TRaCK
Tropical Rivers and Coastal Knowledge

Northern Australia Aquatic Ecological Assets

Assessing the likely impacts of climate change and development in Queensland

Aquatic ecosystems and their importance

Queensland hosts a range of high value aquatic ecosystems, including, estuaries, rivers, lakes and wetlands. These ecosystems have important intrinsic and cultural values, and among other things, provide clean water, food and recreational activities for people. They also support high biodiversity and many species of aquatic plants and animals are found nowhere else. It is important that these valuable assets be sustainably managed and protected so that they provide ongoing value to both human activities and ecological requirements. Climate related changes in rainfall, run off and sea level, together with future development and expansion of agricultural, urban and industrial land use represent significant risks to these high value ecosystems.

What is being done to inform the protection and sustainable development of water resources?

The Northern Australia Water Futures Assessment (NAWFA) is an Australian Government initiative to provide the science needed to inform the protection and sustainable development of northern Australia's water resources. This project, one of a number under the NAWFA, aimed to assess the likely impacts of possible development and climate change on northern Australian aquatic ecosystems.

Uncontrolled cattle represent a significant risk to rivers in QLD

Development and climate change impacts in northern Australia

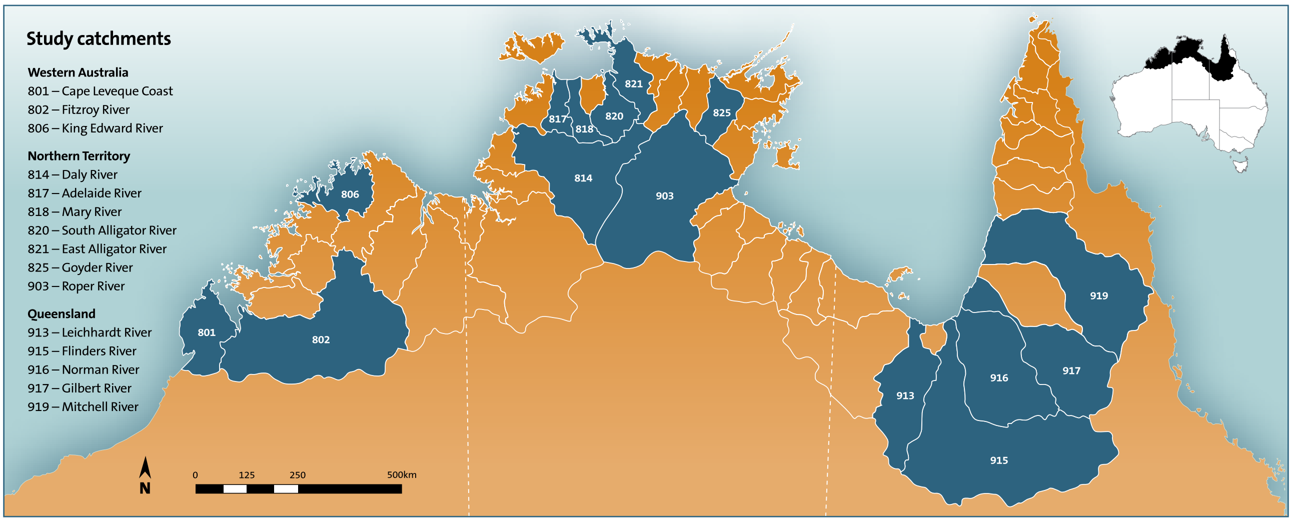
This Project has provided water planners and managers with additional information on the possible impacts of future development and climate change scenarios on aquatic ecosystems in northern Australia. The intent is that this new knowledge will be incorporated into the decision making process for future water management plans, to ensure that potential impacts resulting from development and climate change can be managed more effectively.

The Project addressed seven key tasks:

1. Describe the ecology and hydrology for northern Australian aquatic assets
2. Identify the major human related factors impacting upon the assets and their relationship to future development and climate change risks
3. Assess the impacts of these threats on landscape connectivity
4. Identify key ecological thresholds in terms of ecological water requirements, ecosystem function and habitat use by key biota
5. Describe the relationships between assets and their social and cultural values
6. Recommend management strategies and monitoring frameworks to report on environmental change
7. Identify specific knowledge needs and future investment priorities

Where was the research undertaken?

The geographical area being considered by the project stretches more than 3,000 km, from Broome in the west to Cairns in the east. This area includes three drainage divisions; Timor Sea, Gulf of Carpentaria and the part of the North-east Coast Drainage Division, north of Cairns. The Project focused on 15 catchments identified by Jurisdictions



as likely to experience hydrological change due to water resource development or climate change.

In Queensland, this project investigated climate change and development risks within five focus catchments; **Leichhardt**, **Flinders**, **Norman**, **Gilbert** and **Mitchell** river catchments.

Major project findings

Hydro ecology relationships

This project undertook a comprehensive review, synthesis and analysis of existing knowledge and data to identify critical links between surface and groundwater regimes and ecological values. Four key features of the annual flow regime underpin the structure and function of tropical river systems: i) peak wet season flows and their variability, ii) the drawdown period of flows and flood residence times during the wet to the dry transition, iii) low and disconnected flows during the dry season, and iv) the initial flushing flows during the dry to wet transition. To facilitate the application of waterway management strategies, this project identified specific flow-ecology relationships within each major season as described below.

Dry season

Base flow, cease to flow and groundwater levels are important components of dry season hydrology.

The duration and timing of hydrological disconnection, the magnitude and variability of base flow and the persistence and level of groundwater discharge have the greatest impact on ecological values.

Hydrology supports a wide range of biological values, and maintain ecological integrity and vital ecosystem processes such as reproduction and migration.

An ecologically important water hole on the Mitchell River floodplain

Dry-wet season transition

The onset of flows and floods at the commencement of the wet season are important hydrological characteristics.

The duration, timing and magnitude of flow have the greatest impact on ecological values.

Values associated with longitudinal connectivity are central during this transitional season, with dominant processes including cues for reproduction, and the alleviation of stresses related to the late dry season.

Wet season

Flood events, peak and total annual flow, and groundwater recharge are important components of wet season hydrology.

The duration, magnitude and extent of flood inundation, as well as the timing and volume of total wet season flow, and the rate of groundwater recharge, have the greatest impact on ecological values.

Flow components support a wide range of biological values and extensive aquatic and terrestrial primary productivity. Dominant processes include habitat maintenance, nutrient supply and connectivity: allowing migration/reproduction strategies and appropriate genetic exchange.

Wet season flows inundate the Norman River floodplain

Wet-dry season transition

High flow recession and groundwater dynamics are the key flow components during this transition.

The magnitude, duration and timing of groundwater discharge effects primary productivity values whilst the recession of flood and peak flows, and groundwater levels effects the persistence of aquatic fauna.

All seasons

Variability, base flow and mean annual flow are important flow components throughout all seasons.

Variability in seasonal wetting and drying, and in flow parameters such as rates of rise, magnitude and constancy impact ecological values such as species diversity, productivity and habitat structure.

Base flow perenniality, and the magnitude of mean annual flow increases fish biodiversity due to increased connectivity and productivity.

A variety of biota rely on natural patterns of river flows

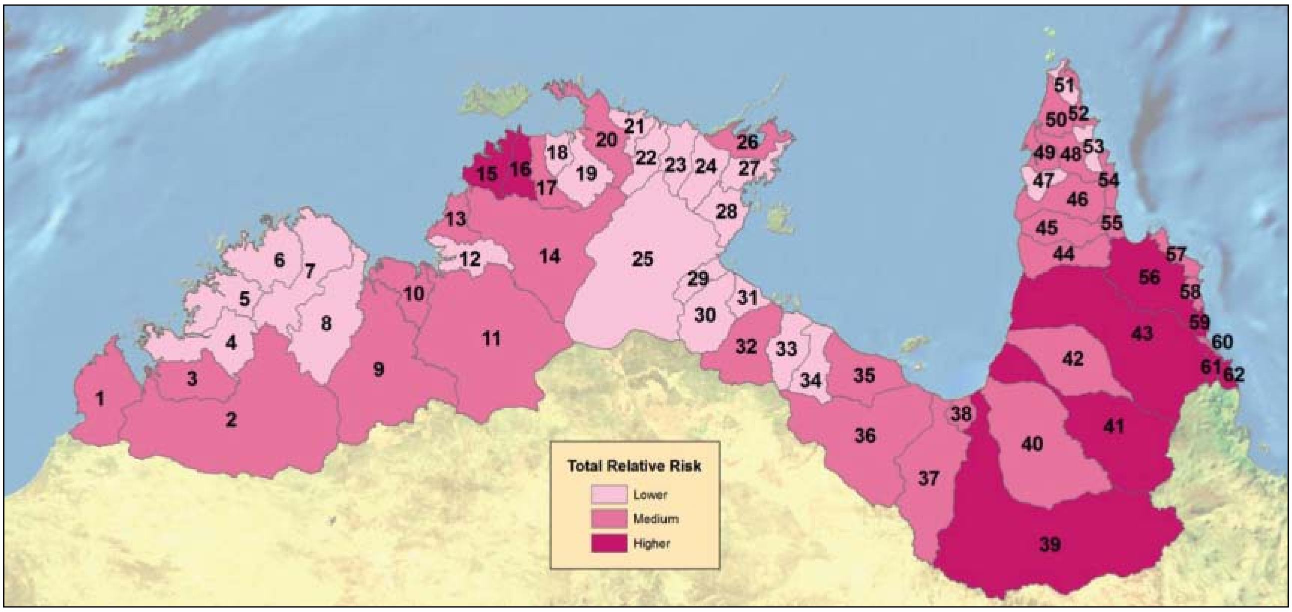
Hydrology

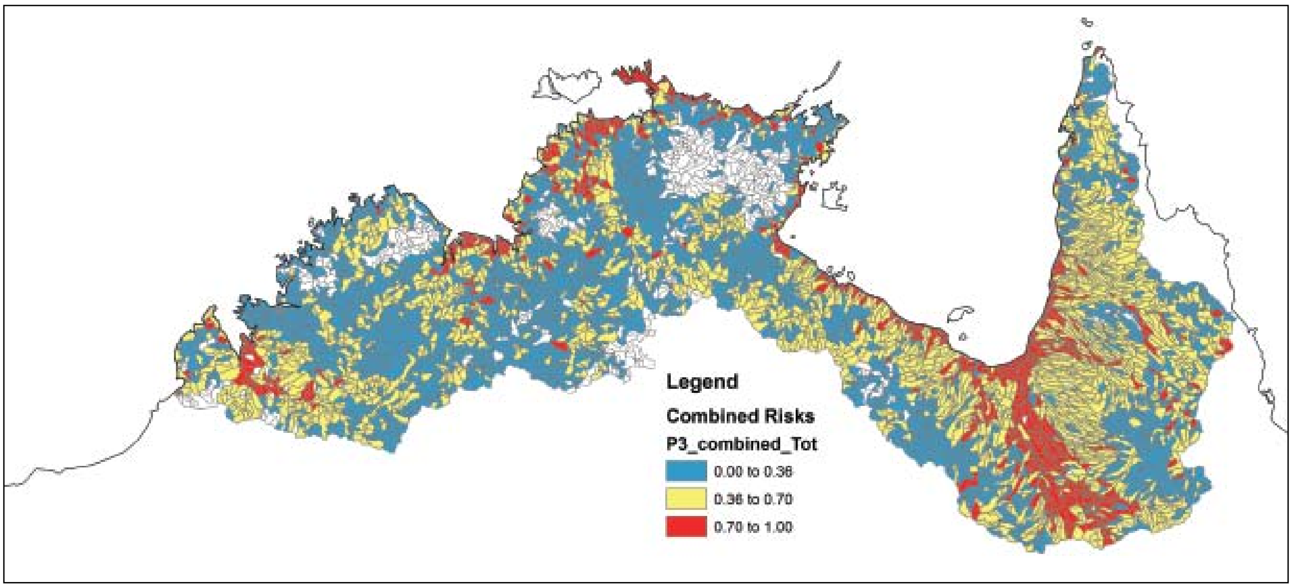
Groundwater plays an important role in maintaining the health of northern Australian waterways. In Queensland, significant groundwater inputs are important in maintaining dry season river flows and permanent waterholes in catchments of the Northern Coral, South-West & South-East gulf regions. Groundwater recharge may increase by up to 50% under wet-climate scenarios, where as under a dry-climate scenario, recharge may reduce by as little as 1%. In terms of surface water features that are dependent upon groundwater discharge, the impacts of climate change will be more immediate than those fed by shallow, local unconfined aquifers, such as the Flinders-Leichhardt and Mitchell River regions. Conversely, the impacts of climate change will be delayed for surface water features that are fed by deep, regional aquifers

Climate change and development impacts on surface water regimes were investigated in the Leichardt, Flinders, Gilbert and Mitchell rivers. The greatest impact on annual and seasonal flows in all catchments was predicted under wet-climate (30-66% increase) and dry-climate (up to 40% decrease) scenarios. The combination of future development and dry-climate scenario was expected to decrease river flows by up to 40%, particularly in the Leichardt and Flinders rivers. The most significant impact on low flows, in all catchments, is predicted under a combination of a dry-climate scenario and full use of existing water entitlements. Under these circumstances, the number of zero flow days is predicted to increase by up to 34%, particularly in the Leichardt and Mitchell rivers, and to a lesser extent in the Gilbert and Flinders rivers. The most significant impact on high flows is expected to occur in the Mitchell River, where large increases and decreases in the high flows are predicted under wet and dry-climate scenarios respectively. Rates of rise and fall are predicted to increase substantially in most catchments under a wet-climate scenario.

Climate and Development Risks

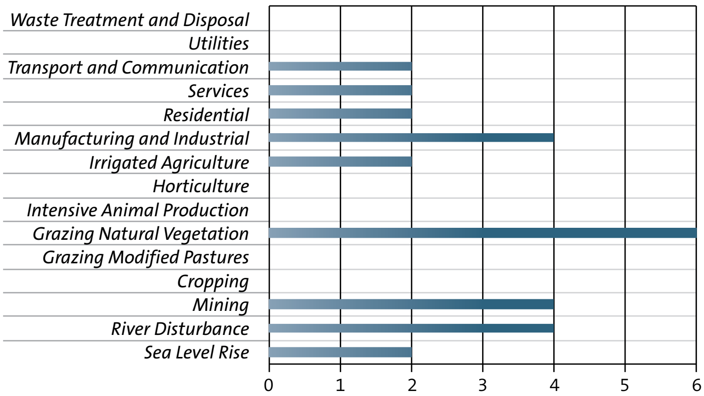
Across the entire NAWFA study region, risk from development was five-times greater than sea level rise for aquatic ecosystems and in excess of twenty-times greater for those ecosystems identified as High Conservation Value. An assessment of a variety of threats associated with climate change and development highlighted that the combined relative risk to aquatic ecosystems in Queensland was high, particularly in those catchments in the Gulf of Carpentaria. Mornington Inlet was predicted to be the catchment most at risk from sea level rise.



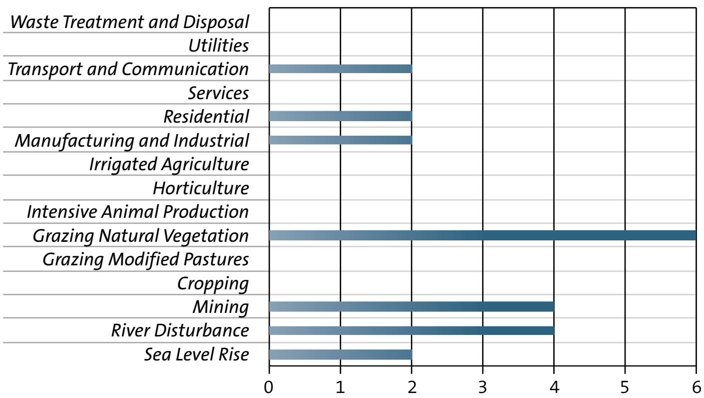


The Leichardt and Norman rivers were identified as having moderate risk from climate and development threats, whereas the Flinders, Gilbert and Mitchell were all identified has having relatively high risk. Risk profiles for the Leichardt and Norman rivers are shown below.

Leichhardt River



Norman River



Management options

Available options for integrated management frameworks were reviewed and a framework that combines Management Strategy Evaluation (MSE) with Bayesian Belief Networks (BBN) was considered to provide substantial benefits for management. A test-application of a combined MSE-BBN approach to analyse the effects of development (under different climate change scenarios) on social, environmental and economic indicators in northern Australia highlighted the utility of this approach as a relatively simple and rapid management tool, capable of addressing complex interacting management issues.

An assessment of management objectives, monitoring and assessment priorities and frameworks, and their capacity to report against likely risks associated with climate change and development in Northern Australia indicated that Queensland management agencies have the capacity to address climate change and development risks to northern Australian aquatic ecosystems.

Expansion of irrigated agriculture threatens some waterways in QLD

Future management considerations

This project has provided jurisdictional water planners in northern Australia with new information, techniques, data and knowledge that can be incorporated into management frameworks to address the risks associated with climate change and development to aquatic ecosystems in Queensland. A variety of knowledge gaps and key recommendations were identified from this project. While existing research programs provide significant benefit to the management of climate change and development risks identified through this NAWFA project, specific knowledge gaps and recommendations identified here will remain unanswered. Consequently, these gaps should be explicit within the adaptive management frameworks of relevant water and biodiversity management agencies thereby allowing opportunities for existing management and monitoring actions to be adapted, enhanced or extended to incorporate new knowledge. This approach will also need to be accompanied by future investment in research and monitoring of Northern Australian aquatic ecosystems and associated ecological values and process.

A small permanent stream in the upper reaches of the Mitchell River catchment

Further information

The project is funded as part of the Northern Australia Water Futures Assessment (NAWFA). NAWFA is a multidisciplinary program being delivered jointly by the Department of Sustainability, Water, Population and Communities and the National Water Commission, in close collaboration with the Office of Northern Australia and State and Territory government agencies. Through the Raising National Water Standards program under Water for the Future, the Australian Government has allocated up to $13 million for projects between 2007-2008 and 2011-2012. This project was developed in collaboration with research partners from TRaCK (Tropical Rivers and Coastal Knowledge www.track.gov.au) – a research hub which has drawn together more than 70 of Australia's leading social, cultural, environmental and economic researchers.

The project was lead by The University of Western Australia's Centre of Excellence in Natural Resource Management. The project team included researchers from The University of Western Australia, Griffith University, Charles Darwin University, James Cook University, the Environmental Research Institute of the Supervising Scientist and CSIRO. The project was undertaken in collaboration with the jurisdictions; Department of Water (WA), Natural Resources, Environment, The Arts and Sport (NT) and Department of Environment and Resource Management (QLD).

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Foodwebs and Biodiversity