



Australian Government

## **National Land & Water Resources Audit**

*An initiative of the Australian Government*



## **Land use**

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Status of information for reporting against indicators under the National Natural Resource Management Monitoring and Evaluation Framework

[www.nlwra.gov.au](http://www.nlwra.gov.au)

## About the National Land & Water Resources Audit

The National Land & Water Resources Audit ('the Audit') provides data, information and nationwide assessments of Australia's land, water and biological resources to support sustainable development. It is an initiative of the Natural Heritage Trust. It commenced in 1997 and published the first set of detailed assessment reports in 2002.

The Audit (2003–08) has six key areas of activity:

- developing a consistent national reporting mechanism for collating natural resource information collected under the National Natural Resource Management Monitoring and Evaluation Framework
- collating information to support the national State of the Environment (SoE) reports

- developing nationally consistent, but regionally relevant integrated resource condition reports
- facilitating reporting on the ongoing collection of natural resource information for key theme areas, including those related to the National Natural Resource Management Monitoring and Evaluation Framework
- reporting on national data and information management (in collaboration with ANZLIC — the Spatial Information Council)
- developing national assessments (as requested) and supporting program evaluations.

For further information see <http://www.nlwra.gov.au>

### The Audit's mission

To provide data, information and nationwide assessments of Australia's land, water and biological resources to support sustainable development.



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## Foreword

Effective management of natural resources requires good quality data and information at the right level of detail to be available for those who need it. Australia invests significant resources each year in the collection and maintenance of data to inform natural resource management decisions.

Since 1997, the National Land & Water Resources Audit has played a vital role in the national coordination, collation and reporting of this information. The Audit collaborates with a range of partners, including the Australian Government, state and territory governments, regional natural resource management bodies, industry, the private sector and community organisations.

This booklet is part of a series describing the status of data and information for reporting on natural resource condition indicators agreed under the National Natural Resource Management Monitoring and Evaluation Framework. Specifically, it reports on land use information.

Clarification of the current status of data and information on land use is a vital step towards future strategic investment for its improved management.



Geoff Gorrie  
Chair, Audit Advisory Council





## Acronyms and abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ACLUMP	Australian Collaborative Land Use Mapping Program
ALUM	Australian Land Use and Management
ASRIS	Australian Soil Resources Information System
BRS	Bureau of Rural Sciences
ESCALUM	Executive Steering Committee for Australian Land Use Mapping
LMP	land management practice
LUMIS	Land Use and Management Information System
MERI	Monitoring, Evaluation, Reporting and Improvement
National M&E Framework	National Natural Resource Management Monitoring and Evaluation Framework
NCAS	National Carbon Accounting System
NCC	National Coordination Committee
NHT	Natural Heritage Trust
NLWRA	National Land & Water Resources Audit (the Audit)
NRM	natural resource management
NRMSIS	Natural Resource Management Spatial Information System
SD	statistical division
SENC	Social and Economic National Coordination Committee
SLA	statistical local area
SPREAD	Spatial Reallocation of Aggregated Data
TAGALUM	Technical Advisory Group on Australian Land Use Mapping

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## Executive summary

Information about land use is fundamentally important for better management of natural resources. Land use is one of several natural resource data and information 'themes' coordinated by the National Land & Water Resources Audit.

Nationally consistent land use and land management practices information is collected by the Australian Collaborative Land Use Mapping Program. Its membership includes Australian, state and territory government partners. The Australian Land Use and Management classification has been adopted by all partner agencies and is supported by nationally agreed technical standards.

Complete continental coverage of land use mapping is now available at national and catchment (or regional) scales. National-scale maps (1:2 500 000) and data are available online for a series of years from 1992–93 to 2002–03. Catchment and regional maps are available at a variety of scales — 1:25 000 to 1:100 000 — except in sparsely settled areas where the recommended scale is 1:250 000. The currency of catchment-scale mapping ranges from 1997 to 2008.

Land use data provides context that is important, sometimes essential, to meet the information needs for monitoring, evaluation and reporting against

indicators used by natural resource management programs. Similarly, spatial and temporal information on land management practices is essential for reporting on progress towards long-term resource condition outcomes.

There are several key priorities in land use mapping:

- methodological improvements in national-scale modelling and verification procedures
- timely updating of catchment-scale mapping in areas of major or rapid change
- enhanced mapping of land management practices through further development of the Land Use and Management Information System.

The way forward includes:

- refinement of the land management practice classification
- application of new technologies for data collection
- stronger alignment with agencies, programs, projects and industry groups that collect social and economic information.

Changes in the attitudes and behaviour of land managers are of particular interest. They can change the spatial distribution of management practices and potentially lead to improved resource condition.



Irrigated nut plantation, Lismore (ALUM Class 4.4.3) (photo by the NSW Department of Environment and Climate Change)



## Introduction

Land use is one of the several natural resource data and information 'themes' coordinated by the National Land & Water Resources Audit (the Audit).

This booklet summarises the current capacity to provide nationally consistent and relevant information about land use. It also reports on progress towards improved information about land management practices and land use change.

Nationally consistent land use and land management practices information is being developed through the Australian Collaborative Land Use Mapping Program (ACLUMP). The program is advised by the Executive Steering Committee for Australian Land Use Mapping (ESCALUM) (Box 1).

The membership of ESCALUM includes Australian, state and territory government partners (Table 1). ACLUMP is sponsored by the Australian Government Department of Agriculture, Fisheries and Forestry and

### Box 1: The Executive Steering Committee for Australian Land Use Mapping (ESCALUM)

The goal of ESCALUM is 'to provide leadership, vision and strategic direction to progress the development of an integrated, contextual land use and land management practice information system built on complementarity of national and state approaches'. It meets annually, with intervening teleconferences, to:

- facilitate a framework for land use and land management practice information
- review information needs and facilitate access to information
- facilitate consistent development and maintenance of information products

- identify priorities and develop proposals for reporting on change in land use and land management practices
- promote the development and adoption of LUMIS
- foster cooperation with other NCCs and with information suppliers and users
- provide advice to ministers and to policy and program areas as required.

LUMIS = the Land Use and Management Information System; NCC = National Coordination Committee

the Bureau of Rural Sciences (BRS) has day-to-day responsibility for its development. General information about ACLUMP is maintained on the BRS website.<sup>1</sup>

The Australian Land Use Management (ALUM) classification has been adopted by all partner agencies. It is primarily oriented to non-urban land uses, but is sufficiently flexible to allow for additions. ALUM is supported by nationally agreed technical standards that cover coding and attribution, data structure, spatial referencing and accuracy, validation, quality assurance, data and metadata.

ESCALUM is supported by a Technical Advisory Group (TAGALUM) with wider membership that includes Geoscience Australia, the Department of the Environment, Water, Heritage and the Arts and the Murray–Darling Basin Commission.

Key issues considered at meetings of ESCALUM (and TAGALUM) include:

- national (continental) and regional (catchment)-scale mapping programs
- data standards and methods for mapping land use and land management practices
- maintenance of an up-to-date national land use data directory

<sup>1</sup> <http://www.brs.gov.au/landuse>

**Table 1 Agencies represented on the Executive Steering Committee for Australian Land Use Mapping (ESCALUM)**

Jurisdiction	ESCALUM agency
NSW	Department of Environment and Climate Change
NT	Department of Natural Resources, Environment and the Arts
Qld	Department of Natural Resources and Water
SA	Department of Water, Land and Biodiversity Conservation
Tas	Department of Primary Industries and Water
Vic	Department of Primary Industries
WA	Department of Agriculture and Food
Australian Government	Department of Agriculture, Fisheries and Forestry
	Bureau of Rural Sciences
	Department of the Environment, Water, Heritage and the Arts
	Australian Bureau of Statistics
National	National Land & Water Resources Audit Commonwealth Scientific and Industrial Research Organisation





- custodianship of land use data sets by Australian, state and territory governments
- collaboration across natural resource management themes
- requirements for regional and national reporting
- assessment of emerging data needs and development of clients (eg information to support responses to climate change)
- technical developments and methods for the acquisition of land use, land cover and land management practice data
- analysis of land use change in collaboration with other interests.

The Audit works with and through a series of National Coordination Committees (NCCs). Although some of these committees have been established by other mechanisms, they have been identified by the Audit as having the stakeholder representation to provide advice and recommendations on Australia-wide information issues. ESCALUM is the NCC for land use information.



Irrigated vine fruits (ALUM Class 4.4.4) (photo by the Department of Agriculture, Fisheries and Forestry)

## Land use and land management practice data and information systems

Consistency and data sharing with agreed procedures is provided by ACLUMP, covering coding and attribution, data structure, spatial referencing and accuracy based on a systematic approach to classifying and recording land use information (ALUM). The ALUM classification has been adopted by all partners; as a result, ACLUMP can deliver nationally consistent land use mapping covering Australia at national and catchment scales.

The ALUM classification is structured according to the degree to which landscapes have been modified. It has six primary classes with two levels of subclasses (Appendix 1). The classification specifically targets land use, avoiding the complication of classifications that mix land use and land cover. Its flexibility allows the addition of 'new' land uses and enables linkage to land management practices information (Leslie et al 2006). The methods are set out in a technical handbook (BRS 2006).<sup>2</sup> Use of the ALUM classification for recording land use will also be covered in the *Australian Soil and Land Survey Field Handbook*, Volume 2, to be published in 2008.

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<sup>2</sup> Available for download at <http://www.brs.gov.au/landuse> and in hardcopy from [salesbrs@brs.gov.au](mailto:salesbrs@brs.gov.au)

ACLUMP partners are collaborating to develop a Land Use and Management Information System (LUMIS). It will provide a consistent basis for the classification of land management practices, which will be equivalent to ALUM for land use mapping.

### National-scale mapping

The national-scale map is compiled by coupling data derived from satellite imagery with commodity statistics from the agricultural census using the Spatial Reallocation of Aggregated Data (SPREAD) method. The original national map was published in 2001 (based on 1996–97 data) at a nominal scale of 1:2 500 000. Mapping was undertaken by the BRS under contract to the Audit. An update of the map to 2001–02 has been completed with the support of other partners and is available on the Australian Natural Resources Atlas.<sup>3</sup>

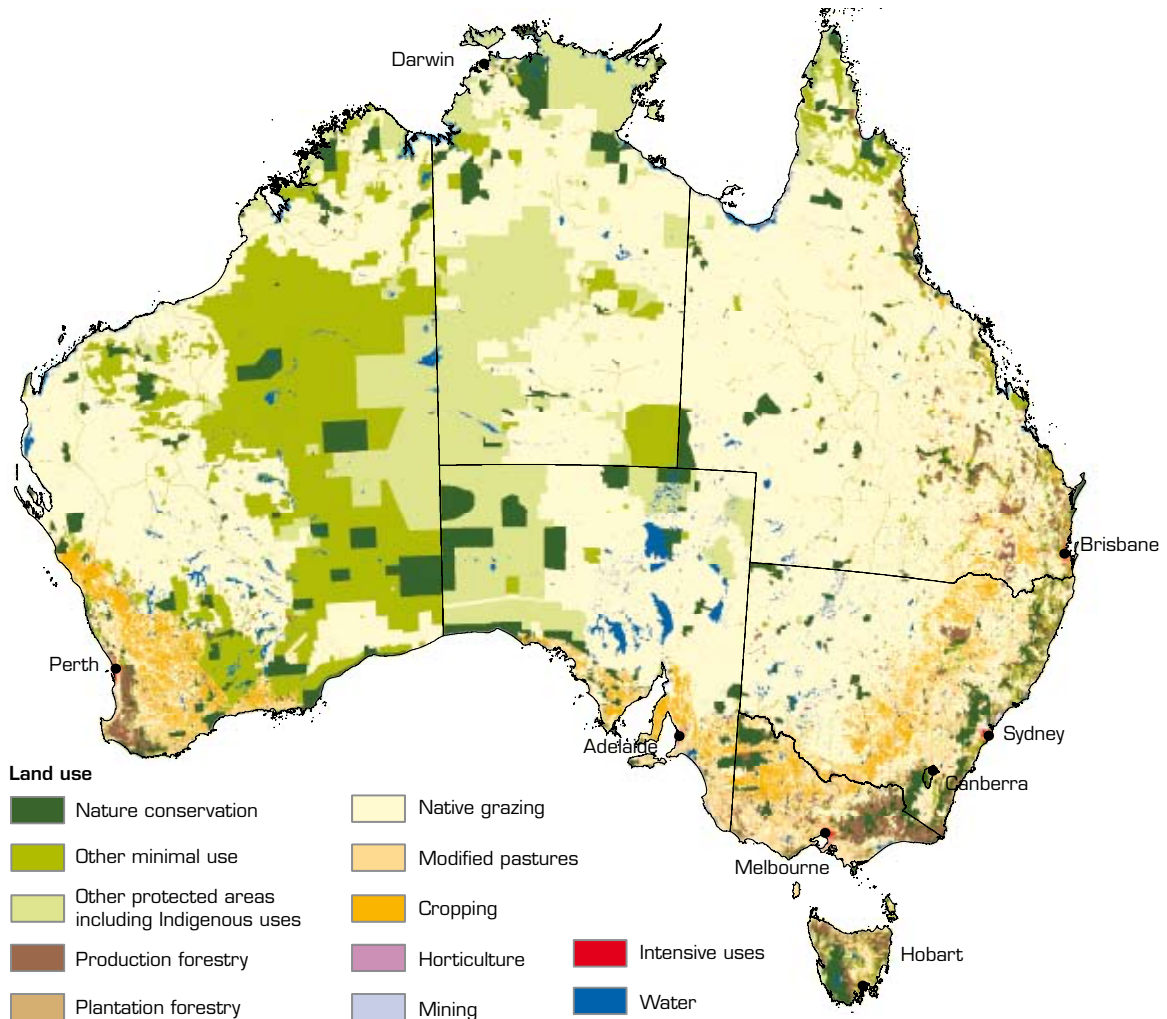
An update using 2006 data is subject to the availability of funding. An enhanced version of the SPREAD method was used to compile a sequence of datasets for the Murray–Darling Basin, dating from 1983 to the present (BRS 2006). A time series of maps was produced for five financial year periods between 1992–93 and 2001–02 to meet the needs

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<sup>3</sup> <http://anra.gov.au>

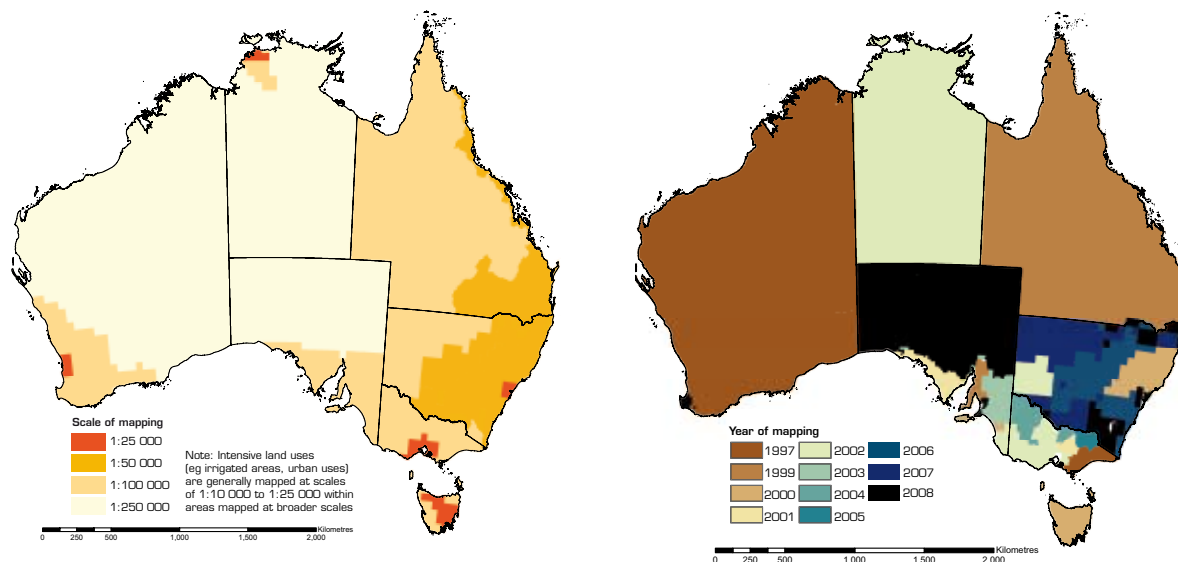


Figure 1 A 2000-01 national-scale land use map constructed using Version 3 of the SPREAD method



Data source: Bureau of Rural Sciences. Map compiled by NLWRA.

Figure 2 Maps showing scale and year of mapping



Source: Bureau of Rural Sciences

of the Audit and the Australian Greenhouse Office (Knapp et al 2006).<sup>4</sup>

BRS maintains the mapping and metadata records in the Australian Natural Resources Data Library. A twelve-class example of national-scale land use mapping is shown in Figure 1.

<sup>4</sup> Available for download at [http://www.nlwra.gov.au/Publications\\_and\\_Tools/Project\\_Reports](http://www.nlwra.gov.au/Publications_and_Tools/Project_Reports)

## Catchment-scale mapping

Catchment-scale mapping is undertaken by state and territory government agencies with financial assistance from the Australian Government.

Although mapping at the catchment scale has been compiled progressively, it effectively provides a 'snapshot' of land use at a level of detail appropriate for regional planning and catchment management (Figure 2). This scale is useful for problems affecting



**Table 2 Summary of catchment-scale mapping updating activities**

Jurisdiction	Date of existing coverage	Proposed update/revision schedule or other relevant work in progress
ACT	Not available	The Bureau of Resource Sciences has produced a draft map
NSW	1998–2008	No updates, but refinements, such as edge-mapping of the base map (1:250 000 scale)
NT	2002	Some updates complete; detailed work in progress for selected areas
Qld	1999–2006	Mapping on a catchment-by-catchment basis, with updating for five catchments complete
SA	1999–2008	Ongoing program of updates expected
Tas	2001	No updates
Vic	1997–2006	A state-wide land use information system has been established that will provide ongoing updates, as well as the compilation of a simplified state map at nominal 1:100 000 scale
WA	1999–2008	Final stages of current updates; ongoing program expected

land, water and biological resources (eg salinity, nutrients and sediments, and pests and diseases), and provides a baseline for verifying interpretation of remote-sensing imagery.

Some updates are in progress (Table 2), but full coverages are unlikely to be repeated. The detection and mapping of land use change is considered later in this booklet.

### Currency of data and issues for repeat (series) land use mapping

#### New South Wales

Work to fill minor gaps in mapping is progressing, with aerial photography and field mapping of land use (including land management practices and land cover) now complete. Data capture will be completed with the digitising of three 1:100 000

map sheets. A series of seamless 1:250 000 datasets, involving edge-matching and some reclassification, is approximately three-quarters complete. A separate project to map land use for the Penrith 1:100 000 map sheet on the western edge of Sydney has required the identification of additional classes for the ALUM classification.

The availability of digital aerial photography and the acquisition of annual SPOT 5 (satellite) imagery have improved the data available for further work on land use change. This is driving enhancements to organisational capacity, through new skills and procedures. Work on land use change can also use other relevant datasets (eg clearing and cropping licences on leased lands, plantation approvals and records of tree planting for carbon offsets).

### **Northern Territory**

Earlier data has been re-attributed to improve the accuracy of land use categories and to bring mapping up to date with changes in the cadastre as a result of new agricultural development. This has carried over into two LUMIS pilot projects in the Daly Basin and Darwin hinterland, where current ALUM codes have been applied, sometimes at the subportion level to achieve spatial accuracy.

### **Queensland**

State-wide coverage is complete to 1999 (as a consolidated state dataset or as 79 catchments). Updating for selected catchments to the Great Barrier Reef continues, with a focus on intensive land uses and land use change. Mapping to date includes the Burdekin–Fitzroy, Johnston, Murray, Plane and Pioneer–Tully catchments and is planned for the Barron catchment.

Other work includes mapping land use change from 1999 to 2006 for southeastern Queensland.

### **South Australia**

Acquisition of satellite imagery and aerial photography and state-wide collection of baseline data is enabling the upgrade of Digital Elevation Models (DEMs) and supporting a program for updating of land use mapping to the same year. The Adelaide–Mt Lofty, the South Australian Arid Lands and the Alinytjara Wilurara natural resource management (NRM) regions are complete, with other regions to follow.

Fieldwork to compile base data for the South East, Eyre Peninsula, Northern and Yorke, and Murray regions is in progress. Desktop mapping for the Kangaroo Island region is complete and desktop mapping of other areas is planned.





### Tasmania

Areas that need updating have been identified, but no updates are in progress. Further work is dependent on available resources.

### Victoria

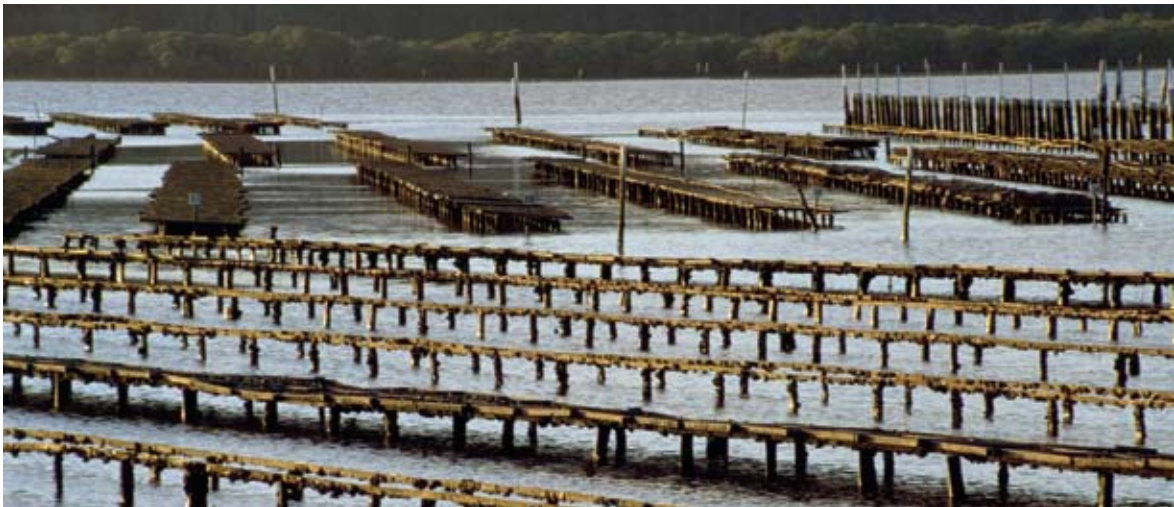
A state-wide land use information system, established in 2007, will provide for the ongoing maintenance and updating of catchment-scale land use mapping and other mapping products. This includes the preparation of a seamless state-wide map at a nominal scale of 1:100 000. Work is also continuing to edge-

match and remove anomalies resulting from mapping over an extended period.

### Western Australia

Updated catchment-scale mapping consistent with ALUM commenced in 2006. Data have been collected for the state and two regions have been mapped.

Other sources of land use information include regional bodies and horticulture industry groups. Some relevant information is provided by mapping of remnant vegetation (2007), which has now been completed across the state.



Aquaculture (ALUM Class 5.2.6) (photo by the Department of Agriculture, Fisheries and Forestry)

## Data availability

The BRS website<sup>5</sup> provides access to an online mapping tool, which includes catchment-scale mapping and national-scale mapping for 1996–97 and 2001–02. Maps can be generated for a set number of classes (16) and for a range of 'geographies' (eg NRM regions, statistical local areas [SLAs] or states) and downloaded as a pdf file. Figure 3 shows an example map at the catchment scale for an area incorporating the Eyre Peninsula NRM region. Work is in progress to improve the viewer for online mapping. Future versions may provide statistics for selected regions.

BRS provides a land use DVD on request.<sup>6</sup> Downloads of national and catchment-scale land use data are available from the Australian Natural Resources Data Library.<sup>7</sup> Users can generate maps flexibly in a geographic information system (GIS) using different levels of the ALUM classification. Land use mapping is also available from the Australian Natural Resources Atlas.<sup>8</sup>

Data are also available from the partner agencies in the states and the Northern Territory. The BRS

website provides links to the partner agencies and, in some cases, to their data sources. The individual jurisdictions have independent data and information systems developed to meet their own particular needs.

## Land use information for monitoring and evaluation

To guide reporting of outcomes for the National Action Plan for Salinity and Water Quality and Natural Heritage Trust (NHT) programs, a Monitoring and Evaluation Working Group developed the National NRM Monitoring and Evaluation Framework (National M&E Framework, see Appendix 2). The Audit is responsible for ongoing development of indicators to support this national framework. Monitoring and evaluation protocols specify the indicators, and the data requirements for these indicators have been identified. The Audit has further responsibility for supporting national data collection and collation, and reporting against each indicator.

The Audit has completed an assessment of the data needed and available to report against the National M&E Framework. The report (Beaten Track Group 2004) is available online.<sup>9</sup> It uses a threefold categorisation of data needs for each indicator. In this approach, data are either identified:

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<sup>5</sup> <http://www.brs.gov.au/landuse>

<sup>6</sup> Contact details are available from <http://www.brs.gov.au/landuse>

<sup>7</sup> <http://adl.brs.gov.au>

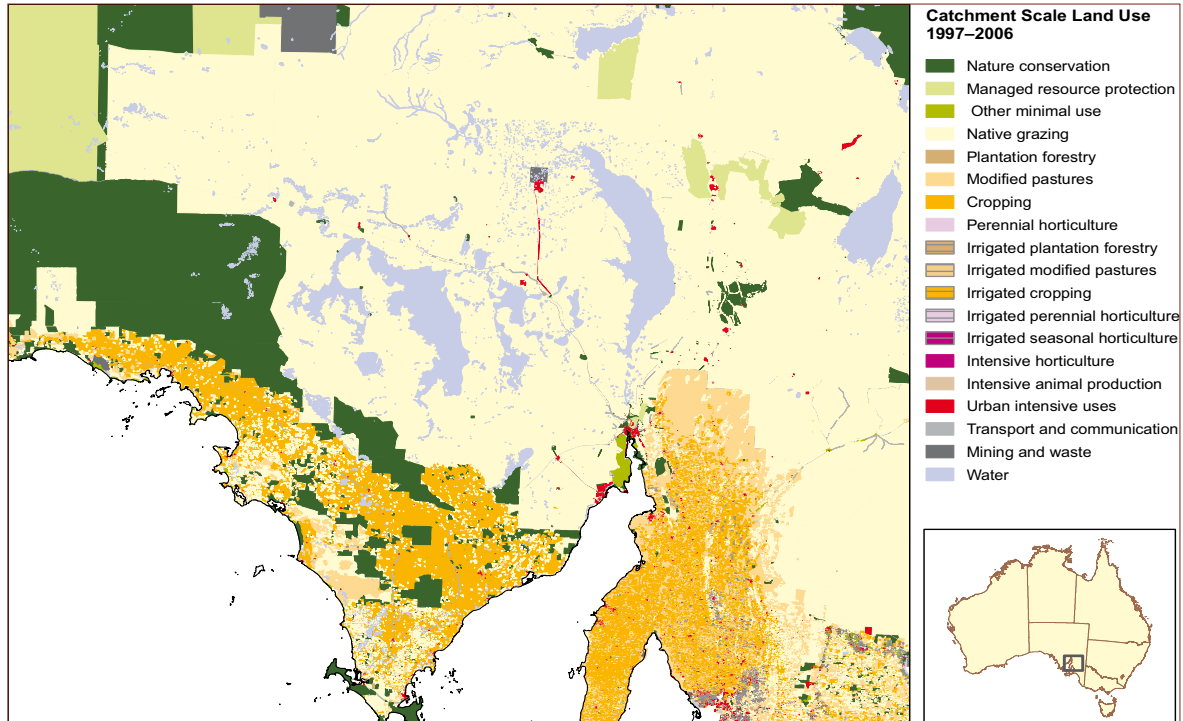
<sup>8</sup> <http://www.anra.gov.au>

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<sup>9</sup> [http://www.nlwra.gov.au/Publications\\_and\\_Tools/Project\\_Reports](http://www.nlwra.gov.au/Publications_and_Tools/Project_Reports)



Figure 3 Catchment-scale land use for the Eyre Peninsula NRM region and surrounds



- specifically in a protocol as essential for measurement of an indicator
- as contextual data that are critical for an understanding of the indicator
- as contextual data that are useful in that they assist an understanding of the indicator.

The report notes that land use information is important for monitoring the suite of indicators as a whole. Land use data provides contextual information that is useful, and sometimes critical, to understand the indicators and to recording and reporting outcomes in terms of change and trends.



Urban residential (ALUM Class 5.4.1) (photo by Vivienne Bordas)

### Land management practices information

Land use data also provide a framework for reporting on land management practices. ACLUMP partners are collaborating to develop LUMIS, which will contain spatial information on land management practices — the 'how' of land use. This development recognises that resource condition is strongly related to adoption of and change in sustainable land management practices.

Spatial and temporal information on management practices provides an early insight into likely outcomes and is used for reporting on progress towards long-term resource condition outcomes. LUMIS will provide a consistent classification of the very large number of management practices that can be mapped across the range of land uses. This will enable identification, recording and mapping to nationally agreed standards.



The LUMIS categorisation system is being tested in a number of pilot projects. LUMIS partners are actively addressing issues such as methods for data collection, scales and frequency, and database development. Details are included in a forthcoming report from the BRS.

Further work through pilot projects is expected to resolve technical issues — LUMIS will have the capacity to provide information to, and collate information from, a wide range of natural resource programs. In addition to national programs and state and regional activities, key users of standardised information on land management practices might include the Signposts for Australian Agriculture ('Signposts') project and related research and development corporations and industry groups. In addition to these programs and related monitoring and evaluation activities, key expected sources of information for LUMIS are agriculture and related industry surveys by the Australian Bureau of Statistics (ABS) and the Australian Bureau of Agricultural and Resource Economics (ABARE).

### Interaction with other interests in land management practice information

The development of standard procedures for recording information under the ACLUMP partnership recognises the need for a classification that allows for spatial representation of land management practices and accommodates change in the type and distribution of individual practices.

The information on land use in national and catchment-scale maps represents the use of each identified area at a point in time (ie what the land was used for at the time when data were collected). LUMIS data will represent how an identified area was managed at a particular point in time — they will not provide information on the full range of practices used on all the land under the control of each manager. Similarly, LUMIS will not provide information that can be directly integrated to provide a 'picture' of land management practices across any particular industry (eg dairying). LUMIS must therefore maintain a close linkage with other initiatives that identify data requirements, and that provide manager and industry-based information on land management practices.



Irrigated cotton (ALUM Class 4.3.6) (photo by the Department of Agriculture, Fisheries and Forestry)

## The Social and Economic National Coordinating Committee

The Social and Economic National Coordination Committee (SENCC) has responsibility for developing and implementing social and economic indicators and products to support the National M&E Framework. Its focus is on:

- community and social processes relevant to or affected by NRM programs
- industry-related data on the adoption of sustainable development and production techniques.

The indicators selected by the SENCC relate to:

- land managers' capacity to change and the adoption of sustainable management practices
- regional groups' capacity to make decisions on NRM, including the impact of institutional change and responsiveness
- links between community vitality, viability and health and natural resource condition.



Thus, where LUMIS provides spatially referenced and consistent information on the practices used, SENCC promotes and coordinates the collection of tabular and spatial data that may explain the pattern of use.<sup>10</sup> For example, SENCC identifies factors that affect the adoption of particular management practices or factors that impede wider adoption across an industry. The ability to integrate information from both sources will provide a better understanding of how to improve resource-condition outcomes.

#### Signposts for Australian Agriculture project

The Signposts project also addresses land management practice information from an industry perspective. The project aims to inform government and industry policy development by assessing and reporting on the environmental, economic and social contributions of Australian agricultural industries. Australian agricultural industries can in turn be provided with tools and products to assess and illustrate how their management practices contribute to desirable NRM outcomes.

The Signposts project will deliver products that demonstrate the relationships between:

- land use and land management practices and the achievement of economic, social and environmental outcomes
- levels of adoption of sustainable management practices
- capacities of land managers to change management practices
- impacts of research and development corporation/ government initiatives on capacity to change
- effects of these initiatives on the adoption of alternative management practices.

The project incorporates the SENCC indicators and draws data and information from SENCC participants. Important data sources include surveys conducted by the ABS, ABARE and government programs such as FarmBis, as well as land use mapping and data sets in LUMIS and the Australian Soil Resource Information System (ASRIS). Further information on the Signposts for Australian Agriculture project is available from the Audit's website.<sup>11</sup>

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<sup>10</sup> [http://www.nlwra.gov.au/Natural\\_Resource\\_Topics/Socio-economic](http://www.nlwra.gov.au/Natural_Resource_Topics/Socio-economic)

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<sup>11</sup> [http://www.nlwra.gov.au/Natural\\_Resource\\_Topics/Signposts\\_for\\_Australian\\_Agriculture](http://www.nlwra.gov.au/Natural_Resource_Topics/Signposts_for_Australian_Agriculture)

## Significant providers of land use and land management practice information

### The Australian Bureau of Statistics

The ABS has periodically collected information on land use and management practices using a number of different collections. In 1983–84 the Agricultural Census collected information relating to irrigated cropping areas and sources of water, as well as fertiliser use. In some states and territories, information on land use, land clearing and salt-affected land was collected.

Agricultural censuses conducted annually up to 1996–97 and then in 2000–01 produced estimates for commodities at the substate level for the Australian Standard Geographical Classification (ASGC) regions of SLAs (Box 2). From 2005–06 the five-yearly Agricultural Census will produce estimates for a range of defined geographic regions including NRM regions and river basins as well as SLAs.

The Agricultural Survey is conducted in the years between censuses and in the past has produced substate estimates to the broader level of statistical divisions (SDs). From 2006–07, the survey will be designed to produce national, state, SD and NRM-level data.

### Box 2: Content of the ABS Agricultural Census

Issues covered by one or more surveys have included:

- tree planting (type, method, quantity and purpose)
- fertiliser use (type, quantity, area and purpose)
- fencing (length, area enclosed and purpose)
- salinity problems and effects, including a specific land management and salinity survey in 2002 (type, area affected, treatments/practice changes and reasons, impediments to change)
- land and soil management (cultivation methods used, stubble management)
- land use (area by category of use)
- water use (source, volume applied, area watered, purpose, methods used and information used to guide usage).





The ABS conducted a specific national NRM survey in 2004–05. With funding guaranteed from 2005–06, the NRM surveys are to be conducted every two years (Box 3). Results of the 2006–07 survey of 20 000 farming businesses will be available from mid 2008. The survey is designed to provide data on land and water management practices and factors that affect farmers' ability to manage the environment.

The ABS has completed two special collections — the Land Management and Salinity Survey, which used 'trigger' questions on the 2001 Agricultural Census, and the Water Survey (Agriculture) which used 'trigger' questions on the 2003 Agricultural Survey. The ABS has also conducted some specific regional land management surveys.

Survey output according to SD and SLA is not always useful for land management applications, particularly not at regional levels. In addition, the ABS surveys have used a 'business frame', rather than a flexible spatially-referenced frame, which would be more useful for land management purposes. This issue and other user requirements are being evaluated in current ABS consultations on setting directions for future collections of NRM land management practice data — see 'Discussion and way forward' below.

### **Box 3: Content of ABS Natural Resource Management Surveys**

Key 'subject areas' of the surveys include:

- soils and land management (problems and area affected, response activities, cost and time taken)
- land use (area by category of use)
- water use (type of water-related problems, activities, effort and cost to prevent or manage, changes to irrigation practices)
- weeds (problems, activities and areas treated, time and cost, change in extent).

Farm management issues surveyed include farm planning, income and expenses (including effort and expenditure on NRM), participation in NRM programs, barriers to change and perception of issues such as climate change.

## The Australian Bureau of Agricultural and Resource Economics

Important activities undertaken by ABARE include its annual Farm Survey and periodic Natural Resource Management surveys. ABARE has conducted its surveys of NRM issues and practices on a triennial basis since 1992. Surveys have focused on participation in Australian Government NRM programs (particularly Landcare) and have investigated awareness and management of land degradation by Australian broadacre and dairy farmers. Insight into financial and physical profiles of farms and landholder demographics is also available, as the data have been integrated with the ABARE annual farm survey of broadacre and dairy industries.

Other industries, sectors and regions are surveyed by ABARE subject to the availability of funding. Recent supplementary surveys have included the honey industry, the wine grape industry and a survey of small farms.

### National Carbon Accounting System

In 2002, NCAS published a technical report entitled *Agricultural Land Use and Management Information* (Swift and Skjemstad 2002).<sup>12</sup> This reported on a

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<sup>12</sup> Available from [www.greenhouse.gov.au/ncas/reports/tr13final.html](http://www.greenhouse.gov.au/ncas/reports/tr13final.html)

project designed to provide a nationwide estimation of how changes in land use are reflected in changes in soil carbon. The approach is based on modelling changes under a range of management systems using a calibrated and verified soil carbon model. NCAS is more closely aligned to land cover than to land use.



Irrigated flooded gum plantation (ALUM Class 4.1.1)  
(photo by Jodie Smith)



## Discussion and way forward

All jurisdictions have agreed on the National M&E Framework. This framework is fundamentally important for organising information needs within a system for reporting on program evaluation and resource condition change. There are some key issues associated with the National M&E Framework:

- It needs to be constantly reviewed and developed to ensure that it continues to meet current and emerging information needs.
- Although it does not specifically include land use in its set of indicators, it is a critical data set for the interpretation of recommended indicators of resource condition.
- Information on management practices provides valuable insight into how progress is being made towards resource condition targets under the framework.
- Overall, the key task is to continue to improve linkages between the land use theme and other themes.

### National land use maps

There is both scope and need to continue development of procedures for compilation and integration of data from all relevant sources,

including cadastral and other ancillary data. Areas for further development include:

- refining procedures for linking land use mapping with information on land management practices
- building capacity to use this information to support the national level of decision making.

A key task is to align the production of national-scale land use mapping with the census collections of the ABS. Using major five-yearly updates a map of land use could be produced for 2006–07 that is aligned with the 2006 census and linked with data from the 2006–07 NRM survey that will be available in 2008. The next major edition of the map would then be due for production in 2012.

Developments in sensor technologies and image analysis techniques for collation and interpretation of data need to be supported by:

- ongoing work to improve verification and validation (eg ground truth and signature reference sites)
- an increasing focus on improving rule-based approaches for the identification of change in patterns of land use — requiring particular attention to quality assurance of mapping and data (including metadata) products.

Changes in biophysical and socioeconomic conditions induce change in patterns of land use. New modelling and analysis tools continue to improve our capability in dealing with complexity in land use systems by an increased understanding of the ways land use can change in response to changing climatic, economic and social factors. This understanding may prove particularly important where change of use reflects longer-term trends on a regional or industry-wide basis, compared with changes that are rapid and frequent, such as patterns of crop and pasture rotations at the farm scale.

There are significant opportunities for wider applications of land use mapping in dealing with national issues such as carbon accounting, biodiversity conservation and salinity assessment. Responses to these opportunities will necessarily be built on further advances in continental scale modelling, probability mapping and the development of national land use maps in time series.

### Catchment-scale mapping

National NRM programs are increasingly delivered through regional programs. The Audit's responsibility for coordination of the work of ESCALUM with other NCCs requires a continuing focus on working with theme sponsors to identify multiple interests in

land use mapping at regional scales. The national interest is particularly directed through major programs of the NHT and the National Water Initiative, which are working to provide:

- up-to-date and reliable land use information to NRM programs
- catchment-scale information on land use as it effects interception, overland flow, surface storages and accessions to groundwater
- integration of catchment-scale land use information with information from other themes, especially water, soils and terrain, and vegetation.

State and territory jurisdictions have the primary role in catchment-scale mapping and data management. Their priorities for ongoing work can differ. Program development requires ongoing review of needs for land use and land management information by the jurisdictions.

ESCALUM has a critical role in maintaining commitment to consistency, while allowing flexibility sufficient to meet the particular needs of individual jurisdictions, and ensuring that needs at national, industry and regional levels continue to be effectively serviced. Adequate resourcing and maintenance of skills within state and territory agencies is important





for updating catchment-scale land use mapping and for the maintenance of information products and the facilities that provide access to them.

Other identified requirements to be provided by ESCALUM are:

- to align national models of land use with regional-scale land use mapping where it is current (ie where maps at a regional scale represent changes in land use in the period since the previous national map)
- to ensure that other contributors (eg regional management authorities) use national standards for any collection of catchment-scale data, especially where land use change in a region is rapid or widely distributed.

### Land use change

Tests and methods to measure and report change in land use over time must be developed to monitor progress towards resource condition targets and to evaluate the effectiveness of public investments in NRM. Some work is in progress to develop methodology for mapping and reporting land use change.

At a national scale, current investigations are focused on the use of SPREAD-based methods, coupling time-series satellite image data and agricultural statistics to identify and report on change.



Dryland cropping (canola) (ALUM Class 3.3.4) (photo by the Department of Agriculture, Fisheries and Forestry)

At the regional scale, current efforts are focused on methods for identifying change in key catchments and, more specifically, on the use of remote sensing methods to report change in pasture and cropping land use systems.

ACLUMP is proceeding with the development of a national land use change reporting system with a focus on 'hotspots' for change in priority land uses (eg irrigation) and major changes in land use (eg peri-urban development). The system requires attention to the land use change classification as national standardisation of attributes needs to apply across different scales. Other work in progress is on testing and using advances in technology for remote sensing, image processing and image analysis.

Ongoing work is needed to develop protocols for distinguishing changes that are part of standard farming systems, from changes that reflect longer-term trends. For example, crop and pasture rotations should be distinguished from longer-term trends induced by climatic, economic or social conditions. It is also important to be able to distinguish actual changes from apparent changes that are an artefact of the method of mapping or variation in the experience and skill of the mappers.

Profiles of change on an industry basis are also being identified and described — see the sections of this report on the Signposts for Australian Agriculture program and the SENCC.

Important methodological issues are associated with the spatial frameworks to be used. Particular attention should be paid to progress by the ABS in assessing change in land parcels using cadastral information. There is a pressing need for progress in:

- verification of identified changes
- automation of the procedures.

### Land management practices

There is potential for an unmanageable explosion in the amount of detail that can be collected on land management practices (LMP). Priorities must be set

to identify required data to collect for LUMIS to meet national, state and regional needs and the needs of industry. In addition, the framework for recording data must be appropriate to regional and industry needs.

Key requirements are:

- maintaining consistency across jurisdictions
- ensuring capacity to include information collected by other agencies and programs
- ongoing collaboration with the ABS
- consultation with the SENCC.

The provision of land management practice data within spatial frameworks and at the scales at which investments are considered and programs are delivered is likely to be an increasing focus. Ongoing work to develop the classification, and to determine the data to be recorded and how they are to be mapped, needs to be effectively aligned with data requirements for the National M&E Framework's matters for target.

A revised approach for monitoring and evaluation of NRM programs is being developed through the Monitoring, Evaluation, Review and Improvement (MERI) component. Information from LUMIS will make an important contribution to the 'storybook' approach of MERI. This requires reporting on the





adoption of management practices that are expected to result in progress towards targets for resource condition outcomes. ESCALUM partners are in the best position to promote general adoption of the LUMIS classification and to ensure that data collected at local and regional levels meets required standards, and can be integrated for the MERI storyboards.

Land use and land management practice information is also needed for the joint Department of Agriculture, Fisheries and Forestry and Department of the Environment, Water, Heritage and the Arts project to develop a spatial information system (NRMSIS). This will support prioritisation of NRM investments and service ongoing needs for analysis and information products.

Further refinement of the LUMIS classification of land management practices may be required to:

- support monitoring at local scales, to meet requirements for evaluation and reporting on short to mid-term outcomes of specific investments
- support monitoring at (or aggregation to) regional scales, to provide context for assessments of broader and longer-term trends in resource condition outcomes and evaluation of the appropriateness and effectiveness of investment strategies

- assist in the adoption of a flexible spatial sampling and reporting framework for the ABS and ABARE surveys.

The refined LUMIS classification and the spatial frameworks for LMP surveys need to have input from advances in mapping of on-ground management practices. The development of rapid, low-cost and repeatable methods is essential, and will require the testing of spatial technologies for mapping land management practices.

Another area with high potential for improved LMP information is the further development of survey instruments. ABARE and the ABS are currently deciding how to refocus NRM surveys, with nested regional surveys, to allow the consideration of:

- specific management practice attributes
- business management practices
- other industries and smaller farms
- processes of adoption and agents of change
- protocols for detecting and reporting change.

Other issues identified for LUMIS development include:

- clarification of:
  - the scale and level of detail for information collection

- when data collection needs to be spatially explicit
  - the frequency of collection of data items for different needs
- ensuring consistency in time series, given likely change in personnel.

### Land cover

The ALUM classification avoids, as far as possible, confusing land use and land cover. Land cover mapping is based on characteristics of the land surface represented by various types of natural and man-made features (eg exposed rock, vegetation, soils, water bodies, built-up areas). Land use is the purpose for which the land surface is used (eg vegetation classed as forest may have a nature conservation use or timber production use).

This distinction, which is not made in many other classifications, is necessary to ensure that Australian land use mapping delivers appropriate information. Australian NRM policy and programs focus on investment in specific land uses and land management practices by relevant industries and individuals. Increasingly, NRM programs require information on land cover and land cover change that supports, and is supported by, information on land use and land management.

ESCALUM and its partners are considering a proposed National Land Cover Consortium to promote, develop and coordinate nationally consistent land cover information. Advantages to this approach would include:

- improved imagery resources
- an integrated network of reference sites
- greater efficiencies in mapping programs
- a wider range of enhanced and better-integrated products.

In recognition of responsibilities that extend beyond land use mapping to information on change in land use, land management practices and land cover, ESCALUM is considering changes to its title and membership, and the addition of a second technical advisory group to deal specifically with land management practices. TAGALUM will continue to provide expertise on land use mapping and working groups, set up as needed, will cover other priorities.

These changes will enable closer engagement and collaboration with other NCCs and with industry through relevant research and development corporations and the Signposts for Australian Agriculture project.





## Appendix 1 The Australian Land Use and Management (ALUM) classification

### Australian Land Use and Management classification (version 6)

<b>1. Conservation and natural environments</b>	<b>2. Production from relatively natural environments</b>	<b>3. Production from dryland agriculture and plantations</b>
1.1.0 Nature conservation	2.1.0 Grazing natural vegetation	3.1.0 Plantation forestry
1.1.1 Strict nature reserves	2.2.0 Production forestry	3.1.1 Hardwood production
1.1.2 Wilderness area	2.2.1 Wood production	3.1.2 Softwood production
1.1.3 National park	2.2.2 Other forest production	3.1.3 Other forest production
1.1.4 Natural feature protection		3.1.4 Environmental
1.1.5 Habitat/species management area		3.2.0 Grazing modified pastures
1.1.6 Protected landscape		3.2.1 Native/exotic pasture mosaic
1.1.7 Other conserved area		3.2.2 Woody fodder plants
1.2.0 Managed resource protection		3.2.3 Pasture legumes
1.2.1 Biodiversity		3.2.4 Pasture legume/grass mixtures
1.2.2 Surface water supply		3.2.5 Sown grasses
1.2.3 Groundwater		3.3.0 Cropping
1.2.4 Landscape		3.3.1 Cereals
1.2.5 Traditional Indigenous uses		3.3.2 Beverage and spice crops
1.3.0 Other minimal use		3.3.3 Hay and silage
1.3.1 Defence		3.3.4 Oil seeds
1.3.2 Stock route		3.3.5 Sugar
1.3.3 Residual native cover		3.3.6 Cotton
1.3.4 Rehabilitation		3.3.7 Tobacco
		3.3.8 Legumes
		3.4.0 Perennial horticulture
		3.4.1 Tree fruits
		3.4.2 Oleaginous fruits
		3.4.3 Tree nuts
		3.4.4 Vine fruits
		3.4.5 Shrub nuts, fruits and berries
		3.4.6 Flowers and bulbs
		3.4.7 Vegetables and herbs
		3.5.0 Seasonal horticulture
		3.5.1 Fruits
		3.5.2 Nuts
		3.5.3 Flowers and bulbs
		3.5.4 Vegetables and herbs
		3.6.0 Land in transition
		3.6.1 Degraded land
		3.6.2 Abandoned land
		3.6.3 Land under rehabilitation
		3.6.4 No defined use



4. Production from irrigated agriculture and plantations	5. Intensive uses	6. Water
4.1.0 Irrigated plantation forestry	5.1.0 Intensive horticulture	6.1.0 Lake
4.1.1 Irrigated hardwood production	5.1.1 Shadehouses	6.1.1 Lake — conservation
4.1.2 Irrigated softwood production	5.1.2 Glasshouses	6.1.2 Lake — production
4.1.3 Irrigated other forest production	5.1.3 Glasshouses (hydroponic)	6.1.3 Lake — intensive use
4.1.4 Irrigated environmental	5.2.0 Intensive animal production	6.2.0 Reservoir/dam
4.2.0 Irrigated modified pastures	5.2.1 Dairy	6.2.1 Reservoir
4.2.1 Irrigated woody fodder plants	5.2.2 Cattle	6.2.2 Water storage — intensive use/farm dams
4.2.2 Irrigated pasture legumes	5.2.3 Sheep	6.2.3 Evaporation basin
4.2.3 Irrigated legume/grass mixtures	5.2.4 Poultry	6.2.4 Effluent pond
4.2.4 Irrigated sown grasses	5.2.5 Pigs	6.3.0 River
4.3.0 Irrigated cropping	5.2.6 Aquaculture	6.3.1 River — conservation
4.3.1 Irrigated cereals	5.3.0 Manufacturing and industrial	6.3.2 River — production
4.3.2 Irrigated beverage and spice crops	5.4.0 Residential	6.3.3 River — intensive use
4.3.3 Irrigated hay and silage	5.4.1 Urban residential	6.4.0 Channel/aqueduct
4.3.4 Irrigated oil seeds	5.4.2 Rural residential	6.4.1 Supply channel/aqueduct
4.3.5 Irrigated sugar	5.4.3 Rural living	6.4.2 Drainage channel/aqueduct
4.3.6 Irrigated cotton	5.5.0 Services	6.5.0 Marsh/wetland
4.3.7 Irrigated tobacco	5.5.1 Commercial services	6.5.1 Marsh/wetland — conservation
4.3.8 Irrigated legumes	5.5.2 Public services	6.5.2 Marsh/wetland — production
4.4.0 Irrigated perennial horticulture	5.5.3 Recreation and culture	6.5.3 Marsh/wetland — intensive use
4.4.1 Irrigated tree fruits	5.5.4 Defence facilities	6.6.0 Estuary/coastal waters
4.4.2 Irrigated oleaginous fruits	5.5.5 Research facilities	6.6.1 Estuary/coastal waters — conservation
4.4.3 Irrigated tree nuts	5.6.0 Utilities	6.6.2 Estuary/coastal waters — production
4.4.4 Irrigated vine fruits	5.6.1 Electricity generation/transmission	6.6.3 Estuary/coastal waters — intensive use
4.4.5 Irrigated shrub nuts, fruits and berries	5.6.2 Gas treatment, storage and transmission	
4.4.6 Irrigated flowers and bulbs	5.7.0 Transport and communication	
4.4.7 Irrigated vegetables and herbs	5.7.1 Airports/aerodromes	
4.5.0 Irrigated seasonal horticulture	5.7.2 Roads	
4.5.1 Irrigated fruits	5.7.3 Railways	
4.5.2 Irrigated nuts	5.7.4 Ports and water transport	
4.5.3 Irrigated flowers and bulbs	5.7.5 Navigation and communication	
4.5.4 Irrigated vegetables and herbs	5.8.0 Mining	
4.6.0 Irrigated land in transition	5.8.1 Mines	
4.6.1 Degraded irrigated land	5.8.2 Quarries	
4.6.2 Abandoned irrigated land	5.8.3 Tailings	
4.6.3 Irrigated land under rehabilitation	5.9.0 Waste treatment and disposal	
4.6.4 No defined use (irrigated)	5.9.1 Stormwater	
	5.9.2 Landfill	
	5.9.3 Solid garbage	
	5.9.4 Incinerators	
	5.9.5 Sewage	



## Appendix 2 The National Monitoring and Evaluation Framework

The National Natural Resource Management Monitoring and Evaluation Framework (referred to in this series as 'the National M&E Framework') was endorsed by the Natural Resource Management Ministerial Council in 2002. It was developed to assess progress towards improved natural resource condition through the development of accurate, cost-effective and timely information on:

- the health of Australia's land, water, vegetation and biological resources
- the performance of programs, strategies and policies that provide national approaches to the conservation, sustainable use and management of these resources.

Assessment of information collated under the National M&E Framework will assist the Ministerial Council to 'identify areas of concern and to better target the use of resources'.

The framework identifies three key requirements for monitoring natural resource condition:

1. a set of natural resource condition indicators (including those for the 'matters for target' identified in the National Framework for Natural Resource Management Standards and Targets) to measure progress towards agreed national outcomes on a medium and long term basis
2. a set of indicators for monitoring community and social processes relevant to or affected by NRM programs, as well as measures of the adoption of sustainable development and production techniques
3. contextual data pertinent to the indicator being considered.

The National Land & Water Resources Audit ('the Audit') is responsible for ongoing development of these indicators, as well as supporting the national collection and collation of data, and reporting against each indicator:

Such reporting will help to answer questions such as:

- What is the nature and extent of the issue?
- Is the existing or proposed intervention appropriate for the size of the issue?
- What types of intervention work best, are most cost effective, and have the best transferability across regions?
- What was the impact of the policy or program investment — in the intermediate and long term?

Monitoring and evaluation of core indicators supports evidence-based decision making at national, state and territory, and regional levels. However, each level may have a wide variety of data and information needs, in terms of content, context or scale. There is also complexity across the three levels of use associated with multiple needs, values, preferences and timeframes.



Grazing modified pasture (ALUM Class 3.3.0) (photo by the Department of Agriculture, Fisheries and Forestry)



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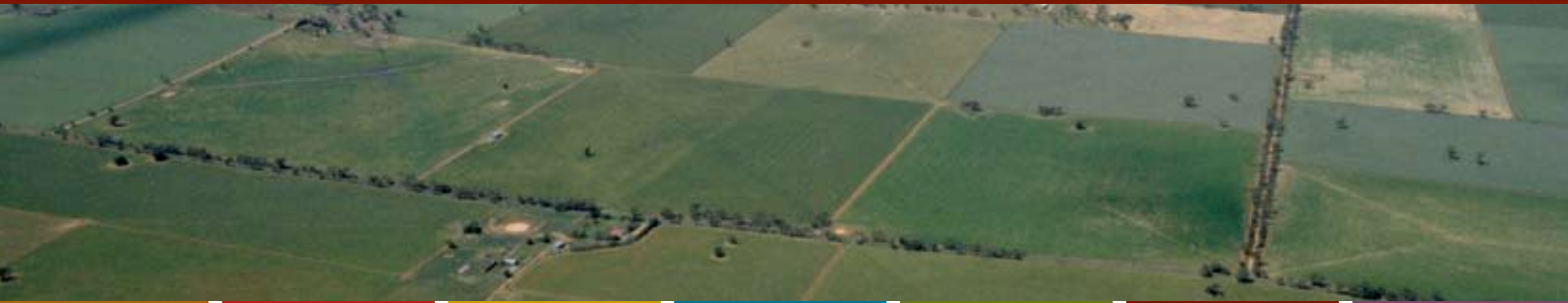
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## About the 'Status of Natural Resource Information' series

This series of booklets outlines the status of data and information relating to indicators agreed under the National Natural Resource Management Monitoring and Evaluation Framework (2002). Each booklet describes the status of coordination, indicators, information management systems, and data and information products for a particular theme area.

- Estuarine, coastal and marine
- Inland aquatic ecosystems
- Land salinity
- Land use
- Native vegetation
- Significant invasive species (vertebrate pests)
- Significant invasive species (weeds)
- Significant native species
- Social and economic information
- Soil condition
- Water quality



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