

Australia's Tropical Rivers — Data Audit

NGIS Australia



Australian Government
Land & Water Australia



Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

The National Rivers Consortium is one of three research and development programs in Land & Water Australia's Rivers Arena. The consortium is a strategic collaboration between policy makers, river managers and scientists, that funds projects to improve catchment and river management across Australia.

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Summary and recommendations

In response to the need to better understand Australia's tropical river systems, the Tropical Rivers Data Collation Project was commissioned in July 2003 by Land & Water Australia with funding provided by the Natural Heritage Trust's Rivercare program. The project was undertaken between July and December 2003, by NGIS Australia in conjunction with Gutteridge Haskins Davey and Ecobyte Systems.

The project area was defined on a broad scale as that part of Australia taking in the coverage of north-flowing tropical rivers. The assessment region included all catchments draining into the Timor Sea and Gulf of Carpentaria, in addition to Bathurst, Melville, Groote, Wellesley and Mornington islands. The region stretches from Cape York to the Kimberley, across north coastal Queensland, the Northern Territory (NT) coast and north-western coastal Western Australia (WA). This initial scope was extended during the project to include part of the North East Coast Drainage Division (north of Cairns) taking in the tropical east coast of Queensland.



The aim of the project was to undertake a collation of available data sets relating to the project theme — Australia's Tropical Rivers — and from this information produce a set of information suitable

for uploading to the Australian Natural Resources Atlas. The data assessment included rivers, wetlands, estuaries and floodplains as integrated systems within both a catchment and land-use context.

The project also aimed to provide an information base to support the development and implementation of regional plans, assist with the integration of program outputs across Australia's tropical rivers regions and jurisdictions in regional, river and catchment planning, and provide a basis for the reporting of natural resources outcomes across a range of local, State/Territory and national initiatives.

The outputs and deliverables produced from this project are:

- GIS-based coverages of the specified project themes, provided in a format suitable and fully ready for inclusion onto the Australian Natural Resources Atlas and accessible via the Australian Spatial Data Infrastructure/Australian Spatial Data Directory.
- A printed document (on which this report draws heavily) that presents the outputs in map form, details data collation or synthesis methods used and includes a metadata appendix (Appendix 1) of all data sets collated.
- A summary document suitable for publication as a colour brochure that provides a precis of what is known about Australia's tropical rivers.

Data collection was undertaken between August and October 2003 in the tropical northern regions of WA, the NT and Queensland, as well as at a national level. The data sought covered the major project themes of Typology and classification, Water resources, River condition, Biodiversity, and Estuary condition.

The project succeeded in collecting over 250 data and metadata sets covering the targeted themes within the project area. It was found that many of these themes were adequately covered by existing data sets. However, there were important gaps in information about some

of the key themes, leading to recommendations being made regarding data acquisition.

Further investigation at a more specific and theme-oriented approach (as opposed to the broad scope of this project) should be directed towards State agencies, to ensure that all existing data sets are made available for future research into tropical rivers. Data exchange licence agreements between State agencies (especially in WA and Queensland) and the Australian Government need to be put in place to ensure that there is non-restrictive access to all available data on Australia's tropical rivers.

Recommendations

1. Elevation data in the form of the 9-second digital elevation model (DEM) are at too coarse a resolution to be useful for detailed study of river systems. The existing 1- and 3-second DEM, available from the Department of Defence (through Geoscience Australia), should be used.
2. Fire scar history data for Queensland need to be obtained to complete the coverage of the project area. Monthly updates (appended to the existing data set) also need to be undertaken to maintain currency.
3. Streamline data at the highest possible resolution need to be used. These data could be purchased for a large part of the project area through Geoscience Australia. The two main data sets are the Mapdata 100k (1:100,000 scale) topography and the Defence Imagery and Geospatial Organisation 1:50,000 topography.
4. Current data models and research programs relating to the classification of Australia's tropical wetland habitats need to adopt a consistent approach across the region.
5. A classification should be developed of tropical streams and rivers based on their hydrological features such as rainfall and flow regimes, hydrological processes (for example, degree of groundwater influence), geomorphological features, catchment and riparian vegetation, and catchment soils and geology.
6. Future programs need to develop spatial data sets for detailed rivers and streamlines (once obtained) to capture hydrological data. These data sets could be developed from existing high-resolution spatial data that can be linked to existing and future databases.
7. Information about water resources is limited and incomplete for large parts of remote northern Australia. Data collection networks and coverages need to be considered for climate, and ground and surface water themes by instigating new field surveys in areas not previously sampled.
8. An increase in the number and reliability of monitoring bores and gauging station networks in priority catchments would assist in overcoming hydrological data gaps. Given the considerable cost of installation and maintenance, consideration should also be given to improving methods of prediction in ungauged catchments. This would increase the density of data-collection points and significantly aid the understanding of water resources in tropical Australia.
9. A project-wide database of current and historical mining activity (similar in detail to the WA abandoned-mine-site database) would greatly enhance the understanding of disturbance and point source pollution in the project area. The National Pollutant Inventory should be investigated further to establish links to spatial data sets.
10. Existing riparian vegetation data within the project area are at too coarse a scale, and obtaining higher resolution data is important. This may be achieved through a combination of field mapping and remote-sensing studies with ground truthing.
11. Further investigation at a more specific and theme-oriented approach (as opposed to the broad scope of this project) should be directed towards State agencies to ensure that all existing data sets are made available for future research into tropical rivers.
12. The lack of spatial data relating to inland fish is a major gap in project information. It is likely that sufficient data are not being collected. Further investigation is required to find out from the State fisheries agencies whether data exist and how they may be obtained. If it is found that data are not being collected, then procedures need to be instigated so that the data are captured in the future.

13. More detailed biodiversity data are required. Further research is required to source and acquire it.
14. More accurate and higher resolution data should be acquired for wetlands and floodplains systems, to achieve greater consistency and accuracy.
15. Access to data from the Australian Terrestrial Biodiversity Assessment should be negotiated, to assist in further identifying spatial gaps and future directions for tropical rivers research.
16. More up-to-date information at finer spatial scales is required for weeds, pests and feral animals, particularly for the species of greatest concern to catchment and wetland management authorities.
17. Water quality and biodiversity data specific to estuaries are a gap in the current project database. Additional data need to be obtained.
18. Given that most estuaries are classified as “near pristine” (NLWRA 2002a), there is a need to develop measures of estuary condition that are more sensitive to change.
19. Licensing agreements for data exchange between State and Territory agencies and the Australian Government need to be put in place to ensure that there is non-restrictive access to all available data on Australia’s tropical rivers.

Acknowledgments

The authors acknowledge the contributions of their GIS Australia colleagues Paul Harris (project director), Dennis Puniard (data collection, ACT) and Richard Booth (data collection, WA), and of the Ecobyte Systems and GHD personnel who collected data in the Northern Territory and Queensland, respectively.

We thank the Natural Heritage Trust for funding the project, and members of the project management committee — Brendan Edgar (LWA), Bruce Gray (DEH), Maria Cofinas (ERIN), Karl Bossard (ERIN) and Rochelle Lawson (ANZLIC) — for their contributions.

Finally, we acknowledge the assistance of the numerous Australian, State and Territory government agencies that provided data for the project.

Abbreviations

ANRA	Australian Natural Resources Atlas
ANRDL	Australian Natural Resources Data Library
ANZLIC	Australia New Zealand Land Information Council
ARC	Assessment of River Condition
ASDD	Australian Spatial Data Directory
ASDI	Australian Spatial Data Infrastructure
ASRIS	Australian Soil Resource Information System
AusRivAS	Australian River Assessment Scheme
AUSLIG	Australia’s national mapping group, part of GA
AWRC	Australian Water Resources Council (disbanded)
BRS	Bureau of Rural Sciences
CALM	Conservation and Land Management department (WA)
DEH	Department of the Environment and Heritage
DEM	digital elevation mapping
DIGO	Defence Imagery and Geospatial Organisation
DLI	Department of Land Information (WA)
DNRM	Department of Natural Resources and Mines (Queensland)
DIPE	Department of Infrastructure, Planning and Environment (NT)
DBIRD	Department of Business, Industry and Resource Development (NT)
EDD	Environmental Data Directory
ERIN	Environmental Resources Information Network (DEH)
ESRI	ESRI Australia Pty Ltd
GA	Geoscience Australia
GIS	geographic information system(s)
IBRA	Interim Biogeographic Regionalisation for Australia
LWA	Land & Water Australia
NLWRA	National Land and Water Resources Audit
NPI	National Pollutant Inventory
NT	Northern Territory
NVIS	National Vegetation Information System
WA	Western Australia
WALIS	Western Australia Land Information System

1 Introduction

1.1 Project overview

1.1.1 Project aims and participants

This report documents the aims, methodology and findings of the Australia's Tropical Rivers Data Collation Project (hereinafter called the Tropical Rivers Project) which was undertaken between July and December 2003. The project was commissioned by Land & Water Australia (LWA) and funded by the Natural Heritage Trust's Rivercare program.

The aim of the project was to collate available data sets relating to the project theme — Australia's tropical rivers — and from this information produce information sets suitable for upload to the Australian Natural Resources Atlas (ANRA) <http://audit.ea.gov.au/ANRA/atlas_home>. The data assessment included rivers, wetlands, estuaries and floodplains as integrated systems within both a catchment and land-use context.

A broad selection of target data themes was chosen to ensure that the maximum volume of relevant spatial data and metadata was assembled. This approach was also adopted to identify gaps in knowledge that would become evident during data collation. In addition to the spatial information that was considered central to the project's primary tropical rivers theme (streamlines, estuaries, wetlands, catchments and biodiversity), related data sets such as climate, elevation, soils, geology and infrastructure were also sought. Table 1 lists the themes targeted by the project.

The project aimed to provide an information base to support the development and implementation of regional plans, and to assist with the integration of program outputs across Australia's tropical rivers regions and jurisdictions into regional, river and catchment planning. It also aimed to provide a basis for the reporting of natural resources outcomes across a range of local, State/Territory and national initiatives.

Table 1. Themes targeted for data collection in the Tropical Rivers Project.

Theme	Data Subset
Geology	
Raster data sets	Digital elevation mapping (DEM) Digital ortho-photos Satellite imagery
Climate	
Tides	
Soils	
Geomorphology	
Fire Regime	
Land use /tenure	Land use Tenure
Infrastructure	Tracks Roads Railways Dams Weirs Bridges Causeways Mine sites Indigenous communities/outstations Heritage sites
Vegetation	Riparian Mangroves Threatened species
Rivers	
Channels	
Wetlands	
Estuaries	
Floodplains	
Permanent waterbodies	
Water regimes	
Hydrological regimes	Hydrological response
Biodiversity	Fish Macrophytes Birds Mammals Reptiles Amphibians Inverts
Water quality	Sediment Nutrient
Weeds and pests	Weeds Feral animals

NGIS Australia, a Perth-based geographic information systems (GIS) consultancy, was awarded the contract to complete all phases of the data-collation project. Overall project management and data collection for WA, together with data evaluation, processing and database assembly were undertaken by the Perth-based project manager. NGIS engaged the services of two sub-consultants — Ecobyte Systems and GHD — to assist with the data collection and processing stages in the NT and Queensland, respectively.

The data evaluation and final reporting stages of the project were assisted by Dr Michael Douglas, Senior Lecturer in Ecology at the Charles Darwin University's Centre for Tropical Wetland Management. He has long been involved in research, consulting and teaching programs specialising in ecological impacts and management of tropical wetlands. The input of a technical expert allowed for a thorough understanding of the importance and fitness-for-purpose of the data collected, and its significance to the broader programs of tropical rivers research currently underway within Australia.

1.1.2 Project outputs and deliverables

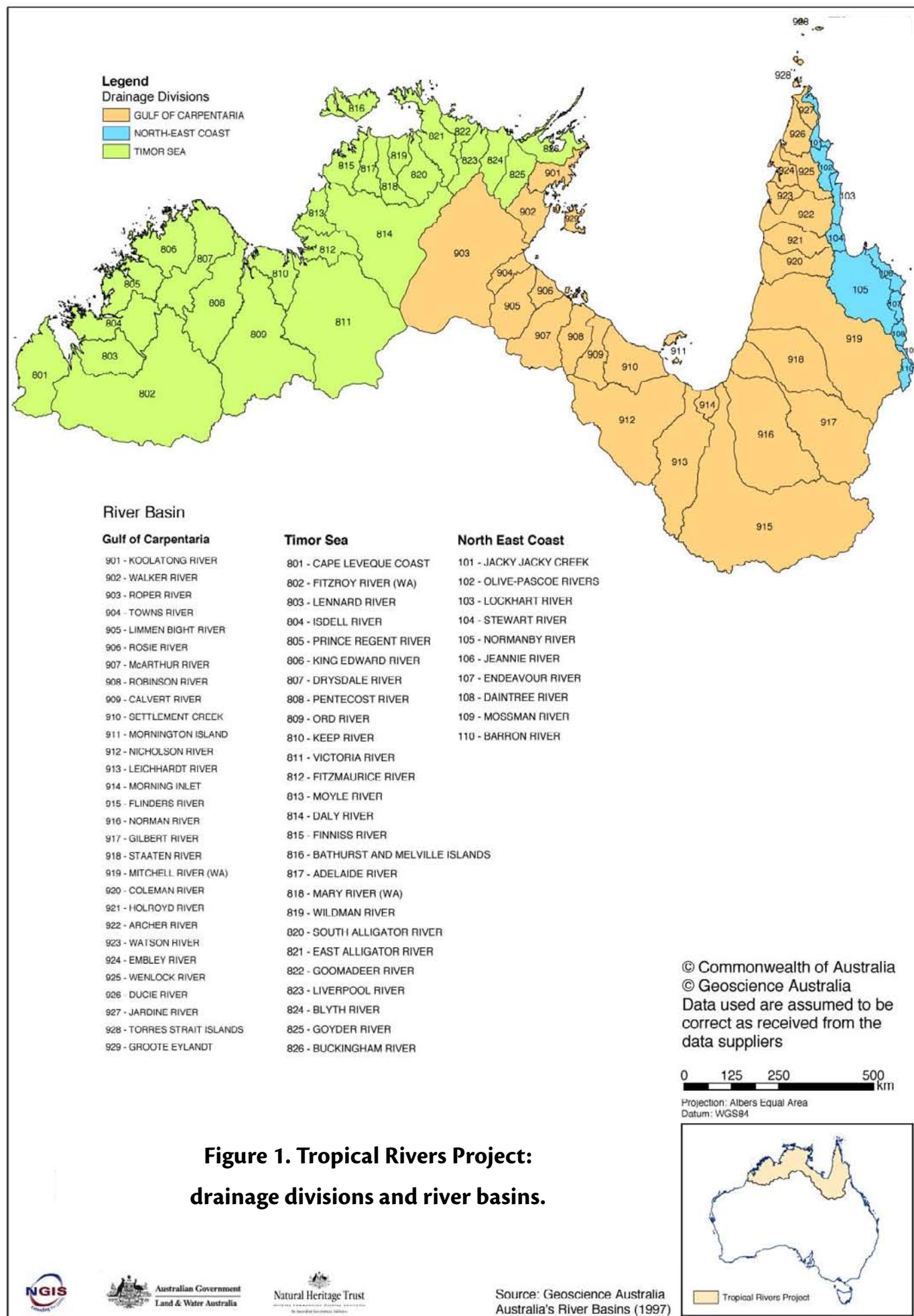
The outputs and deliverables produced from this project are:

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- a printed document (on which this report draws heavily) that presents the outputs in map form, details data collation or synthesis methods used and includes a metadata appendix (Appendix 1) of all data sets collated
- a summary document suitable for publication as a colour brochure that precis what is known about Australia's tropical rivers.

1.2 Project area

The project area was defined on a broad scale as that part of Australia taking in the coverage of north-flowing tropical rivers. The assessment region included all catchments draining into the Timor Sea and Gulf of Carpentaria drainage divisions, in addition to Bathurst, Melville, Groote, Welesley and Mornington islands. The region stretches from Cape York to the Kimberley, across north coastal Queensland, the NT coast and north-western coastal WA. This initial scope was extended during the project to include part of the North East Coast Drainage Division (north of Cairns) taking in the tropical east coast of Queensland.

Figure 1 is a map of the project area showing the drainage division boundaries and listing the names of river basins.



2 Project methodology

This section of the report discusses the project methodology adopted for data collection, evaluation, processing and output. In general, the methods used for data collection were adopted on a project-wide basis, although specific issues relating to individual State and Territory requests did arise and are also reviewed here.

2.1 Data collection

Identification of potential source data custodians was undertaken at the beginning of the data-collection phase. The following broad groupings were used as the starting points to ascertain initial points of contact:

- national data custodians (compiled by the NGIS representative in Canberra). These included the existing databases of previously compiled data sets at the Department of Environment and Heritage and the National Land and Water Resources Audit (NLWRA), as well as large Australian Government custodians such as Geoscience Australia (GA).
- State data custodians (compiled by NGIS in Perth and the sub-consultant representatives in the NT and Queensland). Enquiries within each State were not limited to recognised State government authorities, and were extended to include the less-obvious sources such as private companies, university and research organisations, and local councils.

The potential data custodians identified were initially approached by telephone to:

- encourage their active participation
- identify the appropriate personnel to contact
- make an initial assessment of data of interest
- discuss licensing issues in broad terms
- discuss issues relating to sensitive data and metadata.

These telephone calls were followed-up with emails confirming the phone discussions and attaching:

- NGIS request letter
- LWA letter of support

- map of project area
- checklist of themes of interest.

The responses received by data custodians varied significantly and were complicated by a number of issues relating to the initial understanding of the project aims, the willingness to cooperate and licence agreements.

2.1.1 State approach

The Tropical Rivers Project takes in broad areas of WA, the NT and Queensland. Because of the potentially large number of custodians spread out over three States, and the need for an in-depth understanding of the systems and procedures that operate in each of these jurisdictions, the task of data collection was subdivided according to State, and responsibility was then allocated to the local sub-consultant.

Northern Territory

Ecobyte Systems was allocated the task of collecting the NT data. Table 2 lists the custodians of NT spatial data.

The full report produced by Ecobyte Systems accompanied the final report to LWA. That report outlines in detail the data-collection phase within the NT, including the custodians contacted, the responses received and a summary, by theme, of the data sets and metadata collected.

Western Australia

Data collection in WA was undertaken by NGIS consultants in Perth. Table 3 list the custodians of WA spatial data.

A summary report was provided in the final project report to LWA. That report outlines in detail the data-collection phase within WA, including the custodians contacted, the responses received and a summary of the data sets and metadata collected by theme.

Queensland

GHD was allocated the task of collecting the Queensland data. Table 4 lists the custodians of Queensland spatial data.

A summary report was provided in the final project report to LWA. That report outlines in detail the data collection phase within Queensland, including the custodians contacted, the responses received and a

summary of the data sets and metadata collected by theme.

2.1.2 National approach

A two-pronged approach was adopted to collect national data sets. Firstly, to ascertain and collect the data already accessible to the Department of Environment and Heritage (DEH) through the Environmental Data Directory (EDD) and the

Table 2. Custodians of Northern Territory spatial data.

Agency/land council	Division/department
Indigenous Areas Protection Authority	
Australian Defence Force	Defence Estate Military Geographic Information
Bushfires Council of the NT	Darwin
Department of Community Development, Sport and Cultural Affairs	Museums and Art Galleries of the NT
Charles Darwin University	Faculty of Education, Health & Science
Cooperative Research Centres	Tropical Savannas CRC
Commonwealth Scientific and Industrial Research Organisation	Tropical Ecosystems Research Centre
Department of Business, Industry and Resource Development	Aquaculture Fisheries Mines & Energy – NTGS Primary Industries
Australian Government Department of the Environment and Heritage	Environmental Research Institute of the Supervising Scientist
Department of Infrastructure, Planning and Environment	Biodiversity Unit Land Administration Land Information Weeds Management Conservation & Natural Resources
Northern Territory Land Councils	Northern Land Council

Table 3. Custodians of WA spatial data.

Agency/organisation	Division/department
Agriculture WA	
Department of Conservation and Land Management (CALM)	CALM Estate
Department of Environment, Water and Catchment Protection	(formerly Waters and Rivers Commission)
Department of Fisheries	
Department of Indigenous Affairs (DIA)	Heritage and Communities
Department of Industry and Resources (DOIR)	Geological Survey of WA
Department of Land Information	Remote Sensing Services
Fire and Emergency Services (FESA)	
Department of Planning and Infrastructure (DPI)	
Main Roads Western Australia (MRWA)	
National Native Title Tribunal	
Kimberley Land Council	
Local councils (Shire of Broome; Shire of Derby/West Kimberley; Shire of Wyndham/East Kimberley; Shire of Halls Creek)	
Private companies (Woodside, Chevron Texaco, Western Metals, Rio Tinto)	

Australian Natural Resources Data Library (ANRDL) database, and secondly to contact known national agencies and data custodians.

Following consultation with LWA, a list of important data sets relevant to the project themes was drawn up and a spatial search made of what was available in the EDD and ANRDL. The list was then further subdivided into those data sets that were definitely required, and those that might require further investigation before they were obtained. Metadata for these data sets were also obtained.

Table 5 lists the custodians of spatial data available at a national level.

A summary report was provided in the final project report to LWA. That report outlines in detail the data collection phase at a national level, including the custodians contacted, the responses received and a

summary of the data sets and metadata collected by theme.

2.1.3 Licence agreements

The ANZLIC Model Data Access and Licence Agreement <<http://www.anzlic.org.au/policies>> was accepted as the preferred protocol to be adopted for data exchange between State and Australian Government agencies. During the data-collection phase, all oral and written requests included citation of the model agreement as the preferred documentation.

The responses to this request were markedly different in each of the States. In the NT, the approach to licensing of data by different agencies varied widely. In some cases, such as with the Northern Territory Geological Survey, data were readily available and there were no license requirements. The NT Department of Infrastructure, Planning and

Table 4. Custodians of Queensland spatial data.

Agency/Organisation	Division/Department
Environmental Protection Agency (EPA)	
Greening Australia	
Queensland Fisheries	
Wet Tropics Management Authority	
CSIRO	Townsville Research Centre
Department of Natural Resources and Mines (DNRM)	
Local authorities (various)	
Mining companies (Mt Isa Mines, Comalco).	

Table 5. National Spatial Data Custodians.

Agency/organisation	Division/department
Geoscience Australia	
Department of Defence	Defence Imagery and Geospatial Organisation
National Land and Water Resources Audit	
CSIRO	Land and Water Sustainable Ecosystems
CRC for Freshwater Ecology	
CRC for coastal zone, estuary and waterway management	
Australian Greenhouse Office	
Bureau of Rural Sciences (BRS)	
National Oceans Office	
Bureau of Meteorology	
Australian Hydrographic Office (Navy)	
Department of the Environment and Heritage	

Environment (DIPE) proved to be the most concerned about licensing issues, and a data agreement was negotiated between DIPE and LWA for the specific digital data sets provided by that group.

In WA, data were generally released only under existing standard State agency agreements, which placed limitations and restrictions on the subsequent use of the data by DEH. The practice of signing existing State agreements with a view to developing an umbrella agreement during the next phase of the project was suggested by the WA Land Information System (WALIS) as a way of ensuring that some data were released to DEH for review.

In Queensland, where licence agreements were necessary the approach taken was similar to that used in WA.

2.2 Data evaluation

The methodology for evaluation of the data sets collected was based on a number of factors relating to both a data-quality (GIS) perspective and a tropical rivers technical (expert opinion) perspective. The data were reviewed using the following criteria:

- the relevance of a data set's theme and content to the overall Tropical Rivers Project target themes
- data quality
- metadata availability and quality
- contemporaneousness of the data
- scale/resolution of the data
- proportion of coverage of the data within the defined project area.

These factors were used in combination to assess the value of each data set and to decide whether it should be included in the output database of the project.

2.3 Data processing

Data were received in a variety of different formats and projections, and consequently a significant amount of processing was required to convert to a common format and spatial coordinate system. Common data themes from a number of sources were also received, which required merging into a single theme layer, and clipping to the Tropical Rivers Project boundary.

2.3.1 Data conversion

The following procedures were adopted to convert data to a common format and spatial coordinate system.

- Vector data were converted to ESRI shapefile format.
- Raster data were, where possible, converted to ArcInfo grid format.
- In a number of cases, non-spatial databases were linked to existing spatial files through spatial joining and exported to 'shapefile' format.
- All data sets were transformed to the required spatial coordinate system (WGS84/GDA94 datum in geographic (non-projected) coordinates). It was a requirement that all shapefiles be linked to an associated projection (.prj) file.

2.3.2 Data merging and clipping

One of the aims of the project was to create a set of single-theme layers that represent the highest quality and most complete coverage within the project area. Data collected from various sources had to be merged in order to achieve this aim.

The process of merging data sets was achieved only for base themes (eg. streamlines, geology, regolith), and, in general, was not appropriate for derived or specialised themes. In some cases, the highest quality and most complete coverage was already present in a single theme (eg. many of the EDD and ANRDL data sets) and so merging was not required.

Where merging of data sets was undertaken, a specific and pre-defined procedure was adopted to ensure consistency of output data sets. The following procedures were adopted:

- Data sets with a common theme collected within the same State were first merged into a single theme layer (eg. in WA numerous 1:250,000 scale geology polygon shapefiles were merged into a single data set). This work was completed by the individual State representative sub-consultants.
- Once all data had been received by NGIS in Perth, a metadata review was conducted to establish the highest quality (most current, highest resolution, widest coverage) data sets to select for inclusion within the project output themes. Common theme layers were then merged into a single theme layer covering the Tropical Rivers Project area.

- Where data sets from different origins were merged together, a 'Source' attribute field was added to the shapefile to track the primary data custodian and retain a link to the source metadata.

Many of the original and merged data sets were also clipped to the project boundary to ensure consistency of coverage, and to help in the data analysis. However, data sets that were received as nationwide coverages were generally retained as such. Clipping of these data sets was required only where the size of the data set precluded efficient loading and analysis within the ArcGIS desktop environment.

2.4 Metadata

Quality metadata are a vital component required for all spatial data sets and need to be constantly maintained and updated. The majority of data custodians have supplied metadata with their own data sets, although for some of the smaller State agencies this is still not being enforced adequately.

For all data sets newly created for the Tropical Rivers Project, an associated metadata file was created using the ANZMeta Editor (an editor that allows the creation and maintenance of ANZLIC ANZMeta v1.2 metadata in the ESRI ArcCatalog environment).

In addition, a folder containing the source metadata files was included as a reference. Where existing data sets were not modified but still included in the final output database, the source metadata were also included in the output.

2.5 Data outputs

Data outputs were organised into the major project themes and sub-themes (Table 1) within the five major report themes as follows:

1. Typology and classification
2. Water resources
3. River condition
4. Biodiversity
5. Estuary condition.

The final Tropical Rivers Project GIS database supplied on DVD was organised into an identical folder hierarchy to ensure consistency between the final report and the digital database. Each theme folder contains the newly created metadata file (XML format) together with a folder containing the source metadata (in the format as originally supplied; commonly HTML, XML or TXT).

3 Analysis and assessment

3.1 Project theme classification overview

An approach was adopted whereby the project target themes were grouped into broad reporting classifications based on the type of data and the expected purpose and usage within the broader research into Australia's tropical river systems.

Each of the report theme sections provides a detailed description of the data sets that were collated for the final project output database. A reference to Appendix 1. Metadata denoted "MRxxx" (where 'xxx' is a numerical reference to the "Mref" field of Appendix 1) is also given, so that the textual information can be easily linked to the metadata.

The quality (scale or resolution, currency, coverage) are discussed, as well as the gaps (spatial and thematic) in the knowledge base resulting from the information being either not made available for the project or non-existent.

Further technical discussion and expert opinion on the future actions relating to the known status of the data, based on the outcome of the data availability and gap analysis have also been included.

Recommendations for further actions and/or work programs are highlighted in ***bold italics*** throughout the report.

3.2 Typology and classification

3.2.1 Introduction

This reporting theme includes information that provides the physical and management context for the subsequent project target themes. It provides details on the region's physical features (streamlines and catchments, coastline, soils, geomorphology, geology, hydrogeology, regolith and elevations), land use and tenure, boundaries (political and Indigenous), basic

infrastructure (including mine-site information) and recent bushfire history.

3.2.2 Data available

Indigenous

Indigenous heritage sites and community and outstation data were requested from State custodians. No such data were available in WA and Queensland, because of sensitivities associated with them. In the NT, data were received for Indigenous land under claim (MR114), Indigenous freehold (MR113) and major and minor Indigenous communities (MR156). Metadata only were obtained for NT sacred sites (MR157) and WA sites and communities (MR158–159). No data or metadata were received from Queensland. National data received included the ATSIC (Aboriginal and Torres Strait Islander Commission) Boundaries 2001.

Catchments

Several catchment data sets were received. Named catchment boundaries within the Tropical Rivers Project are shown in Figure 1. These were generated from the GA drainage divisions and basins data set (MR123) clipped to the project boundary. The former Australian Water Resources Council (AWRC) formally defined the drainage divisions and river basins in the early 1960s, and, with minor modifications, this has been the basis for the study of Australian hydrology since.

A much more detailed polygon data set containing nested catchments and sub-catchments for the Australian continent (MR125) down to 125 m resolution was also obtained. The catchments have been determined from the version 2 of the 9-second continental digital elevation model (DEM) produced by the Australian National University's Centre for Resource and Environmental Studies for AUSLIG, and show close but not complete agreement with the Australia's River Basins data from GA (AUSLIG 1997). Appendix 3 shows the resolution of the

nested sub-catchment layer compared with the main catchment boundaries.

A number of other catchment data and metadata sets (MR126–130, 132–135) were received from the States, but these offer no added value to the project and are probably derived from the national data sets.

Table 6 gives statistics including the area, annual run-off and annual outflow for the catchments contained in the project area.

Coastline

The national coastline data were well represented, with a number of data sets received, and varying in scale from 1:100,000 to 1:5 million (MR119–120). Data at the highest available resolution of 1:100,000 were selected for use for the project. The coastline component of the “Coast – 100k” product is primarily sourced from the 1:100,000 scale national topographic map series produced by AUSLIG and the Royal Australian Survey Corps.

Table 6. Tropical Rivers Project catchment statistics by drainage division. Source: NLWRA (2000a).

Basin name	Basin ID	Area (km ²)	Outflow (GL/year)
Gulf of Carpentaria			
Koolatong River	901	7910	1700
Walker River	902	9724	3350
Roper River	903	79599	5000
Towns River	904	5428	500
Limmen Bight River	905	15926	1660
Rosie River	906	5042	540
McArthur River	907	20014	4200
Robinson River	908	11371	1000
Calvert River	909	10040	1000
Settlement Creek	910	17349	2720
Mornington Island	911	1245	257
Nicholson River	912	51762	10040
Leichhardt River	913	33480	2010
Morning Inlet	914	3638	433
Flinders River	915	111163	3030
Norman River	916	50665	2910
Gilbert River	917	47147	5580
Staaten River	918	26243	3600
Mitchell River (WA)	919	73005	12000
Coleman River	920	13103	4200
Holroyd River	921	10373	3860
Archer River	922	14076	4830
Watson River	923	4747	3560
Embley River	924	4758	3190
Wenlock River	925	7581	3370
Ducie River	926	6917	3580
Jardine River	927	3343	2190
Torres Strait islands	928	796	202
Groote Eylandt	929	2362	2000
Timor Sea			
Cape Leveque Coast	801	23920	120
Fitzroy River (WA)	802	96126	5500
Lennard River	803	15199	1130

Basin name	Basin ID	Area (km ²)	Outflow (GL/year)
Timor Sea (continued)			
Isdell River	804	20570	3200
Prince Regent River	805	15854	2930
King Edward River	806	18011	3250
Drysdale River	807	26473	4450
Pentecost River	808	29604	NA
Ord River	809	56095	5100
Keep River	810	11965	500
Victoria River	811	78510	5000
Fitzmaurice River	812	10434	1600
Moyle River	813	7131	640
Daly River	814	53322	6730
Finniss River	815	9532	3000
Bathurst and Melville islands	816	7518	3300
Adelaide River	817	7486	2000
Mary River (WA)	818	8090	2400
Wildman River	819	4826	800
South Alligator River	820	11927	6600
East Alligator River	821	15883	6900
Goomadeer River	822	5682	1140
Liverpool River	823	8941	3810
Blyth River	824	9212	1860
Goyder River	825	10382	2120
Buckingham River	826	9596	2330
North-east Coast			
Jacky Jacky Creek	101	2972	1930
Olive–Pascoe rivers	102	4279	4250
Lockhart River	103	2924	1630
Stewart River	104	2748	1160
Normanby River	105	24900	5950
Jeannie River	106	4047	2420
Endeavour River	107	2123	1780
Daintree River	108	1971	3560
Mossman River	109	553	687
Barron River	110	2212	1150

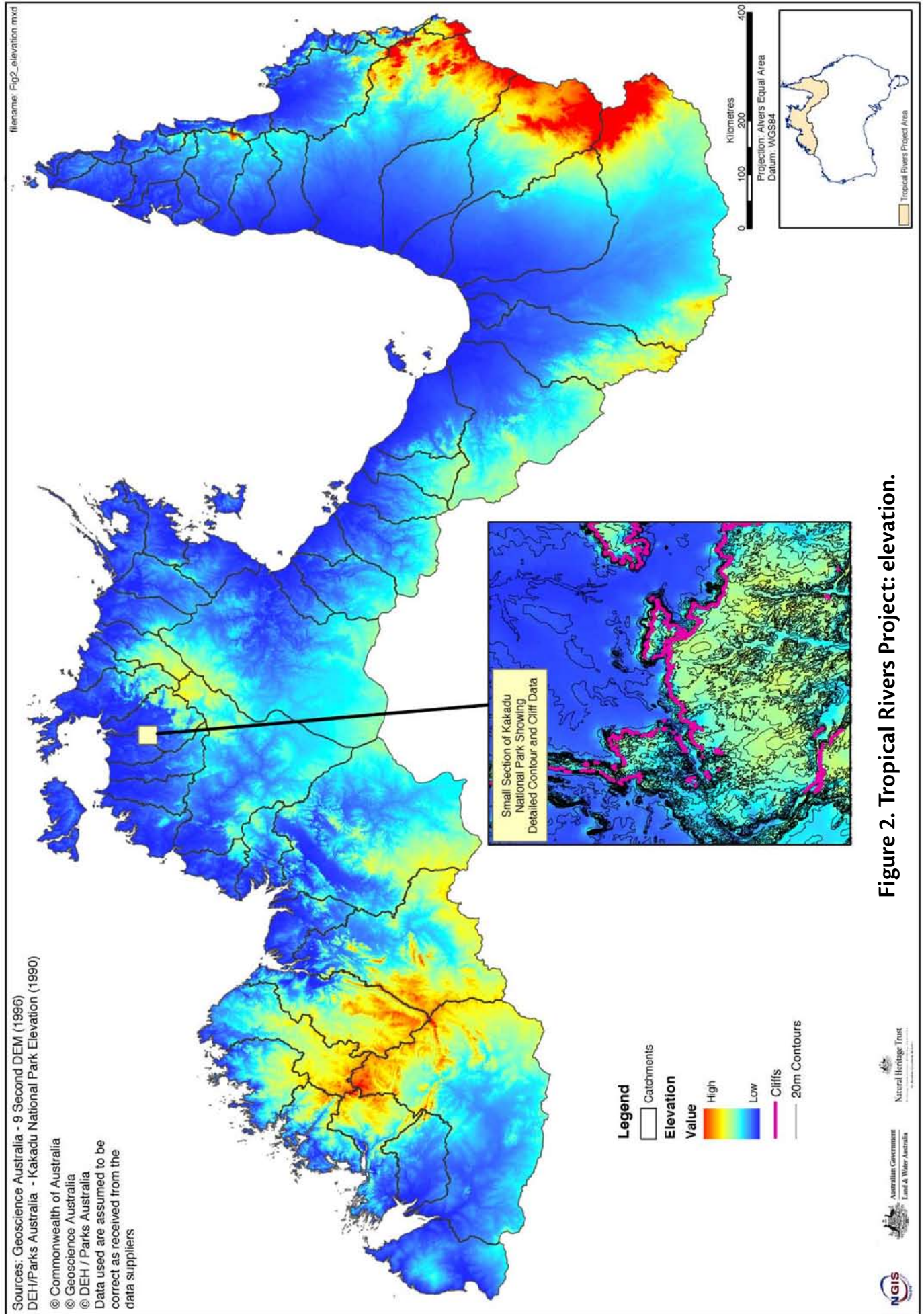


Figure 2. Tropical Rivers Project: elevation.

Data processing to create a polyline shapefile from the original polygon file was undertaken, and was used for many of the hard-copy map outputs.

Elevation

The national DEM at 9-second (approximately 250 m) resolution was obtained (MR22), and covers the entire project area. Figure 2 shows the coverage of elevation in the project area at this scale.

Digital elevation data at a higher resolution (1-second and 3-second) exist for much of the project area from GA (which is the distributor for the Defence Imagery and Geospatial Organisation (DIGO)). However, many of these data are restricted and/or too expensive to obtain for this phase of the Tropical Rivers Project (the price quoted was \$108 per tile for the first 9 tiles and \$54 for each tile thereafter, giving a total cost of approximately \$19,600 for the 354 1-second tiles and \$23,700 for the 430 3-second tiles that are within the project area). A sample data set of topographic data (1:50,000 and 1:100,000 scale) and high resolution DEM was provided, but further investigation of the format of these data is required.

Contour data sets at 50 and 100 m intervals were also received (MR23). These data sets have been derived from the 9-second DEM and their resolution is therefore limited to approximately 250 m.

More-detailed contour data are known to exist from GA — from the “Mapdata 100k” data set that covers part of the project area including most of Cape York and a large part of Arnhem Land. Once again the cost of these data prevents their being obtained for this phase of the project (the price quoted was \$108 per tile for the first 10 1:100,000 tiles, \$54 each for the next 90 tiles and \$27 each thereafter, giving a total cost of approximately \$6200 for the 110 tiles within the project area).

GA is known to have a project underway to capture 20 m contours from the 100k map series, which covers those parts of the project area that are not covered by either the Mapdata 100k data set or the DIGO 1:50,000 topographic series. Information on pricing and availability of these data has not yet been released.

Project area coverage of the 1- and 3-second DEM, Mapdata 100k and 20 m contours are shown in Appendix 2.

Detailed elevation data have been obtained for a part of the Kakadu National Park (MR30), including 20 m contours, cliff lines and spot height data sets. The coverage of these data is shown in Figure 2, which also shows a magnified inset of a small part of the area, with cliff lines and contours overlain on the 9-second DEM.

Many data sets derived from the 9-second DEM were also obtained from the ANRDL. These files are mainly CSIRO Land and Water ArcInfo grid coverages related to slope, erosion, relief and distance, and path length to rivers and ridges (MR24–44).

Fire history

Fire regime was one of the project target themes. Destruction of catchment and riparian vegetation by fire is a continuing process that requires documenting through spatial data sets showing fire scars.

The major source of fire-history data for all of northern Australia is the WA Department of Land Information (DLI). Polygon fire scar history data derived from interpretation of NOAA–AVHRR satellite imagery (fire scars are located using AVHRR channel 2 on daytime NOAA-16 images) and updated monthly data are available for free download from the DLI website for NT and WA data. The Queensland data are available only by request, and the cost (quoted at \$500 for the 2002–03 data) was considered to be beyond the project budget.

The monthly data for WA and NT from January 2002 to August 2003 were obtained, and merged into a single data set with dates added as an attribute field (MR96). These data are shown in Figure 3.

In addition, data sets were received from the NT for fire frequency during 1993–2002 (MR98), comprising a grid cell map of the top end of Australia showing the number of years fires have been identified in each cell. The northern Australia fire scar temporal data series at 0.01 degree resolution (MR97) was also obtained. These data are derived from the analysis of monthly normalised difference vegetation index (NDVI) change.

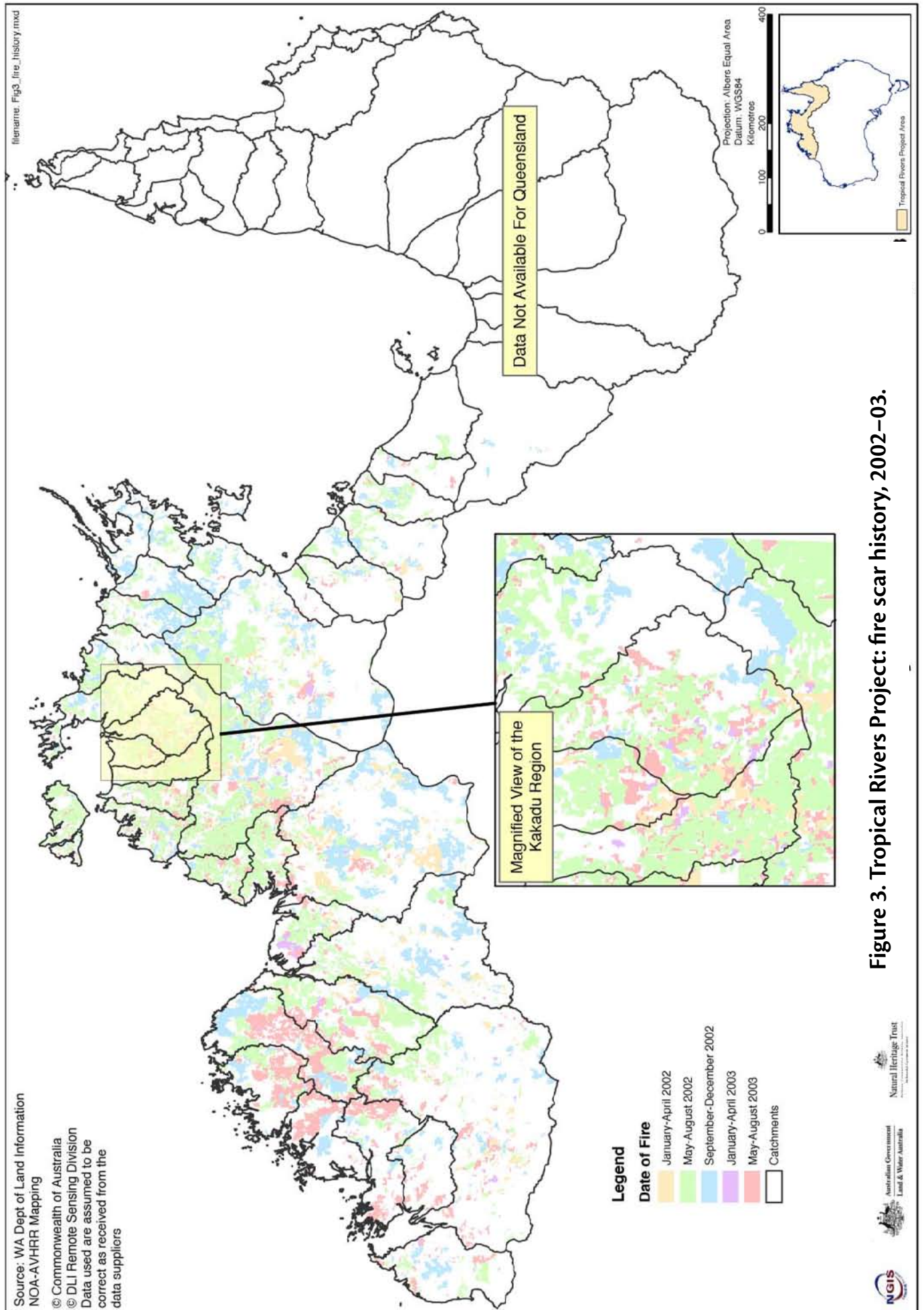


Figure 3. Tropical Rivers Project: fire scar history, 2002–03.

Geology

Geological data are readily available at low resolution (1:2.5 million) over the entire project area (MR13), but at larger scales there is still only partial coverage of digital data available (although hard-copy maps can be sourced for most of the area). Coverage at 1:100,000 scale exists for only limited parts of the project area (< 5% total coverage). Data at this scale were obtained for a small section of WA (MR5), with additional metadata only obtained for Queensland (MR17). Coverage at this scale is too sporadic to be of any real benefit to the project at this stage.

Geological polygon data at 1:250,000 scale cover approximately 75% of the project area, and were obtained from the State geological surveys (WA ref MR6; NT ref MR9 for series 2 data) and GA (Queensland and NT series 1 data ref. MR26). These data were received in individual 1:250,000 tiles, with each tile containing a number of shapefiles for geological regions (polygons), structural data (faults and lineaments line data) and point mineral locations and structural measurements. The polygon data were extracted and merged into a single shapefile for inclusion in the final output database, but point and line data were not included in the processing.

Data at 1:500,000 were also received from WA in the form of a complete State-wide coverage (MR7), but were not obtained at this scale for NT and Queensland.

Geomorphology

A relative relief and landform map of Australia (MR94) was clipped to the project boundary. It shows landform classifications at a large scale (1:2.5 million) (Figure 4). This data set was created using the descriptions of landscape found in the 10 handbooks of the *CSIRO Atlas of Australian Soils* and the soil-mapping units found in the digital *Atlas of Soils*.

A detailed data set covering the Kakadu area (see inset area on Figure 4) in the NT was also received (MR95).

Hydrogeology

A nationwide coverage of the principal hydrogeological divisions of Australia at a scale of 1:5 million was obtained (MR252). This data set defines the sedimentary basins and fractured rock provinces that make up the regional hydrogeological divisions

of Australia. These hydrogeological provinces have been further classified with regard to either a fractured rock province or a sedimentary basin, distribution of aquifers within the province, and aquifer productivity.

A more detailed State-wide coverage of WA at a scale of 1:2.5 million was also received (MR208). It provides information on aquifer type, lithology and age, and whether the aquifer is confined or unconfined.

Infrastructure

A number of base infrastructure data sets have been collected from the various State and Australian Government custodians. The major provider of national infrastructure data sets was GA, with much of this information coming from the “Geodata Topo 250k” data set, which contains data for road, rail and air transportation as well as built-up areas, localities and homesteads, utilities, pipelines, fences and powerlines. The coverage of information in this data set is not comprehensive for many of the themes included.

Individual themes from 1:250,000 tiles were extracted and merged into single layers, and then clipped to the project boundary. The following infrastructure layers were obtained:

- *Buildings* — this point layer depicts permanent and walled-roofed constructions or the ruins of such constructions. Buildings are not shown in built-up areas (MR150).
- *Pipelines* — the pipeline layer is a linear network representing pipelines that carry water, oil, gas and/or other materials. Pipelines are not shown in built-up area polygons (MR153).
- *Utilities* — these point and line data sets show a range of purpose-built features, including aerial cableways, mines, fences and yards, storage tanks, dams and landmarks (MR151).
- *Waterpoints* — this point layer shows water features such as bores and springs that exist independently of the drainage network (MR149).
- *Road transport* — The national data set (GA – MR142) contains roads classified by type. It also includes additional attributed information such as pavement and median strip status. A State road centreline data set covering part of the project area was also received in WA (MR143), but the level of

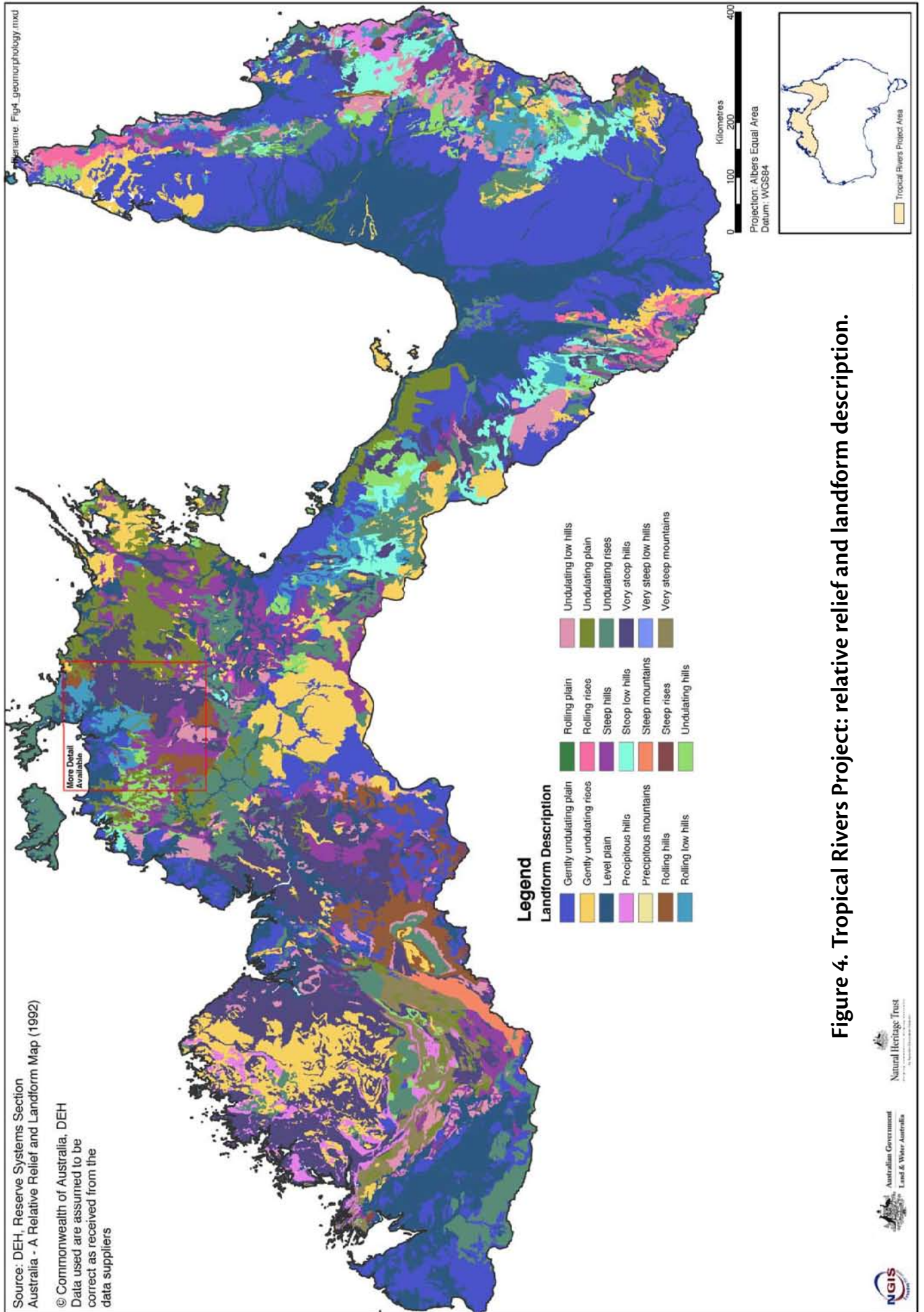


Figure 4. Tropical Rivers Project: relative relief and landform description.

detail was not sufficient to consider merging with the national data set.

- *Rail Transport* — Freight and passenger railway networks are given, together with the status of the railway, the number of tracks and the rail gauge.

Tenure

The “Australia, Public and Indigenous Land” (TENURE 250K) (MR104) data set shows boundary and attribute information for parcels of public, Aboriginal and Torres Strait Islander land in Australia that are greater than 40 ha. Categories include: nature conservation reserves; forestry reserves; Indigenous land; water reserves; defence reserves; and mining reserves. Attribute information includes (as applicable to the type of reserve): State and reserve name; reserve type; administering authority; size (in ha); identification number; and dates of original proclamation and latest update. Tenure classifications from these data are shown in Figure 5. It should be noted that the information was first published in 1992 and is therefore outdated.

Land use

Several data sets depicting land use and land-use change within the project area were obtained. Useful national coverages include the NLWRA’s 1996–97 “Land Use of Australia”, Version 2 (MR101), which shows agricultural and non-agricultural land uses for April 1996 to March 1997 with a 0.01 degree cell size. The land-use classifications include cropping and grazing, farm and production forestry, horticulture, irrigation, nature conservation, residential, transport and communication (Figure 6).

Another important data set is the “Agricultural Land Cover Change datasets — Land cover themes 1990” (MR102) which shows the extent of woody vegetation (native and exotic vegetation ≥ 2 m tall with $\geq 20\%$ crown cover) in Australia’s more intensively used agricultural areas in 1990–91; the rates of clearing of this woody vegetation and tree planting 1990/91–1995, and the reasons for clearing and planting; and the types and biomass of vegetation cleared.

This data set can be used to show land-cover change (clearing and regrowth), but the coverage includes only a relatively small section of the project area (Figure 7).

Other national land-use theme data sets that were obtained include World Heritage Listed areas (MR105), land tenure and land-use change in Australian rangelands (1956–1996) (MR106–108).

Several State land-use theme data sets were also received, and include land use in WA (1997) (MR109), CALM Estate (Department of Conservation and Land Management controlled land in WA for 2003) (MR115), Northern Territory land-use management mapping (LUMP) (MR111), and two metadata only sets for specific catchment areas in Queensland (MR116–117).

Localities

A national coverage showing localities (population centres and linked geographical features) was obtained from the GA “Geodata Topo 250k” data set, and clipped to the project boundary (MR159).

Mine sites and mineral occurrences

Data relating to mining activity were readily available at both national and State levels. The “Ozmin” database (spatially linked to point objects) contains geological and resource information for Australian mineral deposits, with over 1000 major and historically significant mineral deposits for 60 mineral commodities (including coal).

A useful and very detailed data set for abandoned mine sites was received for WA. Over 80,000 abandoned mining activity reference points are mapped, and are richly attributed (including linked image files) (MR154). This information was collected from extensive field surveys where accurate GPS locations have been logged. The very high level of detail captured (down to the small-workings level) makes this data set critical for studying catchment disturbance and point-source pollution.

Regolith

Regolith mapping has become increasingly important within the resources sector over the past decade, and data are now readily available for the entire project area. The national coverage at 1:5 million (MR2) is probably at too coarse a scale to be of value for many purposes, but the WA data set at 1:500,000 (MR4) is more detailed. Regolith data contain important information on dynamic landform regimes (erosional and depositional) and landform classifications.

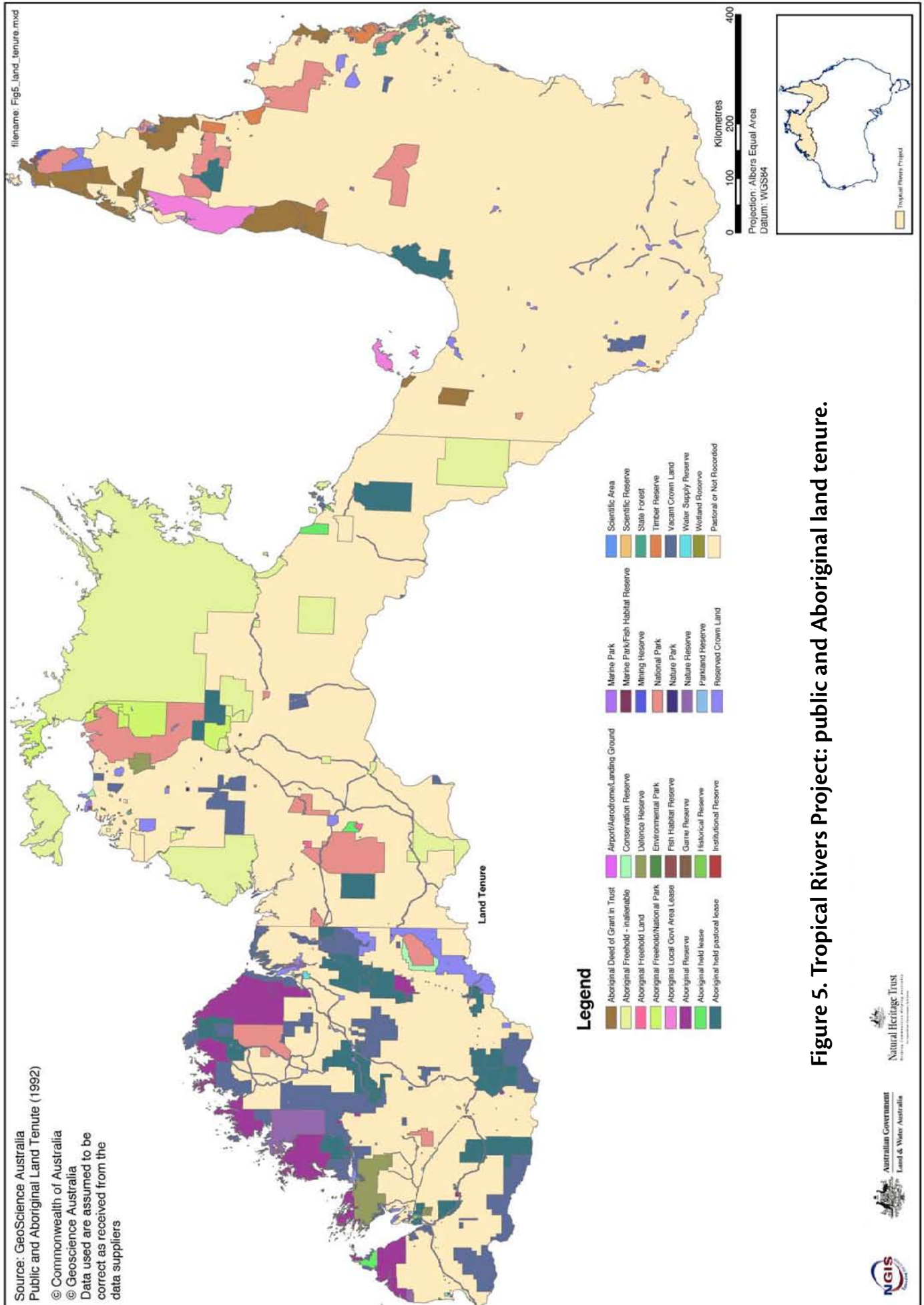


Figure 5. Tropical Rivers Project: public and Aboriginal land tenure.

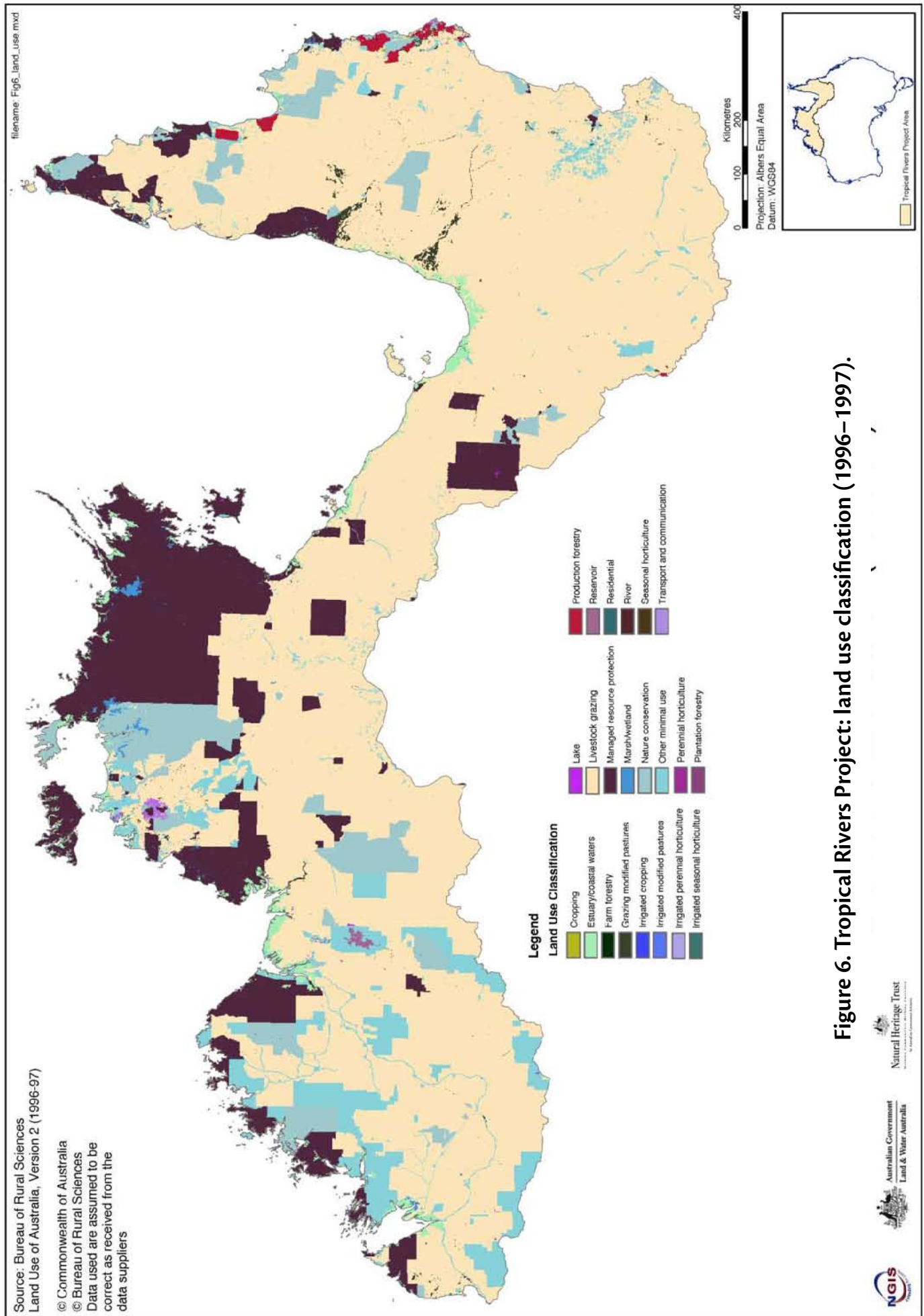
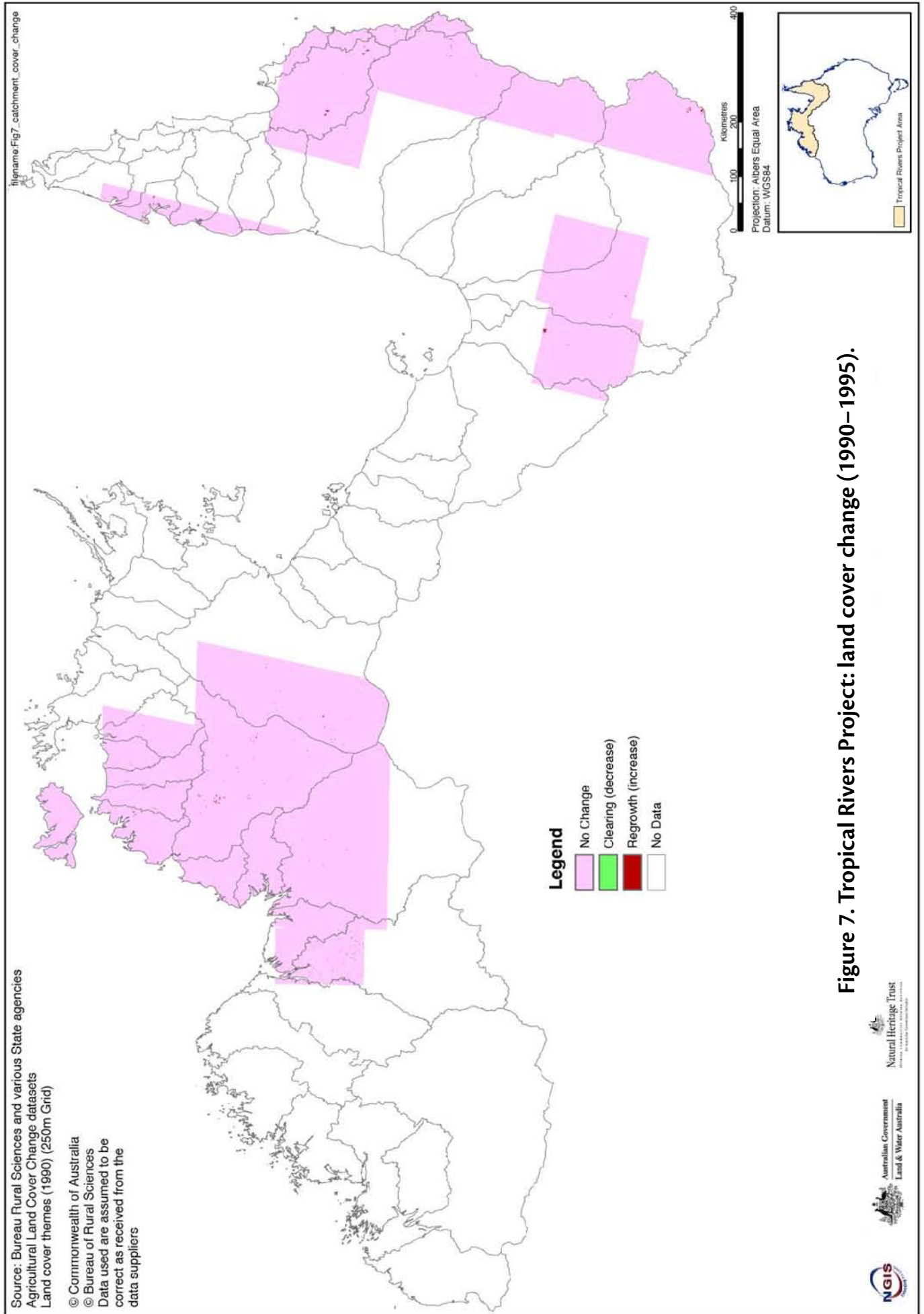


Figure 6. Tropical Rivers Project: land use classification (1996-1997).



Soils

Soil classifications are readily available at both national and State levels. The CSIRO *Atlas of Australian Soils* (MR56) is a national coverage at 1:2.5 million scale, and is useful at a broad level, but the digital data are based on the paper map, and should not be considered more accurate than details provided on the original *Atlas of Australian Soils*. Figure 8 shows the coverage and detail of this information.

Soil mapping received from the NT (MR84) appears to be an extract from the national atlas. However, the Queensland Soil Survey and Agricultural Suitability of Cape York Peninsula (MR86), which formed part of the Cape York Peninsula Land Use Strategy (CYPLUS), is captured at a larger scale (1:900,000). Several related metadata records were also supplied (MR87–92). No soil data were obtained for WA.

3.2.3 Gaps in data

Indigenous heritage and community data are known to exist in State/Territory agencies but (with the exception of NT data) were not made available for use within this project.

Adequate data exist for some of the physical features of the region, including catchment boundaries and the broad classifications of geomorphology and soil type. However, although low resolution (9-second DEM) elevation data were obtained for the project area, detailed high-resolution DEM and contour data (1-second and 3-second), which are known to exist through DIGO, were not made available for this project. This information may be critical for some aspects of tropical rivers research and it is recommended that it be obtained in future phases of the broader program.

Recommendation 1. Elevation data in the form of the 9-second digital elevation model (DEM) are at too coarse a resolution to be useful for detailed study of river systems. The existing 1- and 3-second DEM, available from the Department of Defence (through Geoscience Australia), should be used.

Coarse scale geological data (1:2.5 million) are available for the entire region, but coverage of finer scale geological data (1:250,000 and 1:100,000) in

a digital format was incomplete (printed maps are still available for a large part of the area but were not sourced for this project). This also applies to the regolith and hydrogeology data themes. Mine site and mineral occurrences are well documented nationally, but abandoned mining activity data were available only in WA.

Monthly fire history data are now readily obtainable for WA and NT from a free website, but the value of this information is maintained only if the data are updated regularly. There are known to be data for Queensland, but due to cost these were not obtained for the project (a quotation of \$500 for the 2002 and 2003 data was received from DLI).

Recommendation 2. Fire scar history data for Queensland need to be obtained to complete the coverage of the project area. Monthly updates (appended to the existing data set) also need to be undertaken to maintain currency.

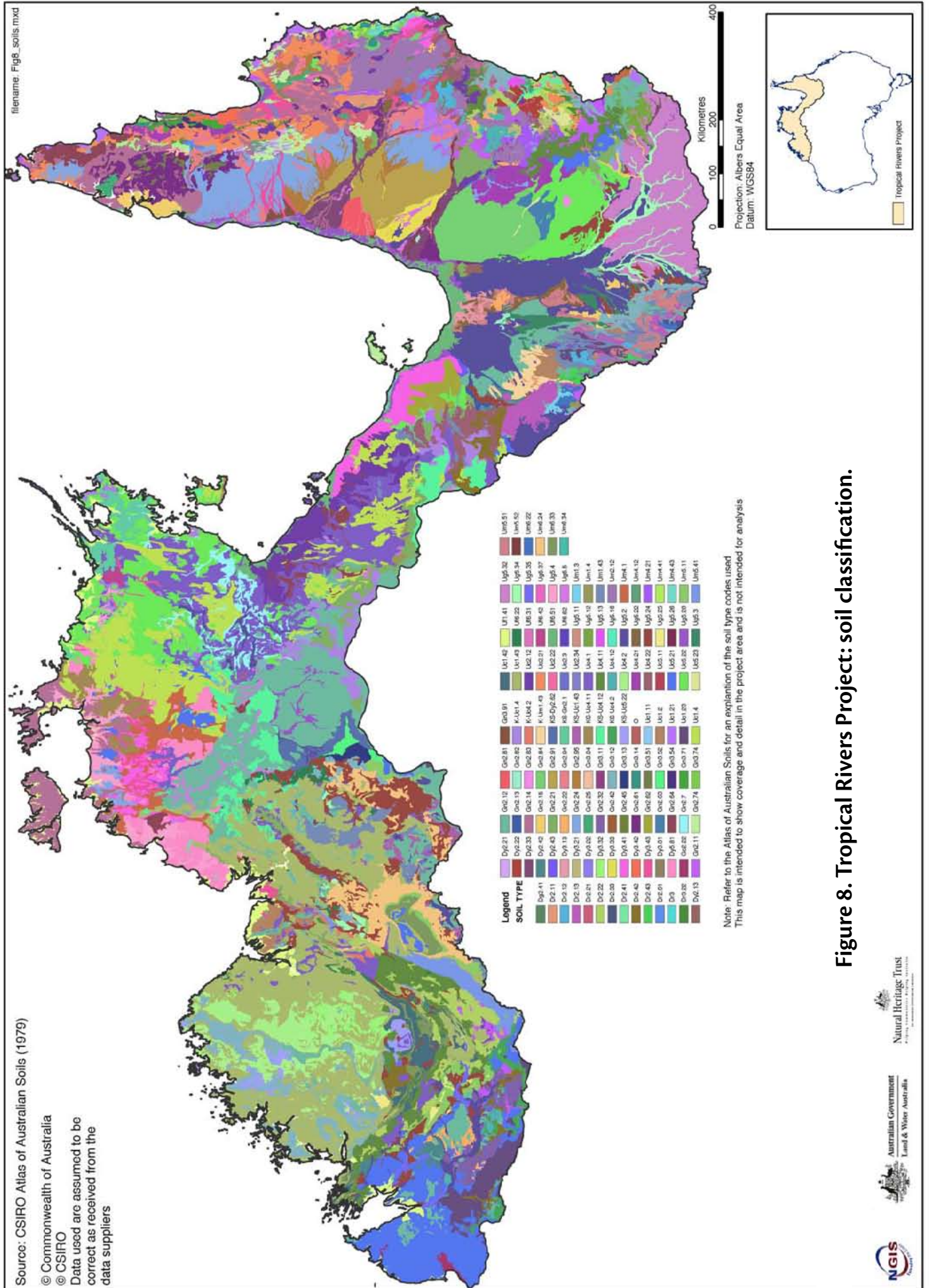
Infrastructure data are generally available at a coarse scale (1:250,000) for the entire project area, and the majority of the information is current. Detailed access-track data have not been obtained (this information may be captured with the DIGO 1:50,000 topography).

Land use and tenure data sets were readily available for the project area, but many of these data are now several years old (dating back to 1992). Given that some of these data are dynamic, the currency needs to be verified and the availability of more up-to-date data needs to be further investigated.

Data on soil condition have been noted nationally as a gap in soils data sets (NLWRA 2000b) and are lacking for the study region.

3.2.4 Data quality

Data sets for streamlines, digital elevation models and geology have complete coverage, but are less suitable because mostly they are available at a scale that is considered too coarse for this project. There are finer scale data available for some features in some areas (eg. for elevation in Kakadu National Park). Data on the location of low-order streams are also less adequate due to the coarse scale of the streamlines data set.



Recommendation 3. Streamline data at the highest possible resolution need to be used. These data could be purchased for a large part of the project area through Geoscience Australia. The two main data sets are the Mapdata 100k (1:100,000 scale) topography and the Defence Imagery Geospatial Organisation 1:50,000 topography.

The delineation of river basin boundaries was based on the AWRC data sets. Although these boundaries are widely used and well recognised, they have deficiencies in terms of accuracy and relevance to drainage and biogeographic setting (Norris et al. 2001). Some of these problems could be resolved by basin maps drawn from more-detailed elevation models.

3.2.5 Discussion and conclusions

In general, the data available for the physical and management context are relatively abundant compared with other themes. Adequate data have been collated for most of the important management context information. Biophysical data are more variable and several future directions can be identified.

- The suitability of two of the most important physical sub-themes — digital elevation models and streamlines — would be greatly improved if they were based on finer-scale data. This is particularly true for the tropical rivers region, which is characterised by very little landscape relief. Better data exist and can potentially be obtained without the need for further data collection. These data are fundamental to many proposed activities of the Tropical Rivers Program, so access to them needs to be resolved/negotiated as a high priority.
- Gaps in higher resolution data on geology and in information on soil condition are recognised, but are not considered high priorities for future directions.

This theme attempted to collate information that presents classifications and typologies. Although some basic physical features — such as geomorphology, groundwater aquifers and soils — have been meaningfully classified at a broad scale across the study region, classifications in other sub-themes — such as wetlands — would likely be of great value for the tropical rivers program. Developing a

spatial classification of wetlands is hampered to some extent by the use of different classification schemes throughout the region. While Queensland has been using an approach for wetlands classification for over 10 years (Blackman et al. 1992), the classification adopted for the *Directory of Important Wetlands* (ANCA 1996) has also been widely used and new classifications continue to be developed (Begg et al. 2001). The adoption of a consistent wetland classification system would greatly assist future efforts to collate wetland data across the region.

Recommendation 4. Current data models and research programs relating to the classification of Australia's tropical wetland habitats need to adopt a consistent approach across the region.

3.3 Water resources

3.3.1 Introduction

This theme documents the water resources in the study region. The climatic data sub-theme describes the factors that determine the amount and seasonal availability of water. Data on quantity and quality of surface and groundwater available and used within each catchment are described. The infrastructure present to modify the flow or extract and divert water is also listed.

3.3.2 Available data

Climate

Historical climate-related data for Australia are readily available as both monthly and mean annual data sets. Temperature, precipitation and evaporation are directly related to catchment run-off and river flow and are therefore important sources of information to the project.

Gridded monthly and annual climate data can be downloaded from the ANRDL (CSIRO Land and Water is the custodian) (MR47–52). These surfaces are derived from Bureau of Meteorology (BoM) data, interpolated to a daily time step and a spatial grid of 0.05 degrees. Monthly and annual meteorological surfaces are temporal averages of 20 years (1980–1999) of daily gridded data at 0.05° spatial resolution.

As an example of these data, the mean annual temperature, rainfall, evaporation and run-off data sets were obtained. Figure 9 shows the coverage of the project area.

The other major source of climate information is the “Various Anuclim 1.8 BIOCLIM climate” data sets (MR54). BIOCLIM surfaces generated for the ASRIS project include annual mean temperature, mean diurnal change, isothermality, temperature seasonality, maximum and minimum temperature for the warmest and coldest periods, temperature annual change, annual precipitation, precipitation for the wettest and driest periods, precipitation seasonality, annual mean radiation, highest and lowest period radiation, radiation seasonality, annual mean moisture index, highest and lowest period moisture index and moisture index seasonality.

Dams

Attributed point data for dams were received from several different sources, including State agencies. The “Australia, Dams and Storages” data set (MR136) appeared to have the most complete coverage of the project area. It shows point locations of large Australian reservoirs that are owned by a public authority. Attribute information includes the name of the dam and associated impoundment; name of the stream on which it is located; storage capacity and surface area of the impoundment; ownership; and construction details of the dam wall. Dam locations are shown in Figure 10.

Additional data received for dams included the “Major Water Resource Infrastructure Database” (MR137), as well as State agency metadata from Queensland (MR136a, 148) and WA (MR137a).

Groundwater

Information on groundwater was provided in the “Australian Groundwater Flow Systems” (NLWRA) data set (MR199). The data show the distribution of groundwater flow systems at a national scale. These flow systems were based on their hydrogeological characteristics using a combination of geology, geomorphology and topographical (DEM) information at a national scale. The groundwater flow systems identify the extent of groundwater

processes contributing to salinity, together with the characteristic hydrogeological processes considered likely to result in dryland salinity given suitable climatic conditions. Groundwater flow systems for the project area are shown in Figure 11.

Groundwater areas are also classified in the “Australian Groundwater Management Units, Unincorporated Areas and Provinces” data set (MR200). This data set contains the boundaries and names of groundwater management units, unincorporated areas and groundwater provinces.

A groundwater management unit (GMU) is a hydraulically connected groundwater system that is defined and recognised by State and Territory agencies. This definition allows for management of the groundwater resource at a scale at which resources issues and intensity of use can be incorporated into groundwater management practices.

The data contain the boundaries (captured at various scales) and the name and number of each groundwater management unit, unincorporated area and province.

Gauging stations

Gauging station data are represented in the data set “Surface Water Gauging Stations” (part of the Australian Water Resources Assessment 2000 database) (MR146). This data set contains the spatial location of surface water gauging stations and their unique identifiers. Figure 10 shows the location of these gauging stations within the project area.

Data were also received from the NT “HYDSYS” database (MR209) containing information on surface water quantity and quality measured at gauging stations. It includes information on surface water sites in creeks and streams as well as other sites of interest, such as rain gauges. The sites are identified by a site number. An example of the information that is stored includes water flow rates as well as stream heights. Figure 12 shows these stations classified using one of the collected attributes — maximum measured water level.

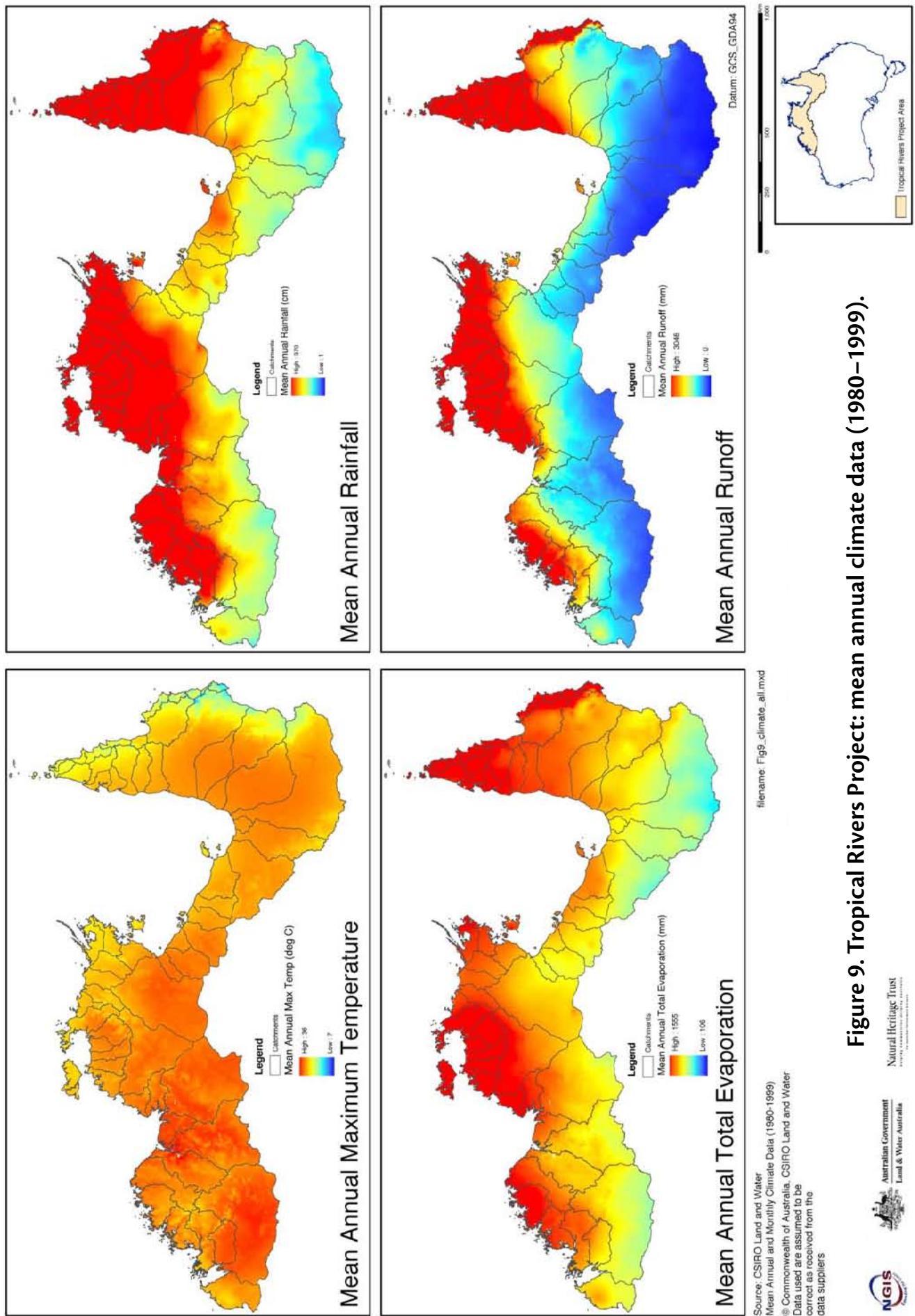


Figure 9. Tropical Rivers Project: mean annual climate data (1980–1999).

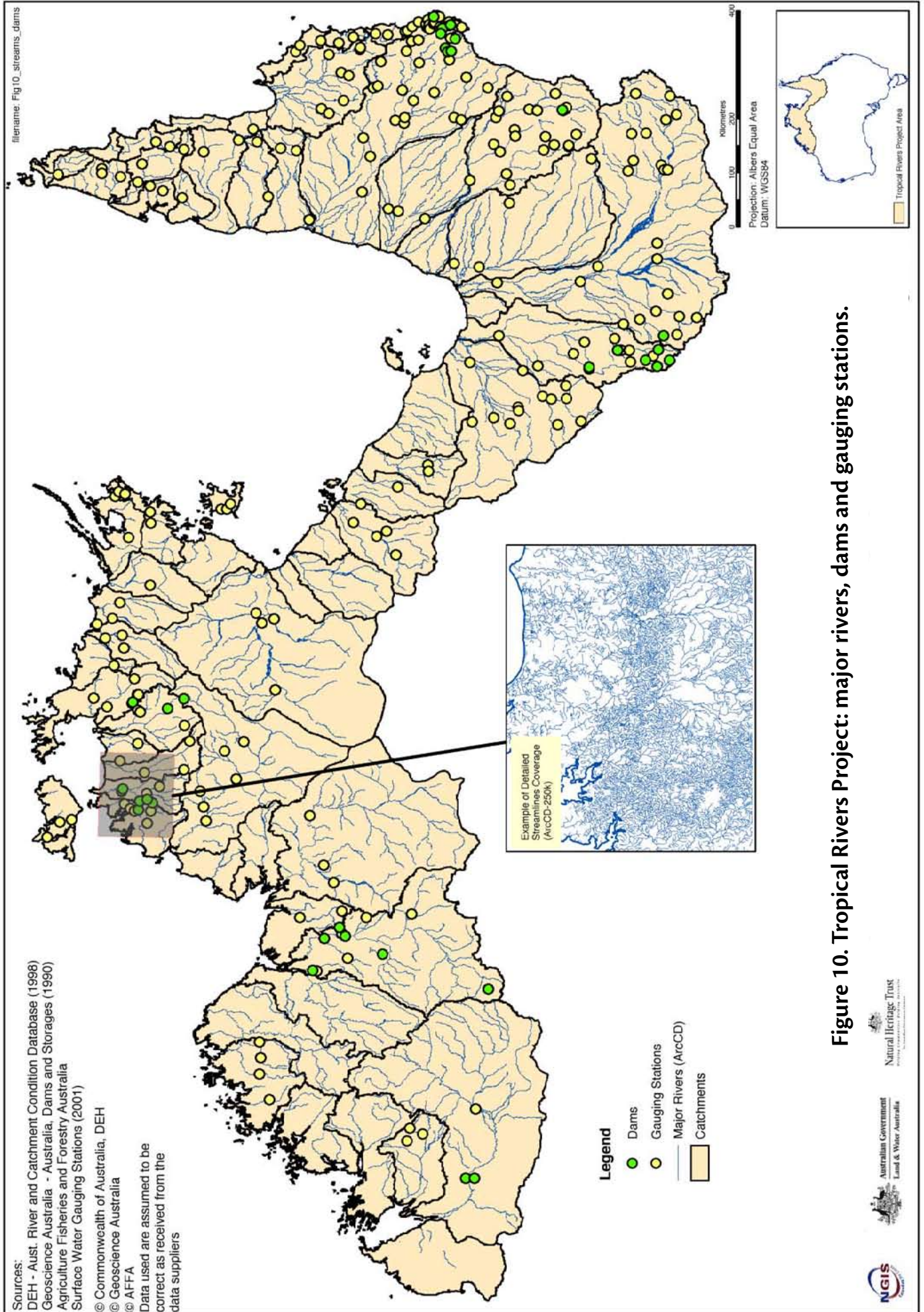


Figure 10. Tropical Rivers Project: major rivers, dams and gauging stations.

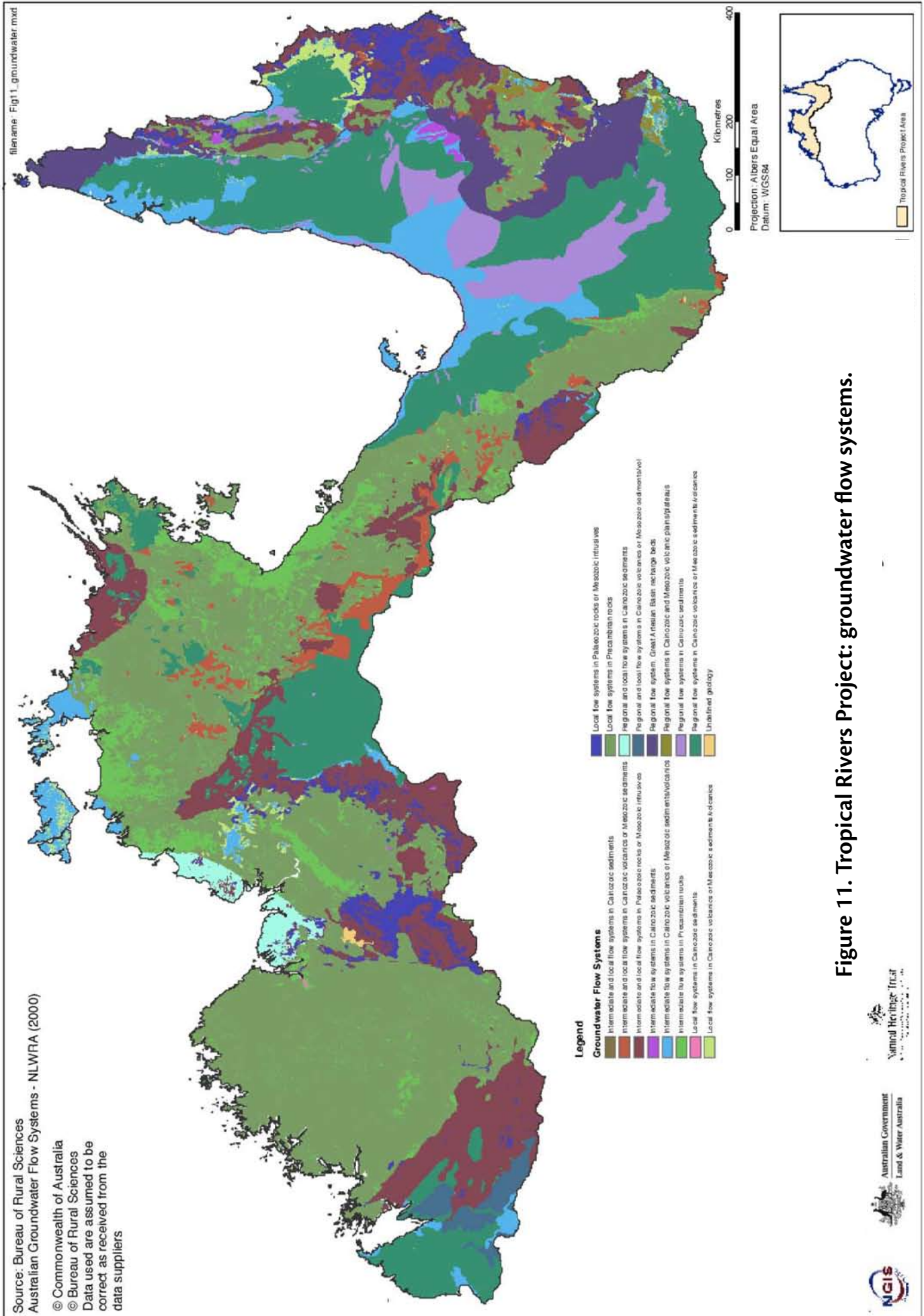


Figure 11. Tropical Rivers Project: groundwater flow systems.

Run-off

Information on catchment run-off is captured in the data set “Mean annual and monthly runoff (mm) in the present day and pre-1788 scenario” (MR51). The data set contains mean annual and monthly run-off (mm) for the period 1980–1999. Run-off is calculated as rainfall + irrigation – evaporation. These are model-based estimates from the BiosEquil model. Results are given for the “Base” (pre-1788) and “Agric” (present day) conditions. The “Agric” case includes current agricultural inputs of water from irrigation.

Catchment outflow is also recorded in the “Australian Water Resources Assessment 2000” data set (MR202). The Australian Water Resources Assessment 2000 was undertaken by the National Land and Water Resources Audit (NLWRA) in partnership with all States and Territories. The assessment database contains attributes about the availability, use, allocation, sustainability and management of water. Figure 13 classifies catchments according to their mean outflows.

Surface water

Surface water management areas (SWMAs) are regions defined by State and Territory water-management agencies for use in national water-resources reporting.

Many SWMAs are the same as the “Australia’s River Basins” (AUSLIG 1997) boundaries, but in some States and Territories some SWMAs are a sub-set or a major part of the river basins.

Metadata (MR201) were received for this data set. The data are normally freely available from GA via download, but were temporarily unavailable during the term of this project.

3.3.3 Gaps in data

Theme gaps

A classification of tropical streams and rivers based on their hydrological features would be a useful addition to this theme.

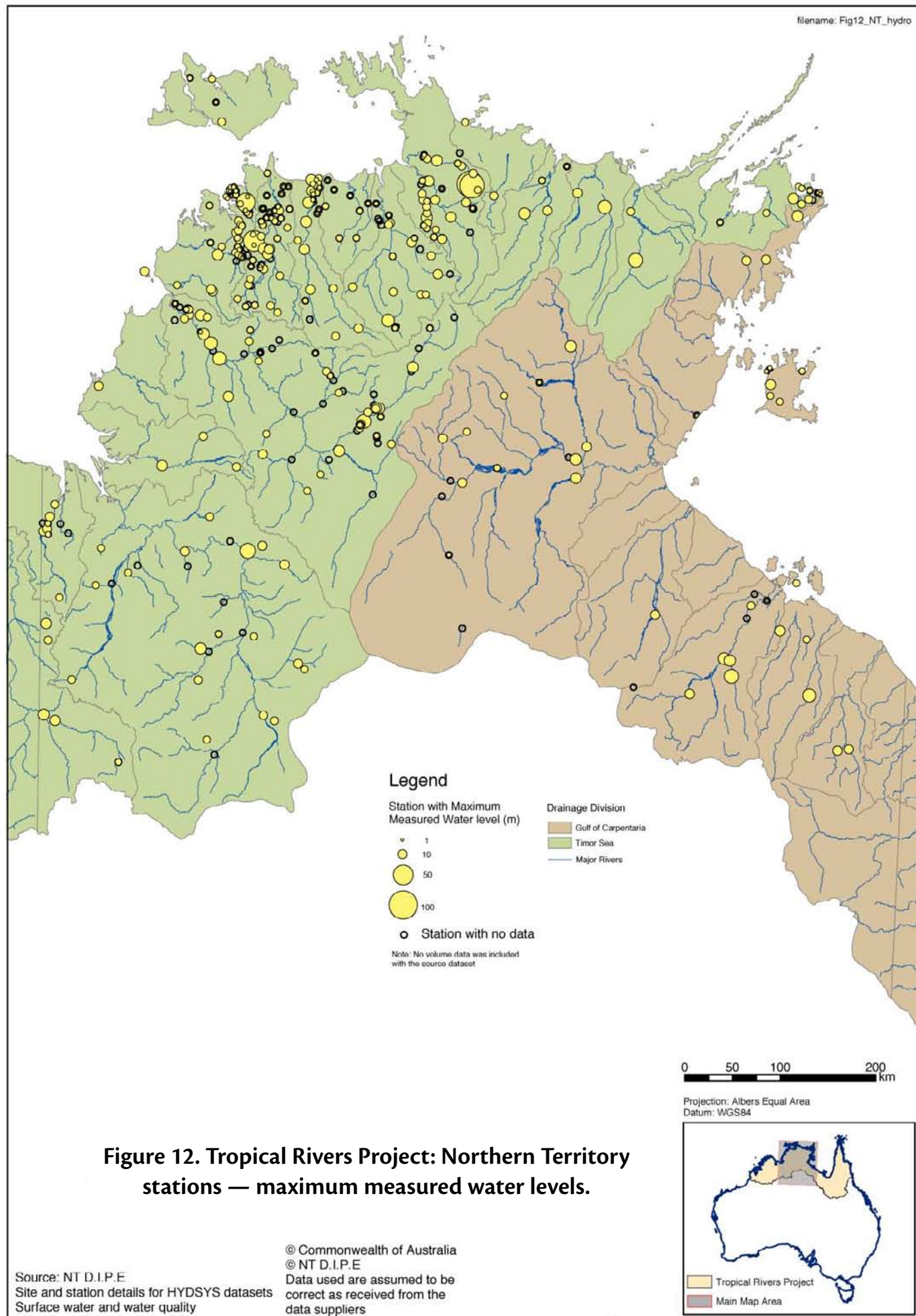
Recommendation 5. A classification should be developed of tropical streams and rivers based on their hydrological features such as rainfall and flow regimes, hydrological processes (for example, degree of groundwater influence), geomorphological features, catchment and riparian vegetation, and catchment soils and geology.

To develop such a classification would require good information on the long-term streamflow patterns throughout the region, and extensive field assessment. Streams could be classified based on flow characteristics including the degree of intermittency, spate frequency and intensity, flow variability and timing. It may be possible to develop an interim classification based on the limited existing rainfall and hydrological data, with additional modelling.

Recommendation 6. Future programs need to develop spatial data sets for detailed rivers and streamlines (once obtained) to capture hydrological data. These data sets could be developed from existing high-resolution spatial data that can be linked to existing and future databases.

Throughout much of the study region there is no basis for determining the ecosystem water requirements for surface or groundwaters (NLWRA 2001a), although water resource planning is already under way in States such as Queensland. This is an important gap in the information base for catchments that are currently being developed by, or subject to assessment by, industries that may draw heavily on the water resources.

Better information on the values and benefits of the water resources is needed throughout most of the study region. Although these are currently appreciated in terms of agricultural potential (NLWRA 2001b), there is a need for a broader understanding. In particular, there is little published information on the cultural values of water resources for Indigenous people, yet this is especially relevant in the study region. There is some literature on Aboriginal perspectives on wetland management in the NT (Thurtell et al. 1999, Whitehead et al. 1999) but information is scarce in the Gulf (QDNRM 2003) and the Kimberley (Yu 2000).



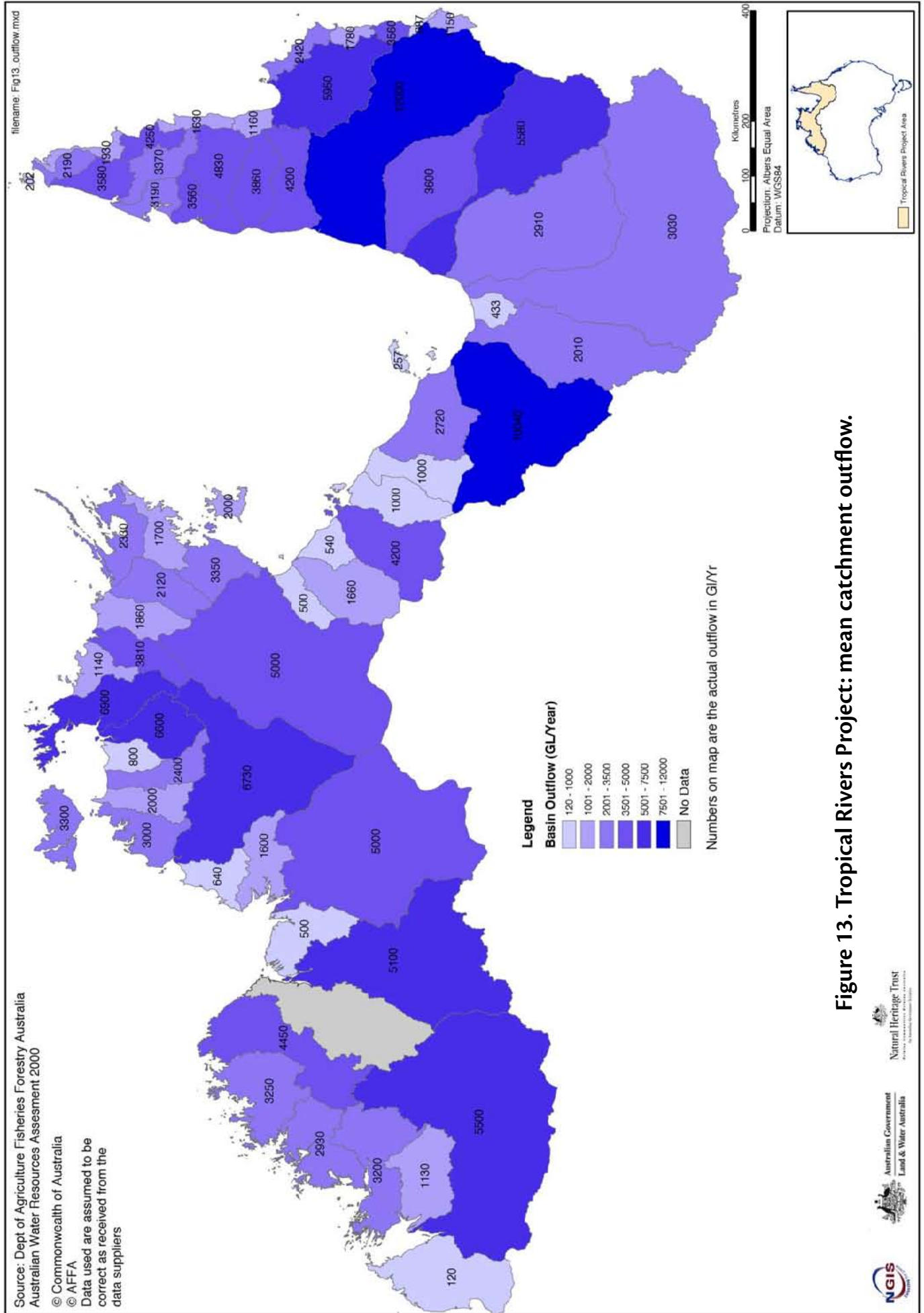


Figure 13. Tropical Rivers Project: mean catchment outflow.

Spatial gaps

Much of the information in this theme suffers from limited coverage of the study region. Data on water resources are somewhat better for the southernmost catchments in the East Coasts Drainage Division than for the Gulf or Timor divisions.

Adequate rainfall data are sparse and the pluviometer network across the study region is poor. For example, in the NT only a few large catchments contain gauges or pluviometers that are read daily (NLWRA 2001a).

Adequate streamflow data in the study region are very limited. Modelled streamflow data from 1901–1998 exist for 286 catchments across Australia (Peel et al. 2000). Only five gauging stations in the study region, four in the NT and one in Queensland, had adequate streamflow records to allow modelling (Peel et al. 2000). No stations in the entire Gulf drainage division were identified as having adequate data.

The surface water gauging network in the study region is somewhat limited spatially, with no stations in about one-third of the basins in Queensland and the NT. Data were not available for WA, but it is unlikely to be better. Groundwater monitoring bores are few and sparsely located throughout the study region. Many are located near population centres and are often influenced by nearby bores being pumped.

The information on water use is also limited, with few data on surface water usage for community water supply, irrigation, aquaculture, mining, and riparian uses in the NT (NLWRA 2001a), and even fewer on use in unregulated streams. In Queensland, water resources and strategic planning processes for the Gulf are looking to fill some of these gaps (QDNRM 2003).

In 1996, water quality monitoring in the study region was described as “comprehensive” for only 4 of the 71 SWMA, “broad scale” for a further 16 and “limited or none” for the remaining 51 (NLWRA 2001c). The lack of coverage for water-quality monitoring in the study region is amply illustrated by the fact that adequate data were available for the assessment of water quality for the NLWRA for only six basins in Queensland, and exceedence and trend analyses could be determined for only four and two basins, respectively. There were no adequate data for *any* basins in WA or the

NT. Additional water quality data exist for the study region (through State and Territory agencies, NRM boards, *eriss*, AIMS, universities and industry), though in many cases they are limited to basic physico-chemical parameters (dissolved oxygen, temperature, conductivity, pH) with few data on sediments, nutrients and phosphorus.

Recommendation 7. Information about water resources is limited and incomplete for large parts of remote northern Australia. Data collection networks and coverages need to be considered for climate, and ground and surface water themes by instigating new field surveys in areas not previously sampled.

Despite the numerous spatial gaps in the data for this theme, some areas are particularly well monitored, usually because there are mine sites. Parts of the Alligator Rivers region, for example, are much better studied than most other areas in the region.

3.3.4 Data quality

The accuracy of information on groundwater resources for most of the study area is, for several reasons, less than adequate (NLWRA 2001a). Monitoring bores are often located close to towns or communities and are affected by nearby pumped bores. The data are usually read manually and at irregular intervals, and the earliest records date back only as far as the 1960s. Recharge estimates are based mostly on first-order estimates and rarely on broad-scale aquifer modelling.

Gauging station stage and flow data often have gaps. The accuracy of the flow data at important times is considered poor, as most stations are not adequately rated for high-flow or flood events (which are important disturbance and transporting events), or for low-flow periods (which are critical times for environmental flows) (NLWRA 2001a).

For many catchments with grazing as the primary land use, water use is estimated on the basis of cattle densities (NLWRA 2001a). Indirect estimates such as this are likely to be inaccurate.

Groundwater quality information in Queensland may not be sufficiently up-to-date, as many sites have not been sampled for more than 10 years (NLWRA 2001c).

Recommendation 8. An increase in the number and reliability of monitoring bores and gauging station networks in priority catchments would assist in addressing hydrological data gaps. Given the considerable cost of installation and maintenance, consideration should also be given to improving methods of prediction in ungauged catchments. This would increase the density of data-collection points and significantly aid the understanding of water resources in tropical Australia.

3.3.5 Discussion and conclusions

Addressing the spatial gaps in the data for this theme will require the collection of a greater amount of basic data about water resources.

- In recent years there has been a substantial reduction in the number of gauging stations operating in the study region, yet at the same time there is recognition that the current network of stations may be inadequate. There is a need for more stations, but these must be installed in catchments where there is a clear management need, such as those with current or planned development. Within these priority catchments, it is important that stations are installed in strategic locations to best address the identified land or water management issues.
- The quality and relevance of streamflow data might be greatly improved if stations were more accurately rated for high- and low-flow events. Better rating of stations is therefore considered a high priority for making the best use of the limited number of gauging stations currently operating.
- Given the considerable cost of installation and maintenance of increasing the network of gauging stations, consideration should also be given to improving methods of prediction in ungauged catchments.
- There is a need to develop a better understanding of basic hydrological processes in the study region. In particular there is a recognised need for data on groundwater recharge rates (NLWRA 2001a). Such data will aid understanding of the link between groundwater and surface water, particularly during low-flow periods. Addressing this data gap will require additional groundwater monitoring bores in priority catchments. Ideally, new monitoring bores should be automated and located away from pumped bores.

- More pluviometers are required to develop an adequate understanding of rainfall–run-off relationships, particularly for smaller catchments.
- There is a critical need for more water-quality data throughout most of the study area. The need for establishing water-quality monitoring programs to assess potential water-quality impacts associated with extensive land-use areas was recognised by NLWRA as a national priority (NLWRA 2001d). This effort should be directed to priority catchments and should be conducted for a clear purpose and designed to adequately service management needs.
- There is a need for more ecological studies to determine the requirements of riverine and groundwater-dependent species/communities. While some research has been conducted in a few catchments in the study region (e.g. Erskine et al. 2003), more information is needed in these and in other priority basins where water allocation is a current or future issue.
- There are some data on the value and benefits of important wetlands in the study region, and the significance for possible agricultural development is well documented. However, the values of Indigenous water users have often been overlooked. There is a great need to engage with Indigenous peoples and develop a better understanding of what they consider to be the values and benefits of ground and surface-water resources.

3.4 River condition

3.4.1 Introduction

This theme provides information on the data required to conduct an assessment of river condition, following the methods used by the NLWRA (Norris et al. 2001). This includes information on indices of catchment disturbance, hydrological disturbance, habitat quality, water quality (nutrients and suspended sediments), and aquatic biota.

3.4.2 Data available

AusRivAS

The AusRivAS data set (the Australian River Assessment Scheme) (MR125a) represents one of the critical data sets defining the health of Australia's rivers on the basis of their aquatic biota.

The Australia-wide assessment of river health utilises a rapid, standardised method for assessing the ecological health of rivers, based on biological monitoring and habitat assessment. Sites have been selected with advice from State agencies, local governments, industry, catchment organisations and communities, with regard to key river and catchment management issues. River health assessment is based on the differences between the species found at test sites and those that are assessed to have once been there, using a set of reference sites with similar geographic, physical, and chemical features.

The majority of the AusRivAS sites are located in southern Australia, and coverage over the Tropical Rivers Project area is sporadic (Figure 14).

River condition

River condition is assessed in the “Australia — Assessment of River Condition (Reach and Basin) 2001” data set (MR177).

The Assessment of River Condition (ARC) is the first attempt to report on river condition for key river basins across Australia. The integrated assessment provides a basin-wide context, and a framework within which decisions and river management priorities can be considered. The assessment incorporates a range of attributes that are considered to indicate key ecological processes at the river reach and basin levels. The two indices developed are an “aquatic biota index” using macro-invertebrates (AusRivAS data), and an “environment index” with four sub-indices: catchment disturbance; hydrological disturbance; habitat; and nutrient and suspended sediment load. A range of data types and approaches was used, including direct measurements and modelling of nutrient and sediment loads.

The river basins assessed include areas that contain intensive land use and selected areas of non-intensive land use, such as part of the NT. Whole river basins were used, so that processes such as hydrology and sediment and nutrient movement could be modelled and balanced over entire catchments.

The ARC database is richly attributed and captures a wide range of river and catchment indicators. However, the data have limited coverage over the Tropical Rivers Project area, with large parts of WA

and Queensland, and part of the NT, not included. This coverage is shown in Figure 15 for several of the indicators.

Another data set that relates to catchment condition is the “Australia — Landscape Health Database 2001” (MR235). This data set captures a diverse range of information relating to the physical, cultural and biodiversity aspects of catchments. The data were supplied in the form of Excel spreadsheets for each of the main indicators, and spatially linked to the “Interim Biogeographic Regionalisation for Australia” (IBRA) sub-regions data set (MR 229).

The IBRA sub-region boundaries differ markedly from the catchment boundaries. For this report, landscape stress classes were recalculated by NGIS at the catchment scale, using proportional areal interpolation of the IBRA sub-regional data set. The result of this assessment is shown in Figure 16.

The hydrological change is also captured in this data set and has been classified (by IBRA sub-region) in Figure 17. This indicator is also shown by catchment for a limited part of the project area in Figure 15.

Catchment vegetation

The “National Vegetation Information System (NVIS) — Pre-European and Present Native Vegetation” (MR163a) was obtained for northern Australia. The NVIS spatial database of native vegetation data was collated by NLRWA through collaboration with Australian Government, State and Territory agencies across the country.

The NVIS vegetation classification system contains information on vegetation structure (growth form, height, cover) and floristics (genus and species). The NVIS information hierarchy summarises detailed vegetation association data at six levels of description. Level 1 (Class) is the most general description describing a single vegetation type (eg. tree, tussock grass etc.) while Level 6 (Sub-association) is the most complex, describing up to five vegetation strata/layers, five growth forms and five species per layer.

Figure 18 shows the coverage of NVIS vegetation within the project area using “L2 — Structural Formation” as the classification field.

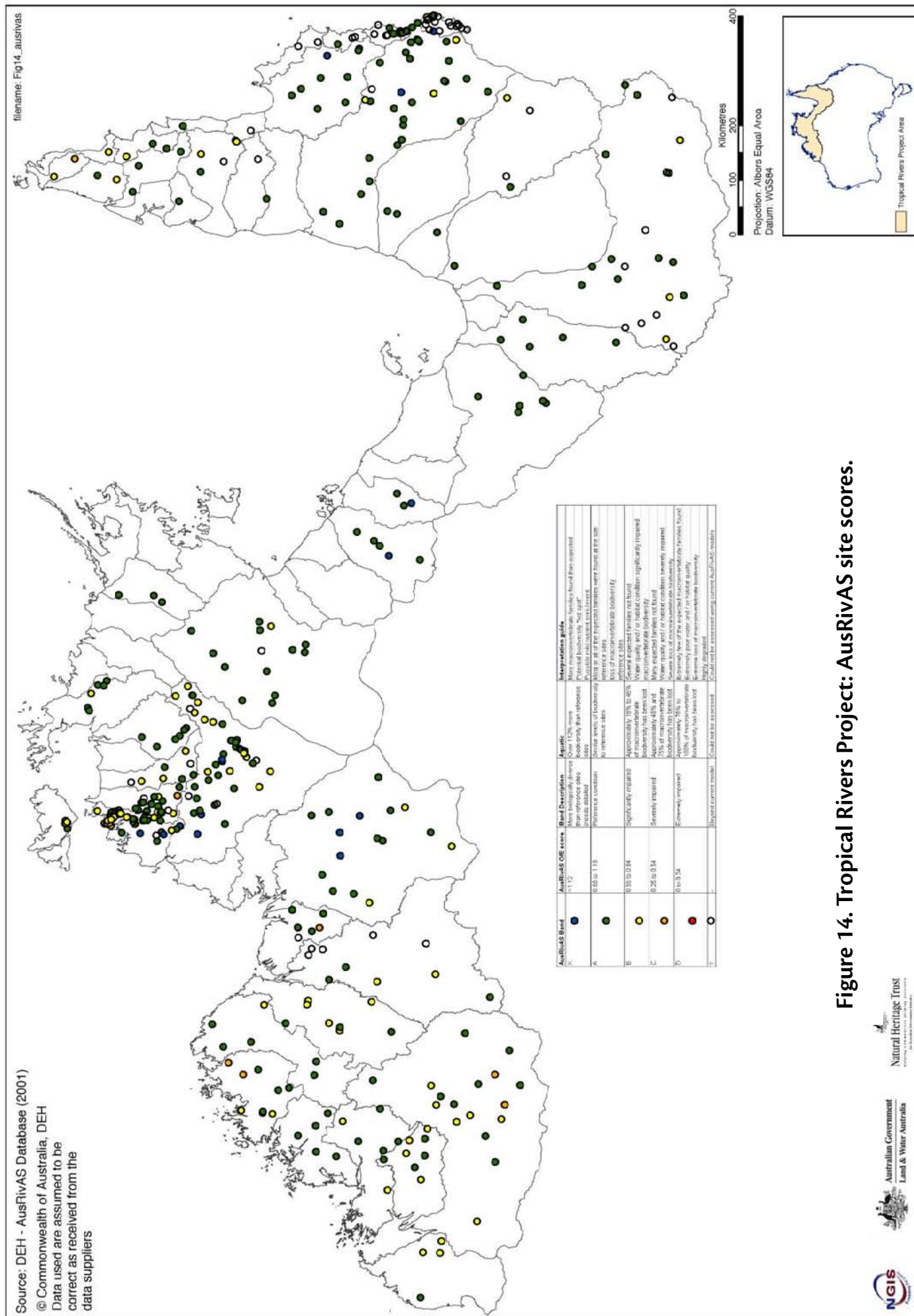
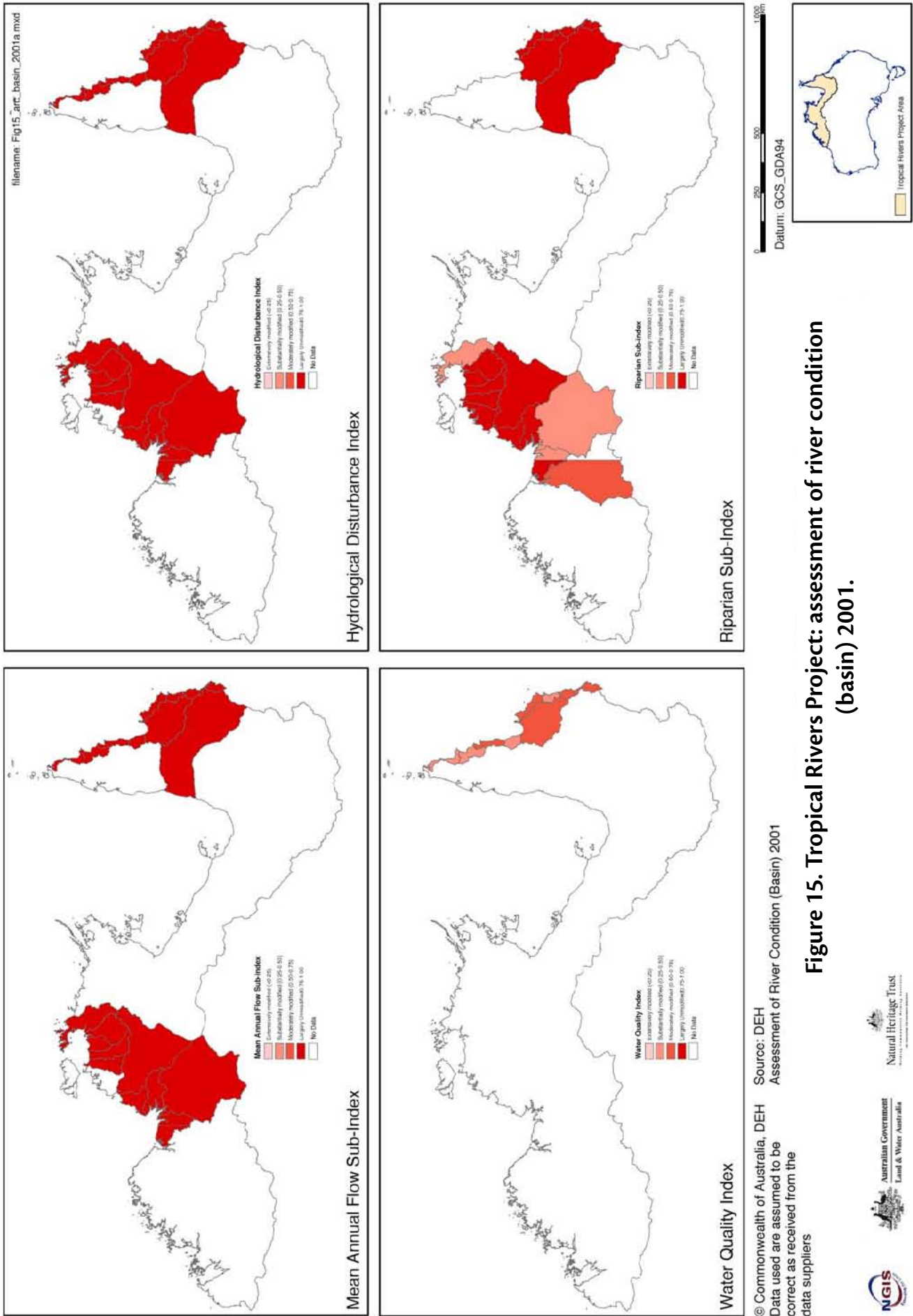


Figure 14. Tropical Rivers Project: AusRivAS site scores.



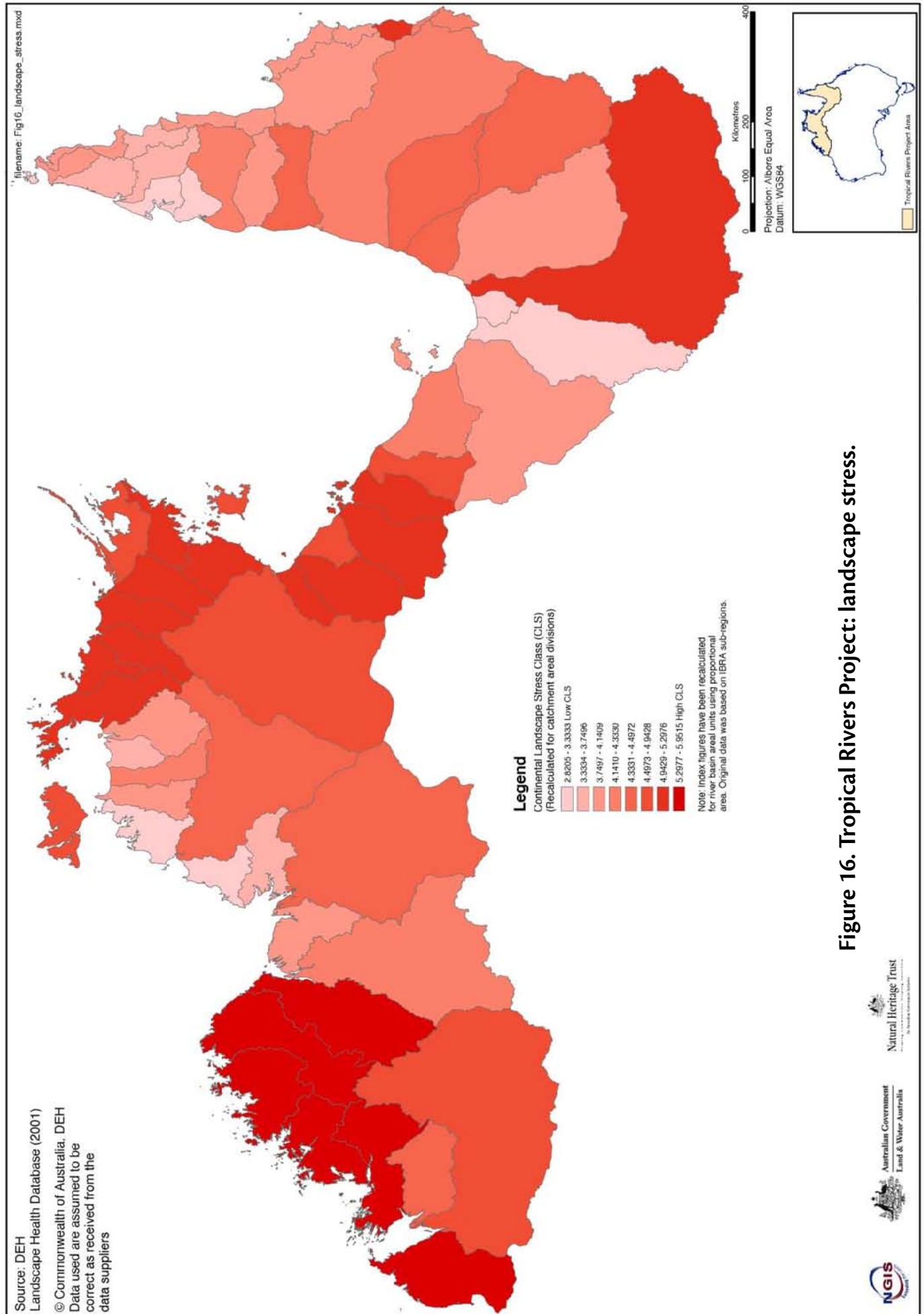
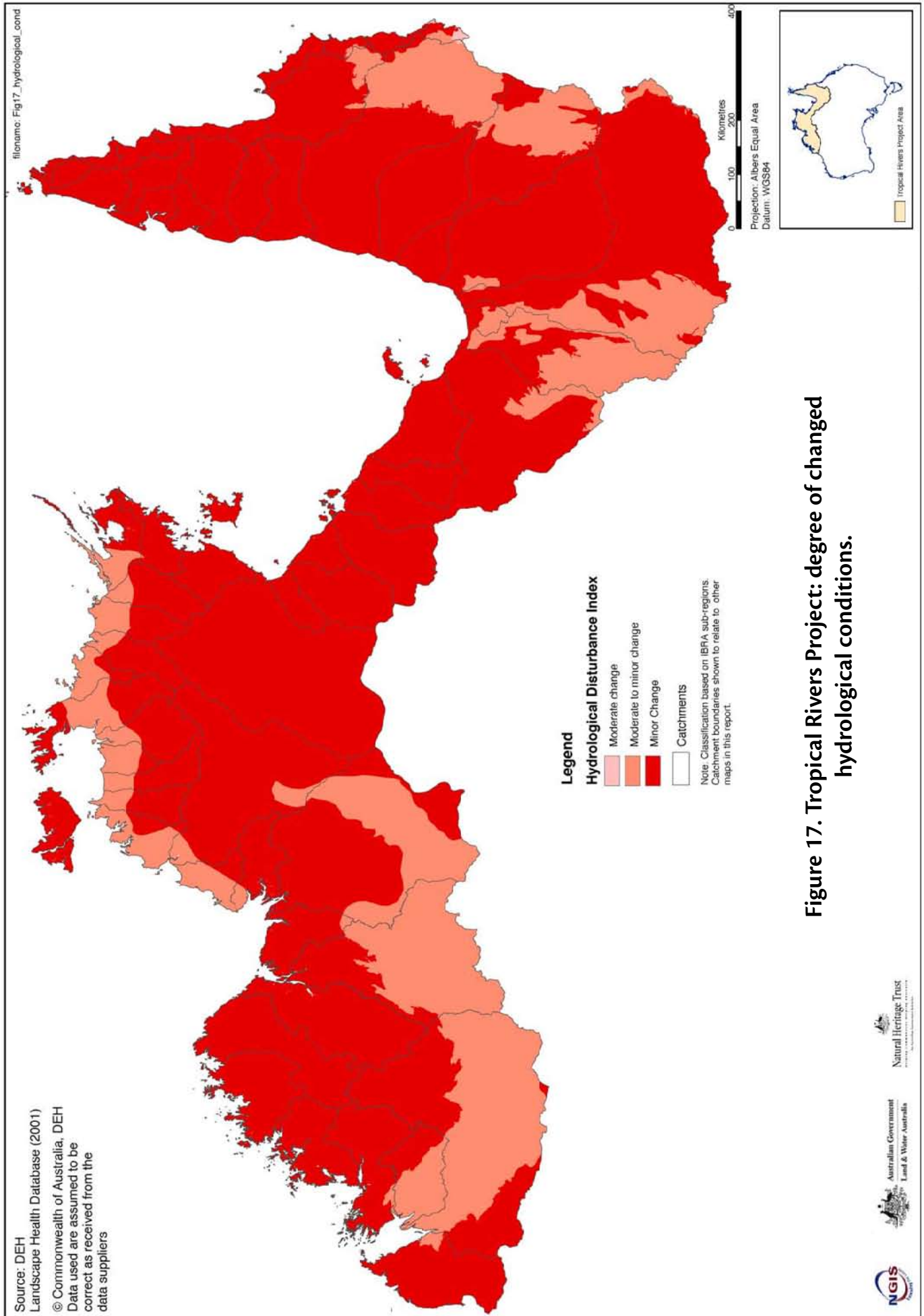


Figure 16. Tropical Rivers Project: landscape stress.





A number of data sets that relate to catchment vegetation were obtained from State and Australian Government agencies (in particular from Queensland).

A major project-wide data set is “The Vegetation of the Australian Tropical Savannas” captured at 1:1 million scale (MR165). The data set is based on a generalised compilation of the lines and legends of a number of vegetation maps including the Kimberley region, NT, Cape York Peninsula, Einasleigh Uplands, Desert Uplands, Brigalow Belt North and Central Western Queensland. It includes new vegetation mapping for north-west Queensland.

Another Queensland data set is “Vegetation Survey and Mapping of Far North Queensland” (MR166) which is captured in more detail at a scale of 1:250,000. It includes the offshore islands and extends north through Torres Strait to the Papua New Guinea border.

Also of importance in Queensland is “Remnant Vegetation Cover of Queensland” (MR167), which is a delineation of remnant vegetation, cleared areas and other features for that State. It is compiled from individual remnant and/or landcover coverages of 1:250,000 map sheets.

Data sets received from the NT agencies include the “Vegetation Map of the NT” (MR173). This data set is a 1:1 million representation of the present vegetation of the NT compiled from Landsat imagery and extensive ground-truthing. Vegetation and rainforest data sets were also obtained for the Kakadu region (MD161–162).

No vegetation data sets were received for WA, although several are known to exist (CALM and Agriculture WA are the custodians) and metadata were obtained from the Australian Spatial Data Directory (ASDD) (MR246–247).

“Australian Rivers and Catchment Condition Database” (previously “Wild Rivers”)

The “Australian Rivers and Catchment Condition Database” (ArcCD) (MR178–180) contains attributed streamline vectors at 1:250,000 scale for Australia. The assessment recently had a name change from “Wild Rivers”, but is still commonly referred to by its former name. This data set shows the State of

disturbance of Australia’s rivers. The river disturbance indexes (RDIs) are classified in Figure 19.

More detailed streamlines were also obtained for parts of northern WA (MR182) which has been captured at 1:50,000 and 1:100,000. Merging of these data sets was completed in order to create a detailed rivers shapefile for the project area. Figure 10 shows a magnified inset of an area where detailed streamlines are available. Detailed (1:50,000 scale) streamlines were also obtained for a small part of east-coastal Queensland (MR184). Streamline data at 1:50,000 scale are known to exist for a large part of the project area through DIGO, but were not available for this project.

Another useful data set that was obtained in WA was the “Wild Rivers of Western Australia” polygon shapefile (MR183). The Waters and Rivers Commission and the Australian Heritage Commission identified catchments in WA that have not been significantly altered by modern human impacts. These catchments are considered of very high environmental value due to the undisturbed state of their water quality and biodiversity, and because they serve as benchmarks of undisturbed catchment conditions, against which other catchments can be measured. The catchments remain in their natural condition due to their isolation, rugged topography and/or land tenure.

Wild Rivers data for NT and Queensland are also known to exist, but were not supplied for this project.

Water quality

Data relating to water quality (sediment content and nutrient supply to rivers) were received in the “Sediment and Nutrient Supply to Rivers” data set (CSIRO Land and Water custodian) (MR215–216). This data set is the vector streams coverage generated from the 9-second DEM data attributed with sediment and nutrient source, sink, load and delivery information. The data set is a product of the “Water-borne Soil Erosion Project” of the NLWRA.

The “Assessment of River Condition Database 2001” (MR177) also contains information on water quality, but is restricted to only a small part of the project area. Figure 20 shows this limited coverage of sub-indices created for suspended sediment, bedload condition, total phosphorous and total nitrogen in rivers.

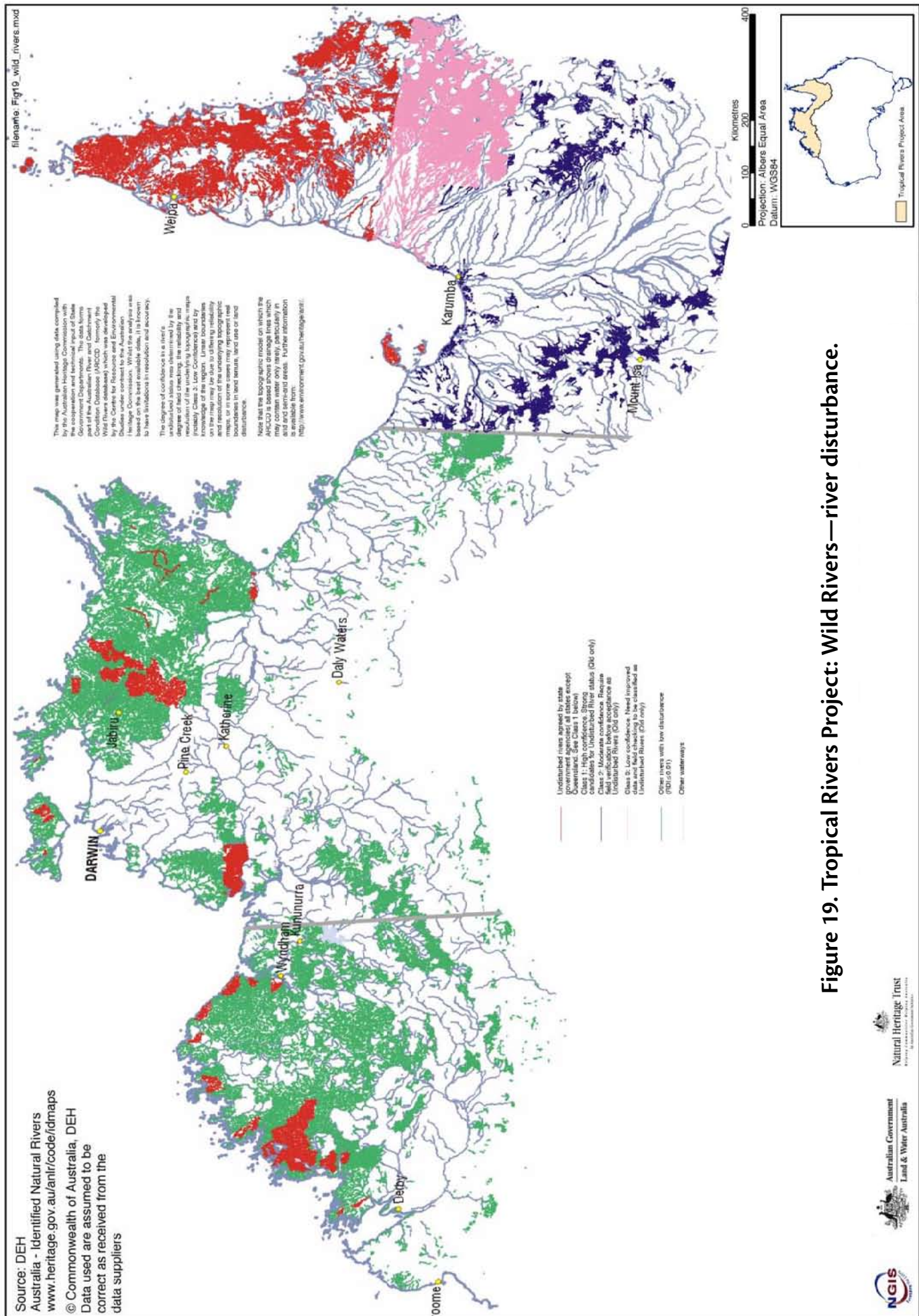


Figure 19. Tropical Rivers Project: Wild Rivers—river disturbance.

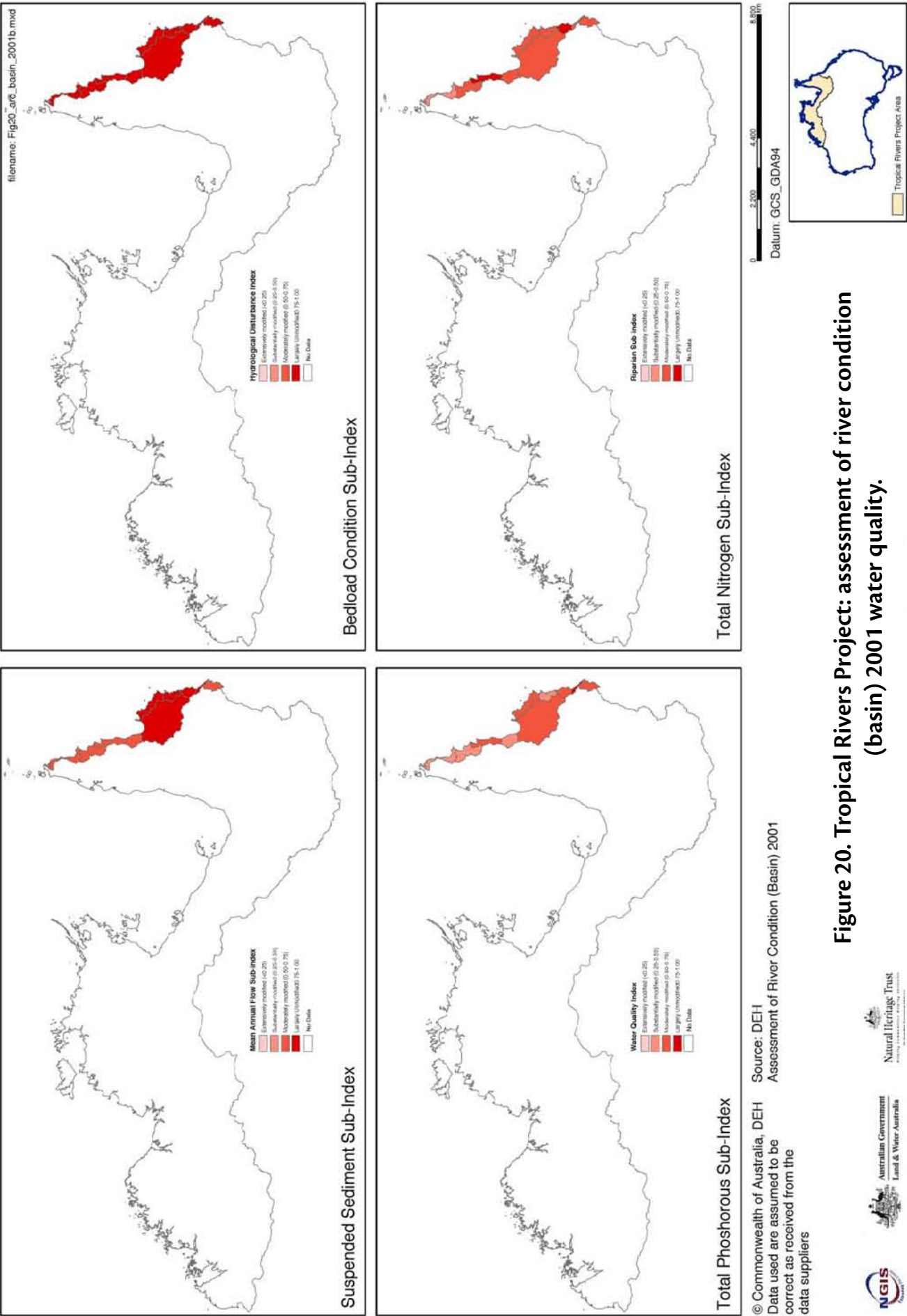


Figure 20. Tropical Rivers Project: assessment of river condition (basin) 2001 water quality.

3.4.3 Gaps in data

Theme gaps

The mining industry has been important in the development of the study region and mining operations can be both a source of pollutants and hydrological disturbance. Therefore, the paucity of data on the location of current and past mine sites (excluding WA where some detailed data exist) represents an important gap in information that, if available, could be used to assess river condition. Such data are likely to exist in State agencies and some data could be obtained through the National Pollutant Inventory (NPI).

Recommendation 9. A project-wide database of current and historical mining activity (similar in detail to the WA abandoned-mine-site database) would greatly enhance the understanding of disturbance and point source pollution in the project area. The National Pollutant Inventory should be investigated further to establish links to spatial data sets.

Spatial gaps

The hydrologic disturbance index (HDI) (Norris et al. 2001) was estimated for some of the catchments in the study region. Data required to calculate the HDI are available mostly as modelled flows due to the limitations of the existing gauging network in the study region. As most of the rivers are unregulated, several sub-indices could be assigned a value of “1” without a need for additional data.

The bedload condition sub-index used in the Assessment of River Condition (ARC) was based on modelled data, which were unavailable for the NT and Gulf Drainage divisions (Norris et al. 2001). Therefore data on this sub-index are unavailable for the study region.

The vegetation structure and floristic data used to develop the riparian vegetation sub-index have coverage across the study region but the Australian Land Cover Change (ALCC) data do not have adequate coverage of the entire study area. This may not be a major limitation, as there has been limited clearing in much of the study region. Other data have been collected for specific catchments (Roper

and Daly rivers in the NT) but these data were not collated in this project.

Data on nutrients and suspended sediment loads were unavailable for most of the study region. Modelled data are available for only the East Coast Drainage Division. This is a major spatial gap. Data on point source pollutants should be available through the NPI but were not obtained in this project. Data from the NPI are available for only a limited number of sites in the study region.

Data for the aquatic biota index are available for much of the study area. The “AusRivAS” data set represents one of the few systematic collections of data to assess river health across the study region. Even so, some catchments were not sampled and most catchments are represented by very few sites.

3.4.4 Data quality

The data on vegetation types are adequate over a broad scale for a national assessment, but there is a need for more detailed (1:250,000 or finer scale) maps of vegetation for the study region. The riparian vegetation index used in the ARC assessed the presence or absence of vegetation within a 100 m buffer from the stream. This is likely to be too coarse a scale for many of the riparian zones in the study region, which are typically very narrow strips in their natural state.

Recommendation 10. Existing riparian vegetation data within the project area are at too coarse a scale, and obtaining higher resolution data is important. This may be achieved through a combination of field mapping and remote-sensing studies with ground truthing.

The quality of modelled sediment and nutrient data used in the ARC for the East Coast basins in the study region has been questioned by the State agency (Norris et al. 2001). The modelling method used incorrect land-use data, which resulted in substantial overestimates of loads from many rivers that are in near pristine condition.

The quality of the hydrological disturbance data may be impaired by the problems with hydrological data noted in section 3.3.4.

The Biota Index is derived from macro-invertebrate data. Townsend (2001) outlined a number of concerns regarding the use of macro-invertebrates as indicators of river health in the NT. The apparent insensitivity of the SIGNAL index, the higher than expected frequency of band B sites in areas with no discernable disturbance and issues regarding the timing of sampling for seasonally flowing rivers were noted as reasons to exercise caution in applying the AusRivAS approach in this region.

3.4.5 Discussion and conclusions

Extensive reviews of approaches to monitoring river health were undertaken before the catchment, river and estuary assessment was undertaken. The method adopted for determining river health was considered robust and appropriate for the broad area of coverage. Given the size of the Tropical Rivers Project study region, it is reasonable that the same or a similar approach be used to assess the condition of tropical rivers. Given this, the data available to undertake such an assessment have several notable gaps described above. A more detailed assessment may be desirable for some rivers, but it would be likely that such activity would encounter similar data limitations. To address these gaps and to develop a data set that would enable a broad assessment of river condition, it is recommended that a high priority be given to obtaining and evaluating those additional data sets held by State agencies that might be valuable for determining river condition. These data sets include those holding information on:

- Land use. New data sets on land-use mapping that use the Australian Land Use and Mapping (ALUM) classification provide the most current and detailed assessment of land use in the region and this classification also includes water feature as a separate cover feature (BRS 2002; Lesslie et al. 2003).
- Land cover change. More detailed data on land clearing are likely to be available (eg. from the Australian Greenhouse Office) in several key catchments. The data used by Norris et al. (2001) were based on land change up to 1995, but there are some areas in the study region (eg. Daly Basin) for which more recent data would be valuable.
- Mining. Databases listing the location of current and former mining sites.
- Riparian condition. For some catchments in the study region, State agencies have also conducted

detailed assessments of riparian condition using the Anderson method (Anderson 1993a,b). In Queensland this has been done as part of the State of the Rivers assessments. In the NT, it has been done for key catchments including the Roper River (Faulks 2001), Daly River (Faulks 1998) and the Victoria River (Faulks, unpublished data). These data sets should also be obtained and evaluated.

Recommendation 11. Further investigation at a more specific and theme-oriented approach (as opposed to the broad scope of this project) should be directed towards State agencies to ensure that all existing data sets are made available for future research into tropical rivers.

3.5 Biodiversity

3.5.1 Introduction

This report theme summarises the state of knowledge on the biodiversity of tropical rivers. Project target themes focus on the extent of wetland and riparian habitats, on the distribution of threatened species and relevant indicator species, and the presence of pest plants and animals.

3.5.2 Data available

Feral animals

Information on feral animal species was generally not readily available from the agencies that were approached. The “Landscape Health Database” (MR235) contains limited data, arranged by IBRA sub-regions. Data exist for density and trend class values for seven feral vertebrate species (fox, goat, cat, rabbit, buffalo, pig, cane toad) per sub-region. Figure 21 (lower map) gives summed total feral densities for all these species, classified in six steps between low and high.

Metadata for pest species were obtained from Queensland (MR221).

Weeds

The situation with weeds data is similar to that for feral species in that there are few data available for the project area. The “Landscape Health Database” (MR235) contains limited data arranged in IBRA sub-

regions. There are data for density class values for 24 weeds and exotic plant species (alligator weed, athel pine, bitou bush/boneseed, hymenachne, lantana, mesquite, mimosa, Parkinsonia, parthenium, pond apple, prickly acacia, rubber vine, salvinia, serrated tussock, willows, buffel grass, para grass, gamba grass, mission grass, boxthorn, broom, olive, radiata pine, wards weed), a summed total weed density class, total weed density class and a weed stress summary class (condition attribute c7a) per sub-region.

Weeds in the project area are mapped according to summed total density classes in the upper part of Figure 21.

Some weeds data were also received from the NT (“Historical Weeds Locations NT”) (MR220). This is a point shapefile with 5773 historical weed locations, with taxonomy and source attributes recorded.

Metadata were received from only Queensland agencies. They included information on weeds and the prevention of weed spread (MR221–222).

Threatened species

Threatened and endangered species data were generally not released from State agencies (and were subsequently not requested due to their restricted nature). Summary information is available through DEH. Of the national data sets obtained, the “Landscape Health Database” (MR235) contains limited data arranged by IBRA sub-regions. Data exist for the number of threatened plant species, number of threatened terrestrial vertebrate species, a summed total threatened species class and a threatened species summary class per sub-region.

Threatened species in the project area are mapped according to summed total density classes in Figure 22.

Metadata only for “Threatened Ecological Communities” in WA (MR247) was sourced from the ASDD. The data set describes ecological communities throughout WA that are “presumed totally destroyed”, “critically endangered”, “endangered”, “vulnerable”, “data deficient”, “lower risk” or “not evaluated”. Communities are based on various life-forms including plants, invertebrates and microorganisms. Digital data are available only with written permission of the custodian.

Wetlands

Some wetlands data were available through national data sets. The “Directory of Important Wetlands Spatial Database” (MR192) is a critical data set for the Tropical Rivers Project. The criteria for the definition of a wetland used in the GIS is that adopted by the Ramsar Convention, namely: “areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters”.

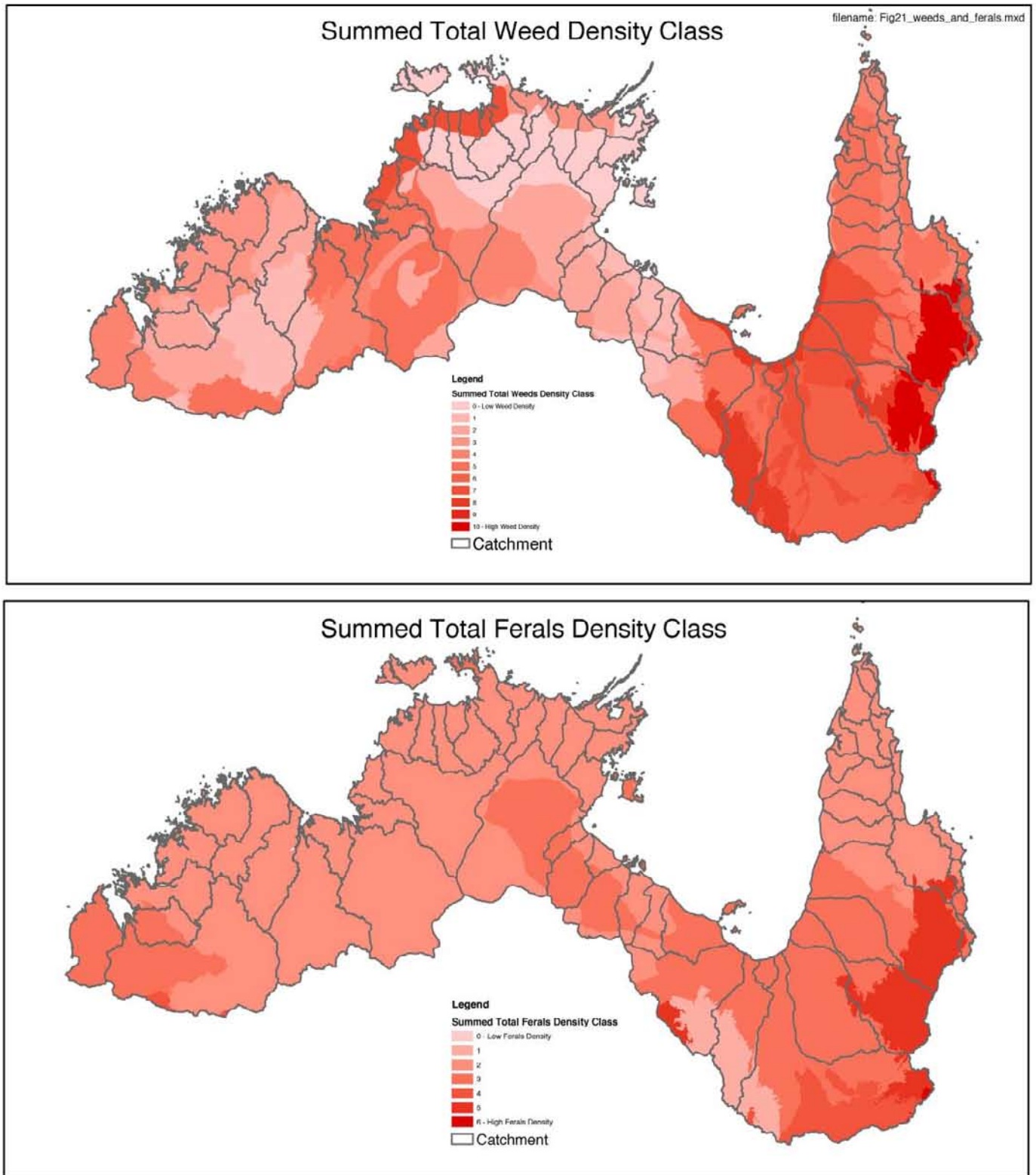
This data set is used in Figure 23 to classify important wetlands by type (eg. swamp, lake or mangrove). A magnified inset of part of the NT is also shown, to give an indication of the polygon resolution and detail.

Another major data set received was the “Directory of Ramsar Wetlands in Australia” (MR191), which is, for the most part, incorporated into the “Directory of Important Wetlands”. Also obtained was the “Wetlands — Estimated Areas” data set (MR193), which estimates the areas in km² of 17 wetland types for the whole of Australia, using the data recorded for half-degree grid cells.

Metadata only for “Coastal Wetland Mapping” were obtained in Queensland (MR194). Metadata were also obtained for WA from the ASDD for “Ramsar Sites in Western Australia” (MR281) which describes the official boundaries of the nine wetland areas proposed in February 1990 by the Government of Western Australia for listing as “Wetlands of International Importance” under the Ramsar Convention.

Fauna

Specific data sets relating to fauna occurrences within the project area were generally not available, but a number of metadata only records were obtained. In the NT these include the “NT Fauna Atlas” (MR210), which is a database housing vertebrate records for the NT, and “Fauna Collections” (MR211) in which the NT Museum maintains several databases relating to the biodiversity of tropical rivers in northern Australia. Currently, access to these data is through application to the museum, but the information will soon be available over the Internet through distributed database systems such as OZCAM (Online Zoological Collections of Australian Museums). The WA Museum also holds data for birds, crustaceans, fish, mammals and reptiles (MR214).



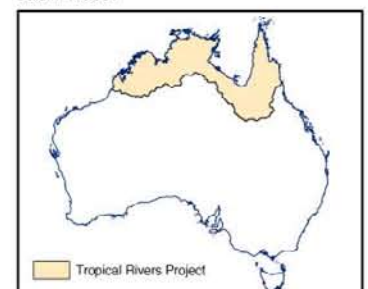
Source: DEH
Landscape Health Database (2001)
© Commonwealth of Australia, DEH
Data used are assumed to be
correct as received from the
data suppliers

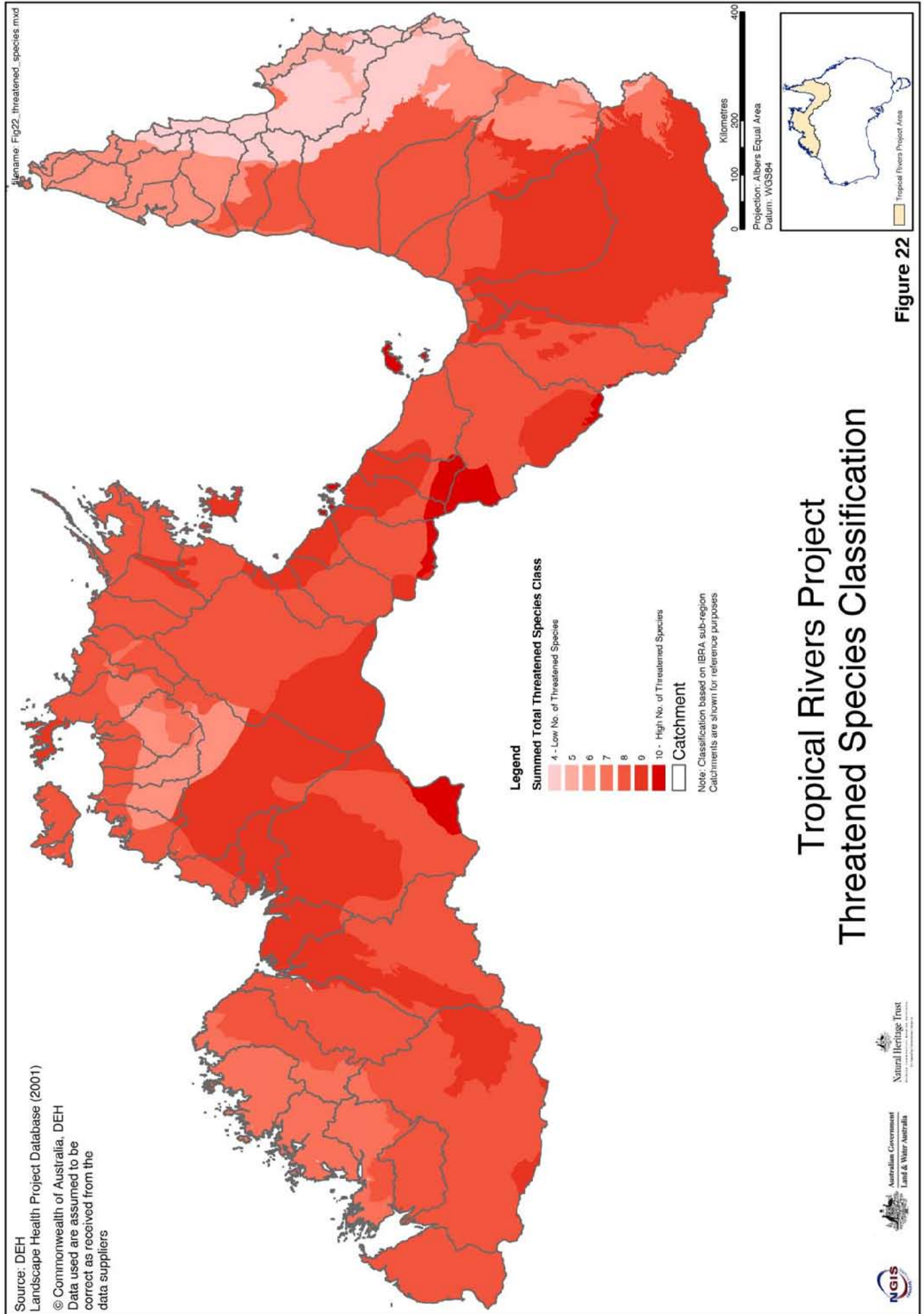
Note: Classification based on IBRA sub-regions
Catchments shown only for reference purposes

0 125 250 500 km

Projection: Albers Equal Area
Datum: WGG84

**Figure 21. Tropical Rivers Project:
weeds and feral animal classification.**





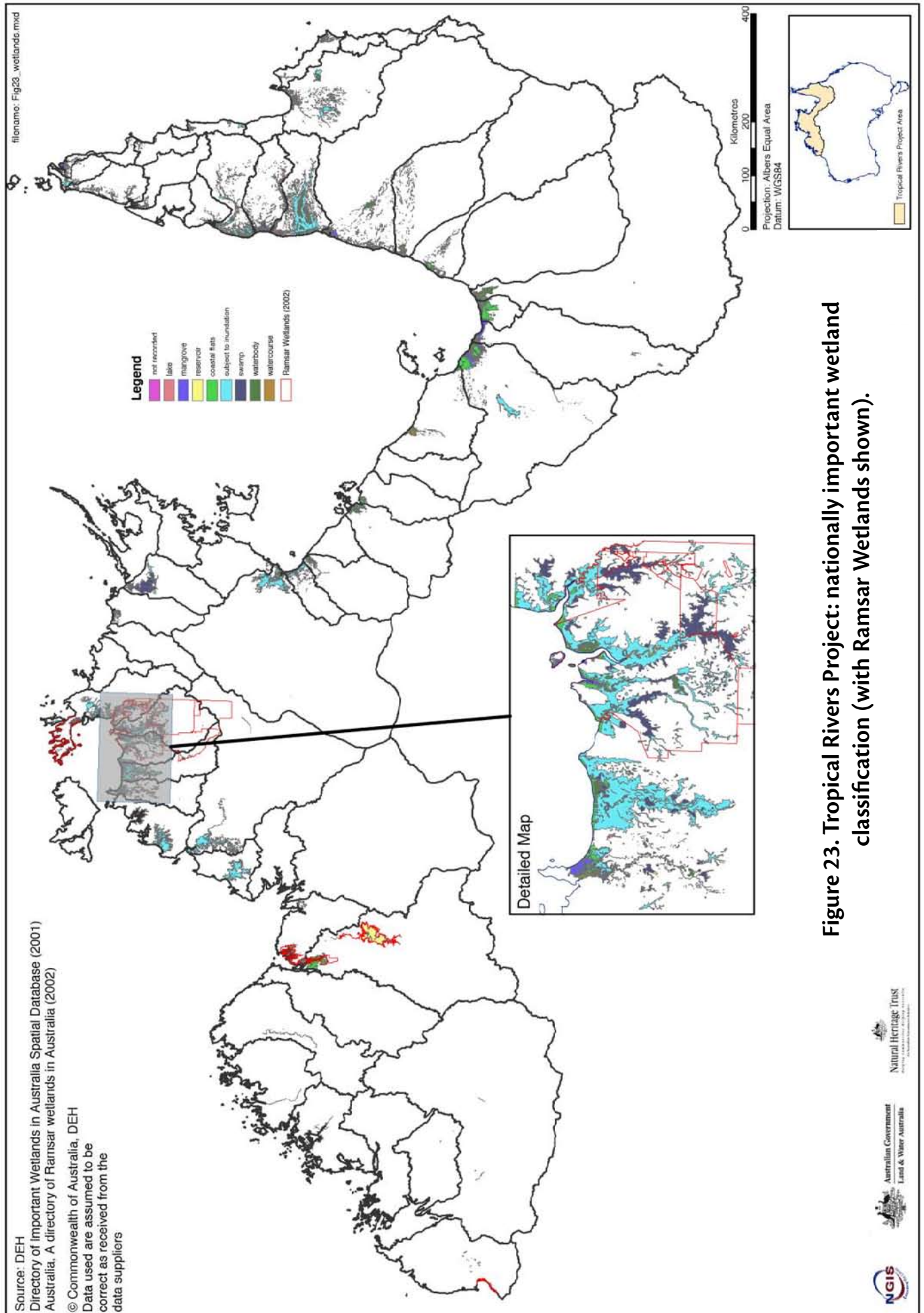


Figure 23. Tropical Rivers Project: nationally important wetland classification (with Ramsar Wetlands shown).

Fish

No data sets specifically related to fish (catches or occurrences) were received, despite requests to the State fisheries agencies. The majority of existing data appear to be for offshore catches, and inland information is still sparse. In WA, information is generally either lacking or restricted for the far north. Metadata obtained for fisheries in WA included the “State of Fisheries Report — 2001”, which is a comprehensive document (over 200 pages) that may contain useful information for the project area. Metadata files were also sourced from the ASDD. These show existing data sets for Fisheries WA covering abalone, prawns, mud-crabs, barramundi and estuary cod (MR213). Metadata for Queensland fish habitat areas (MR212) were also obtained.

3.5.3 Gaps in data

Several sources of information on the extent of wetlands were collated for this project and most of these provide national coverage. There is more information available on important wetlands, as there has been an ongoing systematic assessment of these, as outlined in the Directory of Important Wetlands (ANCA 1996). For much of the study area this is the only source of information about trends in condition of wetlands. It must be recognised that this represents only a subset of the wetlands in the region.

Some data on biodiversity indicators are available across the entire study region for some groups (macro-invertebrates, waterbirds), but are almost completely lacking for other groups, such as fish.

Recommendation 12. The lack of spatial data relating to inland fish is a major gap in project information. It is likely that sufficient data are not being collected. Further investigation is required to find out from the State fisheries agencies whether data exist and how they may be obtained. If it is found that data are not being collected, then procedures need to be instigated so that the data are captured in the future.

The AusRivAS database has information about macro-invertebrates from points across the study region, although some basins were not sampled. Other, more detailed, macro-invertebrate information exists for some locations (eg. Alligator Rivers region) but metadata are available for only some of this.

Some data on water birds are available in the “Directory of Important Wetlands”, which has coverage across the region. Other data on vertebrates are available in the NT fauna atlas; metadata are available for these. For WA, metadata are available on birds, reptiles, fish, crustaceans and mammals.

There is no single data set that specifically covers the location of floodplains, although this information could be derived to some extent from both of the wetlands data sets and from the topographic features database (for example the “Waterbody” layer of the GA topo 250k data set). The choice of features mapped from each of these data sets will influence the accuracy of the resulting floodplain map (Lowry and Finlayson 2002).

Recommendation 13. More detailed biodiversity data are required. Further research is required to source and acquire it.

3.5.4 Data quality

The accuracy of the data on wetland extent is questionable. A recent study that attempted to estimate the area of wetlands in the study region based on nine different data sets (including three used in this project) found great variation in results (Lowry and Finlayson 2001). Large areas of seasonally inundated wetlands characterise the study region. Mapping the extent of such habitats is likely to be more difficult than mapping permanent wetlands, because the time of maximum extent is also the time when wetlands are least accessible and when cloud cover is likely to hamper many remote sensing devices, though work to resolve these issues is ongoing (e.g. Blackman et al. 2002).

The region is also typified by low relief, so the lack of higher resolution DEMs further increases the difficulty of mapping habitats such as floodplains. More detailed data on wetlands mapping are available for a limited number of sites (eg. Kakadu National Park and the Mary River), but most areas are generally mapped at scales too coarse to detect the relatively subtle changes on floodplain systems. The coverage of the wetlands data is likely to be uneven due to variable inventory effort (Whitehead and Chatto 1996). Accuracy of the wetlands data will depend on the source data set, but estimates may be

extremely variable between the three data sources collated for mapping wetlands by this project (Lowry and Finlayson 2001).

Recommendation 14. More accurate and higher resolution data should be acquired for wetlands and floodplains systems, to achieve greater consistency and accuracy.

Macro-invertebrate data quality is quite variable, generally reflecting the different purposes that the data were originally collected for. For example, AusRivAS data, which were collected as part of a national assessment of river health (Norris et al. 2001), are based on single samples identified semi-quantitatively at family level. In contrast, data from Magella Creek, which were collected to determine the effects of uranium mining in Kakadu National Park, are based on replicate samples from multiple sites, collected over many years and identified to species level (Humphrey et al. 1999).

Priorities and recommendations

Recommendation 15. Access to data from the Australian Terrestrial Biodiversity Assessment (NWRLA 2002b) should be negotiated, to assist in further identifying spatial gaps and future directions for tropical rivers research.

- Additional data exist for macro-invertebrates for some areas in the study region, but most of these data, and even the metadata, are not readily available. Including these metadata would be a useful task to pursue in the future.
- In general, the data on biodiversity are poor. Some of this stems from the lack of key data sets being available for inclusion in this project, but other gaps are real and will need to be filled through the collection on new information. River and wetland biodiversity surveys are needed in high priority basins with deficiencies in biodiversity data.
- Documenting the extent of wetlands is a fundamental requirement for inventory and management, yet this cannot be achieved with any certainty using the currently available information (Lowry and Finlayson 2001). Therefore, future work needs to evaluate the techniques for

estimating wetland extent using remotely sensed information, verified by ground-truthing.

- Some information is available on weed and feral animal distributions but much of these data are at a very coarse scale and may be up to 20 years old. Landscape health data are based on expert opinion and unlikely to improve without further data collection. The distribution of pest species may be highly dynamic due to natural rates of spread and in response to management/control activities.

Recommendation 16. More up-to-date information at finer spatial scales is required for weeds, pests and feral animals, particularly for the species of greatest concern to catchment and wetland management authorities.

- Although some information is available on the distribution of the most important weeds and animal pests, determining the threat posed by these pests relies on some understanding of their impacts. This information is lacking for most pest species, and needs to be collected in order to determine the likely outcome of invasion and the need for pest management.

3.6 Estuary condition

3.6.1 Introduction

This theme summarises the state of information available for the estuaries in the study region. Information was collected on the classification of estuary types, the water quality of estuaries, their current use and condition, and their biodiversity.

3.6.2 Data available

Estuaries

The main estuaries data set received was the “Australian Estuaries Database — CAMRIS” (MR196). CAMRIS incorporates the Australian estuarine database, which includes the “National Estuaries Study” (Bucher and Saenger 1989). Attributes include location, name, climatic variables, run-off coefficients, land use, flood frequency, water quality, habitat types including seagrass/mangrove/saltmarsh, fisheries/conservation/amenity values, administration, literature and threats. The 2000 Audit Estuary

Condition Assessment (discussed below) updated and significantly added to this database.

Another major estuaries spatial database that is known to exist is the “OzEstuaries Online Spatial Database”. This data set was not available for this project, but metadata were obtained (MR197).

The OzEstuaries online GIS database <www.ozestuaries.org> contains data for Australian estuaries (coastal waterways) and for oceans in the Australian region. Estuaries data include geomorphic habitat mapping, estuary condition, colour composite images (Landsat, MODIS and Quickbird satellite imagery and aerial photography), benthic classifications (from Landsat satellite imagery), bathymetry and population centres.

The other important estuaries database is the “Estuary Assessment 2000” (MR197a), which assessed the condition of 979 estuaries and classified each by the key geomorphological processes driving it. GA developed a process-based classification covering physical forces (wave, tide and river energies) driving the form and function of Australian estuaries. Geomorphic characteristics and sedimentary environments have been mapped for 405 of Australia's modified coastal waterways.

The assessment was made in two stages.

- Stage 1: Identification of Australia's near-pristine estuaries based on expert opinion through State-based workshops.
- Stage 2: Determining the extent of change for those estuaries no longer considered to be in near-pristine condition through a more quantitative condition assessment based on a pressure-state-response model.

Estuary condition is mapped in Figure 24, and clearly shows an overwhelming abundance of near pristine estuaries in the Tropical Rivers Project area.

Mangroves

A number of mangrove data sets covering parts of the project area have been received. The main national coverage is the “Mangroves of Australia compiled from data from all major Australian State and Commonwealth Herbaria” data set (MR163). Original data from the “Preliminary Atlas of Mangroves

in Australia” have been augmented by data from a range of additional sources, mainly State and Commonwealth herbaria. Data are from collections made since the beginning of European settlement in Australia. Figure 24 shows where mangroves occur in the project area.

Two, very detailed mangrove polygon data sets for the Darwin area (Darwin Harbour and Bynoe Harbour) (MR171–172) were also received.

Tidal regime

Information on the tidal regime for northern Australia is contained in the “Tidal Dataset — CAMRIS” (MR55), which contains maps showing the principal attributes of tides around the Australian coast. It has been derived from data published in the *Australian National Tide Tables*.

3.6.3 Gaps in data

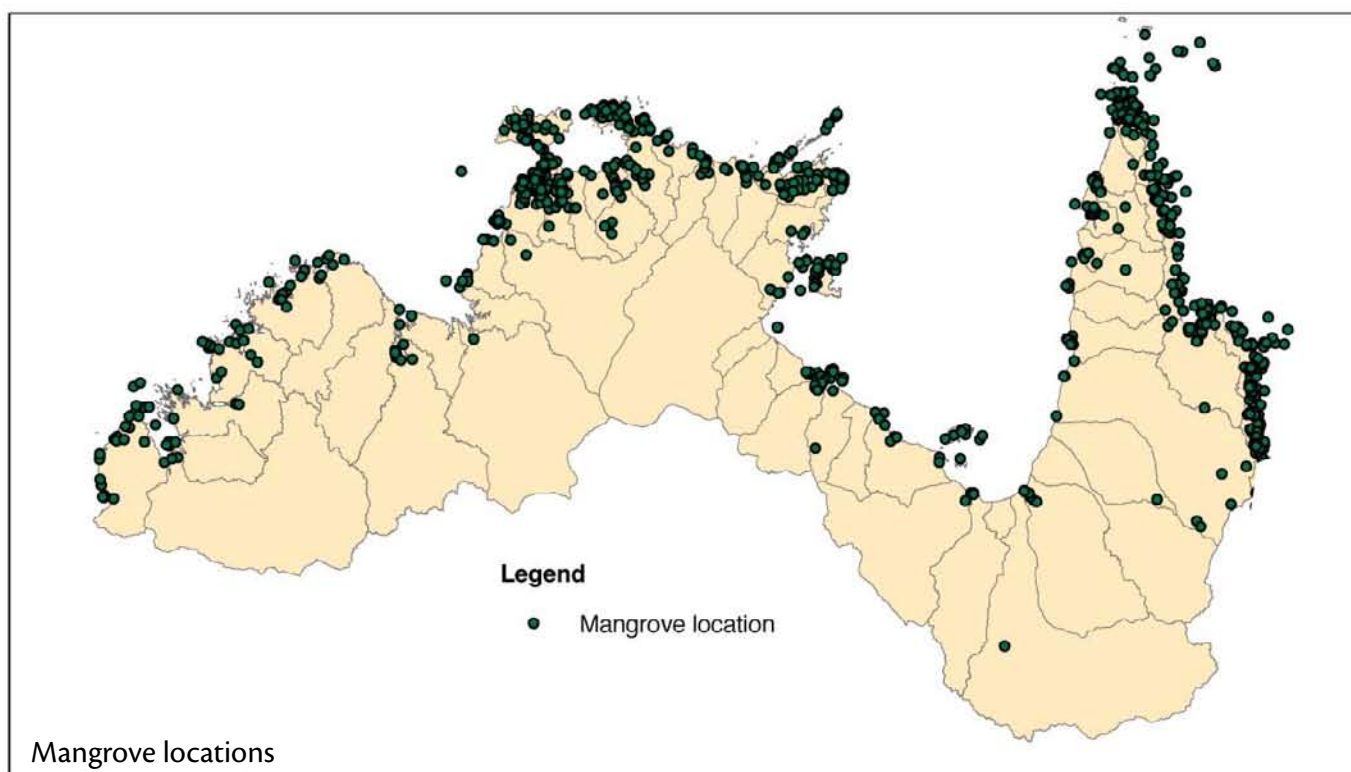
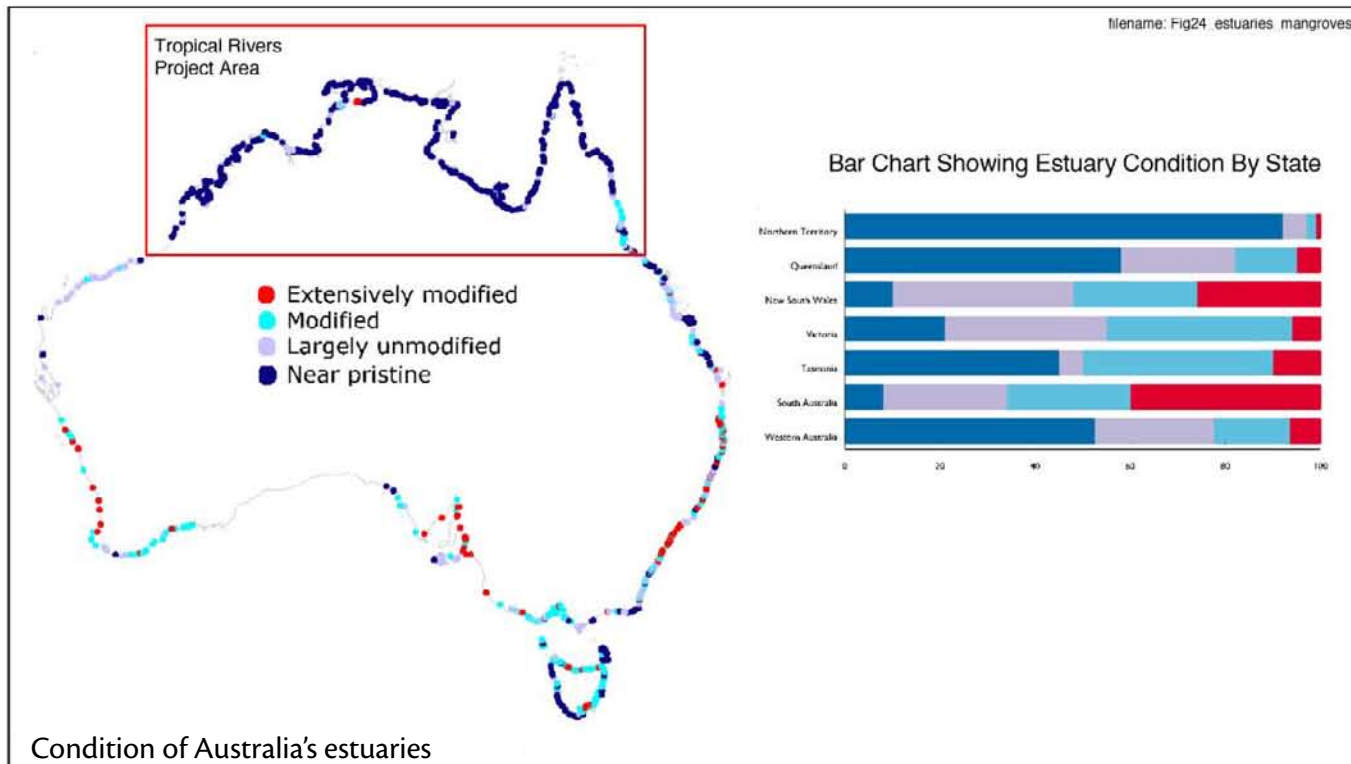
The classification of estuaries based on dominant processes (river or tidal) has been applied to the estuaries in the region (NWRLA 2002a) and is appropriate for the purposes of this project. The assessment of estuarine condition that was undertaken for the NLWRA (2002a) covers the region. There are adequate data on the tidal regime for most estuaries in the region.

There is very little information on the water quality of estuaries in the study region. Little information was provided to assist in determining resource use in most estuaries. Limited information exists on estuarine biodiversity, focusing on mangroves and fish. Mangrove data are available at fine scale for Darwin Harbour. Metadata are available for fish surveys undertaken by the NT Government. Most components of estuarine biodiversity are very poorly known.

Recommendation 17. Water quality and biodiversity data specific to estuaries are a gap in the current project database. Additional data need to be obtained.

3.6.4 Data quality

Most of the estuaries in the study area have been classified as “near-pristine condition” (NLWRA 2002a). It has been noted that the information on near-pristine estuaries is very limited and that the

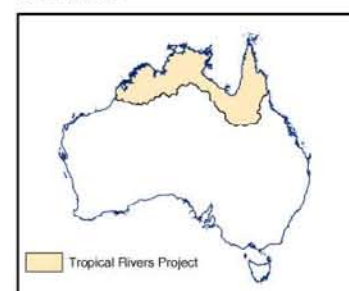


© Commonwealth of Australia, DEH
Data used are assumed to be correct as received from the data suppliers

Sources: Estuaries: Estuary Assessment 2000
Mangroves: DEH

0 125 250 500 km
Projection: Albers Equal Area
Datum: WGS84

Figure 24. Tropical Rivers Project: estuary and mangrove locations.



assessments of estuaries are highly subjective and rely heavily on expert opinion (NLWRA 2002a).

3.6.5 Discussion and conclusions

- Investigating access to and evaluating additional data that exist for estuaries in the study region should be a priority for future work.
- There is a need to develop better hydrodynamic models for estuaries in the region, to better understand and predict the impacts of activity in the estuary and the dynamics of materials transported into estuaries from rivers. Such work should be undertaken in high priority estuaries which have current or planned development likely to affect estuary condition.
- There is a need for better information on the links between catchment management and estuary condition, particularly their implications for fisheries management.
- Given the limited knowledge on estuary biodiversity, there is a need for better assessments of estuarine flora and fauna. In high priority catchments, there is a requirement for understanding of their needs and responses to sediment and nutrient loads, and altered river flows.
- More long-term monitoring is needed of water quality and catchments, to determine natural baseline variability in near-pristine estuaries that can act as benchmarks for modified estuaries.

Recommendation 18. Given that most estuaries are classified as “near pristine” (NLWRA 2002a), there is a need to develop measures of estuary condition that are more sensitive to change.

4 Conclusions and future directions

This project has successfully collated data on and associated with tropical rivers. These data have come from a range of sources. In general, the most relevant, current and accurate data available for the purposes of the Tropical Rivers Project are those that were collected and synthesised as part of the NLWRA. Some NLWRA data, such as basic physical attributes of the catchments including soils and basin outflows, cover the entire study region. However, key components of the NLWRA data, such as landscape health and condition indicators, were restricted to the intensive land-use zone of Australia. In other cases, data for the tropical rivers region were compiled for by NLWRA (eg. riparian vegetation condition, trend in catchment features relating to wetlands, estuary condition) but the quality of the data is noted as being less than ideal for scientific research, and often based on expert opinion rather than quantitative assessment.

The project sought to address these gaps by approaching State/Territory agencies and other custodians to obtain additional data sets. Data from some State agencies were not readily available and, consequently, many of the data collated for this project were derived from NLWRA data. In most cases, the failure to obtain additional data sets highlights a real gap in the data currently available for the study region. In a few other cases, suitable additional data exist but it was not possible to collate them for this project due to time constraints, data-access agreements or the cost of acquisition.

Recommendation 19. Licensing agreements for data exchange between State and Territory agencies and the Australian Government need to be put in place to ensure that there is non-restrictive access to all available data on Australia's tropical rivers.

It should be appreciated that many of the inadequacies of the existing data sets available for the region stem from the different purposes for which they were originally collected. Finlayson et al. (2001)

recognise that data sets on wetlands have typically been collected for three distinct (although often used interchangeably) reasons: wetland inventory; wetland assessment; and wetland monitoring. These different purposes are broadly reflected in the data sets collated. For example, most data collected for the NLWRA was for a condition assessment at a national scale. These data generally have the best coverage across the region but may be considered too coarse for purposes of improving management of rivers in the study region and even less suitable for management of individual basins.

Data collected for the "Directory of Important Wetlands of Australia" (ANCA 1996) were collected as part of a national inventory of a subset of important wetlands. They typically contain a more comprehensive set of information for a particular wetland, but their coverage is patchy, which may limit their use for broad-scale assessments. Data sets collected for monitoring programs are designed to detect changes in particular features at specific sites. These data sets generally contain very detailed information but for a small number of attributes and their coverage is usually very restricted. Data collected for monitoring are also the most likely to have access restrictions. Data collected for monitoring programs in the Alligator Rivers region typify this category.

Recommendations for future research

Four broad areas for further research can be identified from this data-collation process. These areas represent a sequence of activity that builds logically on the data-collation project:

1. obtaining and evaluating additional data sets
2. analysing collated data
3. identifying priority basins and their data needs
4. collecting new data.

1. Obtaining and evaluating additional data sets

This project has identified several data sets that could not be included for evaluation in this project largely

because of time constraints or ongoing data-access negotiations. Priority should be given to obtaining and evaluating the following additional data sets:

Data set	Custodian
National Pollutant Inventory	DEH
Land Use Mapping Program data	BRS
Australian Terrestrial Biodiversity Audit: riparian and wetland condition data	NLWRA
High resolution topography and digital elevation models	GA (DIGO)
Threatened species database	DEH

2. Analysing collated data

The primary objective of this project was to obtain, evaluate and collate the (spatial) data that currently exist for Australia's tropical rivers. This represents a valuable resource and the most comprehensive data set on rivers ever assembled for the region. However, given the time constraints of the project, only cursory analysis of the collated data was possible. There is a clear opportunity, and in fact a pressing need, for more detailed analysis of this data set. Further analysis could also include data from sources that provided only metadata to the collation project. Further analysis could be used to:

- conduct a more comprehensive gap/needs analysis focused at smaller spatial scales (such as identified priority basins)
- develop a broad classification of tropical river types based on biophysical properties such as rainfall and flow regimes, hydrological processes (eg. degree of groundwater influence), geomorphological features, catchment and riparian vegetation, and catchment soils and geology (see Activity 4a below).

3. Identifying high-priority basins and their data needs

For many of the themes examined in this project, data are absent or of poor quality for most of the study region. However, sufficient resources will never become available to collect new data to rectify these gaps across the entire region. Therefore, it is recommended that future research include identification of those areas within the study region with the greatest requirement for particular types of data. Determining which basins have the greatest need for data to assess river condition or monitor the effects of management activities and resource

development should be based on factors including current resource use, catchment condition and landscape stress.

However, given that one of the biggest information gaps in river management elsewhere is suitable baseline information on pre-disturbance conditions, priorities should be focused on those areas with expected or predicated resource use or catchment modification. For example, no further water resource development will be pursued in most of the Gulf catchments in Queensland (QDNRM 2003). Consideration should also be given to how representative a basin is within the region. This could be determined on the basis of bioregional classifications or, preferably, based on a classification of tropical rivers types (see above).

In basins with little development impact, feral animals, grazing and weeds may continue to degrade the wetlands and rivers, but in the absence of basic inventory data we may never know what has been lost. This may also be true for areas managed for conservation. Such catchments could be considered high-priority areas for basic inventory or assessment surveys rather than full baseline monitoring programs.

4. Collecting new data

It is recommended that the collection of new data be guided by the identification of high-priority basins and their data needs. However, given that many of the data gaps apply to most of the catchment areas, it is likely that any new collection will include elements of the following list of research programs having high priority for data collection. This list is based on a summary of the recommendations for each theme. It is not presented in any particular order, as the order of priorities will vary between basins.

a) Classification and typology

Several recommendations related to the need for regionally consistent approaches to classification of wetlands, rivers and riparian zones. Such classifications will assist in determining the degree of representativeness of particular basins, and this will help to identify priority areas for data collection. They may also be valuable for assessing the reliability of extrapolating results from one basin to another. Classifications based largely on biophysical properties

will also provide a basis for the development of river typologies that incorporate functional values such as ecological processes, vulnerabilities and risks (G. Lukacs, pers.comm.)

The application of these classifications across the tropical rivers region will require additional analysis of the collated data and further refinement of techniques such as those based on remotely sensed imagery for identifying and mapping habitats.

b) Hydrological processes

Several recommendations related to the need for research directed at developing a comprehensive understanding of hydrological processes. This will rely on research designed to obtain a better understanding of: rainfall patterns at smaller scales than are currently available; streamflow patterns, particularly from extreme (high and low) flow events; groundwater dynamics and links between surface and groundwater exchange; and hydrodynamic processes in estuaries.

This research will involve the strategic use of additional pluviometers, monitoring of bores and gauging stations, and more comprehensive collection of data from stations during floods and dry season low-flows. The use of tidal and streamflow data will be required for the development of better hydrodynamic models from understanding mechanisms of sediment transport and deposition in estuaries and rivers.

c) Water quality

There is a need for better water-quality data in almost all river basins and associated estuaries. Better water-quality monitoring programs will rely on the use of skilled staff to collect key water-quality information to meet specific management needs in identified catchments. Attention must be paid to the timing of sample collection to ensure that data can be collected to indicate baseline seasonal and inter-annual variation. Data required for sediment and nutrient modelling should be obtained for high-priority basins.

d) Condition indicators

There is a need for research to improve the methods available for assessing the condition of rivers, riparian zones and estuaries. Further research is required to determine the adequacy of macro-invertebrates as indicators of river condition. Other taxa and a

broader range of indicators, including ecosystem processes, should also be evaluated. Techniques suitable for detecting changes in riparian condition of tropical rivers, using more information than the extent of clearing, are also required. Further development of the techniques used in NLWRA are needed to improve methods of assessing estuarine condition, this should include the evaluation of suitable indicator species. Research that integrates these findings and improves understanding of the links between catchment and estuary condition is a high priority.

e) Biodiversity surveys

Research is needed to undertake inventories of freshwater and estuarine biodiversity in priority areas. Many areas are very poorly understood, so systematic surveys will be required. If data are required for monitoring or assessment, then data-collection programs should be designed to provide sufficient baseline data with adequate temporal and spatial replication.

f) Ecological effects of major threatening processes

Research is needed to better understand the extent and impact of potentially threatening processes prevalent in the tropical rivers region. Work is needed to provide more up-to-date assessments of weed and feral animal distributions, and for understanding and quantifying the impacts of pest species on native species, populations, communities and ecosystem processes. Other threatening processes commonly identified throughout the study region, which also require research into their impacts, include altered fire regimes and grazing pressure.

g) Ecological processes/requirements

In addition to the paucity of information on the types and distribution of wetland, riverine and estuarine flora and fauna, there is only a basic understanding of the major ecological processes that drive these ecosystems or their ecological requirements. Research is needed to address this knowledge gap, but the specific aspects of information required should be determined in relation to the current or likely future development status of particular basins. Ecological requirements in terms of flow and habitats are a high priority for rivers, whereas understanding the effects of sediment and nutrient loads have high priority for both rivers and estuaries.

h) Cultural values

Given that vast areas of tropical river basins and coastlines are owned and managed by Indigenous peoples there is a need for research that will document Indigenous values for estuarine, riverine and wetland environments.

The Tropical Rivers Data Collation Program has successfully assembled a very significant volume of currently available data and metadata that can be carried forward into the next phase of any broader research program. It has also highlighted a number of important theme and spatial gaps where data are either not available or are not known to exist.

The next phase of the project will require a focused and theme-specific approach (dependent on the type of research being undertaken) to gain access to the additional data needed to increase our understanding of tropical river systems and to instigate new data-collection programs that will expand the existing database.

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APPENDIXES

1. Metadata
2. Topography and DEM index map
3. Tropical Rivers Project catchments and sub-catchments map

Appendix 1

Metadata

SOURCE	DATA SUBSET (THEME)	MRef	CUSTODIAN	DESCRIPTION	FORMAT	SCALE	METADATA	DATUM	PROJECTION	CONVERTED	MERGED
Data Source: States (WA, QLD, NT)	EDD(1)&(2)=EA supplied; ANRDL=Aust Nat Res Data Library downloads; * =data identified as needing further investigation (BE/OP) ** awaiting more info										
Major Project Theme											
Metadata Only											
Geology			Australian Geological Survey Organisation (AGSO)	Australia, Geology of Australia 1:2,500,000	Arcinfo Export	2500000	yes	WGS84	geographic	yes	NA
EDD(2)		1	Australian Geological Survey Organisation (AGSO)	Australian regolith map	Arcinfo Export	5000000	yes	Australia	geographic	yes	yes
EDD(2)		2	Australian Geological Survey Organisation (AGSO)	GEOLOGY (LITHOLOGY) 1:2 500 000 SCALE	Shapefile	500000	yes	GDA94	geographic	NA	yes
EDD(2)		3	Bureau of Rural Sciences (BRS)	State regolith cover	Shapefile	100000	yes	GDA94	geographic	NA	part
WA		4	DOIR	100k GSWA mapping - 30 sheets	Shapefile	250000	yes	GDA94	geographic	NA	part
WA		5	DOIR	250k GSWA mapping - 7 sheets	Shapefile	500000	yes	GDA94	geographic	NA	N/A
WA		6	DOIR	500K Geology statewide	Mapinfo	2500000	Created	GDA94	Geographic	Shapefile WGS84	N/A
WA		7	DOIR	Geological Map of the NT 2002 (1 CD)	Mapinfo	2500000	Created	GDA94	Geographic	Shapefile WGS84	N/A
NT		8	NTGS	Geological Maps 250K (1 CD)	Mapinfo	2500000	Created	GDA94	Geographic	Shapefile WGS84	Yes
NT		9	NTGS	Radiometric Map of the NT 2003 (6 CDs) (metadata)	ERMMapper ERS	Not known	Created	GDA93	MGA53	ESRI GRID WGS84	N/A
NT		10	NTGS	Magnetic Map of the NT 2003 (1 CD)	ERMMapper ERS: ECW	Not known	Created	GDA93	MGA53	ESRI GRID WGS84	N/A
NT		11	NTGS	Mineral Occurrence Database MODAT (1 CD)	Access 97/Mapinfo/ArcView	250000	Created	GDA94	Geographic	Shapefile WGS84	N/A
NT		12	NTGS	Drill Collars	Mapinfo	100000	Created	GDA94	Geographic	Shapefile WGS84	N/A
NT		13	NTGS	Rock chips	Mapinfo	100000	Created	GDA94	Geographic	Shapefile WGS84	N/A
NT		14	NTGS	Soils	Mapinfo	100000	Created	GDA94	Geographic	Shapefile WGS84	N/A
NT		15	NTGS	Stream sediments	Mapinfo	100000	Created	GDA94	Geographic	Shapefile WGS84	N/A
NT		16	NTGS	100k Geological digital data some coverage	doc & PDF	100000					
Old		17	DNRM	Carpentaria - Kurumba Basins	doc & PDF	1000000					
Old		18	DNRM	Nth Old	doc & PDF	1000000					
Old		19	DNRM	1-250000 Digital Geology Sheets For QLD and NT	Shapefile / Mapinfo	250000	yes	AGD66	Geographic	yes	yes
GA		20	Geoscience Australia	Landsat 7 (1998-2001) All Bands (48 CDs)	ERMMapper: ECW	30m		GDA94	MGA	No	No
Satellite Imagery		21	NTGS	Aerial Photography coverage between 25k & 80k over m	Hardcopy						
NT			DNRM	Australia, Digital Elevation Model (DEM) 9 seconds	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
QLD				Australia, Contours at 50 and 100 metre intervals (derived from 9 second DEM)	Arcinfo Coverage	9 sec	yes	WGS84	geographic	yes (shapefile)	NA
DEM				CONTRIBUTING AREA	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
EDD(2)		22	Geoscience Australia - National Mapping Division (formerly AUSLIG)	DEPOSITIONAL PATH LENGTH	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
EDD(2)		23	Geoscience Australia - National Mapping Division (formerly AUSLIG)	DISTANCE TO RIVERS	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
ANRDL*		24	CSIRO, Land and Water	DISTANCE TO RIVER	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
ANRDL*		25	CSIRO, Land and Water	EROSION GULLY DENSITY	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
ANRDL*		26	CSIRO, Land and Water	EROSION PATH LENGTH	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
ANRDL*		27	CSIRO, Land and Water	Kakadu National Park Elevations	Arcinfo Export	9 sec	yes	?	?	yes (shapefile)	
ANRDL*		28	CSIRO, Land and Water	MEAN ELEVATION	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
ANRDL*		29	Environment Australia, Parks Australia	MEAN SLOPE (S FACTOR)	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
EDD(1)*		30	North	MEAN SLOPE SURFACE	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
ANRDL*		31	CSIRO, Land and Water	PRE-EUROPEAN HILLSLOPE EROSION	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
ANRDL*		32	CSIRO, Land and Water	PRESENT ANNUAL HILLSLOPE EROSION	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
ANRDL*		33	CSIRO, Land and Water	RATIO OF HILLSLOPE EROSION PRESENT TO PRE-EUROPEAN	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	NA
ANRDL*		34	CSIRO, Land and Water	EUROPEAN	Arcinfo Grid	9 sec	yes	WGS84	geographic	NA	

SOURCE	DATA SUBSET (THEME)	MRef	CUSTODIAN	DESCRIPTION	FORMAT	SCALE	METADATA	PROJECTION	CONVERTED	MERGED
Old	DEM				txt					
Climate		46	DNRM	1:50000 Digital Elevation Models						
ANRDL	Climate	47	CSIRO, Land and Water	MEAN ANNUAL AND MONTHLY MAXIMUM DAILY TEMPERATURE (DEGREES CENTIGRADE)	HDR / FLT	0.05 degrees	yes	GDA94 geographic	yes (grid)	NA
ANRDL	Climate	48	CSIRO, Land and Water	MEAN ANNUAL AND MONTHLY MINIMUM DAILY TEMPERATURE (DEGREES CENTIGRADE)	HDR / FLT	0.05 degrees	yes	GDA94 geographic	NA	NA
ANRDL	Climate	49	CSIRO, Land and Water	MEAN ANNUAL AND MONTHLY POTENTIAL EVAPORATION (MM)	HDR / FLT	0.05 degrees	yes	GDA94 geographic	NA	NA
ANRDL	Climate	50	CSIRO, Land and Water	MEAN ANNUAL AND MONTHLY RAINFALL (MM)	HDR / FLT	0.05 degrees	yes	GDA94 geographic	yes (grid)	NA
ANRDL	Climate	51	CSIRO, Land and Water	MEAN ANNUAL AND MONTHLY RUNOFF (MM) IN THE PRESENT DAY AND PRE-1788 SCENARIO	HDR / FLT	0.05 degrees	yes	GDA94 geographic	NA	NA
ANRDL	Climate	52	CSIRO, Land and Water	MEAN ANNUAL AND MONTHLY TOTAL EVAPORATION (MM) IN THE "AGRIC" (PRESENT DAY) AND "BASE" (PRE-1788) SCENARIO	HDR / FLT	0.05 degrees	yes	GDA94 geographic	yes (grid)	NA
EDD(1)*	Climate	53	Environment Australia, Strategic Development Division, ERIN Unit	Australia, Estimated Climate Grids	ArcInfo Export / ArcInfo Grid	9 sec	yes	?	?	NA
ANRDL*	Climate	54	Bureau of Rural Sciences (BRS)	VARIOUS ANUCLIM 1.8 BIOCLIM CLIMATE DATASETS. DATASETS PERTAIN TO ASRIS STUDY AREAS.	ArcInfo Grid	0.01 degrees	yes	WGS84 geographic	NA	NA
Tides										
EDD(2)	Tide	55	Environment Australia, Strategic Development Division, ERIN Unit	Tidal Dataset - CAMRIS	ArcInfo Export	1000000	yes	WGS84 geographic	yes (shapefile)	NA
EDD(2)	Soils	56	CSIRO Division of Soils	Atlas of Australian Soils; Attributes	ArcInfo Export	2500000	yes	WGS84 geographic	yes (shapefile)	NA
ANRDL	Soils	57	NLWRA	Nutrient Status of Australian Agricultural Soils (1989-1999)	Shapefile	Various	yes	?	?	NA
ANRDL*	Soil	58	CSIRO, Land and Water	AVAILABLE WATER CAPACITY FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 1 (A-HORIZON - TOP-SOIL) (DERIVED FROM SOIL MAPPING)	ArcInfo Grid	0.01 degrees	yes	WGS84 geographic	NA	NA
ANRDL*	Soil	59	CSIRO, Land and Water	AVAILABLE WATER CAPACITY FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 2 (B-HORIZON - SUB-SOIL) (DERIVED FROM SOIL MAPPING)	ArcInfo Grid	0.01 degrees	yes	WGS84 geographic	NA	NA
ANRDL*	Soil	60	CSIRO, Land and Water	CLAY CONTENT FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 1 (A-HORIZON - TOP-SOIL) (DERIVED FROM SITE MEASUREMENTS OF CLAY CONTENT)	ArcInfo Grid	0.01 degrees	yes	WGS84 geographic	NA	NA
ANRDL*	Soil	61	CSIRO, Land and Water	CLAY CONTENT FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 2 (B-HORIZON - SUB-SOIL) (DERIVED FROM SITE MEASUREMENTS OF CLAY CONTENT)	ArcInfo Grid	0.01 degrees	yes	WGS84 geographic	NA	NA
ANRDL*	Soil	62	CSIRO, Land and Water	SOIL BULK DENSITY IN SOIL LAYER 1 (A-HORIZON - TOP-SOIL) FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF SUB-SOIL (DERIVED FROM SOIL MAPPING)	ArcInfo Grid	0.01 degrees	yes	WGS84 geographic	NA	NA
ANRDL*	Soil	63	CSIRO, Land and Water	SOIL BULK DENSITY IN SOIL LAYER 2 (B-HORIZON - SUB-SOIL) FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF SUB-SOIL (DERIVED FROM SOIL MAPPING)	ArcInfo Grid	0.01 degrees	yes	WGS84 geographic	NA	NA
ANRDL*	Soil	64	CSIRO, Land and Water	SOIL CLAY CONTENT FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 1 (A-HORIZON - TOP-SOIL) (DERIVED FROM SOIL MAPPING)	ArcInfo Grid	0.01 degrees	yes	WGS84 geographic	NA	NA
ANRDL*	Soil	65	CSIRO, Land and Water	SOIL CLAY CONTENT FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 2 (B-HORIZON - SUB-SOIL) (DERIVED FROM SOIL MAPPING)	ArcInfo Grid	0.01 degrees	yes	WGS84 geographic	NA	NA
ANRDL*	Soil	66	CSIRO, Land and Water	SOIL ERODIBILITY OF SOIL LAYER 1 (A-HORIZON - TOP-SOIL) FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF SUB-SOIL (DERIVED FROM SOIL MAPPING)	ArcInfo Grid	0.01 degrees	yes	WGS84 geographic	NA	NA

SOURCE	DATA SUBSET (THEME)	MRef	CUSTODIAN	DESCRIPTION	FORMAT	SCALE	METADATA	DATUM	PROJECTION	CONVERTED	MERGED
ANRDL*	Soil	67	CSIRO, Land and Water	SOIL NITROGEN FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE (DERIVED FROM SITE MEASUREMENTS OF CARBON/NITROGEN RATIO)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	68	CSIRO, Land and Water	SOIL ORGANIC CARBON FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 1 (A-HORIZON - TOP-SOIL) (DERIVED FROM SITE MEASUREMENTS OF CARBON)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	69	CSIRO, Land and Water	SOIL ORGANIC CARBON FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 2 (B-HORIZON - SUB-SOIL) (DERIVED FROM SITE MEASUREMENTS OF CARBON)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	70	CSIRO, Land and Water	SOIL PH FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF SUB-SOIL (DERIVED FROM SITE MEASUREMENTS)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	71	CSIRO, Land and Water	SOIL PH FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF TOP SOIL (DERIVED FROM SITE MEASUREMENTS)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	72	CSIRO, Land and Water	SOIL SAND CONTENT FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 1 (A-HORIZON - TOP-SOIL) (DERIVED FROM SOIL MAPPING)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	73	CSIRO, Land and Water	SOIL SAND CONTENT FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 2 (B-HORIZON - SUB-SOIL) (DERIVED FROM SOIL MAPPING)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	74	CSIRO, Land and Water	SOIL SATURATED HYDRAULIC CONDUCTIVITY IN SOIL LAYER 1 (A-HORIZON - TOP-SOIL) FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF SUB-SOIL (DERIVED FROM S)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	75	CSIRO, Land and Water	SOIL SATURATED HYDRAULIC CONDUCTIVITY IN SOIL LAYER 2 (B-HORIZON - SUB-SOIL) FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF SUB-SOIL (DERIVED FROM S)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	76	CSIRO, Land and Water	SOIL SILT CONTENT FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 1 (A-HORIZON - TOP-SOIL) (DERIVED FROM SOIL MAPPING)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	77	CSIRO, Land and Water	SOIL SILT CONTENT FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 2 (B-HORIZON - SUB-SOIL) (DERIVED FROM SOIL MAPPING)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	78	CSIRO, Land and Water	SOIL TEXTURE IN SOIL LAYER 1 (A-HORIZON - TOP-SOIL) FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF SUB-SOIL (DERIVED FROM SITE MEASUREMENTS)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	79	CSIRO, Land and Water	SOIL TEXTURE IN SOIL LAYER 2 (B-HORIZON - SUB-SOIL) FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF SUB-SOIL (DERIVED FROM SITE MEASUREMENTS)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	80	CSIRO, Land and Water	SOIL THICKNESS FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 1 (A-HORIZON - TOP-SOIL) (DERIVED FROM SOIL MAPPING)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	81	CSIRO, Land and Water	SOIL THICKNESS FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 1 AND 2 (A AND B-HORIZON - TOP AND SUB-SOIL) (DERIVED FROM SOIL MAPPING)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA
ANRDL*	Soil	82	CSIRO, Land and Water	SOIL THICKNESS FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE OF LAYER 2 (B-HORIZON - SUB-SOIL) (DERIVED FROM SOIL MAPPING)	ArctInfo Grid	0.01 degrees	yes	WGS84	geographic	NA	NA

SOURCE	DATA SUBSET (THEME)	MRef	CUSTODIAN	DESCRIPTION	FORMAT	SCALE	METADATA	PROJECTION	CONVERTED	MERGED
ANRDL*	Soil	83	CSIRO, Land and Water	SOIL TOTAL PHOSPHORUS FOR AUSTRALIAN AREAS OF INTENSIVE AGRICULTURE (DERIVED FROM SITE MEASUREMENTS)	Arctio Grid	0.01 degrees	yes	WGS84 geographic	NA	NA
NT	Soils	84	NT DIPE	Soils Map of the Northern Territory	Coverage	2000000	Created	WGS84 Geographic	Shapelle WGS84	N/A
QLD	Old Soils	85	DMR	This dataset describes the Old soils.	Shapelle	Not given		WGS85 Geographic	Yes(Shapelle)	No
QLD	Cape York Soil Survey	86	DNRM	Soil Survey & Agricultural Assessment of Cape York	Shapelle	900000	yes	WGS84 geographic	No	No
QLD	salinity	87	DNRM	Salinity Hazard Mapping	txt	2500000 & 2000000				
QLD	Soils	88	DNRM	Assessment of Agricultural potential of soils in the Gulf of Carpentaria	Arctio Grid					
QLD	Soils	89	DNRM	Soil survey & irrigated agriculture suitability along the Gulf of Carpentaria	Arctio Grid	100000				
QLD	Soils	90	DNRM	Inventory of the Agricultural Resources and Production of the Gulf of Carpentaria	Arctio Grid					
QLD	Soils	91	DNRM	Assessment of the Agricultural and Pastoral Potential of the Gulf of Carpentaria	Arctio Grid					
QLD	Soils	92	DNRM	Soil Survey and Irrigated Agricultural Suitability Assessment	Arctio Grid					
Geomorphology										
EDD(2)	Geomorphology - coast	93	Australian Geological Survey Organisation (AGSO)	Geomorphological Classification of Australia's coast	Arctio Grid	100m	yes	WGS84 geographic	NA	NA
EDD(1)	Relief and landform	94	Environment Australia, Reserve Systems Section	Australia - a relative relief and landform description map	Arctio Grid					
NT	Geomorphology	95	ERISS	Geomorphic Landscapes of the Kakadu Region	Arctio Grid	2500000	yes	WGS84 geographic	yes (Shapelle)	NA
Fire Regime										
WA	Fire scar history	96	DLI	NOA-AVHRR monthly fire scar history 2002-03	Shapelle		Requested		yes	yes
EDD(1)	Firescar	97	Environment Australia, Portfolio Strategies Group	Firescar temporal data series covering Northern Australia at 0.01 degree resolution.	Arctio Grid	0.01 degrees	yes	WGS84 geographic	NA	NA
NT	Fire Frequency	98	BFCNT	Fire Frequency in the Top End 1993 - 2002	ESRT Grid	500000	Created	WGS84 Geographic	Shapelle WGS84	N/A
NT	Fire History	99	BFCNT	Fire Scars in the NT 2002	Shapelle	250000	Created	WGS84 Geographic	Shapelle WGS84	N/A
QLD	Historic Fires	100	DNRM	Active fires are monitored on a daily basis	txt					
Land Use / Tenure										
			Bureau of Rural Sciences (BRS)	1996/97 LAND USE OF AUSTRALIA, VERSION 2, NATIONAL LAND AND WATER RESOURCES AUDIT	Arctio Grid					
ANRDL	Land Use	101	Bureau of Resource Sciences	Agricultural Land Cover Change (ALCC) data sets	Arctio Grid	0.01 degrees	yes	WGS84 geographic	N/A	N/A
ANRDL	Land Use	102	Bureau of Resource Sciences	Australia - SOE 2001 - Interim 1996/97 Land Use	Arctio Grid	100m	yes	AGD86 geographic	NA	
ANRDL	Land Use	103	Geoscience Australia - National Mapping Division (formerly AUSLIG)	Australia, Public and Aboriginal Land (TENURE 250K)	Arctio Coverage					
EDD(2)	Tenure	104	Environment Australia, Australian & World Heritage Division	Australia, World Heritage Areas	Arctio Coverage	250000	yes	WGS84 geographic	yes (Shapelle)	NA
EDD(1)	Land Use	105	National Land and Water Resources Audit (NLWRA)	LAND TENURE IN AUSTRALIA RANGELANDS (1955 TO 2000)	Shapelle	250000	yes	WGS84 geographic	NA	NA
ANRDL	Land Use	106	National Land and Water Resources Audit (NLWRA)	LAND USE CHANGE IN AUSTRALIA RANGELANDS (1955-1996)	Shapelle	Various	yes	WGS84 geographic	NA	NA
ANRDL	Land Use	107	National Land and Water Resources Audit (NLWRA)	LAND USE IN AUSTRALIA RANGELANDS (1955-1996)	Shapelle	?	yes	WGS84 geographic	NA	NA
ANRDL	Land Use	108	National Land and Water Resources Audit (NLWRA)	LAND USE IN AUSTRALIA RANGELANDS (1955-1996)	Shapelle	250000	yes	WGS84 geographic	NA	NA
ANRDL*	Land Use	109	Agriculture WA	LAND USE IN WESTERN AUSTRALIA 1997, VERSION 5.0	Shapelle	Various	yes	?	geographic	NA
ANRDL	Land Use (Aboriginal)	110	NLWRA / BRS	Rangelands - Aboriginal Lands	Shapelle	10000000	yes	WGS84 Albers Equal Area Conic	NA	NA
NT	Land Use	111	NT DIPE	Land Use Management Mapping (LUMP)	Shapelle	Variable	Created	WGS84 Geographic	N/A	N/A
NT	Cadastral	112	NT DIPE	Land Administration Cadastral Data	DB2	-	Created	WGS84 Geographic	Shapelle WGS84	N/A
NT	Tenure	113	NT DIPE	Aboriginal Freehold	Mapinfo	Not known	Created	WGS84 Geographic	Shapelle WGS84	N/A
NT	Aboriginal Claim	114	NT DIPE	Land under claim (polygon & line themes)	Mapinfo	Not known	Created	WGS84 Geographic	Shapelle WGS84	N/A
WA	Calm Estate	115	CALM	Calm land use estate for WA	Shapelle		no	WGS84 geographic	NA	NA
QLD	Land Use	116	DNRM	Sustainable Management of Mitchell River Catchment	Shapelle					
QLD	Land Use	117	DNRM	Land Resources Survey of the Mayvale Land System, Gtbt	Arctio Coverage					
Boundaries										
EDD(2)	Maritime boundaries	118	Geoscience Australia - National Mapping Division (formerly AUSLIG)	Australia, Australian Maritime Boundaries Information System (AMBS)	Arctio Coverage	100000	yes	WGS84 geographic	Will not be done	N/A
EDD(2)	Coastline	119	Geoscience Australia - National Mapping Division (formerly AUSLIG)	Australia, Coastline and State Borders 1:100,000	Arctio Coverage	100000	yes	WGS84 geographic	yes (Shapelle)	NA
EDD(2)	Coastline	120	Geoscience Australia - National Mapping Division (formerly AUSLIG)	Australia, Coastlines derived at various scales from 1:250,000 to 1:5,000,000	Arctio Coverage	various	yes	WGS84 geographic	NA	NA
QLD	LGA's	121	Department Main Roads		Mapinfo	Not known	no	WGS84 geographic	yes (Shapelle)	
Old	Digital Cadastral Database(DCDB)	122	DNRM	Digital boundaries and database						
Catchments										

SOURCE	DATA SUBSET (THEME)	MRef	CUSTODIAN	DESCRIPTION	FORMAT	SCALE	METADATA	DATUM	PROJECTION	CONVERTED	MERGED
GA	Drainage divisions and basins	123	Geoscience Australia - National Mapping Division (formerly AUSLIG)	Australian Water Resources Commission (AWRC) Drainage Divisions and Basins	Shapefile			GDA94	geographic		
ANRDL	Catchment	124	Bureau of Rural Sciences (BRS)	INDICATORS OF CATCHMENT CONDITION IN THE INTENSIVE LAND USE ZONE OF AUSTRALIA	Arctinfo grid	various	yes	GDA94	geographic	NA	NA
ANRDL	Catchments	125	Australian Surveying and Land Information Group (AUSLIG)	NESTED CATCHMENTS AND SUB-CATCHMENTS FOR THE AUSTRALIAN CONTINENT	Arctinfo Grid / Arctinfo Export	125m	From web	GDA94	geographic	yes	NA
EDD	River Health	125a	Department of Environment and Heritage	AusRivAS	MS Access	NA	100000	WGS84	geographic	yes (shapefile of locations)	
EDD(2)	River Basins	126	Queensland Department of Natural Resources	Minor River Basins - Queensland	Arctinfo Export		no	GDA94	geographic	yes	
WA	Catchments	127	Department of Environment (WRC)	Hydro catchments	Shapefile		no	GDA94	geographic		
NT	Harbour	128	Department of Environment (WRC)	Hydro sub-catchments	Shapefile						
Old	Catchments	129	NT DIPE	Darwin Harbour Catchment Boundary (metadata)	HTML	-	Created	-	-	XML	N/A
Old	Catchments	130	DNRM	Sub-Basin Areas	txt						
Old	Catchments	131	DNRM	Queensland Gauging Station Catchments	txt						
Old	Catchments	132	DNRM	Declared Catchments	txt						
Old	Catchments	133	DNRM	Queensland Drainage Basins	txt						
Old	Catchments	134	DNRM	Queensland Drainage Divisions	txt						
Old	Catchments	135	DNRM	Queensland River Basins	txt						
Infrastructure											
EDD(2)	Dams	136	Geoscience Australia - National Mapping Division (formerly AUSLIG)	Australia, Dams and Storages	Arctinfo Coverage	variable	yes	WGS84	geographic	yes (shapefile)	NA
Old	Dams & Lakes	136a	DNRM	Dams & Lakes	txt	100000					
ANRDL	Water Resources (dams)	137	Agriculture Fisheries and Forestry - Australia (AFFA)	MAJOR WATER RESOURCES INFRASTRUCTURE (PART OF THE AUSTRALIAN WATER RESOURCES ASSESSMENT 2000 DATABASE)	Shapefile	?	yes	GDA94	geographic	NA	NA
WA	Dams	137a	Water Corporation WA	Dams Register	HTML						
EDD(2)	Localities	138	Geoscience Australia - National Mapping Division (formerly AUSLIG)	topo250k_local	Arctinfo Export		250000	GDA94	geographic	yes (shapefile)	NA
GA	Localities	139	GA	Geodata 250k - localities	Shapefile		250000	GDA94	geographic	N/A	yes
EDD(2)	Built up areas	140	Geoscience Australia - National Mapping Division (formerly AUSLIG)	topo250k_bua	Arctinfo Export		250000	GDA94	geographic	yes (shapefile)	NA
EDD(2)	Airports	141	Geoscience Australia - National Mapping Division (formerly AUSLIG)	topo250k_aero	Arctinfo Export		250000	GDA94	geographic	yes (shapefile)	NA
EDD(2)	Roads	142	Geoscience Australia - National Mapping Division (formerly AUSLIG)	topo250k_roads	Arctinfo Export		250000	GDA94	geographic	yes (shapefile)	NA
WA	Road Centrelines	143	MRWA	Road centrelines	Shapefile		various (25000 to yes)	GDA94	geographic	NA	
EDD(2)	Railways	144	Geoscience Australia - National Mapping Division (formerly AUSLIG)	topo250k_rail	Arctinfo Export		250000	GDA94	geographic	yes (shapefile)	NA
	Railways (QLD)	145	DMR	Major railways only.	Mapinfo	Not given			Not given	No	No
ANRDL	Gauging stations	146	Agriculture Fisheries and Forestry - Australia (AFFA)	SURFACE WATER GAUGING STATIONS (PART OF THE AUSTRALIAN WATER RESOURCES ASSESSMENT 2000 DATABASE)	Shapefile/MS Access			GDA94	geographic	NA	NA
BOM	Gauging stations	147	Bureau of Meteorology	Gauging Station Data	Excel / HTML	Unknown	yes				
Old	Dams & Weirs	148	DNRM	Dams & Weirs in Qld	txt		250000				
GA	Waterpoints	149	GA	Geodata 250k - waterpoints (storage dams and bores)	Shapefile		250000	GDA94	geographic	NA	yes
GA	Buildings	150	GA	Geodata 250k - buildings	Shapefile		250000	GDA94	geographic	NA	yes
GA	Utilities (mainly fences)	151	GA	Geodata 250k - utilities	Shapefile		250000	GDA94	geographic	NA	yes
GA	Powerlines	152	GA	Geodata 250k - powerlines	Shapefile		250000	GDA94	geographic	NA	yes
GA	Pipelines	153	GA	Geodata 250k - pipelines	Shapefile		250000	GDA94	geographic	NA	yes
WA	Minesites	154	DOIR	Inventory of abandoned minesites	Shapefile / MS Access		GPS accuracy	GDA94	geographic	NA	
WA	Minesites	155	DOIR	Minedex 2002 Update	Shapefile	?	yes	GDA94	geographic		
NT	Aboriginal communities and outsta	156	NT DIPE	Aboriginal Communities	ASCI	Not known	Created	GDA94	Geographic	Shapefile WGS84	N/A
NT	Aboriginal Sacred Sites	157	AAPA	Northern Territory Aboriginal Sacred Sites (metadata)	HTML	-	Created	-	-	XML	-
WA	Aboriginal Sites Register System	158	DIA	Aboriginal Sites	HTML						
WA	Location of Aboriginal communities	159	DIA	Aboriginal Communities	HTML						
Vegetation											
EDD(1)	Mangroves	160	Environment Australia, Strategic Development Division, ERIN Unit	Biogeographic Regions of Mangroves and Saltmarshes in Australia in relation to IMCRA regions	Arctinfo Export		1000000	yes	WGS84	geographic	yes (shapefile)
EDD(1)	Vegetation	161	Environment Australia, Parks Australia, Parks Australia North	Kakadu National Park Vegetation	Shapefile	100m	yes	AGD66	AMG Z53	yes (shapefile)	

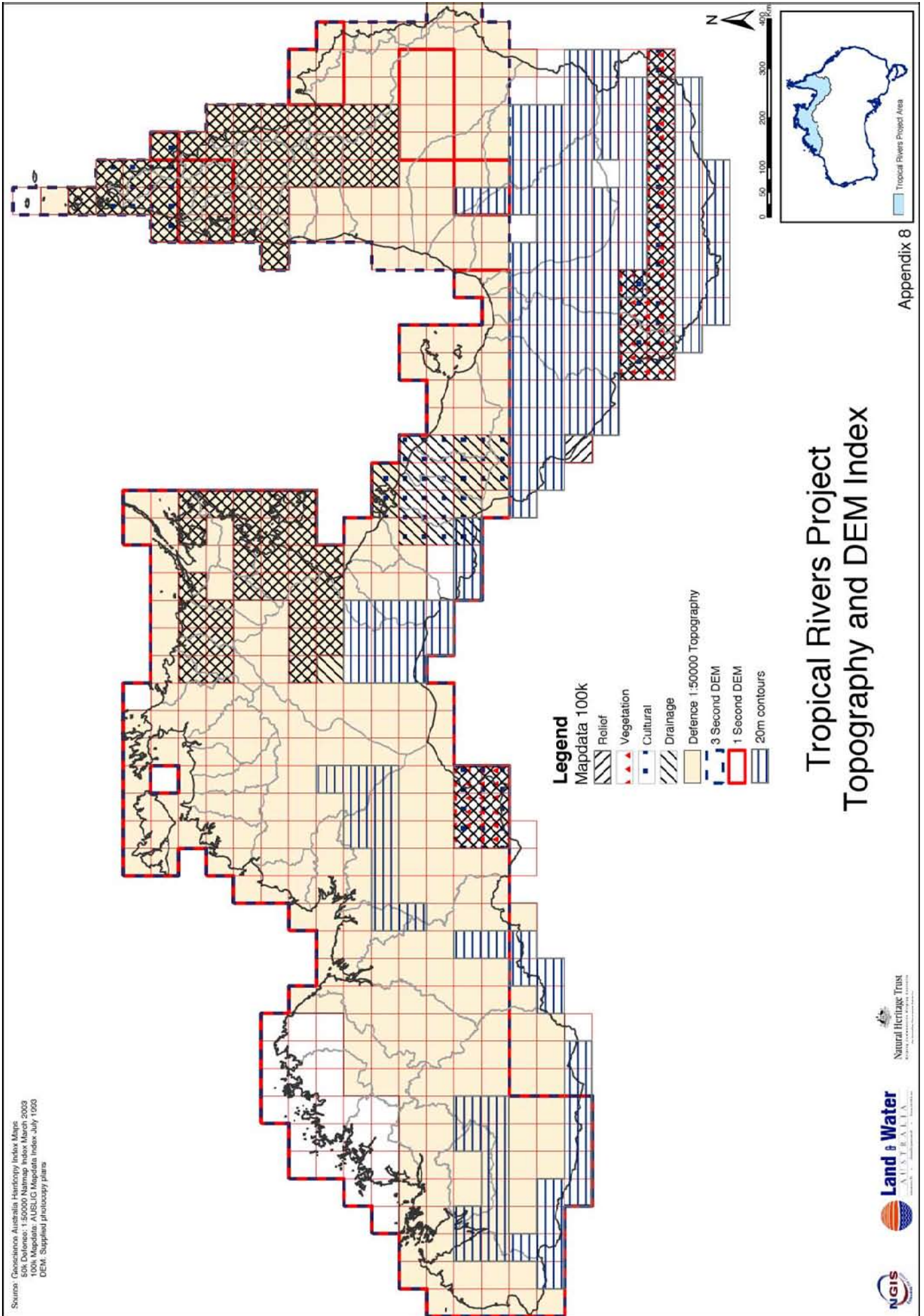
SOURCE	DATA SUBSET (THEME)	MRef	CUSTODIAN	DESCRIPTION	FORMAT	SCALE	METADA	DATUM	PROJECTION	CONVERTED	MERGED
EDD(1)*	Rainforest	162	Environment Australia, Parks Australia, Parks Australia North	Kakadu Rainforest Maps	Shapefile	100m	yes	AGD66	AMG Z53	yes (shapefile)	
EDD(1)*	Vegetation	163	Environment Australia, Strategic Development Division, ERIN Unit	Mangroves of Australia compiled from data from all major Australian State and Commonwealth Herbaria	Arctinfo Export	variable	yes	WGS84	geographic	yes (shapefile)	
EDD(1)*	Vegetation	163a	Australian Government Department of the Environment & Pre-European and Present Native Vegetation	Regional Ecosystem Mapping	Shapefile	1:1000000	yes	WGS84	geographic	NA	yes
QLD	Vegetation	164	Environment Protection Agency	The Vegetation of the Australian Tropical Savannas	Shapefiles	1000000	yes	GDA94	UTM	no	no
QLD	Vegetation	165	Environment Protection Agency	The Vegetation of the Australian Tropical Savannas	Shapefiles	1000000	yes	WGS84	geographic	no	no
QLD	Vegetation	166	Environment Protection Agency	Vegetation Survey and Mapping of Far North Queensland	Shapefiles	250000	yes	GDA94	geographic		
QLD	Vegetation	167	Environment Protection Agency	Remnant Vegetation Cover of Queensland	Shapefiles	250000		GDA94	UTM		
QLD	Vegetation	168	Wet Tropics Management Authority	Stanton / Stanton vegetation update mapping	Mapinfo	250000	no	GDA94	geographic	yes(shapefile)	yes
QLD	Vegetation	169	Wet Tropics Management Authority	wet tropics specific species & datasets	Mapinfo	various	no	GDA94	geographic	yes(shapefile)	yes
QLD	Vegetation	170	CSIRO	Webb/Tracey Mapping 1982	Mapinfo	100000		GDA94	geographic	yes(shapefile)	yes
NT	Mangrove	171	NT DIPE	Mangrove Communities of Darwin Harbour	Coverage	25000	Created	GCS	AMG52	Shapefile WGS84	N/A
NT	Mangrove	172	NT DIPE	Mangrove Survey of Bynoe Harbour	Shapefile	25000	Created	GCS	AMG52	Shapefile WGS84	N/A
NT	Vegetation	173	NT DIPE	Vegetation Map of the Northern Territory	Coverage	1000000	Created	WGS84	Geographic	Shapefile WGS84	N/A
NT	Vegetation History	174	TSCRC	North Australia Vegetation	Shapefile	1000000	Created	GDA94	Geographic	Shapefile WGS84	N/A
Old	Vegetation	175	DNRM	100k Regional Vegetation Management Plan	txt						
Old	Vegetation	176	DNRM	Statewide Land and Tree Study	txt						
Rivers											
EDD(1)	Rivers	177	Environment Australia	Australia - Assessment of River Condition (Reach and Basin) - 2001	Shapefile	250000	yes	?	?	NA	NA
EDD(1)	Rivers	178	Environment Australia, Strategic Development Division, ERIN, Heritage Team	Australian Rivers and Catchment Condition Database (ARCCD) Grids	Arctinfo Grid	250m	yes	Australia	geographic	NA	
EDD(1)	Streamlines	179	Environment Australia, Strategic Development Division, ERIN, Heritage Team	Australian Rivers and Catchment Condition Database (ARCCD) Streamlines	Arctinfo Coverage	250000	yes	WGS84	geographic	yes (shapefile)	NA
EDD(1)	Streamlines	180	Environment Australia, Strategic Development Division, ERIN, Heritage Team	Australian Rivers and Catchment Condition Database (ARCCD) Streamlines - 1 Million tiles	Arctinfo Coverage	250000	yes	WGS84	geographic	NA	NA
			National Land and Water Resources Audit (NLWRA)	EXTENSION OF UNIMPAIRED MONTHLY STREAMFLOW DATA AND REGIONALISATION OF PARAMETER VALUES TO ESTIMATE STREAMFLOW IN UNGAUGED CATCHMENTS (NLWRA 2000)							
ANRDL	Streamflow	181			Shapefile	?	yes	?	?	NA	NA
WA	Rivers	182	Department of Environment (WRC)	Tropical rivers	Shapefile	50000 & 100000	no	GDA94	geographic	NA	
WA	Rivers	183	Department of Environment (WRC)	Wild Rivers	Shapefile	various	yes	GDA94	geographic	NA	NA
QLD	Water courses	184	Wet Tropics Management Authority	East Coast rivers from Cairns to Cooktown	Mapinfo	50000	no	GDA94	geographic	yes (shapefile)	
QLD	Rivers	185	DNRM	River health assessment of Qld rivers	txt						
Old	Rivers	186	DNRM	Surfacewater Resource Information	txt						
Old	Rivers	187	DNRM	Monitoring River Health Initiative	txt						
Old	Rivers	188	DNRM	River Improvement Trust Areas	txt						
Old	Rivers	189	DNRM	State of the Rivers	txt						
Old	Rivers	190	DNRM	Surface Water Ambient Network	txt						
Wetlands											
EDD(1)	Wetlands	191	Environment Australia	Australia, A directory of Ramsar wetlands in Australia	Arctinfo Export	250000	yes	?	?	yes (shapefile)	NA
EDD(1)	Wetlands	192	Environment Australia	Directory of Important Wetlands in Australia Spatial Database	Arctinfo Export	250000	yes	WGS84	geographic	yes (shapefile)	NA
EDD(2)	Wetlands	193	CSIRO Division of Wildlife & Ecology	Wetlands - Estimated Areas	Arctinfo coverage	1000000	yes	WGS84	geographic	yes (shapefile)	NA
Old	Coastal Wetlands	194	Old Fisheries	coastal wetland mapping	Shapefile						
Old	Seagrass meadows	195	Old Fisheries	Coastal seagrass meadows along the Queensland coast	Shapefile						
Estuaries											
EDD(1)*	Estuaries (CAMRIS)	196	Environment Australia, Strategic Development Division, ERIN Unit	Australian Estuaries Database - CAMRIS	Shapefile	1000000	yes	WGS84	geographic	NA	NA
GA	Estuaries	197	GA	OrEstuaries Online GIS Database							
DEH (ANRA)	Estuaries Assessment 2000	197a	GA, CSIRO, EA?	Estuaries Assessment 2000							
Permanent Waterbodies											
GA	Waterbodies	198	GA	Geodata 250k - waterbodies	shapefile	250000	yes	GDA94	geographic	N/A	yes
Water Regimes											
EDD(1)*	Groundwater	199	National Land & Water Resources Audit	Australian Groundwater Flow Systems - National Land and Water Resources Audit, January 2000.	Shapefile	5000000	yes	Australia	geographic	NA	NA
ANRDL	Groundwater	200	National Land & Water Resources Audit	Australian Groundwater Management Units, Unincorporated Areas and Provinces	Shapefile		yes	GDA94	geographic	NA	NA

SOURCE	DATA SUBSET (THEME)	MRef	CUSTODIAN	DESCRIPTION	FORMAT	SCALE	METADATA	PROJECTION	CONVERTED	MERGED
ANRDL	Surface Water	201	National Land & Water Resources Audit	Australian Surface Water Management Areas						
ANRDL	Water Resources	202	Department of Agriculture, Fisheries, Forestry Australia	Australian Water Resources Assessment 2000	MS Access 97		yes			
ANRDL	Water Resources	203	National Land & Water Resources Audit	Australian Water Resources Assessment 2000 - Water Quality Point Sources	MS Access 97		yes			
ANRDL	Water Resources	204	National Land and Water Resources Audit (NLWRA)	1985 REVIEW OF AUSTRALIA'S WATER RESOURCES AND WATER USE						
NT	Bores	205	NT DIPE	Bore Location of the Northern Territory (metadata)	XLS	-	Created	-	-	N/A
QLD	Water Resources	206	DNRM	Irrigation Areas and Storages - Water Supply Systems	txt					
QLD	Water Resources	207	DNRM	Queensland Water Resource Plans	txt					
Hydrological Regimes										
WA	Hydrology	208	Department of Environment (WRC)	Statewide hydrology	Shapefile		2500000	yes	geographic	NA
NT	HYDSYS datasets (metadata)	209	NT DIPE	Site and station details for HYDSYS datasets - Surface	XLS	-	Created	WGS84	Shapefile WGS84	Yes
GA	Hydrology	252	AGSO	Hydrogeological Regions of Australia	Shapefile		5000000	yes	WGS84 geographic	NA
Biodiversity										
NT	Fauna	210	NT DIPE	Northern Territory Fauna atlas (metadata)	XVIL	-	Provided	-	XVIL	-
NT	Fauna	211	MAGNT	Fauna Collections (metadata)	DOC	-	Created	-	XVIL	N/A
Old	Fish	212	Old Fisheries	Fish Habitat Areas	doc		1000000 & 250000			
WA	Abalone, fish, prawns	213	Fisheries WA	10 datasets covering various themes	HTML					
WA	Fauna	214	WA Museum	5 datasets covering birds, reptiles, fish, crustaceans and	HTML					
Water Quality										
ANRDL	Sediment & nutrient	215	CSIRO, Land & Water, Black Mountain	Sediment and nutrient supply to river links	Arctinfo Coverage	250m (9 sec)	yes	WGS84	geographic	yes (shapefile) NA
ANRDL	Sediment & nutrient	216	CSIRO, Land and Water	SEDIMENT AND NUTRIENT SUPPLY TO RIVER LINKS	Arctinfo Grid	250m (9 sec)	yes	WGS84	geographic	NA
NT	See Hydrological regimes HYDSYS	217								
Weeds and Pests										
EDD(1)	Ferals	218	Environment Australia, Strategic Development Division, ERIN Unit	Landscape Health Project Ferals Theme Maps	Excel	NA	yes	NA	NA	
EDD(1)	Weeds	219	Environment Australia, Strategic Development Division, ERIN Unit	Landscape Health Project Weeds Theme Maps	Excel	NA	yes	NA	NA	
NT	Weeds	220	NT DIPE	Weeds NT	Shapefile	Not known	Created	WGS84	Geographic	Shapefile WGS84
Old	Pests	221	DNRM	Weed and Animal Pest Information	txt					
Old	Pests	222	DNRM	Prevention of weed spread	txt					
Topography										
NT	Land Systems	223	NT DIPE	Land system - Barkly Tableland region	Coverage		1000000	Created	AGD66	Geographic
NT	Land Systems	224	NT DIPE	Land system - Katherine-Darwin region	Shapefile		1000000	Created	AGD67	Geographic
NT	Land Systems	225	NT DIPE	Land system - Ord/VPD region	Shapefile		1000000	Created	AGD68	Geographic
NT	Land Units	226	NT DIPE	Land Unit Mapping in the NT (metadata)	HTML	-	Created	-	XVIL	-
Other										
ANRDL	Salinity	227	National Land and Water Resources Audit (NLWRA)	AUSTRALIA DRYLAND SALINITY ASSESSMENT SPATIAL DATA (1:2,500,000) - NLWRA 2001	Arctinfo Export	2500000	yes	GDA94		
EDD(1)	IBRA	228	Environment Australia, Reserve Systems Section	Australia, Interim Biogeographic Regionalisation for Australia (IBRA), Version 5.1	Arctinfo Export	250000	yes	WGS84		
EDD(1)	IBRA	229	Environment Australia, Reserve Systems Section	Australia, Interim Biogeographic Regionalisation for Australia (IBRA), Version 5.1-Sub-regions	Arctinfo Export	250000	yes	WGS84	geographic	yes (shapefile) NA
EDD(1)	IMCRA	230	Environment Australia	Australia, Interim Marine and Coastal Regionalisation for Australia (Mesoscale) (IMCRA)	Shapefile	2500000	yes	?	?	NA
EDD(1)	National Estate	231	Environment Australia, Australian & World Heritage Division	Australia, Register of the National Estate (RNE) - Spatial Database (RNESDB)	Shapefile	250000	yes	WGS84	geographic	NA
EDD(1)	Landscape Health	232	Environment Australia, Strategic Development Division, ERIN Unit	Landscape Health Project Final Maps	Excel	NA	yes	NA	NA	
EDD(1)	Landscape Health	233	Environment Australia, Strategic Development Division, ERIN Unit	Landscape Health Project Primary Data	Excel	NA	yes	NA	NA	
ANRDL	Irrigation	234	CSIRO, Land and Water	PROPORTION OF LAND AREA UNDER IRRIGATION Australia - Landscape Health Database 2001	HDR / FLT		yes			
EDD(1)*	Landscape Health	235	Environment Australia, Strategic Development Division, ERIN Unit	Australian Coastal Regionalisations - CAMRIS	Excel	NA	yes	NA	NA	
EDD(1)*	Coastal Regionalisation (CAMRIS)	236	Environment Australia, Strategic Development Division, ERIN Unit	Australian Regional Cyclone Intensity and Frequency Index - CAMRIS	Arctinfo Export		1000000	yes	WGS84	geographic
EDD(1)*	Cyclone (CAMRIS)	237	Environment Australia, Strategic Development Division, ERIN Unit	Australian Regional Cyclone Intensity and Frequency Index - CAMRIS	Arctinfo Export		1000000	yes	WGS84	geographic
QLD	Land Management	238	CSIRO	Catchment Management, Water Quality & nutrient Flows	Report					

SOURCE	DATA SUBSET (THEME)	MRef	CUSTODIAN	DESCRIPTION	FORMAT	SCALE	METADA	DATUM	PROJECTION	CONVERTED	MERGED
QLD	Land Management	239	Greening Australia	Greening Australia Southern Gulf Catchments	Report						
EDD(2)	?	240	GA	topo250k_offsh	Arctio Export	250000	yes	GDA94	geographic		
EDD(2)	?	241	GA	topo250k_water	Arctio Export	250000	yes	GDA94	geographic		
ANRDL	Remoteness Index	242	ABS	Accessibility and Remoteness Index of Australia	Shapfile	25000000	yes	WGS84	Albert Equal A	N/A	NA
GA	Reserved Areas	243	GA	Geodata 250k - reserved areas	shapfile	2500000	yes	GDA94	geographic	N/A	yes
GA	Relief area	244	GA	Geodata 250k - relief area	shapfile	250000	yes	GDA94	geographic	N/A	yes
GA	Assorted Themes	245	GA	Geodata 250k	shapfile	250000	yes	GDA94	geographic	n/a	no
WA	Various	246	Agriculture WA	16 datasets - assorted themes	HTML						
WA	Various	247	CALM	12 datasets - assorted themes	HTML						
WA	Petroleum	248	DOIR	WA Petroleum Map (WAPMAP)	HTML						
WA	Petroleum pipelines	249	DOIR	WA Petroleum pipelines (WAPIPE)	HTML						
WA	Various	250	DLI	22 datasets - assorted themes	HTML						
WA	Various	251	WRC	17 datasets - assorted themes	HTML						

Appendix 2

Topography and DEM Index Map



Appendix 3

Tropical Rivers Project Catchments and Sub-catchments Map

