NATIONAL PROGRAM FOR
Sustainable Irrigation

Research Bulletin

# Understanding Water Systems of Northern Australia

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Burdekin Falls Dam - one of the largest above ground water storages in the north. This picture illustrates the flat landscape of northern Australia.

There is growing interest in developing some of the water resources of northern Australia. This trend is being fuelled partly by widespread perceptions of abundant water resources in northern Australia, declining rainfall in southern Australia and recognition that some water resources in the south are over-allocated and over-used. This study presents an overview of the landscape of northern Australia with respect to its soil and water resources, climate and hydrology and with special emphasis on attributes relevant to irrigation.

The Northern Australian Irrigation Futures (NAIF) project examined and synthesised existing geological, geomorphological and hydrogeological studies of northern Australia and assessed the practicality of developing a groundwater flow classification system for northern Australia.

Key messages from the research include:

- Irrigated systems are complex systems and we need to accept, understand and work with that complexity
- Water availability and storage needs for irrigation in event-driven tropical systems are poorly understood
- Irrigation must be preceded by catchment scale water, salt and nutrient management plans to deliver on long term sustainability objectives
- Policies and management strategies must be suitable for event-driven tropical systems
- Groundwater can be critical to base flow and maintenance of ecological function
- Groundwater quantity (level) and quality targets must be set in irrigated systems and management practices must be adjusted to meet those targets
- Water quality is as important as quantity, especially in meeting ecological needs
- Irrigation and water management is an individual and collective responsibility

***"Probably the biggest take home message is the complexity of the system and the need to manage that complexity".***

DOUG HALL, IRRIGATION AUSTRALIA

# Background

The purpose of this work is to address community perceptions and misconceptions about northern Australia. It aims to highlight key issues, constraints and opportunities for irrigation in the north and provide a broad knowledge base that will enable all stakeholders the opportunity to participate in debate about irrigation in northern Australia. Particular emphasis has been placed on illustrating the differences between water systems in northern Australia and those found in temperate southern Australia.

This study sets the context for understanding the distribution of water and soil resources across northern Australia. This has been achieved by examining:

- the geological history and evolution of key landscape features of the region
- the climatic processes that drive precipitation and evaporation
- key aspects of the terrestrial water balance and resulting streamflow observations across the region
- the challenges posed by a highly seasonal water balance
- the connectivity between surface and groundwater systems as well as the time lags associated with lateral groundwater flow

Groundwater has been a focus of the study because irrigation typically causes groundwater imbalances (in terms of quantity and quality), and groundwater is often a key conduit for the transport of solutes. As such, this work also summarises the understanding of attitudes to and potential benefits of developing a groundwater classification system.

# Key features and issues in northern Australia

## Hydrological constraints for irrigation in northern Australia

Because Australia has experienced relatively little glaciation or volcanism, many of the landscapes of the north are very old and with prolonged erosion have become relatively flat. The antiquity of the landscape is often cited as the reason for the relatively infertile Australian soils. With exposure to a variety of climates over geological time scales, Australia has a complex pattern of highly weathered soils that are generally low in nutrients and as such soils in large parts of southern Australia have been extensively modified through cultivation and application of fertilisers.

Rainfall across northern Australia is considerably more seasonal than that of southern Australia resulting in distinctive 'wet' and 'dry' seasons. The prevalence of cyclonic depressions as rain-generating mechanisms means that many regions across the north are characterised by a high inter-annual variability in rainfall. Northern Australia has some of the highest daily rainfall intensities in the world and potential evaporation is much greater in northern Australia than in the south.

Sixty to 70 per cent of Australia's water runoff occurs in the north. Climate primarily drives the seasonality of streamflow and most externally draining rivers are ephemeral. The very few perennial rivers that do exist are fed by groundwater systems and as such there are strong connections between these rivers and their groundwater systems. These groundwater-fed perennial river systems also support unique natural ecosystems dependent upon the quantity and quality of flow in the dry season. This means that the water in these rivers is not necessarily any more available for other uses (such as irrigation) than in the ephemeral rivers.

The relatively flat landscape of northern Australia limits the opportunities to build storages to supply water through the dry season. Also, this option may seldom be viable as high evaporation rates and intermittent streamflow would mean reduced water levels.

Even with these challenges, the north offers a number of opportunities. With limited irrigation occurring in northern Australia there is the opportunity to plan proactively and not be reactive to problems and failures.

## Developing a groundwater flow classification system for northern Australia

A groundwater classification system would numerically categorise a geographical area according to sets of generic characteristics. This principle is similar to that used in the Australian Soil Classification system, where each class would have a set of geological, hydrogeological and topographic characteristics that would suggest the landscape behaves in a certain way. A classification system would allow assessment and identification of an area and whether it may be suitable for irrigation.

Irrigation has been practiced for many centuries but there are no known groundwater classification systems specific to irrigation. One reason may be that because of the large resources associated with major irrigation developments, considerable investment is made in identifying potentially suitable areas. This investment includes investigating water availability, water quality and hydrogeological assessments and so a classification system may have been considered unnecessary.

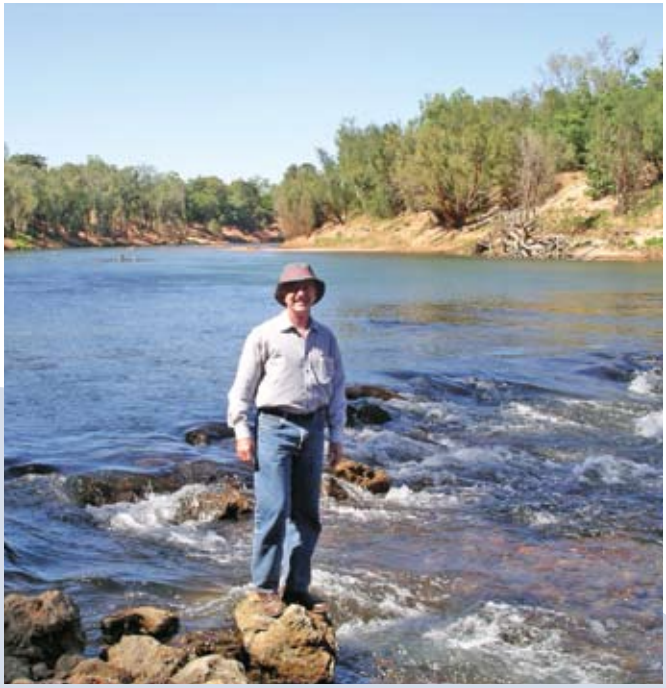
However, given the problems associated with many irrigation systems around Australia and internationally, perhaps insufficient attention has been given to the studies and/or the resulting hydrogeological information during the planning, design, approval and early management phases. The question remains as to whether different, potentially more successful, approaches would have been taken if suitable groundwater classification systems were available.

This work found that a groundwater flow classification system may be a useful management and communication tool for those responsible for water, irrigation and catchment planning and management. This is because resources to make on-site assessments of proposals are often limited and so a framework in the form of a classification system to guide initial evaluation and decision-making may be of considerable benefit. This could also be of particular benefit when it comes to evaluating small areas of land, as would be needed for implementing irrigation mosaics (distributed patches of irrigation). There is growing interest in irrigation mosaics in the north as an alternative to large scale contiguous areas of irrigation, however, there are both potential positive and negative impacts of this type of irrigation. These issues are discussed in the Research Bulletin 'Irrigation Mosaics in Northern Australia'.

## What this means for northern Australia

While development of water resources in northern Australia appears attractive on the basis of the high levels of rainfall and runoff, this research has identified a number of constraints and further research is needed to address these issues before any development is undertaken.

While few rivers in the wet-dry tropics are perennial, those that are have strong connection to underlying groundwater systems that supply groundwater baseflow. This connection supports unique natural ecosystems that are dependent upon the quantity and quality of flow in the dry season. Furthermore, high flow events have important ecological implications for in-stream, estuarine, near-shore and marine environments. Some ecosystems are also dependent upon groundwater and some deep rooted vegetation types have been found to depend upon groundwater (to varying extents) during the dry season.



Project leader Keith Bristow at the Daly River which is one of the few perennial rivers with a base flow dependent on groundwater.

In the semi-arid and arid zones of northern Australia, average annual recharge and discharge rates are very low. This imposes considerable constraints to development of groundwater-based resources in those regions, particularly when ecological values are applied. The use of groundwater for irrigation presents substantial management challenges because of the uncertainties associated with recharge, discharge and lateral flow, and the time lags associated with these processes. Such detailed information exists in few areas of northern Australia.

The scarcity of rainfall and streamflow across most of northern Australia during the dry winter months necessitates either large above ground storages, or the extraction of groundwater of sufficient quantity and quality for irrigation.

## Where to from here

There is a need to understand and manage connected systems of the north, including the relationships between surface and groundwater, and the importance of both water quality and quantity in systems that are spatially and temporally highly variable.

There is a need to develop an understanding of what ecologically sustainable development means in northern Australia. New forms of development may need to be explored that are uniquely northern Australian in character, and hence different to traditional irrigation and dryland agricultural development. Specific aspects of irrigation design requiring investigation include:

- Salt and drainage management in regions of large seasonal watertable fluctuations
- Social, economic and biophysical costs and benefits of irrigation mosaics
- Aquifer management, perhaps involving artificial recharge, within an irrigation context in a highly seasonal tropical environment
- Management of tail water in highly ephemeral systems
- The potential for water harvesting in the wet-dry tropics of northern Australia

Most current data indicates a wetting trend in the central north and north-west of Australia. However, global climate change models suggest this wetting trend may be short term (15 years or so) and rainfall may then revert to the overall drying trend predicted for all of Australia.

NAIF is a collaboration between the National Program for Sustainable Irrigation and:

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Department of Natural Resources, Environment and the Arts

Queensland Government
Natural Resources and Water

North Burdekin Water Board

SunWater

## For more Information


Bristow, K.L. and C. Petheram. 2007. Assessment of the practicality and benefits of developing a groundwater flow classification system for irrigation in northern Australia (*Internal report to the NAIF Steering Committee*).

Petheram, C and K.L. Bristow. 2008. Towards an understanding of the hydrological factors, constraints and opportunities for irrigation in northern Australia: A review. CSIRO Land and Water Science Report No. 13/08, CRC for Irrigation Futures Technical Report No. 06/08.


NAIF reports can be found at **www.npsi.gov.au** or visit the NAIF website at **www.clw.csiro.au/naif**


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## About the Program

The National Program for Sustainable Irrigation defines and invests in research on the development and adoption of sustainable irrigation practices in Australian agriculture. The aim is to address critical emerging environmental management issues, while generating long-term economic and social benefits that ensure irrigation has a viable future.

The Program has 16 funding partners: Australian Government Department of Environment and Water Resources, Cotton Research & Development Corporation, Gascoyne Water Asset Mutual Co-operative, Gascoyne Water Co-operative, Goulburn-Murray Rural Water Corporation, Grains Research & Development Corporation, Harvey Water, Horticulture Australia Limited, Land & Water Australia, Lower Murray Water, Ord Irrigation Asset Mutual Co-operative, Ord Irrigation Co-operative, South Australian Research and Development Institute, Sugar Research & Development Corporation, Sunwater, and Western Australia Department of Water.

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