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# Science
## FOR DECISION MAKERS

# LAND USE MAPPING AT CATCHMENT SCALE

*Information for catchment solutions*

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*Science for Decision Makers* is a new 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:**

- 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).
- Land uses have a major impact on Australia's natural resources through their effects on water, soil, nutrients, plants and animals. There is also a strong link between changing patterns of land use and economic and social conditions, particularly in regional Australia.
- Land use information is critical to those responsible for developing sustainable long-term solutions for our catchments. This includes local government, catchment authorities, emergency services, quarantine and pest management authorities, industry and non-government groups.
- BRS is coordinating land use mapping across Australia, working collaboratively with Commonwealth and State agencies, local governments and catchment groups. Plans are in place to complete catchment scale land use mapping for the continent by 2004–05.

## WHY MAP LAND USE AT CATCHMENT SCALE?

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 practices can play a key role in processes affecting catchment salinity and water quality, 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.

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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. Catchment scale land use mapping contrasts with national scale mapping recently completed by BRS as part of the National Land and Water Resources Audit, which gives an overview of land use across the continent (**Figures 1 and 2**).

PHOTOS: MICHAEL F. RYAN

### >> KEY TERMS USED IN LAND MAPPING

Information on land use, land cover, 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.

These terms are used as follows:

**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 land management objective. 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 means by which the land management objective is achieved—the 'how' of land use (e.g. cultivation practices such as minimum tillage and direct drilling). Patterns in land cover can relate to land management practice and land use.

**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 land use.

## PUTTING THE NATIONAL PICTURE TOGETHER

Substantial progress is being made in putting the national land use picture together at catchment scale. BRS, as the lead agency in the development of nationally consistent land use mapping, has worked collaboratively with its State agency partners and other organisations to develop an approach to digital land use data production across 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.

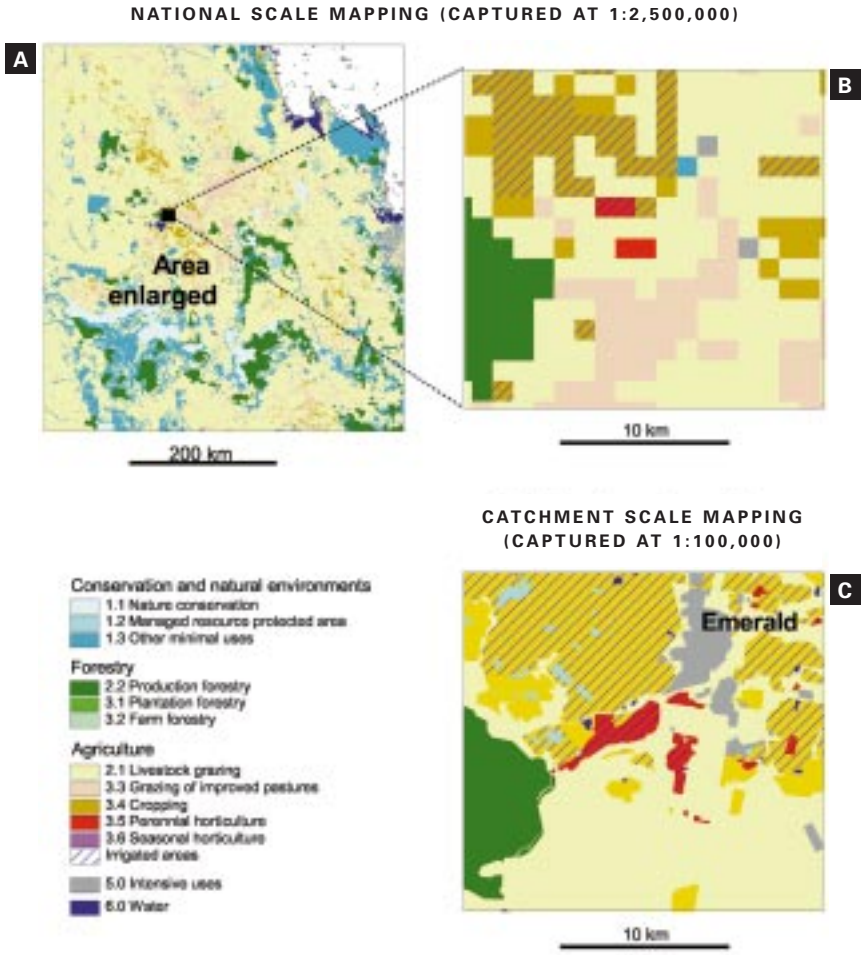
Nationally agreed methods allow cost-effective production, the best use of pre-existing land use information contained in sources such as cadastre (property boundary information), public land databases and land cover mapping. The aim is to keep the costs of mapping to a minimum (e.g. from $2.50–$4.00/km$^2$ for 1:100,000 scale mapping) depending on the intensity of land use and extent of the mapping.

Mapping is undertaken using a staged process (**Figure 3**). The first stage 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. 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 interpretation and assignment of land use classes according to a nationally agreed land use classification.

**FIGURE 1**

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.

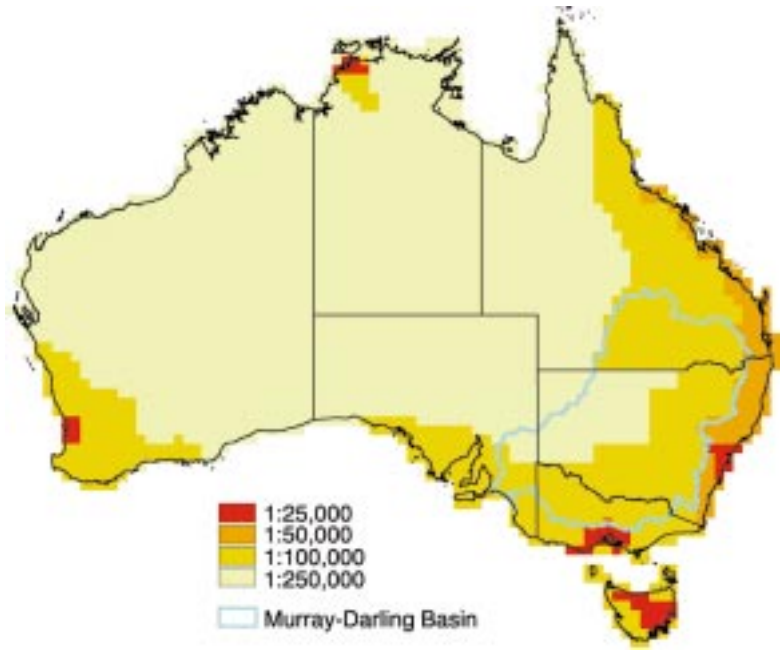
**A** National scale mapping for part of the Fitzroy Basin in Queensland, based on data captured at approximately 1:2,500,000 (1cm on the map = 25km on the ground).

**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 greater detail provided by this finer scale mapping.

**FIGURE 2**

RECOMMENDED SCALES FOR CATCHMENT SCALE LAND USE MAPPING IN AUSTRALIA – MAY 2003




PHOTOS: MICHAEL F. RYAN

The final stages of mapping include field checking, editing draft land use maps and validation. This mapping, of course, 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.

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**).

Catchment scale land use data sets have been produced with the support of the National Land and Water Resources Audit, the National Action Plan for Salinity and Water Quality, the Murray-Darling Basin Commission, the Bureau of Rural Sciences and the Department of Agriculture, Fisheries and Forestry – Australia (through the Natural Heritage Trust) and collaborating State agencies (noted at the end of this brochure). Plans are in place to complete continental coverage by 2005–06.

## 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. A recent example is the Snowy River Shire Council which, in collaboration with BRS, produced catchment scale land use mapping for the Snowy River catchment in New South Wales.

The economic and social base of the Snowy catchment in New South Wales, like much of rural and regional Australia, is changing. 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

**BOX 1**

## AUSTRALIAN LAND USE AND MANAGEMENT CLASSIFICATION

Commonwealth and State agencies involved in land use mapping 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 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 environments:** 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.

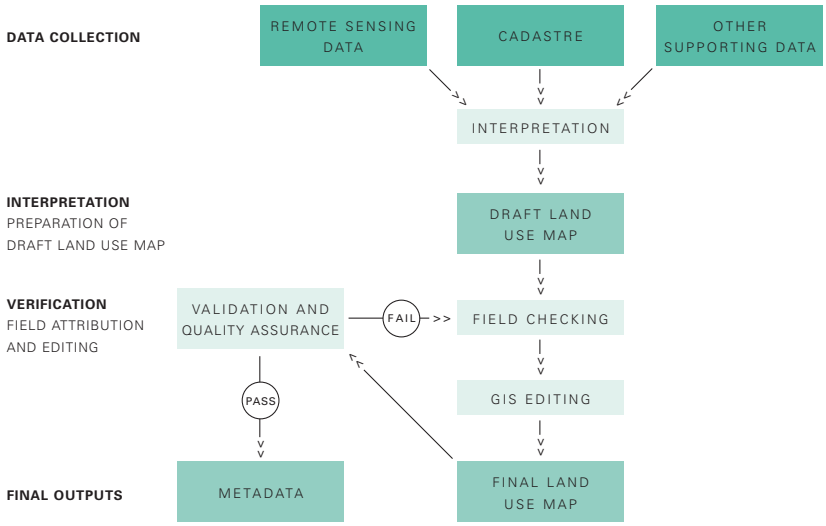
**4. Production from irrigated agriculture and plantations:** Land used mostly for primary production based on irrigated farming.

**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.

**FIGURE 3**

LAND USE MAPPING PROCESS




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. (See also Box 2).

## A COLLABORATIVE EFFORT

The development of land use datasets and their application to natural resource management issues calls for effective links between Commonwealth and State agencies, local governments and community groups. Councils and community groups bring to the table a network of local individuals and organisations with detailed on-ground knowledge. State agencies are important storehouses of land information (e.g. property, agriculture and land resource data). At the Commonwealth

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PHOTO: MICHAEL F. RYAN

level, BRS is working to:

- establish nationally agreed land use mapping standards and specifications for Australia
- coordinate land use mapping across jurisdictions
- promote and disseminate land use information to support natural resource management issues such as salinity and water quality.

## FUTURE DEVELOPMENTS

Nationally consistent digital land use mapping at catchment and farm scale (together with climate, land cover and soils data) is basic information needed to help attain sustainable use of Australian landscapes. Now that the first challenge of completing a continental dataset is within reach, new priorities for information are emerging.

These new priorities include:

- **Mapping updates**, 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 crops and pastures is also important. This can be achieved by incorporating changes detected via aerial photography or other spatially explicit data into the existing data sets.
- **Additional detailed mapping for peri-urban, intensive horticulture and irrigated areas**. Developing effective responses to natural resource management problems is a particular challenge in these areas, where patterns of use and interactions with landscape processes are complex.

### USING MAPPING AT THE REGIONAL LEVEL

Catchment management groups have a keen interest in land use information. Members of the Fitzroy Basin Association discuss mapping completed for the Fitzroy Catchment, Queensland as part of the National Land and Water Resources Audit. **Left to right**: Elizabeth Nicholson, Information Coordinator; Michael Bent, Action Planner; and Barbara Wildin,Chair.

**PHOTO:** QUEENSLAND DEPARTMENT OF NATURAL RESOURCES AND MINES.

Sufficiently detailed mapping (at scales of 1:25,000 or finer) is yet to be completed in many of these areas.

- **Production of catchment scale land management practices and commodities mapping**. There is increasing demand for commodity and land management practice information as this is valuable in many natural resource planning and management applications, including predictive modelling.

  The Australian Bureau of Statistics' Agricultural Census is one of the few sources of information currently available. It includes information on commodities and farm level practices such as stubble management methods.

  BRS has developed methods for mapping from the Census in a way that does not compromise farmer confidentiality—this requires the geo-referencing of farms in the Census, a task now in the planning stages for Australia. However, the census can only collect a limited amount of data.

  New methods will need to be developed to collect other land management practice inputs required for many currently used models.

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. The national land use mapping program established by BRS and its partners will continue working to produce and disseminate the data that meets these needs.

## FURTHER READING

Technical specifications for land use mapping are included in: Bureau of Rural Sciences (2002). *Land Use Mapping at Catchment Scale: Principles, Procedures and Definitions*. Bureau of Rural Sciences, Canberra.

**BOX 2**

### APPLYING LAND USE INFORMATION

Catchment scale 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:

- plan flight lines for a locust control program and in planning Foot and Mouth and Newcastle disease preparedness exercises in Western Australia (Agriculture Western Australia)
- 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 investment and develop regional strategies for industry development in South Australia (South Australian Department of Water, Land and Biodiversity Conservation)
- identify groundwater pollution risk associated with horticulture in the Bowen district, and to develop methods for collecting agricultural and veterinary chemical use information in Queensland (Queensland Department of Natural Resources and Mines)
- develop a horticulture database and to plan pest and disease response planning in the Northern Territory (Northern Territory Department of Infrastructure, Planning and Environment).

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## FURTHER INFORMATION

More information about land use mapping at catchment scale in Australia is available at: **www.affa.gov.au/landuse**

Land use data are available from the Australian Natural Resources Data Library at **adl.brs.gov.au** and from BRS, Commonwealth, State and Territory partner agencies.

**NSW** Dept of Land and Water Conservation **www.dlwc.nsw.gov.au**

**VIC** Dept of Primary Industries **www.nre.vic.gov.au**

**QLD** Dept of Natural Resources and Mines **www.dnr.qld.gov.au**

**WA** Agriculture Western Australia **www.agric.wa.gov.au**

**SA** Dept of Water, Land and Biodiversity Conservation **www.dwlbc.sa.gov.au**

**TAS** Dept of Primary Industries, Water and Environment **www.dpiwe.tas.gov.au**

**NT** Dept of Infrastructure, Planning and Environment **www.ipe.nt.gov.au**

**COMMONWEALTH** National Land and Resources Audit **www.nlwra.gov.au**
Murray Darling Basin Commission **www.mdbc.gov.au**

Land & Water Conservation
Victoria Department of Primary Industries
Queensland Government Natural Resources and Mines
Department of Agriculture Government of Western Australia
The Department of Water, Land and Biodiversity Conservation
Tasmania
Northern Territory Government Department of Infrastructure, Planning and Environment
National Land & Water Resources Audit *A program of the Natural Heritage Trust*
Murray-Darling Basin