



An Australian Government Initiative



An improved online Bioenergy Atlas of Australia

**A report for the RIRDC/Land & Water Australia/FWPRDC/MDBC
Joint Venture Agroforestry Program**

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Foreword

The online Bioenergy Atlas is an innovative tool to support the emerging Bioenergy Industry in Australia. The Bioenergy Atlas was originally launched at the Bioenergy Australia conference in Sydney, in December 2002. It has received good feedback from industry, government and researchers. This project was undertaken to update and maintain the Bioenergy Atlas.

The improved Bioenergy Atlas is easier to use and has new and updated data and information. Because the success of bioenergy projects will depend on co-products in many instances, the Bioenergy Atlas provides a range of information to assist in identifying opportunities for energy production from biomass. The Bioenergy Atlas links to other supporting information, such as the biomass database. It also includes useful information about current and potential distribution of forests and plantations, including selected low rainfall tree species.

The improved Bioenergy Atlas will assist with planning for bioenergy production, and inform researchers and the public about opportunities.

This project was funded by the Joint Venture Agroforestry Program (JVAP), which is supported by three R&D Corporations — Rural Industries Research and Development Corporation (RIRDC), Land & Water Australia (L&WA), and Forest and Wood Products Research and Development Corporation (FWPRDC). The Murray-Darling Basin Commission (MDBC) also contributed to this project. The R&D Corporations are funded principally by the Australian Government. State and Australian Governments contribute funds to the MDBC.

This report is an addition to RIRDC's diverse range of over 1600 research publications. It forms part of our Agroforestry and Farm Forestry R&D program, which aims to integrate sustainable and productive agroforestry within Australian farming systems. The JVAP, under this program, is managed by RIRDC.

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Peter O'Brien

Managing Director

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Abbreviations

AGO	Australian Greenhouse Office
BRS	Bureau of Rural Sciences
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEH	Australian Government Department of Environment and Heritage
GA	Geoscience Australia
JVAP	Joint Venture Agroforestry Program
NCAS	National Carbon Accounting System
NFI	National Forest Inventory
NLWRA	National Land and Water Resources Audit
NPI	National Plantation Inventory
RIRDC	Rural Industries Research and Development Corporation

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Executive Summary

What the report is about: This report provides a summary of the updated features and improvements to the Bioenergy Atlas, to assist users of the online Atlas.

Who is the report targeted at?: The online Bioenergy Atlas is a new and innovative tool to support the emerging Bioenergy Industry in Australia

Background and Aims: There are developing opportunities for bioenergy in Australia, and a need to improve the availability of information for researchers, policy, planners and potential investors. The Bioenergy Atlas was developed by the University of Adelaide and the Bureau of Rural Sciences (BRS), with funding from the Australian Greenhouse Office and the Joint Venture Agroforestry Program (JVAP). The Atlas can be found on the Bureau of Rural Sciences website at <http://adl.brs.gov.au/mapserv/biomass/index.phtml>. This second project was undertaken to update and maintain the online Bioenergy Atlas of Australia, with funding from the same organisations.

Methods: The new and improved Bioenergy Atlas incorporates more up to date data and has other enhancements. It is now easier to create maps online with improved quality and to make a map for selected themes and regions. Maps can be customised and queries performed using the Geographic Information System (GIS), to incorporate a choice of data.

New data compiled for inclusion in the Atlas includes the extent and type of forest, existing plantations, and the potential distribution of plantations of selected tree species. Data on the location of renewable energy plants and biomass database sample sites was added, along with updated data for wood processing facilities.

Suggestions on how to improve the Atlas were sought from industry, researchers, government and other users through newsletters, an online survey and face-to-face discussions or phone interviews.

Results/Key findings: New and updated data has been added on key themes: forests, plantations, agriculture, industry and infrastructure. A much simpler Atlas has been created that makes it easier to create maps online, for a selected region and theme.

Usage statistics indicate that the Atlas is a useful tool for the emerging bioenergy industry in Australia, with strong interest from both Australian and international domains.

Recommendations: Two key needs emerged from consultation with users: tabular summaries of resources for regions; and worked case studies (with methodology) for particular industries. One case study was conducted during this study. The other user needs were beyond the scope of this project, and are recommended for further work:

- Undertake a national assessment of existing resources, industry and infrastructure for bioenergy production, and identify and address information gaps;
- Conduct further regional case studies to identify opportunities for bioenergy industries;
- Further improve the Atlas functions and ease of use, possibly as part of a suite of decision support tools for the industry;
- Promote the bioenergy atlas and build links with other researchers to share data, increase use of the Atlas and promote its use as a means for delivering research outputs; and
- Develop and implement an agreed strategy for research and development that includes update of data and information in the Bioenergy Atlas and other resources, including new data on where trees can be grown and potential growth rates, as data becomes available from JVAP and other related research

1. Introduction

The Atlas is a new and innovative tool to assist in planning an emerging bioenergy industry in Australia. It can be used to make maps and find information about existing and potential biomass resources, industry and infrastructure.

The Atlas was originally developed by the University of Adelaide and Bureau of Rural Sciences for a JVAP project called Bioenergy Atlas of Australia: an online Geographic Information Systems and Decision Support System (UA-55A). Funding for the Bioenergy Atlas of Australia was provided by the JVAP and Australian Greenhouse Office. The development of the Atlas is described in the JVAP Research Update series No. 5 (Bugg *et al.* 2002) available from the Rural Industries Research and Development Corporation <http://www.rirdc.gov.au/reports/AFT/02-137.pdf>. The Atlas was launched at the Bioenergy Australia conference, Sydney, in December 2002.

Since the Atlas was launched more up to date data has become available and online mapping systems have been improved. This project, BRR-10A, was undertaken in 2003-2004 to update and maintain the Atlas. The JVAP and AGO provided funding for BRS to undertake the work. This report outlines the updating of the Atlas to improve its functionality, provide more up to data and ensure its continued availability.

The online Bioenergy Atlas of Australia is available at <http://adl.brs.gov.au/mapserv/biomass/index.phtml>.

2. Improved Atlas

A much simpler Atlas has been created that makes it easier to create maps online. Users of the new Atlas can make a map simply by selecting a theme of interest and a particular region. The themes available are forests, plantations, agriculture, industry and infrastructure. Regions included are boundaries for states and territories, National Action Plan regions, National Plantation Inventory regions and Statistical Local Areas. More advanced users can still customise the map and perform queries using the Geographic Information System (GIS). Images with improved resolution and detail have been used to produce better maps. Masks for public land, forested, urban and other unsuitable land have also been included.

2.1 Map creation

Users start by selecting a theme and a region of interest (see below). The Atlas then provides a map showing the selected region and theme. The user can then customise the map using the GIS. Alternatively, the user can display maps for other themes and regions. The Atlas home page, simple atlas and GIS are shown in Appendix 1. Appendix 2 shows an example of a map created using the new and improved Atlas.

2.1.1 Regions

Users select the type of region from:

- Jurisdictions – All of Australia or Australian states and territories
- NAP – National Action Plan regions
- NPI – National Plantation Inventory regions
- SLA – Statistical Local Areas (from the Australian Bureau of Statistics)

The Atlas/GIS zooms to the selected region.

2.1.2 Themes

Users select the theme of interest:

- Forests – Forest type and extent (from the National Forest Inventory). The map also shows wood processing facilities
- Plantation – Plantation type and extent (from the National Plantation Inventory)
- Agricultural production – Cropping (from the National Land and Water Resources Audit)
- Industry – Landuse (from the National Land & Water Resources Audit) and industry locations including proposed and operating renewable energy plants, agricultural processing facilities, wood processing facilities
- Infrastructure

2.1.3 GIS

The online GIS is connected to the Atlas and provides more advanced functions. Users can still select the region and theme from the Atlas and select from the list of available data. The GIS can be used to zoom, pan and query data.

2.2 Atlas outputs

2.2.1 On-line maps

The Atlas provides a simple interface to create maps online. Users are presented with a map and legend for default layers. Users can then create maps for other themes and regions or customise the map using the GIS.

2.2.2 Save as PDF

This is used to create an electronic copy of the map in PDF format. This can be saved to the user's directory, and printed. Previously, users needed to use a screen capture function to save outputs.

3. Data

New and updated data has been added for the extent and type of forest and existing plantations sourced from the National Forest Inventory (NFI 2003) and the National Plantation Inventory (Wood *et al.* 2001) respectively. Using selected low rainfall tree species identified by the Australian Low Rainfall Tree Improvement Group (Harwood and Bush 2002) and using improved species climatic profiles developed by CSIRO (Jovanovic and Booth 2002), suitable growing regions have been identified and presented as predicted plantation distributions. Other important additions are links to locations for sustainable energy projects (from the Business Council for Sustainable Energy plant register), analysis of biomass samples from the biomass database (developed by CSIRO Energy Technologies; see Stein and Tobiasen 2007), and updated data for wood processing facilities data. A brief description and contact details for relevant bioenergy research projects has been included on the website.

Table 1 Changed/updated data in the Updated Bioenergy Atlas

Name	Description	Notes
Biomass database samples	The locations of samples collected for the Biomass database that contains analysis results for a range of biomass fuels.	New location data from biomass samples collected during JVAP and CSIRO biofuels project
Built up areas	Urban residential, Transport and communications	Replaced with data from GEODATA Topo 250K from Geoscience Australia
Cropping	Cropping areas showing agricultural commodities including cereals, hay and silage, legumes, oilseeds and oleaginous fruit, sugar, cotton and other cropping. Non-agricultural land and protected areas are not shown	Added more detailed mapping from landuse data
Electricity transmission	Electricity transmission lines (over 110 kiloVolts)	Updated with latest data
Existing plantations	National Plantation Inventory data on the extent and type of existing plantations in Australia	Replaced with latest NPI data
Forests and woodlands	The extent and type of forests and woodlands in Australia obtained from the National Forest Inventory.	New data added from NFI
Landuse	National Land and Water Resources Audit Landuse data showing conservation and natural environments, intensive uses, dryland farming systems, irrigated farming, native vegetation and water features	Replaced with better resolution data.
Operating and proposed renewable generators	Operating and proposed Renewable Energy Electricity Generation Facilities	Replaced with latest data from Geoscience Australia compiled for the Australian Greenhouse Office
Plantation potential	Potential growth of important commercial timber species is classified as either High, Medium or Low based on annual rainfall	Plantation potential shown for individual species
Potential climatic distributions	The potential distribution of selected tree species according to improved climatic profiles	New data added
Protected areas	Conservation and protected areas that meet the guidelines of the IUCN (1994) – World Conservation Union	Replaced with new mask (so that unsuitable areas are excluded from maps)
Protected land and woody vegetation	Land not suitable for tree plantations that includes land that is publicly owned, land with existing woody vegetation and conservation/protected areas	Replaced with masks for forest, public land and protected areas.
Public land	Public land extracted from the tenure item of the 1996/97 Landuse of Australia	Replaced with better resolution data
Renewable Energy Plants	The location of sustainable energy projects in Australia from the 2003 Sustainable Power Plant Register maintained by the Business Council of Sustainable Energy.	New data
Tenure	Tenure from the 1996/97 Landuse of Australia.	Replaced with better resolution data
Water bodies	Lakes, reservoirs, rivers, marshes/wetlands, estuaries/coastal waters	Replaced with topographic data
Wood processing facilities	The location of wood processing mills (eg sawmills) and capacity (classified)	New and improved data

4. Consultation and use

Suggestions for how to improve the Atlas were sought from industry, researchers, government and other users. This was done through newsletters, an online survey and face-to-face discussions or phone interviews. Electronic flyers advertising the Atlas were sent to industry groups, government and research organisations in September and October 2003. The updated Atlas was also presented at the Bioenergy Australia conference in December 2003.

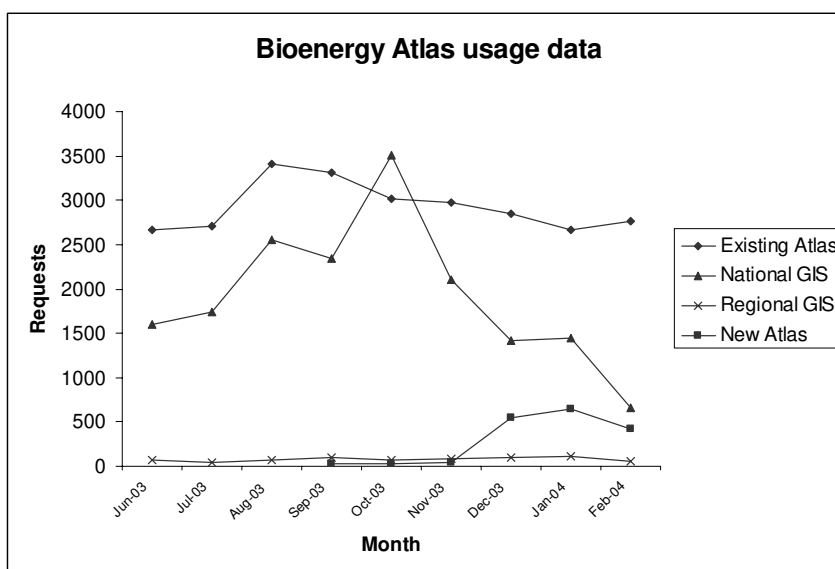


Figure 1 Monthly usage data showing the number of requests – the new Atlas was available online in December 2004.

During the study, the web site address was www.brs.gov.au/bioenergy_atlas. This has subsequently been moved to the address given in the Introduction. There were 26,362 page requests to www.brs.gov.au/bioenergy_atlas between June 2003 and February 2004. This is over 8% of requests to the BRS web applications server. 29% of requests were from Australian domains, 18% from International domains and the remainder are unknown or unresolved. The increase in number of requests for the National GIS in October corresponds with the busiest month for the BRS web applications server.

A short online survey was implemented at <http://data.brs.gov.au/mapserv/biomass/projectbio.php>. The few responses were considered as part of this project, but there were insufficient returns to warrant presenting this data. Notwithstanding the low response rate, the online survey will be retained as a possible feedback mechanism.

5. Discussion and conclusions

Two key needs emerged from consultation with users: tabular summaries of resources for regions; and worked case studies (with methodology) for particular industries. Tabular summaries of resources for regions would facilitate rapid assessment of opportunities by bioenergy project proponents/planners. However, development and provision of tabular summaries for regions was not feasible for this project so this remains an area where further work is needed.

A case study was undertaken in collaboration with the Clean Energy Future for Australia project to work through how to use and present the Atlas data. This provided an example of how the Atlas can be used to assess opportunities for bioenergy development. Each bioenergy project is likely to have its own characteristics - so the user must research this themselves.

This study suggests that promotion of the Bioenergy Atlas has increased use of the site. Increases in use occurred during the months that electronic flyers were sent to industry and other stakeholders. Use of the new and improved Atlas is expected to increase now that it has replaced the existing Atlas. Links to other researchers and resources, such as the biomass database, are expected to increase access and use of these research outputs.

6. Further work

There are several areas where further work would be worthwhile. These are:

- A national assessment of existing resources, industry and infrastructure for bioenergy production and undertaking activities to identify and fill information gaps;
- Further regional case studies to identify opportunities for bioenergy within specific regions and industries and provide regional/industry profiles;
- Inclusion of further data and information on where trees can be grown and potential growth rates, as data becomes available from JVAP and other related research;
- Additional activities to improve the Atlas functions and ease of use, possibly as part of a suite of decision support tools for the industry;
- Promotion of the bioenergy atlas and building links with other researchers to share data, increase use of the Atlas and promote its use as a means for delivering research outputs; and
- Development and implementation of an agreed strategy for research and development that includes update of data and information - extending to include the Bioenergy Atlas and other resources.

7. References

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Wood, M.S., Stephens, N.C., Allison, B.K., and Howell, C.I. (2001). Plantations of Australia – A report from the National Plantation Inventory and the National Farm Forestry Inventory. National Forest Inventory, Bureau of Rural Sciences, Canberra.

Appendix 1. Atlas interface

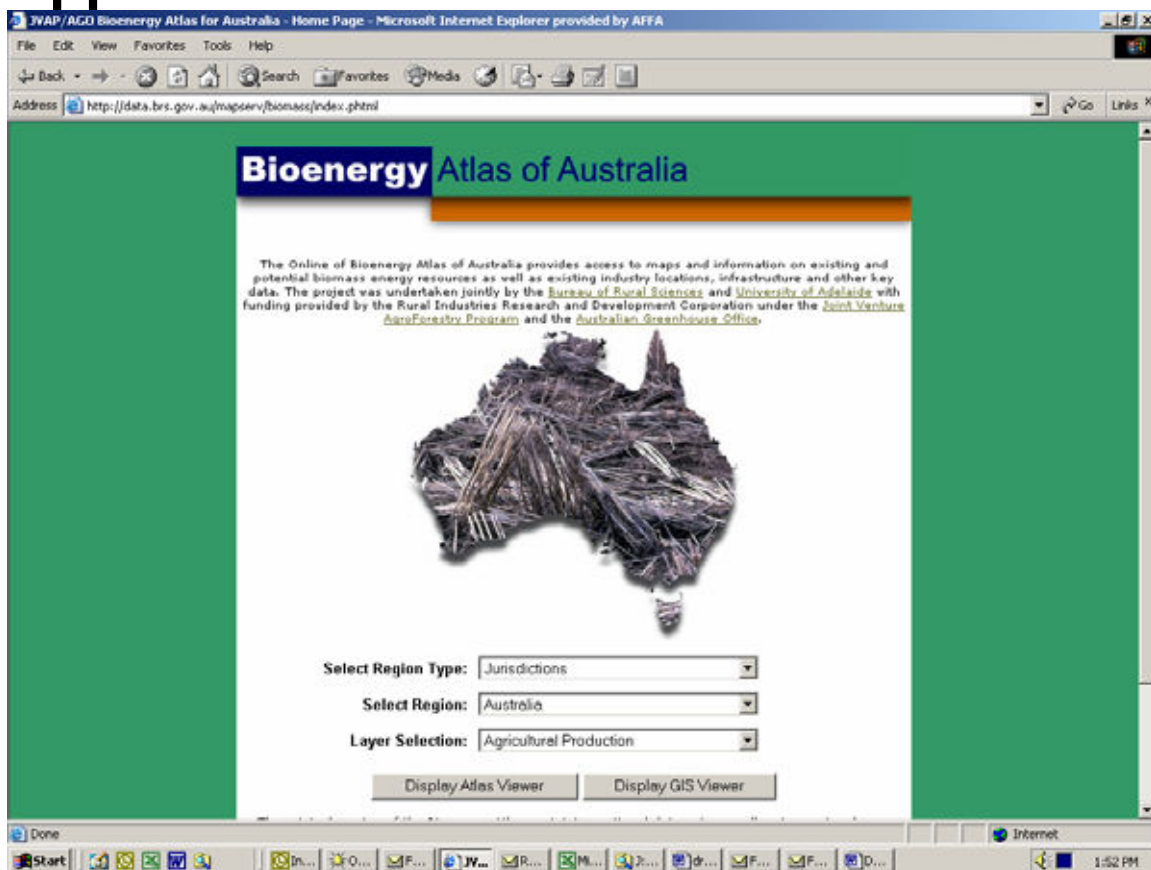


Figure 2 Bioenergy Atlas Home Page <http://adl.brs.gov.au/mapserv/biomass/index.phtml> (previously www.brs.gov.au/bioenergy_atlas)

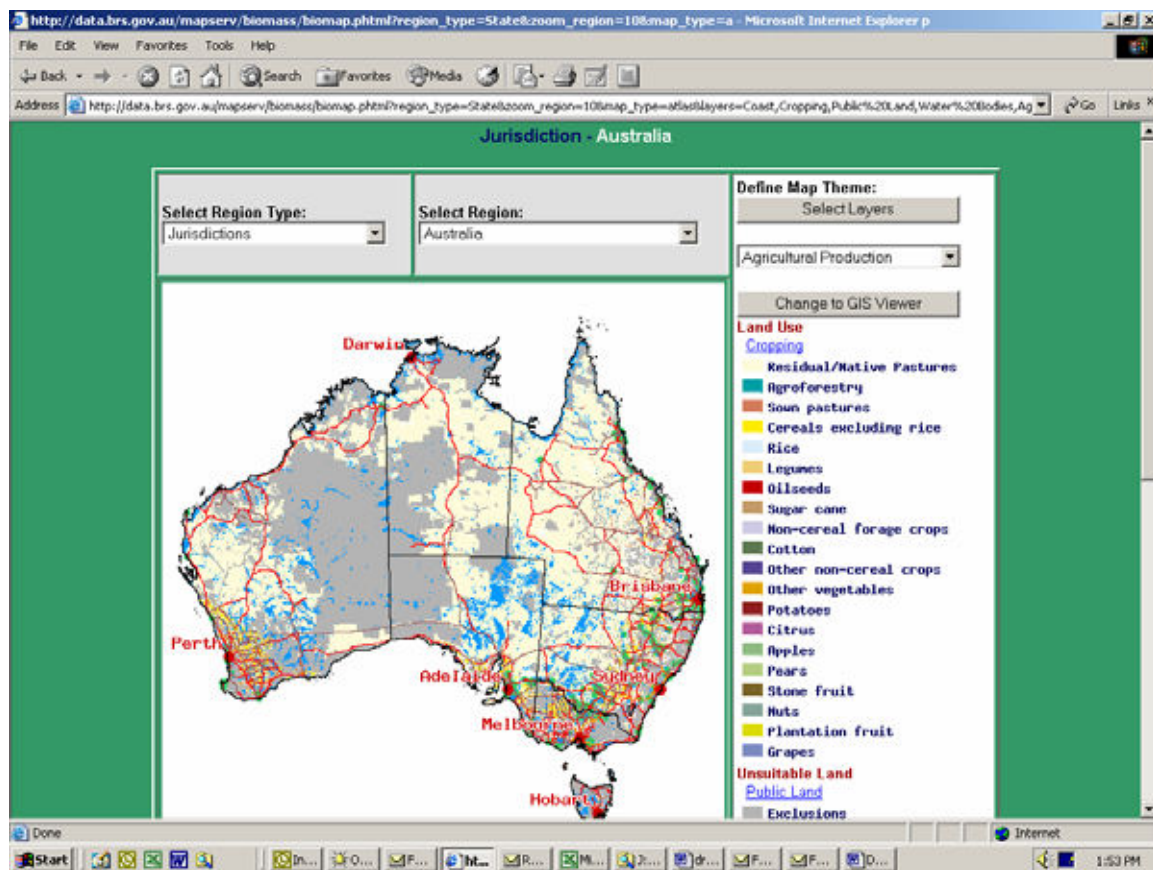


Figure 3 Atlas showing the agricultural production theme for Australia

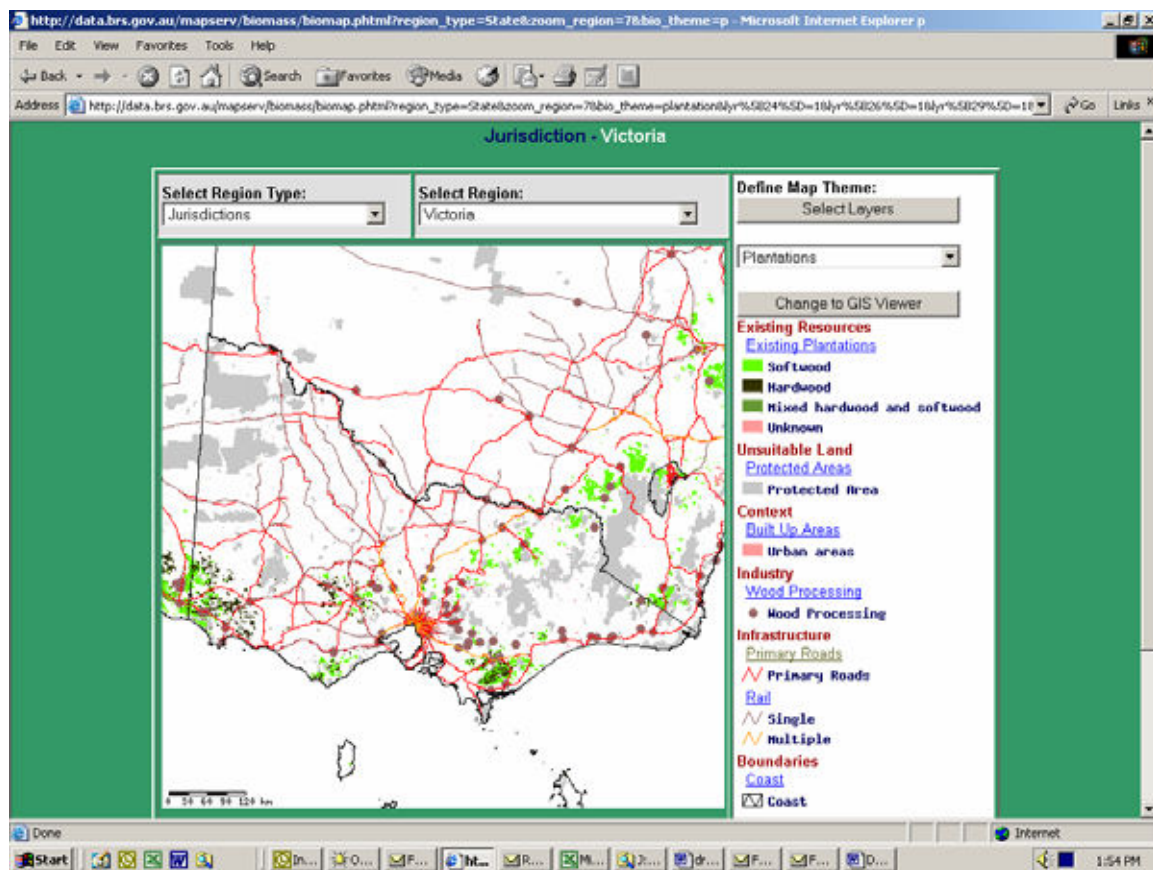


Figure 4 Atlas showing plantations theme for Victoria

Appendix 2. Atlas output

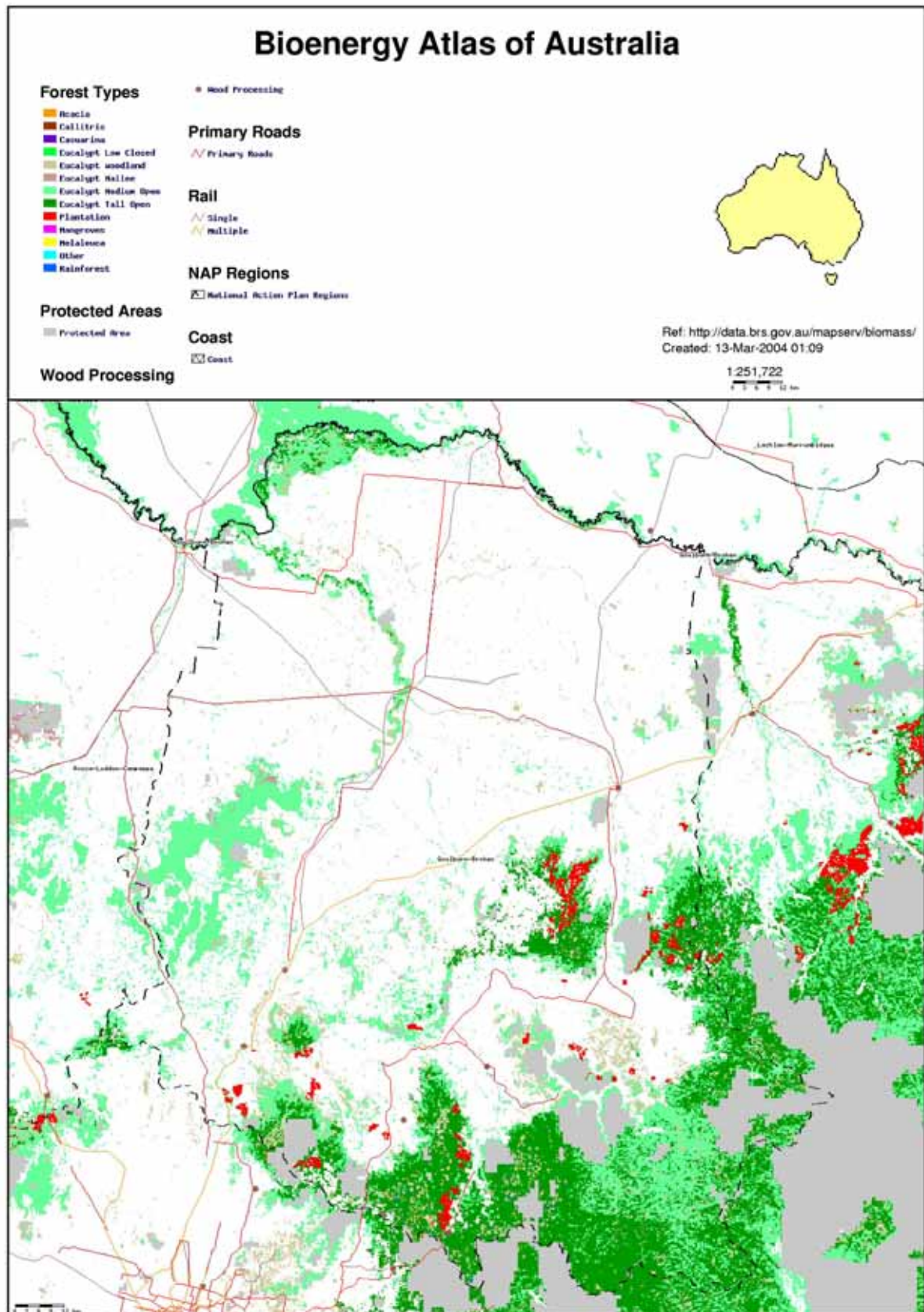


Figure 5 Map of forest cover and type for the Goulburn-Broken National Action Plan region produced using the Bioenergy Atlas

Appendix 3. Atlas data

Table 2 Complete list of Atlas data

Name	Description
Agricultural in-field resources	In-field residues are material that is not removed during harvesting of crops.
Agricultural plant oil residue	Plant oil is the organic material left over from processing of canola, sunflower, linseed, oil poppies, safflower and sesame seeds into various products.
Agricultural processing	Agricultural processing facilities including wineries, breweries, canneries and rice mills
Agricultural trash	Trash is material left over at the facility after the processing of sown pastures, rice, cottonseed, etc. An example is rice husks.
Average Annual Rainfall	Average annual rainfall classification for semi-arid (250-400 mm) and low rainfall (400-650) regions
Biomass database samples	The locations of samples collected for the Biomass database that contains analysis results for a range of biomass fuels
Built up areas	Urban residential, Transport and communications
Cleared private land	Cleared private land includes private freehold or private leasehold land that is either crop, pasture or bare
Cotton mills	Locations of cotton mills with estimated cotton production for 2000-2001
Cropping	Cropping areas showing agricultural commodities including cereals, hay and silage, legumes, oilseeds and oleaginous fruit, sugar, cotton and other cropping. Non-agricultural land and protected areas are not shown.
Electricity distribution	Available data for electricity distribution lines (various voltages)
Electricity transmission	Electricity transmission lines (over 110 kiloVolts)
Existing plantations	National Plantation Inventory data on the extent and type of existing plantations in Australia
Flow systems	National Land and Water Resources Audit groundwater flow systems showing local, intermediate and regional flow systems
Forest biomass	Biomass estimates for existing woody vegetation excluding conservation and protected lands. Existing vegetation cover is classified into broad forest types (using Carnahan structural codes).
Forests and woodlands	The extent and type of forests and woodlands in Australia obtained from the National Forest Inventory
Landuse	National Land and Water Resources Audit Landuse data showing conservation and natural environments, intensive uses, dryland farming systems, irrigated farming, native vegetation and water features
Major refineries	Location and name of major petroleum and non-petroleum refineries
National Action Plan priority regions	21 priority regions for the National Action Plan for Salinity and Water Quality
National Plantation Inventory regions	National Plantation Inventory regions are key regions identified for plantation development
Operating renewable generators	Operating Renewable Energy Electricity Generation Facilities
Plantation potential	Plantation potential provides an indication of potential tree growth in plantations, referred to as land capability. Several areas have been excluded from this data (see the exclusions data)
Plantation potential	Potential tree growth for important commercial timber species, classified as either High, Medium or Low based on annual rainfall

Population	The locations of major towns and cities classified according to population size
Potential climatic distributions	The potential distribution of plantations of selected tree species according to growth criteria based on improved species climatic profiles
Potential tree crops for salinity hazard reduction	Potential tree growth on cleared private land where a salinity hazard exists. Revegetation of these areas may reduce salinity hazard.
Proposed renewable generators	Proposed Renewable Energy Electricity Generation Facilities
Protected areas	Conservation and protected areas that meet the guidelines of the International Union for the Conservation of Natural Resources (IUCN, 1994)
Protected land and woody vegetation	Land not suitable for tree plantations, which includes land that is publicly owned, land with existing woody vegetation and conservation/protected areas
Public land	Public land extracted from the tenure item of the 1996/97 Landuse of Australia
Rail	Major railways
Renewable Energy Plants	The location of sustainable energy projects in Australia from the 2003 Sustainable Power Plant Register maintained by the Business Council of Sustainable Energy
Roads	Primary and secondary routes
Salinity hazard	National Land and Water Resources Audit Salinity Hazard showing areas of high or moderate salinity hazard
SLA - Statistical Local Areas	Statistical Local Areas (SLA) are regions defined by ABS for data collection
SLA based agricultural production resources	SLA-based estimates of seed oil, trash and in-field residues. Includes cereals, oilseeds and pulses, cotton, bagasse, rice, lucerne (stems) and other crops
SLA based Native forest harvesting residues	SLA-based estimates of in-field residues from timber production harvesting of native forests in regions covered by a Regional Forest Agreement (RFA)
SLA based plantation material	SLA-based estimates of uncommitted material from softwood and hardwood plantations
SLA based plantation potential	SLA-based estimates of potential production from plantations on capable and suitable land
Tenure	Tenure from the 1996/97 Landuse of Australia
Unavailable land	Crown land, Multiple use forests, Nature conservation areas, Aboriginal land and water production
Water bodies	Lakes, reservoirs, rivers, marshes/wetlands, estuaries/coastal waters
Wood processing	Location of wood processing mills (eg sawmills) and production/capacity (depending on data availability), including estimated biomass residue.
Wood processing facilities	The location of wood processing mills (eg sawmills) and capacity (classified)