Land use and management: the Australian context

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Research by the Australian Bureau of Agricultural and Resource Economics and Sciences

Research report 13.1
January 2013
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# List of acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABARES</td>
<td>Australian Bureau of Agricultural and Resource Economics and Sciences</td>
</tr>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ACEDP</td>
<td>Australia China Environment Development Partnership</td>
</tr>
<tr>
<td>ACLUMP</td>
<td>Australian Collaborative Land Use and Management Program</td>
</tr>
<tr>
<td>AVHRR</td>
<td>Advanced Very High Resolution Radiometer</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
</tr>
<tr>
<td>DAFF</td>
<td>Department of Agriculture, Fisheries and Forestry</td>
</tr>
<tr>
<td>EPBC Act</td>
<td><em>Environment Protection and Biodiversity Conservation Act 1999</em></td>
</tr>
<tr>
<td>FEDRC</td>
<td>China State Forestry Administration – Forestry Economics and Development Research Center</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic information system</td>
</tr>
<tr>
<td>MODIS</td>
<td>Moderate Resolution Imaging Spectroradiometer</td>
</tr>
<tr>
<td>MODIS NBAR</td>
<td>MODIS Nadir Bi-directional Reflectance Distribution Function Adjusted Reflectance</td>
</tr>
<tr>
<td>MODIS EVI</td>
<td>MODIS Enhanced Vegetation Index</td>
</tr>
<tr>
<td>MCAS-S</td>
<td>Multi-Criteria Analysis Shell for Spatial Decision Support</td>
</tr>
</tbody>
</table>
Background

This paper is one of two background papers prepared as part of a collaborative project between ABARES and the Forestry Economics and Development Research Center (FEDRC) of China’s State Forestry Administration to develop a sustainable land and forest management research agenda. The other paper is Sustainable forest management: the Australian context (Clancy & Howell 2013).

The Sustainable Land and Forest Management Research Agenda project, funded through AusAID’s Australia China Environment Development Partnership (ACEDP) program, has strengthened technical cooperation in areas of common interest in sustainable forest management and land resources assessment.

The two background papers supported discussions held by FEDRC and ABARES (in Beijing in October 2011 and in Canberra in December 2011). The discussions led to agreement on common areas of research interest in sustainable forest management and land resources assessment. The project partners ABARES and FEDRC intend to use the papers as background information to support collaborative engagement and as reports to the ACEDP managing contractor (GHD Pty Ltd) and AusAID.
1 Introduction

Australia has unique land, water, vegetation and biodiversity resources. Australia’s 7.7 million square kilometres supports a wide range of agricultural and forestry industries. Production from natural resources earns over $38 billion a year in exports from agriculture, fisheries and forestry. Competitive pressures are driving the need for improved productivity, which includes increased diversification and intensification. These trends are occurring against a background of increased climate variability.

The way land is used has a profound effect on Australia’s social and ecological systems. There is a strong link between changes in land use and environmental, economic and social conditions. Information on land use and management is fundamental to understanding landscapes, agricultural production and the management of natural resources.

Land use choices have a major effect on our food production, natural environment and communities. Land use change and land management is central to current debate in Australia around food security, water, climate change adaptation, population and urban expansion. Informed land use and land management choices are critical to developing effective responses to natural resource management priorities such as biodiversity protection, sustainable and productive agriculture, water quality and quantity, salinity, and food security.
2 Key land statistics

The pattern of land use in Australia is shown in Map 1. The dominant land use is livestock grazing. This occurs mostly on native vegetation and makes up 56 per cent (or 4.3 million square kilometres) of Australia (Table 1). Other agricultural uses, including broadacre cropping (almost 270,000 square kilometres or 3.5 per cent) and horticulture (5000 square kilometres or less than 0.1 per cent), occupy a much smaller proportion of land area. The total area of land under primary production in Australia (livestock grazing, dryland and irrigated agriculture) is nearly 4.6 million square kilometres or 59 per cent.

Approximately 569,240 square kilometres or 7 per cent of Australia is set aside for nature conservation. Other protected areas, including for use by Indigenous Australians, cover more than 1 million square kilometres (or 13 per cent) of Australia.

Forestry tends to be confined to regions with higher rainfall and covers nearly 2 per cent of the continent. Intensive uses (mostly urban) occupy about 17,000 square kilometres or 0.2 per cent of Australia.

Map 1 National land use of Australia, 2005–06
<table>
<thead>
<tr>
<th>Land use</th>
<th>Area (sq. km)</th>
<th>Proportion of Australia (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing native vegetation</td>
<td>3,558,785</td>
<td>46.30</td>
</tr>
<tr>
<td>Minimal use</td>
<td>1,242,715</td>
<td>16.17</td>
</tr>
<tr>
<td>Other protected areas, including Indigenous uses</td>
<td>1,015,359</td>
<td>13.21</td>
</tr>
<tr>
<td>Grazing modified pastures</td>
<td>720,182</td>
<td>9.37</td>
</tr>
<tr>
<td>Nature conservation</td>
<td>569,240</td>
<td>7.41</td>
</tr>
<tr>
<td>Dryland cropping</td>
<td>255,524</td>
<td>3.32</td>
</tr>
<tr>
<td>Water</td>
<td>125,618</td>
<td>1.63</td>
</tr>
<tr>
<td>Production forestry</td>
<td>114,314</td>
<td>1.49</td>
</tr>
<tr>
<td>Plantation forestry</td>
<td>23,929</td>
<td>0.31</td>
</tr>
<tr>
<td>Intensive uses (mainly urban)</td>
<td>16,822</td>
<td>0.22</td>
</tr>
<tr>
<td>Irrigated cropping</td>
<td>12,863</td>
<td>0.17</td>
</tr>
<tr>
<td>Irrigated pastures</td>
<td>10,011</td>
<td>0.13</td>
</tr>
<tr>
<td>Rural residential</td>
<td>9,491</td>
<td>0.12</td>
</tr>
<tr>
<td>Irrigated horticulture</td>
<td>3,954</td>
<td>0.05</td>
</tr>
<tr>
<td>Intensive animal and plant production</td>
<td>3,329</td>
<td>0.04</td>
</tr>
<tr>
<td>No data</td>
<td>2,243</td>
<td>0.03</td>
</tr>
<tr>
<td>Waste and mining</td>
<td>1,676</td>
<td>0.02</td>
</tr>
<tr>
<td>Dryland horticulture</td>
<td>1,092</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7,687,147</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

*Source: Based on ABARE–BRS 2010*
3 History

Aboriginal occupation of Australia has been associated with systematic burning of vegetation to increase the availability of plant and animal foods and reduce fuel for wildfires (Gammage 2011). Since European settlement about two centuries ago, Australia’s landscapes have changed significantly. European settlement began with early pastoralism, cropping and prospecting, and led to today’s major agricultural, forest and mining industries, reserve landscapes and urban communities. Land use change over this period was driven by relatively unrestricted access to land, technological change and growth in productivity and population.

More recently, land has been increasingly managed for multiple objectives, including food, fibre, minerals, energy, landscape amenity, water, carbon and biodiversity. A well-managed landscape provides high-quality, essential ecosystem services to farmers and the Australian community. Australian governments have implemented a mix of programs and regulations to enhance land management and use. The Australian Government has also invested in programs to improve land management practices, such as the Natural Heritage Trust, the National Action Plan for Salinity and Water Quality and Caring for our Country.
4 Current situation

Policy/legislation framework

Significant areas of Australia are used for livestock grazing on native pastures. This may be freehold or public land leased by private landholders. Agricultural uses, including cropping and livestock grazing on improved pastures, urban uses, other intensive uses and Indigenous uses are mainly located on privately owned (freehold) land. Most land allocated to forestry (native forests) and nature conservation is publicly owned and managed.

Australia has six states and two mainland territories. Under the Australian Constitution, the state governments have prime responsibility for land administration and public land management. The Australian Government has a limited land ownership and management role. Its primary role is to promote more efficient land management and land allocation. An example is the National Forest Policy process, which has established a nationally agreed basis for determining forest assessment and resource allocation principles, resource inventory and national reporting. There are similar national coordination processes for nature conservation; for example, through the National Reserve System. Important themes of governance at the state level include urban and rural land zoning, forestry plantations, mining development, and environmental regulations around native vegetation management.

There are three key challenges:

1. Land use governance and tenure arrangements need to accommodate multi-objective land use and land management options. Modern approaches to nature conservation include joint management and partnership arrangements that can simultaneously provide for multiple uses that can include biodiversity protection, recreation uses, Indigenous cultural uses, mineral exploration, mining and grazing production.

2. Land use and land management incentives for non-market ecosystem goods and services may play an important role. These may be applied where these goods and services are not adequately reflected in market systems.

3. Sufficient data and information is required to support informed land use and management planning. This includes decision support capability to enable informed, transparent consideration of options and trade-offs.

Agricultural land management

In 2007–08 the Australian Bureau of Statistics (ABS) surveyed farmers about their land management practices. Table 2 shows characteristics of Australian farms broken into four major industries: broadacre cropping, horticulture, dairying and grazing (beef cattle/sheep meat).
### Table 2 Summary of characteristics and management of Australian farm businesses (farmers)

<table>
<thead>
<tr>
<th>Farm business characteristics and management</th>
<th>Broadacre cropping</th>
<th>Horticulture</th>
<th>Dairying</th>
<th>Grazing (beef cattle/sheep meat)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Farm business characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average age</td>
<td>54</td>
<td>53</td>
<td>53</td>
<td>55</td>
</tr>
<tr>
<td>Average years managing holding</td>
<td>24</td>
<td>19</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td><strong>Farm management plans (formal and informal)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production management</td>
<td>56 891 (81%)</td>
<td>13 934 (59%)</td>
<td>8 270 (83%)</td>
<td>75 579 (82%)</td>
</tr>
<tr>
<td>Business financial</td>
<td>51 371 (73%)</td>
<td>15 490 (65%)</td>
<td>7 796 (79%)</td>
<td>64 734 (70%)</td>
</tr>
<tr>
<td>Extreme circumstances</td>
<td>47 800 (68%)</td>
<td>12 994 (55%)</td>
<td>7 502 (76%)</td>
<td>64 123 (69%)</td>
</tr>
<tr>
<td>Natural resource management</td>
<td>42 215 (60%)</td>
<td>11 887 (50%)</td>
<td>6 557 (66%)</td>
<td>56 537 (61%)</td>
</tr>
<tr>
<td>Succession</td>
<td>39 593 (57%)</td>
<td>10 705 (45%)</td>
<td>6 055 (61%)</td>
<td>49 996 (54%)</td>
</tr>
</tbody>
</table>

**Note:** Numbers in brackets are proportion of farmers adopting farm plans by enterprise type.

*Source: ABS Agricultural Resource Management Survey 2007–08*

Innovation in Australian agriculture has generally driven enough growth in productivity to offset consistently declining agricultural terms of trade. Innovation, through improved land management practices, has also increased agriculture’s ability to lessen threats to soil, water resources and biodiversity. Land management practices can bring about the changes needed for sustainable use of Australian landscapes. For example, conservation tillage helps improve soil carbon, reduce soil erosion and nutrient loss and increase cost savings and other production benefits. Of agricultural businesses preparing land for crops or pastures, 40 000 (53 per cent) reported using no-till over a total of more than 170 000 square kilometres in 2007–08. Map 2 shows how tillage management practices differ across the country.
Note: Refers to cultivation practices used to prepare crops and pastures as a percentage of the area prepared for crops and pastures, by natural resource management region.

Source: ABS 2009

Natural resources

Water

Long-term average annual rainfall varies across Australia from less than 300 millimetres per year in most of central Australia to more than 3000 millimetres per year in parts of far north Queensland (Map 3).
Of all the inhabited continents, Australia has the lowest proportion of rainfall going into its rivers and aquifers—11 per cent compared with a world average of 65 per cent. About 65 per cent of run-off occurs in far north Australia and coastal Queensland (Map 4). By contrast, only 6.8 per cent of Australia’s run-off occurs in the Murray–Darling Basin, although more than 50 per cent of Australia’s water use occurs there. The seasonal distribution of rainfall also varies widely—run-off in northern Australia occurs predominantly in the monsoonal wet season, while run-off in the Murray–Darling Basin is spread throughout the year.
Irrigation is a well-established and important feature of the agricultural landscape, especially in the Murray–Darling Basin. In 2007–08, 90 per cent (6285 gigalitres) of the water used by agricultural industries was used to irrigate crops and pastures, while 10 per cent (704 gigalitres) was used for other agricultural purposes. Water use for irrigation, industry and urban needs has placed pressure on water-dependent ecosystems. The challenge is using water for production purposes while maintaining water quality and conserving the natural environment. A national program of water reform is being implemented to achieve this balance.

**Soils**

The agricultural landscape in Australia includes a wide range of soil types, ranging from old, deeply weathered and infertile soils, to younger, more fertile soils (Map 5).
Important soil management issues include erosion (wind and water), salinisation (dryland and irrigation), acidification and compaction. Soils are managed by maintaining ground cover and wind breaks, avoiding steep slopes, applying fertilisers (mainly phosphorus and nitrogen) and by using lime and gypsum to manage soil condition and pH.

**Vegetation**

Australia’s native vegetation estate comprises shrublands and heathlands (37 per cent), native grasslands and minimally modified pastures (33 per cent), and native forests and woodlands (19 per cent). The remaining 10 per cent of the continent comprises non-native vegetation, such as annual crops and modified pastures (9 per cent) and plantations (0.2 per cent) (Map 6).
In areas with higher rainfall and more fertile soils, native vegetation has been extensively cleared and replaced with intensive agriculture. In these landscapes, remnants of native vegetation and non-native vegetation exist as a mosaic of vegetation types. In areas with lower rainfall, much of the native vegetation remains and supports pastoral industries. Providing water (bores) has enabled extensive development of these rangelands.

The clearing of native vegetation has declined since the 1990s as states and territories introduced regulatory controls. Vegetation management can profoundly affect landscape condition, soil health and the supply of ecosystem goods and services, such as food, fibre and water production. The importance of managing vegetation for ecosystem goods and services is reflected in the on-the-ground investments being made through conservation programs, land clearing controls and environmental management systems.

**Environment protection**

**Government programs**

The Australian Government’s central piece of environmental legislation is the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. It provides a legal framework to protect and manage flora, fauna, ecological communities and heritage places—defined as matters of national environmental significance. The objectives of the EPBC Act are to:

- provide for the protection of the environment, especially matters of national environmental significance
- conserve Australian biodiversity
• provide a streamlined national environmental assessment and approvals process
• enhance the protection and management of important natural and cultural places
• control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife
• promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources.

Environment protection objectives are also pursued by the Australian Government under the Caring for our Country initiative, which supports environmental management of natural resources. The Caring for our Country initiative addresses six national priority issues:

• expanding Australia's National Reserve System
• addressing threats to biodiversity and natural icons
• managing and protecting coastal environments and critical aquatic habitats, including the Great Barrier Reef
• encouraging farmers to adopt sustainable farm practices
• promoting sustainable natural resources use and environmental protection in northern and remote Australia
• supporting and increasing community skills, knowledge and engagement.

This initiative supports regional natural resource management groups, local, state and territory governments, Indigenous groups, industry bodies, land managers, farmers, Landcare groups and communities.
5 Outlook

Climate change

Australia’s climate is changing as part of a global trend. Climate change is expected to continue and perhaps accelerate, presenting both challenges and opportunities for Australian agriculture.

The effects of climate change will vary across sectors and regions, altering risk profiles both positively and negatively. Adapting to climate change will require information systems that identify the effects of climate change alongside other business management risks.

Agriculture is the dominant source of both methane and nitrous oxide emissions in Australia. Most agricultural emissions come from livestock (methane), burning of savannas and nitrous oxide emissions from soils.

Pests, diseases and weeds

More than 80 species of exotic vertebrate animals have established wild populations in Australia and more than 30 of these species have become agricultural or environmental pests. Major agricultural impacts of pest animals include:

- grazing and land degradation by rabbits and feral goats
- livestock predation by wild dogs, foxes and feral pigs
- damage to grain and fruit crops by mice and birds.

The direct costs to agriculture (including pest impacts and expenditure on management, administration and research) from wild dogs, rabbits, foxes, pigs, pest birds and mice was estimated at approximately $745 million in 2009 (DAFF 2012). Introduced insects, such as cattle ticks and aphids, cost agriculture more than $5 billion per year in production losses and $1 billion in control costs (DAFF 2012).

Around 28 000 exotic plant species have been introduced into Australia since European settlement and 3480 of these have become weeds. Many of these weeds are escaped garden plants. Weeds contaminate crops, displace pasture plants and compete with crop and pasture plants for water and nutrients. Weeds also harbour diseases and insect pests, reduce livestock carrying capacity and condition, and can be toxic to livestock. The effect and control of weeds costs Australian agriculture more than $4 billion per year (DAFF 2012). Farmers consider weed control as one of their highest priorities to prevent long-term land degradation.

Biosecurity

Australia’s biosecurity system minimises the risk of exotic pests and diseases entering the country and harming the natural environment. Australia expanding economic ties with developing regions has led to inherent biosecurity risks. Warmer climates and faster transport systems can encourage pests and disease. Within Australia, disease and pest security is also increasing with climate change and improved logistics. The Australian Government is implementing reforms to Australia’s biosecurity system to ensure it is responsive and targeted in a changing global trading environment.
Land use

There is an overall trend of land use intensification in Australia, although this varies regionally and is set against a slow decline in the proportion of Australia’s land area used for agriculture. According to ABS data, the area planted to crops (excluding pastures and grasses, and crops harvested for hay and seed) increased between 1992–93 and 2009–10, from almost 17.3 million hectares to almost 26 million hectares. Projected increased population will create further pressure for land use intensification for residential, commercial and production purposes. The potential effect of climate change on agriculture and the possible contraction of food producing areas, such as the Australian wheatbelt, will add to this pressure.

The causes and drivers of land use change are:

- pressures on resource availability including land productivity, resource condition and population
- changing opportunities including market development, production costs, new technologies, infrastructure and transport costs
- policy interventions including subsidies, taxes, property rights, infrastructure and governance arrangements
- vulnerability and adaptive capacity including exposure to natural hazards and the coping capacity of communities and individuals
- social changes including changes in access to resources, income distribution and urban-rural interactions.

Land use change needs to be monitored to manage Australian landscapes and implement policy settings and program arrangements dealing with agricultural productivity, biosecurity, carbon, natural resources management, biodiversity, and food security.

Australia is improving its capacity to track land use change, drawing on information such as satellite remote sensing and statistical collections. ABARES is working with the Australian Collaborative Land Use and Management Program’s (ACLUMP) partners to promote collaboration among Australian and state government agencies and others with interests in land use change analysis. The recent move by the Australian Government to establish a National Plan for Environmental Information and the ABS to introduce land and water accounting will further promote tracking and reporting on land use change.

More recent statistical evidence from the ABS confirms this general pattern of change in agricultural land uses. Between 1992–93 and 2005–06 the area of agricultural holdings decreased by 5.5 per cent to 4 349 250 square kilometres. The most recent ABS information for 2009–10 shows that the area of land used for agriculture continued to decline to 3 985 800 square kilometres (13.4 per cent decrease from 1992–93). The area planted to crops (excluding pastures and grasses, and crops harvested for hay and seed) increased by 42 per cent between 1992–93 and 2005–06, and increased by 50 per cent between 1992–93 and 2009–10 (Figure 1).
However, there is considerable variability in the spatial distribution of change across Australia over the period. For example, from 1993–94 to 2005–06 there was an increase in cropping area on the western slopes of New South Wales, western Victoria and generally across the grain growing regions of South Australia and Western Australia (Map 7). There was a small decline in area under cropping across most of northern New South Wales and southern Queensland.
In some cases land use change can be represented as a process of land use intensification. Agricultural land use intensification is one response to the challenges of the cost-price squeeze faced by agricultural producers and increasing population. It reflects the attempt to secure more economic yield from each hectare through increasing concentrations of inputs including nutrients, water, energy and management effort.

Agricultural land use intensification in Australia is illustrated in Map 8, expressed as the cost of production per unit area. Intensification is generally concentrated in the more agriculturally productive regions that have a greater range of viable land use options, including opportunities for irrigation. Agricultural land use intensification is also concentrated in and around large population centres.
Map 8 Change in agricultural land use intensification, 1985–86 to 2005–06

Source: Lesslie, Mewett & Walcott 2011

Table 3 Weighting factors

<table>
<thead>
<tr>
<th>Land use category</th>
<th>Representative industry</th>
<th>Weighting factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual or extensive grazing</td>
<td>Beef cattle</td>
<td>1</td>
</tr>
<tr>
<td>Sown pastures</td>
<td>Sheep–beef cattle</td>
<td>2</td>
</tr>
<tr>
<td>Grain crops</td>
<td>Grains</td>
<td>10</td>
</tr>
<tr>
<td>Irrigated pastures</td>
<td>Dairy cattle</td>
<td>40</td>
</tr>
<tr>
<td>Irrigated crops</td>
<td>Cotton, sugar cane, rice</td>
<td>50</td>
</tr>
<tr>
<td>Vegetables</td>
<td>Vegetables</td>
<td>80</td>
</tr>
<tr>
<td>Fruit</td>
<td>Fruit</td>
<td>80</td>
</tr>
<tr>
<td>Nurseries/ turf</td>
<td>Horticulture</td>
<td>80</td>
</tr>
</tbody>
</table>

Note: Weighting factors for land use categories and representative industries used to calculate land use intensity index.

Statistical collections from ABS Agricultural Census and Agricultural Resource Management Surveys indicate that major changes in farm management practices are underway. For example, there has been a shift to conservation tillage over the past 15 years in broadacre cropping (Figure 2). Conservation tillage helps promote improvements in soil carbon, reduced soil erosion and nutrient loss, cost savings and other production benefits. In 1996 conventional tillage (three or more cultivation passes) was the most common practice, by area, in all states except Western Australia and South Australia. By 2010 it was the least common practice in all states—‘no cultivation’ had replaced it as the most common cultivation practice.
Ecosystem services

An ecosystem services approach integrates the ecological, social and economic dimensions of natural resources management, including conservation and production objectives, by explicitly identifying and classifying the benefits from ecosystems. These include market and non-market, use and non-use, and tangible and intangible benefits.

The ecosystem services concept has been used successfully in Australia and internationally to identify natural resources management priorities at the catchment, regional, national and global scales and to report on the relationship between the environment and human wellbeing. For nearly two decades it has been a component of Australian Government policies and programs focused on sustainable management and development. For example, ecosystem services were a feature of the policies and programs that flowed from the National Strategy for Ecologically Sustainable Development (1992), especially the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality. The ecosystem services concept is also identified in the overarching goal of the Caring for our Country initiative.

The ecosystem services approach is particularly relevant to using and managing land cover. Land cover is related to a range of ecosystem services, such as helping to regulate water flow and maintain water quality. Such services have traditionally been treated as public goods with little or no explicit financial value, but this is changing. Potential payments for vegetation-based services, such as biodiversity conservation, carbon sequestration, salinity abatement and opportunities for ecotourism, wildlife photography and environmental education, can provide significant environmental, economic and social benefits and contribute to reducing the cost of management. While markets for such services remain a minor component of the national economy, they are expected to grow.
6 Research capacity—land use and management

ABARES provides professionally independent economic and scientific analysis, including integrated socio-economic and biophysical analysis that informs the difficult policy issues facing Australia’s primary industries.

ABARES has staff with skills across a range of economic, science and social science disciplines. These include scientific and economic analysis and modelling, data (including survey) collection and statistical analysis, risk assessment and management, geographical mapping particularly in areas related to natural resource management, commodity and market analysis, and integrated analysis.

ABARES has an established capacity to compile national land use, land management and land cover information and track change using regular statistical collections by government and industry and remotely sensed imagery. These types of information are combined to take advantage of their complementary spatial and temporal characteristics—for example, in the national scale land use mapping produced by ABARES.

Tracking and reporting change

ABARES is working with the Australian Collaborative Land Use and Management Program’s (ACLUMP) partners to promote collaboration among Australian and state government agencies and others with interests in land use change analysis.

Australia's large land area means that remote sensing is an attractive option for cost-effective mapping of aspects of land use change. Free access to imagery archives such as Landsat, MODIS and AVHRR has resulted in ready uptake in mapping programs. Agricultural statistics compiled by the ABS and ABARES are also important sources of information for analysing and reporting change.

National land use mapping

National scale land use mapping is modelled using coarse-scale satellite data (pixel size of 1.1 square kilometres), ABS Agricultural Commodity Census statistics for agricultural land uses and pre-existing finer resolution data (principally at the 1:250 000 scale) for other uses. The relatively low cost of national mapping provides an opportunity for time series mapping. National scale (1:2 500 000) datasets have been completed for 1992–93, 1993–94, 1996–97, 1998–99, 2000–01, 2001–02 and 2005–06 (see Map 1 for the most recent). The next national scale dataset will be based on the 2010–11 Agricultural Commodity Census. National scale mapping produced by ABARES is in strong demand for synoptic-level land use assessments and for strategic planning and evaluation (such as developing programs for natural resource management). It is also used in modelling applications, such as national carbon accounting and salinity assessments at the river basin level.

Dynamic land cover mapping

A dynamic land cover map and databases for Australia produced by Geoscience Australia in partnership with ABARES provides new insights into aspects of land use and land management change for Australia. The map and time series data, produced for 2000–2008 by ABARES using MODIS Enhanced Vegetation Index (EVI) data, allows trends and changes in land cover over time.
to be investigated. This database can provide insight into the response of land cover to a wide variety of drivers, both natural and anthropogenic. This allows natural resource managers to identify emerging patterns of land cover change and provides a broad spatial and historical context within which to interpret that land cover change.

**Ground Cover Monitoring for Australia**

Ground Cover Monitoring for Australia is a national program, coordinated by ABARES, that involves the remote sensing of fractional cover (green cover, dry cover, and bare ground) across Australia using MODIS NBAR data. The program includes the establishment of a national system of ground validation sites using nationally agreed methods. The data are being used initially to support soil erosion modelling and it is intended that this will be extended to mapping management practices (such as tillage/stubble management) in the cropping zone. Partners include key national research organisations (CSIRO, Geoscience Australia, and Terrestrial Ecosystems Research Network) and natural resources management / agriculture departments in each state.

**Land management practices**

Land management practices are analysed primarily using agricultural statistics collections such as those of the ABS and ABARES. In 2007–08 the Agricultural Resource Management Survey was conducted by the ABS to provide a baseline of key practices to help guide national investment programs to improve natural resources management. Practices include those relating to tillage, stubble management, ground cover management, fertiliser use, soil testing and liming. This survey was also run for 2009–10 and will be again for 2011–12. These results will be used to measure change in land management practices over time.

ABARES carries out a smaller annual survey, the Australian Agricultural and Grazing Industry Survey, of the broadacre cropping, grazing and dairy industries. This survey produces estimates of land area and tenure, labour, farm capital, crop type and production, fertiliser use, irrigation, farm receipts, farm costs, farm performance measures, farm debt and farm equity.

**Spatial decision support**

**MCAS-S tool**

The Multi-Criteria Analysis Shell for Spatial Decision Support (MCAS-S), developed by ABARES, is an easy-to-use spatial decision support tool designed to help visualise and combine mapped information in a flexible, interactive way. MCAS-S is the latest of several multi-criteria decision support aids used by the Australian Government Department of Agriculture, Fisheries and Forestry since the early 1990s to support policy decision-making.

MCAS-S allows the user to import, select and display spatial data in a dynamic workspace window, see multiple datasets simultaneously, group datasets under themes, interactively modify and combine these datasets, and carry out two-way and multi-way comparisons to form meaningful map-based flow diagrams. Layers can be combined using simple weights, complex functions or through pair-wise comparison. It also allows users to document their results and the decision-making process, including assumptions.

A project can be constructed at any scale and resolution and ‘live updates’ are available, which are particularly helpful at workshops. MCAS-S assists in decision-making where transparency between different approaches to map combination is needed. Stakeholders can see the effects their decisions may make. Successful use of the software does not require GIS (geographic
information systems) programming, which removes the usual technical obstacles non-GIS users have in accessing and analysing spatial information.

MCAS-S is being used at the national, regional and catchment scale for:

- wind erosion extent and risk assessment 2009
- soil acidification risk assessment 2010
- soil carbon potential evaluation 2009
- targeting investment—Great Barrier Reef water quality 2009–10
- indicators of community vulnerability and adaptive capacity 2010
- rabies risk mapping 2011
- weeds risk assessment 2011
- asian honey bee risk assessment 2009
- animal disease risk mapping 2011
- re-vegetation planning 2006
- land acquisition priorities for conservation 2010
- catchment re-vegetation planning 2011
- priorities for regional natural resources investment 2011
- wildfire assessment (soil erosion) 2011
- agricultural land quality evaluation 2011.

Figure 3 shows data layers that have been combined using MCAS-S to produce a national map of the extent and severity of wind erosion. These data included modelled wind erosion data (created using a model), an index of dust storm activity based on observed data, and expert opinion (rankings by region) of the extent and severity of wind erosion. The input data layers were weighted for each state according to expert opinion on their confidence in each layer and were combined spatially using the MCAS-S tool. The darker areas are those with the highest wind erosion extent and severity in Australia as determined by an expert panel.
Figure 3 MCAS-S project screenshot to determine the extent and severity of wind erosion in Australia

Note: States were analysed individually and then combined to provide a national picture.

Source: Smith & Leys 2009
7 Key issues

A number of potential issues in the land use and resources area were identified as context for discussions between ABARES and FEDRC on common technical interests. These include:

- Australia’s food supply system and its potential to contribute to food security domestically and globally
- where and how sustainable agriculture can be maintained and developed in response to climate change and loss of productive agricultural land
- options for managing carbon in Australian agricultural production systems (including farm forestry)
- tracking ‘hotspots’ of land use change, including land use intensification on the fringes of cities and urban areas and loss of productive agricultural land, productive land resources and biodiversity
- transitions in irrigated agriculture, forestry and carbon farming, and the trade-offs between biofuels and other forms of agriculture.

Addressing these issues will require:

- more effective use of newly available remote sensing and statistical information
- new methods for change analysis (including automated change detection) and better measurement of error and uncertainty
- better links between existing data collection and analysis activities, including international engagement
- better methods for identifying and classifying thematic transitions, cyclic variability and trends
- better methods for forecasting land use change, including change in response to increased climate variability and disaster risk (including biosecurity, fire, flood and cyclone)
- land use and land management incentives for non-market ecosystem goods and services
- decision support capability to enable informed, transparent consideration of options and trade-offs.
8 Potential areas for collaboration

The Sustainable Land and Forest Management Research Agenda project has strengthened technical cooperation in areas of common interest. To further improve the sustainable management of land and forests, potential areas for collaboration have been identified and include:

- spatial decision support systems
- land resources assessment
- landscape classification
- ecosystem services
- remote sensing of land use and land cover change
- climate change adaptation
- carbon accounting relating to land use and land management change.
References


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