



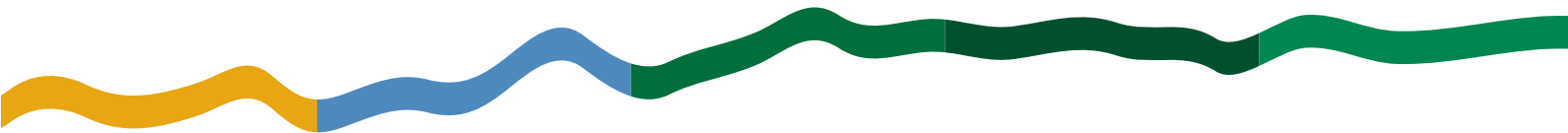
Australian Government
Land & Water Australia

knowledge for managing Australian landscapes

Australia's Tropical Rivers

Program Plan and Prospectus
2005–2010





Australia's Tropical Rivers

Program Plan and Prospectus

2005–2010

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The Flora River, NT

Executive summary

The Board of Land & Water Australia has identified Australia's unique tropical rivers and associated catchments and estuaries as a priority area for a major investment over five years from July 2005. Land & Water Australia is negotiating with potential partners, undertaking workshops and engaging with relevant States, the Northern Territory, Indigenous land councils and other stakeholders to build a shared vision for the program. Land & Water Australia is also inviting expressions of interest from prospective investors interested in partnerships in research and development to improve the knowledge base for managing Australia's tropical rivers and associated catchments and estuaries.

Northern Australia offers a unique opportunity to productively develop land and water resources while protecting downstream users and rivers of high conservation value. The Governments of Queensland, Northern Territory and Western Australia are also working to support knowledge generation in tropical Australia, including the joint Tropical Science, Knowledge and Innovation Program, where the wise management of natural resources requires a depth of biophysical, technical and institutional understanding. This initiative will make a significant contribution to this knowledge. It aims to work with the regions involved to build capacity and understanding so that the best available knowledge can be used to achieve integrated natural resource management in tropical Australia.

The program is being managed through the National Rivers Consortium, a strategic collaboration between policy makers, river managers and scientists. An independent program management committee will be formed if new partners join the initiative. Start-up funding for 2003/04 and 2004/05 has been secured from the Natural Heritage Trust, National Landcare Program and the National Rivers Consortium, and work has commenced on a number of preliminary projects to scope and initiate the larger investment.

Goal

To undertake research and knowledge exchange to support the sustainable use, protection and management of Australia's Tropical Rivers.

Program area / geographic scope

The geographic scope of the program is the two major drainage divisions in Australia's north draining into the Timor Sea and Gulf of Carpentaria.

Research themes

1. Assess river assets and threats
 - compile information and undertake assessments of rivers, groundwater, floodplains, wetlands and estuaries;
 - undertake threat and risk assessment based on future scenarios;
 - support classification and description of river types to enable transfer of knowledge;
 - assess land and water resource capability.
2. Support regional planning frameworks
 - provide targeted knowledge support for the National Water Initiative, National Action Plan for Salinity and Water Quality, and Natural Heritage Trust regional management initiatives;
 - promote scientifically based resource condition targets and indicators;
 - develop monitoring and evaluation methodologies.
3. Assess social, cultural and economic values, and opportunities
 - undertake research to determine what people value in rivers;
 - value ecosystem services;
 - understand Indigenous cultural and economic values;
 - analyse economic and resource development, river protection and management.
4. Understand river ecosystems
 - understand ecosystem processes and develop conceptual models of how river ecosystems function;
 - understand river and groundwater flows and hydrology;
 - understand the fluxes and balance of nutrients and contaminants in rivers.

Australia's Tropical Rivers



The Daly River, NT

1. Social and economic context

Fundamental to the vision for sustainable growth in northern Australia will be the development of water resources, the industries that prosper and the values of rivers to be protected.

There is a long history of interest for northern Australian development, and this is currently being highlighted by increasing pressure on water supply and river systems in southern Australia. Tropical rivers and groundwater systems contain roughly 70% of Australia's freshwater resources, although there is uncertainty surrounding actual water availability. The long held perception that the tropics hold abundant water resources for exploitation may be an exaggeration produced by overly simplistic analyses. The region carries a large volume of runoff but inadequate hydrological data and highly seasonal and variable flows mean that estimates of sustainable water yields, where they are available, may be unreliable.

In a relative context, however, the quantities of water available are still many times larger than those in southern Australian catchments, and are likely to provide increasing incentives for growth of water-based industries in the future. Despite the potential availability of water, development of irrigated agriculture, especially within tropical catchments, may be limited by other factors such as unsuitable soil types and low relief in some regions. The development of tropical Australia is likely to result in conflicting responses as physical intervention to provide secure water supplies will trigger reactions from environmental and social sectors and downstream users. Environmental changes resulting from water development are also likely to have social and cultural implications for regional communities.


Projections for human population growth and expansion of economic activities in the near term are relatively low across most of the region, supported in part by remoteness, a lack of supporting infrastructure, and the large proportion of land held by Aboriginal and pastoral title.

Industries including pastoralism, mining, aboriginal enterprises, fisheries, and irrigated agriculture are linked by access to water resources and the consequences of using that water. Competing values also mean that in addition to consumptive uses, rivers are increasingly important for ecotourism and high-value fisheries. Water resource development will influence all of these industries and vice versa. The commitment by governments to full cost recovery may increase the price of water use.

Because of the opportunities and threats to social, economic and environmental values local communities want more input into management decisions concerning these systems. Cultural differences and the remoteness of many communities from centres of policy, decision-making and economic activity makes a complex and challenging social geography. Community knowledge remains largely untapped, whilst traditional knowledge held by Indigenous communities is being lost. Conservation and natural resource management programs are likely to have only limited success without the support of local communities.

Accordingly social and economic science must be part of the core research alongside environmental research programs. Land managers have strong interests and experience in environmental management systems, and their knowledge and understanding should be included in developing management approaches. Including these inputs in the core research offers a basis for understanding social and economic services, as well as the ecological services provided by tropical rivers.

The ability of tropical river systems to sustain development as well as environmental, social and cultural values raises the need for innovative institutional arrangements to transfer knowledge into policy. A common assumption is that northern catchments will be developed yet this assumption does not distinguish the types of development desired by communities, or the specific plans of individual communities. The aspirations of stakeholders in catchments may require social research to inform policy on river development, as well as an understanding of the social, economic and environmental drivers for tropical rivers.



The social consequences of development decisions, and implications for future generations with respect to environmental sustainability require a combined social, economic and environmental research approach in the same manner as anywhere else in Australia, but with the added consideration of the cultural links of Indigenous people who live closely with river environments.

Future social aspirations for tropical river systems will be influenced by the degree of environmental change that is considered acceptable. Within a national framework to ensure ecosystem health, it is unreasonable to expect that communities from different regions will have the same aspirations. This diversity of opinion is likely to drive community efforts to obtain robust scientific information to support local decisions.

Science has played a key role to date in decision making and policy development with regard to tropical rivers, but mostly in reaction to specific issues (e.g. mining, ocean pollution) as opposed to supporting broader conservation and management goals, or in devising sustainable options for economic and social development. For example, assessments such as the National Land and Water Resources Audit, and the National River Health Program have generated useful baseline information, but ratings of condition relative to other Australian regions may produce inaccurate conclusions because of the degree of extrapolation from sparse data sets that produced those assessments.

The skills required to advance understanding and management of tropical rivers are fundamentally the same as in other areas of Australia, but with a stronger emphasis on seasonal changes, integration of large spatial scales, remote technologies, and social integration to meet future needs.

There is an acknowledged need to build regional capacity to conduct, interpret, and use research outputs. Nonetheless, this need must be balanced against the reality that much of the national research capacity is located elsewhere, resulting in some research being done by external research providers in close consultation with local agencies. This process may be facilitated by research being incorporated into the business of local and regional agencies.

Continuity of scientific activities is an important issue. Research that can provide long-term or large-scale data sets is often discontinued prematurely once immediate resource management needs have been met. It is likely that local drivers to support research continuity will be enhanced through greater interaction with local communities.

The objectives of the National Water Initiative and national natural resource management processes are of direct relevance to river systems across tropical Australia; and ensuring the availability of appropriate scientific knowledge is crucial to support these objectives. There is also a national emphasis on regional natural resource management planning, with expectations of improved resource conditions being achieved through enhanced regional management capacity and knowledge systems.

2. Environmental context

The rivers, floodplains, wetlands and estuaries of northern Australia are relatively undisturbed and are highly distinctive compared with those in other regions of Australia. Tropical river systems, their wetlands and estuaries are important for biodiversity, supporting a high levels of species diversity and endemism for many taxonomic groups such as aquatic plants, fishes and invertebrates.

Ecological communities show distinct biogeographic provinces that reflect regional geography and climatic patterns. Community composition is also relevant in an international context, as estuaries in northern Australia contain elements of broader Indo-West Pacific biological groups that have suffered greater disturbances in other locations.

For the development of northern Australian water resources to be sustainable, we require a better understanding of how rivers function as systems. Many of these riverine ecosystems have not been studied in a systematic way, and neither has the knowledge of the people who live along them been gathered. From Cape York to King Sound, generally only those catchments with mining, industrial or intensive agricultural development have information on the region's ecology, biology, geomorphology, hydrology and management opportunities. This limited information is fragmented and insufficient for addressing the management demands of the future. This Tropical Rivers Program aims to reconcile this information shortfall, so that a knowledge base can be built to support regional planning and protective management.

Whilst some tropical catchments have been extensively developed and are now the focus of environmental management efforts, many catchments are relatively unchanged from their natural condition. The combination of a growing interest in water at the national level, regional development aspirations in the tropics, and the condition of tropical rivers provides a unique opportunity for science to be proactive in providing the information needs for sound management into the future. Accordingly environmental protection can be a more effective long-term management strategy than environmental restoration.

Tropical river systems in Australia are subject to greater seasonal variability than rivers in other regions, and can display a high level of ground water dependency in the dry season. The compatibility of water resource development with maintenance of ecological integrity is likely to raise different issues to those being confronted in southern regions.

Tropical marine systems have been studied extensively for many years, and Australia is recognised as an international leader in this area. Similarly, the concentration of research effort in south-eastern Australia has greatly advanced our understanding of temperate river systems. In contrast, Australian scientific involvement in tropical river systems is lagging behind its marine and temperate freshwater counterparts. Enhancing scientific capacity and knowledge of Australian tropical rivers will not only benefit Australia, but also will also open opportunities to assist water management in other tropical countries.

Developing research approaches that integrate land and water management issues, rather than treating them in isolation, will provide an opportunity to identify connections, and manage them by applying systems approaches to address such inter-relationships.

State and Territory governments have recognised the values that tropical rivers provide and are developing legislative and policy frameworks to protect these values consistent with the National Water Initiative. Future proposed uses and assessments will need to be consistent with these legislative and policy frameworks.

A workshop on Sustainable Futures for Australia's Tropical Rivers organised by CSIRO Land and Water and held in Darwin on 1–3 February 2004 considered a range of future development and environmental scenarios for northern Australia. The scenarios included:

- agricultural expansion and land release for large-scale development;
- increased water harvesting (floodplain development, small dams, groundwater extraction);
- aquaculture expansion (freshwater, estuarine and marine);
- expansion of mining;
- spread of pest species, including plants, terrestrial and aquatic animals;
- climate variability impacts, saltwater intrusion;
- social pressures, e.g. development to provide regional employment.

Other scenarios were considered that might act to mitigate adverse environmental effects. For instance, pastoral industries may continue as a very stable land use in many areas and effectively exclude activities that rely on more intensive use of the land or water. Ecotourism and cultural tourism can provide an economic return from protecting natural environments. Improved knowledge of environmental and social responses to development of water resources can assist policy formulation and decision-making to avoid or mitigate adverse impacts on river systems. The consideration of scenarios can assist in the scoping of research priorities and is also an area of potential social and institutional research focus in its own right.

3. Program goal

A comprehensive and systematic approach to water resource management for northern Australia is essential to complement and assist initiatives by the States and the Northern Territory (e.g. water resource planning), industry (e.g. development planning), communities (e.g. Landcare, Indigenous resource management) and the Australian Government (e.g. regional marine planning, Natural Heritage Trust). This has led to the development of the following Program Goal.

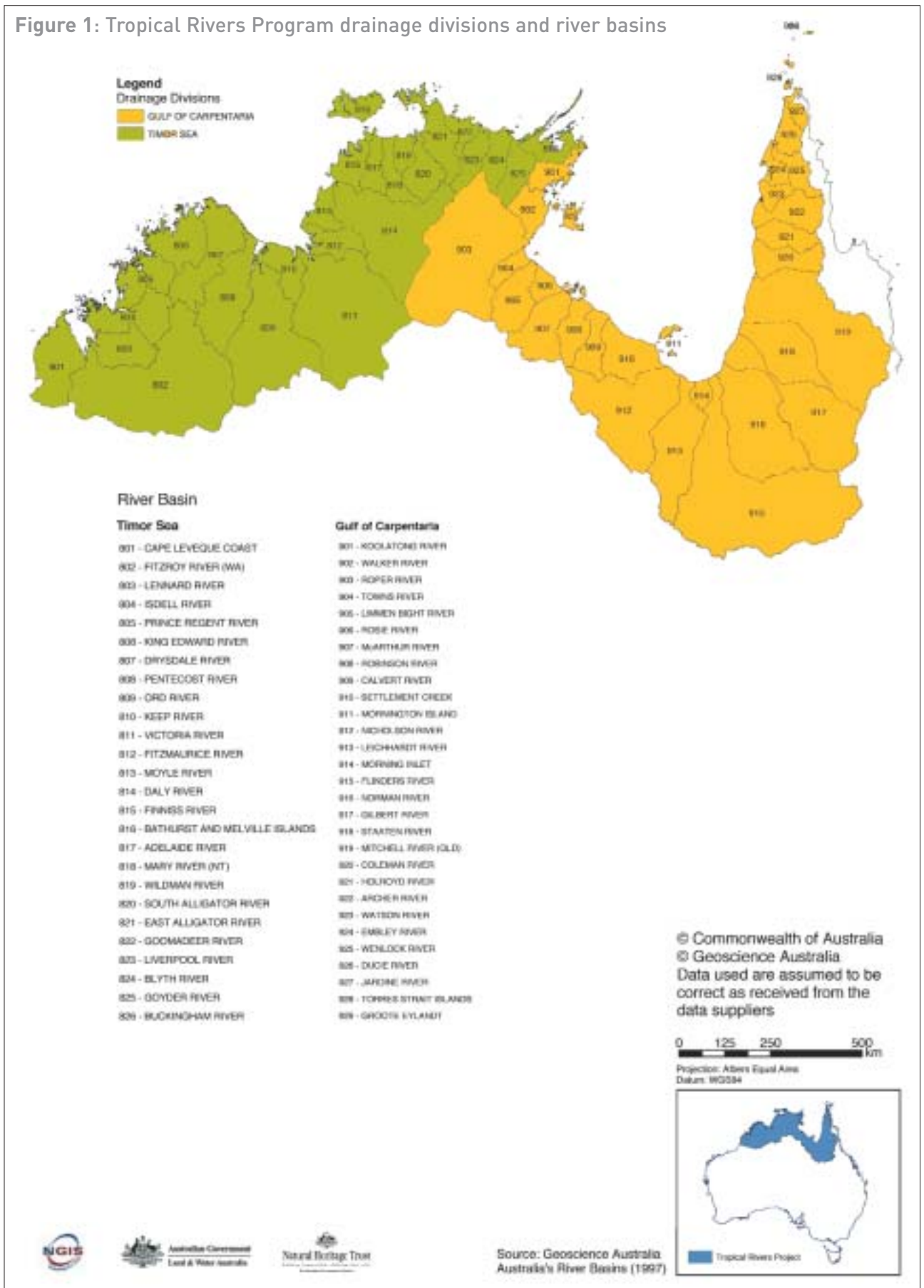
To undertake research and knowledge exchange to support the sustainable use, protection and management of Australia's Tropical Rivers.

4. Program area / geographic scope

The geographic scope of the program is planned to include the two major drainage divisions in Australia's north draining into the Timor Sea and Gulf of Carpentaria. The region extends across all catchments from the west side of Cape York to the Kimberley, across Queensland, the Northern Territory and Western Australia.

The environments proposed to be covered include rivers, wetlands, floodplains and estuaries within a catchment and land use context, supporting whole-of-river system analyses and impacts of land-use, water use and other activities.

Figure 1: Tropical Rivers Program drainage divisions and river basins



5. Program outcomes

The research program will seek to contribute to a number of broad outcomes across northern Australia:

- **Improving knowledge for determining management priorities and evaluating land use practices**
 - giving greater recognition to the importance of rivers, groundwater, floodplains and estuaries within land use and regional planning;
 - demonstrating that strategic approaches that minimise the impact of threatening processes are cost effective;
 - identifying examples where improved knowledge can influence the policy agenda and public debate;
 - Improving the knowledge base of aquatic ecosystems and their management across northern Australia.
- **Informing strategic approaches to resource management**
 - supporting regional frameworks for natural resource management;
 - promoting a knowledge-based system of policies that are based on an adequate understanding of natural resources;
 - identifying the critical knowledge gaps where this and other R&D programs could contribute.
- **Supporting Indigenous management**
 - building links with Indigenous groups and bridging cultural boundaries;
 - supporting the development of Indigenous natural resource management knowledge and skills in rivers and river management.
- **Developing an integrated approach to river assessment**
 - implementing multi-disciplinary research spanning biophysical sciences, social science, economics and policy.

6. The research plan

Australia's Tropical Rivers Program will be managed as a seven-year investment where partners and investors determine the precise details of the research in each phase as the work progresses, under the following priority research areas.

6.1 Assess river assets and threats

Research theme summary — Assess river assets and threats

- compile information and undertake assessments of rivers, groundwater, floodplains, wetlands and estuaries;
- undertake threat and risk assessment based on future scenarios;
- support classification and description of river types to enable transfer of knowledge.

Compile information

The environmental assets of Australia's tropical rivers and groundwater systems are incompletely documented, and therefore more difficult to manage or protect. An on-going component of long-term data collection activities should be to compile an inventory of assets accumulated from sequential investigations. This information will provide essential technical input to regional strategy development and inform trend analyses. Hydrologic information is required for planning new developments while ecological information is required for biodiversity conservation and management, and to protect key environmental values. Similarly, riverine biodiversity and condition data is needed if these river systems are to be managed effectively.

This area of research will provide an information basis so that we can integrate our understanding of the assets, threats, values and opportunities that exist across tropical rivers. It will undertake assessments across rivers, floodplains, wetlands and estuaries, building upon existing data and knowledge. Baseline descriptive data exists for many ecological system components, but spatial and temporal coverage is patchy and ecosystems are changing, presenting difficulties when interpolating available data among and within systems. There is an opportunity to make more use of innovative data sources, such as remote sensing, and automated monitoring systems for both routine data collection and specific information needs.

Processes at catchment scales tend to occur over relatively long periods of time, so that individual assessments may not reflect the degree and rate of change. There is a need for strategic long-term data collection to build an information base on which to base sound policy, recognising that monitoring is normally the responsibility of river management agencies.

Landscape analysis and systematic conservation planning are underway at scales from catchment to nationwide. Coordination of these activities for maximum efficiency relies on sharing of data among organisations, supported by open access policies on data availability where possible, subject to confidentiality and cost of transfer issues. There may also be a requirement to integrate existing data sets into newer electronic and spatially referenced systems to ensure maximum efficiency.

An initial data collation project has already been completed as part of the scoping process for this Tropical Rivers Program. The Tropical Rivers Data Audit was commissioned in July 2003 by Land & Water Australia with funding provided by the Natural Heritage Trust's Rivercare program. The project was undertaken by NGIS Australia, in conjunction with Gutteridge Haskins Davey and Ecobyte Systems.

The project collected over 250 data and metadata sets covering the targeted themes within the project area. It was found that a number of these themes were adequately covered by existing datasets. However, there were important gaps on some of the key themes, resulting in recommendations regarding data acquisition. The project produced:

- GIS-based coverages of the specified project themes delivered in a format suitable for inclusion onto the Australian Natural Resources Atlas;

- a hard copy report that presents the outputs in map form, details data collation or synthesis methods used, and including a Metadata Appendix of all datasets collated;
- identification of existing data sets and information gaps;
- priorities for future research into Australia's tropical rivers;
- potential inputs to a range of natural resource management assessments such as the National State of the Environment Reporting, and National Land and Water Resources Audit.

The report was published in April 2004 and is available on the Land & Water Australia website (www.lwa.gov.au).

Classification and description

Conservation of tropical river systems needs to reflect the hierarchical organisation of drainage systems at multiple scales, from drainage divisions and river basins down to subcatchments and river segments and reaches, including groundwater and estuarine systems. Frameworks for river conservation are needed that provide the potential to transfer information across catchments by adopting consistent river classification systems across the tropics, allowing data to be extrapolated to similar systems to minimise duplication of effort. The classification and description of rivers and aquatic ecosystems from spatial data are also important for policy development, regional planning and management.

Potential research themes emerge at pan-tropical scales, covering larger issues that span multiple catchments and jurisdictions and which may have international implications for neighbouring countries, and catchment-based scales that tend to be more focused on specific issues within individual catchments. The hierarchy of issues is similar across scales, differing in the level of detail and transferability required.

Data collection over the wide range of river systems in tropical Australia is likely to be expensive because of the geographical scope of the area of interest. Costs of data collection can be reduced by developing a broad description of tropical river systems or a comprehensive river classification system of representative river types that will allow greater transfer of information among functionally similar river systems. There is a need to ensure that research programs provide representative coverage of different river types, to assist with transferability of knowledge between regions and projects.

Threat and risk assessment

Tropical river systems are characterised by pronounced seasonal patterns, but with great consistency from year to year. Episodic events, such as cyclones, provide an unpredictable cycle of disturbance and recovery. The different climatic drivers of tropical river systems mean that concepts of ecosystem resilience and recovery from disturbance are likely to differ from the better-known responses of rivers in temperate climates.

Risk assessment provides a way of assessing the implications of potential trends in resource use and management, and analysing threats. Risk assessment approaches need to be linked to future scenarios, and predictive modelling is required to allow a strategic investment in areas of greatest risk. Risk assessment priorities need to be based on multiple visions for the future that include development opportunities, social and economic values, as well as catchment condition and conservation priorities. For example information from assessments of river assets can be utilised to investigate threats to ecosystems, and threats from one economic activity to another, such as land use impacts on estuarine fisheries.

Environmental risk assessment and risk mapping associated with identified threat or development scenarios, or drivers of change, may include vegetation clearing, fire regimes, grazing, roads, rail, mines, climate change or sea level rise. More direct impacts occur at permanent pools, gorges and river reaches at road crossings, which are intensely used for recreation and tourism during the dry season. The cumulative impacts of these activities on local ecosystems and downstream river health are currently unquantified, and minimal predictive information is available on potential future impacts. For example present fires and changed fire regimes are impacting on river health due to their cumulative large spatial extent and changed frequency.

Assessments need to be able to consider scenarios that allow for comparisons of values, risks and threats where catchments may not be developed to the same extent, and where information is required on relative priorities for protection.

Current projects

The program is currently supporting a two year project being managed by the National Centre for Tropical Wetland Research, on behalf of the Environmental Research Institute of the Supervising Scientist (ERISS) and the Australian Centre for Tropical Freshwater Research (ACTFR), to undertake an integrated data assessment and analysis of Australia's tropical rivers. The objectives of the project are to:

- undertake a multiple-scale inventory of the habitats and biota of the rivers and wetlands of tropical Australia, where necessary developing suitable classification of aquatic ecosystem types;
- undertake risk assessments of the major pressures on the habitats and biota of the rivers and wetlands of tropical Australia;
- provide a framework for analysis of the ecosystem services (e.g. provision of water for multiple uses), provided by the habitats and biota of the rivers and wetlands of northern Australia.

The program is also co-funding Griffith University with the Queensland Smart State Fellowship program to support a Postdoctoral Fellowship to develop a description and classification of the hydrological and landform features of the rivers of northern Australia. The project is using satellite imagery, aerial photography and geographical information systems (GIS) to define the different landscape characteristics of rivers draining into the Gulf of Carpentaria and to increase knowledge of the physical and ecological processes driving the Gulf rivers.

6.2 Support regional planning frameworks

Research theme summary — Support regional planning frameworks

- provide targeted knowledge support for State, Territory, National Water Initiative, National Action Plan for Salinity and Water Quality, and Natural Heritage Trust regional management initiatives;
- promote scientifically based resource condition targets and indicators;
- develop monitoring and evaluation methodologies.

National framework approach

As Australian Government initiatives such as the National Water Initiative, Natural Heritage Trust and the National Action Plan for Salinity and Water Quality increasingly emphasise national framework approaches to achieve consistent policy implementation, activities within tropical catchments will be required to demonstrate consistency with national policy to achieve local-scale priority objectives.

An outline of current regional natural resource management planning processes is provided in Figure 2. Social, institutional, and bio-physical research is fundamental to implementing the framework in tropical river systems, and in natural resource management-related activities such as developing preferred futures with communities, asset assessment, setting resource condition targets, monitoring and evaluation, and in determining what management actions are required to achieve resource condition objectives.

The National Framework for Natural Resource Management Standards and Targets establishes the principles and requirements to guide investment, particularly through integrated regional Natural Resource Management plans under the National Action Plan for Salinity and Water Quality, and the Natural Heritage Trust.

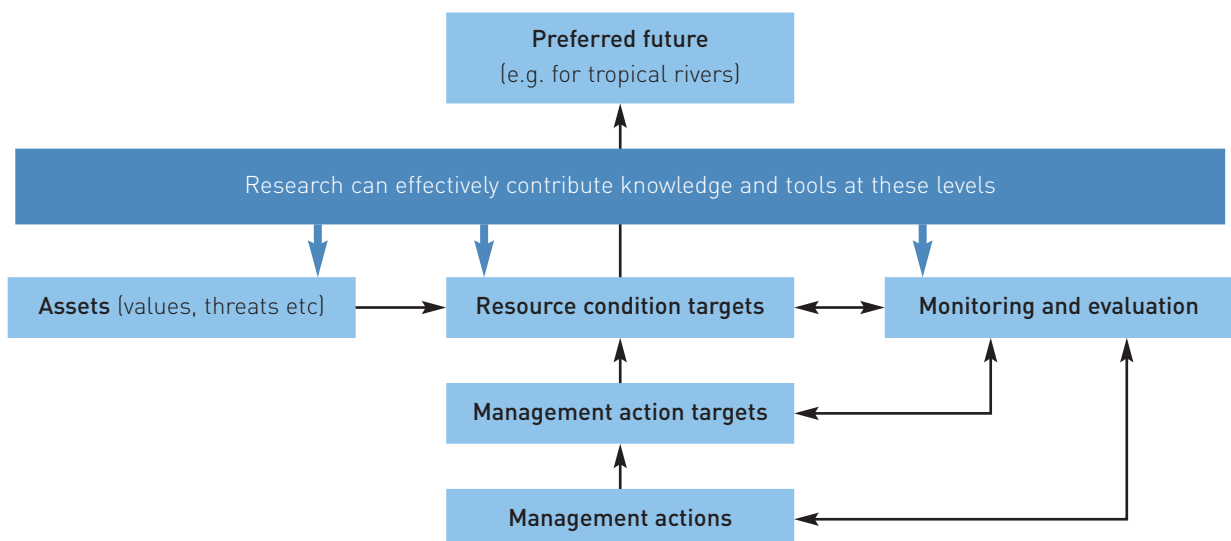
There is also a growing trend toward viewing catchment landscapes as mosaics of differing geographical features and land uses. Research into the relative roles of different landscape features, such as savannahs, wetlands, mangroves, and grasslands is needed to aid integrated planning processes for multiple catchment uses.

Resource condition targets

Natural Resource Management regions in Queensland, the Northern Territory and Western Australia are required to set 10–20 year Resource Condition Targets to receive funding under Australian Government/State Bilateral Agreements. Resource Condition Targets associated with river systems might include:

- inland aquatic ecosystems integrity (rivers and other wetlands);
- turbidity/suspended particulate matter in aquatic environments;
- nutrients in aquatic environments;
- estuarine, coastal and marine habitats integrity.

Figure 2: Role of research in Natural Resource Management Regional Planning Framework



Research is needed to better understand tropical rivers, define resource assets to determine baseline condition, to establish relationships between Resource Condition Targets and ecological values, and to establish appropriate indicators to measure and monitor changes in condition. Useful resource condition targets must link to practical management action targets and are likely to be different to those used for more impacted river systems in other parts of Australia.

Indicators for monitoring and evaluation

Specific indicators have been recommended to measure progress towards Resource Condition Targets and to provide national consistency. Monitoring and evaluation of trends in resource condition (biological, surface and groundwater, physical resources) is now a primary responsibility of regional natural resource management organisations. However research may be needed to develop monitoring tools and approaches, and to provide regional analyses for national reporting.

Indicators to track environmental condition over time, and appropriate monitoring and evaluation systems are not generally in place for most rivers. It is essential that understanding of tropical river systems can be reflected as a suite of indicators that track environmental responses to change in order to assess impacts of development and to help formulate appropriate management actions. The collation of data and information to provide a sound basis for reporting on natural resource condition targets is an important outcome of the National Land and Water Resources Audit over the period 2002–07.

It is critical that any research investment in a long-term, science base for tropical river systems must have useful outcomes for local communities and regional organisations. For this reason, monitoring should fall into an adaptive management framework so that management can respond to improvements in scientific knowledge and options for development.

6.3 Assess social, cultural and economic values

Research theme summary — Assess social, cultural and economic values, and opportunities

- undertake research to determine what people value in rivers;
- value ecosystem services;
- understand Indigenous cultural and economic values;
- analyse economic and resource development, river protection and management opportunities.

Tropical Australia covers a wide area of diverse community interests, so that a focussed program of social and economic research is required to identify what people value within their regions. Social and economic research is required to inform natural resource management decisions on sustainable agricultural systems with respect to land capability and operating costs. Potential developments also need to be studied in an integrated way across northern Australia, including details of social and economic values, for example commercial fisheries, tourism, and Indigenous values and their management needs.

Social values

Foremost is the need to identify the vision for societies, based on their values for tropical river systems. Subsequently, an assessment is required of the values of current and potential uses of rivers, wetlands and estuaries, their water use and the conservation measures that are supported by the community. Reliable valuing of ecosystem services in economic terms is also fundamental to framing research questions to protect key environmental assets.

Economic values

Economic values are important when considering opportunities for infrastructure investment and resource development in northern Australia that will arise in the future, including consequent rural and regional impacts. The economic environment also constrains particular land management options. The valuation of industry sectors (fisheries, agriculture, mining, tourism) and environmental goods and services, as well as non-marketable commodities is important to build a complete picture.

Potential developments in northern Australia include water use for crop irrigation, pastoralism, mining and water storages. Development is likely to be subject to a range of economic and geographical constraints that will influence the type of development and the pace of change. There is a need to assess land and water resource capability to assist in planning potential resource development opportunities. Development will also need to be balanced against the values provided by the largely undeveloped land and water resources in northern Australia, and the impact on downstream industries and other economic activity.

There is an increasing requirement to cost externalities such as environmental protection in the establishment of new industries, and the nature of industries also has an impact of policy instruments utilised for the management of impacts, such as the licensing of emissions versus self regulation and education.

Poorly planned development could result in threats to river-dependent communities such as in-stream biota, wetlands, riparian zones, estuaries and near-shore marine environments. The threats from development include increased sedimentation from land use, clearing and mining, nutrient enrichment, mobilisation of acids from acid sulphate soils, changes to flow regimes, and possible salinity impacts arising from irrigation activities.

Ecosystem services

It is important to build an understanding of the ecosystem services provided by natural systems in northern Australia because of the significant support that they provide to tourism, fishing and Indigenous communities.

Water resource planning also needs to have available the full range of values and costs of development and protection options in making decisions about the future of rivers in northern Australia.

Work is needed to reliably value specific ecosystem services that are most relevant to the social and economic environment of northern Australia. This will involve undertaking analyses of industry sectors and societal values, and identifying the specific habitats and ecosystem components that contribute value to those industries.

Indigenous values

The values and aspirations of Indigenous communities with respect to river systems and their visions for the future need to be integrated into research and natural resource management in a way that reflects economic, social, environmental and spiritual values. Research on Indigenous lands needs to be meaningfully incorporated into the program and be driven by Indigenous people. It is proposed to provide for the assessment of Indigenous values of river landscapes, including current and potential natural resource management activities.

Relatively little work has been done on incorporating Indigenous indicators of river condition, and Indigenous approaches to measuring and monitoring them, into improved river condition assessment and management. Many research opportunities exist in northern Australia for Indigenous people, research scientists and other land managers to work together to establish appropriate indicators of river condition and identify practical approaches to monitoring and managing typically extensive and remote river systems.

Such work could provide a foundation for documenting, synthesising and embedding traditional Indigenous approaches to river and catchment management into mainstream natural resource management principles and practices. The research could have several indirect benefits for Indigenous communities including capacity building and involvement/ employment in longer term monitoring of indicators and on-ground work to maintain river health.

Analyse economic and resource development, river protection and management opportunities

Research is required to develop management and policy options that allow for resource development while protecting river systems. Such research will inform the development of sustainable management strategies for tropical river systems, built on an understanding of river ecosystem processes and integrate these findings with social and economic considerations. This will assist managers and the community to plan for the protective management of rivers and underpin the development of strategies for sustainable land and water resource development.

It is possible to explore a range of scenarios for intensification and expansion of rural industries that identify the drivers and areas likely to be the focus for development, the nature of that development and, hence, the opportunities, threats and trade-offs that different development scenarios might pose.

An important part of this work will be to undertake activities that support the development of Indigenous natural resource management knowledge and skills in rivers and river management. This will include opportunities for protecting natural resources and supporting resource development.

This work would be complementary to supporting regional planning frameworks and probably broader in its scope. As there are relatively few river systems that cross State jurisdictional boundaries in tropical Australia, coordination among jurisdictions is simplified, with cooperative approaches among the States, Territory and the Australian Government potentially being more efficient.

The program will work to complement the Northern Australia Irrigation Futures project led by CSIRO Land and Water (Townsville) and being funded under the National Program for Sustainable Irrigation. This project will deliver a framework for use by policy makers, regulators, managers, and investors to ensure irrigation is developed in a sustainable manner across northern Australia. The project will use past experience and new knowledge to build an understanding of key landscape attributes (including soil and water resources, climate, vegetation, rivers, near shore marine environments) relevant to sustainable irrigation in tropical systems.

The program also recognises the Co-operative Framework on Tropical Science, Knowledge and Innovation signed by the Governments of the Northern Territory, Queensland and Western Australia which seeks to undertake strategic collaborations across the Australian tropics. The framework has a number of objectives including the development of tropical science and building value-adding partnerships.

6.4 Understand river ecosystems

Research theme summary — Understand riverine ecosystems

- Understand ecosystem processes and develop conceptual models of how river ecosystems function;
- Understand river and groundwater flows and hydrology;
- Understand the fluxes and balance of nutrients and contaminants in rivers.

Ecosystem processes

River ecosystem processes, structure and function within tropical river systems are poorly understood. This includes hydrology, material fluxes and processes, responses to changes in flow, riparian linkages, estuarine and coastal linkages and groundwater interactions. Further research is needed to identify whole-of-system links, material fluxes, and trophic systems that drive productivity from tributaries and riparian zones to coastal marine environments.

Effective management options to protect and manage aquatic ecosystems can be designed once the linkages between catchment features and fluxes in flow and nutrients are understood. Description of the fluxes of water, sediment, carbon, nitrogen and phosphorus from a whole of river system approach can guide this understanding.

The development of conceptual models of river system structures and processes required to sustain aquatic ecosystems is important to demonstrate our understanding of how rivers function. The development of conceptual models will raise hypotheses that will need to be tested in the field, and will identify knowledge gaps to be filled. Basic ecological research can then be targeted to priority areas and also focus on ecological processes of key importance to the protection of assets.

Beyond the descriptive inventory data sets, little information is available on ecosystem processes and the services provided by aquatic ecosystems. Methods for biological assessment of ecological condition in tropical rivers require more development to deliver robust and sensitive indicators that can be applied across major regions. Existing indicators based on invertebrates or fish require further research and development, and the suitability of waterbirds, diatoms, indicator species, riparian vegetation, sediments and nutrients, or geomorphic characteristics require further investigation.

River and groundwater flows and hydrology

The implications of variations in rainfall and flow for tropical river systems are not well understood and are difficult to predict and the impact of climate change adds further uncertainty. This makes it difficult to formulate long-term planning policies that provide adequate protection for river systems.

Foremost among the needs for information on tropical rivers is their dynamic range throughout the seasonal cycle and longer term climatic cycles, and the implications of this dynamic behaviour for their potential use. Existing baseline hydrological monitoring may be adequate for minimalist management purposes, but the development of comprehensive, long-term hydrological data sets is essential to underpin resource allocation and management decisions and policy.

Types of basic hydrological information required include flow processes in tidal estuarine reaches, especially those with large tidal ranges, estimation of floodplain flows, stage–discharge relationships at lowest and highest flows linked with flood forecasting and rainfall patterns. Current estimations of sustainable water yield are subject to large levels of uncertainty, and would be vastly improved by enhanced hydrological data. It needs to be recognised however that a significant increase in resources for stream gauging is unlikely and therefore we need to improve the predictive capacity of the hydrology of ungauged areas.

There is a need for improved investment in water accounting systems and associated infrastructure, supported by research to improve the cost-effectiveness of water measurement, with opportunities including automated, remote, smart-sensor systems.

There is a pressing need for integrated management of surface and groundwater systems, with balanced water accounting systems that avoid double accounting of water. Water resource planning also needs to address the ways that surface water and ground water interact to produce stream flow and sustain wetlands in different seasons.

Nutrients and contaminants

Research is needed to define more precisely the roles of fluxes of water, carbon and nutrients in sustaining aquatic ecosystems, and the effects of excess nutrients and other pollutants upon them. Flow regimes, ecosystem water and habitat requirements, and water quality thresholds are all areas of further investigation. Aspects of this may be to understand natural flow regimes and to explore the environmental flow requirements of ecosystems, to examine critical water quality thresholds, and to specify physical habitat requirements.

Understanding the connections provided by fluxes of water, associated drivers of food webs, and pollutants are important. The conceptualisation of threats and ecosystem processes will outline the water and constituent nutrients that are required to maintain viable aquatic ecosystems, and conversely the excess fluxes that threaten ecosystems. The sources of water and its constituents, and their link to ecosystems of concern, will need to be assessed in greater detail so that we can clearly define the links between different parts of the catchment.

There is a growing need to understand ecological linkages among hydrologic subsystems, such as interactions between ground water and surface water; river and floodplain habitats; freshwater, estuarine and marine coastal systems. The basal food resources for economically important food webs, supporting species such as prawns, barramundi and crocodiles, are poorly understood, so that there is insufficient knowledge about critical resources that should be protected to sustain these key resources. Related questions focus on how river-borne nutrients and sediments affect estuaries and coastal waters, and the mechanisms underlying the observed positive influence of river flow on fisheries.

The quality and quantity of river flow to the coast is extremely important to major biological and economic assets of the region. For example the Northern Prawn Fishery is believed to be Australia's largest Australian Government managed fishery, and is highly dependent on maintenance of estuarine habitats and food web processes to maintain prawn populations and sustain the fishery. The interactions between catchment change, river flow cycles and water quality, estuarine and coastal productivity are not well understood.

7. Knowledge management

Development of a research program for tropical Australia requires consultation with all levels of government, community and industry to involve the necessary interests from the beginning, and to draw on their collective knowledge of the problems at stake. On-going communication among stakeholders to maintain engagement and commitment will be critical as will be a commitment to supply and develop capacity to undertake research and implement outcomes.

The knowledge management component of the Tropical Rivers Program will be developed with those people living and working in the region to ensure that it meets their needs. At present, the primary focus of the knowledge strategy is to focus on the interaction between those undertaking the R&D and those needing or benefiting from the results of R&D. This will require significant engagement and partnerships with all those involved in the Tropical Rivers Program, with project outcomes communicated in ways that are meaningful and relevant for the communities involved in making land and water management decisions.

The following knowledge management principles will be adopted for the Program:

- to facilitate and encourage participatory research projects involving resource users and managers working with researchers;
- to encourage and fund research projects where the social, cultural, policy and economic context has explicitly informed the projects' goals;
- to facilitate interaction between researchers and the community, including agribusiness and extension providers;
- to involve the research community in identifying R&D priorities and developing research proposals;
- to work with and build capacity within existing institutions, industries and communities in northern Australia;
- to include a decentralised communications capacity involving local regional communications facilitators;
- to provide communication products and services based on identified needs of their intended end-users.

Throughout the life of the Tropical Rivers Program, we will integrate the findings of each of the program elements into practical advice for the protection and management of river systems in the region. Some of the ways we will do this and outputs from the program will include:

- integrating across projects to deliver key products in ways that are easily accessible and relevant for State, Territory, Indigenous communities and regional clients;
- supporting regional natural resource management bodies with information generated by the projects for incorporation into regional natural resource management planning frameworks and strategy development;
- building capacity in the communities living and working in the regions so that local knowledge and experience can be complemented with scientific approaches;
- providing readily available data and information sets, and spatial information products suitable for the Australian Natural Resources Atlas;
- reporting findings and management opportunities for sustainable management of water resources;
- identifying sources and management opportunities to reduce any excessive export of sediments and nutrients to rivers and estuaries;
- quantifying the values, assets and threats of rivers and wetlands to support planning for river protection;
- evaluating program activities so that further research priorities can be developed to support further work in the region;
- supporting workshops and conferences to promote interaction, communication and adoption.

8. Partnerships

Because of the vastness of tropical Australia, there are obvious advantages to coordinating research on tropical rivers to maximise the transferability of results among regions, and to add value to pre-existing knowledge across different spatial and temporal scales. Coordination across scientific disciplines and government jurisdictions will add value to prior and future work, and will help build the critical mass necessary to ensure the effectiveness of research efforts.

Because of the small economic base for investing in research in most regions of tropical Australia, partnerships and shared institutional arrangements will be vital to ensure maximum information return for research investment. Partnerships such as cooperative research centres, consortia of funding bodies, networks of research institutions, and community organisations will be required to avoid duplication of effort and synergies between communities, government, research providers and industry groups.

No single research institution in Australia has all the required skills and experience to tackle the research needs of Australia's tropical rivers. Few have the experience in applying those skills to tropical environments and at the scales demanded of the region; hence a strong team approach across institutions will be required. For this program we require researchers that can contribute across discipline boundaries and work at large system scales. Reference or focus catchments may be selected for strategic issues relevant to multiple locations.

A range of organisations are being approached as potential partners, or to be engaged closely through representation on the management committee or through the communications component of the Initiative. Ongoing negotiations with potential partners will build a shared vision for the program and will include:

- State and Territory Government Agencies;
- Indigenous Land Councils, North Australian Indigenous Land and Sea Management Alliance (NAILSMA);
- Universities, institutes and research centres — e.g. National Centre for Tropical Wetland Research;
- Cooperative Research Centres;
- Australian Government agencies — e.g. Department of the Environment and Heritage, Department of Agriculture, Fisheries and Forestry, and the National Oceans Office;
- Rural research and development corporations — especially Fisheries Research and Development Corporation, Meat and Livestock Australia and Cotton Research and Development Corporation;
- Regional Integrated Natural Resource Management Groups;
- Community based groups — such as Waterwatch and Landcare;
- Non-government organisations — e.g. WWF, ACF, Inland Rivers Network;
- Other funding agencies and philanthropic organisations — such as the Myer Foundation; and
- Industry bodies — e.g. fisheries, petroleum, mining and pastoral.

9. Budget


Land & Water Australia anticipates that at least \$7 million is needed to give the program critical mass, although an investment of up to \$10 million could be responsibly justified on the basis of this proposed program. An indicative budget is shown in Table 1.

While some resources have already been committed to the program, the identification of substantial additional cash and in-kind resources will be critical to the success of the program. An investment target of matching each dollar invested by Land & Water Australia with an additional dollar of funding from program partners is proposed.

Where a research project is more directly relevant to an industry sector or region, the program will consider co-funding individual projects with the relevant research provider, agency or industry group. Partnership arrangements will also be developed to attract in-kind support from collaborating agencies.

Table 1. Indicative budget summary

Financial year	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
LWA (\$ thousands)		\$100	\$250	\$500	\$750	\$750	\$750	\$750
Natural Heritage Trust (\$ thousands)	\$200	\$300	\$300					
National Landcare Program (\$ thousands)			\$250					
Other partners (\$ thousands)				\$700	\$700	\$700	\$700	\$700
Total (\$ thousands)	\$200	\$400	\$800	\$1,200	\$1,450	\$1,450	\$1,450	\$1,450

 Start-up funding committed

10. Program management

Subject to the agreement of major partners, the Tropical Rivers Program will be administered by Land & Water Australia, with appropriate governance and management models negotiated with co-investing partners. These typically involve a Program Management Committee composed of key investors. Land & Water Australia will provide support for financial management, register research proposals, develop research contracts, and support communication and adoption activities. In the interim, the Tropical Rivers Program will be governed by the National Rivers Consortium, advised by a steering committee composed of key stakeholders.

Research proposals will be sought through either commissioned projects or an open call for proposals. Detailed project briefs will be prepared for commissioned projects, which will be publicly advertised or subject to a select tender process, and will be assessed by the Program Management Committee against agreed criteria.

The Land & Water Australia Board is committed to the highest standards of corporate governance in accordance with required statutes and principles. Land & Water Australia has an excellent accountability record in its management of external funds, demonstrated through internal and external audits. All investments are covered by contracts specifying clear deliverables within defined timeframes.

11. Contacts

For further information on the Australia's Tropical Rivers Program, please contact Brendan Edgar at Land & Water Australia:

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Aerial view of Katherine Gorge, NT

