

## Introduction

# Sustainable futures for Australia's tropical rivers: introduction to current research and information needs

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The Forum on Sustainable Futures for Australia's Tropical Rivers was held at Charles Darwin University in Darwin in February 2004. The concept emerged in response to increasing social, political and business interest in the water resources of northern Australia, recognising the need for science to be proactive in providing the knowledge to guide current and future policy and decision making on the use of these rivers. Pressures on tropical systems worldwide are increasing and Australian systems are not isolated from this reality. The papers within this issue focus on Australia, but the lessons learned and conclusions drawn are relevant to many parts of the world.

There is a long history of interest in development of northern Australia and this is currently being fuelled by increasing pressure on water supply and river systems in southern regions. Tropical rivers and groundwater systems contain roughly 70% of Australia's freshwater resources. Water availability has been the driver of many grand schemes in the past and there are many examples that have proven to be non-feasible, or which have had significant unforeseen environmental impacts. Further development of water resources in tropical Australia is likely to result in conflicting opinions concerning risks to environmental goods and services and cultural values, as well as the intended social and economic benefits.

Land use across the Australian tropical region is dominated by grazing, agriculture, Aboriginal tenure and traditional use, mining and tourism, with significant fishing interests in estuaries and coastal waters. Current management priorities are focussed on water-resource planning, water quality, fisheries, invasive plants, salinity, conservation, grazing and fire management. Outside of catchments such as the Ord and Burdekin, which have existing irrigation areas, estimates of existing water use as a percentage of sustainable yield are low. Scientific understanding of rivers in southern Australia has largely developed in a reactive fashion as unforeseen consequences of earlier development decisions have become apparent. While some tropical catchments have

been extensively developed and are now the focus of environmental management efforts, many catchments are relatively unchanged from their historical condition under traditional ownership. The combination of growing interest in water at a national level, development aspirations in the tropics and the relatively good ecological condition of tropical rivers provides an opportunity for science to lead the information needs for sound management of Australia's tropical rivers into the future.

The objectives of the forum were to assemble and synthesise existing scientific knowledge of Australia's tropical river systems and to identify critical knowledge gaps for future research priorities. The forum covered catchments spanning tropical Australia from Broome in Western Australia to Rockhampton in Queensland, adopting a system-scale approach to the functioning of tropical rivers, their wetlands, floodplains, estuaries and near-shore environments, and the impacts of land use, water use and other activities. Forum themes covered present and future use and management of tropical rivers, aquatic ecosystem assets and threats, tropical aquatic ecosystem processes, the role of flow and connectivity in tropical rivers and information needs to protect tropical rivers in the face of increasing development pressure.

Erskine *et al.* (2005) review the geomorphological template of tropical Australian rivers and present a detailed typology of characteristic reaches. The template provides a sequential spatial framework for the ecological function of tropical rivers, with clear implications for the fish communities likely to be encountered in each region.

Wetlands are characteristic geomorphic habitat features of tropical Australia that support high levels of biodiversity, but large areas of wetlands have been lost or are under threat from human activities in some regions. Finlayson *et al.* (2005) offer an analysis of the drivers behind the changing face of tropical wetlands, including both direct drivers and the less direct social attitudes that encourage or allow wetlands to be degraded. They propose a model based on inventory, assessment and monitoring to maintain the character of tropical

wetlands, coupled with inclusive processes for capacity building, decision making, priority setting and management to sustain tropical wetlands.

The impacts of catchment land use on water quality in tropical rivers and coastal waters is a major concern in developed catchments draining into the Great Barrier Reef lagoon. This issue has implications for all tropical regions where changes in land-use and runoff patterns have potential to increase nutrient loads discharged into coastal waters. Brodie and Mitchell (2005) review studies of suspended sediment and nutrient dynamics across tropical Australia, and the trends toward eutrophication of freshwater, estuarine and coastal ecosystems.

The monsoonal climate that is characteristic of many tropical catchments has strong implications for rivers in the wet–dry tropics, where flows are driven by runoff in the wet season and are dependent on groundwater springs in the dry season. The different sources of flow deliver differing amounts of nutrients to the riverine system. Webster *et al.* (2005) examine the dynamics of primary production in the Daly River during the low-flow season, when nutrient concentrations are low. Subsequently, Townsend and Padovan (2005) examine the roles of nutrient availability and seasonal changes in water velocity in maintaining the biomass of benthic algae in the Daly River.

The dynamics of algal production are critical for tropical rivers and estuaries, with the increasing realisation of the importance of algal carbon sources in aquatic food webs. Changes in catchment condition that favour changes in the composition of epiphytic communities attached to other plants, hard substrata, or even intertidal mudflats as microphytobenthos, are emerging as driving significant flow-on effects through higher-order consumers. In a significant paper, Douglas *et al.* (2005) review the international literature and draw on available data from tropical Australian rivers to develop five general principles about aquatic food-web processes. These principles provide key directions for natural-resource management and provide testable hypotheses about aquatic-ecosystem function.

River flow has been described as the maestro that orchestrates pattern and process in riverine ecosystems (Walker *et al.* 1995), although the ecological dependencies on river flow have not been as extensively demonstrated in tropical Australia as they have been in temperate regions. Forum presentations demonstrated the role of flow in forming channel morphology, delivering sediments and nutrients downstream, supporting benthic production and wetland connectivity, as well as food-web processes that support commercial and recreational fisheries. Robins *et al.* (2005) explore the processes linking pulses in fish production with seasonal and interannual flow cycles in an attempt to clarify fisheries-specific needs for freshwater flow to sustain estuarine fisheries. Mechanisms for such links include effects of flow on fish behaviour and catchability, enhanced recruitment

through changes in habitat availability, or increased productivity associated with nutrient delivery by freshwater inflows to estuaries.

The papers presented here, combined with the discussion summaries from the forum (Gehrke *et al.* 2004), are synthesised by Hamilton and Gehrke (2005) to identify the key issues for further research and special considerations for tropical Australia.

This collection of papers provides a selective review of prominent themes across the diverse catchments that make up tropical Australia and provides a platform for new studies to provide additional information needed to manage the multiple interests that are coming together within this region. It is more apparent than ever before that even subtle changes in catchment condition, which are well known to have concomitant effects on local aquatic ecosystems, can be multiplied across catchments and downstream into estuarine and coastal waters, so that the combined effects of apparently local-scale activities can have dramatic consequences for the social, economic and ecological values that make up tropical river systems. The growing approach for catchment management and compatible management of adjacent catchments presents a challenge for scientists to collect and integrate data over spatial and temporal scales that are relevant to the scales of management, and also to the scales on which these processes occur. These papers offer some principles, hypotheses, processes and frameworks to accept the challenge and to contribute to a sustainable future for tropical river systems within Australia and around the world.

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## References

- Brodie, J. E., and Mitchell, A. W. (2005). Nutrients in Australian tropical rivers: changes with agricultural development and implications for receiving environments. *Marine and Freshwater Research* **56**, 279–302. doi:10.1071/MF04081
- Douglas, M. M., Bunn, S. E., and Davies, P. M. (2005). River and wetland food webs in Australia's wet–dry tropics: general principles and implications for management. *Marine and Freshwater Research* **56**, 329–342. doi:10.1071/MF04084
- Erskine, W. D., Saynor, M. J., Erskine, L., Evans, K. G., and Moliere, D. R. (2005). A preliminary typology of Australian tropical rivers and implications for fish community ecology. *Marine and Freshwater Research* **56**, 253–267. doi:10.1071/MF04078
- Finlayson, C. M., Bellio, M. G., and Lowry, J. (2005). A conceptual basis for the wise use of wetlands in northern Australia – linking information needs, integrated analyses, drivers of change and human well-being. *Marine and Freshwater Research* **56**, 269–277. doi:10.1071/MF04077
- Gehrke, P., Bristow, K., Bunn, S. E., Douglas, M., Edgar, B., *et al.* (2004). Sustainable futures for Australia's tropical rivers: a strategy for

- developing research directions for Australia's tropical river systems. CSIRO Land and Water Technical Report No. 17/04.
- Hamilton, S. K., and Gehrke, P. C. (2005). Australia's tropical river systems: current scientific understanding and critical knowledge gaps for sustainable management. *Marine and Freshwater Research* **56**, 243–252. doi:10.1071/MF05063
- Robins, J. B., Halliday, I. A., Staunton-Smith, J., Mayer, D. G., and Sellin, M. J. (2005). Freshwater-flow requirements of estuarine fisheries in tropical Australia: a review of the state of knowledge and application of a suggested approach. *Marine and Freshwater Research* **56**, 343–360. doi:10.1071/MF04087
- Townsend, S. A., and Padovan, A. V. (2005). The seasonal accrual and loss of benthic algae (*Spirogyra*) in the Daly River, an oligotrophic river in tropical Australia. *Marine and Freshwater Research* **56**, 317–327. doi:10.1071/MF04079
- Walker, K. F., Sheldon, F., and Puckridge, J. T. (1995). A perspective on dryland river ecosystems. *Regulated Rivers: Research and Management* **11**, 85–104.
- Webster, I. T., Rea, N., Padovan, A. V., Dostine, P., Townsend, S. A., and Cook, S. (2005). An analysis of primary production in the Daly River, a relatively unimpacted tropical river in northern Australia. *Marine and Freshwater Research* **56**, 303–316. doi:10.1071/MF04083