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Water in northern Australia

Water for a Healthy Country Flagship

National Research FLAGSHIPS
Water for a Healthy Country

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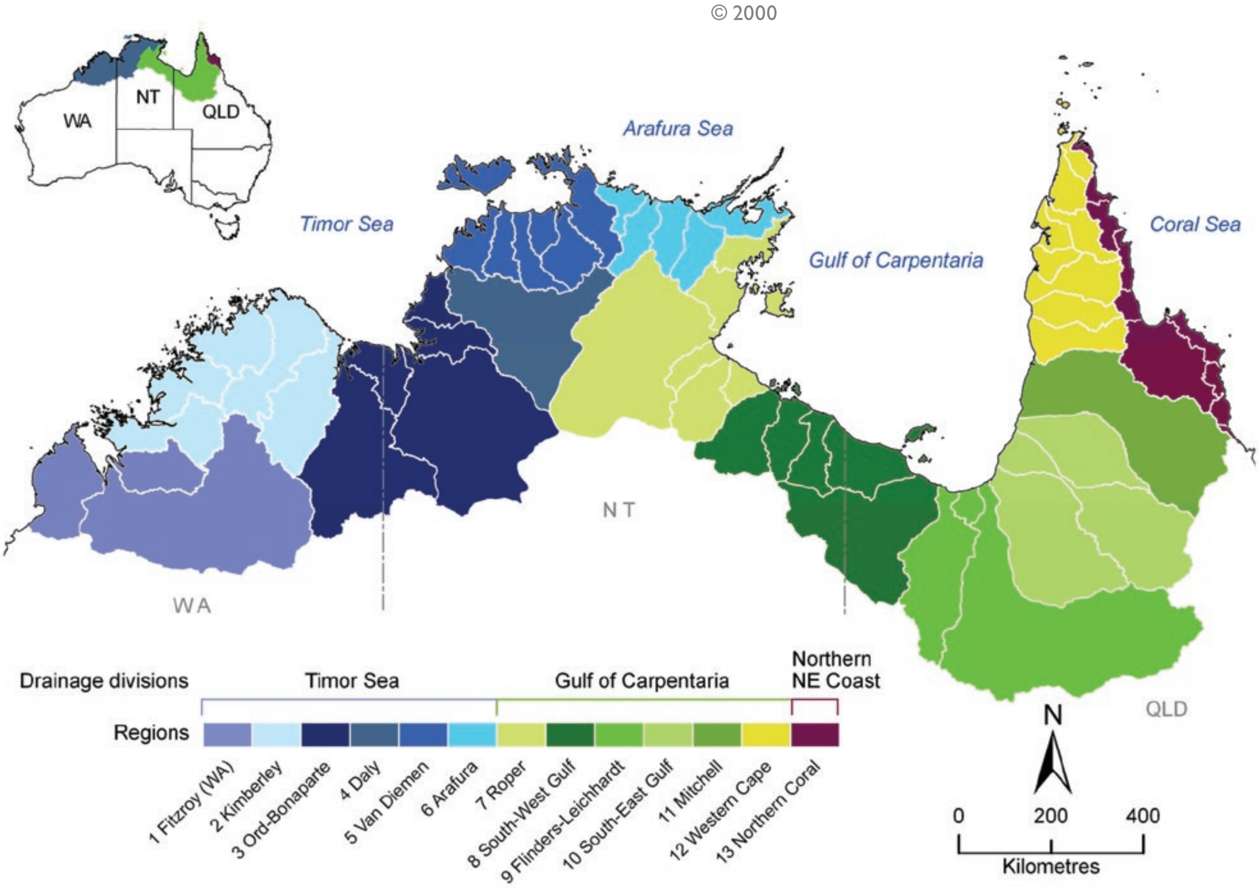
The CSIRO Northern Australia Sustainable Yields Project provides science to underpin the sustainable planning and management of the water resources of northen Australia

Led by CSIRO's Water for a Healthy Country Flagship, the Northern Australia Sustainable Yields Project is the nation's most comprehensive assessment of water availability in northern Australia. From Broome in Western Australia to Cairns in Queensland, this project provides critical information on current and likely future water availability for the 13 regions of northern Australia, an area renowned for its high rainfall, pristine tropical environments and relatively low level of development. This information will help governments, industry and communities consider the environmental, social and economic aspects of the sustainable use and management of the water assets of the north.

The findings of the project are similar across the three drainage divisions of northern Australia and are summarised here. It is important to remember that all elements of the water cycle are strongly inter-related. These findings reflect the complex relationship between water resources, climate and landscape in northern Australia.

> Morning glory roll cloud, Gulf of Carpentaria, from 8000 ft, north-east Queensland. Courtesy of Russell White, Sydney NSW © 2000



> The three drainage divisions and 13 regions of northern Australia

1. This project provides a contiguous, consistent, robust and transparent assessment of water resources

There is a perception, reflected in the popular press, that northern Australia has a surplus of water and that some of this should be reallocated to alleviate water shortages in the southern States. Concerning this issue, reasoned planning, should be undertaken including the measurement of how much water is there and determination of its availability for consumptive use, while also taking into account environmental needs, cultural needs, future development and the extreme climate.

This project has developed and tested models that can provide a contiguous, consistent, robust and transparent analysis of water across northern Australia.

2. Assessment of water availability for some key catchments

Water resources can be assessed at three levels, each offering more predictability but requiring more data and models than the one before. Not all regions have the data and models required for assessment at each level:

Level 1 – How much water is there? (water resources assessment)

Regions assessable: All regions

Level 2 – How much water can be taken, as well as where and when can it be taken? (water availability assessment)

Regions assessable: the Daly region, the Ord-Bonaporte region and part of the Van Diemen region in the Timor Sea Drainage Division; large parts of the Mitchell, South-East Gulf and Flinders-Leichhardt regions in the Gulf of Carpentaria Drainage Division

Level 3 – At what rate can water be taken, allowing for environmental and cultural needs, and social, political and economic values? (sustainable yield assessment)

Regions assessable: parts of the Ord-Bonaporte and Daly regions in the Timor Sea Drainage Division (indicative assessment only).

3. The climate is extreme, extremely seasonal and water-limited

Rainfall in northern Australia varies hugely between seasons (wet and dry) and from year to year. Almost all rain (94 percent) falls during the wet season. Typically, there is no rain for three to six months of the year, except in the south of the Timor Sea Drainage Division.

Mean annual rainfall ranges from 493 mm in the Flinders-Leichhardt region to 1417 mm in the Western Cape region.

Mean annual potential evapotranspiration exceeds mean annual rainfall in all regions, resulting in a 'rainfall deficit' or a 'water-limited' climate.

Most rain falls near the coast and generally decreases significantly from north to south. Exceptions are the North-East Coast Drainage Division where rainfall also decreases strongly from east to west, and that part of the Gulf of Carpentaria Drainage Division near the Great Dividing Range, where it increases significantly towards the east.

Runoff follows the same pattern as rainfall with the largest flows between January and March and most runoff occurring near the coast making coastal regions prone to flooding. Again, exceptions are the North-East Coast Drainage Division and the east of the Gulf of Carpentaria Drainage Division where runoff occurs in the upper catchments, generating large flows in the Mitchell and Western Cape regions.

4. The recent climate should not be used as a guide to the future

In recent years (1996 to 2007), rainfall intensity (rainfall per rainy day) has increased slightly across the north compared to the past (1930 to 2007). The climate has been similar to the past in the Northern North-East Coast drainage Division, and wetter in the Timor Sea Drainage Division and much of the Gulf of Carpentaria Drainage Division. However, none of the drainage divisions have recently experienced the variability seen in the past. Therefore, the recent climate is not representative of the long term and should not be used as a guide to the future climate.

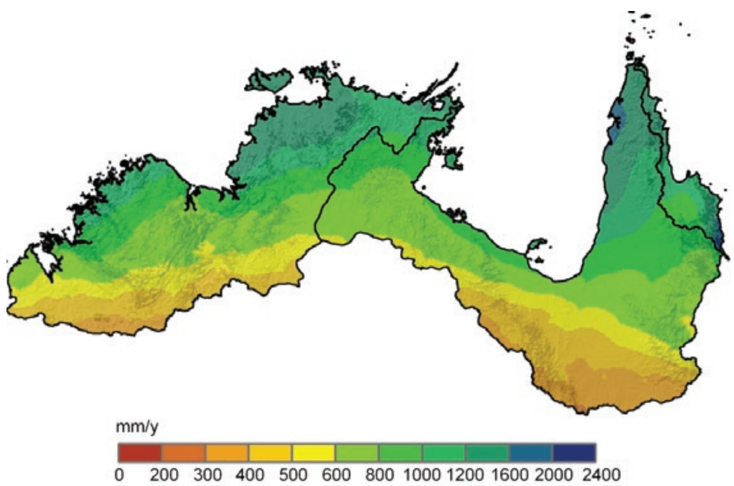
5. The future will be warmer; rainfall may be more intense; some areas may receive slightly less rainfall

The near future (around 2030) is expected to be warmer, with less rainfall than in recent years (1996 to 2007) but about the same as in the historical past (1930 to 2007). As a result, it should be drier than recent years.

> Historical (1930 to 2007) climate in northern Australia

	Timor Sea	Gulf of Carpentaria	Northern North-East Coast	Northern Australia
Mean annual rainfall	868 mm	779 mm	1338 mm	850 mm
Mean annual potential evapotranspiration	1979 mm	1939 mm	1853 mm	1954 mm
Mean annual rainfall deficit*	-1111 mm	-1160 mm	-515 mm	-1104 mm

*rainfall minus potential evapotranspiration



> Spatial distribution of historical wet season rainfall across northern Australia overlaid on a relative relief surface

> Future (~2030) climate compared to historical (1930 to 2007) climate

	Timor Sea	Gulf of Carpentaria	Northern North-East Coast	Northern Australia
Mean annual rainfall	slightly drier (875 mm)	slightly drier (777 mm)	similar (1350 mm)	similar
Mean annual potential evapotranspiration	slightly higher (by up to 4%)	slightly higher (by up to 4%)	slightly higher (by up to 4%)	slightly higher (by up to 4%)
Rain falling in the wet season	slightly lower (down 1% to 94%)	slightly lower (down 1% to 93%)	slightly lower (down 1% to 91%)	slightly lower (down 1% to 93%)
Mean annual runoff	similar	similar	similar	similar
Mean annual recharge to groundwater	similar	similar	similar	similar

Very high intensity rainfall is expected to increase along the northern coast of the Timor Sea Drainage Division, particularly in the Arafura region, in the north of the Gulf of Carpentaria Drainage Division and across the northern Cape area in Queensland. There may also be increased cyclonic activity in the Timor Sea Drainage Division.

Runoff and recharge to groundwater systems are expected to be similar to the historical past in all regions but lower than in recent years for the Timor Sea and Northern North-East Coast Drainage Divisions.

6. Known future development will have minimal regional consequences, but may be locally important

Known future developments are unlikely to have a significant effect at the regional scale. Locally, however, these changes may affect flow regimes, especially where critical surface–groundwater interaction takes place.

Expansion of irrigated agriculture in the Katherine and Douglas-Daly areas of the Daly region and the Ord expansion in the Ord-Bonaparte region are likely to have local consequences. Water supplies in the Fitzroy region may come under stress if irrigation activities resume near Camballin, and the recently announced gas hub on the coast requires significant volumes of water.

Expansion of mining activities in the northern Western Cape region (Weipa area), expansion of irrigation in the eastern Mitchell region (Mareeba area) and growth in the upper Leichhardt river basin (Mount Isa area) may have local consequences.

No major development is expected in the Northern North-East Coast Drainage Division, except very locally (for example, expansion of the Port Douglas area).

7. Perennial rivers are vital assets

Many of northern Australia's larger rivers stop flowing during the dry months. The few that keep flowing are fed primarily by groundwater systems.

Perennial rivers are an environmental asset, supporting a high level of endemic species; a development asset, vital for irrigation water supplies during the dry months; and an ecotourism asset (mainly during the dry months). Pools in the rivers keep some ecosystems alive through the dry season. There is an intricate balance between surface water and groundwater flows and the plants and animals they support.

In the Timor Sea Drainage Division, perennial rivers are fed primarily by shallow groundwater systems.

In the Northern North-East Coast Drainage Division, they are fed primarily by deep groundwater discharged via artesian springs or leaked upward through shallow aquifers.

In the Gulf of Carpentaria Drainage Division, they are fed primarily by shallow groundwater systems and, to a lesser degree, by deep groundwater discharged via artesian springs or leaked upward through shallow aquifers.

8. Opportunities to increase water storage are limited

Across the Timor Sea and Gulf of Carpentaria drainage divisions, most rainfall falls near the coast where the landscape is generally flat. So there is little opportunity to increase surface water storages. The main exception to this is in the Van Diemen region in the catchments surrounding Darwin.

Opportunities are mainly in the upper reaches of catchments; however, in these areas rainfall is lower and more sporadic, and potential evapotranspiration is highest. Storages would have large evaporation losses.

In the headwaters of the Mitchell and other Cape York catchments, where rainfall is higher and there is higher relief, there are opportunities for surface water storages, but environmental flow regimes need to be considered.

In the Northern North-East Coast Drainage Division, because of the high relief away from the coast, the potential for surface water storage is good, but high evaporation rates mean that storages can rarely be large enough to survive through the dry season.

High variability in streamflow also necessitates larger carry-over storages compared to rivers in southern parts of the country (or elsewhere in the world), for a given rainfall regime. Drought severity is also greater than elsewhere and, to be able to provide for runs of multiple dry years, future storages would require two to 10 times the volume of a similar supply for elsewhere.

Streamflow is largely event-driven, with a rapid rise and fall of flow. There is little opportunity for water harvesting, which is generally only allowed from the waning phase of streamflow, following an event.

Seventeen rivers (six in the Northern North-East Coast Drainage Division and 11 in the Gulf of Carpentaria drainage division) are either declared, proposed or potential wild rivers. This imposes management rules that constrain future development on, or near, these rivers.

There may be opportunities to artificially recharge aquifers in the Timor Sea and Gulf of Carpentaria drainage divisions to supply groundwater for niche developments in the dry season. Injection wells are likely to be required because the soils that cover much of the divisions preclude the use of infiltration pits. The cost of establishing injection wells is generally prohibitive for irrigation.

9. There are opportunities for groundwater development but more data are required to determine extraction limits

Several karstic carbonate aquifers, mainly in the Daly region in the Northern Territory, may provide opportunities for large-scale (greater than 100 gigalitres/year) groundwater extraction. Extraction levels are currently low, although existing and potential future entitlements may be approaching extraction limits in some local areas, e.g., the Katherine-Douglas-Daly irrigation area. Water allocation planning in the Northern Territory is resulting in caps to groundwater extraction. Smaller extractions (10 to 100 gigalitres/year) are feasible within the aquifers of the Canning Basin and have been developed in the Proterozoic carbonate aquifers in the Darwin Rural Area. The latter, however, have reached their extraction limit.

Aquifers extending from the Roper region in the Northern Territory to the South-West Gulf region in Queensland may provide opportunities for large-scale (greater than 100 gigalitres/year) groundwater extraction, although extraction limits are yet to be determined. Extraction levels are currently minimal. Smaller extractions (10 to 100 gigalitres/year) are feasible within the Gilbert River Formation and the Karumba Basin on Cape York.

Groundwater recharge rates in the Gulf of Carpentaria Drainage Division are only estimates. Rejected recharge along the Great Dividing Range supplies streams into the dry season, but has not been quantified. Modelling indicates very low recharge rates, except over the carbonate catchments in the west.

The Gilbert River Formation of the Great Artesian Basin may provide opportunities for medium-scale groundwater extraction (10 to 100 gigalitres/year). There is large uncertainty, however, about the volumes of water that could be extracted.

To assess future groundwater availability, refining our knowledge of extraction limits is more important than assessing the impacts of climate change.

10. There are few quantified environmental flow thresholds. Ecosystems have adapted to the extreme, seasonal climate conditions and are highly responsive to any change

Only a few environmental assets, in the Timor Sea Drainage Division, have any quantified flow requirements. There are currently insufficient data to define quantitative environmental metrics across all environmental assets although some good examples of ecologically-based flow metrics are available for the Ord-Bonaparte, Fitzroy and Daly regions. The lower Ord represents an altered natural system, where a previously ephemeral river now flows year-round due to releases from upstream dams. So any changes in natural flow conditions can be mitigated by changes to the release strategy. The Fitzroy and Daly systems are in near-pristine condition and future development has the potential to significantly alter flow regimes in the vicinity of extractions and/or diversions.

Ecosystems have adapted to the harsh climate and are capable of surviving three to six months of no rain, high temperatures and scorching sun. They can survive multiple years of little or no rain, or periods of intense rain, flooding, high flow and high-water levels. These extreme climate conditions have resulted in a very high level of endemism and genetic separation, leading to multiple sub-species. Ecosystems are typified by complex life histories and commonly significant migration strategies.

> Katherine River, NT. © Skyscans

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AUGUST 2009

Printed on recycled paper

VRU 2009 • NASY_ALL_Factsheet.indd

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