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SCIENCE *for* DECISION MAKERS

Co-ordinated Land Use Mapping for Australia

INFORMATION FOR LANDSCAPE SOLUTIONS

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Science for Decision Makers is a series published by the Bureau of Rural Sciences. It describes the latest developments in scientific advice, assessments or tools relating to agricultural, fisheries and forestry industries, including their supporting communities.

Its purpose is to make rural science more accessible to those needing to quickly understand the benefits and implications of the most recent research as a basis for decision-making.

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Key Points

- 1 Land use mapping shows how and where our land resources are used. This includes the production of goods (such as crops, timber and manufactures) and services (such as defence, recreation, biodiversity and natural resources protection).
- 2 Land uses have a major impact on Australia's natural resources through their effects on water, soil, nutrients and plants and animals. There is also a strong link between changing patterns of land use and economic and social conditions, particularly in regional Australia.
- 3 Land use information is critical to those responsible for developing sustainable long-term solutions for our landscapes. This includes local government, catchment authorities, emergency services, quarantine and pest management authorities, industry and non-government groups.

- 4 BRS is leading a partnership of Australian and State government agencies promoting the development of nationally consistent land use and land management practices information — the Australian Collaborative Land Use Mapping Program (ACLUMP). This forms part of Australia's national natural resources information coordination arrangements.
- 5 With nationally consistent land use coverage at catchment scale approaching completion, ACLUMP is turning its attention to measuring and reporting changes in land use over time, and the classification and mapping of land management practices — the 'how' of land use. This capacity is critical to assessing trends in natural resource condition, and targeting public investment to address problems such as salinity, water quality and soil loss.



Why Map Land Use?

Different types of land use have a major impact on Australia's natural resource base including its soil, water, plants and animals. For example, crop selection and other farm management

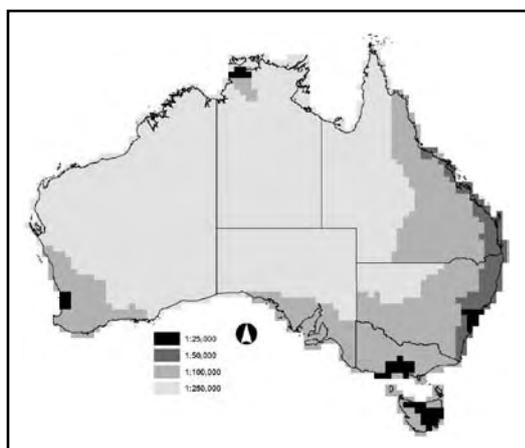
Land use information has an important role to play in developing effective solutions to Australia's natural resource management issues

practices can play a key role in processes affecting catchment salinity and water quality, and rates of soil erosion, acidification, nutrient decline and carbon losses.

Landscape processes involving our soils and water generally operate at catchment scale. Land use information at catchment scale therefore has an important role to play in developing effective solutions to Australia's natural resource management issues.

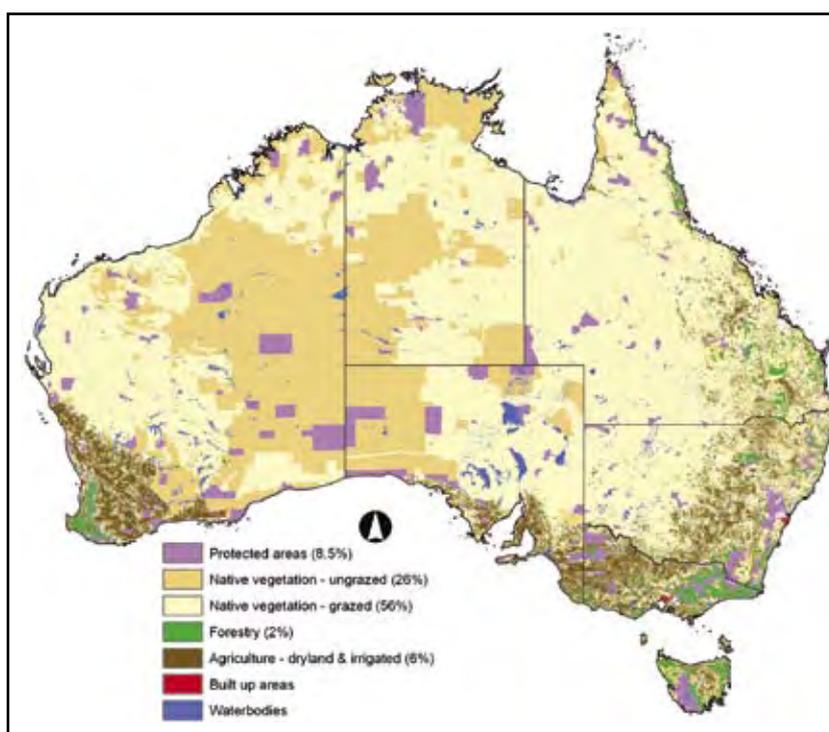
The diverse character of Australian landscapes and varying intensities of development means that catchment scale mapping can vary from 1:25,000 (where 1cm on the map = 250m on the ground) for irrigated and peri-urban areas (the semi-rural fringe of cities or towns) to 1:100,000 scale (1cm = 1km) for broadacre cropping regions and 1:250,000 (1cm = 2.5km) for the semi-arid and arid pastoral zone (Figure 1).

FIGURE 1 Recommended Scales for Catchment Scale Land Use Mapping in Australia.



National scale mapping (approximately 1:2 500 000 scale) is useful for strategic planning and evaluation applications, for example, setting regional priorities and developing programs to address natural resource management problems. It is also of value in continental-scale applications such as national carbon accounting. A generalised national scale picture of land use in Australia compiled for the National Land & Water Resources Audit in 2001 is shown in Figure 2. In Figure 3 national and catchment scale land use mapping for part of the Fitzroy catchment in Queensland shows the difference in the level of information contained in each type of mapping.

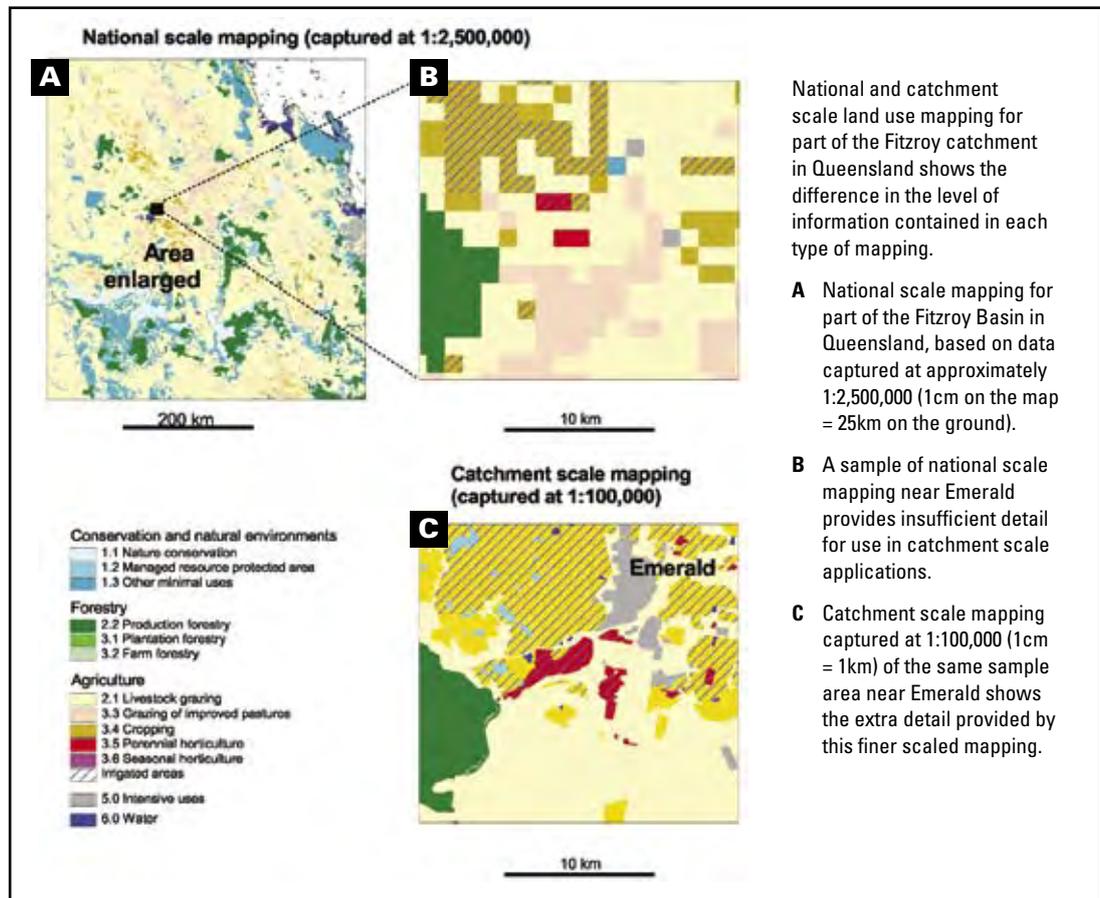
FIGURE 2 Land use in Australia.



A generalised picture of land use in Australia

The estimate of the total area of land under primary production (livestock grazing, dryland and irrigated agriculture) in Australia is 473 million hectares or nearly 62% of the continent. The dominant land use in arid and semi-arid regions is livestock grazing (430 million hectares or 56%). Approximately 21% of Australia (155 million hectares) is set aside to nature conservation, other protected areas and indigenous uses – based on data compiled for Land Use of Australia 1996/97, Version 2, National Land & Water Resources Audit (Stewart *et al.* 2001).

FIGURE 3 Differences in scale and information contained in the national scale and catchment scale land use maps in the Fitzroy Basin, Queensland.



National and catchment scale land use mapping for part of the Fitzroy catchment in Queensland shows the difference in the level of information contained in each type of mapping.

- A** National scale mapping for part of the Fitzroy Basin in Queensland, based on data captured at approximately 1:2,500,000 (1cm on the map = 25km on the ground).
- B** A sample of national scale mapping near Emerald provides insufficient detail for use in catchment scale applications.
- C** Catchment scale mapping captured at 1:100,000 (1cm = 1km) of the same sample area near Emerald shows the extra detail provided by this finer scaled mapping.

Information on land use, land cover and land management practices and land capability contributes to better understanding and management of Australian landscapes. However, there is often confusion between the terms 'land use' and 'land cover' because of the common use of remotely sensed data (either satellite-based or airborne) for mapping. The distinction between land use and land management practice is also poorly understood.

Land Cover

This refers to the physical surface of the earth, including various combinations of vegetation types, soils, exposed rocks, water bodies as well as anthropogenic elements such as agriculture and built environments. Land cover classes can generally be discriminated by characteristic patterns using remote sensing.

Land Use

This refers to the purpose to which the land cover is committed. Some land uses, such as agriculture, have a characteristic land cover

pattern. These generally appear in land cover classifications. Other land uses, such as nature conservation, are not readily discriminated by a characteristic land cover pattern. For example, where the land cover is woodland land use may be timber production or nature conservation.

Land Management Practice

This refers to the approach taken to achieve a land use outcome — the 'how' of land use (e.g. cultivation practices such as minimum tillage and direct drilling). Some land management practices, such as stubble disposal practices, tillage and rotation systems, may be discriminated by characteristic land cover patterns and linked to particular uses.

Land Capability and Land Suitability

Land capability assesses the limitations to land use imposed by land characteristics and specifies management options. Land suitability (part of the process of land evaluation) is the fitness of a given type of land for a specified kind of use.



Putting the National Picture Together

Substantial progress has been made in putting the national land use picture together. BRS is working with Australian and State government partners in the Australian Collaborative

BRS is working with Australian and State government partners in the Australian Collaborative Land Use Mapping Program (ACLUMP) to promote the development of nationally consistent land use information for Australia.

Land Use Mapping Program (ACLUMP) to promote the development of nationally consistent land use information for Australia. This includes a national land use classification — the Australian Land Use and Management (ALUM) Classification — and other agreed procedures dealing with coding and attribution, data structure, spatial

referencing and accuracy. The program is part of national natural resource information coordination arrangements established by the National Land & Water Resources Audit.

Agreed methods allow cost-effective mapping, the best use of pre-existing land use information contained in sources such as agricultural statistics, cadastre (land parcel boundary information), public land databases, land cover mapping satellite imagery and aerial photography.

Catchment scale mapping is undertaken using a staged process (Figure 4). The first stage of mapping involves collecting existing land use information and compiling it into a digital data set using a geographic information system (GIS). This includes remotely sensed

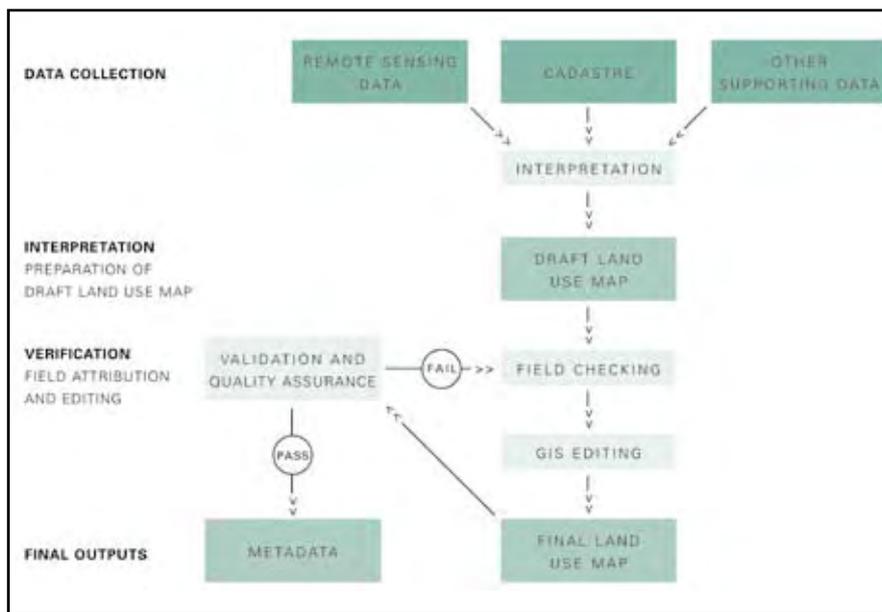
information (satellite imagery and aerial photography) and cadastre (land parcel boundary information). Other important information sources are digital forest and reserve estate mapping, land cover, local government zoning information and other land management data. The second stage involves interpreting land use classes according to a nationally agreed land use classification. The final stages of mapping include field checking, editing draft land use maps and validation. This mapping represents a single 'snap-shot' in time, but the use of digital data and GIS methods means that new information can be incorporated into the existing mapping, allowing it to be regularly updated.

The mapping procedure is detailed in a technical handbook produced by BRS to support catchment scale land use mapping programs in Australia. This handbook is also the primary technical reference for the ALUM classification (Box 1).

National scale mapping is produced by coupling agricultural census commodity statistics to satellite imagery (Advanced Very High Resolution Radiometer (AVHRR)), combined with pre-existing data for other uses. The mapping procedure matches the growth characteristics of different crops and pastures over a one year period to a Normalised Difference Vegetation Index (NDVI) time-series (Bureau of Rural Sciences 2004). The procedure is relatively inexpensive, and amenable to update, although there are difficulties separating NDVI profiles for some crop and pasture classes, and identifying land uses that



FIGURE 4 Catchment scale land use mapping procedure.



are fine-scaled or spectrally heterogeneous. National scale land use datasets have been completed for Australia for 1996/97 and across the Murray-Darling Basin for the years 1993, 1996, 1998 and 2000. A national database is currently being prepared for a sequence of years from 1983 to the present.

Access to downloadable data and metadata, mapping facilities, technical specifications and reports on mapping methods and how land use information is being used is provided through a web-based national land use information directory accessible online at www.brs.gov.au/landuse.

BOX 1

AUSTRALIAN LAND USE AND MANAGEMENT CLASSIFICATION

Partners in the Australian Collaborative Land Use Mapping Program (ACLUMP) have adopted agreed procedures dealing with coding and attribution, data structure, spatial referencing and accuracy. The agreed land use classification is the Australian Land Use and Management (ALUM) Classification.

The ALUM Classification is structured in terms of the potential degree of modification to the 'natural' landscape. The classification is flexible so that new land uses or land management systems can be accommodated. Five primary levels of land use are distinguished in order of generally increasing levels of intervention or potential impact on the landscape.

1. **Conservation and natural environment:** Land used primarily for conservation purposes, based on the maintenance of the essentially natural ecosystems present.

2. **Production from relatively natural environments:** Land used primarily for primary production based on limited change to the native vegetation.
3. **Production from dryland agriculture and plantations:** Land used mainly for primary production, based on dryland farming systems.
4. **Production from irrigated agriculture and plantations:** Land used mostly for primary production based on irrigated farming.
5. **Intensive uses:** Land subject to extensive modification, generally in association with closer residential settlement, commercial or industrial uses.
6. **Water:** Water features. Water is regarded as an essential aspect of the classification, because of its importance for natural resources management, but it is primarily a cover type.



Land Use Information for Catchment Management

Catchment scale land use information is increasingly being used by regional communities and local governments to help address natural resource management and development issues. An example is the Snowy River Shire Council which, in collaboration with BRS, produced catchment scale land use mapping for the Snowy River catchment in NSW.

The development of land use datasets and their application to natural resources management issues calls for effective links between Australian and State government agencies, local governments and community groups.

The economic and social base of the Snowy catchment in NSW, like much of rural and regional Australia, is changing and land use information is proving essential to developing effective responses to that change and in planning for sustainable development. Land use information is helping assess the capacity of the land

to support more intensive development (such as recreation-based tourism) and in exploring opportunities for new agricultural enterprises such as plantation forestry, horticulture and aquaculture.

The management of pest plants and animals is also a particular challenge in the Snowy catchment. For example, Serrated Tussock (*Stipa trichotoma*) is a weed that poses an increasing threat to native species and significantly impacts on agricultural productivity. Risk assessment and response planning requires analysis of the relationship between land use and factors affecting the distribution of this weed. Land use data is also contributing to assessments of habitat decline, threats to remnant native woodlands and grasslands and to strategic planning for native vegetation conservation and biodiversity protection.

A Collaborative Effort

The success of ACLUMP in meeting the needs of the community and natural resource managers depends on effective links between Australian and State government agencies, regional management authorities, local government and community groups. The development of land use datasets and their application to natural resources management issues calls for effective links between Australian and State government agencies, local governments and community groups.

BOX 2

APPLYING LAND USE INFORMATION

Land use mapping is being used in Australia to help manage catchment salinity, nutrient and sediment problems, assess agricultural productivity and opportunities for agricultural diversification, land value determination, local and regional planning, pest and disease control and emergency response planning. Land use information has recently been used to -

- manage sediment and nutrient loads in the Gippsland Lakes and surface water resources modelling in the Macalister Irrigation District in Victoria (Victorian Department of Sustainability and Environment)
- support regional integrated natural resource planning and develop regional strategies for industry development in South Australia (South Australian Department of Water, Land and Biodiversity Conservation)
- underpin analysis by Queensland government agencies aiming to identify nutrient sensitive zones affecting water quality within Great Barrier Reef catchments and to help plan for future growth in south-eastern Queensland (Queensland Department of Natural Resources and Mines)
- plan for locust control and Foot and Mouth and Newcastle disease preparedness programs in Western Australia (Agriculture Western Australia)
- develop a horticulture database and to plan pest and disease response planning in the Northern Territory (Northern Territory Department of Natural Resources, Environment and the Arts).

Regional authorities, councils and community groups bring to the table a network of local individuals with detailed on-ground knowledge. State agencies are important storehouses of land information (e.g. property, agriculture and land resource data). Australian Government partners help establish nationally agreed standards and coordinate land use mapping across jurisdictions.

Future Developments

Nationally consistent digital land use mapping (together with climate, land cover and soils data) is basic information needed to help attain sustainable use of Australian landscapes. With the completion of continental coverage at catchment scale and a new national land use map due in mid 2006, new priorities for information are emerging. Demand from natural resources planners and managers

for digital land use and land management practices mapping will continue to increase.

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Catchment management groups have a keen interest in land use information. Local knowledge input is an important aspect of mapping work.

Photo: Queensland Department of Natural Resources and Mines

These include

- **Detection and reporting of land use change**, particularly for regions undergoing rapid land use change, or facing critical natural resources management issues. The detection and mapping of rapidly changing land uses such as cropping is also important. This capacity is critical to evaluating and monitoring trends in natural resource condition and the effectiveness of public investment in natural resource management. The coupling of time-series satellite imagery to agricultural statistics used in national scale land use mapping in the ACLUMP program is a practical and widely applicable approach to mapping agricultural land use change. For instance, where historical satellite imagery and agricultural statistics can be matched, a temporal sequence of land use maps may be produced and changes over time observed.
- **Classification and mapping of land management practices**. The management practices adopted by farmers and other land managers have a critical role in mediating the effects of land use on natural resources, particularly soil and water. A national classification system for land management practices is being developed that will accommodate a wide range of information on practices associated with crop selection and management (e.g. rotational and cultivation practices), water management (e.g. water quality maintenance, irrigation application, scheduling and water storage methods), livestock husbandry, pasture management, nutrient budgeting, soil conservation, integrated pest management, protection and management of native vegetation and biodiversity.

Technical issues for mapping land management practices include data acquisition and maintenance, sampling and spatial extension. Remote sensing is an important information source for practices with distinctive landscape patterning (such as cultivation). Compliance systems including property management planning and Environmental Management Systems are also potential information sources.

Demand from natural resources planners and managers for digital land use and land management practices mapping at catchment and farm scale will continue to increase. BRS and its ACLUMP partners will continue working to produce and disseminate the data that meets these needs.



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FURTHER INFORMATION

More information about land use mapping in Australia can be obtained at: <http://www.brs.gov.au/landuse>. A land use CD-ROM is also available on request.

Land use data are available from the Australian Natural Resources Data Library at <http://adl.brs.gov.au> and from BRS' State and Territory partner agencies.

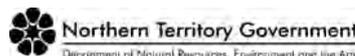
- NSW** Dept of Natural Resources
www.naturalresources.nsw.gov.au
- VIC** Dept of Primary Industries
www.dpi.vic.gov.au
- QLD** Dept of Natural Resources and Mines
www.nrm.qld.gov.au/science/lump
- WA** Agriculture Western Australia
www.agric.wa.gov.au
- SA** Dept of Water, Land and Biodiversity Conservation
www.dwlbc.sa.gov.au/land/use/index.html
- TAS** Dept of Primary Industries, Water and Environment
www.dpiwe.tas.gov.au
- NT** Dept of Natural Resources, Environment and the Arts
www.nt.gov.au/nreta/naturalresources/soil/landuse/index.html

FURTHER READING

Bureau of Rural Sciences 2002. *Land Use Mapping at Catchment Scale: Principles, Procedures and Definitions*. Bureau of Rural Sciences, Canberra.

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National Land & Water Resources Audit

A program of the Natural Heritage Trust

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