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Towards national reporting on agricultural land use change in Australia

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Contents

Tables

Figures

Maps

Boxes

Summary

Land use describes the purposes assigned to land. It refers to the purpose for which the land is committed. It is fundamental to understanding landscapes, agricultural production and the management of natural resources. Land use can include the production of goods (such as crops, timber and manufactures) and services (such as defence, recreations, biodiversity and natural resources protection). It also includes urban and rural settlement. Land use choices have a major effect on food production, the natural environment and communities.

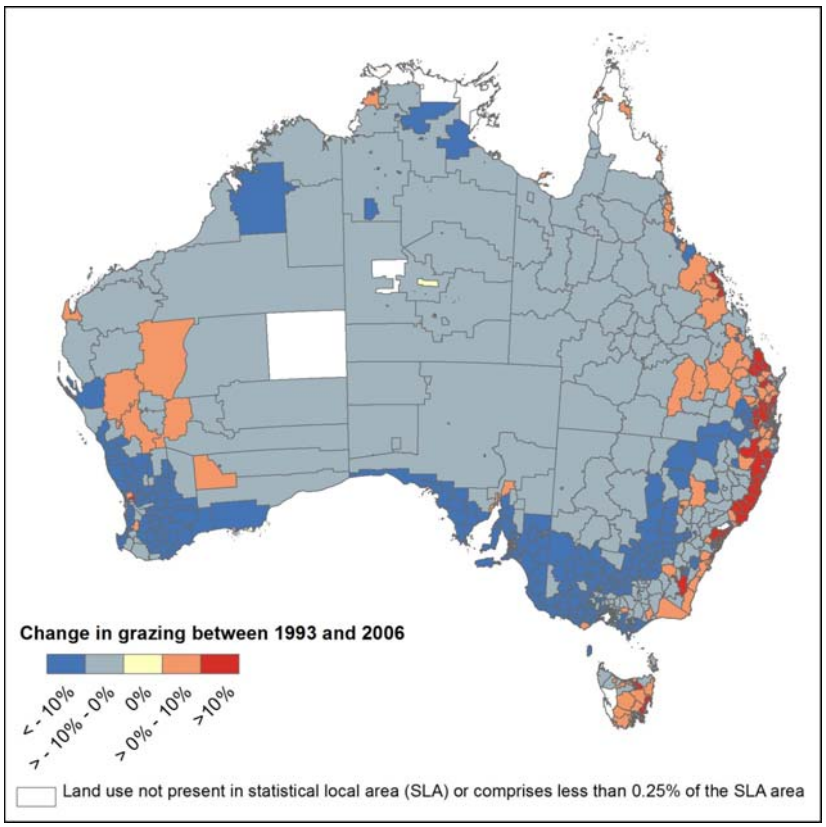
Land use change is central to much current debate in Australia around agriculture and food and fibre security, forestry, water management, mining, climate change mitigation and adaptation, population, urban expansion, biodiversity protection, community development and landscape aesthetics.

This report provides the latest available information on national land use and land use change. It draws heavily on the ABARES time series of national scale land use maps and Australian Bureau of Statistics (ABS) agricultural statistics as these are the most reliable and consistent for reporting on land use change at the national level. The strength of the ABARES national scale land use maps is that they combine ABS agricultural statistics with other land use information into one complete spatial dataset for Australia.

The broad trends in agricultural land use change are as follows:

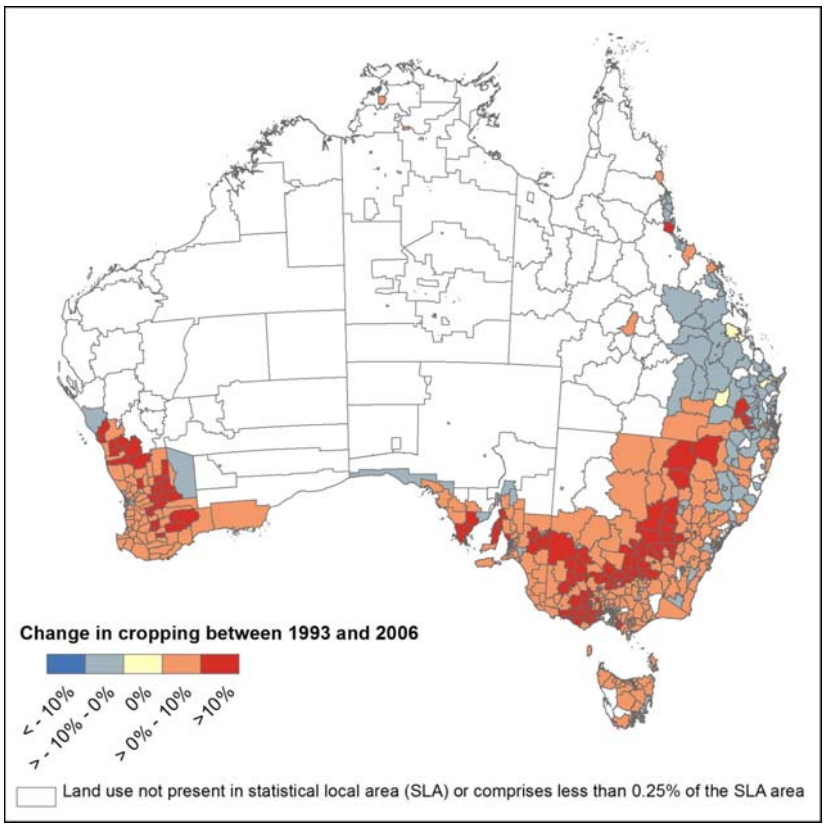
- Agriculture remains Australia's dominant land use, covering around 456 million hectares (ha) or 59 per cent of the continent in 2005-06, a decrease of around 18.8 million ha (4 per cent of the agricultural area) since 1992-93.
- The most common agricultural land use by area is grazing on native vegetation and modified pastures which occupies 428 million ha or around 56 per cent of Australia and occurs mostly in the arid and semi-arid regions of inland Australia.
- The area of grazing decreased by 6 per cent between 1992-93 and 2005-06. Over the same period, the area of land used for cropping increased by 39 per cent to 27 million ha (3.5 per cent of Australia's land area). These changes vary across the country, see Maps S1 and S2.
- In 2005-06, areas of minimal use, nature conservation and other protected areas including Indigenous uses occupied around 282 million hectares or 37 per cent of Australia. Based on the Collaborative Australian Protected Area Database (CAPAD), between 1992-93 and 2005-06, the area of formal nature conservation increased by 15 million ha (37 per cent). In some regions, decreases in the area of land used for grazing are associated with increases in the area of land used for cropping and nature conservation although locations where direct conversions from one land use to another have occurred cannot be identified from the national-scale data reviewed in this report.
- The number of farm businesses decreased from 144 860 in 1997-98 to 135 447 in 2010-11. However, decreases by farm size were only reflected in the medium (50 to 2 500 ha) category. The number of large farms (greater than 2 500 ha) and small farms (less than 50 ha) both increased between 1997-98 and 2010-11. Changes in farm size can arise from a range of factors including pressures to increase economic productivity and efficiency as well as sub-division for peri-urban lifestyle blocks or for more intensive production.

Map S1 Change in the area used for grazing between 1992-93 and 2005-06



Data source: ABARES national scale land use maps (BRS 2006; ABARE-BRS 2010).

Map S2 Change in the area used for cropping between 1992-93 and 2005-06



Data source: ABARES national scale land use maps (BRS 2006; ABARE-BRS 2010).

- While the growth in peri-urban areas (those that lie on the fringe of the major built-up areas of cities) can compete with agricultural land and the loss of agricultural land to urban growth is important, these changes do not necessarily translate into a decrease in the value of agricultural production. The Melbourne Statistical Division, for example, had only 2 per cent of the total area of Victoria's agricultural holdings in 2010-11, but this area produced 13.4 per cent ($1.2 billion) of the State's agricultural commodities by value. Mining is also expanding into agricultural lands and some new coal seam gas developments occur in areas of high value agricultural activity.

- While the national picture suggests relatively modest changes in area for key land uses (grazing, cropping and nature conservation) over the period 1992-93 to 2005-06, regional land use change patterns can vary significantly from national trends. Over the longer term the impacts of increased climate variability and population pressure may strongly impact the location of agricultural and non-agricultural activities. Changes in the location of traditional agricultural activities (grazing and cropping) are already emerging.

Australia is improving its capacity to track land use change, drawing on information sources including satellite remote sensing and statistical collections. The next national scale land use map, based on 2010-11 agricultural census information, is due for release by ABARES late in 2013 and will provide the opportunity to analyse change across the country for a number of key land uses (grazing, cropping and conservation) from 1992-93 to 2010-11. It will also be possible to analyse change for a wider range of land uses between 2005-06 and 2010-11. This is being developed by the Australian Collaborative Land Use and Management Program (ACLUMP), a consortium of national and state agencies coordinated by ABARES.

1 Introduction - why is agricultural land use change important?

Land use describes the purpose assigned to land. It refers to the purpose which the land is committed, including the production of goods (such as crops, timber and manufactures) and services (such as defence, recreations, biodiversity and natural resources protection) (ACLUMP 2010). The way that land is used has profound effects on economic, social and environmental systems. Land use change arising from intensification, diversification and innovation (Box 1) provides increased economic returns to farmers, improved productivity and outcomes that have implications for natural resources such as soil, water and biodiversity. Information about the areal extent of land use and land use change is therefore central to decision-making in Australia around issues such as food and fibre security, water management, mining (including coal seam gas extraction), biodiversity protection, climate change mitigation and adaptation, urban growth and community development.

Box 1 Describing land use change

Common concepts and approaches to characterising land use change (Lesslie et al. 2011) are:

• Area—the spatial extent of land use. This is a basic expression of the status of a land use, usually measured in hectares or square kilometres.

• Productivity—the efficiency with which land use inputs are converted into outputs.

• Intensification—the degree of concentration of land use inputs and outputs.

• Innovation—improvement in the approach taken to achieve a land use outcome. Innovation usually occurs through changes in land management practice.

Concepts relevant to tracking aspects of land use change over space and time (Lesslie et al. 2011) include:

• Spatial location—position in space. Spatial location describes where a land use is physically located using geospatial coordinates.

• Trend—persistence in a condition over time. Trend is often represented as unidirectional change against a baseline period or point in time.

• Dynamics—rates of change and periodicity. This may reveal important trends in land use and land management not evident in expressions of simple area change or transformations. Successful analysis of land use dynamics requires consistent, high quality, time-series data.

• Prediction—forecasting spatial or temporal patterns of change. Models are used to replicate the past and to predict.

Examples of land use analysis based on productivity, intensification and innovation are presented in Lesslie *et al.* 2011.

Researchers, policymakers and land managers need accurate and timely information on land use change to help analyse its impacts and manage its consequences. A better understanding of agricultural land use change is central to an informed analysis of the future of agricultural

production and agricultural land management in Australia. At a national level, the evidence suggests that change in the area of land used for agriculture from 1992-93 to 2005-06 was modest (ABARES 2011a; ABS 2011a). At the regional level, however, the effects of change may be far more significant, particularly in areas with high growth rates of urban development. The potential impacts of climate change on agriculture may also affect land use in the future (ABARES 2011b).

This technical report builds on the ABARES Science and Economics Insights Report *Landscapes in transition: tracking land use change in Australia* (Lesslie et al. 2011) in scoping our capacity to consistently report on land use change at the national level using currently available national datasets. It outlines the current extent of agricultural land use in Australia, and describes how agricultural land use is changing. It highlights the dynamic nature of agricultural land use and the pressures for change from alternative land uses. Changes in some land uses, such as grazing, cropping, nature conservation and plantation forestry as well as changes in peri-urban environments, are also discussed.

Challenges to the reporting of land use change include the availability of accurate and timely land use change information, particularly variability in the spatial and temporal scale of source information. Changes in data collection methods can also affect the reliability of land use change estimates. This report highlights how different data sources can be used to paint a picture of land use change in Australia. It also identifies some of the factors to be aware of when comparing land use information from different sources.

2 Sources of land use information

Key sources of land use information for Australia include nationally coordinated catchment scale land use maps, ABARES national scale land use maps, the Australian Bureau of Statistics (ABS) agricultural statistics, ABARES farm surveys, industry reports and surveys and forestry data included in the National Forest Inventory.

Data sources

Catchment scale land use mapping is produced using land tenure and other types of land use data, fine-scale satellite data and information collected in the field. The operational scale of catchment scale land use mapping varies according to the intensity of land-use activities and landscape context. Mapping ranges from fine scale (1:10 000 to 1:25 000) for irrigated and peri-urban areas to coarser scales for cropping regions (1:100 000) and for the semi-arid and arid pastoral zone (1:250 000). Catchment scale mapping is commonly used to help address natural resource management issues affecting soils, water and vegetation (ABARES 2011a). This mapping is generally produced by state and territory governments with involvement from natural resource management bodies.

National scale land use mapping is produced by ABARES using coarse-scale satellite data (pixel size of 1.1 square kilometres), ABS agricultural statistics and ground control point data for the agricultural land uses and various other digital maps, including the finer resolution catchment scale land use data, for the non-agricultural land uses. ABARES national scale land use maps are used for broad-scale land use assessments and for strategic planning and evaluation (ABARES 2011a). The most current map is for 2005-06 and the next map (2010-11) is currently in production and due for release in late 2013.

The ABS Agricultural Census is a five-yearly census of all agricultural businesses with an estimated value of agricultural operations (EVAO) in excess of $5000 (ABS 2012a). The Agricultural Census collects area and production data as well as data on inputs (i.e. water and fertilisers) for a wide range of agricultural commodities. In certain years some land management and other environmental data are also collected. Data from the census are used to provide statistics to primary producers, industry organisations and suppliers, other agricultural service and support industries and the national and state governments. As stated above, data are also used to inform the ABARES national scale land use maps. In the years when the census is not undertaken the ABS conducts an Agricultural Survey which samples approximately 20 per cent of all agricultural businesses with an EVAO in excess of $5000. National estimates of production and area data are calculated from this sample (ABS 2012a).

ABARES farm surveys (the Australian Agricultural and Grazing Industries Survey - AAGIS; and Australian Dairy Industry Survey - ADIS) sample around 1600 broadacre businesses and around 300 dairy businesses. The surveys collect detailed financial, physical and socioeconomic information to provide profiles and forecasts of the financial performance of farm businesses in the grains, livestock and dairy industries. The relatively small sample sizes of these surveys limit the use of these data for detailed spatial analysis. However, area information for key commodities, in the form of the past and forecast national areal extent, is reported in the quarterly Agricultural Commodities report (ABARES 2011c).

Industry reports and surveys also exist for key agricultural industry bodies. These generally identify numbers of registered businesses within an industry and average farm size, or survey and report on best practices. This information is sometimes collected in conjunction with land

use data. For example, the Grains Research and Development Corporation (GRDC) carried out a farm practices survey of 1300 grain growing businesses in 2011 which included a collection of land use information to examine how well farmers were matching land capability to land use (Edwards et al. 2012). The generally small sample sizes of industry body surveys limit the use of the data in analysis of change at the national scale.

National forest data are collected by all state and territory agencies and are standardised and collated into the National Forest Inventory (NFI) and its constituent National Plantation Inventory (NPI) by ABARES (ABARES 2012). These data can be used to calculate, amongst other things, the location and extent of native and plantation forest in Australia. National forest is allocated to one of six NFI-recognised land tenure categories (multiple-use public forests, nature conservation reserves, forests on 'other Crown land', private forests, leasehold forest and unresolved tenure). The area of native forests is based on a cover assessment that does not take into account use (e.g. wood production, conservation, grazing, etc). Wood production generally occurs in multiple-use public forests and private forests categories. The NFI includes the area of forest plantations which is collated (from state and territory agencies and private companies) under the National Plantation Inventory (NPI) (Gavran 2013). The NPI includes areas of native species and areas of exotic species, but only includes commercial plantations.

Data inconsistencies

Inconsistencies evident in data from different data sources present a challenge to land use change assessment. These generally result from different geographic or temporal scales, sampling frames, measurement methods and/or definitions. Each information source has different strengths and weaknesses. Careful thought must be given to the original intentions, comparability and planned use of data sources when considering them to inform analysis and reporting.

For example, there are differences in the area of agricultural land as reported by the ABARES national scale land use maps and the ABS agricultural statistics. The ABARES national scale land use maps reported that the area of agricultural land uses was 61 per cent of the total area of Australia in 2000-01 and 59 per cent in 2005-06 (ABARES 2011a). The ABS reported the area of agricultural holdings as 59 per cent in 2000-01 and 57 per cent in 2005-06 (ABS 2002 and ABS 2008). This is due to the different sampling frames and methodologies used to determine the area of agriculture. The ABARES national scale land use dataset is constructed by integrating data from a variety of sources as already discussed. The ABARES national scale land use maps define agricultural land as that used for grazing, cropping and horticultural land uses. The agricultural land figures published by the ABS are based on agricultural census or survey which are self-reported by the respondents and include; the total area of agricultural holdings, a breakdown of this into areas for key on-farm land uses (such as grazing, cropping, farm infrastructure, forestry and conservation), and a variety of more detailed information (such as area and production figures for a wide range of commodities and commodity groups). Not all agricultural businesses complete these surveys, only those with an estimated value of operations of $5,000 or more. Therefore, smaller properties such as hobby farms may not be included.

The ABARES national scale land use maps and ABS agricultural statistics are fit for different purposes. The ABS agricultural statistics are best used when analysing change for particular commodities over time (provided they have been consistently collected). The ABARES national scale land use maps are best used when reporting on groupings of agricultural commodities (such as cropping or horticulture) or land uses that are not collected regularly by the ABS (such as grazing and nature conservation). The strength of the ABARES national scale land use maps is

that they combine ABS agricultural statistics with other land use information into one complete spatial dataset for Australia.

There are also differences in the area of forest as reported by the NFI and ABARES national scale land use maps. For the ABARES national scale land use map, most of the forests reported under the NFI are allocated to land use categories based on prime use that do not separately identify the forests component. Much of Australia's native forests and woodlands are therefore allocated to other classes such as conservation and grazing as timber production is not the prime use. Production forests are separately identified where the predominant use of native forests is timber production for sawlogs, pulpwood and other non-wood products. Plantation forests for the ABARES national scale land use map are sourced from a combination of the NFI plantations and areas reported as plantation forestry in the catchment scale land use maps. The catchment scale land use maps vary temporally across the country and so may include areas that have been converted to plantations or from plantations to another use. Plantation forests for the ABARES national scale land use map include land on which plantation trees and shrubs (native or exotic) have been established for production, or environmental and resource protection purposes, including farm forestry, except where the planted trees are grown in conjunction with pasture, fodder or crop production. Plantation forests in the NPI include plantation trees but not shrubs, and only include commercial plantations grown for wood production and not environmental plantings or small-scale farm forestry. The important difference to note between the NFI and the ABARES national scale land use maps is that the NFI maps forests in terms of tree cover while the ABARES national land use map allocates forests to their primary land use.

This report provides agricultural land use change analysis for Australia using the most current nationally consistent land use information sources. It draws heavily on the ABARES national scale land use maps and ABS agricultural statistics. Where applicable, this report analyses and explains specific instances where different information sources appear to conflict.

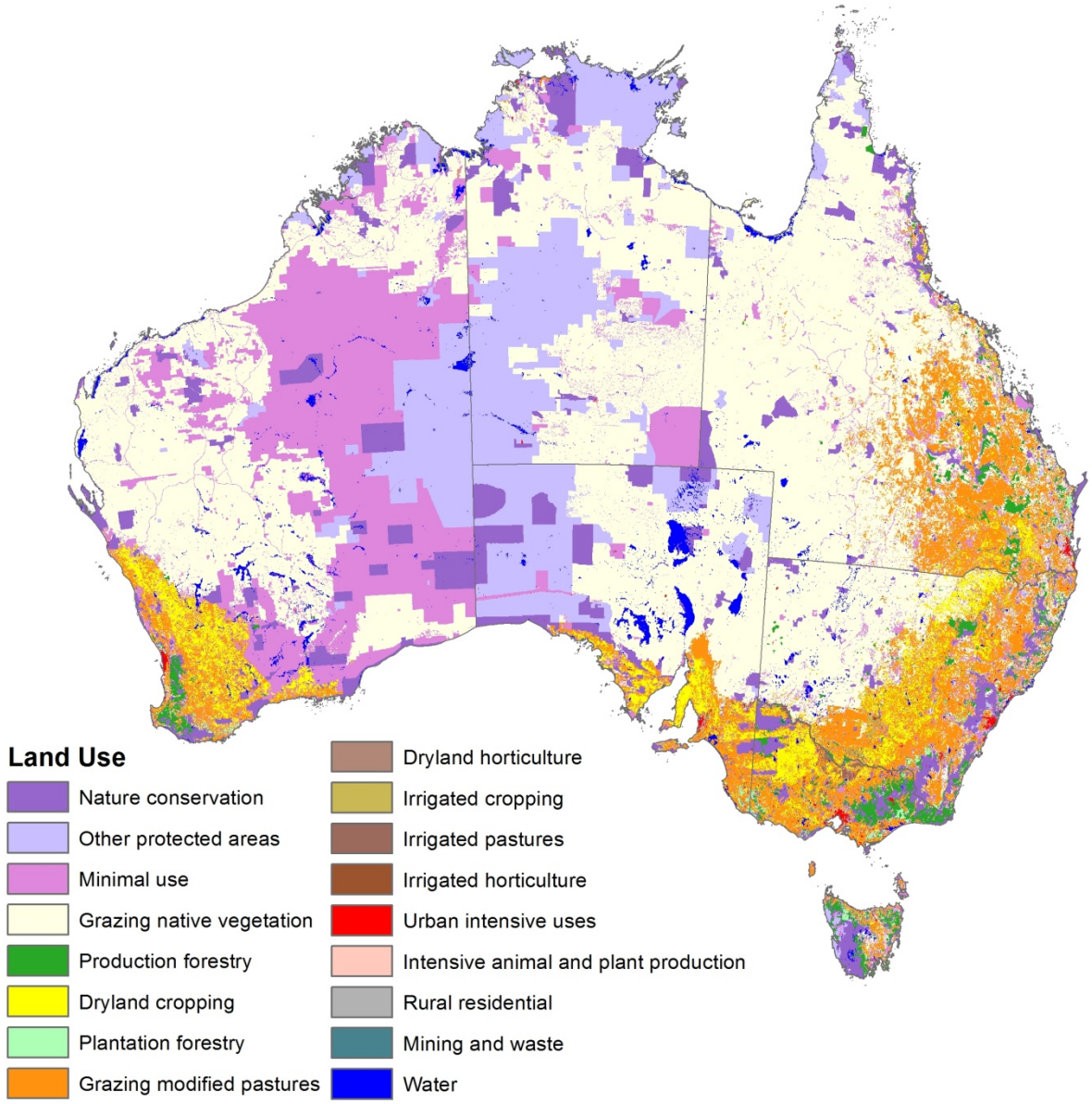
Catchment scale land use maps, while very high resolution, differ in currency across the country and are therefore not suitable for nation-wide analysis at this time. At its annual meeting in 2013, The Australian Collaborative Land Use and Management Program (ACLUMP), a consortium of national and state agencies coordinated by ABARES, investigated methods to improve the temporal consistency of high resolution catchment scale land use mapping in Australia. This would result in more up-to-date catchment scale land use maps for Australia and also increase the potential to report on land use change as part of the mapping process. Information delivered through ACLUMP informs land use planning and can inform the development of responses to issues such as urban expansion, sustainable resource management, and climate change adaptation and mitigation. This may also contribute to national initiatives such as the National Urban Policy (Australian Government 2011) and the Multiple Land Use Framework for the mineral and energy resource sector (SCER 2012) for the minerals and energy resource sector and to relevant state and regional land use planning and policy initiatives. Further information on ACLUMP products is available at www.daff.gov.au/abares/aclump.

3 Agricultural land use in Australia

In 2011-12 Australian agricultural land uses were worth $42.6 billion in production. In the same year agriculture and forestry (including support services) employed around 478 000 people (ABS 2013). Agricultural land uses also provided a range of benefits for biodiversity, soil and water management, over and above their value for food production.

How much land is used for agriculture?

Map 1 ABARES national scale land use map (2005-06)



Note: This 2005–06 land use map for Australia is the latest in a series produced since 1992–93. Seven national land use maps are available, for the years 1992–93, 1993–94, 1996–97, 1998–99, 2000–01, 2001–02 and 2005–06. The 2010-11 map is in prep.

Data source: ABARES national scale land use map (ABARE-BRS 2010).

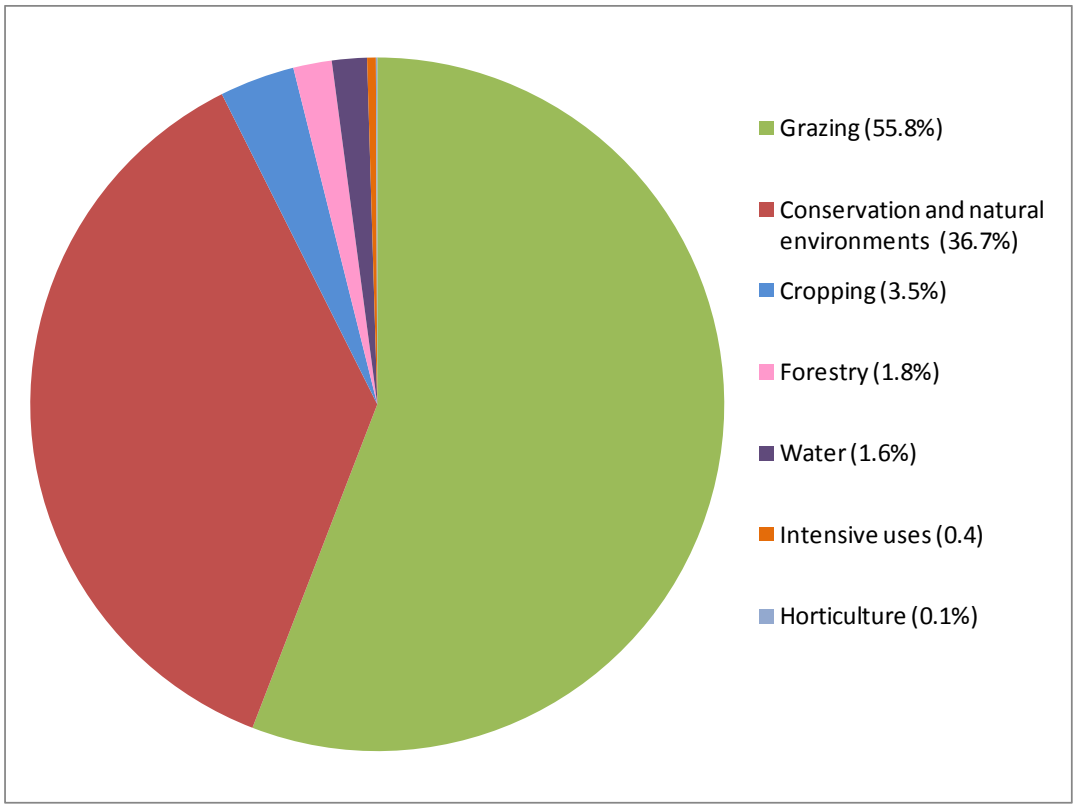
The total area of land used for agriculture in Australia in 2005-06 was almost 456 million ha or about 59 per cent of the continent (ABARE-BRS 2010). Livestock grazing on natural vegetation and modified pastures is the most widespread activity, accounting for 429 million ha or 55.8 per cent of Australia (Map 1; Figure 1). Much of this occurs in the arid and semi-arid regions of Australia. Other agricultural uses occupy a much smaller portion of the continent, including: cropping (27 million ha or 3.5 per cent of Australia) and horticulture (0.5 million ha or less than 0.1 per cent) (Figure 1).

In 2005-06 intensive land uses, a class which includes intensive plant production (e.g. glass houses and nurseries) and animal production, manufacturing, residential, services, utilities, transportation, mining and waste, occupied a relatively small proportion of the continent (3 million ha or 0.4 per cent; Figure 1), mainly centred around the capital cities (ABARE-BRS 2010).

Approximately 283 million ha (36.7 per cent) of Australia was used for conservation and natural environments. This was made up of formal nature conservation which occupied 7.4 per cent of Australia, other protected (including Indigenous) lands which occupied around 13 per cent and minimal use (other natural areas with minimal production use) which occupied a further 16 per cent (ABARE-BRS 2010).

In 2005-06, according to the ABARES national scale land use map, production forestry (commercial production from native forests on public and private land) used 11.4 million ha (1.5 per cent of Australia) and plantation forestry (including environmental and other plantings) used 2.3 million ha (0.3 per cent) (ABARE-BRS 2010).

Figure 1 Proportion of major land uses in Australia (2005-06)



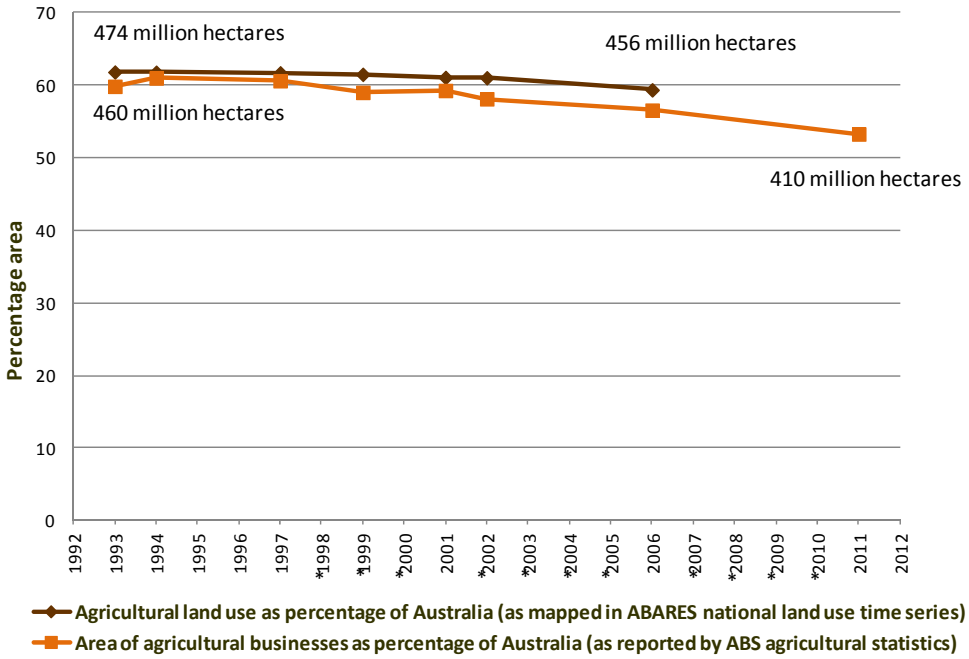
Note: These statistics are drawn from national scale land use mapping produced by ABARES through the Australian Collaborative Land Use and Management Program (ACLUMP).

Data source: ABARES national scale land use map ABARE-BRS 2010.

4 Is agricultural land use changing: a national perspective?

Overall, the total area of agriculture in Australia has decreased over time, though the rate of change is modest (Figure 2). Based on the ABARES national scale land use maps, the area of agricultural land uses decreased 4 per cent between 1992-93 and 2005-06 (relative to the 1992-93 area), with the majority of this decrease occurring since 2001-02. Based on the ABS agricultural statistics the total area of agricultural holdings also show a downward trend, with the area of holdings decreasing by 5 per cent between 1992-93 and 2005-06 and 11 per cent between 1992-93 and 2010-11.

Figure 2 Area of land used for agriculture in Australia, 1992-93 to 2010-11

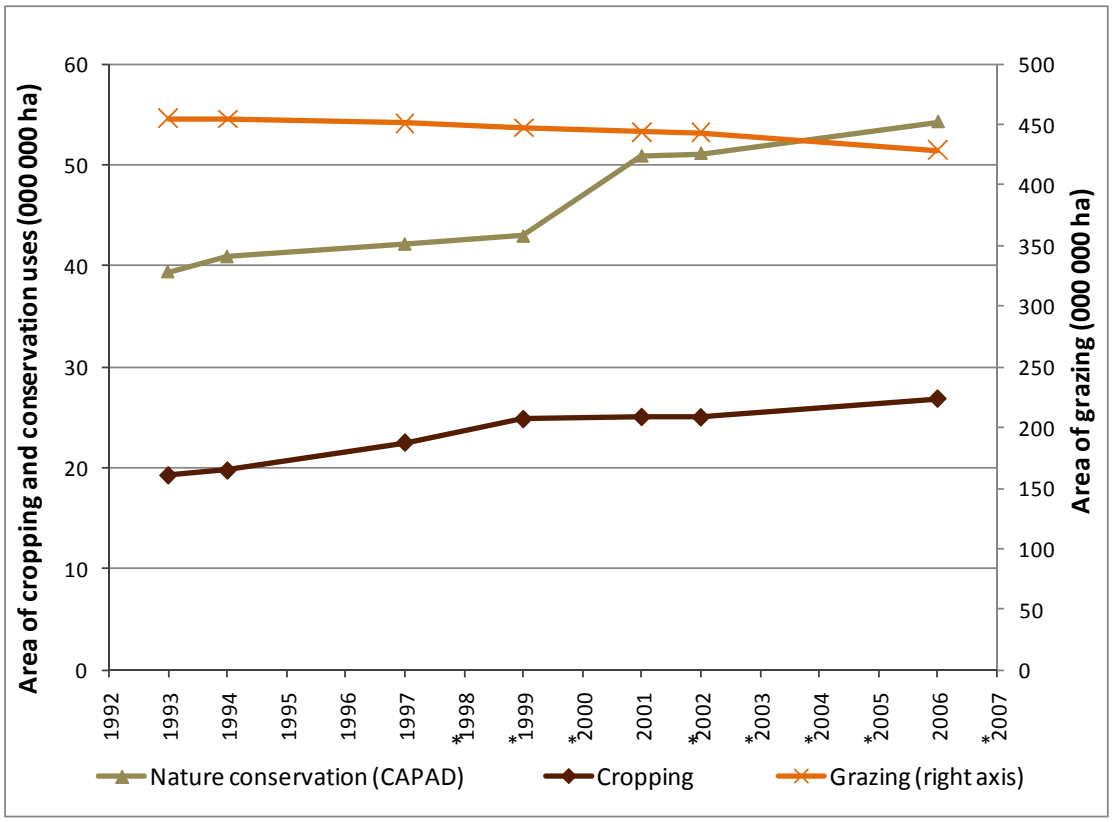


Note:* Agricultural survey rather than agricultural census, survey years are subject to greater sampling errors than census years. The years given correspond to financial year endings i.e. 1992 corresponds to 1991-92.

Data source: ABARES 2011a; ABS 2012a, 2011a, 2008, 2003, 2002, 2000, 1998, 1995 and 1994.

The majority of the decrease in agricultural land area between 1992-93 and 2005-06 evident from the ABARES national scale land use maps is associated with a 6 per cent decrease in the area of livestock grazing (relative to the 1992-93 area) (Figure 3). Although the percentage decrease was modest, in absolute terms the decrease was 26 million ha. During the same time period the area of cropping increased by 7 million ha (39 per cent) and the area of formal nature conservation (a subset of conservation and natural environments based on changes recorded through the Collaborative Australian Protected Area Database (CAPAD)) increased by 15 million ha (37 per cent). In absolute terms the increase in area of formal nature conservation was more than double that of cropping (Figure 3). It is difficult to report change in these major land use categories using the ABS agricultural statistics as they are either not collected (in the case of conservation areas on public land) or inconsistently collected (for grazing, sown pastures have regularly been collected but native pastures have not).

Figure 3 Change in area of selected land uses between 1992-93 and 2005-06 based on ABARES national scale land use map



Note:* Agricultural survey rather than agricultural census.

Data source: BRS 2006; ABARE-BRS 2010. Data for nature conservation (comprising strict nature reserves, wilderness areas, national parks, natural feature protection, habitat/ species management areas and protected landscapes) derived from ABARES national land use map layers based using CAPAD.

Changes in grazing, cropping and nature conservation varies at the state and territory level (Table 1). Between 1992-93 and 2005-06 the area of grazing decreased in five of the states and territories. The largest decrease in the area of grazing was in Victoria whereas the largest increase occurred in Tasmania. The area of cropping increased in all states and territories except Queensland and the Northern Territory where there was no change. The area of nature conservation increased in all states and territories with the largest increases in Tasmania and South Australia.

Table 1 Change in the percentage of each state and territory occupied by selected land uses between 1992-93 and 2005-06

	NSW	Vic	Qld	SA	WA	Tas	NT
Grazing	-6.0	-12.3	0.3	-4.8	-3.6	2.8	-4.2
Cropping	3.5	7.8	0.0	0.8	0.8	1.1	0.0
Nature Conservation	2.2	1.2	2.1	4.8	0.7	5.1	1.6

Note: The percentage change was calculated as the difference between the area of the state occupied by each land use in 2005-06 and 1992-93

Data source: BRS 2006; ABARE-BRS 2010. Data for nature conservation (comprising strict nature reserves, wilderness areas, national parks, natural feature protection, habitat/ species management areas and protected landscapes) derived from ABARES national land use map layers based using CAPAD.

5 How are farm businesses changing?

In 2010-11, the ABS estimated there were 135 447 farm businesses in Australia, a reduction almost 6.5 per cent from 1997-98 (Table 2). This trend was not reflected across farm size classes (Table 2).

Changes in farm size can arise from a range of factors including pressures to increase economic productivity and efficiency as well as sub-division for peri-urban lifestyle blocks or for more intensive production. Farms may become bigger when they are amalgamated to improve their financial viability - larger farms tend to be more productive and more profitable, and are better able to benefit from changes in production technology (Sheng et al. 2011). Between 1997-98 and 2010-11 the number of properties greater than 2 500 ha in area increased by 0.9 per cent. Alternatively, farms may become smaller when they are subdivided with more intensified operations in response to increasing land value. Between 1997-98 and 2010-11 the number of properties less than 50 ha in area increased by 11.7 per cent. Farms between 50 and 2 500 ha declined from 101 112 properties in 1997-98 to 88 048 properties in 2010-11, a decrease of 12.9 per cent (Table 2).

Table 2 Number of farm holdings in Australia, 1997-98 and 2010-11

	Number of holdings		Per cent change
Farm size (ha)	**1997-98**	**2010-11**	**1998 to 2011**
50 ha and below	30 043	33 571	11.7
50 to 2 500 ha	101 112	88 048	-12.9
Greater than 2 500 ha	13 705	13 828	0.9
Total	144 860	135 447	-6.5

Data source: ABS 1999; ABS 2012a.

Currently, foreign ownership of agricultural businesses, agricultural land and water entitlements is quite low. An ABS survey in December 2010 found that:

- 99 per cent of agricultural businesses in Australia were entirely Australian owned
- 89 per cent of agricultural land was entirely Australian owned, that is agricultural businesses which were entirely Australian owned accounted for 89 per cent of agricultural land
- 91 per cent of water entitlements for agricultural purposes were entirely Australian owned (ABS 2011b).

The state of Queensland, maintains a register of foreign owned rural and urban land as well as water entitlements under its Foreign Ownership of Land Register Act 1988. Under the Act, the titles office must be notified of any transactions involving foreign individuals or companies. The titles office reports on holdings by foreigners to parliament annually (Moir 2011). The Australian Government announced in 2012 that it will implement a national foreign ownership register for agricultural land following consultations with stakeholders.

6 Is agricultural land use changing: a regional perspective?

Trends in the change of agricultural land use vary between different agricultural land uses, and there are important regional differences. This can be assessed by comparing changes in key agricultural land uses using the ABARES national scale land use maps, in this case, aggregated to the statistical local area (SLA) level. This enables the relative proportion of land use by area to be determined.

How has grazing changed?

Livestock grazing (on both native and modified pastures, including dairy) accounted for more than 429 million ha or 56 per cent of the continent in 2005-06 (ABARE-BRS 2010). Regionally, changes in the area under grazing between 1992-93 and 2005-06 were variable. Increases in the proportion of area under grazing were largest in the coastal regions of New South Wales and southern Queensland. Decreases in the area under grazing were most evident across much of the southern Australia (Map 2).

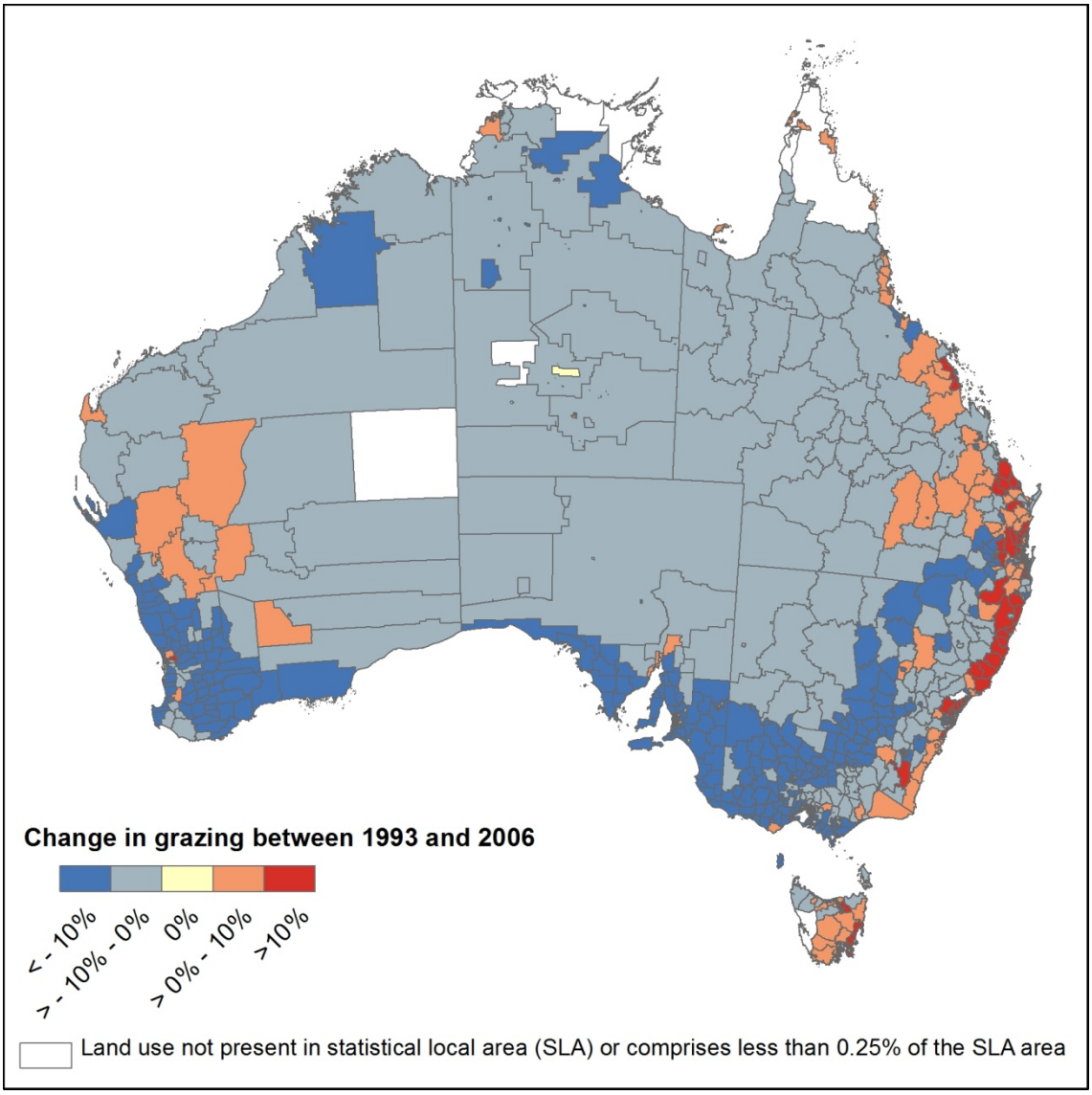
Between 1992-93 and 2005-06 sheep numbers declined from 138 million head to 91 million head (-34 per cent; ABS 2012a) mainly through western Victoria, central New South Wales and south-western Western Australia. This may have been due to a significant change in relative returns from wool as compared with cropping and other livestock enterprises. A shift from wool to meat sheep also occurred (ABARE 2007). Beef cattle increased by around 19 per cent, and dairy cattle also increased by around 11 per cent. Regionally, declines in the area of land used for grazing are generally associated with increases in the area of land used for cropping, and nature conservation (Maps 3 and 6). Grazing decreased and cropping increased in 62 percent of statistical local areas (SLAs) where both land uses occurred. Grazing decreased and nature conservation increased in 44 per cent of SLAs where both land uses occurred. Areas where direct conversions from one land use to another have occurred cannot be identified from the data used in this analysis.

How has cropping changed?

Between 1992-93 and 2005-06 the area of land used for cropping increased by around 7.5 million ha or 39 per cent to 27 million ha (Map 3). Increases were evident across much of southern Australia - for example inland New South Wales, western Victoria, parts of South Australia and south-west Western Australia, probably in response to climatic and economic conditions. There was a small decline in the area of northern cropping.

Investigation of changes in canola and cotton production between 1985-86 and 2005-06 also show increases within the Murray Darling-Basin for both commodities (Maps 4 and 5). Canola had lower production and a small spatial distribution in 1985-86 but by 2005-06 it had expanded to most of south-west Western Australia and south-east South Australia. Cotton also expanded its distribution with the higher production areas moving south. This may be a response to climatic factors such as water availability.

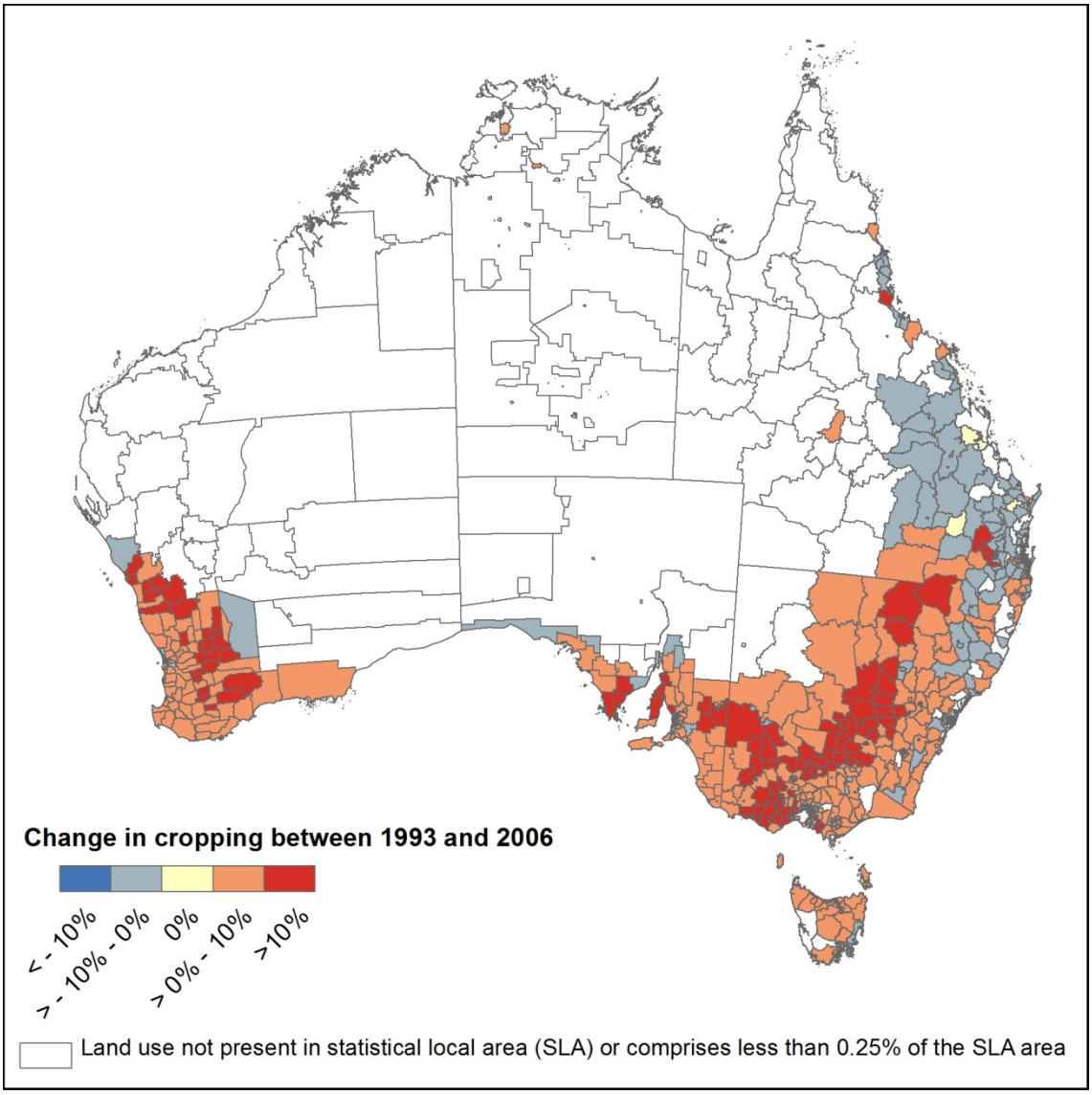
Map 2 Change in the area used for grazing between 1992-93 and 2005-06



Note: Change in land used for grazing derived from the 1992-93 (BRS 2006) and 2005-06 (ABARE-BRS 2010) national land use maps. Change is represented at the statistical local area (SLA) level by subtracting the percentage of the SLA area grazed in 1992-93 from that in 2005-06.

Data source: ABARES national scale land use maps (BRS 2006; ABARE-BRS 2010).

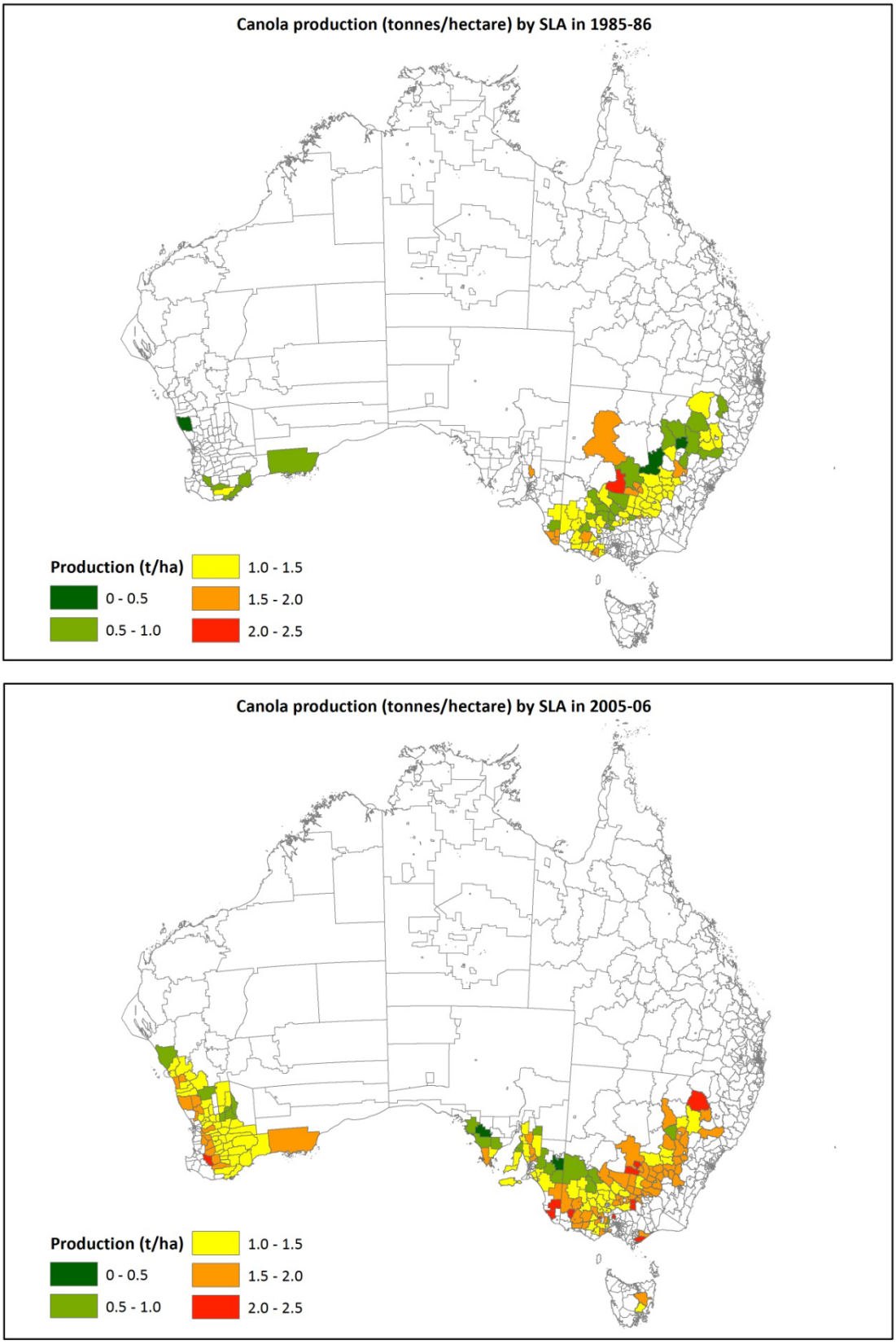
Map 3 Change in the area used for cropping between 1992-93 and 2005-06



Note: Change in land used for grazing derived from the 1992-93 (BRS 2006) and 2005-06 (ABARE-BRS 2010) national land use maps. Change is represented at the statistical local area (SLA) level by subtracting the percentage of the SLA area grazed in 1992-93 from that in 2005-06.

Data source: ABARES national scale land use maps (BRS 2006; ABARE-BRS 2010).

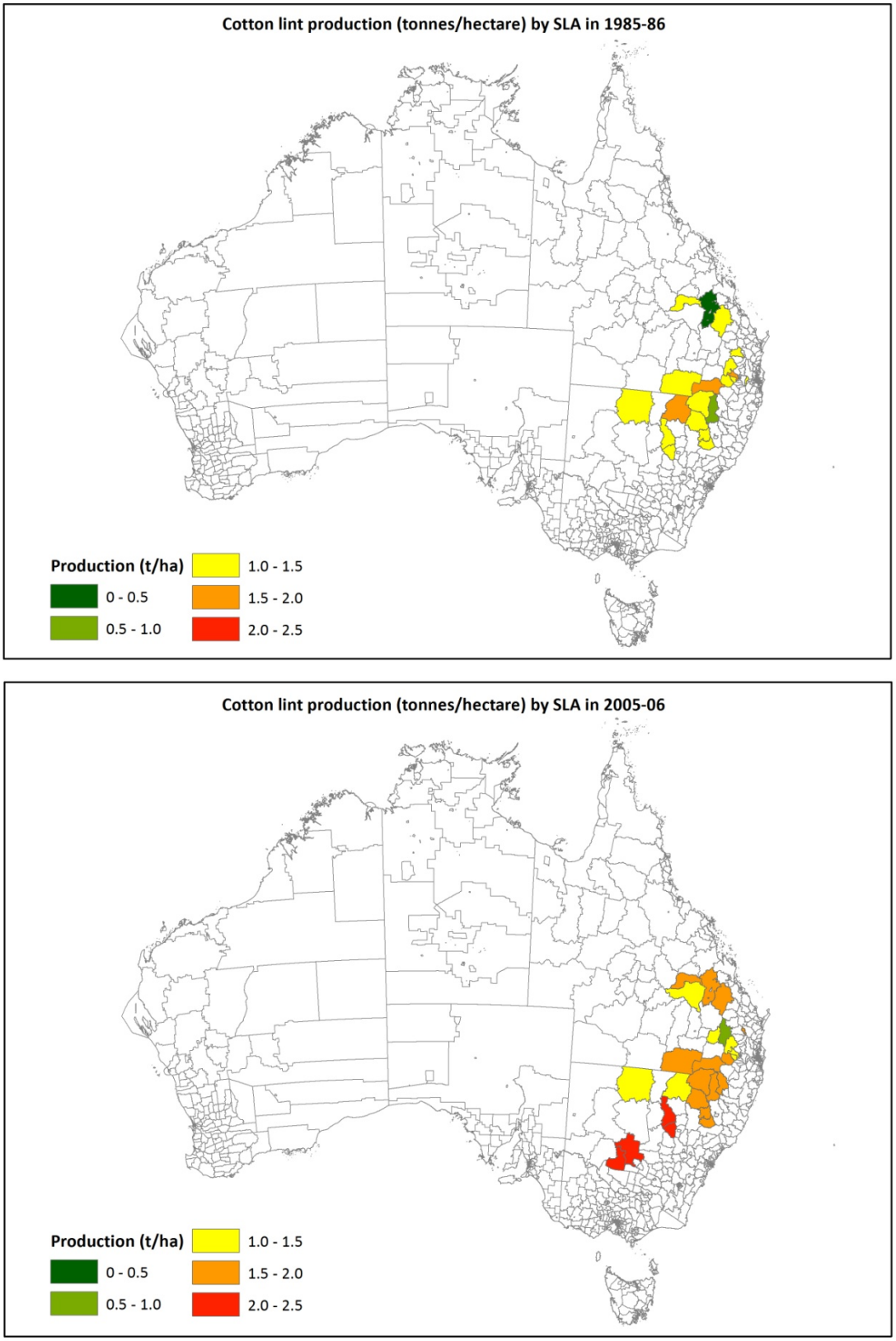
Map 4 Change in the production of canola between 1985-86 and 2005-06



Note: Statistical local areas (SLAs) with less than 100 ha of canola or less than three businesses reporting canola have been excluded.

Data source: ABS 1988 and 2008.

Map 5 Change in the production of cotton between 1985-86 and 2005-06



Note: Statistical local areas (SLAs) with less than 100 ha of cotton or less than three businesses reporting cotton have been excluded.

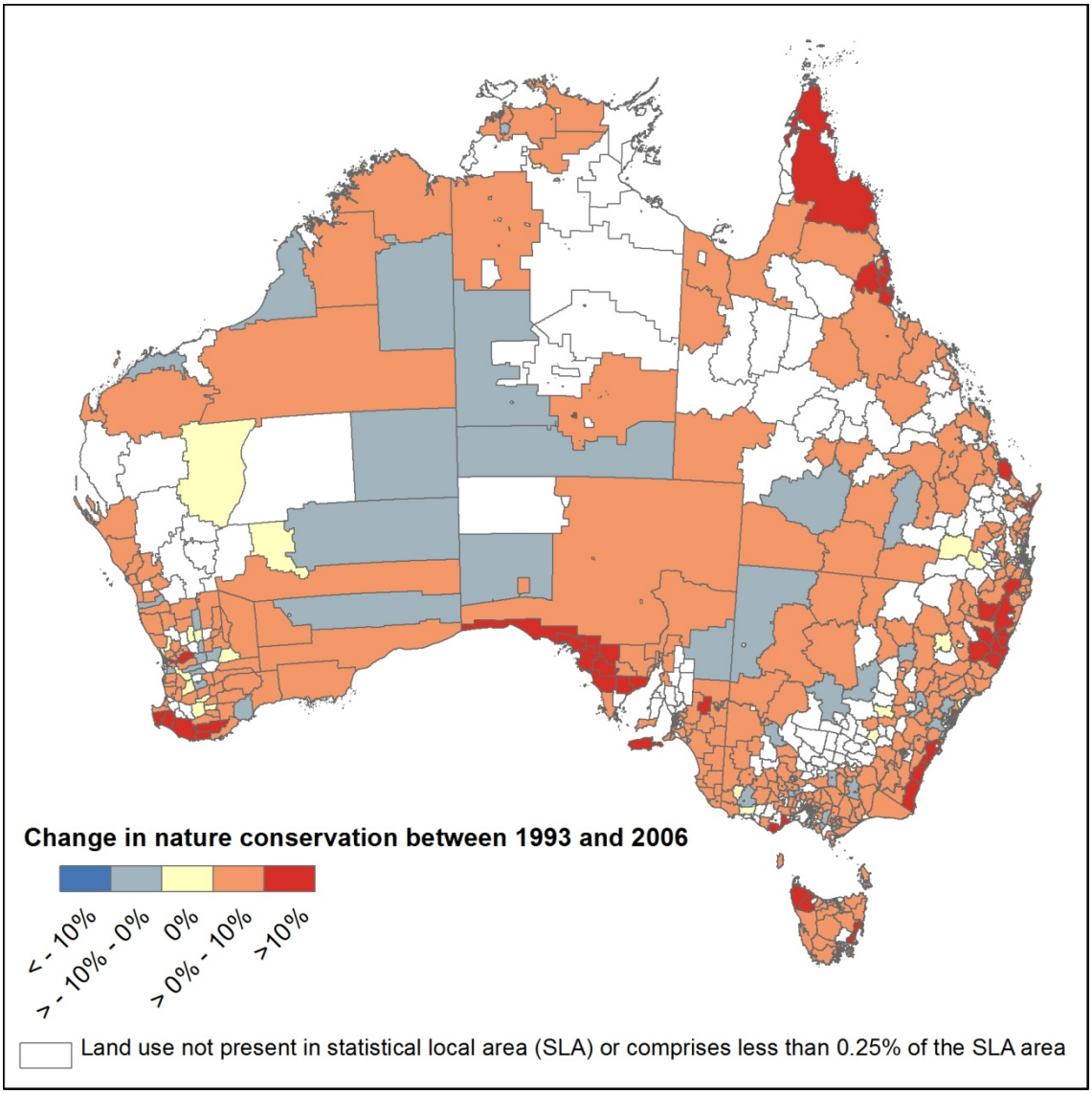
Data source: ABS 1988 and 2008.

How have other land uses changed?

Changes in the area of two non-agricultural land uses - nature conservation and plantation forestry - are briefly discussed below.

Conservation and natural environments is defined as land used for nature conservation, managed resource protection and other uses including stock routes, residual native cover, defence and Indigenous use. In 2005-06, an area of 283 million ha (37 per cent of Australia) was classified as conservation and natural environments with the largest areas located in central and northern Australia.

Map 6 Change in the area of formal nature conservation between 1992-93 and 2005-06



Note: Change in land used for nature conservation derived from the 1992-93 (BRS 2006) and 2005-06 (ABARE-BRS 2010) national land use maps layers based on CAPAD categories Ia-V. Change is represented at the statistical local area (SLA) level by subtracting the percentage of the SLA area under conservation and other minimal use in 1992-93 from that in 2005-06.

Data source: ABARES national scale land use maps (BRS 2006; ABARE-BRS 2010).

There was an increase in the area of formal nature conservation (a component of conservation and natural environments comprising strict nature reserves, wilderness areas, national parks, natural feature protection, habitat/species management areas and protected landscapes) between 1992-93 and 2005-06, especially in south-west Western Australia, the southern parts of South Australia, and coastal New South Wales (Map 6). Small (less than 10 per cent) decreases in area were recorded mainly in remote areas of central Australia.

Australia's total commercial plantation forestry area was 2 million ha in 2011-12 (0.26 per cent of Australia's area), an increase of 36 per cent since 2000 (Gavran 2013). The majority of large scale plantations are in the higher rainfall areas (greater than 600 mm per year) with only a small proportion occurring in major agricultural areas such as the Murray-Darling Basin. In 2011-12, Victoria had the largest areas of plantations, followed by Western Australia and New South Wales (Table 3).

The area of plantations has increased significantly since 2000 in all jurisdictions except the Australian Capital Territory, with the largest proportional increase (504.5 per cent) occurring in the Northern Territory (from a low baseline) and the largest increases in area (126 000 hectares) occurring in Tasmania (Gavran 2013). New plantations are defined as those established on land not previously used for plantation forestry. About 4 200 ha of new plantations were established in 2011-12, or about 0.2 per cent of all plantations. This is the smallest area of new plantations established since the early 1990s (Gavran 2013).

Table 3 Change in plantation forest area in area, 2000 to 2012

	2000	**2012**	**Change 2000-2012**
	'000 ha	'000 ha	Per cent
Australian Capital Territory	15	8	-48.1
New South Wales	319	392	22.9
Northern Territory	7	42	504.5
Queensland	191	233	22.2
South Australia	136	188	39.0
Tasmania	185	311	67.8
Victoria	319	434	36.1
Western Australia	314	405	29.1
Total	**1 485**	**2 013**	**35.6**

Data source: from Gavran 2013.

7 Other pressures on agricultural land use

Factors influencing agricultural land use change in Australia include economic, environmental and social drivers, as well as government policy. Economic drivers include changes in industry performance arising from market and production cost pressures, the introduction of new technologies and new market opportunities. Environmental drivers for agricultural land use change result from pressures on resource availability including the condition of land and the availability and quality of water for agriculture. Social factors include changing income distributions, urban-rural interactions, the vulnerability and adaptive capacity of communities and population change. Policy interventions by governments such as subsidies, taxes, property rights, infrastructure and governance arrangements are also influential (Lambin et al. 2003).

Current pressures on land resources and issues surrounding land use change include mining and other extractive industries (such as coal seam gas) and peri-urban growth. Policy interventions to promote climate change mitigation, including carbon farming, are also among those factors likely to influence land use change in the future.

The productivity of land used for agriculture varies widely, and there is concern that even agricultural land at the more productive end of the spectrum is under pressure from competing land uses. As a result, a growing number of Australian state agencies are reviewing the classification of agricultural lands with the aim of identifying productive or strategically important agricultural land.

The definitions and terms used to categorise the suitability of land for agriculture vary according to purpose, and some states are using classifications to implement policies that constrain the types of development that can occur on some classes of agricultural land. For example, the Queensland government has legislated that development applications on land defined as "strategic cropping land" are subject to additional assessments to minimise permanent impacts on the land that would make it unsuitable for cropping. The New South Wales government is also implementing strategic regional land use planning in order to address concerns about competing land use interests such as agriculture and mining.

Mining and extractive industries

A number of regions across Australia are being explored and developed for mineral and energy resources. Mining operations occupied approximately 0.02 per cent of Australia in 2005-06 (ABARE-BRS 2010). Some of these industries have been operating for a long time and include extraction of coal, uranium, iron ore, nickel, bauxite, gold, lead, copper, zinc, mineral sands, coal seam gas (CSG) and diamonds. Depending on the resource being mined, extraction generally involves surface (open cut) or sub-surface techniques.

The surface footprint of individual mining activities can vary and has the potential to impact land and water resources not just within land occupied by the mine, but in the surrounding area. This may be significant where there are potential cumulative impacts. Of particular interest is the significant expansion of the CSG industry in Australia, which has led to increased pressures on land and water resources in some regions (Box 2).

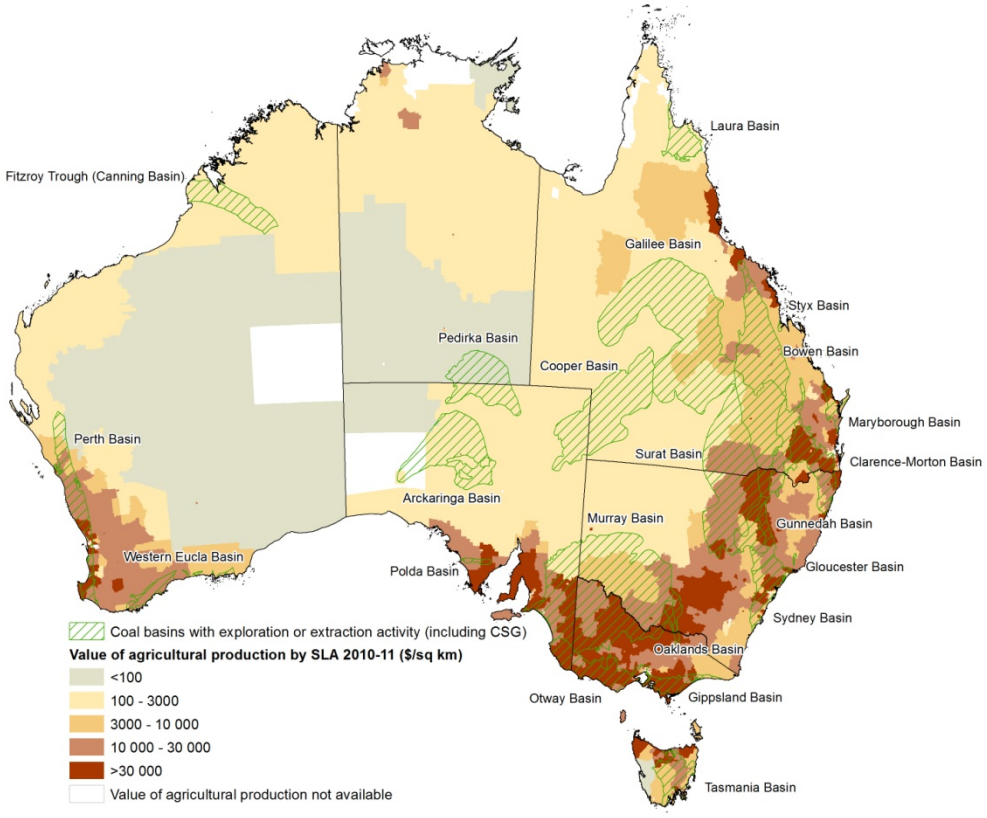
Box 2 Coal seam gas (CSG)

Australia has significant reserves of CSG. The growth of the CSG industry is likely to be important in terms of its economic impact at the local, state and national levels.

Coal basins in the Surat and Bowen Basins in Queensland and the Sydney, Gunnedah and Clarence-Moreton Basins in New South Wales, among others, are currently being explored and developed for domestic supply and overseas export (Map 7).

Unlike other forms of mining which are generally concentrated around specific locations, CSG can involve relatively dispersed activity across a larger area under some circumstances. CSG operations can operate with a range of land uses, including agriculture. The scale and rate of expansion of the CSG industry may impact existing land use and land management practices. There are also potential impacts of CSG on groundwater and surface water resources, some negative, but also potential positive impacts of increases in water supplies for agricultural and other uses.

Map 7 Coal basins under exploration and the value of agricultural production by SLA 2010-11



Note: Coal basins under exploration coincide with areas of high production agricultural land in south east Queensland, north east New South Wales and the southern Murray-Darling Basin. The value of agriculture is expressed as the total gross value of agricultural commodities produced (VACP) per km^2 for statistical local areas (SLAs) in 2010-11. This scale of mapping does not indicate where individual CSG locations overlap with areas of high agricultural production. This map indicates the location of sedimentary basins with potential for CSG.

Data source: Geoscience Australia 2012; ABS 2012b.

Peri-urban growth

Peri-urban lands are among Australia's most productive agricultural lands. Peri-urban areas are those that lie on the fringe of the major built-up areas of cities. They can be characterised as falling in non-urban zoning categories, and having lower population density and larger plot sizes than suburban areas (Aslin et al. 2004). As cities and towns expand, the growth of built up areas at the fringe (peri-urban lands) may compete with agricultural lands. The value of agricultural commodities produced (VACP) as a proportion of the state total is often many times higher than the equivalent proportion of land area used for agriculture (Table 4). The Melbourne region (ABS Statistical Division), for example, had only 2 per cent of the total area of Victoria's agricultural holdings in 2010-11, but this area produced 13.4 per cent ($1.2 billion) of the State's VACP (Table 4).

Table 4 Value of agricultural commodities produced (VCAP) in state capital city statistical divisions and the area of agricultural holdings

Statistical Division (SD)	VACP as a per cent of the state	Area of agricultural holdings as per cent of state
Sydney (New South Wales)	6.4	0.2
Melbourne (Victoria)	10.3	2.0
Brisbane (Queensland)	4.3	0.1
Adelaide (South Australia)	3.3	0.1
Perth (Western Australia)	7.6	0.1
Greater Hobart (Tasmania)	3.6	2.5
Darwin (Northern Territory)	13.4	0.6

Data source: ABS 2012a; ABS 2012b.

As urban areas expand, agricultural production may intensify, with a shift to higher yielding or higher value production - for example, a move from grazing to intensive horticulture (Buxton and Low Choy 2007). Less intensive agricultural activities may relocate or decline. Horticulture accounts for a much higher proportion of VACP for capital city statistical divisions than for corresponding states as a whole (Table 5). Peri-urban farmers often benefit from being close to a larger, wealthier consumer base and a larger labour market. They can, however, be negatively affected by restrictions on farm activities such as noise, odour, stock movements and the use of agricultural sprays.

Table 5 Horticulture as proportion of VACP for capital city statistical divisions and states

Statistical Division	Horticulture as proportion of VACP for SD	Horticulture as proportion of VACP for state
Sydney (New South Wales)	47.3	11.9
Melbourne (Victoria)	62.0	22.5
Brisbane (Queensland)	50.7	23.7
Adelaide (South Australia)	92.3	20.5
Perth (Western Australia)	61.0	14.5
Greater Hobart (Tasmania)	49.5	30.1
Darwin (Northern Territory)	79.1	23.6

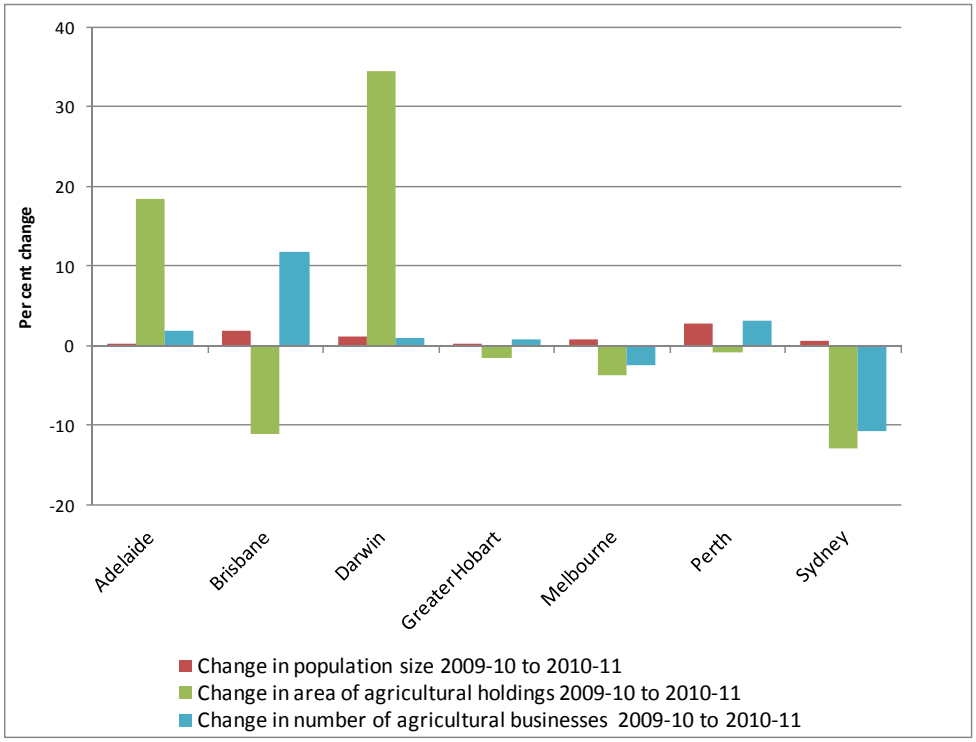
Note: Horticulture includes cut flowers and turf, fruit, and vegetables.

Data source: ABS 2012a; ABS 2012b.

There is a complex relationship between the process of urban growth and the consequent changes in the area of agricultural land and agricultural intensification in capital city regions

(Figure 4). For example, in Sydney between 2009-10 and 2010-11, both the area under agriculture and the number of agricultural businesses declined by 13 per cent and 11 per cent respectively (Figure 4), while population increased. In contrast, in the Adelaide region, the area under agriculture and the number of agricultural businesses increased by 18 per cent and 2 per cent over the same period. This occurred along with an increase in population of over 9 000 people (Figure 4). The changes in area under agriculture reflect the dynamic nature of land use change in response to environmental, social and economic factors, however, it is not possible to confidently say which land uses were converted from or to agriculture.

Figure 4 Change in population size, area of agricultural holdings and the number of agricultural businesses between 2009-10 and 2010-11 in selected state capital city statistical divisions



Note: Change comparison cannot be conducted further back than 2009-10 as the geographical area of the statistical divisions are not consistent (statistical divisions expand or contract in size as population increases and decreases). Between 2009-10 and 2010-11 there were no changes to the capital city statistical divisions (ABS 2011d). Analysis over a greater time period would require concording of the population data to a common boundary.

Data source: ABS 2012a, 2012c, 2011c, 2011e.

Conclusion

Land use choices have a major effect on food production, the natural environment and communities. Land use change is therefore relevant to much of the current debate in Australia around agriculture and food security, forestry, water, mining, climate change mitigation and adaptation, urban expansion, biodiversity conservation, and landscape aesthetics.

Current pressures on agricultural land and issues surrounding land use change include mining and exploration (including coal seam gas extraction) and urban growth at the margins of major metropolitan areas and in coastal regions in southern and eastern Australia.

Australia is improving its capacity to track land use change, drawing on information sources including satellite remote sensing and statistical collections. The next national scale land use map based on 2010-11 agricultural census information is due for release by ABARES late in 2013 and will provide the opportunity to analyse change across the country for a number of key land uses (grazing, cropping and conservation) from 1992-93 to 2010-11. It will also be possible to analyse change for a wider range of land uses between 2005-06 and 2010-11.

Currently it is not possible to conduct national assessments of land use change using detailed catchment scale land use data produced by the states and territories as the time at which the data was collected varies from 1997 to 2009. The Australian Collaborative Land Use and Management Program (ACLUMP), is working to improve the temporal consistency of catchment scale land use mapping across the country and investigating techniques to build land use change analyses into the mapping process. This will improve the ability to report on land use change across the country at the catchment scale.

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