TRaCK Tropical Rivers and Coastal Knowledge

Northern Australia Aquatic Ecological Assets

Assessing the likely impacts of climate change and development in the Northern Territory

Aquatic ecosystems and their importance

The Northern Territory 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.

Irrigated agriculture on the Daly River floodplain

Development and climate change impacts in northern Australia

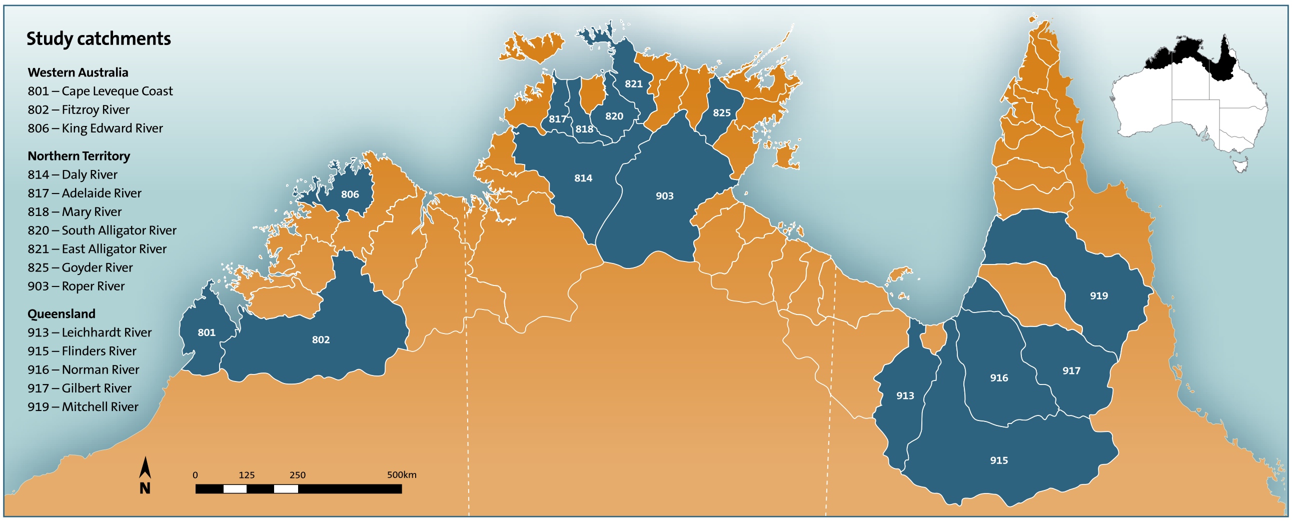
This Project has provided water planners and managers with additional information on the possible impacts of future development and climate change scenarios on aquatic ecosystems in northern Australia. The intent is that this new knowledge will be incorporated into the decision making process for future 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 the Northern Territory, this project investigated climate change and development risks within seven focus catchments; **Daly**, **Adelaide**, **Mary**, **South and East Alligator**, **Goyder** and **Roper** 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.

The Northern Territory has vast areas of wetlands

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 a tropical floodplain river

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 the Northern Territory, significant groundwater inputs are important in maintaining dry season river flows to several iconic rivers, including the Daly, Roper and Alligator rivers. The impact of climate change on groundwater recharge is uncertain. Groundwater recharge may increase by up to 50% under wet-climate scenarios, where as under a dry-climate scenario, recharge may reduce by 10%. In terms of surface water features that are dependent upon groundwater, the impacts of climate change will be more immediate to those fed by shallow, local unconfined aquifers. For systems maintained by deep, regional aquifers, such as those in the Daly River catchment, the impacts are likely to be delayed. Although development impacts on groundwater have been estimated in very few locations, in the Daly catchment, the greatest impacts to groundwater resources from increased development will occur in parts of aquifers that are distal to the rivers; that is, groundwater extraction will likely lead to large drawdown of water levels in the aquifers that cannot be mitigated through increased leakage from the rivers.

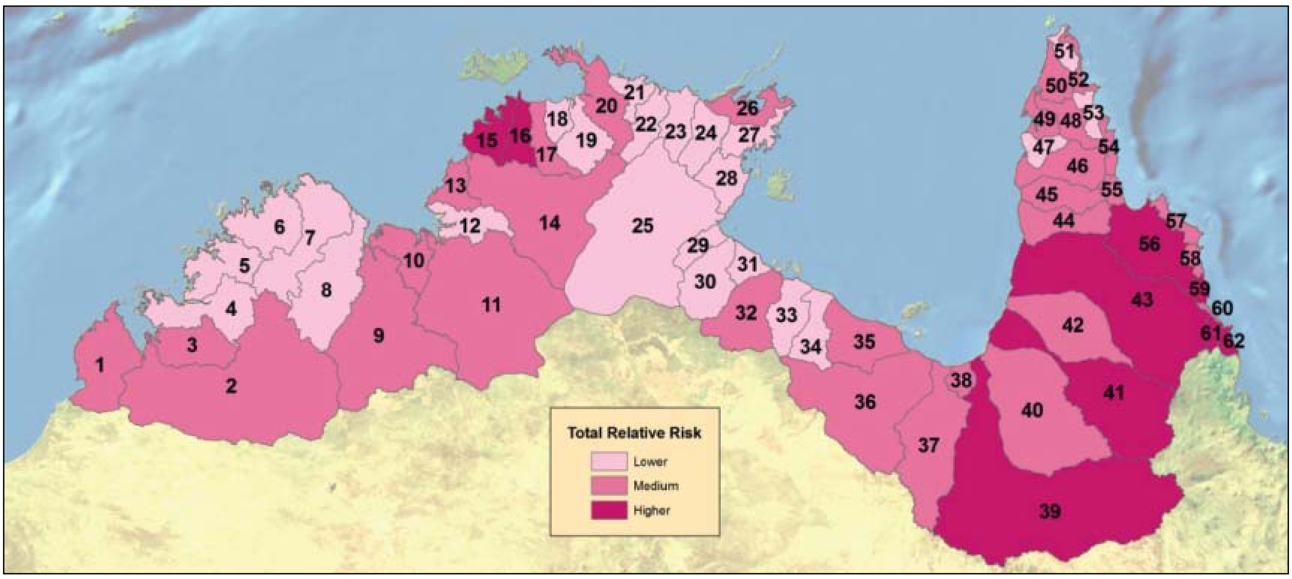
Climate change and development impacts on surface water regimes were investigated in the Daly, South and East Alligator and Finniss river catchments. Annual and seasonal flows are expected to increase by at least 20-30% under a wet-climate scenario, and decrease by up to 40% under a dry-climate scenario. The most significant of

Horticulture development on the Banks of the Daly River

these changes is expected to occur in the East Alligator River. Very little additional impact on these hydrological regimes is expected as a result of proposed development. The most significant impacts on low flows are expected under a dry-climate scenario where the number of zero flow days, and duration of low flow events are expected to increase by up to 30% and 50% respectively. In the Daly River catchment, development is expected to result in additional and substantial reduction in low flows under a dry-climate scenario. Climate change impacts on high flows vary among the four catchments. Only moderate changes to high flows are expected in the South Alligator River, whereas large increases and decreases are expected in the other catchments under a wet-climate and dry-climate scenario respectively. These changes are expected to alter frequency, duration and rates of rise and fall of high flow events, although the degree of changes in each of the catchments is variable.

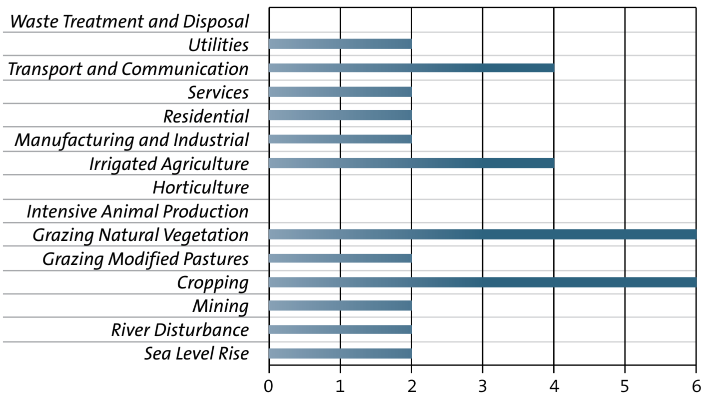
Climate and Development Risks

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 Northern Territory catchments was moderate-high, with generally higher risk associated with catchments in the east. In general, the isolated rivers in the Top-End, including the South Alligator, Goyder and Roper rivers were identified as having relatively low risk. Catchments where development and climate change are expected to represent moderate risk include the Daly, East Alligator and Mary rivers. The Adelaide and Finniss rivers were two of only a few catchments across the entire NAWFA region that were considered to be at high risk from development and climate change.

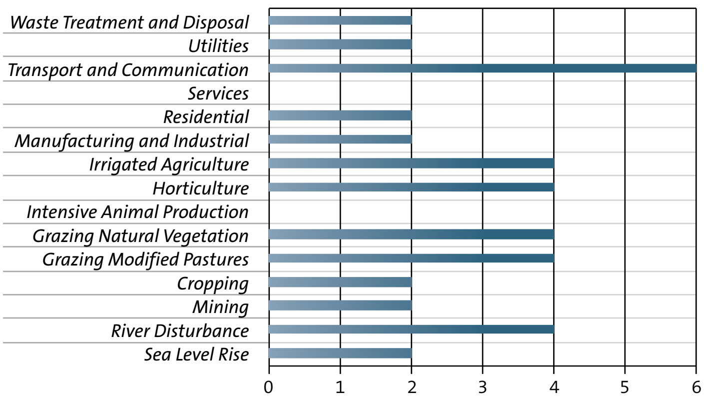


Aquatic ecosystems in the Adelaide-Mary-Roper region were identified as one of three regions across the NAWFA area considered to be a substantial risk from development threats. Catchments in Arnhem Land were identified has being at significant risk from sea level rise. High Conservation Value aquatic ecosystems in the Upper Daly and Darwin rivers were identified as having substantial risks associated with development, and those in Arnhem Land were considered at high risk from sea level rise. The risk profiles of high-risk catchments are shown below.

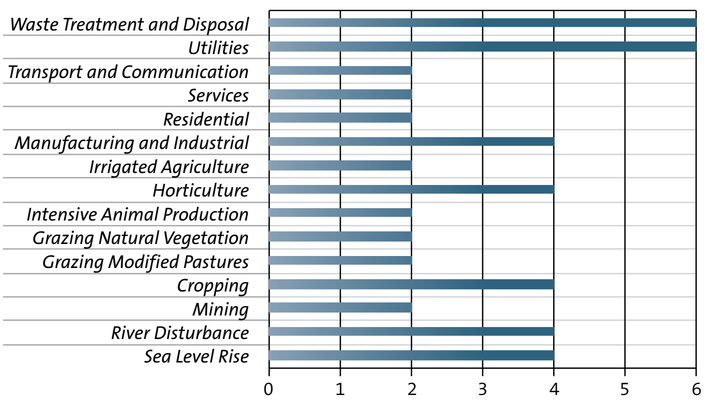
Daly River



Adelaide River



Finniss 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.

Groundwater maintains year-round flows in the Daly River

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 the Northern Territory. 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.

An ecologically important waterhole on the Daly River

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