Water in the Timor Sea Drainage Division

Water for a Healthy Country Flagship

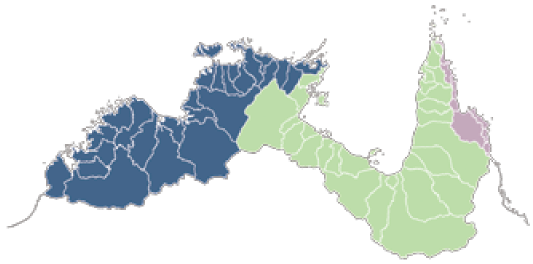
National Research
FLAGSHIPS
Water for a Healthy Country

CSIRO

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

Project overview

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 drainage division

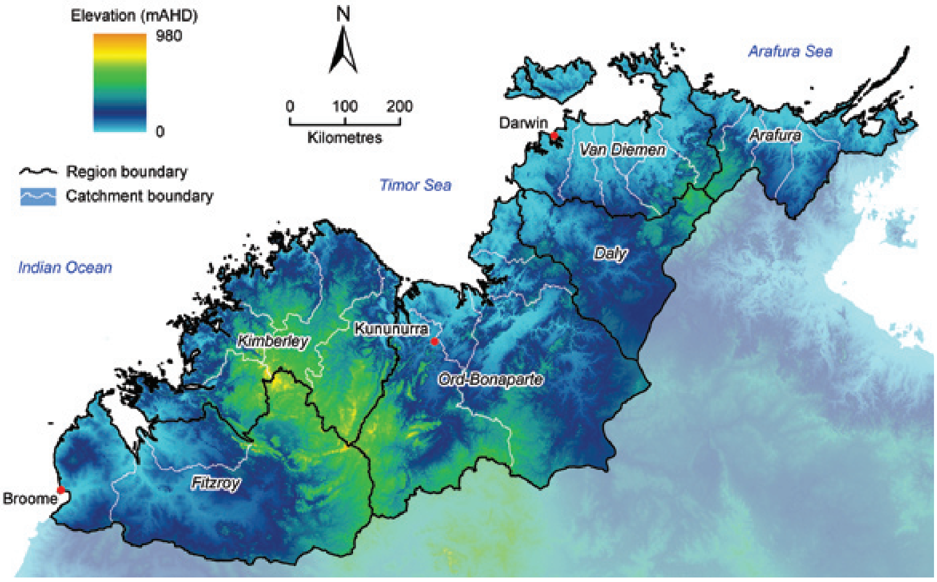
The Timor Sea Drainage Division includes most of the Top End and the Kimberley, and covers an area of 564,647 km^2. Much of the landscape forms a patchwork of harsh, dry escarpments and tablelands, and low-lying river flats.

The region is hot and dry during the dry season (May to October) and hot and often flooded during the wet season.

Streams generally run west to the Indian Ocean or north to the Timor Sea and can be very large by Australian standards. On a streamflow per area basis, it is the second wettest drainage division in Australia (after the Tasmanian Drainage Division).

The large river systems – Ord, Victoria, Daly and Fitzroy – have relatively low gradients; they mainly drain expansive savannah woodland plains and form extensive floodplains and coastal wetlands. The Kimberley in the south-west and Arnhem Land in the north-east have short river basins with high gradients. Most rivers drain to coastal floodplains and wetlands.

The climate is predominantly tropical, with high temperatures year-round (averaging 28°C) and high, yet very seasonal, rainfall. Rainfall decreases rapidly southwards from the northern coast. ranging from 1687 mm/year in the north to 383 mm/year in the south. Almost all rainfall falls during the wet season, from November to April.



> The Timor Sea Drainage Division and its six regions

Potential evapotranspiration rates are high year-round. Annually, rainfall is usually less than potential evapotranspiration, so the drainage division may be described as water-limited.

Grazing is the dominant land use. There are large areas of nature conservation and Indigenous land use. Extensive areas of highly productive seasonal coastal wetlands support important prawn and finfish fisheries.

The drainage division has a great diversity of freshwater fish species, with almost 100 different species recorded (27 of them endemic to the division) and is host to an extraordinary variety of bird life, both resident and migratory.

All of the drainage division's wetlands are important for ecological reasons or because they have historical significance or high cultural value, particularly to Indigenous people, or a combination of these reasons. Nine wetlands are classified as Ramsar sites.

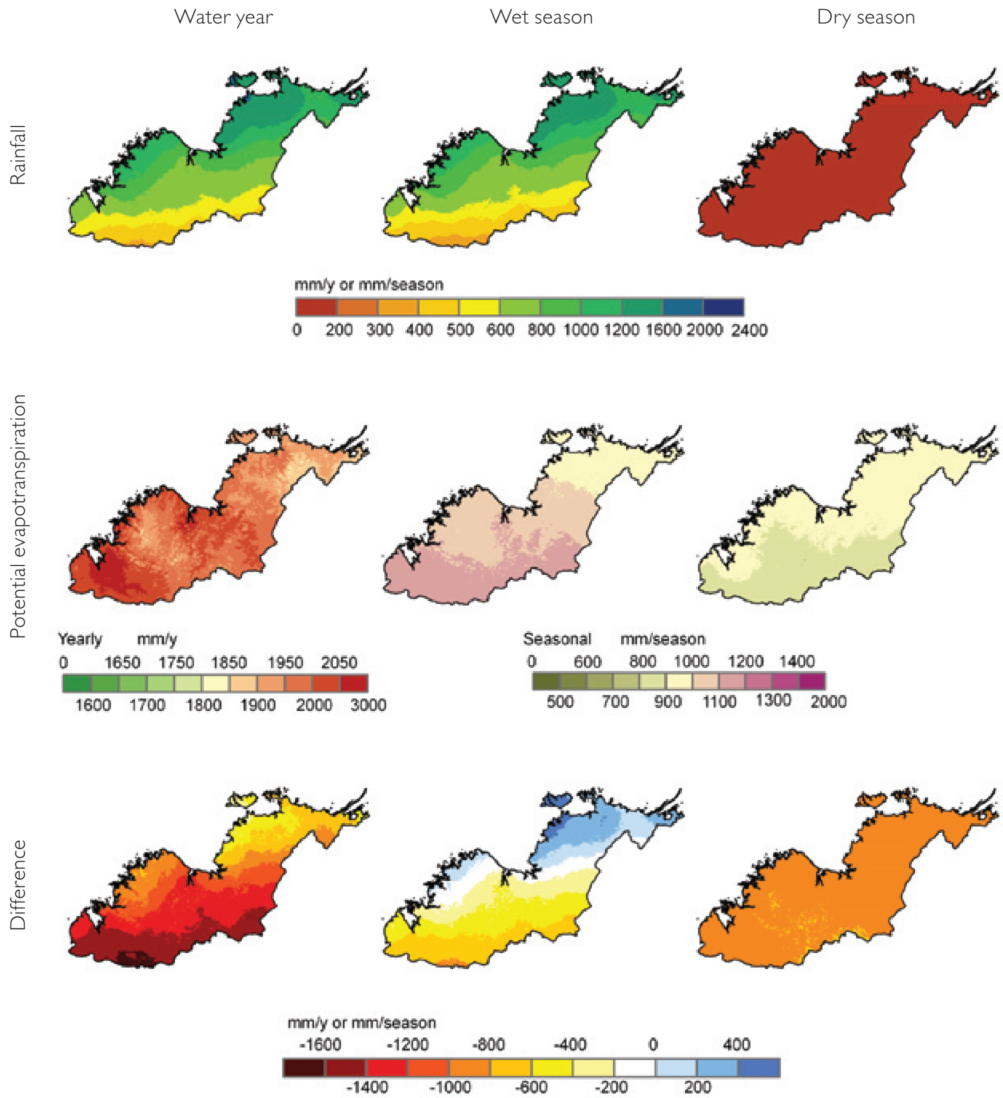
During the dry season, rivers have little rain water to ensure a continuous flow. Hence all perennial rivers and ephemeral springs are important sources of water, and most are also sacred sites.

Historical and recent climate trends

For the entire drainage division, the recent (1996 to 2007) climate has been 30 percent wetter than than the previous 66 years. The wettest year in the west (Fitzroy (WA) and Kimberley) and north (Van Diemen) was 2000; for the north-east (Arafura), 2001 and the centre (Ord-Bonaparte and Daly), 1974.

Potential evapotranspiration was highest in 1952 for the east of the drainage division; for the far west the driest year was 1953, while for the Kimberley, 1936.

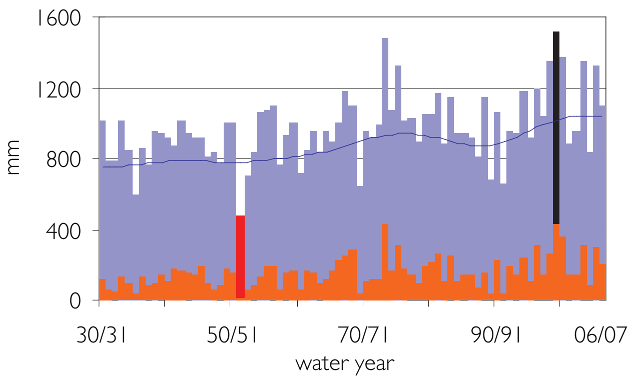
In the northern catchments, there has been a slight increase in rainfall intensity in the last 77 years, with a slight increase both in rain days and rainfall per day.



> Distribution of historical mean annual (water year), wet season and dry season rainfall and potential evapotranspiration and their difference (the annual rainfall deficit). Water year – September to August; wet season – November to April; dry season – May to October

> Historical (1930 to 2007) climate in the Timor Sea Drainage Division

Mean annual rainfall	868 mm
Mean annual potential evapotranspiration	1979 mm
Mean annual rainfall range	383–1688 mm
Rain falling in the wet season	95 %
Mean annual volume of rain	503,000 GL
Mean annual streamflow	90,000 GL



> Historical annual rainfall (blue) and modelled runoff (orange) averaged over the Timor Sea Drainage Division. The trend line indicates longer term variability; highest and lowest rainfall years are indicated

> Fitzroy River at Fitzroy Crossing, WA. Courtesy of the Western Australia Department of Water

Historical and current water resources

Runoff follows the rainfall pattern with largest flows between January and April. A historical mean of 90,000 gigalitres/year flows across the landscape, more than a quarter of this occurring in the Van Diemen catchments, which have a historical mean annual runoff of 375 mm.

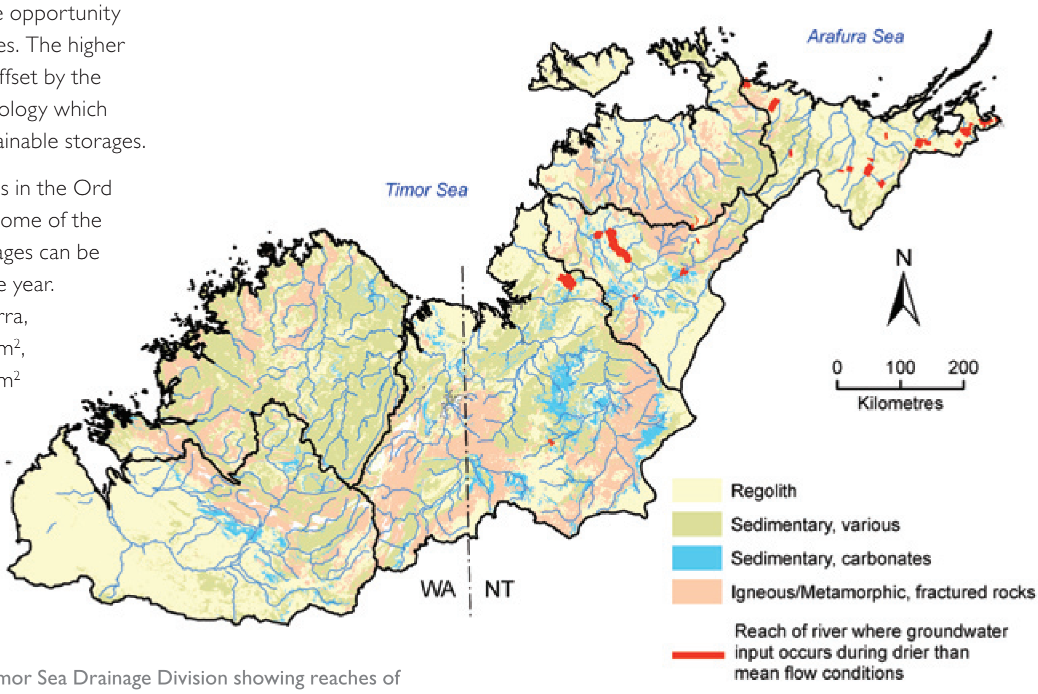
The strong rainfall gradient away from the northern coasts combined with the generally low relief of most of the coastal region means there is little opportunity to increase surface storages. The higher relief in the Kimberley is offset by the fractured nature of the geology which drains too rapidly for sustainable storages.

The major surface storages in the Ord River catchment provide some of the only locations where storages can be maintained throughout the year. Lake Argyle, near Kununurra, covers on average 1000 km^2, but can extend to 2000 km^2 at maximum flood stage which would hold 35,000 gigalitres of water. Average storage is about 6000 gigalitres, with a nominal storage capacity of 10,700 gigalitres. The lake filled in the first wet season after the dam wall was completed (1973) and currently provides irrigation water to 150 km^2 of farmland.

The coastal regions of the far north and far west are flood-dominated, which can locally result in poorer quality surface water, both through increased sediment load and increased tidal influence.

Rainfall intensity decreases rapidly away from the northern coast. Extreme rainfall events (>100 mm/day) occur along the northern coast during the wet season.

Groundwater recharge is strongly seasonal.



> Surface geology of the Timor Sea Drainage Division showing reaches of river that remain perennial under drier than average conditions

What the future holds

The future (~2030) climate is expected to be similar to the historical climate. Modelling gives a future range of between 14 percent lower and 5 percent higher rainfall. Potential evapotranspiration increases under all future scenarios, possibly up to 4 percent relative to the historical climate. Extreme rainfall events are expected to increase along the northern coast, particularly in the Arafura region.

Runoff is affected more by rainfall than by potential evapotranspiration. So, despite higher future potential evapotranspiration, future runoff is expected to be similar to historical runoff.

Uncertainty in rainfall projections makes it difficult to project characteristics and water availability.

Recharge is expected to be similar to historical levels.

The strong rainfall gradient away from the northern coast combined with the generally low relief for most of the coastal region means there is little opportunity to increase surface water storages. Opportunities are mainly in the upper reaches of catchments; however, in these areas rainfall is lower and more sporadic, and potential evapotranspiration is highest. The main exception to this is in the Van Diemen region in the catchments surrounding Darwin.

To increase supply to Darwin, the dam wall of the Darwin River Dam is being raised and this will increase available yield by 20 percent. The nearby Manton Dam has an additional potential supply but recreational activities limit its use to emergencies.

Three new dam sites have potential: Marrakai Dam next to Marrakai Crossing on the Adelaide River; Warrai Dam upstream of the Adelaide River township; and Mt Bennet Dam on the Finniss River to the west of the Darwin River Dam.

New surface storages would have large evaporation losses. 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 here and, to be able to provide for runs of multiple dry years, future storages would require 2–10 times the volume of a similar supply for elsewhere years.

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

Several aquifers, mainly in the Daly region, may provide opportunities for large-scale (greater than 100 gigalitres/year) groundwater extraction. Current extraction levels are low, although entitlements may be approaching extraction limits in some local areas. Water allocation planning in the Northern Territory is resulting in extraction caps.

Smaller extractions (10 to 100 gigalitres/year) are feasible within the aquifers of the Canning Basin. Development in the Proterozoic carbonate aquifers in the Darwin Rural Area has reached its extraction limit and there is a moratorium on any further groundwater development. Even smaller extractions (i.e. less than 10 gigalitres/year) are feasible across most of the division.

Groundwater recharge rates are not well constrained. In the parts of the Daly and Ord-Bonaparte regions, where opportunities are highest, aquifers fill from wet season rains, but then drain through the dry season to progressively lower levels. This fill-and-spill regime is being maintained due to wetter-than-average rainfall regimes experienced over the last 10–20 years. If climate conditions return to those experienced prior to the 1990s, it is likely that there will be years when the aquifers do not return to full capacity.

Opportunities for managed aquifer recharge are limited. Storages will be at full capacity towards the end of the wet season when surface water is available for injection. Furthermore, injection wells would be needed to recharge the aquifer, making costs prohibitive for irrigation. The Canning Basin sandstone aquifers probably have the greatest potential. The carbonate aquifers of the Daly Basin have some potential for recharging via boreholes.

There is an intricate balance between surface and groundwater flows and the environmental regimes they support, resulting in a high level of endemic species across the drainage division. The nature of this interaction is poorly quantified, and is currently being investigated in the Daly and Fitzroy river catchments.

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

Mean annual rainfall	slightly drier (875 mm)
Mean annual potential evapotranspiration	slightly higher (by up to 4 %)
Rain falling in the wet season	slightly lower (94 %)
Mean annual streamflow	similar
Mean annual recharge to groundwater	similar

Australian Government
National Water Commission
Raising National Water Standards Program

For further information:

Water for a Healthy Country Flagship
Project Leader
Dr Richard Cresswell
Phone: 07 3214 2767
Email: Richard.Cresswell@csiro.au
Web: www.csiro.au/partnerships/NASY

Northern Australia Water Futures Assessment
Department of the Environment, Water, Heritage and the Arts
Phone: 02 6274 1111
Email: northern.assessment@environment.gov.au
Web: http://www.environment.gov.au/nawfa

AUGUST 2009

Printed on recycled paper

VRU 2009 • NASY_TS_Factsheet.indd

Contact Us
Phone: 1300 363 400
+61 3 9545 2176
Email: enquiries@csiro.au
Web: www.csiro.au/flagships