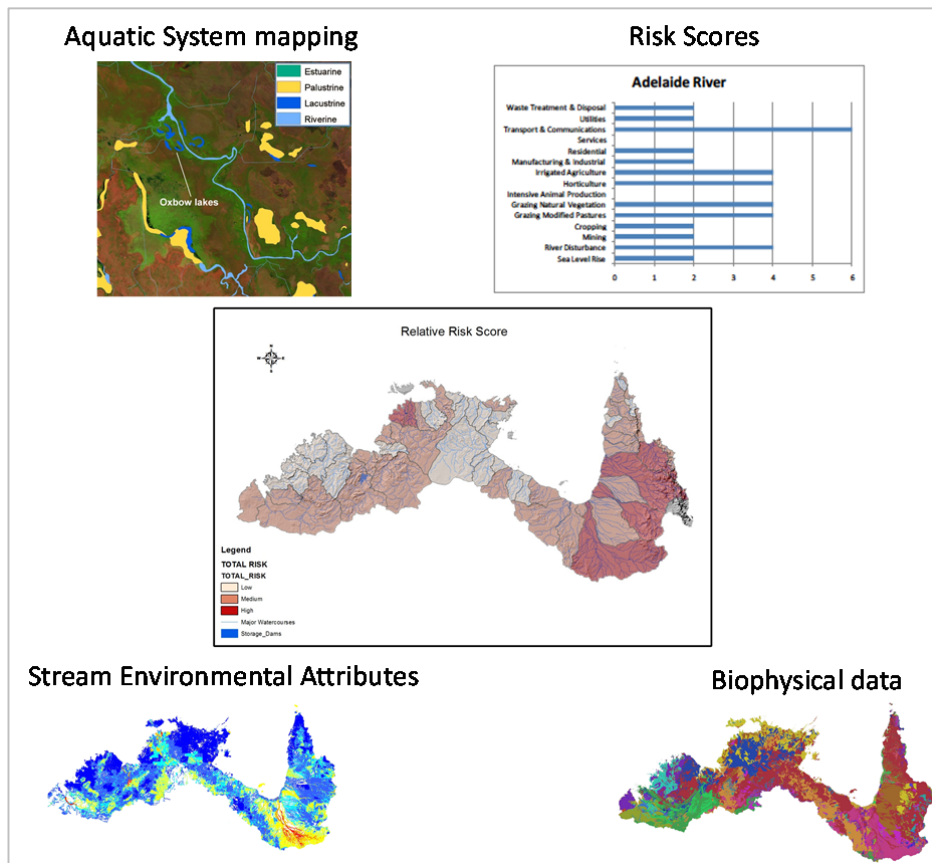# CLIMATE CHANGE ADAPTATION ACROSS AUSTRALIA'S MONSOONAL NORTH – NORTHERN MONSOON NRM CLUSTER

NORTHERN AUSTRALIAN AQUATIC ASSETS GEODATABASE V2.0 – USER GUIDE

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NORTHERN AUSTRALIAN AQUATIC ASSETS GEODATABASE V2.0
User Guide

SUMMARY

The Northern Australian Aquatic Assets Geodatabase (NAAAG) v2.0 has been developed to assist in the quantification and communication of risks associated with threats to aquatic ecological assets across northern Australia. The NAAAG comprises a base level set of spatial layers on aquatic features (rivers, lakes, swamps, estuaries, springs) and context layers (catchments, land use, protected areas, terrain, vegetation, roads and places) associated with the aquatic features. The NAAAG also includes a catchment based assessment of relative risk scores associated with threats arising from factors such as flow alteration, sea level rise and climate change. Because a great deal of spatial data is now freely available for download, the NAAAG is not a comprehensive database but has been designed as a base level set of data on aquatic features upon which users can incorporate additional data sets if desired.

The NAAAG v1.0 data package has been developed using ESRI Geodatabase technologies and the data layers have been set up for viewing as an ArcMAP 10.1 project. This document is a User Guide for the NAAAG, providing information on the design and structure of the geodatabase, how to use the data, and background information on data layers stored in the geodatabase. Metadata and supporting documentation for the data sets incorporated into the geodatabases is also included in the data package.

NAAAG DATA PACKAGE DESCRIPTION

The NAAAG v1.0 data package comprises four ESRI Geodatabases and the data layers have been set up for viewing as an ArcMAP 10.1 project. A folder containing supporting documents and metadata is also supplied.
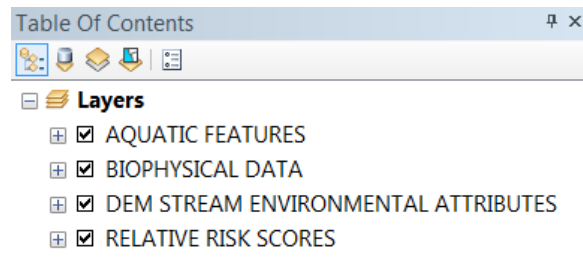
To access the data, unzip the data package. The data package will unzip as follows:

To view the data in ArcMAP, double click the "Northern Australia Aquatic Assets Geodatabase v1.0.mxd"

NOTE: Users will require ArcMAP Version 10.1 or greater to view the data using the supplied ArcMAP mxd.
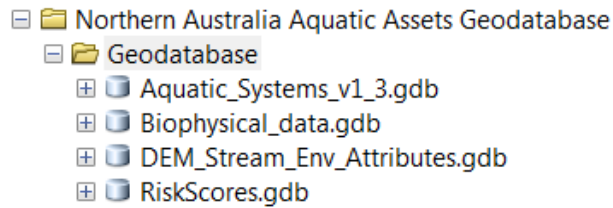
The data layers have been grouped into the following four themes:

Clicking on the '+' beside each theme in the table of contents will reveal the data layers under each theme:

Spatial data associated with each data theme in the NAAAG is stored in a separate stand-alone ESRI Geodatabase:

GEODATABASE THEMES

1. Aquatic Features

This geodatabase contains the aquatic features (rivers, lakes, swamps, floodplains, springs, estuaries), which have been classified into broad AQUATIC SYSTEMS (Riverine, Lacustrine, Palustrine, Estuarine, and Springs) based on the Australian National Aquatic Ecosystem (ANAE) Classification System (AETG, 2010,). A further classification of aquatic systems into AQUATIC SYSTEM ECOTOPES based in similarity in environmental characteristics is also provided (Ward et al., 2010).

2. Stream Environmental Attributes

This geodatabase contains the NATIONAL STREAM ENVIRONMENTAL ATTRIBUTES geodatabase (Stein et al., 2012). The geodatabase comprises Digital Elevation Model (DEM) derived stream network and sub-catchments and an associated set of lookup tables supplying attributes describing the natural and anthropogenic characteristics of the stream and catchment environment. These attributes cover a range of themes drawn from a range of sources and scales and are calculated for the finest scale catchment units (segments) in the National Catchment Boundary (NCB) framework (Stein et al., 2011).

3. Biophysical Data

This geodatabase comprises base level biophysical context information relevant to the Aquatic Features:

- Catchments
- Land Use
- Protected Areas
- Terrain
- Vegetation
- Roads and Places
- Flood Mapping
- Imagery

4. Relative Risk Scores

This geodatabase contains spatially explicit maps of Relative Risks and Vulnerabilities (based on semi-quantitative Relative Risk Models) for all of northern Australia's coastal river catchments. See the document "*Vulnerability and risk assessment of northern Australian catchments and biodiversity*" (Close et al., 2015) included in the 'Supporting documents and metadata' folder for methods and results of the Relative Risks and Vulnerabilities analysis.

GEODATABASE LAYERS

This section provides an overview and background of the data layers associated with each data theme and identifies any specific information that assists the user in applying the data.

AQUATIC FEATURES

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☐ ☑ AQUATIC FEATURES
    ☐ ☐ AQUATIC SYSTEMS
        ⊞ ☐ Estuarine
        ⊞ ☐ Riverine_Watercourse
        ⊞ ☐ Riverine_Waterbody
        ⊞ ☐ Lacustrine
        ⊞ ☐ Palustrine
        ⊞ ☐ Springs
    ☐ ☑ AQUATIC SYSTEM ECOTOPES
        ⊞ ☐ Riverine_ecotopes
        ⊞ ☐ Lacustrine_ecotopes
        ⊞ ☐ Palustrine_ecotopes
```

Aquatic Systems

The Australian Hydrological Geofabric Surface Cartography product (Commonwealth of Australia (Bureau of Meteorology), 2014) was used as the primary data source for the collation and classification of the Aquatic Systems for Northern Australia (Ward et al., 2010). This product provides a seamless surface hydrography layer for Australia at a nominal scale of 1:250,000. It consists of lines, points and polygons representing natural and man-made features such as watercourses, lakes, dams and other water bodies, as well as information on naming, hierarchy and perenniality. The Australian Hydrological Geofabric Surface Cartography product was developed primarily from the GEODATA TOPO 250K Series 3 (GEODATA 3) product (Geoscience Australia, 2006). The Australian National Aquatic Ecosystem (ANAE) Classification System (AETG, 2010) was applied to delineate the Geofabric hydrography data into five broad Aquatic Systems classes (Riverine, Lacustrine, Palustrine, Estuarine and Artificial) for northern Australia (Table 1 and Figure1a, b, c, d).

Table 1. Northern Australian Aquatic Systems and their associated aquatic ecosystem types within the Australian National Aquatic Ecosystem (ANAE) Classification System (AETG, 2010)**.**

Aquatic System	Ecotope types present in northern Australia
Estuarine	Semi-enclosed embayments receiving sea water and fresh water inputs, mangrove forests, saltmarshes, saltflats, intertidal flats.
Riverine	Rivers, streams and waterbodies that may have fringing aquatic vegetation (but not including the hyporheic zone).
Lacustrine	Large waterbodies situated in a topographic depression or river channels that are largely open water features but may contain fringing aquatic and terrestrial vegetation.
Palustrine	Floodplains and vegetated wetlands such as marshes, bogs and swamps, and including small, shallow, permanent or intermittent water bodies.
Artificial	Reservoirs, farm dams, mine tailings dams, flood irrigated field, canals and drainage channels
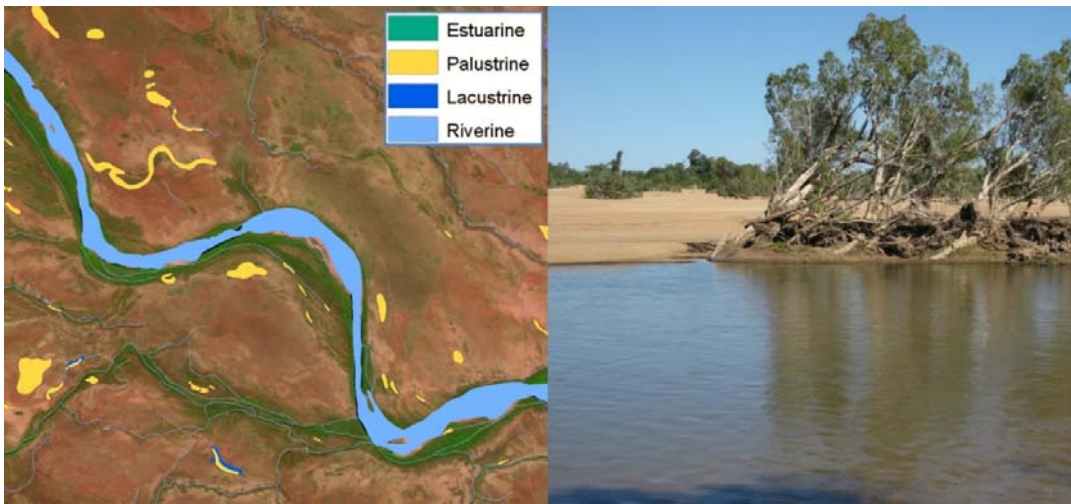
Figure 1a. Riverine example showing the Mitchell River main channel at Koolatah.
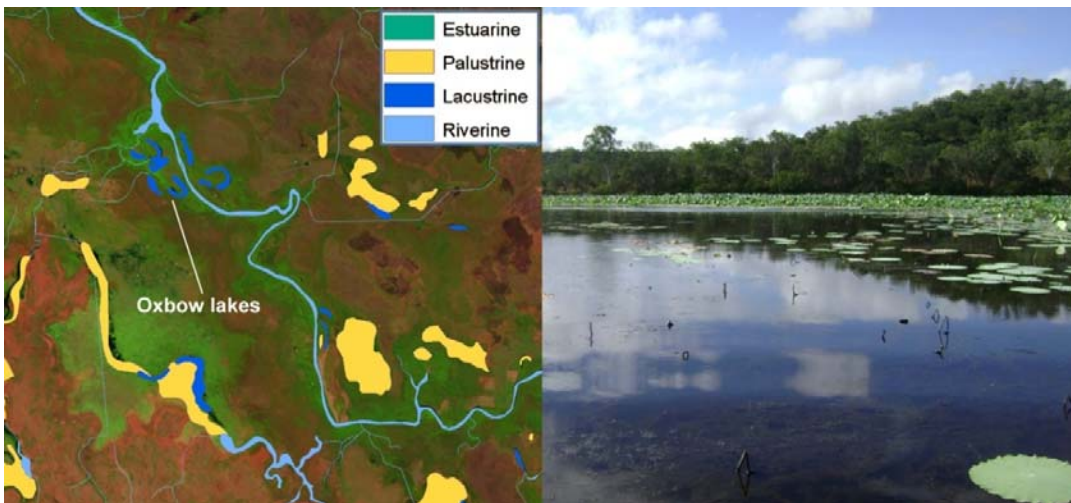
Figure 1b. Lacustrine example showing Oxbow lakes on the Daly river floodplain.
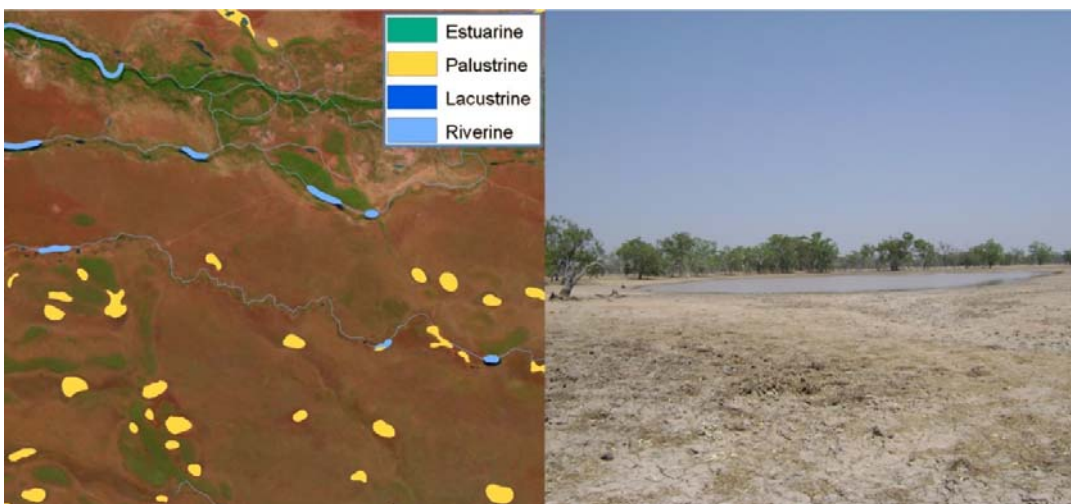
Figure 1c. Palustrine example showing Palustrine water bodies on the Mitchell-Coleman river floodplain

Figure 1d. Perennial and non-perennial water bodies on the Fitzroy River, Western Australia.

Aquatic System Ecotopes

Further application of the ANAE scheme was implemented in the classification of Aquatic System Ecotopes. The approach adopted in implementing the ANAE Ecotope classification was to attribute Aquatic System level water features with environmental data and apply statistical classification techniques to delineate ecotopes within each Aquatic System class (Ward et al., 2010) (Figure 2, Figure 3). The environmental data used in attributing Aquatic Systems comprised the broad themes of Climate, Catchment Water Balance, Vegetation, Substrate and Topography.
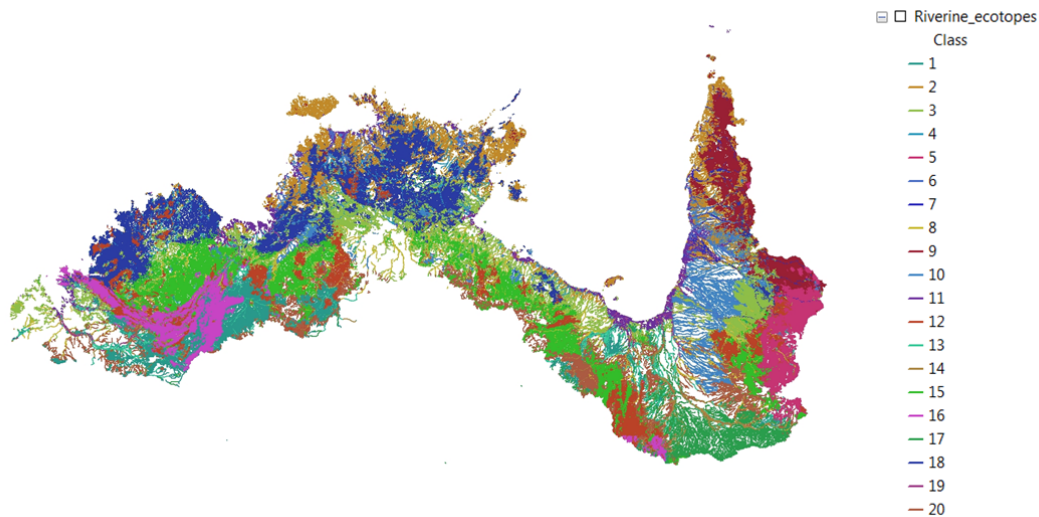
Figure 2. Riverine Ecotopes for northern Australia

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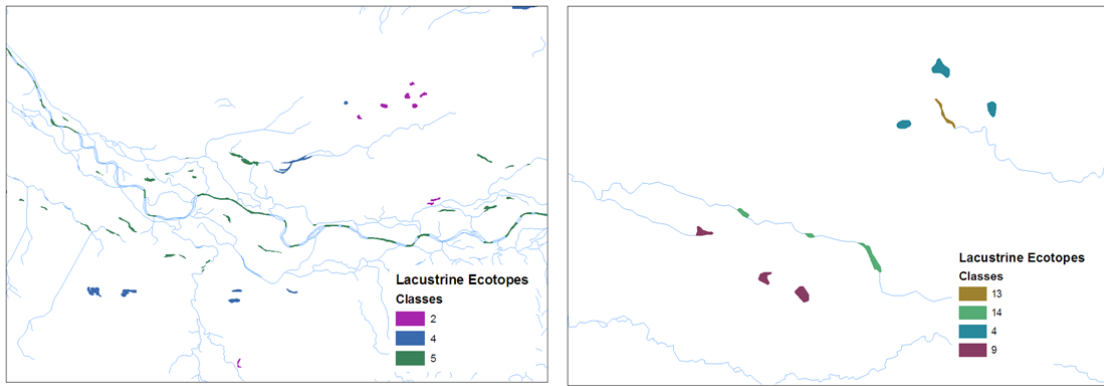
Figure 3. Lacustrine Ecotopes on the main channel of the Fitzroy river showing ecotope classes 2, 4 and 5, and on the Mitchell river floodplain showing ecotope classes 4, 9, 13 and 14.

The delineated Aquatic Systems and associated Aquatic System Ecotopes provide a base level mapped aquatic assets for Northern Australia at a scale of 1:250,000.

Spatial representation of Aquatic Features

Aquatic feature are represented spatially as either points, lines and polygons:

The original GEODATA mapping was at a scale of 1:250,000 and consequently aquatic features (e.g. waterholes) less than approximately 1 ha is size are not mapped as polygons but are represented as points. Similarly, small streams are mapped as single lines and only large river channels are represented as double line streams.

The process of classifying Aquatic Systems to Ecotopes based on environmental attributes resulted in the allocation of a class number to aquatic features. For the ecotope classification exercise, only classification of Riverine lines, and Lacustrine and Palustrine polygons was undertaken (Figure 2, Figure 3).

Aquatic System Validation

To assess the validity of applying the ANAE Aquatic System delineation scheme to the 1:250,000 Geodata Hydrography features, Ward et al., (2010) made a comparison between the Geodata derived Aquatic Systems and the Aquatic Systems delineated by the Queensland Wetland Mapping and

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Classification program. The result of comparing 1:250,000 Geodata Palustrine Aquatic System with the Queensland DERM 1:100,000 and 1:50k Palustrine Aquatic Systems generally supports the premise that while mapping scale will significantly influence the number of mapped features, the resulting proportions between river basins are similar. The Pearson correlation coefficient for the relationship between the raw counts of the 1:250,000 Geodata and the raw counts of the DERM 1:50,000 data is 0.97.

BIOPHYSICAL DATA

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☐ ☑ BIOPHYSICAL DATA
   ☐ ☐ CATCHMENTS
      ⊞ ☐ AWRC_catchments_GDA94_nth_au
      ⊞ ☐ NCB_level2_catchments_nth_au
   ☐ ☐ LAND USE
      ⊞ ☐ Land_Use
   ☐ ☐ PROTECTED AREAS
      ⊞ ☐ CAPAD
   ☐ ☐ TERRAIN
      ⊞ ☐ Digital_Elevation_Model
      ⊞ ☐ Valley_Bottom_Floor_Index
   ☐ ☐ VEGETATION
      ⊞ ☐ NVIS_Major_Vegetation_Subgroug
   ☐ ☐ ROADS & PLACES
      ⊞ ☐ Placenames
      ⊞ ☐ Populated_Places
      ⊞ ☐ Roads
   ☐ ☐ FLOOD MAPPING
      ⊞ ☑ DFO_flood_map
   ☐ ☐ IMAGERY
      ⊞ ☐ Australia_north
```

Catchments
Two catchment layers are provided:
1) National Catchment Boundaries (NCB) Level 2 Drainage Divisions
- This catchment layer is part of the Australian Bureau of Meteorology 's water resources information system, a continent-wide catchment framework, known as the National Catchment Boundaries (NCB) (Stein et al., 2011).

http://www.bom.gov.au/water/awid/id-1105.shtml

2) Australian Water Resources Council (AWRC) catchment layer
- This catchment layer is an earlier representation of drainage divisions and is in the process of being replaced. However, it is still commonly used and so is included here.

Land Use
Land use data is sourced from The Australian Collaborative Land Use and Management Program (ACLUMP) which develops nationally consistent land use mapping for Australia at both 'national' and 'catchment' scale.

http://www.agriculture.gov.au/abares/aclump/about-aclump

Protected Areas

Protected area information is sourced from the Collaborative Australian Protected Area Database (CAPAD) 2012.
http://www.environment.gov.au/topics/land/nrs/science-maps-and-data/capad.shtml

Terrain

The terrain data comprises the GEODATA 9 Second Digital Elevation Model (DEM-9S) Version 3 which is a grid of ground level elevation points covering the whole of Australia with a grid spacing of 9 seconds in longitude and latitude (approximately 250 metres).
http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_66006.html

Vegetation

Vegetation data is sourced from the National Vegetation Information System (NVIS) and provides information on the NVIS Major Vegetation Group (MVG) and Major Vegetation Subgroup (MVS).
http://www.environment.gov.au/topics/science-and-research/databases-and-maps/national-vegetation-information-system/data-products.shtml

Roads and Places

Roads and places are sourced from the GEODATA TOPO 250K Series 3 vector representation of the major topographic features appearing on the 1:250,000 scale maps.
http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_63999.shtml

Flood Mapping

Flood mapping is sourced from the Dartmouth Flood Observatory, Colorado which undertakes space-based measurement and modelling of surface water.
http://floodobservatory.colorado.edushtml

Imagery

Imagery is a 2002 Landsat mosaic captured between July and November.

NATIONAL CATCHMENT BOUNDARIES (NCB) STREAM ENVIRONMENTAL ATTRIBUTES

The National Catchment Boundaries(NCB) GeoDatabase is a linked set of spatial layers and associated attribute tables describing key elements of the surface water hydrology of the Australian continent at a map scale of about 1:250,000 (http://www.bom.gov.au/water/awid/id-1105.shtml). It is built upon the representation of surface drainage patterns provided by the GEODATA national 9 second Digital Elevation Model (DEM) Version 3. The stream network and catchment boundaries contained within the database form foundation elements of the Bureau of Meteorology's Australian Hydrological Geofabric, the spatial framework that underpins the Australian Water Resources Information System (AWRIS). This database adds additional environmental attributes and comprises the following components:

1. National_Catchment_Boundaries geodatabase – the National Catchment Boundaries delineate hierarchically nested catchments subdivided into successively finer sub-catchments using a modified version of the Pfafstetter reference system (Figure 4)
2. DEM Derived Streams – a fully connected and directed stream network (Figure 4)
3. Stream environmental attribute geodatabase – a set of lookup tables supplying attributes describing the natural and anthropogenic characteristics of the stream and catchment environment (Table 2).
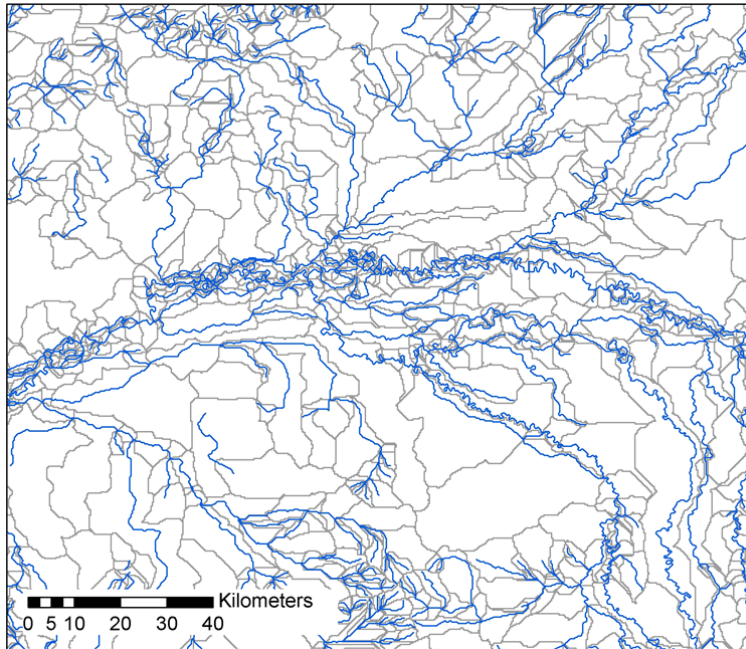

Figure 4. Finest scale delineation National Catchment Boundaries with DEM derived stream network. Each catchment and stream segment has attributes describing the natural and anthropogenic characteristics of the stream and catchment environment.

The NCB STREAM ENVIRONMENTAL ATTRIBUTES geodatabase attributes cover a range of themes (Table 2) drawn from a range of sources and scales and are calculated for the finest scale catchment units (segments) in the NCB framework (see Figure 4).

Table 2. NCB Stream and catchment environmental attribute themes and description
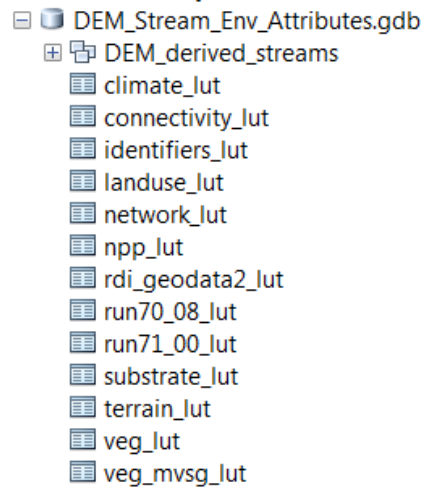
THEME	DESCRIPTION
Connectivity	Natural (cliff) and artificial (Dams etc) barrier information
Disturbance	Information on the spatial extent and potential magnitude of impact of human activities on riverine ecosystems using geographic data on land-use, urbanization, extractive industries and other point sources of pollution, and water infrastructure (i.e. a 2010 update of the River Disturbance Index described in Stein et al 2002).
Landuse	Information on landuse such as irrigation, animal production, plant production, mining, forestry etc
NPP	Monthly mean net terrestrial primary productivity
Runoff	Modeled monthly long term runoff statistics (mean, CofV, seasonality etc)
Vegetation	NVIS broad vegetation classes (shrubs, woodland, forest etc) and broad major floristic sub-groups
Substrate	Geology and soil information
Terrain	Elevation, slope, aspect, catchment area, distance to outlet etc
Climate	Rainfall, temperature, radiation, growth indices

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NCB stream environmental attributes are of two types:
- Local attribute relating only to a specific stream segment (e.g. Mean segment elevations)
- Routed data such that information in a segment reflects the influence of all segments that drain into any specific segment (e.g. River Disturbance Index)
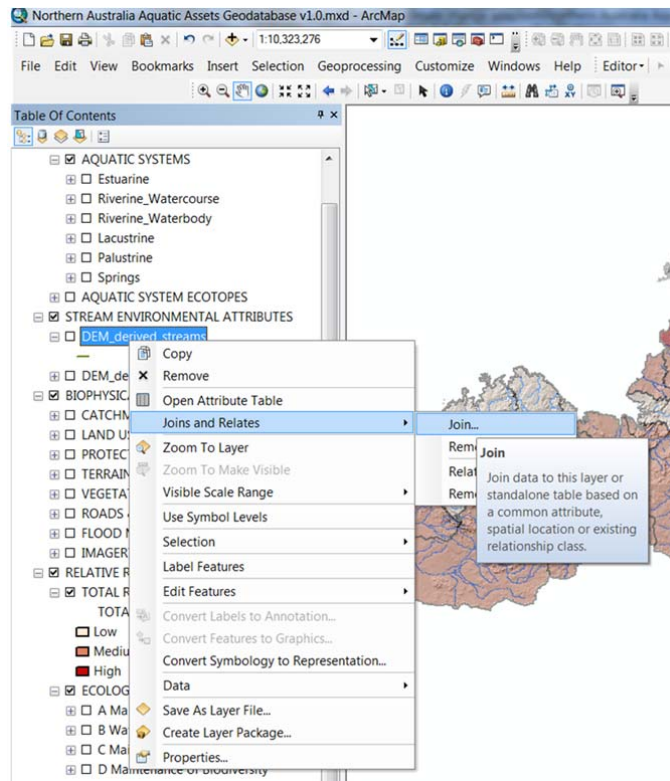
Using the NCB Stream Environmental Attributes

The environmental attributes associated with each stream segment and segment catchments are stored in lookup tables in the STREAM ENVIRONMENTAL ATTRIBUTES geodatabase:

NOTE: A full list and description of the environmental attributes for each look-up table is provided as a spreadsheet in the "Supporting documents and metadata" folder.

To visualise and use the stream environmental attribute data, the user will need to JOIN the look-up table (e.g climate_lut) to either the DEM derived stream network or stream catchments. Right click the stream or catchment layer and use the "SEGMENTNO" field to JOIN the look-up table to the stream or catchment layer:

There are a large number of tables and each table contains a lot of data so the user is advised to minimise the number of tables joined at any one time. Once the data is joined, the environmental attributes can be displayed as either stream lines or stream fine scale catchments (Figure 5).
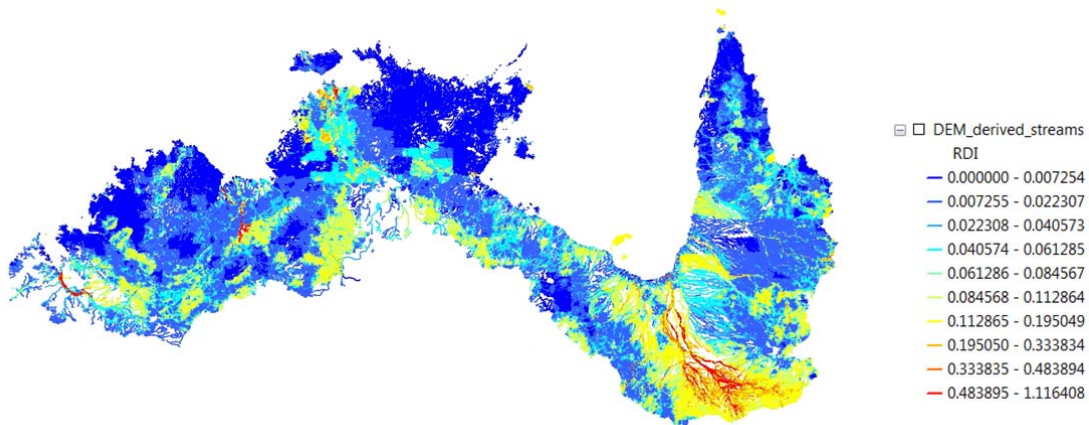
a)
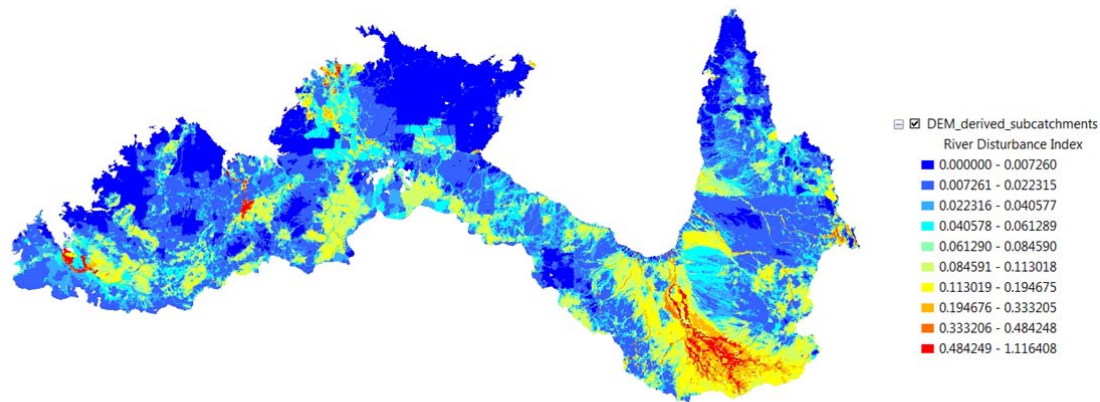
b)

Figure 5. The 'River Disturbance Index (RDI)" displayed using a) stream lines, and b) fine scale subcatchments.

RELATIVE RISK SCORES

Relative risk scores are based on a vulnerability and risk assessment of northern Australian catchments and biodiversity (Close et al., 2015). The risk assessment is derived from integrated spatially-explicit models for assessing risks to ecological assets that built on recent work conducted through the Northern Australia Water Futures Assessment (Close et al., 2012) and the earlier Tropical Rivers Inventory and Assessment Project (Bartolo et al., 2008). The factors incorporated in the risk assessment process that lead to assessment endpoints were the maintenance of flow regimes, riparian vegetation, biodiversity and water quality.

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Geosience Australia (2006). GEODATA TOPO 250K Series 3. Available at: http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_63999. Stein, J.L., Hutchinson, M., Stein, J.A. (2011). National Catchment Boundaries v 1.1.4. Commonwealth of Australia (Geoscience Australia). Available at: http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_73078 *or* http://www.bom.gov.au/water/awid/id-1105.shtml

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