 1955–56 and 1998–99, despite falling real prices for farm product, the real gross value of farm production rose by over 25 per cent'. On an annual basis, this is a growth of just less than 0.6 per cent.

Caution is needed in interpreting short-term changes in agricultural statistics due to the substantial volatility in seasonal conditions and in the prices paid for agricultural products. Nevertheless, the past pattern is reasonably clear and it is not accurately reflected in the foregoing quotes.

Using regression analysis, Gleeson and Piper (2002) calculated that during the period 1980–81 to 2002–03, national gross domestic product (GDP) rose by 109 per cent in real terms, while the corresponding figure for farm GDP was an increase of just eight per cent in real terms; with farm GDP now contributing about three per cent of national GDP. The increase in the real value of agricultural production over the past two to three decades has been marginal, notwithstanding substantial increases in the volume of agricultural production and in spite of fairly constant levels of investment and minimal changes in real farm costs. Furthermore, notwithstanding the increase in the volume of production, aggregate net farm income has fallen substantially (Gleeson and Piper 2002; Synapse Research & Consulting and Bob Hudson Consulting 2005).

Another example of a striving for the 'high ground' is the recent publication by the Australian Farm Institute of a study titled *The Farm Dependent Economy* (Econtech Pty Ltd 2005). This analysis attributes to the farm economy post–farm gate manufacturing and service inputs, hence enabling interpretations that elevate the apparent importance of the farm sector at the expense of other sectors (see Watson 2005).

This capturing by farm sector analysts of inputs from other sectors is not new; it is embedded in national export statistics.

ABS (1996), DPIE (1997), SCARM (1998), NLWRA (2001a) and O'Brien (2002) have all reported that between 70 to 80 per cent by value of Australian agricultural products is exported, leading to an understanding that agricultural exports represent about 20 per cent by value of all Australian exports. More recently the Productivity Commission (2005) reported that 'Whilst agriculture's output, employment and investment shares are broadly comparable, its share of exports is considerably greater, being more than five times greater than its output share'.

These export statistics are computed by comparing values of products as they leave the farm (farm gate values) with values of products at the point of export (export values) hence

heightening both the contribution of the farm sector to exports *vis a vis* other sectors and also the proportion of farm products seemingly exported.

In a similar vein, reports about the export performance of the 'farm' sector rarely note that, misusing the same farm-centric terminology, 'farm' imports are about half as much as the value of food and fibre exports, with net exports in 1996–97 being valued at about $12 billion (ABS 1998).

Not only do agriculturally related organisations portray agriculture in a favourable light, they portray the economic woes of the sector as being due to external forces, to such as adverse terms of trade, 'unfair' trading practices and drought and floods. In so doing they ignore the inevitability of the changing position of agriculture in maturing economies as the demand for price elastic services outstrips the demand for relatively price inelastic food and fibre products (Watson, in press).

Intentionally or otherwise, the analytical and interpretative limitations described above and the externalisation of the causes of difficulties act to sustain an artificially elevated impression of the economic performance of the agricultural sector. This then creates pressures for the maintenance or expansion of agricultural output, with continued or expanded pressure on the land resource. For example there is increasing pressure to 'develop' northern flowing catchments and, ironically given the current oversupply of grapes, a recent report (Pratt Water 2004) advocates use of water 'saved' through improvements in water infrastructure for expansion of viticulture in the Murrumbidgee catchment in New South Wales.

Polarisation of views develop wherein farm organisations and their support agencies respond defensively to environmental concerns. In turn, governments respond by creating more legislation or another short-term prescriptive support programme. Farmers and their organisations, with some considerable justification, point to the pressure placed on them by governments to improve land management without there being equivalent pressure on the practices used by those same governments, for instance in relation to the use of fossil fuels in government owned energy production businesses (see ABC Landline 2005).

Institutions reinforce the beliefs and values that lead to their creation, hence crowding out other understandings of reality. Feedback loops between beliefs and values and institutions lead to institutional paralysis and a reduced ability to alter the pressures on the land resource and to respond to those pressures.

Given our less-than-admirable track record in designing responses to better meet the pressures on the land resource, more attention might be directed towards understanding and modifying the drivers leading to those pressures. We believe this would lead to fundamental improvements in the design of institutional arrangements related to the management of the land resource.

Institutional challenges

The principal levers used by governments to protect and improve the condition of land include regulation, financial incentives, support for research and development, education and training; and each is briefly considered in this section of the commentary after having discussed the multifunctionality of landscapes.

Whilst the focus here is primarily on reform of public sector institutional arrangements, the need and responsibility for institutional reform is as great in the private sector as it is in the public sector. Almost without exception, established agricultural organisations have been reluctant to develop strong and genuine partnerships with governments, catchment management agencies or community groups such as Landcare to improve environmental management; and it is questionable how well they might serve environmentally innovative landholders should they be members. Unless this situation improves, the effectiveness of efforts to protect and improve land condition will be severely constrained to the detriment of landholders and the community more broadly.

Multifunctionality of landscapes

Our starting point in identifying the challenges facing land managers and governments is that there needs to be greater acceptance of the multifunctional nature of landscapes. This will require movement from the view that land should be transformed and managed solely for the production of food and fibre and the view that this is only one of the multiple functions of rural landscapes—landscapes are multifunctional. Acceptance of this broader view of the functions of landscapes is a precondition to the reform of institutional arrangements to prevent further deterioration in land condition.

The OECD (2001) defined multifunctionality as the attribute of an economic activity whereby it can have multiple outputs and, by virtue of this, the activity can contribute to several societal objectives at once. We take a broader view of multifunctionality, seeing it as an attribute of the landscape rather than of an economic activity. This broader view of multifunctionality enables recognition of the importance of the non-commodified (unpriced) aspects and outputs of landscapes.

Considerations of multifunctionality in the Australian policy context have been restricted almost exclusively to agriculture and have been and continue to be primarily influenced by two factors.

The first has to do with trade policy. There is concern that recognition of multifunctionality will lead to obstacles to global agricultural trade through competing countries increasing subsidisation of farmers under the guise of environmental and other objectives. There is also concern that mandating environmental practices or outcomes will constrain trade between countries.

The second factor has to do with culture and, in particular, agricultural culture. Landholders traditionally are judged, by themselves and by their peers, as being successful or otherwise on the basis of their agricultural activities and outputs. These attributes are used to distinguish 'professional' farmers. Furthermore a raft of agricultural investment, innovation and price support policies substantially disadvantage land mangers having lower agricultural outputs. Australian governments and society are very much focused on income-generating activities, leaving little space for recognition of the broader attributes of socially constructed rural landscapes (see Gleeson 2005).

Some authors argue on efficiency and equity grounds that multifunctional features should be dealt with separately by policies specifically directed to those ends (Freeman and Roberts 1999).

Other authors argue that consideration of multifunctional features needs to be embedded in agricultural policies. For instance Edwards and Fraser (2001) argue that using agri-environmental policies to account for jointly produced agricultural and other outputs is potentially consistent with ecoefficiency and ecological integrity. These authors point to the important role to be played by agri-environmental policy in correcting externalities, for instance off-site effects generated by modern agriculture. Similarly, Potter and Burnley (2002) suggest that the design of agri-environmental policies needs to accommodate the fundamental interplay between agriculture and production and landscape design objectives, the difficulty being that without broad community involvement it is hard to be sure that (beliefs and values leading to) public preferences are accurately reflected in current policies.

In our view, the apparent conflict here, at least as it relates to land condition, reflects a failure to establish, elevate and adhere to an ecologically coherent set of environmental policy goals. In short, we will not improve land condition in the ILZ while environmental policy goals are subservient to growth in agricultural production; and on economic, ecological or social grounds they don't need to be. Having established such environmental goals, the choice and application of policy instruments must take account of the activities of land managers (farmers and others) and of their motivational, informational, financial and other needs.

Regulatory arrangements

Governments enact legislation to control activities that are deemed to be detrimental to the environment, for instance tree clearing and inappropriate chemical and water use. In most instances the legislation is issue specific—dealing with vegetation, water or chemical use etc.

The extent of legislative compliance is unknown; however, our experience across several states suggests that most land managers struggle to understand and apply regulatory requirements and that governments do not adequately support regulatory frameworks with education and training, information flows or monitoring.

One of the difficulties facing legislators is the question of timeliness: often the political will for legislation post-dates the environmental damage it is designed to prevent. For instance, legislation in southern Australia to control tree clearing was enacted after extensive tree clearing had occurred. Additionally, and particularly given the fragmented nature of natural resource legislation, the potential for perverse effects should not be underestimated. For example the clearing of trees in anticipation of legislative controls on clearing and the repeated clearing of regrowth to maintain exemption from controls are significant aspects of the regulatory framework. These issues are canvassed fully in the Productivity Commission report on the Impacts of Native Vegetation and Biodiversity Regulations (2004) that, in brief, found vegetation regulations to be neither effective nor equitable.

There is a *prima facie* case for a fundamental re-conceptualisation of the role and nature of environmental legislation concerning land condition. Issues such as how well the legislation deals with ecological and behavioural complexity, diversity and uncertainty, overlapping jurisdictions, the need for adaptive management, monitoring and the interplay between regulation and other policy instruments are important determinants of future land condition.

The state of the regulatory environment

Paul Martin

Over the past few decades there has been an explosion of natural resource regulation in Australia. In 2000 there were over 250 distinct State and National legislative instruments that regulate aspects of natural resource management. Counting other local government regulations, statutory or non-statutory plans, policies, rulings and advisory instruments it is true to say that there are literally hundreds of laws and policies which are intended to advance sustainable resource use and conservation of environments. Catchment Management Plans are a recent addition to this armoury and in one NSW estuary alone there are more than 30 of these.

In terms of sheer quantity, it would be hard to say that there is any lack of regulations or regulatory bureaucracy in our collective pursuit of sustainability. A more important question would be whether we are securing the required effectiveness and sufficient outcomes from all of this effort. If not, then the case for major reform of the regulatory approach is readily made.

Another concern is the cost and complexity imposed on those who are trying to 'do the right thing'. The costs of our regulatory approach fall on government as it seeks to administer, police and coordinate its legal obligations. Local government particularly reports that it is increasingly burdened with implementing laws that are not its own, and it is at the level of the officer in the field that the uncertainty and confusion associated with a complex system fall heavily. The effort invested into a regulatory morass is effort that is diverted from other important initiatives.

The costs and frustration also fall heavily on landholders who try to understand their obligations. It is reported that primary producers who are trying to implement voluntary Environment Management Systems incur substantial costs as they struggle to work out their compliance obligations, and are often left still uncertain as to their ongoing obligations. Those who are not concerned about their responsibilities, of course, are not saddled with this expense, effort and concern.

Financial incentives

All levels of government provide financial and other support to individuals and groups of landholders to achieve environmental targets. Increasingly the support provided by the Australian Government in partnership with state and territory governments through programmes such as NHT and NAP is provided through catchment management organisations established throughout Australia.

NHT, NAP and related initiatives present as a significant package for institutional change. It would be premature to judge these programmes in terms of their likely impacts on land condition, would that even be possible considering the time-scales of degradation and repair. Equally it would be premature to be complacent about their effectiveness and efficiency. Certainly the achievements of these programmes, as outlined in the 2003–04 Regional Programmes Report are, at best, modest.

It is beyond the purpose of this commentary to critique the design and application of these specific programmes, but they do provide a focus for a generic discussion of design features likely to be critical to the success of programme-based responses to the pressures on the land resource.

As discussed earlier in this commentary, the pathways for institutional change are not without obstacles. Perseverance and adaptability will be required to enable catchment level organisations to contribute significantly to reducing pressures on land condition and to improve the responses to those pressures.

Links across the landscape

There is a self-evident ecological rationale for the adoption of a catchment-based approach to natural resource management, as has been advocated in Australia at least since the middle of the nineteenth century (see Mitchell 1946). Irrespective of where the landscape is viewed from, there is a need for linkages across space, in the case of the catchment perspective down to subcatchment and property perspectives and up to regional, national and global perspectives.

Effective policy and programme integration

The effectiveness of a particular policy instrument, such as NHT, is dependent upon there being adequate integration across policies, policy instruments and organisations that have complementary roles within and beyond the catchment.

At least in some instances, the establishment of catchment-based organisations has resulted in (further) separation of regulatory responsibilities from support and advisory functions. Whilst this is usually attractive for organisations without regulatory responsibilities, such separation may result in fragmentation, inefficiency, heightened conflict at the operational level and a less receptive environment for legitimate regulatory programmes.

Another aspect related to the introduction of an additional organisational layer or new programme is the potential incremental transfer of responsibilities between organisations and programmes, with or without commensurate funding, as might occur for instance between catchment organisations and state government departments. Certain functions can move from a secure funding base to one that is short-term and uncertain and, especially for activities like long-term monitoring of land condition, this trend can have dire consequences.

The introduction of a new source of funding such as is provided by NHT and NAP will inevitably affect the security of previously existing funding. Certainly the appointment of many state government employees to positions in catchment based organisations and the concurrent reductions in employment levels in state government departments would point to there being a dynamic between funding programmes that may result in there being no net increase in the size or efficacy of support.

Longevity

Programmes to support the improvement of land condition need to be sustained for periods commensurate to the nature of the pressure and response. In contrast, the regional components of NHT and NAP provide support for catchment-based organisations in the form of short-term programme and project-based funding. This funding arrangement seems to be at odds with the necessity for sustained effort by the catchment organisations, collaborating landholders and other organisations.

Motivation

Support programmes such as NHT and NAP are designed to reduce the gap between desirable outcomes and what market and regulatory forces could be expected to deliver. Hence they are heavily reliant on individuals and businesses acting in the public good in sustained and creative ways; and for this individuals need to be intrinsically motivated. However, many of these programmes adopt command and control processes which reduce the motivation and creativity necessary for their effectiveness (see Gleeson et al. 1999).

Against this background, top-down hierarchical command and control approaches to establish goals, objectives, indicators and targets must be and can be avoided. They must be avoided because, without full compensation, landholders are reluctant or unable to embrace externally established goals. Even when there is no conflict between these externally established goals and the goals of the individual businesses, landholders have difficulty in incorporating them into their broader business imperatives. At best, the links with individual property goals and investment strategies can be tenuous, notwithstanding that the capital invested by the private sector on activities affecting land management and utilisation far exceeds the public sector investment through these and other programmes.

There now is a range of planning processes that enable landholders, individually or in groups, to develop property based natural resource management plans or environmental management

plans taking into account broader landscape imperatives. Building up from these plans and activities to subcatchment plans and activities and on though to catchment plans will in all probability result in far greater commitment from landholders than will otherwise eventuate. The establishment of a voluntary national whole-of-property environmental management certification system or systems would reinforce such commitments as it would provide a mechanism for greater recognition of improving environmental performance. Importantly a broadly informed bottom-up approach would help ensure that proposed targets, indicators and monitoring procedures are subject to reality checks from early in the programme.

Support for innovation

The third principal form of government intervention to improve environmental management is through the provision of funds for research and development and for education and training. In contrast, existing organisational structures, cultures and processes for innovation in the farm sector lack diversity and are risk averse.

The execution of agricultural research and development is principally confined to the public sector and has a technological emphasis, an arrangement begun in the mid-1850s, with the establishment of experimental farms that were staffed almost exclusively by agricultural and veterinary scientists. This arrangement has persisted for more than 150 years despite (or because of) frequent reviews and restructurings of state departments of agriculture.

The rural research and development corporations account for at least two-thirds of the influence on the direction of agricultural research and development (Gleeson et al. 1999). The corporations are focussed primarily on optimising the profitability and environmental sustainability of existing industries through, for instance, breeding more productive varieties and developing improved livestock grazing systems. As discussed previously, the product-by-product focus of most of these corporations limits their willingness and capacity to progress whole-of-farm and catchment-related environmental management initiatives.

The innovation supporting processes are almost universally restricted to partial project funding and projects are of short duration. Furthermore, agricultural researchers, whilst recognising the need for prioritisation of research goals and for accountability, believe the priority setting processes and accountability arrangements adopted by the corporations place heavy constraints on creativity (Gleeson et al. 1999).

Research is most often evaluated on the basis of relatively short-term changes in productivity and there is little attention to the interdependency between the nature of the innovation systems and the nature of the resultant innovation products.

If the innovation system is highly planned and controlled, especially if by people with interests in existing systems, as is most often the case, then generally the resultant innovation products make incremental changes to existing systems. Such changes are necessary, but alone they are unlikely to represent the range of innovation products needed to enable

expression of the multifunctional capabilities of landscapes. For instance, research organisations supported and managed by existing industries generally have not supported the development of alternative or even of complementary industries such as agroforestry.

Challenges—monitoring condition, pressures and responses

This commentary is testimony to the inadequacy of the trend data provided in relation to land condition.

Previous state of the environment reports have highlighted the need for improved environmental data collection and management, a need recognised as far back as the mid-1980s leading to the establishment of the National Resource Information Centre.

The continued inadequate state of trend datasets in relation to key indicators presumably is a consequence of a lack of sustained commitment to collect and manage data. There seems to be a presumption within programmes such as NHT and NAP that state and territory governments will maintain adequate generic data collection and management, but, generally speaking, neither funds nor staff are allocated for these purposes.

The collection, management and use of environmental data are crucial to our understanding of environmental condition, to our understanding the impacts of pressures on the environment and to the design and implementation of actions to protect and improve environmental condition.

The national move to establish catchment-based approaches needs to be complemented with core funding and capabilities for agreed monitoring and data management. It would seem that the discussion of the ideal indicator sets is based on the false assumption that whatever indicators are agreed upon will be monitored and fed back in a way that can be used. When these data are not easily available at a national level, more time and resources must be spent on data mining, often from projects that make data available on an *ad hoc* basis. This is an arduous and largely ineffective approach.

More cost-effective regional approaches to spatial data base system development and maintenance are required, for use by land managers and catchment and regional authorities. Some work in this regard is being supported with the NHT–DAFF Environmental Management System Programme and within the Desert Cooperative Research Centre at Alice Springs. The key challenge will be to ensuring that these and similar projects actually deliver practical, spatial database tools and datasets to practising land managers.

There needs to be a more realistic assessment of what data can be collected by individuals and organisations responsible for environmental management at all spatial scales, from the individual land management scale through to subcatchment, catchment, regional and national scales. There is also a need for greater coordination between state of the environment

reporting processes and national data collation projects. The National Land and Water Resources Audit projects from 1999 to 2001 were completed a year after *SoE2001*. We have been informed (DEH pers. comm.) that Audit 2 is focusing more on national coordination committees to set up protocols for collecting data than on the actual collection of data, in itself a high level recognition that systems are not in place for data collection and management.

In *SoE2006*, the focus of data collection has shifted from reliance on information collected at the state and territory level to an increased use of nationally relevant datasets that are collected using techniques such as remote sensing and satellite imagery. There is considerable potential for an expansion of this approach so that national state of the environment reporting could ultimately be based entirely on such national datasets. The benefits of this approach are two fold. Firstly, the data for use in the national state of the environment report will be collected using collection approaches that are effective and cost-efficient at the national scale. Secondly, as long as these data are available at other spatial scales (state and territory, regional, catchment and below) it will enable cost-effective complementary indicator selection and data collection at each of these subsidiary scales.

Given the paucity of trend datasets for key biophysical parameters it might be counterproductive to propose collection of additional datasets. Nevertheless monitoring arrangements that focus only on the condition of the land will not inform us of the beliefs and values that should govern the design and operation of institutional arrangements that impact both on the pressures on the land resource and on the responses to those pressures. Additionally there is a need for independent evidence-based trend assessments of the efficacy of institutional arrangements in relation to land condition.

Conclusions

To recap, the purpose of this commentary is to identify and discuss the implications of the data on trends in the condition of the land resource, the pressures on the land resource and the efficacy of responses to those pressures.

The commentary has focused on the land resource in the Intensive Landuse Zone (ILZ) and, within that zone, on the pressures arising from agriculture, the dominant user of the land resource.

The limited available national trend data point to continued deterioration in the condition of the land resource. The extent of woody vegetative cover in the ILZ is still decreasing and many ecosystems are threatened. Soil erosion is occurring at rates that threaten the health and productive capacity of ecosystems. The problems of soil salinity and acidity are widespread and unabated.

National-scale data do not identify the positive and negative changes that occur at lower spatial levels. Conversely, property level perspectives do not, by themselves, capture the significance of pressures and responses occurring further up the spatial scale

There are considerable pressures on the land resource in the ILZ from agriculture. This reflects agriculture's high levels of access to land and water resources in the ILZ and continuing pressures to increase the volume of agricultural production.

Whilst it can be argued that it is neither desirable nor realistic to 'fix' ecosystems at a particular point in time, it can also be argued that it is unwise to accelerate changes in particular directions as now occurs, especially when the consequences are not and cannot be fully known and when many may not be reversible.

Responses to agricultural pressures focus primarily on the impacts of the pressures. Consequently policy and programme analysts and land managers face an uphill battle against the strong economic and cultural forces supporting greater extraction of agricultural product from the ecosystems in the ILZ. If the national will is to maintain or improve the condition of land then new and additional effort will be required.

Widespread institutional paralysis and complacency is the most significant threat to the land resource. This condition festers behind misunderstandings of the current contribution of agriculture to the economy and to the social fabric of rural and urban Australia. The resultant shrouding of Australian mindscapes prevents new ways of visioning rural landscapes and of our places in those landscapes.

Tinkering at the edges of failed policies and production practices will not restore or protect the land resource. Rather there is a need to release the motivation and the creativity necessary to find new pathways to new destinations.

These things are possible.

Australia has motivated, experienced and capable land managers and support personnel who have a passion to improve land condition. These men and women need to be enabled.

We need to remove the shackles of externally established goals and targets. We need to remove the shackles of excessive project fragmentation and short-term scheduling. We need to move from punitive command and control approaches to ones that challenge and reward exploration of pathways that lead to more sustained outcomes. We need to support those explorations with the considerable informational, skill, financial, and technology resources available in the public and private sectors. In short, we need enabling leadership.

References

ABARE[Australian Bureau of Agriculture and Resource Economics] 1999, *Changes in Non Metropolitan Population: Jobs and Industries*, Report to the Department of Transport and Regional Services, Canberra.

ABC Landline 2005, viewed May 2005, <http://www.abc.net.au/landline>.

ABS [Australian Bureau of Statistics] 1996, *Australian Agriculture and the Environment*, *cat. no. 4606.0*, ABS, Canberra.

ABS [Australian Bureau of Statistics] 1998, *International Merchandise Trade, cat. no. 5422.0, ABS,* Canberra.

Ball, R 1996, *Institutions of Innovation and Prosperity*, Occasional Papers 58, The Centre for Independent Studies, Sydney.

DAFF [Department of Agriculture, Forestry and Fisheries] 2001, *Plantations of Australia. Summary Report 2001*, Department of Agriculture Fisheries and Forestry, Canberra.

DEH [Department of the Environment and Heritage] 2005, *National Action Plan for Salinity and Water Quality and Natural Heritage Trust Regional Programmes Report 2003–04*, Department of Environment and Heritage, Canberra.

DPIE [Department of Primary Industries and Energy] 1997, 'Mid-term review of the Rural Adjustment Scheme' in *Rural Adjustment: Managing Change*, Department of Primary Industries and Energy, Canberra.

Econtech Pty Ltd 2005, *Australia's Farm-Dependent Economy: Analysis of the Role of Agriculture in the Australian Economy*. Australian Farm Institute, Surrey Hills, Australia.

Edwards, G and Fraser, I 2001, Reconsidering agri-environmental policy permitted by the Uruguay round agreement. *Ecological Economics* 37:313–326, Boston, USA.

Freeman, F and Roberts, I 1999, *ABARE Current Issues: 'Multifunctionality': A Pretext for Protection?* Rural Industries Research and Development Corporation, Canberra.

Gleeson, T, Russell, G and Woods, E 1999, *Environmental Factors Affecting Creativity in Agricultural Research in Australia,* Rural Industries Research and Development Corporation, Canberra.

Gleeson, T and Piper, K 2002, 'Institutional reform in rural Australia: defining and allocating property rights', in *Property: Rights and Responsibilities. Current Australian Thinking,* Land and Water Australia, Canberra.

Gleeson, T 2005, 'Land, spirit and health: a non-indigenous perspective', National Rural Health Alliance Conference Papers, Alice Springs. National Rural Health Alliance.

Gleeson, T, Lewis, L and Grosser, M (in press) A*lliances to Assist Implementation of Environmental Management Systems*, Rural Industries Research and Development Corporation, Canberra.

Gleeson, T, Turner, C, Beeton, B and Drinan, J (in press) 'Digging deeper: reflections on a symposium on Australian values' in Gleeson, T, Turner, C and Drinan, J (eds) *Australian Values – Rural Policies: Proceedings of a Symposium in the Year 2000*. Australian Landcare Management System Ltd, 'Avondale' Legume NSW 2476

Loughran, RJ, Elliot, GL, McFarlane, DJ, and Campell, BJ 2004, 'A survey of soil erosion in Australia using caesium-137' in *Australian Geographical Studies* 42(2):221–233.

Mitchell, E 1946, *Soil and Civilisation*, Angus and Robertson Ltd, Sydney NSW.

Newton, PW 2006, 'Human settlements', theme commentary prepared for the 2006 Australian State of the Environment Committee, Department of the Environment and Heritage, Canberra, <http://www.deh.gov.au/ soe/2006/commentaries/settlements/index.html >.

AGO 2004, 'Factsheet 4: National Carbon Accounting System', in *National Greenhouse Gas Inventory 2003*, Australian Greenhouse Office, Department of Environment and Heritage, Canberra.

NLWRA 2000, *Australian Dryland Salinity Assessment 2000*, National Land and Water Resources Audit, Canberra.

NLWRA 2001a, *Australian Agriculture Assessment 2001,* National Land and Water Resources Audit, Canberra.

NLWRA 2001b, *Native Vegetation Assessment 2001*, National Land and Water Resources Audit, Canberra.

NLWRA 2002, *Australian Terrestrial Biodiversity Assessment*, National Land and Water Resources Audit, Canberra.

NSW Agriculture 1999, *The Causes of Soil Acidity*, New South Wales Department of Agriculture, Sydney.

O'Brien, P 2002, 'Agriculture at the crossroads: planning an environmentally, socially and economically vibrant future', Paper for the Australian Academy of Science's Fenner Conference on the Environment; *Agriculture for the Australian Environment,* 30 July–1 August 2002, Canberra.

OECD 1989, *Integration of Agricultural and Environmental Policies*, Organization for Economic Cooperation and Development, Paris.

OECD 1999, *Environmental Data Compendium*, Organization for Economic Cooperation and Development, Paris.

OECD 2001, *Multifunctionality: Towards an Analytical Framework*, OECD Publications Services, Paris.

Potter, C and Burnley, J 2002, 'Agricultural multifunctionality in the WTO – legitimate non-concern or disguised protectionism?' *Journal of Rural Studies* 18:35–47.

Pratt Water 2004, *The Business of Saving Water, The Report of the Murrumbidgee Valley Water Efficiency Feasibility Project*, Pratt Water, Victoria.

Productivity Commission 2004, *Impacts of Native Vegetation and Biodiversity Regulation*, Productivity Commission Report No 29, Productivity Commission, Melbourne.

Productivity Commission 2005, *Trends in Australian Agriculture*, Productivity Commission Research Paper, Productivity Commission, Melbourne.

Pyper, W 2002, 'Cattle and conservation can be a costly mix', *ECOS* 113: 11–13, CSIRO Publishing, Canberra.

RPDC 2003, *State of the Environment Report Tasmania 2003*, Resource Planning and Development Commission, Hobart.

Rogers, EM, Burdge, RJ, Korsching, PF and Donnermeyer, JF 1988, *Social Change in Rural Societies*, Prentice Hall, Eaglewood Cliffs, NJ.

SCARM 1998, *Sustainable Agriculture: Assessing Australia's Recent Performance, A Report to SCARM of the National Collaborative Project on Indicators for Sustainable Agriculture*, SCARM Technical Report 70 Standing Committee on Agriculture and Resource Management, Canberra.

Synapse Research & Consulting and Bob Hudson Consulting 2005, *Australian Farm Sector Demography: Analysis of Current trends and Future Farm Policy Implications*, Australian Farm Institute, Surrey Hills, Australia.

Watson, A 2005, Australia's Farm-Dependent Economy or Australia's Dependant Farm Economy? Connections http://www.agrifood.info/connections/winter_2005/.

Watson, A (in press) 'Australian Agriculture: persistent myths and current realities and/or current myths persistent realities', in Gleeson, T, Turner, C and Drinan, J (eds) *Australian Values – Rural Policies: Proceedings of a Symposium in the Year 2000*. Australian Landcare Management System Ltd, 'Avondale' Legume NSW 2476

Yencken, D and Wilkinson, D 2000, *Resetting the Compass: Australia's Journey Towards Sustainability*, CSIRO, Victoria, Australia.