



# Northern Australia Land and Water Science Review 2009

## CHAPTER SUMMARIES

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Peter Stone, Managing Editor CSIRO Sustainable Ecosystems.



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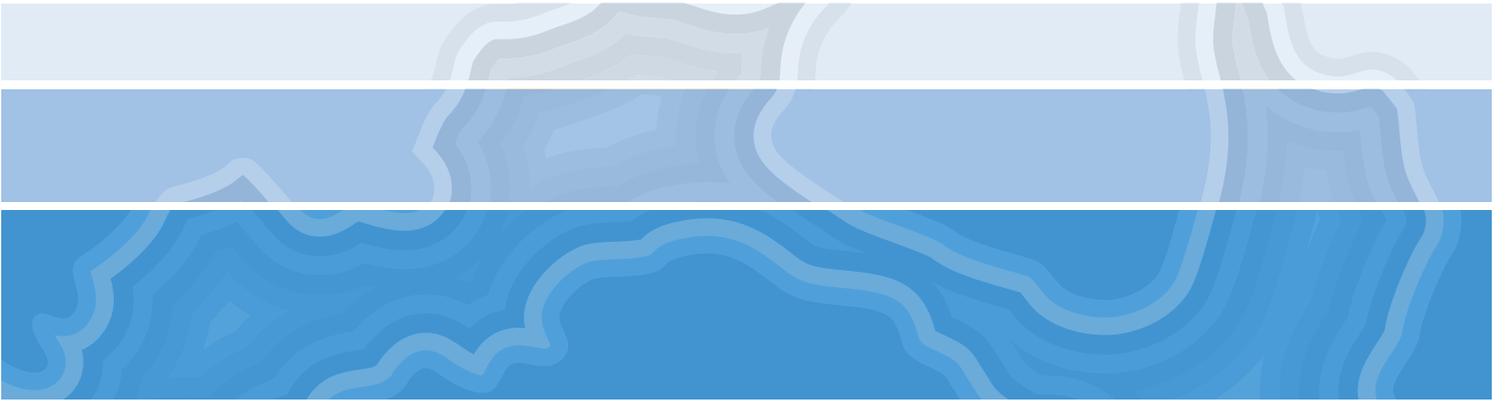
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## EXECUTIVE SUMMARY

The Northern Australia Land and Water Taskforce has been charged with finding new opportunities for economic development in northern Australia based on water availability and sustainability. It is to report on the potential impact of new development on water balance and quality, the environment, existing water users and the broader community. It commissioned the *Northern Australia Land and Water Science Review 2009* to inform that report.

The Taskforce's five terms of reference and the Review's response to them are outlined below.

### **1. Identify, consistent with the provisions of the National Water Initiative (NWI), the sustainable capacity of the river systems and/or drainage basins to support increased consumptive water use**

The Review has provided the best available quantitative estimate of the amount and distribution of water in the northern Australian landscape. The 1 million gegalitres of rainfall received each year supports a wide range of uses. These include unique aquatic and terrestrial ecosystems; recreational and commercial fisheries and tourism that are based upon them; a range of largely non-consumptive Indigenous uses; and consumptive use by irrigated agriculture, stock and domestic and mining. Water is critical to each of these uses, and increased consumptive use will involve a degree of trade-off between new uses and the range of existing consumptive and non-consumptive uses.

Surface and groundwaters are frequently highly connected. Consequently, groundwater abstraction from one point may influence surface water flow and function at another, and vice versa. Consequently, trade-offs between different water uses must take into account impacts on and responses to both ground and surface waters. These linkages are imperfectly quantified and specific abstractions require site-level assessment.

Conserving and accessing surface water for consumptive use is highly constrained by difficulties in impoundment. Groundwater therefore provides the best prospect to support new consumptive use. We estimate that there may be ca 600 GL, across northern Australia, that could support new consumptive use. This volume would be adequate, for example, to irrigate ca 40,000 to 60,000 ha of

intensive agriculture. To be NWI compliant, this water would need to be assigned according to an agreed statutory water plan that takes into account diverse and competing water uses.

### **2. Identify, consistent with sustainable resource use principles and practices, economic development and diversification opportunities (including non-consumptive or in-stream uses) which rely on access to locally or regionally significant water resources**

All of northern Australia's major economic development and diversification opportunities rely on access to water resources. This, along with their social and environmental importance, makes virtually all water resources locally or regionally significant.

Development need not be confined to deliberate modification of the landscape, or to extractive use of water or soil. Tourism, for example, contributes ca \$2.8b p.a. to the northern Australian economy, and relies heavily on the largely pristine land and water of the north. Extractive industries such as commercial fishing (>\$160 m) are heavily water dependent non-consumptive uses of water. Opportunities available to these industries would be curtailed by significant consumptive water use or landscape modification.

Intensive irrigated agriculture (ca \$160 m) and beef production (ca \$1 b) are significant contributors to the northern Australia economy, the expansion of which is directly limited by access to water. Suitable (though not necessarily advantageous) agricultural soil is comparatively plentiful. Mining (>\$9.1b) may recycle more water than it consumes, but remains a large (and unspecified) consumer of water resources.

It is critical to understand that water dependent development need not imply monetised exchange. The hybrid economy that characterises many Indigenous livelihoods is heavily reliant on water-dependent natural resources, which intersect and support its customary, state and market sectors. Changes to the natural resource base impact the value of the Indigenous hybrid economy, upon which up to a third of the north's population may depend.

### **3. Identify the potential impact of such development opportunities on the natural environment and other users and the broader community**

Pursuit of the diverse range of development opportunities detailed in the *Review* requires trade-offs amongst opportunities, especially where consumptive use is implicated. Key to development evaluation is how trade-offs are measured. Specific trade-offs are highly enterprise, site and activity dependent, and beyond the scope of the *Review*. Instead, we indicate the scale of opportunities available and their water requirements and impacts.

Cultural life in northern Australia is extraordinarily dependent on the region's high natural values. These, in turn, emanate from the intact landscapes and relatively undisturbed flows of the north's waterways. Development can directly reduce these values by depleting water, reducing water quality or by changing the natural flow of water in the landscape; all of which impact aquatic, marine and terrestrial environments. Development can also indirectly and inadvertently impact these. Roads, for example, can disturb the flow of water across the landscape, altering connections between waterways and floodplains that support communities of vegetation, fish, birds and mammals. The impacts of development on the natural environment are varied, and many are persistent and difficult to correct.

### **4. Identify incentive, market, regulatory or planning instruments that could be used to facilitate, control or influence development, such that it proceeds in a manner consistent with the principles of the National Water Initiative**

A robust system of institutions and governance has been developed consistent with the principles of the NWI. It is applicable across the changing climatic and hydrologic realities of northern Australian basins and relevant to the various stages of development of water resources. The whole of basin approach accounts for neglected Indigenous rights and interests and aims to meet fairness and efficiency criteria. Robust design for northern Australia consists of independently managed instruments including a negotiated statutory water plan; access entitlements as secured, long term unit shares of the extractive pool; periodic allocation of water to each share and finally; a licence prescribing the obligations of water use.

These processes enable the systematic matching of instruments to northern basins, classified according to their current and potential cultural, ecological and development status. Included is a reserve pool which provides sufficient water to satisfy future unresolved Native Title claims and to buffer scientific uncertainty. The three classes are: Customary Management: with limited water extraction and co-management negotiated through a non-statutory water plan; Open: with a water sharing plan, some water extraction and a reserve pool and; Closed: with fully assigned environmental and extractive entitlements, no reserve pool, and opportunities to develop trading in entitlements and seasonal allocations. Entitlements assigned in this way indicate a potential role for water to promote and enable both water dependent enterprises and Indigenous autonomy. Compared to southern systems, it will be much easier to create the pre-conditions in northern Australia for NWI compliant and sustainable water management and avoid the costly retrofitting of unplanned water resources.

### **5. Recommend governance arrangements for the effective management of surface and groundwater resources that cross jurisdictional boundaries**

There are three basins that cross state jurisdictional boundaries in northern Australia. This is unlikely to be of major concern. Potential exists for a closer working partnership between the Commonwealth and water managers in the Northern Territory. The relationship could be used to trial implementation ideas which could then be proposed to the states as evidence-based working models.

# INTRODUCTION

Peter Stone; CSIRO Sustainable Ecosystems

## Federal Government explores sustainable development opportunities in northern Australia

### Northern Australia Land and Water Taskforce convened by Federal Government

The large scale, comparative lack of development and apparent abundance of natural resources in northern Australia invites enquiry as to its development potential. The recent and projected scarcity of water in the Murray-Darling basin has increased this interest and prompted the Australian Government to convene the Northern Australia Land and Water Taskforce (the 'Taskforce').

The Taskforce has been charged with finding new opportunities for economic development in northern Australia based on water availability and sustainability. It is to report on the potential impact of new development on water balance and quality, the environment, existing water users and the broader community.

## Terms of reference

The Taskforce was instructed to address 5 terms of reference:

1. Identify, consistent with the provisions of the National Water Initiative, the sustainable capacity of the river systems and/or drainage basins to support increased consumptive water use
2. Identify, consistent with sustainable resource use principles and practices, economic development and diversification opportunities (including non-consumptive or in-stream uses) which rely on access to locally or regionally significant water resources
3. Identify the potential impact of such development opportunities on the natural environment and other users and the broader community
4. Identify incentive, market, regulatory or planning instruments that could be used to facilitate, control or influence development, such that it proceeds in a manner consistent with the principles of the National Water Initiative
5. Recommend governance arrangements for the effective management of surface and groundwater resources that cross jurisdictional boundaries

Northern Australia as defined by this report, includes basins within the Timor Sea and Gulf of Carpentaria drainage divisions, and that part of the North East Coast drainage division north of Port Douglas.

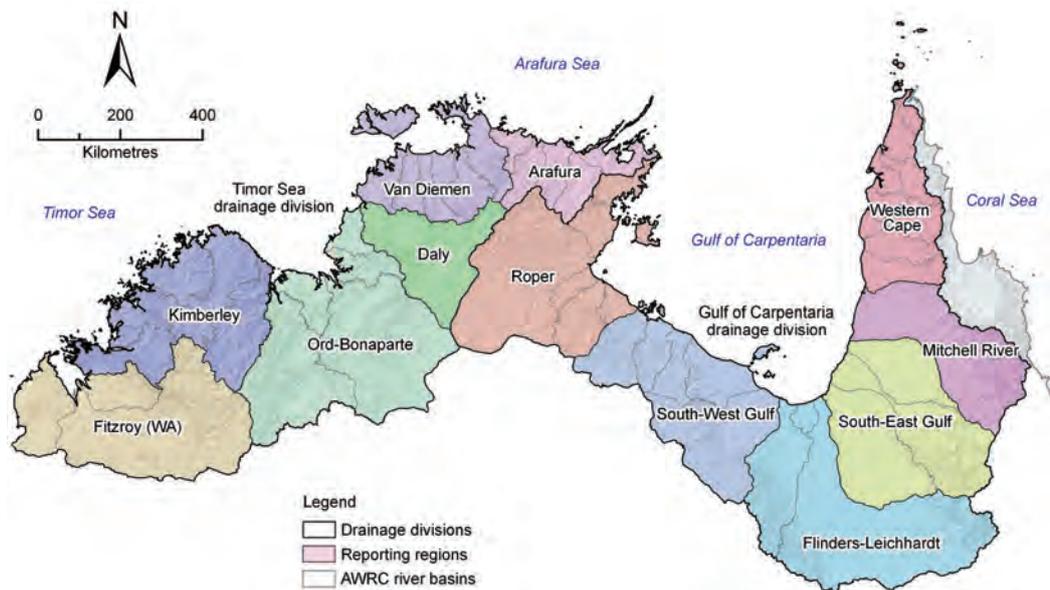


Figure 1. Geographic bounds of 'northern Australia' as defined in this report. Patches indicate drainage basins.

## Northern Australia Land and Water Science Review 2009

The Taskforce commissioned CSIRO to manage a project that synthesises existing information to explore a range of development alternatives and land use change activities, and their social, economic and environmental sustainability. Highlights from each chapter of that report, the *Northern Australia Land and Water Science Review 2009* (the 'Review'), are presented here in summary form.

The Review draws on the contributions of over 70 community and industry representatives and technical specialists from many institutions. Our immediate goal has been to enable the Taskforce to address its terms of reference. We have also sought a more far-reaching goal: to provide knowledge, data and principles to inform discussion and debate of sustainable development options for the north.

### What you will and won't find in the Review

We don't try to provide sustainable development 'solutions'. Sustainability is a concept that involves values as well as objective data. Our role is to provide data and insights so that others might apply their values to the problems and opportunities of sustainability.

We don't try to prescribe or proscribe particular sustainable development activities. The range of potentially sustainable or unsustainable activities is almost limitless, and many have yet to be identified or invented. It is not our intention to privilege those of which we're aware over those of which we're not.

We do not undertake detailed regional case studies, designed to identify best-bet development or non-development options. Northern Australia comprises >1.2 million km<sup>2</sup> of highly variable landscape. Understanding its form and function at the scale required to identify the impacts of specific uses of land or water (i.e. individual developments) is beyond the scope of the *Review*.

We have sought to broaden perspectives of development. Development needn't be confined to modification of the landscape, or to extractive use of water or soil. Development can be based on non-extractive use of resources, such as for aesthetic or recreational purposes. Development needn't imply

simple economic activity, where money changes hands. It can include non-monetary activities such as the improvement of spiritual or physical wellbeing, or money-substituting activities such as the collection of food.

We have sought to identify, by example, the consequences of undertaking a range of commonly and less-commonly considered development actions. We attempt to concentrate on the connections between action in one sphere (e.g. using water for irrigation) and impacts in another (e.g. river flows and aquatic fish stocks and, hence, tourism and fisheries). By this means we seek to inform debate and decision about what might be possible, who might benefit and who might not.

We have sought to identify the scale and threshold of connections and impacts. How much of a given activity can occur before it impacts on another, and what is the likely trade-off between the two? Reliable information on thresholds is scarce and highly location- and activity-specific. Nevertheless, we have attempted to inform debate over not only what, but how much, might be acceptable uses of land and water resources.

### What makes Northern Australia special? Why does this matter?

The north's relative lack of development means that the footprint of the past is smaller than in the south. The north is in many senses much more of a 'blank slate'.

This means that the landscape and its natural values are more intact and, in a broad sense, 'pristine'. For many, this implies a high intrinsic value that warrants preservation. For those who draw a different inference it presents a rare opportunity to pursue development based on the values and knowledge of today's society rather than those of past eras. The north is simultaneously much less enabled and encumbered by legacy than the south.

The *Northern Australia Land and Water Science Review 2009* seeks to inform discussion of these varying perspectives and preferred trajectories.



## 01

## WATER RESOURCES IN NORTHERN AUSTRALIA

*Richard Cresswell, Cuan Petheram, Glenn Harrington, Heinz Buetikoffer, Malcolm Hodgen and Phil Davies; CSIRO Land and Water*

**A lot of rain falls on northern Australia, but where and when it falls makes it hard to capture and manage. Above-ground water storages will have large evaporation losses and dry-season water supplies may need to come from groundwater storages. The few rivers that flow during the dry season are fed by groundwater, so co-management of surface water and groundwater is critical. Understanding how groundwater storages are replenished and how water moves under the ground should be a precursor to any extraction development. The future climate is likely to be drier due to increased rates of evaporation.**

### A lot of rain but highly variable from year to year and highly seasonal

On average, more than a million gígalitres—equivalent to 100 times the capacity of Lake Argyle (mainland Australia's largest lake) or 2000 Sydney Harbours—of rain falls across the north each year. From year to year, however, the amount varies greatly. A single extremely wet year (e.g. 1974) can dramatically increase the long-term rainfall average. This variability increases away from the coast and towards the south: year-to-year variability of rainfall for Mt Isa in the south is twice that of Darwin in the north.

Rainfall is highly seasonal, with more than 94% falling between November and April and three to six months receiving little or no rain at all. The potential for evaporation and plant transpiration is so high throughout the year that, on average, for 10 months of the year, there is not enough rain to meet this demand i.e. on an annual basis the north has a water deficit.

### No water is going to waste

All water in northern Australia is being fully used. Even water flowing out to sea is needed by plants and animals that live in the estuaries and near the coast. The few rivers that flow during the dry season are fed by groundwater and plants growing on the banks of these rivers would not otherwise survive the dry season.

While current levels of water use are low relative to the total water available, any changes to river flows will have consequences throughout the water cycle.

Unlike the Murray-Darling Basin which has a single large basin, the north has 55 independent basins. So changes to surface water resources in one basin should have little effect on the others. Groundwater storages, however, may cross catchment boundaries (under the ground), so extracting water from one storage could affect a number of catchments.

### Storing surface water for the dry season is hard to do

Water needs to be stored during the wet season to satisfy consumptive demand during the dry season and in the lead up to the wet season. But the variability of rainfall from year to year, its highly seasonal nature and the high potential for evaporation and plant transpiration make it hard to store surface water year-round without very large and deep storages.

River flows mirror the rainfall patterns and therefore:

- Flows can vary hugely from year to year.
- Most rivers stop flowing shortly after the wet season.
- Water runs off very quickly.
- Few rivers flow all year round.

Most rain falls near the coast, on the estuaries, not in the rivers' headwaters (unlike the Murray-Darling Basin). In the southern Gulf catchments, the flat coastal landscape makes it hard to capture runoff except in the upper reaches of catchments. In these areas, however, rainfall is lower and more sporadic, and the potential for evaporation and transpiration is higher. To compensate for evaporation, storages need to be large and able to handle droughts spanning many years. Lake Argyle, for example, loses a quarter of its volume, or about half the annual demand, through evaporation. Across the north, there are 24 sites with a storage capacity greater than 1 GL (a gígalitre is a billion litres).

The wetter regions of the far north and west offer the most potential for storing water. Potential sites around Darwin are currently being considered to increase Darwin's water supply.

### Dry-season water supplies need to come from underground storages

Harvesting water from floodplains after heavy rain might help to prolong water supplies into the dry season, but water levels often drop too quickly for this to be practicable. Storages (above or below ground) that fill each wet season could give certainty of supply volumes during the subsequent dry season.

Beneath the north's 55 river basins lies a complex architecture of water-holding storages (aquifers) that are replenished via a complex interaction with water on the surface. Water levels in shallow aquifers rise and fall rapidly with the seasons (wet and dry). While they often fill to capacity during the wet season and drain during the dry season, a run of dry years or increased extraction could reduce reliability of supply.

Several aquifers have potential for large-scale (greater than 100 GL/year) extraction, mainly in the Daly region in the Northern Territory. Current extraction levels are low, but supplies are fully allocated and caps on extraction are, or are soon to be, in place. Smaller extractions (10 to 100 GL/year) are feasible within the aquifers of the Canning Basin in north-west Western Australia. Extractions in the Darwin Rural Area have reached their limit and there is a moratorium on any further groundwater development.

### Understanding how groundwater moves is critical

The ways in which water flows under the ground are complex and they often vary locally. When groundwater for agriculture (including irrigation) is mismanaged, problems such as dryland salinity, irrigation salinity and over-allocation can arise. For example, failing to implement a drainage strategy in the Murray-Darling Basin caused widespread salinity. Groundwater usually moves slowly over a long time, so problems can be hard to identify and expensive to fix. To avoid such problems, investigations to understand how the water moves through the landscape should be carried out before implementing agricultural developments.

The few rivers that flow year round are fed through the dry season by seeping groundwater, mostly where rivers intersect with limestone aquifers, or where Great Artesian Basin springs occur. Pumping groundwater from shallow aquifers can reduce flows in nearby rivers, so future extractions will need to be sited far enough away from rivers to make sure the rivers are not affected before the wet season breaks.

Understanding how groundwater storages are replenished (recharged) and how groundwater flows laterally should be a precursor to any extraction development.

### The future is likely to be drier

In the future (around 2030), rainfall and river flows are likely to be similar or slightly less than the historical past (the last 100 years), and much less than the recent past (the last 10 years), especially in the Northern Territory and the north of Western Australia. The potential for evaporation and transpiration by plants will be higher, so overall it is likely to be drier.

More intense rains may increase the volume of water recharging underground storages, even if rainfall and runoff volumes do not increase.

Tropical cyclones are likely to become more intense but, at the regional scale, large low-pressure systems often produce larger amounts of rainfall over much bigger areas and, so, may be more important from a water resources perspective.

## 02

## LAND AND SOILS IN NORTHERN AUSTRALIA

*Peter L Wilson, Anthony Ringrose-Voase, David Jacquier, Linda Gregory, Mike Webb, Mike TF Wong, CSIRO Land and Water; Bernie Powell, Dan Brough, Queensland Department of Environment and Resource Management; Jason Hill, Brian Lynch, Northern Territory Department of Natural Resources, Environment, the Arts and Sport; Noel Schoknecht, Ted Griffin, Western Australia Department of Agriculture and Food*

**Soils in northern Australia are easily damaged. Strict land-use controls and guidelines need to be a part of agricultural development to minimise land degradation. We need to better understand the soils and environment of northern Australia to be able to make good development decisions.**

### Soils in northern Australia are easily damaged

Soil plays an essential role in agriculture, water movement and quality, and plant and animal diversity.

Soils in northern Australia are ancient, highly weathered and easily damaged. Soil can be lost from areas much faster than new soil is formed.

Many northern Australian soils are:

- low in nutrients
- relatively intact and little impacted by existing development
- susceptible to erosion (by water or wind which may be accelerated by human and animal activity)
- subject to flooding
- acidic
- gravelly
- shallow.

None of these characteristics is favourable for cropping.

Assessments have been made of northern Australian land and soil resources since 1946; however, recent information from northern Australia is limited to small areas. The Australian Soil Resource Information System (ASRIS) is a collection of soil and land information that provides a basis for a broad national assessment of soils and their potential.

We used ASRIS to assess potential agricultural development in northern Australia. We looked at the landscape, soils and the general climate, and considered the irrigated crops that might be grown in northern Australia, including annual crops (crops planted every year), perennial crops (crops such as fruit trees that are grown all year round and harvested each year), rice, forestry and improved pasture. We had different amounts of information about each area, so we took this into account when we were making our assessments. To make an accurate assessment of the suitability of specific areas for agriculture, more detailed information on local soils and landscapes is needed. In this assessment we did not include a range of other factors that define a priority area for agriculture development such as:

- water availability – we assumed that water supply was not constrained
- local climate events such as flooding and seasonal accessibility
- soil nutrient availability
- economic, social and cultural factors.

### Small-scale irrigation-based farming likely to have most success

There are several reasons why agricultural development in northern Australia should be explored. Good land management could actually lead to better soil quality. Well-managed farms could benefit plants and animals in the surrounding area by making water and food resources more available and providing active fire management. Increased agriculture could lead to higher productivity and profits, creating jobs and income for local communities. Secondary industries involving farm equipment, transportation and infrastructure, could follow.

Agriculture in northern Australia needs good soils, flat land, and water. Around 5–14% of northern Australian soils could be used for agriculture, including:

- the red earthy sands in the Fitzroy River region, Western Australia
- the deep red and yellow earths of the Daly River basin, Northern Territory
- the brown and yellow earths and earthy sands of western Cape York, Queensland.

However, factors that were not considered in the assessment (such as flooding, water availability and nutrient availability) may make agricultural use of the soils unprofitable, practically unfavourable or even impossible. This would be likely to reduce the estimate of 5–14% to a considerably lower figure.

Large-scale cropping would need special management in northern Australia. Poorly managed agricultural developments would have a dramatically negative effect on the environment — soil health would decrease, erosion would increase and plant and animal habitat would be destroyed.

We found that small-scale, irrigation-based farming is likely to be the most appropriate development for northern Australia. For example, industry in the region would benefit if fodder (animal feed) crops were planted to support the established grazing industry. All farms would need some form of irrigation, require access to a suitable water source and may need to be able to relocate irrigation infrastructure during floods, storms and fire events.

### Agriculture in northern Australia faces challenges

When planning for future agricultural development in the north, we can learn from the kinds of agricultural challenges that are already being faced. For example, agriculture in the Ord River Irrigation Area has been hindered by wet-season access, soil variability, low levels of soil nutrients and increasing amounts of salt in the soil.

An increase in farming activity could lead to the contamination of water resources from nutrients and soil erosion. When soil does not hold water, the water drains away, taking valuable nutrients with it. Soils may also form a hard surface crust that does not allow water to soak in — this can increase water runoff and erosion.

Northern Australia is prone to cyclones and heavy rainfall in the wet season that can waterlog and flood areas. We need to map the extent and frequency of flooding over the region to know which areas are suitable for agriculture.

Future agricultural development in the north needs to be planned wisely. There must be adequate information to be able to make good decisions.

If the land use is going to be intensive, then the soil and land surveying need to be intensive and detailed.

The impact of agriculture on the tropical Australian landscape is still relatively poorly understood. A number of examples of extreme soil erosion and other degradation events exist from poorly planned or poorly understood agricultural practices in the north. Very tightly controlled policies and guidelines for improved crop and land management practices are required.

If agricultural development proceeds, long term and appropriate levels of monitoring of soil condition are required. This will help to identify the impacts of land degradation processes such as land clearing and irrigation and provide opportunity for early intervention and adjustment of land management practices.



*Peter Thorburn CSIRO*

## 03

## PROTECTING THE VALUE OF NORTHERN WATERWAYS

*Bradley J Pusey & Mark J Kennard, Tropical Rivers and Coastal Knowledge (TRaCK), Australian Rivers Institute, Griffith University*

**Local communities and industries value northern Australia's waterways for what they offer culturally, aesthetically, socially and economically. They are in good condition due to natural flows connecting rivers with floodplains and estuaries during the wet season. Any changes to river flows by building barriers such as dams or weirs or by extracting too much water will have negative impacts on the condition of waterways.**

### Northern waterways in good condition

Most waterways (rivers, streams, lakes, wetlands and estuaries) in northern Australia have natural water flows that are not modified by barriers such as dams and weirs. Ecologically, they are globally significant. The good condition of most northern waterways reflects the natural flow of water and sediments, as well as the good condition of the tropical and subtropical savanna landscapes they drain. This is very different to the highly regulated rivers of southern Australia. There are only 27 large dams in the region, although there are numerous smaller dams, weirs, barrages and road crossings.

More than 50 major rivers, and many hundreds of smaller streams that flow directly into the sea, collectively discharge more than two thirds of the freshwater released by Australian rivers into the ocean. But this freshwater is not wasted. It is critical for the lifecycle of many plants and animals living in the estuaries. For example, the greater the freshwater flow into estuaries, the greater the fisheries production of prawns and fish such as barramundi and threadfin. Commercial fishing is worth more than \$250 million to the region's economy.

### Natural flows critical for native plants and animals

Northern Australia has a range of waterways supporting a variety of aquatic plants and animals, some of which are found nowhere else. These plants and animals have adapted to the natural patterns of river flows in the north, which have largely not been changed by the construction of barriers such as dams and weirs. The natural patterns of flows rely on the floods of the wet season connecting all the watery

habitats. This is followed by flows reducing or stopping altogether during the dry season. Any changes to river flow patterns would decrease the survival of plants and animals.

The natural patterns of flows reflect northern Australia's monsoonal climate. Ninety percent of northern Australia's rain falls in the wet season (December – April) causing rivers to rise dramatically, flooding narrow gorges like the Katherine in the Northern Territory and spreading across lowland floodplains. Rainfall varies from 3.2 metres a year on the coast to less than 1 metre a year inland. This creates a diversity of environments, from tiny headwater creeks through to large tributaries and mighty lowland rivers.

Regional differences in climate, landscape and connections to groundwater result in a diversity of river systems, which vary in their seasonality, predictability and amount of flow during the dry season.

During the wet season, floods carry sediments and nutrients downstream, forming shallow, warm floodplains that are among the most productive ecosystems on earth. Floodplains lock up huge amounts of carbon and provide perfect habitat for frogs, fish, turtles and waterbirds. Many fish species would not reproduce or grow without the wet season floods.

During the dry season, water on the floodplains recedes to leave a patchwork of isolated billabongs and other permanent or semi-permanent waterways. Similarly, many rivers stop flowing during the dry season, shrinking back to a series of isolated waterholes along the river channel. These isolated waterholes may be fed by groundwater during the dry season and are critical habitat and refuges for many water-dependent plants and animals. Waterholes are also where land animals come to drink during the dry season. Some rivers and streams (e.g. the Daly and Roper Rivers in the NT) flow year-round because they are connected to water stored underground (called aquifers). Many water-dependent animals would not survive the dry season if these rivers did not flow.

Rainfall runoff tops up the underground water habitats (associated with aquifers). These habitats have been little studied in northern Australia but contain an extremely diverse and unique array of aquatic animals.

The river banks (riparian zone) of northern Australia's rivers are often narrow but support specifically adapted plants, including species that make up monsoonal rainforests. River banks provide food for many animals and support the life cycles of animals that are sensitive to changes in surface and groundwater flows.

### People's needs put pressure on waterways' good condition

Some catchments or parts of catchments are under increasing pressure from:

- overgrazing by cattle, increasing runoff, erosion and river bank degradation
- invading feral animals (pigs, buffaloes and cane toads) and weeds
- discharging nutrients from agricultural fertilisers or sewerage effluent causing algal blooms
- contaminating agricultural pesticides and herbicides
- increasing sediments and pollutants from mining and extraction industries
- extracting groundwater for irrigation
- increasing construction of physical infrastructure (dams, weirs, barrages, road crossings) changing natural flows, causing barriers to the movement of animals and increasing problems with weeds
- over-fishing and boating by tourists

While agriculture is patchy across northern Australia, it degrades waterways by changing runoff and using groundwater for irrigation. Agriculture also increases the sediments, nutrients, pollutants, and weeds in waterways. Agriculture's impacts are varied, persistent and hard to correct.

### Climate change predicted to decrease biodiversity

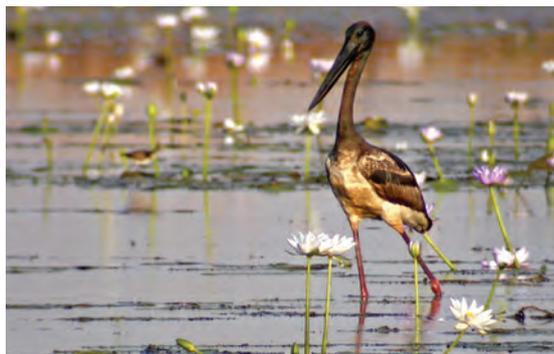
Climate change is predicted to result in fewer lowland freshwater habitats as saltwater moves inland due to rising sea levels and increased storms. Water temperatures are predicted to rise, and the variability and severity of floods and droughts are predicted to increase. As a result, many more rivers may stop flowing through the dry season.

These changes will directly affect aquatic biodiversity. In particular, fish are vulnerable to changes in water temperature and break up of their habitat. Overall, the species found in various watery habitats are likely to change as those that can tolerate saltwater expand their range, freshwater-dependent species become extinct and introduced species that can tolerate human disturbances invade.

### Natural flows must be maintained

Any changes to natural river flows will have negative impacts on biodiversity and conservation values. Keeping the natural flows is the best way of protecting the good condition of northern rivers. Rivers with similar flows are likely to share similar ecological characteristics and to respond to development in similar ways. Different management approaches are needed for different types of flows.

No new development should proceed until river flow has been assessed in detail and long-term baseline ecological data has been collected. It should avoid high conservation areas and changes to natural flows. Any new development needs to minimise risks from erosion, weed infestations and feral animal invasions. Groundwater extraction should proceed with extreme caution, given little is known about the water requirements of groundwater ecosystems.



Mat Gilfedder CSIRO

## 04

## TERRESTRIAL ECOSYSTEMS IN THE NORTH

*Alex Kutt, CSIRO Sustainable Ecosystems*

**Australia's northern tropical savannas are the most intact and best preserved tropical savannas in the world. Northern Australia needs people on the land to manage its resources sustainably.**

### Northern Australian plant and animal diversity covers vast areas

The natural environment in northern Australia is largely intact and covers almost 25% of the Australian continent. The number and variety of plants and animals found in the north — from coastal wetlands, river plains to grasslands and woodlands — is almost half the number found in the entire Australian continent. These northern ecosystems (communities of plants, animals and people) are extremely precious.

Where plants and animals are found across northern Australia is influenced by three key processes; the distinct wet and dry seasonal climate; the long history of Indigenous management; and the subtle shifts in climate and landscapes (from rugged mountains to flat, grassy floodplains) across the country. Species that live in these tropical savannas (plains with grasses and scattered trees) range from specialised species restricted to rocky outcrops or fire protected areas, to other species that occupy vast areas of woodlands and grasslands and respond to large-scale weather variation and fire patterns.

In any one year, northern Australia has about three months of wet followed by nine months of dry weather. Plant flowering, seeding and fruiting respond to this rainfall seasonality. Animals that depend on plants for food can travel huge distances to reach seasonal food sources. Connections between ecosystems are important to allow animals to travel between different areas.

Indigenous people have been managing northern Australia for around 60 000 years. Their hunting, use of fire, trade and movement has had a significant influence on where plants and animals are found over the land.

Northern Australian land ecosystems are very sensitive to change. Despite the impression of a vast, intact and secure environment, many mammals and birds are decreasing rapidly in distribution and number. The reason for this decline is due to a variety

of factors, predominantly cattle grazing and changed fire management practices. Predation by feral cats is also a contributing factor. Climate change predictions suggest already restricted species may be pushed to near extinction.

### Fire and land use shapes the northern environment

Fire has shaped the northern Australian environment. Different habitats for plants and animals are created by many small fires of different intensities and duration burnt across the landscape (mosaic burning). This pattern in plants and animals is a reflection of the long history of Indigenous burning practices.

Changed burning practices since European settlement, (reduced fire in some cases, increased wildlife in others), has resulted in changed vegetation structure and species decline. Poor fire management such as late-season hot wildfires threaten northern Australian ecosystems and careful planning is needed to improve fire management practices.

Grazing also changes the landscape and can reduce number of native species in an area. Pastoralists clear vegetation to promote pasture and sow grasses introduced from overseas to replace native grasses. Grazing changes how water moves into the soil and affects the frequency of fires by removing groundcover. Artificial drinking water points create circles of intense cattle use. These water points are small dams made by pumping from underground bores or by making a hole across a dry drainage line that fills in the wet season. The impact from grazing can be lessened with lower cattle stocking. However, exotic pastures such as Buffel and Gamba grass can completely transform environments and the impact on native species can be permanent. Areas leased from the government for grazing cover more than 60% of northern Australia. Currently, there are duty-of-care obligations for leaseholders to the Government to conserve and protect the land condition, including biodiversity values. Leaving certain areas with reduced or no grazing is one strategy.

Land that is held, managed or owned by Indigenous people covers 30% of northern Australia. This land can include areas of mining, forestry and grazing. Despite the cultural benefits of staying on the land, there are few employment opportunities, and poor access to healthcare and education means

that people are moving to towns and cities. When Indigenous people move away from the land, there is less expertise available for land management.

Land reserved for environmental conservation makes up around 6% of northern Australia. These areas are small and widely dispersed over the land and many northern Australian plants, animals or ecosystems are not in these conservation areas. These land areas are important sites for rehabilitating land and providing places where native species exist in lands managed purely for their conservation. However, such a relatively small area will not protect all of northern Australian biodiversity. Even a place as big as Kakadu National Park is not big enough to protect the range of ecosystems or plant and animal species found in the north. Land outside these reserves is therefore also significant in protecting biodiversity and needs to be managed accordingly to protect all land ecosystems.

The mining industry makes use of 0.5% of northern Australia and can create localised environmental degradation. However, the ecological impact of mining is highly regulated compared to an extensive land use industry such as cattle grazing. Mining can have ecological benefits by goodwill or enforced funding of environmental management. Mining also brings people to remote areas to participate in land management.

Intensive agriculture based on irrigation results in vegetation clearing and habitat fragmentation. Large scale clearing can cause localised declines and extinctions of species. Smaller scale agriculture results in small pockets of clearing, though surrounding ecosystems can be impacted by their water use. Feral animals and pests are commonly introduced to agricultural areas and can move into surrounding ecosystems. Agriculture is also often focussed on productive areas in the landscape – these are often the most productive areas for native species too.

Damming and irrigating changes the way that water moves in the landscape. Northern rivers, wetland and floodplain ecosystems are reliant on regular flood events that promote native aquatic species breeding. Water storage and extraction changes natural patterns of water flow, which in turn changes vegetation patterns, and therefore cause declines in native animal and plant populations. Overshadowing

all land management is climate change which may significantly alter the ecosystems of northern Australia as they depend on and are sensitive to seasonal changes in rainfall and temperature.

### The north must be actively managed to stay healthy

Planning for future conservation is the key to long-term survival of animals and plants. Northern Australia is different to southern Australia and land management strategies are needed that recognise the vast, interconnected and fragile nature of the land ecosystems across the north. There is clear evidence that recent changed land management has negatively affected many species; especially mammals and birds.

A future management priority in northern Australia could be fire management. Managing fire has a clear effect on the conservation of native plants and animals in northern Australia and savanna burning makes up 1–3% of Australia's yearly greenhouse emissions. These emissions could be reduced with careful fire planning. Partnerships between industry and Indigenous land managers are possible, and the West Arnhem Land Fire Abatement project provides a good example.

Hot late-season wildfires in West Arnhem Land burn huge areas of vegetation and release large amounts of greenhouse gases into the air. Early-season light burns to break up the country and prevent late season wildfires were needed. Traditional Owners are often willing to undertake this land management work, but do not always have the resources. Partnerships between Traditional owners and companies looking to reduce carbon emissions, such as Darwin Liquefied Natural Gas can have multiple benefits; reduced greenhouse emissions, job and education opportunities for Indigenous rangers on country, and conservation outcomes for native plants and animals.

## 05

## SUSTAINING GROWTH OF THE NORTHERN BEEF INDUSTRY

*Julian Cribb, Julian Cribb & Associates; Greg Harper, CSIRO Livestock Industries, and Peter Stone, CSIRO Sustainable Ecosystems*

**The northern cattle industry could double production with increased access to water and better transport infrastructure such as roads and bridges. Increased irrigation for pasture could also provide increased water for cropping.**

### Cattle industry dominates northern agriculture

Australia is the world's second largest beef exporter, and its export industry is worth \$8b pa. The beef industry is the nation's second largest agricultural industry, and one third of the nation's 28m cattle are in northern Australia. The cattle industry provides 5% of the jobs in the north and covers 95% of the agricultural land area. It provides 75% of the value of Northern Territory's agricultural production.

The industry has grown on average 3.6% per year, the highest of any Australian farming industry. Continued growth of the industry is likely due to a promising export outlook and water scarcity in the south. Further growth can be achieved by investment in finishing cattle (fattening them to market size) and processing meat in the north, and broadening farming business to include mixed crop-livestock systems based on irrigated pasture, fodder and other crops.

Growth of the industry will depend upon:

1. an increased water allocation for the cattle industry
2. improved road transport, made possible by increased infrastructure spending on all-weather roads and bridges and maintenance of local fuel availability, possibly using biofuels
3. review of the regulations of the Carbon Pollution Reduction Scheme (CPRS, the Federal Government's Emissions Trading Scheme) which, as currently planned, significantly impacts the beef industry

### Increased food output needs increased water input

The challenge to global agriculture is to double food output using less land, less water, fewer nutrients and less energy – in the face of spreading drought.

In this context, the relatively undeveloped pastoral and agricultural opportunities of northern Australia become more significant both internationally and nationally.

By developing the northern water resources and increasing water allocation to cattle farming, the industry can achieve year-round local feed availability using irrigated pastures or fodder crops. This continual feeding will allow the industry to increase live exports and finish more cattle in the north, rather than sending them south to feedlots or finishing areas.

Developing northern water resources may also allow the production of grain crops (e.g. maize), energy crops (for biofuel) and high-value horticultural crops for export to Asia, as part of a mixed crop-livestock farming system. This type of farming would reduce market and production risks by moving away from reliance on a single commodity and more effectively using existing labour and capital in the beef industry

Irrigation infrastructure to support these developments needn't be large in scale. Small-scale irrigation, scattered throughout the landscape (termed mosaic irrigation), may be the best way to incorporate improved pastures or crops into existing beef farms.

### Graziers need to be able to offset their emissions

The beef industry recommends that the Carbon Pollution Reduction Scheme be reviewed to allow graziers to offset their emissions.

The northern cattle industry produces about 4% of Australia's greenhouse gas emissions (measured according to equivalent levels of carbon dioxide emissions) yet contributes only 0.1% to GDP. With the introduction of the CPRS, cash income in northern beef properties could decline by up to 20%.

Cattle producers are seen as big greenhouse gas emitters because of the methane produced by cattle, but no offsets are offered for all the carbon they lock up in pastoral landscapes. Most pastoral leases prohibit practices which could help store carbon or offset emissions, such as revegetation and tree cropping and the production of biofuels for on-farm or wider use.

## Beef expansion needs more infrastructure

Industry expansion in the north requires increased access to water and increased infrastructure spending on roads and locally produced fuel to reduce transport costs.

Intensification of the beef industry, based on small-scale irrigated cattle-feed production and fenced 'stand and graze' feeding systems would provide improved year-round access to stock and the ability to fatten them during the dry season.

To expand in the north, the cattle industry has identified that it needs:

- a detailed assessment of the northern water resources to see how much water can be diverted to agriculture
- technologies and regulations that allow sustainable development of the northern water resources for food production
- renewable energy resources (wind, solar, locally produced biofuels) and tools for 'clean green' cattle production, including methods for reducing methane emissions and offsetting current emissions, for example through tree planting and pasture management
- public investment in bridges, all-weather roads, ports, abattoirs and communication networks for year-round production and movement of animals
- more knowledge about suitable pasture improvement, grain production and alternative cropping options for the north
- more cattle to be grown on Indigenous-owned stations
- greater engagement of Indigenous Australians in station management (older people with experience to work on stations and motivate younger generations to work there)
- ways of attracting and retaining labour



Joe Ross

The beef industry's status as a major part of the economy, culture and landscape of northern Australia make it clear that its future and that of the north are inextricably linked.

# 06

## A HISTORY OF INTENSIVE AGRICULTURAL DEVELOPMENT IN NORTHERN AUSTRALIA

Garry Cook, CSIRO Sustainable Ecosystems

**Cropping has fallen short of expectations in northern Australia, despite many pioneering efforts and the support of government subsidies and research. New technology and economic demand may increase the viability of cropping in the north. But any further expansion of cropping needs to bring together knowledge about farming methods, sustainability and Indigenous issues.**

### Cropping in the north falls short of expectations

Cropping made very little headway in northern Australia in past eras of government subsidisation and limited understanding or regard for sustainability issues and biodiversity conservation.

Soils suitable for growing crops in northern Australia have been in smaller and more isolated areas than those in southern Australia. Where suitable soils do occur, they are typically of low fertility, low water holding capacity, prone to surface crusting, and highly erodible in the heavy tropical rains. The climate is harsh, going from arid in the dry season to flooding in the wet season, causing numerous difficulties for cropping.

Pioneering efforts from the 1800s were unsuccessful and through the 1960s, 70s and 80s a number of large agricultural development projects failed. Early research was based on small plots of land, which led to an over-optimistic view of the potential productivity of the region. Although knowledge of farming has improved over the past decades, the many environmental constraints to agriculture in the north remain a challenge. The climate and generally poor soils of the north are still a major challenge to increasing cropping.

### Southern politics drives northern development

Political imperatives from southern Australia have long driven the push for agricultural development in the north. Not enough attention was paid to the industries and people that inhabit the north. Instead, for much of the 20th century they served the vision of an imaginary well-tended landscape, densely settled with farmers. From the early 20th century, research into cropping sciences was relied on to improve intensive farming methods in the north. Great advances were made, but they were not sufficient to make intensive farming a widespread possibility.

Subsidised development has been prominent for most of the past century. Many of the high profile private agricultural companies had business models requiring large profits from rising property values and share prices, and enthusiastic government support. The failure of such companies is a recurring theme in the history of the north.

### Need to consider Indigenous aspirations

Although Indigenous people have inhabited northern Australia for tens of thousands of years, and comprise nearly 30% of Northern Territory's population, they have often been ignored in the discussions about land use change, including the move to more intensive farming. To be truly sustainable, agricultural development needs to consider Indigenous needs along with ecological and economic needs.

Increased investment in Indigenous natural resource management with a partnership between traditional knowledge and responsibilities and western science and management techniques is important for agricultural development.



## Future farming faces new challenges

There is evidence of a growing momentum for extinction of native plants and animals in northern Australia. Habitat reduction or degradation, such as that imposed by agriculture, is likely to increase this trend. A challenge for cropping in northern Australia is to develop viable cropping areas, whilst maintaining the diversity of natural species found there.

Direct effects of climate change are likely to make the north's hostile and variable climate even more difficult for cropping. These difficulties will be exacerbated by indirect pressures of climate change, such as those related to pressure to develop the north. Increased pressure to develop marginal northern land will make an already challenging enterprise increasingly difficult.

Concerns about food security arose in the 1960s and led to continued pressure for northern development. Globally, food security is once again coming to the fore as a critical issue and is becoming an important driver for developing agriculture in the north.

Development pressures on marginal lands, which make up a large proportion of northern Australia, often follow the boom-bust cycles of national and international economies. Private investment followed that pattern, and the history of the region indicates that other significant events can also trigger increasing external pressures and interest. National security, food security and energy security have been significant factors affecting Australia's marginal lands and triggering government attention.

External drivers are still major factors in the debate about northern development, especially the threat of food security and the difficulties faced by farmers in the south due to droughts. These pressures will continue to make the north seem more favourable for agricultural development, especially cropping.

As the world's population continues to grow, and existing areas of prime agricultural land come under threat from climate change and unsustainable management practices, the economics of crop viability will change. This could make cropping in northern Australia a more viable option.



Joe Ross

## 07

## INDIGENOUS INTERESTS IN LAND AND WATER

*Jon Altman, Kirrily Jordan, Seàn Kerins, Geoff Buchanan, Nicholas Biddle, Emilie-Jane Ens and Katherine May Centre for Aboriginal Economic Policy Research, Australian National University.*

**Many Indigenous people in northern Australia consider water a critical part of the living cultural landscape — inseparable from land, people, ancestors, resources and social and economic relations. There needs to be greater clarity of water rights in northern Australia to improve Indigenous people's access to water and commercial opportunities.**

### Indigenous Australians want water rights and water protection

Around one-third of the northern Australian landmass is owned by Indigenous Australians who make up over 30% of the region's population (predicted to increase to more than 36% by 2031).

Relationships with water differ amongst northern Australia's Indigenous groups. Views may differ among landowners, among settlements or among family groups. Despite these differences, Indigenous Australians commonly identify three key themes for water development and management. Indigenous Australians:

- want any development of water resources to avoid harming the ecological health of their country, or disturbing sites that are sacred or significant, as undermining these values may destroy the livelihood, and cultural and spiritual wellbeing of Indigenous people
- insist on being active participants in water planning and having a real and decisive influence on outcomes
- want fair access to commercial water rights.

### Water resources support Indigenous economies

Indigenous people's relationships to water are expressed through story, social etiquette, ceremony and daily practices. Water is highly significant in Indigenous economies, identities and ways of life.

Northern Indigenous economies can be thought of as a combination of three overlapping sectors:

the market, the state and the customary (or non-market, customary means in accordance with custom or founded upon long-continued practices and traditions). This model properly represents the complex nature of Indigenous economies in northern Australia and recognises that many Indigenous people engage in productive economic activity outside the market, or in the spaces where the market, customary and state sectors overlap. For example, at one point in time a person might rely on a combination of the customary use of natural resources (such as wildlife harvesting), cash incomes from the sale of goods and services (such as art or environmental services) and state support (such as social security payments or through schemes such as the Working on Country program or contract payments for environmental services provision).

Water has a critical role to play in this economy and is a crucial element of Indigenous socio-economic development. Water rights and water-dependent commercial opportunities can provide income-generating opportunities. Water planning needs to recognise and accommodate the diversity of Indigenous economic activity and interests in water resources.

Indigenous natural resource management has clear benefits for water-dependent industries, because it uses Indigenous and local knowledge for environment restoration and protection. As climate change, feral animals, exotic weeds, changed fire regimes and pollution threaten biodiversity, there are clear opportunities for Indigenous people to undertake more environmental management work. Regionally based and locally appropriate environmental strategies that create jobs for young people living on country are needed to respond to ecological threats. 'Country' is a broad concept that includes land, water, sky, minerals, people, other species, ancestors, social relations, and sacred and heritage sites, with all of these elements intimately intertwined.

### Indigenous needs must be included in sustainable development

In northern Australia, a proper sense of the term 'sustainable development' needs to include both ecological sustainability and Indigenous needs and aspirations. Indigenous perspectives on sustainability may include cultural relationships between people and

place, questions of social justice, property rights in land and water, self-governance or co-management of resources, and effectively engaging Indigenous people in decision making. Indigenous people must have a real influence on policy choices and development decisions.

### Drinking water needed in remote communities

Water supply in remote Australia can be a health issue. Some Indigenous settlements in northern Australia do not have safe drinking water. The basic human right of universal access to safe drinking water must be met before there is any future allocation or trade in fresh water.

In the 2006 *Community Housing and Infrastructure Needs Survey*, 69% of Indigenous communities in remote and very remote areas in Western Australia, the Northern Territory and Queensland relied on bore water for their drinking water supply. Only 14% were connected to town water. The water supply failed quality tests in 38 communities, located mostly in Western Australia and the Northern Territory.

### Recognising Indigenous rights to water

Indigenous Australians commonly express their rights to water use and management under customary law, not just western legal regimes.

Australia is a signatory to international agreements that acknowledge Indigenous rights to water resources. These agreements set out principles to guide the development of domestic policy and law.

Even though Native Title does not grant exclusive property rights to water, title holders' tradition-based economy is often highly dependent on fresh and salt water. Allocations of water and the disturbance or pollution of water can impinge on or impair Indigenous peoples' rights to the non-commercial use of water resources under Native Title laws, or devalue access rights under land rights legislation.

Indigenous rights to water can improve the socio-economic situation of Indigenous people as water rights can be used to generate commercial opportunity, jobs and income. Such development could also help the Council of Australian Governments to meet its commitments to 'Closing the Gap' on

Indigenous disadvantage. This disadvantage is evident in large gaps between Indigenous and non-Indigenous life expectancy, mortality rates, levels of literacy and numeracy, and employment and education outcomes.

The National Water Initiative provides an important opportunity to recognise and support Indigenous interests in water and water planning. The initiative takes Native Title interests in water into account seriously, and requires that Indigenous needs and objectives are recognised and addressed in water plans.

It is important that the commitment to Indigenous representation in the National Water Initiative planning process is properly resourced so that Indigenous people can establish their objectives and have a real and decisive influence on decision making.



Barbara Wheeler

## 08

## MINING DEVELOPMENT IN NORTHERN AUSTRALIA

*David Brereton, Robin Evans, Veronica Klimenko and Claire Cote; Sustainable Minerals Institute, University of Queensland*

**Mining has a substantial role to play in developing northern Australia and needs to be considered in the mix of future development activities. Mining can have significant positive and negative impacts on the wellbeing of regional and remote communities and on the environment. The mining industry can manage these impacts by working with governments, Indigenous people and others, through the whole mining lifecycle from exploration through to mine closure.**

### Mining has the potential to grow in northern Australia

Minerals have played an important role in social and economic development across northern Australia, and have significant potential to further contribute to sustainable outcomes across the region. The industry is likely to continue to expand in existing areas of high activity, such as the North-West Mineral Province and Western Cape regions of Queensland, where deposits of base metals and bauxite continue to attract strong interest. There is also likely to be an increased focus on developing the mineral resources of the Kimberley region, in parallel with the development of offshore gas fields and associated onshore infrastructure. The north is likely to have commodities that are important to global economic growth such as aluminium, copper and uranium.

Mining growth will depend on global demand, financial markets and a range of local factors. These include water availability, energy supply, available skills, transport and infrastructure development, relationships with Indigenous communities, access to land and government policy and incentives.

### Mining contributes to social and economic development

Most mining in the north happens as isolated operations located well away from major population centres. However, there are several towns such as Mt Isa, Weipa and Cloncurry in Queensland; Jabiru, Alyangula and Nhulunbuy in the Northern Territory and Kununurra in the Kimberley whose economies are wholly or partly dependent on nearby mineral

operations. Most non-gold operations extract and concentrate minerals into a product that can be economically transported for further processing elsewhere in Australia or offshore. The notable exceptions to this are the copper and lead/zinc smelters at Mount Isa, and the alumina refinery at Gove.

Mining projects have often also led to large-scale infrastructure development, giving rise to a number of modern-day regional centres. However, the trend towards 'fly-in fly-out' operations from the 1990s onwards has meant mines with less development of associated infrastructure than previously.

Mining operations in northern Australia have generated considerable wealth, as reflected in annual revenue, tax and royalty payments, contributions to state / territory economic outputs, creation of direct and indirect job and business opportunities, as well as through development of infrastructure. Companies have increasingly moved towards employing more local people, using local contractors and supporting non-mine related enterprises and industries. Mines face an ongoing challenge to make sure a greater proportion of benefits generated by regions stay in the regions.

### Mining provides Indigenous people with employment and business opportunities

Relations between mining companies and Indigenous peoples have improved substantially since the passage of the *Native Title Act 1993*. As part of this, companies have increased their focus on providing Indigenous people with employment and business development opportunities.

If mining projects are to be an effective mechanism for delivering improved employment outcomes for Indigenous people in the northern regions, a concerted effort is required by companies and state and federal governments to address underlying impediments to employment and grow the labour pool. This will require collaboration rather than competition between companies working in close proximity to each other. In addition, there needs to be a continued focus on creating effective agreements to leverage greater benefits from mining developments for remote Indigenous communities.

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## Mining affects water resources

Several mines in northern Australia are located in or near important groundwater resources. Rigorous ongoing monitoring of groundwater use and impacts is needed to manage this, as are stronger processes for assessing the cumulative impacts of all other water users on groundwater resources.

Heavy rain and storms are not the only causes of water discharge from mining operations. A range of factors, such as the implementation of a water saving initiative, can combine to increase the discharge risk. If the concept of zero discharge is enforced in northern Australia, which has a monsoonal climate, this can potentially force mines to design their water system around containing extreme rainfall events, rather than designing a system that can deal with scarcity of supply. Mining operations need to follow best practice guidelines in designing and monitoring their water systems, and regulation should be designed to encourage appropriate treatment and discharge processes.

Availability of water is not a major constraint to mining, but management of groundwater impacts will be a key focus in several areas, particularly where there are several mining operations in the one area.

## Mining is just one part of the jigsaw

Mining should be considered as part of an integrated development approach, along with other industries and regional priorities. There has been some progress in using the presence of mining operations to improve conditions for Indigenous communities in the region through Indigenous employment initiatives and local business development. However, mining in itself is not a panacea. In designing and managing mining operations and planning for eventual mine closure, a key focus needs to be delivering positive long term outcomes for the region. Outcomes can include physical infrastructure (e.g. buildings, power, airstrips), a skilled and mobile workforce, and a more diversified economic base. Closer alignment with regional planning processes and greater coordination of development in mining intensive regions, such as the Western Cape and North West Queensland is needed. Such coordination could lead to better use and management of resources such as energy and water, and also reduce any negative impacts on the environment from mining and other development.

## 09

## FISHERIES AND AQUACULTURE IN NORTHERN AUSTRALIA

*Elizabeth Clark, EconSearch; Nick Abel and Tom Measham, CSIRO Sustainable Ecosystems; Julian Morison and Lisa Rippin, EconSearch*

**Fisheries and aquaculture provided 781 jobs and \$232 million to the northern Australian economy in 2006/07. Wild fisheries appear to be managed sustainably. Harvests may decline if river flows are reduced due to water allocation changes. Aquaculture has the potential to expand, but must be carefully managed so that it does not pollute waterways, which are valuable to Indigenous communities, tourists, commercial fishers, and people who use waterways for recreation.**

### Wild fish stocks are well managed

Fisheries appear to be healthy and well managed in northern Australia. State and territory governments monitor commercial fishing catches (size and rate) to inform fisheries management policy. While none of the fisheries seem to be overfished, fish habitats should also be monitored. This will help to improve policy responses to climate change and sea level rise. Tensions between commercial and recreational fishers who compete for the same resources could be reduced through better zoning policies.

### Fisheries, resource use and tourism policies should be linked

Fisheries policy should be more tightly linked to policies that regulate land-based development and use of water resources. Changes in flow patterns in the Ord River Irrigation Area, for example, have affected commercial species such as banana prawns, and possibly other species. They are unable to grow and breed in the Ord estuary because increased fresh water flows in the dry season reduce water salinity levels. In other areas in the north, irrigated agriculture does not seem to be affecting fisheries, but an increase in irrigated agriculture or mining, or disturbance to natural flows caused by dams or weirs, could change river flow patterns and cause a decline in fish numbers.

Recreational fishing is a popular tourist activity, and is likely to increase. The relative benefits and social impacts of recreational and commercial fishing should be considered together to ensure that both benefit from any policy changes.

### The bigger the flow the bigger the catch

Fish harvests increase with increases in freshwater flows from rivers, especially for mud crabs, banana prawns, barramundi, grunter, mackerels and sharks. Animals that are prey for these fish also depend upon these flows. Dams and weirs that block river flows stop fish from moving up and down rivers, and prevent nutrients and sediments from reaching the estuaries, which are important feeding grounds for juvenile fish. Commercially important species such as barramundi and grunter need freshwater flows from rivers to breed and grow. Dams change the natural seasonality of flows in the rivers, which fish have adapted to over many years. Under the National Water Initiative, these factors must be considered when planning any new dam, weir or irrigation development.

### Aquaculture is important to the north's economy

Aquaculture is significant to the economy of northern Australia, providing income of around \$66 million and 411 full-time-equivalent jobs in 2006/07.

In the Northern Territory, the most important farmed species are barramundi, mud crabs, pearl oysters and prawns. In Queensland, prawns and barramundi are the most important farmed species, and a significant proportion of the state's aquaculture is based in the north. The Western Australian Government has identified many opportunities for developing aquaculture in the north of the state. These opportunities include barramundi, prawns and black pearl oysters.

### Aquaculture growth achievable if carefully planned

Aquaculture production across northern Australia has grown by around 14% over the last five years, and several new sites are planned across the region.

New sites need:

- electricity
- easy access to all-weather roads
- access to domestic and international transport routes

When selecting new sites, other issues to consider are Indigenous land rights and sites of special significance to Indigenous communities. The location of aquaculture sites is important as sites in remote areas are at a disadvantage to those near urban areas due to high transport costs.

A view in the north is that the benefits from fisheries and aquaculture are exported rather than flowing to local communities. New aquaculture ventures need to consult local residents and Indigenous groups, because they may be a good source of jobs and income for local people. To benefit local Indigenous communities, aquaculture ventures should:

- be wholly or partly owned by the community
- involve and consult community members and traditional owners
- train non-Indigenous partners in how to do business with Indigenous communities

Although aquaculture can create jobs locally, employment in the region as a whole can fall if commonly-owned sites with multiple uses (such as mangroves) are privatised. By selecting the correct site, this conflict can be avoided.

### Effects of climate change not well understood

Climate change will alter fish habitats and food supplies and the species and numbers of fish in the northern Australian rivers and wetlands. These changes will affect the viability of fisheries and aquaculture ventures.

Investment in aquaculture is already risky due to seasonal changes in rainfall and variation in prices. It would become riskier with sea level rises and expected increases in storm frequency. The industry needs to learn more about these effects to prepare for the future.



Neil Armstrong

## 10

## THE FUTURE OF IRRIGATED AGRICULTURE

*Tony Webster, Alexander Herr, Nick Abel, Bruce Taylor, and Peter Stone, CSIRO Sustainable Ecosystems; and Lisa Rippin, Julian Morison, and Elizabeth Clark, EconSearch*

**The development of irrigated agriculture in northern Australia is limited by water availability and poor soils. The best development option for agriculture might be small cropped areas, irrigated with groundwater, and scattered over the landscape.**

### Irrigated agriculture in northern Australia

Irrigated agriculture is economically significant in northern Australia. Irrigated agriculture currently makes up 0.9% of the region's total economic activity and employs around 1.3% of the region's total labour force. If this industry doubled in size over the next 20 years, 1400 full-time jobs would be created, the regional population would increase by an extra 2200 people and the gross regional product (the market value of all goods and services in a region in a particular time) would increase by \$183 million.

Areas that are currently irrigated for agriculture include:

- the Ord River floodplains in northern Western Australia growing crops such as melons, vegetables and sandalwood — this irrigation scheme faced initial financial failure, but has recently had some financial success
- the Katherine–Douglas–Daly area in the Daly River catchment in the Northern Territory grows crops such as maize, peanuts and animal feed — this irrigation scheme is still under development and there are only a few growers operating
- the Mitchell catchment in northern Queensland, where peanuts, avocados, bananas, grass seed, stone fruits, coffee, tea tree, sugar cane, navy beans, citrus, mangos, macadamia nuts and grapes are grown
- small areas of less than 100 hectares near Broome and Derby in Western Australia used to grow mangoes, melons and vegetables.

A major impediment to agricultural development in northern Australia is the lack of transport and infrastructure. Transportation of crops to the south and of agricultural inputs (such as fertiliser and machinery) to the north is mainly done by road and is expensive.

### Irrigated agriculture is limited by water availability

Crops grown in the north have much higher yields when grown under irrigation than under rainfall conditions. In the north, 90% of rain falls in the wet season. Waterlogging, flooding, direct crop damage, erosion and the difficulty of moving farm machinery through wet soils means that irrigated dry-season crops are preferable. Cropping in the dry, however, uses a lot of water because water is lost from the plants and soil through evaporation into the air. Farms in the north usually need a lot more water than farms in the south of Australia.

Northern Australian soils have been weathered by monsoonal rains for thousands of years. They typically contain low levels of organic material and water is not held in the soil, but drains away quickly. Northern soils are easily swept away by water or wind, and this erosion may be accelerated by human and animal activity.

Northern soils commonly form a hard crust on the surface that stops water from soaking in. Water left on the soil surface quickly evaporates in the dry season. This water loss lowers the water efficiency of a cropped area. As water is scarce in the dry season, this is a strict limitation on the expansion of irrigated agriculture.

In northern Australia, there are potentially millions of hectares of soil suitable (though not necessarily advantageous) for annual crops and tens of millions of hectares suitable for forestry, yet there is only enough water available in the dry season to irrigate around 60 000–120 000 hectares of land. This means that existing irrigated agriculture can only increase two to four-fold. This great expanse of soil is unlikely to support viable rainfed agriculture enterprises.

Groundwater, water held under the ground, is the most likely source of water to sustain new development of irrigated agriculture. Surface water, trapped in dams,

is best able to support larger centralised irrigation schemes, such as the Ord River Irrigation Area. Groundwater can support a larger number of small-scale irrigation developments that are spread across the landscape in a 'mosaic'.

### Smaller scattered areas of irrigated agriculture may be the best option

Mosaic irrigation may have many benefits, but at this stage it is largely untested.

Due to the small scattered areas required, mosaic agriculture could reduce the likelihood of soil erosion, salty soils and soil runoff. Irrigation salinity (salt in the soil) happens when minerals and salts, dissolved in water and found in fertilisers, increase in the soil after constant irrigation. It can also happen when a local water table rises, which brings dissolved salts to the surface. Mosaic cropping could decrease the chance of irrigation salinity because scattered irrigated areas will have smaller impacts on local water levels. Areas could also be selected that help to avoid the build up of salinity.

The environmental impacts of mistakes made when 'learning by doing' will be smaller with mosaic irrigation, compared with the impact of land management mistakes made in larger irrigated areas. The smaller scale of mosaic agriculture also reduces the cost of irrigation infrastructure, placing it within reach of private investors, rather than requiring the government support of larger dam-based schemes.

There is a disadvantage to mosaic irrigation—scattering intensive agriculture over the land reduces the likelihood of industry 'hubs' forming. However, if farmers grow stock feed crops in this way, the scattered cropping areas could be located on cattle farms. This would improve the amount, quality and timeliness of stock feed supplies and improve beef industry productivity.

Mosaic irrigation will have a negative impact on biodiversity. Agriculture thrives on productive soils, but these areas also support high levels of biodiversity. Mosaic irrigation may also require more roads than larger centralised irrigation schemes. Areas of agriculture would be spread out over the landscape increasing the risk of introducing pest insects and weeds into the surrounding environment.

### Can irrigated agriculture ever be sustainable?

Crops that might be suitable for northern Australia include:

- annual crops such as vegetables, melons, grain sorghum, maize, rice, cotton, mung beans, soybeans, sesame and peanuts
- perennial crops that grow over several years, such as mango, bananas, citrus, papayas, lychees and other fruit trees
- trees for timber production, shelter and shade on farms, biofuel and fragrance oils
- pasture and fodder crops for livestock

Irrigation has been practised by humans for 5000–7000 years, but has rarely been sustainable. It can lead to increased salt levels in soil, local waterlogging and nutrient depletion, and the degradation of surrounding landscapes through water depletion. These problems usually take a long time to appear and take even longer to mend. If we are realistic about the environmental impacts of irrigated agriculture, we may be able to maximise its benefits and minimise its disadvantages.



Stuart Blanch

## 11

## TOURISM AND RECREATION DEPEND ON NATURAL WATER FLOWS

*Nick Abel and Tom Measham, CSIRO Sustainable Ecosystems and Elizabeth Clark, Julian Morison and Lisa Rippin, Econsearch.*

**Much of northern Australia's tourism and recreation is based on the natural environment. Tourism is expected to increase in the north and relies on conserving and maintaining natural river flows.**

### Tourism and recreation important to economy of northern Australia

The volume of visitors into northern Australia is small by national standards – estimated at almost 5 million in 2006–07. But tourism generates a significant proportion of regional income and employment, with total visitor expenditure in 2006–07 being just over \$2.8 billion. Tourism contributes about 9% to the regional economy.

### Tourism relies on waterways

Fishing, good weather, wildlife, seafood and the landscape are what attract tourists to the north, according to a 2003 survey of visitors to the Gulf of Carpentaria. To a lesser extent they also visit the Gulf to experience Indigenous and European cultural history.

Most visitors (90%) to the Gulf said fishing was the main reason for their visit. In the Carpentaria Shire, the catch from recreational fishing is equal to the commercial catch. Recreational barramundi fishers' expenditure in the region averages an estimated \$51 per fish caught, or \$22 million in total per year.

In the Northern Territory, more people (per capita) go recreational fishing than anywhere else in Australia. Besides barramundi, mud crabs are also a popular catch in the Northern Territory, with more than 80,000 crabs being caught in 2000 and 2001. Most crabbing occurs in Darwin Harbour/Shoal Bay area, the McArthur River and the Roper River. In Darwin three quarters of visitors fly-in. Forty percent of these visitors go on boat trips or cruises, and 36% visit waterfalls or waterholes.

A significant and increasing proportion of visitors to the Kimberley in Western Australia are domestic self-drive travellers aged in their forties to sixties. These visitors want to experience the scenery, landscape and nature of northern Australia.

### Tourism relies on natural water flows

The major attraction for tourists in the north is the pristine natural environment. Water-based attractions include rivers, waterfalls, gorges, waterholes, lakes and estuaries. These waterways are used for water sports and fishing, create the landscapes that attract walkers and sightseers, and are essential habitat for the animals that attract wildlife enthusiasts like bird watchers. Extracting water for urban, mining or agriculture users and reducing freshwater flows could spoil tourists' experiences. For example, recreational fishing visitors catch species dependent on natural flows such as mud crabs, prawns, barramundi, king threadfin, grunter, mackerels and sharks. Groundwater extraction can lower water tables and affect the health of wetlands. Wetlands and floodplains are part of the natural beauty of the region, and provide habitat for many animals and birds.

A 2009 survey of people living in the Daly, Fitzroy and Mitchell River catchments, as well as people in major cities in southern Australia, asked how much they were prepared to pay to preserve the three rivers for the following benefits: floodplain habitat; recreational fishing; species and species habitat important to Indigenous activities at waterholes; and production from irrigated agriculture. Regardless of whether people lived on the rivers or in the cities, they were prepared to pay the most amount of money for maintaining waterholes of Indigenous significance. Overall, people value the three rivers being in the best condition to provide for the environment, recreational use and Indigenous people's needs. While people value some expansion of irrigated agriculture, they prefer a medium expansion rather than a large expansion.

### Possible projections for tourism increase in northern Australia

Three projections for the growth of visitor numbers and tourism expenditure in northern Australia are that growth will be:

1. in line with the Australian industry forecast, with expenditure reaching \$3.3 billion by 2018
2. in line with the Australian industry forecast, except in the Kimberley where, based on historic growth rates, the number of visitors will continue to increase by eight per cent per year

3. 25% above the Australian industry forecast, with expenditure reaching \$4.1 billion by 2018

Tourism in northern Australia could increase by expanding existing activities (such as fishing, farm-stays and nature-based tours) and numbers of the current types of tourist, as well as attracting new types of visitors (such as volunteers, special interest markets) to the region. New forms of tourism are likely to be nature-based, taking advantage of the significant natural and cultural attractions in the region. For example, in East Arnhem Land, opportunities for 'voluntourism' are being explored. Tourists pay for their travel and volunteer their time to work on special projects such as coastal rehabilitation and protection. The 'special interest/knowledge market' is also being explored, where people with particular interests (e.g. bird watching, medicinal plants, and Indigenous art) pay to stay on Indigenous land and learn from local Indigenous people.

### Tourism growth depends on better infrastructure and services

Increased tourism and recreation in the north depends on improvements being made to current facilities such as: road upgrades for access to sites currently inaccessible during the wet season; increased, improved and diversified camping and accommodation facilities; improved directional and interpretive signs; Aboriginal art interpretive centres; increased and improved fuel and food outlets; increased parking bays (particularly at popular sites); and improved waste disposal facilities. Tourism operators also need to be able to source an appropriately skilled, reliable and trustworthy workforce.

Much of the infrastructure needed by tourism, such as roads, waste disposal systems, boat ramps and amenities, are currently provided by local governments. Planning for tourism should include provision for visitor monetary contributions to local governments to assist in maintaining these facilities.

### Increased tourism impacts on the environment

Growth in tourism would likely have relatively low impacts on the environment compared to irrigated agriculture or mining. Tourism requires relatively small amounts of land clearing and the levels of water use

are unlikely to have permanent negative impacts on waterways.

However, there are impacts of tourism on the environment that need to be managed. Barramundi have been overfished in the Northern Territory in the most commonly fished areas. Visiting fishers sometimes use pest fish species as live bait, which could result in the introduction of these species. They sometimes catch endangered species such as saw fish. The wake from boats can damage river banks and aquatic weeds are sometimes brought in on boat trailers and outboard motors. Algal blooms can result from increased nutrients in waterways from visitors' urine, food wastes and detergents.

Infrastructure needed for tourism such as roads, car parks, buildings and storm drains increases rainfall runoff and the intensity of flash floods, which can lead to the erosion of river banks. Runoff can carry pollutants from gardens and parks. Growth of regional centres as a result of tourism will require domestic water supply from dams or bores, which will affect water flows. Effluent from sewage works in these urban centres would cause pollution if discharged into nearby creeks and rivers.

### Potential ways of reducing negative impacts

Where overfishing is a local problem, fish catches can be reduced by encouraging other forms of tourism, establishing fishing zones, or raising licence fees. Demand for water can be reduced by user charges and perhaps education programs. Tourism facilities need to be located where they have minimal impacts on water flows and water quality.



Stuart Blanch

## 12

## CONSERVATION OF RIVERS AND WETLANDS: THREATS AND OPPORTUNITIES

*Nick Abel, CSIRO Sustainable Ecosystems; and John Rolfe, Central Queensland University*

**Most rivers and wetlands in the north are in good condition, and lie within the largest area of intact tropical savanna landscape in the world. Effective conservation requires emphasis on the pastoral and Indigenous lands and waters that cover most of the region. Conservation is a safe choice when considering water allocation options when uncertainty is high, but choices of what and where to conserve need to be prioritised.**

### Waterways and their catchments are in good condition

Most waterways (rivers, lakes, wetlands) in northern Australia are in good condition. This reflects their relatively well preserved tropical savanna catchments. Of the total area of tropical savanna that is considered to be in good condition globally, 90% is in northern Australia. The northern waterways and their associated catchments are highly valued locally, nationally and internationally. Their values are categorised as:

- Direct use – including consumptive uses such as grazing, fishing and hunting, or non-consumptive uses such as tourism and recreation
- Indirect use – the support or protection provided by waterways for other uses, such as providing fish habitat, locking up carbon, and supporting Indigenous culture and activities
- Non-use values – knowing these waterways exist now, having options for future uses, because no irreversible changes have occurred, or leaving them in good condition for future generations

Northern Australian rivers and wetlands require careful conservation to maintain these values.

### Changing water flows decreases the values of waterways

Agriculture, mining and aquaculture are potential threats to conservation. There is enough suitable land and sufficient water in northern Australia to support an increase in all three. However, dams built to supply water for these land uses would change the way rivers flow, stop movements of aquatic animals, block flows of sediments and nutrients to estuaries and change

the habitats and food supply of aquatic plants and animals.

Dams would degrade the conservation values of rivers. As there are few suitable places to build dams along the northern rivers, groundwater is the most likely future water source. Groundwater pumping can change river flows by lowering the water table, with adverse impacts on conservation values similar to dams. The distance of a groundwater bore from a river and the volume of water extracted determine the effect of the bore on river flow. Determining these critical distances and volumes for each groundwater store (aquifer) is necessary for estimating the trade-offs between agriculture and conservation.

Conservation is likely to be affected by climate change. There are likely to be fewer but more intense rainfall events producing larger floods of shorter duration and resulting in less groundwater recharge and reduced stream flows. Increased water extraction, changed land uses and climatic change may interact to multiply their separate impacts on waterways and their catchments.

### Conservation on private land should benefit land owners

Conservation policies need more emphasis on the private, mainly pastoral and Indigenous lands and waters that cover most of the region, but without neglecting public conservation. Cattle grazing on leasehold or Native Title land is the dominant land use on approximately 66% of the land in the north. Indigenous freehold land covers about 30% of northern Australia. Parks and reserves cover 6% of the region, some of it overlapping with Indigenous freehold and Native Title land. Less than 2% of the land is used for dryland or irrigated cropping, mining and defence.

Graziers control a high proportion of the catchments on which the waterways depend, and have direct control over significant areas of the waterways themselves. Governments can change lease conditions to influence pastoral management to regulate groundwater extraction. However, management practices are more likely to change and conservation could occur across larger land areas if pastoralists are offered financial incentives to manage their land for conservation.

On Indigenous freehold land, Indigenous peoples' rights to water are contested and unclear. Their customary use rights (non-market uses that are in accordance with custom or long-continued practices and traditions) under the Native Title Act 1993 need to be recognised, and conflict between their rights and the allocation of water to other users need to be resolved. This would help Indigenous people to manage land for conservation should they choose to do so, with a potential to earn income for this from governments, conservation organisations or tour companies.

### Conserving waterways is a safe option when we are uncertain

Intact waterways have 'high option values' – our options for using these waterways have been preserved because the waterways have not been irreversibly changed. This means our decision for their use can be reserved until a highly attraction option emerges. While we reserve our options, the waterways and catchments are conserved and their values can still be enjoyed. Intact waterways and catchments also have a high bequest value – they can be enjoyed by future generations. In addition, they have economic value because they are scarce elsewhere in the world and so attract tourists by providing a unique experience.

### Priorities for conservation need to be established

As a first step, water planners need to set priorities for what values and areas need to be conserved throughout the north, including public and private lands. Prioritising for conservation should be done with an aim to preserve all types of landscapes and enough area of each landscape. The prioritisation process needs to be focused on preserving those landscapes and species most threatened.

Water planners need to find out the public preferences for conservation or the development of other sectors like agriculture or mining. This can be done by asking individuals or groups to place a monetary value on non-marketable benefits of waterways and catchments, such as the conservation of biodiversity.



*Mitchell River Water Shed Management Group*

## 13

## THE ROLE OF THE AUSTRALIAN DEFENCE FORCE IN NORTHERN AUSTRALIA'S DEVELOPMENT

*Peter Stone, CSIRO Sustainable Ecosystems*

**The Australian Defence Force is one of the major investors, landholders and employers in northern Australia, particularly in the Northern Territory. They influence economic growth and development of infrastructure in the region, and manage their land with high environmental standards.**

### Northern military presence critical for defence

The Australian Defence Force (ADF) has had a military base in Darwin since 1934. The vulnerability of northern Australia has been apparent since the bombing of Darwin, Broome and other parts of the north during World War II. Since the 1970s, the emphasis of our defence strategy has been on Australia being self-reliant in defending our own territory. Darwin is still considered the most vulnerable location to hostile attack. Southern Australia is naturally protected by its relative remoteness and the vastness of the surrounding oceans. Other parts of the north have limited infrastructure to support hostile activities or are difficult to approach through natural barriers such as the Great Barrier Reef, rough terrain, or regular flooding.

Being self-reliant means controlling the air and sea approaches to Australia rather than relying on partnerships with other countries for defence. The main strategy for controlling our approaches is effected by having defence force personnel stationed in Darwin and Katherine. Darwin is the only base from which we can seek to control the seas to our north. Katherine is critical because it is the point at which western, southern and eastern road approaches to Darwin converge. Its bridges are needed to cross the Katherine River and it provides a base for the defence of Darwin. In addition to defence of Australia, it is through having a military presence in the north that the ADF can contribute to humanitarian relief, evacuations, peace-keeping and peace-enforcement in south-east Asia.

### ADF contributes significantly to Northern Territory's economy

The ADF employs about 6% of the Northern Territory's population. They are the second biggest employer of Indigenous Australians in the Northern Territory and try to increase this via their Indigenous Recruitment Strategy.

Military bases in the north have directly contributed over 8% of the Northern Territory's GDP. This contribution occurs through:

- wages of defence personnel
- spending on operational items such as ammunition, transport, catering, office supplies and cleaning
- spending on NT-based industry via contracts related to infrastructure

This direct contribution to the economy can be doubled if we include indirect spending within the regional economy, including spending:

- on the resources required for daily operations which are typically locally-sourced
- by defence families living in the area

There are regular boosts in spending within the Northern Territory when international defence forces visit naval ports and use training areas.

The ADF's contribution to the Northern Territory's economy is predicted to increase. This year, the government has proposed increased spending on Defence and re-affirmed the northern Australia defence strategy. However, there are no specific details about how much money will be spent, or what it will be spent on. We are assuming defence spending in the north will continue to increase by 11% per year, as it has done since 1995. This rate of growth is not matched by other industries in northern Australia, meaning that in the next decade, the ADF is predicted to contribute 15% of the Northern Territory's GDP.

### ADF relies on, and contributes to, civilian infrastructure

The increase in military spending in the north means major growth in the Northern Territory is possible, and this will require regional infrastructure development, including major water utilities.

The ADF primarily sees itself as a user, rather than co-developer, of civilian infrastructure such as roads, pipelines, railroads and ports. Establishing clearer links between military and civilian infrastructure needs and benefits will help to create significantly greater efficiency in infrastructure planning, investment and use. This, in turn, is likely to increase the volume and value of infrastructure in northern Australia. Coordination could be improved if civil developments were submitted to Defence for assessment of their military impacts in much the same way as they are already assessed for environmental impact. Conversely, subject to security constraints, Defence development plans should be canvassed with civil authorities.

Local industry is used as much as possible to support the growth of the ADF in the north. This commitment is supported by the Northern Territory Government, which promotes the use of local industry by clustering industry development in close proximity to defence establishments.

### ADF manages land and water to high environmental standards

The ADF manages over 17,900 km<sup>2</sup> of land in northern Australia, or about 1% of the region's area. About half of this is the Bradshaw Field Training Area, approximately 600 km southwest of Darwin, bounded by the Victoria and Fitzmaurice Rivers and the Bonaparte Gulf.

Another large proportion is the Yampi Sound Training Area, 130 km northwest of Derby in Western Australia's Kimberley. This area has had limited use because it is unsuitable for military exercise needs. This limited use, a lack of ADF infrastructure, and the removal of introduced animals has meant Yampi Sound Training Area has become a place of extremely high natural heritage value. It is situated where three different geographic and biological areas meet. The result is a region of high biodiversity, including some threatened species and species confined to small isolated habitats.

The ADF manages its land according to an environmental management system that conforms to International Standards Organisation requirements. This includes a 'no footprint' policy for exercises, which involves before and after monitoring of environmental conditions, protocols on how to manage any unforeseen negative impacts on the environment, and the rehabilitation of all disturbed sites. ADF devotes considerable resources to understanding the environment and threatened species, developing and implementing management plans, and monitoring and evaluating their performance. The local-scale impacts of training activities on flora, fauna, soils and water quality are relatively minor and not comparable with those of grazing. During normal operations, negative consequences of increased military development are primarily noise and loss of public access to land and water bodies.

### ADF supports Indigenous health and living standards

Since 1996, the ATSIC (Aboriginal and Torres Strait Islander Commission) Army Community Assistance Program (and its successor) has used ADF resources to improve the primary and environmental health and living standards of remote Indigenous communities. To this end, each project includes construction, health and training components. Construction typically develops environmental health infrastructure such as housing, water, sewerage and electrical services. It also improves access to primary health services by constructing or upgrading roads or airfields. Funding for this project has been used to support 15 communities in northern Australia. Further funding is likely to be ongoing.

### ADF provides civilian assistance

Northern Australia's remoteness from supporting infrastructure and exposure to extreme events such as cyclones and floods makes it more reliant than the rest of Australia on the assistance provided by Defence. The ADF routinely supports the civilian community by loaning equipment, expertise and manpower, particularly in response to natural disasters.

## 14

## WATER REFORM IN AUSTRALIA – LEARNING FROM THE PAST

*John Ward, CSIRO Sustainable Ecosystems*

**Looking back over the recent history of Australian water resource management shows how it evolved and reveals important insights that may be applied to the north. Water resources must be managed as coupled ecological, economic and social systems. Indigenous institutions, knowledge and claims to water must be recognised. There are substantial political, economic and social costs in re-balancing water entitlements and changing unsustainable management practices. The north's climate and landscape mean that, unlike the south, water infrastructure and supply costs are likely to be borne by private interests.**

### Northern hemisphere experience proved inappropriate for Australia

The European colonies of 18th century Australia inherited the riparian doctrine, enshrined in British common law, which gave landholders conditional rights to water on or adjoining their land.

As the population in the south grew and land use intensified, the demand for a more reliable water supply grew. But Australia's highly variable climate was far from the expectations of a people used to a stable and predictable water cycle. The existing rules of common law did not accommodate the required appropriation of land titles for catchment and storage, transmission canals, community resettlement and land resumption. Access to financial capital was needed, a process predicated on the existence of secure legal water rights. The rights to water were increasingly reliant on public administration.

Ownership and rights to use water were eventually defined in the Victorian Irrigation Act 1886. This seminal legislation vested the right to use and control water exclusively in the state government. The Act also instituted a system of centralised administrative allocation of water rights, managed by a public water authority. Water could be allocated to private, co-operative and municipal water supply corporations. However, the failure of private trusts and water trading entities, combined with the need for secure urban water supplies, culminated in the almost exclusive supply of public water by government agencies.

The role of government agencies in supplying water, as first defined and codified in Victoria in the 1890s,

remains as the principal operating mode of Australian water authorities.

### The singular focus on national development at any cost was not sustainable

Providing water supply infrastructure, such as dams and pipes, was considered by Australian governments of all persuasions as an unequivocal public good, helping to drought-proof the nation and build the economy.

State governments became extensively involved in the water industry as developers of water supply infrastructure, and developers and owners of large-scale urban and rural supply schemes (including irrigation). With minimal political intervention, the achievement of hydraulic and engineering objectives was vigorously executed to high technical standards. With no legal obligation to consider external consequences, the success of rural water development was measured in engineering terms. The pace of water development, particularly rural irrigation schemes, continued almost unabated over the next 100 years.

With economic development and regional employment as the goals, water diversion and reticulation schemes were provided regardless of cost or likely public revenue. Water was over-allocated and supplied at below-cost and, without adequate signals or incentives to conserve water, resulting in severe environmental degradation. A lack of accounting scrutiny and political oversight resulted in an agricultural sector reliant on extensive subsidisation. Scarce capital was invested in developing irrigation rather than improving dryland farming techniques. Yet, irrigation farmers were unable to pay the full water supply costs. Today's water institutions managing predominantly irrigation water still only partially recover their supply costs. By the 1980s these issues had created a situation conducive to reform.

### Water scarcity and unsustainable water use pushed shift to integrated management

By the end of the 1980s water authorities were compelled to address rising supply costs, more intense competition between disparate users, increasing water scarcity, and increased interdependencies among water uses. Deteriorating supply systems contributed to increased operation

and maintenance costs and pressure for replacement expenditure. Most of the accessible dam sites had been exploited. Demand for water was increasing. Awareness was growing of the severity of environmental degradation and its consequences, including declining water quality.

Conflict was growing between the old developmental objectives and the newer economic and environmental objectives. Institutions were geared to resource expansion rather than the best use of a scarce resource.

The interrelated issues of water scarcity and the need for sustainable water use required a shift to managing water resources as ecological, economic and social systems, an approach known as 'integrated management'. These two issues, the focal points of contemporary water policy, reflected emerging international trends in resource management and became a recurring theme in water reform initiatives of governments, water authorities and analysts in the 1990s.

### Federal and state governments are committed to sustainable water management

Agenda 21 is the action plan ratified in Rio in 1992 at the United Nations Conference on Environment and Development. As a signatory, the Commonwealth of Australia agreed to comply with the principles of ecologically sustainable development as set out in the Rio declaration. In so doing, the Commonwealth committed the states to adhere to those principles, which was a big shift from the engineering and hydraulic objectives that had informed and dominated water management up to that time.

In 1994 the Council of Australian Governments (COAG) endorsed initiatives for the water industry covering: water-pricing reform based on consumption-based pricing and full-cost recovery; elimination of cross-subsidies (such as transport) and making subsidies transparent; water allocation and entitlement; reform of irrigation systems; allocation of water for environmental purposes; and institutional reform. In 1995 compliance was articulated in the National Competition Council's policy package which COAG adopted.

### Indigenous institutions, knowledge and claims to water must be recognised

The legal notion, and myth, of terra nullius (that the land belonged to no-one) meant that Indigenous interests and rights were not recognised and, as a result, Indigenous knowledge of water management was not taken into account. While Australia now recognises native land claims, assumptions that the north's water resources belonged to no-one prior to European settlement (aqua nullius) is without foundation. If governments fail to recognise Indigenous claims to water and include traditional institutions and knowledge in northern water management, they are reintroducing the spectre of terra nullius and the tensions and conflict that go along with it.

### Water entitlements and unsustainable management practices are hard to reverse

The management of the Murray-Darling Basin has struggled to pull back water entitlements and change unsustainable management practices on which many groups became dependent as a result of incremental, often politically expedient, policy steps. These groups lobbied vigorously.

### Supply costs in the north are likely to be borne by private interests

Northern basins are different from those in the south. Most rivers do not flow all year round, surface water and groundwater are often closely connected, extreme weather events are common, and, annually, the potential for evaporation exceeds the average rainfall. Opportunities for dams and delivery channels are severely constrained by the rainfall distribution (most rain falls on the estuaries where it cannot be captured) and the physical characteristics of the river basins. When water is available, underground water stores (aquifers) are likely to be the main mode of storage.

Storage, extraction and distribution costs are likely to be borne by private interests, introducing a different investment landscape from that of the south. Southern irrigation water impoundments and delivery infrastructure have historically been publicly funded and assigned to government agencies and authorities.

## 15

## INDIGENOUS PARTICIPATION IN WATER PLANNING AND MANAGEMENT

*Sue Jackson and Cathy Robinson, CSIRO  
Sustainable Ecosystems*

**Water is of great cultural, social and economic significance to Indigenous communities in northern Australia. It has been managed through Indigenous governance and management systems for thousands of years. Increasing Indigenous participation in future water governance and management can improve and inform water management and provide benefits for Indigenous Australians.**

### Indigenous people want to be involved

Indigenous rights and interests in water have so far been neglected in Australia. This has resulted in limited Indigenous access to water, participation in water management institutions and awareness of water management objectives and processes.

Indigenous Australians are seeking new ways to interact with governments by asserting their rights. They want to be included in water management processes and want these processes to recognise cultural difference. Their aim is to include Indigenous law, custom and economic need in water governance and management processes. However, it is important to note that there are a myriad of differing opinions and needs between and within Indigenous groups.

Australian government resource agencies need to understand the diversity of Indigenous water values and governance in each area. This governance includes a system of rules that are used to make decisions. There are management responsibilities that are negotiated locally that draw on knowledge contained within Indigenous languages, values and practices. These rules and responsibilities are then part of a greater system of Indigenous law.

### Barriers to Indigenous inclusion in water decision making

To date, the Indigenous governance has not been supported by natural resource management processes. Decision making, representation, communication and accountability within Indigenous groups can be supported in many ways, such as assisting Indigenous groups through finance and information to participate in water planning and decision-making.

There are a number of other barriers to Indigenous participation in water decision making such as:

- poor understanding of Indigenous belief systems and environmental philosophies
- poor understanding within Indigenous groups of Government resource management programs, such as the National Water Initiative
- power imbalances between Indigenous people and other stakeholder groups — other stakeholders may have more money, influence and access to resources than the Indigenous representatives
- difficulties in accurately determining how much water Indigenous people need for cultural and economic activities
- differences between Indigenous knowledge and existing governance systems, and differences between Indigenous and non-Indigenous knowledge and thinking
- narrow interpretations of Indigenous water property rights and governance, for example water authorities maintain that Indigenous access to water should be for non-commercial purposes only
- the absence of specific Indigenous water requirements in water management plans
- poor formal recognition of the right of Indigenous people to participate in water management
- a lack of ability to address cross-cultural and technical issues

Currently, Indigenous groups that are not included in decision making about water management are at a disadvantage when competing with groups that have clearly spoken claims to water such as mining companies.

If Indigenous people continue to be excluded from water management, they will not be able to contribute their knowledge of water and ecology. Indigenous knowledge is a valuable resource for policy makers. Not including this knowledge will limit the effectiveness of water-management decisions.

### Improving Indigenous participation in water decision-making and management

Indigenous participation in land and water planning and management requires change in water management law, policy making and planning. There is a range of different ways that Indigenous participation could be increased.

Formal co-management agreements, such as Indigenous Land Use Agreements, can apply formal negotiation processes to agree on natural resource decisions. These agreements are made between a Native Title group and another party. They cover the use and management of lands or waters and are binding when registered with the National Native Title Tribunal. The negotiation processes of these agreements can result in strong ongoing relationships between everyone involved.

National systems managed at a federal government level could support Indigenous groups that require water for enterprise development. This might be in the form of an Indigenous Water Fund allowing Indigenous people to buy water allocations. An alternative strategy could be for water planning to negotiate and allocate Indigenous Reserves for Indigenous community development and commercial purposes.

Indigenous water trusts, similar to the five-million-dollar Aboriginal Water Trust in New South Wales, could boost Indigenous participation in the water market and support water-related enterprises in northern Australia. Funds could be made available for communities or individuals to engage in water conservation, water-based infrastructure, water licence purchases and the preservation of Indigenous water knowledge.

The different water planning processes need to be brought together to improve Indigenous participation. Combining community-based natural resource management initiatives like those operated by Aboriginal Land and Sea Rangers with those of, for example, the Daly River Management Advisory Committee could improve water planning outcomes for all. Other levels of inclusion such as co-management in Kakadu National Park and policy-level Indigenous collaboration like the Cape York Institute could be supported to create Indigenous participation at all levels of natural resource management.

### Policy reform needed to recognise Indigenous water rights

Through the National Water Initiative, the Australian Government expects that water allocation decisions will rely on the best available knowledge, including Indigenous knowledge. However, Australian governments are still at an early stage of formally recognising Indigenous people's relationship with water for spiritual, cultural and economic purposes.

Legal and policy reforms are needed to clarify Native Title holders' water entitlements and decision-making authority. There is ambiguity in the National Water Initiative about how to assign Native Title holders' water entitlements and seasonal allocations. These legal issues and ambiguities could be partially addressed through appropriate negotiation and Indigenous inclusion in natural resource management at local, regional and policy levels.

Any planning efforts should include and acknowledge Indigenous peoples' contribution to environmental water management. Currently, public benefits such as water quality and water capture from Indigenous natural resource management are largely unrecognised.



Stuart Blanch

## 16

## SUPPORTING INDIGENOUS NATURAL RESOURCE GOVERNANCE

*Cathy Robinson and Sue Jackson, CSIRO  
Sustainable Ecosystems*

**All over the world, Indigenous governance systems are being supported to enable Indigenous groups to participate in natural resource planning. Indigenous natural resource governance includes Indigenous beliefs, property rights, and decision-making protocols and rules used by Indigenous groups to manage and use natural resources. Indigenous groups in northern Australia have established community-based groups to work together to coordinate their natural resource management decisions and activities and to collaborate with non-Indigenous resource managers and decision-makers.**

### Multiple Indigenous natural resource governance systems exist in Northern Australia

Indigenous groups in northern Australia continue to voice their own decision-making rules and cultural ways used to co-manage natural resources with other Indigenous and non-Indigenous groups. They want fair and ongoing collaborations that respect their rights and their relationships to their country.

Many northern Indigenous groups are banding together to form cultural and natural resource management community organisations to negotiate resource management decisions and programs. While some progress has been made to ensure natural resource (including water) planning recognises native title and supports Indigenous natural resource governance systems, it is also helpful to look at examples of how this has been achieved overseas.

### Canadian First Nation communities join together to enforce native law

In Canada, Indigenous groups are working together to make decisions about water resources. In working towards sustainable and equitable water resource management outcomes, they needed the support of local and federal Canadian governments for their community-based and collaborative planning.

The Skeena River is the second largest water catchment in British Columbia and is home to five species of salmon and more than 20 species of other freshwater fish. In 1981, the Gitksan and Wet'suwet'en First Nation people presented a

proposal to the Canadian government, calling for salmon co-management arrangements that reflected the First Nation principles and systems of natural resource governance.

The Gitksan and Wet'suwet'en people then took further steps to secure co-management of the Skeena watershed:

- They negotiated co-management arrangements as a step towards a more inclusive native title regional agreement.
- They established a First Nation fishery agency as a way of negotiating and developing their fisheries proposal.
- They used government schemes that employed local Indigenous people to enhance stream habitats and trained Indigenous employees to improve their knowledge of fishing practices. The employees were taken to the local hereditary Chief to learn 'the law' of traditional fish management and conservation.
- They did a major fisheries management study that looked at the issues distinguishing their laws and approaches from those of non-Indigenous people. The study also looked at how Indigenous governance for salmon management and distribution could work with current planning and management regimes.

An alliance was eventually formed between the Gitksan, Wet'suwet'en, Tsimshian and Nat'oot'en First Nation communities. This alliance, known as the Skeena Fisheries Commission, is a community management group that allows First Nation employees to be involved in salmon management agreements and activities based on four principles of 'balanced respect':

- The First Nation people have the right to fish for social, ceremonial and economic purposes.
- The First Nation people rely on the fisheries resource as a mainstay of economic, social and cultural wellbeing.
- The First Nation people's right to fish has priority over non-Indigenous fishing interests and is only limited by the need for proper conservation of threatened fish stocks.

- As rightful 'guardians', First Nation people are obliged to protect, conserve and harvest the fishery resource 'according to traditional law'.

These agreements and activities have enabled Indigenous groups to manage their country according to traditional law, and to fully integrate their customary (founded upon long-continued practices and traditions) use of resources with economic development.

### Indigenous land and water rights found to be inseparable in the United States

In legal cases and negotiated agreements in the United States, Indigenous land and water rights have been found to be inseparable from each other. As land and water rights are currently legally separate in Australia, experience from the United States can provide valuable insights for northern water planning decisions and agreements.

In the United States, there have been many legal cases concerning Native American water rights, with interesting outcomes:

- Water reserved for Native Americans was intended to satisfy both the present and future needs of the reservation (an area of land managed by a Native American tribe).
- Existing non-Native American legal claims to water under state law were used as models to claim Native American water rights.
- In some cases, Native American nations were able to knock back development proposals that may have had negative impacts on their cultural use of water.
- Native American nations have been able to sell or lease some portion of their water rights to other users without having to waive their broader reserve rights.
- A federal Native American right to water, once established, takes precedence over all other uses of that water.

Currently, Native American tribes are using negotiated settlements to establish their water rights. Since 1978, more than half of the 20 or so Native American settlements contain legal agreements about rights to groundwater. These agreements, however, are hard to negotiate:

- There are many thousands of individual water stakeholders who place different values on water. For example, the symbolic, cultural and economic importance of water gives it a fundamental value to Native American groups, not just a commodity value.
- There are multiple levels of government involved in water rights that has created considerable ambiguity about decision-making authority for watershed and water resources.
- Water scarcity may mean that water resource and allocation decisions are deemed to be unfair by both non-Native American Native American interests.

While the legal frameworks for dealing with Indigenous access to land and water differ in the United States and Australia, the United States experience can help us identify pitfalls and pathways to establishing Indigenous land and water rights in Australia.



Joe Ross

## 17

## UNDERSTANDING WATER MANAGEMENT

*R. Quentin Grafton and Sam McClellon, Australian National University; John Ward and Jim McColl, CSIRO Sustainable Ecosystems*

**Water naturally moves through the landscape, making it difficult to manage across political boundaries. Effective water management recognises the need to allocate and independently manage water for both the private and public good. Water property rights and water markets can lead to economic benefits but water institutions need to be robust and make sure social and environmental water needs are also met.**

### Water knows no boundaries

Water ignores government and state boundaries as it seeps, drains, evaporates and flows across and through the landscape and under the ground. In northern Australia, the management of water is challenging due to difficulties in monitoring, containing and controlling water. River flows are extremely variable from season to season and from year to year, and surface water interacts with groundwater stores (aquifers) in complex ways. Aquifers maintain the flow of many rivers during the dry season and are, in turn, replenished by the flow of rivers during the wet season.

### Water is for public and private good

Water provides publicly shared environmental benefits and cultural services through clean drinking water, pleasant environments and habitat for aquatic plants and animals. We also need a secure supply of water for agriculture, mining and other industry. Water resources have both consumptive and non-consumptive uses, have market and non-market values and provide both private and public goods. If we extract too much water for consumption, we will reduce both water quality and quantity which can adversely affect the public and private benefits that water can provide.

If water is unmanaged and taken on an individual and opportunistic basis, it can lead to the overuse of water resources and reduced benefits for all. For example, if too much groundwater is taken from aquifers that supply water to rivers during the dry season, this threatens their value in providing water year round.

### Governance covers whole water system and understands community values

Institutions are established social structures that coordinate individual actions and manage conflict. Institutions shape the decisions society makes about water use when the needs of water conservation and economic development coincide. Institutions operate through systems of 'governance' that include legislation, regulation, policies and processes for determining how communities adapt to, transform and sustain their environments. Water governance has three activities:

- choosing trade-offs between consumptive and non-consumptive water use
- managing and implementing the choices made
- monitoring the outcomes

Effective water governance covers the whole water system, both surface and groundwater, and links management of water with management of the land. It also manages water across geographical and political boundaries and takes into account the many environmental, social and economic values of water. Market-based mechanisms can be used to meet industry's economic needs, water extraction can be capped to keep the environment healthy, and rules or community-based arrangements can be applied to conserve the cultural and social rights to water. Economic efficiency, equity of water access and environmental sustainability are the three global pillars of integrated sustainable water management. However, these three pillars can lead to conflict between water interests, and water agencies need to understand community values when formulating and implementing water policies.

## Water entitlements secure rights to water

When there is variability in water supply and too much water has historically been allocated to various users, water authorities may assign water property rights. Water property rights or entitlements have become a fundamental element of water governance in Australia particularly in the south. They represent a defined societal and economic interest in water and how it is used. Water entitlements allow the user of the right to access, harvest, and manage water. The needs of the environment can also be met by granting entitlements. Water entitlements should:

- give the user secure and enforceable rights to the water
- describe the duties that the user needs to fulfil to obtain their entitlement
- identify the duties and obligations of those managing the water entitlements
- respond to changing community views on water use and entitlements

Water entitlements have six characteristics: exclusivity, duration, flexibility, quality of title (a high quality entitlement is clearly described and easily enforced), divisibility (the entitlement can be separated into distinct parts), and transferability (all or part of entitlement can be transferred to another user). These characteristics differ in importance depending on the specific water resource and how it is managed. Quality of title, transferability and divisibility are important for users who want to be able to sell their water rights.

Water entitlements are secure long-term unit shares of a volume of water for extractive use. As the water resource condition or social values change so too might the number of shares. Water entitlements may also need to account for the timing and variability of water supply. Annual allocations vary and allow managers to account for seasonal changes to surface and groundwater flows. When there is less flow, users are allocated a smaller proportion of their entitlement; higher inflow means a higher proportion.

## Robust water institutions cope with change

A robust water institution independently manages different policy objectives with separate mechanisms and can cope with change. The agreement of the state and federal governments with the National Water Initiative (NWI) has produced a more consistent means of managing water across Australia. Under the NWI, periodic allocations of water are made to entitlement holders based on an annual assessment of the flow into waterways and aquifers, the volume of water being stored in dams and reservoirs, and in proportion to the number of entitlements held. Specific initiatives are needed for each significant water resource problem faced by a region, such as decreased water quality associated with increased soil erosion. Each initiative to correct water misuse or overuse should specify the water entitlements, allocations and how they are used, along with other policies that may be needed to resolve the problems.

## Water markets deliver economic efficiency

The ability to transfer water entitlements opens up water markets that are different to a government-led system for regulating and allocating water. Water markets facilitate a reallocation of water rights from lower value uses towards higher value uses, increasing economic efficiency. This is valuable because water trading in the Murray-Darling Basin is worth hundreds of millions of dollars every year to irrigators.

Water markets need to be set up with a very good understanding of the local water system, including any interactions between surface water and groundwater. They also need to be based on a good knowledge of water uses, including any adjacent land uses that also use water such as plantation forests. They need a specific volume of water to be allocated over a given time period from a water storage that can maintain water supply across the seasons so that trading can occur up and downstream.

The benefits of water trading would increase if institutional barriers to trade across state and territory boundaries were removed. Institutions regulating water markets must also recognise the value of water for both environmental and cultural uses, so that water prices reflect the full costs and benefits of using such water for other purposes.

## 18

## APPLYING NATIONAL WATER INITIATIVE PRINCIPLES TO THE NORTH

*M Ejaz Qureshi and John Ward, CSIRO Sustainable Ecosystems*

**To achieve environmental sustainability and economic efficiency, water plans for northern Australia should reflect the principles of the National Water Initiative: scientifically allocating water for environmental needs; identifying water resources that can be used; and fairly allocating water for Indigenous, irrigation, municipal, livestock, domestic and other uses.**

### National Water Initiative resolves conflicts between competing water interests

The NWI is a policy response to the over-allocation and over-use of water, particularly in southern Australia, resulting in stressed river systems. The National Water Initiative (NWI) aims to resolve conflicts between competing and conflicting interests.

Ratified by the Commonwealth, state and territory governments in 2004, it followed a series of water reforms that started in the 1990s. It extends earlier water reforms by including management across the catchment, the opportunity to trade water rights, full accounting of water resources and water use, regional planning, and the allocation of water for environmental needs.

The NWI is the primary means for managing Australia's surface water (rivers, lakes, streams, estuaries) and underground water (groundwater). It sets out the objectives, outcomes, timelines and actions for reforming Australia's water policies. It describes processes and policies for independently and flexibly managing water for consumption (residential and industrial), for the environment and for cultural use.

The NWI is aiming for both environmental sustainability and economic efficiency in water use. It views the environment, including the animals and plants living in it, as a legitimate user of water. It aims to increase the security of water entitlements for users. A water entitlement right provides a water user (e.g. irrigation farmer) with exclusive access to a share of the water from a specific water resource, such as a river. The user has a statutory right to that water share on an ongoing basis. Indigenous people's needs and their connection to water are recognised, including the need to provide water to meet Native

Title requirements. NWI works in three ways: planning, allocating and marketing of water.

### Principles are relevant to the north

Most of northern Australia's 64 river basins are unmodified by dams, weirs and other structures. However, while the majority of rivers in northern Australia do not suffer from the over-extraction of water, the NWI requires that water plans account for likely future allocations and use of water. Water plans in northern Australia must reflect the principles and processes of the NWI.

In many northern catchments, groundwater and surface water are connected. Groundwater feeds the flow of many rivers, especially during the dry season. On the other hand, river water often replenishes the stores of groundwater. For example, in the Daly River in the Northern Territory almost 700,000 megalitres move between the river and the groundwater stores each year. Extracting groundwater can affect rivers tens of kilometres away from where it is being extracted. The quantity and quality of both surface and groundwater are affected when either source is overused or misused.

While most of the rivers in the north are not overused, the same is not true for groundwater. The Tindal aquifer around Katherine in the Northern Territory, which is used for horticulture and agriculture, is overused. Water allocation planning has started to address overuse. Both the Northern Territory and Queensland Governments are partners in the Great Artesian Basin Sustainability Initiative, and are reducing the amount of water they extract from this huge underground basin.

### Planning is the key to managing water resources

Water planning is the key to addressing overused water systems, achieving environmental outcomes, developing water entitlements and markets, and managing the connections between surface water and groundwater. Four water plans are completed in northern Australia and five have been drafted.

A successful water plan:

- determines the volumes of water and actions needed to protect a body of water's environment

- specifies the limits of how much water can be extracted and when for irrigation, municipal, livestock, domestic and other uses
- uses the best available science to determine environmental needs
- commits to consulting and partnering with water users, communities and Indigenous interests
- states how much water could be sustainably taken from water resources
- corrects any over-allocation or over-use of water resources
- details practical management strategies, individual water rights and environmental water needs within a broader context of trade-offs and natural resource management issues
- includes a water accounting process with methods for measuring, monitoring and reporting on the amount of water being extracted, delivered, traded, and recovered

### Water planning allocates water to users with entitlements

Once water planners work out how much water is available for use, they then allocate this water to users through water entitlements. This process is critical to improving the security and commercial certainty of water supply to users. It does this by clearly specifying the statutory nature of these entitlements.

Usually allocating water entitlements needs to be done in a similar way across catchments. In northern Australia this is not possible because the connections between surface water and groundwater and the seasonal variations in rainfall are different in each catchment. The process of allocating water entitlements determines who experiences costs and benefits. Governments need to assign water entitlements that: are separate to land entitlements; provide certainty and security of water access; acknowledge risks of changes to the water resource; and have the potential to be traded in water markets.

Water is allocated to water entitlements according to rules established in the water plans, which should recognise the needs of the environment and the risks of climate change. The NWI requires that water planners identify any over-allocation of water and

return it to the environment. It also requires that those with water interests bear any risks of a less reliable water allocation, such as that due to climate change.

### Water trading is encouraged

The NWI promotes water markets as a means of coordinating individual actions and decisions rather than relying on government negotiation or administration. Water markets rely on individual and transferable water entitlements or rights that have been assigned by water planners from the consumptive pool available. These rights may be assigned for a limited time or permanently.

Water markets are only effective if there is a scarcity of water and government regulation specifies and enforces contracts. Water can be reallocated between competing uses, offering more flexible responses to issues such as drought as they emerge. National guidelines are needed for developing principles of water trading and for encouraging water trading.

Water markets in northern Australia are unlikely to take off in the short-term, largely because river basins are geographically separate with few inter-connections, and development is constrained by other regulatory (e.g. lease conditions) and commercial impediments. The exception is the Daly River with current applications for water entitlements of 75 gigalitres, which is more than the consumptive pool of 16 gigalitres.

## 19

## MEETING THE GOALS OF THE NATIONAL WATER INITIATIVE

*Kim Alexander and John Ward, CSIRO Sustainable Ecosystems*

**All state and territory governments have processes in place for water planning and trading. Not all states have water planning legislation. All government agencies are struggling to meet the challenges of water planning. Water plans in the north need to be simpler and more precise and should include Indigenous interests. Nationally-agreed principles for water pricing, regulation and accounting are needed.**

### National Water Initiative implemented through water plans

The National Water Initiative (NWI) is an agreement between the federal, state and territory governments to try to resolve conflicts between competing interests for water resources. This agreement represents a policy response to the over-allocation and over-use of water, particularly in southern Australia.

The goals of the NWI are achieved through water planning, which aims to distribute water equitably among different users for various purposes.

Under the NWI, water plans need to:

- reduce the stress on waterways (rivers, streams, lakes, estuaries) and underground water stores (aquifers) where water has been over-allocated and/or over-used
- allocate water for public and environmental needs
- reflect any regional differences in water supply
- identify and protect waterways and groundwater stores with a high conservation value, such as rivers in national parks and wetlands of international significance
- give Indigenous people access to water and recognise native title rights to water

### Water planning legislation almost nationwide

All states and territories in Australia have processes in place for assessing the economic and ecological sustainability of current and future water use. The water planning process identifies three types of water use where water can be:

- extracted directly from rivers, lakes, farm dams and groundwater stores
- distributed to users through pipes, open channels and bores
- reused in the form of treated wastewater

All states and territories except Western Australia have legislation that specifies water planning processes and principles. Western Australia is in the process of finalising its legislation.

Water trading is possible in all states and territories, but has been limited in Western Australia and the Northern Territory, where there is less competition over scarce water supplies than in other states / territories. Establishing water trading requires complex administration which takes time to set up and some people are suspicious or have personal reservations about its effectiveness.

As required by the NWI, in all states and territories water charges are directly related to the amount of water used.

### Governments struggle with water planning

Government agencies in all states and territories are struggling to adequately meet the challenges of water planning, as set down in the National Water Initiative.

Water planning approaches and progress vary widely across states and territories. This makes it hard to compare their effectiveness. Some water plans provide a broad geographic or thematic (e.g. managing nutrients, salinity or erosion) view of the issues, but lack practical rules for water management. Others are much more specific, but are less likely to recognise wider issues, such as how land management practices can affect the health of rivers.

Most water plans in northern Australia suffer from a lack of:

- skills in both planning and implementation, made worse by the remote nature of the country
- knowledge about the connections between waterways and groundwater, which allows many rivers to keep flowing, especially during parts of the dry season
- connectivity between water planning and land planning
- knowledge about the social and economic impacts of any changes to water management
- nationally-agreed methods for determining trade-offs between the water used by people and the water needed for the health of the environment
- environmental managers with clear authority and with the necessary technical and financial skills
- engagement with or understanding of Indigenous interests and uses of water; Indigenous cultural values are often dismissed as being 'spiritual' and not relevant to water planning

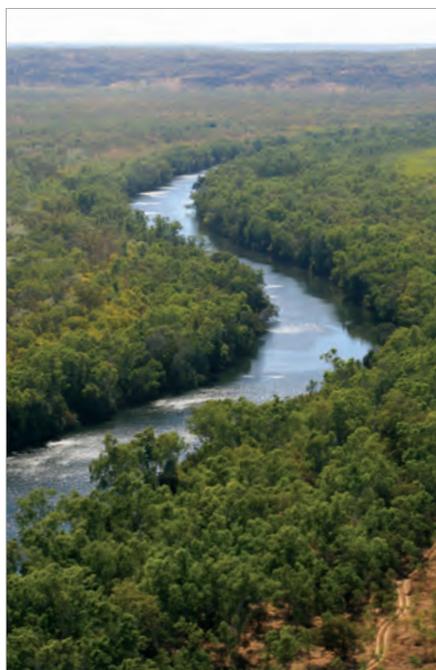
### Water plans need to be simpler and more precise

Water management could be improved with simpler and more precise plans that include easy-to-measure performance indicators. Plans would also benefit from:

- having input from a wide range of disciplines, including social scientists and economists
- using economic analysis, for example for water resource accounting (putting a value on various market and non-market water uses)
- assessing social impacts of water extraction
- connecting with any land planning
- making it easy for Indigenous people to participate
- getting the public more involved
- being actively enforced
- being reviewed at least every five years so that they can be adapted to any social, economic and environmental changes

### Nationally agreed principles for pricing, regulation and water accounting

The NWI needs to take a lead in developing nationally-agreed principles for water pricing, regulation and water accounting. In particular, the Australian Government needs to shape the way we account for water required by the environment and for traditional cultural purposes.



*Stuart Blanch*

## 20

## MANAGING THE NORTH'S WATER RESOURCES

*Kim Alexander and John Ward, CSIRO  
Sustainable Ecosystems*

**Water resources in northern Australia are managed according to the different legislation, policies and plans of each of the state and territory governments. Initial efforts are being made to follow the principles and processes of the National Water Initiative, which need to be shaped by regional needs and communities.**

### National Water Initiative promotes collaboration between states and territories

The National Water Initiative (NWI) aims to replace the previous aggressive competition for water resources, often driven by individual state and territory governments, with a collaborative approach based on an understanding of the rights and interests of different water users.

State and territory governments are responsible for fashioning the NWI's principles and processes according to regional water resources and economic, environmental and social needs. Apart from some limited attempts to jointly manage waterways (rivers, streams, lakes, estuaries) or groundwater (water stored underground) that cross borders, Queensland, Northern Territory and Western Australia have developed their own legislation, processes and plans for managing water. Legislation to meet the water planning requirements of the NWI has been finalised for Northern Territory and Queensland but not for Western Australia.

### Remoteness makes water management difficult

The tropical rivers of the north stretch from Broome in WA to Cape York in Queensland, draining into the Timor or Arafura Seas or the Gulf of Carpentaria. The 54 river catchments of the region cover a huge area of more than 1.2 million km<sup>2</sup>. This makes it very difficult to have a simple 'one size fits all' means of managing water. There are more than 20 policies and programs and 26 pieces of legislation that affect water use in northern Australia.

Water planning and legislation appropriate to the southern regions of Australia are often not appropriate to the needs of northern Australia. Here, there is less over-use of water, the rivers are driven by a climate of flooding wet seasons and harsh dry seasons, and the population is made up of remote, often Indigenous communities.

There is confusion about who is responsible for supplying water, both for domestic and industry use, in the small regional urban communities typical of northern Australia. In some places, poorly-resourced local governments bear this responsibility.

### Indigenous participation in water reform and planning is poor

Indigenous participation in water reform and planning is inadequate and inappropriate because it often:

- relies solely on Indigenous participants who may not be representative of wider Indigenous views or preferred Indigenous decision making processes
- assumes allocating water for the environment will also meet Indigenous social, cultural and spiritual needs
- waits for Native Title claims to be proven in the courts before addressing Indigenous water needs
- fails to obtain reliable data of Indigenous water use – how much they are using and how they are using it
- lacks the means to accurately and equitably determine Indigenous water needs

In some cases, Native Title recognises limited and non-exclusive rights to waters within boundaries of the claim. This protects the Native Title holders' rights to take water for drinking and domestic uses and to fish, hunt and pursue cultural activities without a special licence.

Only Queensland has legislation that gives Indigenous people in northern Australia the right to have water allocated for cultural, social or economic uses. However, these recently introduced rights do not appear to be popular with Indigenous groups. No government has yet developed performance indicators for measuring water outcomes for Indigenous people.

## Increased water use needs new knowledge

While the pressure on northern Australia's water resources is likely to increase as urban populations and agricultural enterprises grow, critical knowledge for managing water resources into the future is required.

Often our current knowledge of water resources is limited to where there is already urban and agricultural

use of water. With any further development and use of water resources, water managers will need:

- more detailed water data across a larger area
- data on how much water is needed to support the environmental needs of waterways and groundwater
- a quantitative understanding of the links between surface water and groundwater

## Comparing states and territories

	Northern Territory	Queensland	Western Australia
<b>Managing agency.</b>	Department of Natural Resources, Environment, The Arts and Sport	Department of Environment and Resource Management	Department of Water
<b>Legislation</b>	<p><i>Water Act 1992</i> controls waterways and groundwater separately; the government owns all water resources</p> <p>Extraction and use of any water resource requires a licence</p> <p>No-one can alter flow of water with a barrier like a dam, but can store water away from waterway if it does not affect flows</p>	<p><i>Water Act 2000</i> working through the Water Legislation and Planning Framework, gives planning responsibility to local river basin authorities</p> <p><i>Wild Rivers Act 2005</i> allocates water in northern river catchments that still have intact natural values (this has caused recent contention with some Indigenous groups)</p>	<p>State Water Resource Management and Reform program is developing policies and plans and implementing 100 priority actions by 2011 (aims to consolidate 11 Acts into two bills: The Water Services Bill and Water Resources Management Bill)</p> <p>The State Water Plan 2007 guides water resource management</p>
<b>Water allocation</b>	<p>Given out 329 water entitlements representing 494 gegalitres (GL) to productive (domestic, irrigation, etc), environmental and cultural uses</p> <p>Water control districts manage competing water demands in Darwin rural area, Gove Peninsula and Daly-Roper regions of north</p>	<p>Assigns water entitlements to various interests and uses, including for the environment</p>	<p>Regional Water Plans include land use planning to minimise duplication and speed up decision making</p> <p>Regional water plans assess current water resources, identify current and future water demand and availability; and allocate water</p>
<b>Plans</b>	<p>Katherine draft water allocation plan says a maximum of 13% of the water can be extracted for human use in dry season, 30% in wet season</p> <p>Other plans are in various stages of being developed</p>	<p>10-year water resource plans are at various stages of planning and implementation</p>	<p>Regional water plans direct more specific water management plans, including water allocation plans</p> <p>The Kimberley has water plans in place to protect river catchments and groundwater stores</p> <p>Strategic water issue plans address urgent needs such as drought</p>

# 21 NATIONAL WATER INITIATIVE COMPLIANCE IN THE NORTH

Kim Alexander and John Ward, CSIRO  
Sustainable Ecosystems

**The few existing water plans in northern Australia have made initial steps towards complying with the National Water Initiative. More work is needed to develop water plans that allocate water sustainably, recognise likely future development pressures, and link management of surface waterways with groundwater stores.**

## The north's water plans start to comply with the National Water Initiative (NWI)

Given the many river basins in northern Australia, there are relatively few well-developed water plans. Some plans are in progress and others have state-wide policy coverage. The planning that complies with the NWI for northern Australia is shown for each state and territory in the figure below.

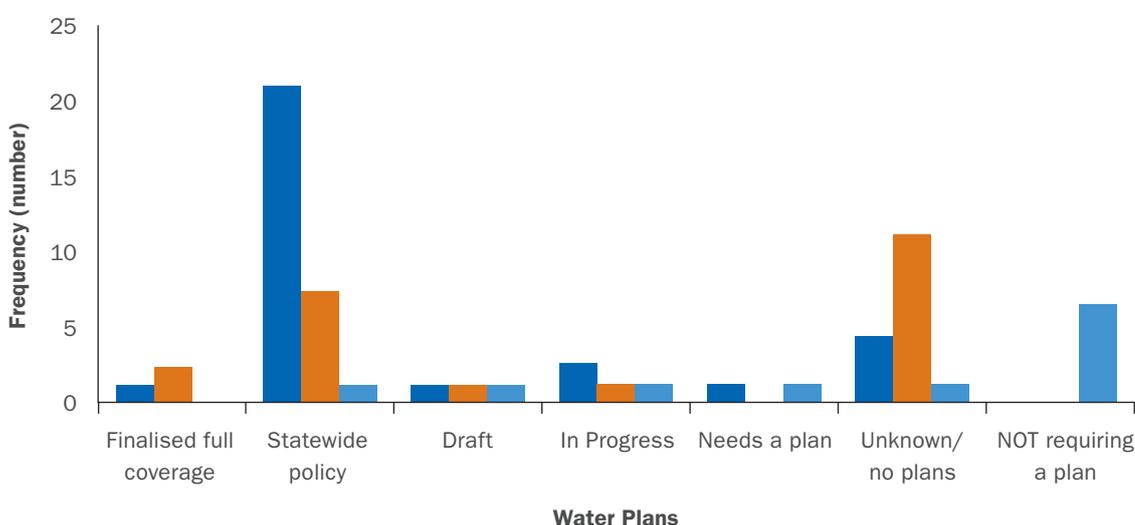


Figure 1. State and territory water plans in northern Australia that comply with the NWI

### Northern Territory, Queensland and Western Australia working towards NWI compliance

Twenty nine of the 40 basins in the Northern Territory are part of the tropical river system of northern Australia. The NT government has finalised one plan for the Katherine Tindal catchment and has two close to being finalised for the Oolloo aquifer (groundwater store) in the Daly catchment and the Tindal aquifer at Mataranka. About 1.5 gegalitres (GL) is extracted from the Daly-Tindal aquifer each year, and the amount that can be extracted is capped at 16 GL, despite water licence applications totalling 75 GL. An additional 25GL has been allocated for Indigenous use. All caps on water extraction in the NT are provisional and yet to be agreed within legislation. To date, surface water planning does not comply with the NWI.

Of Queensland's 54 basins, 22 are part of the tropical river system. The state government has finalised water resource plans for the Mitchell River and Gulf catchments, which includes nine sub-catchments

across north Queensland. How they determined water caps for individual catchments is unclear. While the state has made good progress in water planning in accordance with the NWI principles, they have not as yet linked surface water management with groundwater management.

The north of Western Australia has 30 of the state's 41 basins. The Ord and Le Grange catchments have draft water planning documents which will become NWI-compliant once state legislation is passed. Demand for water in these catchments is expected to increase as horticulture and mining expand. Western Australia's water plans do not currently report on land management and its impacts on water, and only a few account for water required for environmental needs. There has been no assessment of the limits on water use or extraction. There are no links between surface water and groundwater management. However, there has been significant progress towards compliance with the NWI's surface water management.

### Daly River plans secure water supply and protect the environment

The Daly River catchment south of Darwin in the NT has extensive areas of natural landscape that support breeding areas and habitat for fish, turtles and waterbirds, including a number of threatened species. The Daly Water Roper Control District was declared by the NT government in 2008. Water managers then identified the need for: licences for extracting water (surface and groundwater) except for that used for domestic or stock purposes, permits for building bores and design standards to prevent water contamination, and water allocation plans to be declared.

The water allocation plan for the Tindal aquifer at Katherine assigns 73 water licences, identifies water trading opportunities in the area, specifies standards and procedures for protecting water quality, protects groundwater-dependent ecosystems such as Katherine Hot Springs, discharges groundwater from the aquifer to the Katherine River, and recognises Indigenous water uses and values.

The water allocation plan for the Tindal aquifer at Mataranka aims to protect the pristine groundwater-dependent ecosystems and secure water for water users. It defines sustainable development rules for industries expanding in the area, including irrigated agriculture, cement manufacturing, grazing and tourism.

### Mitchell River plan caters for future demand, water trading and Indigenous needs

The Water Resource Plan for the Mitchell River catchment on Cape York Peninsula in Queensland covers all waterways (rivers, streams, lakes), groundwater (springs, aquifers and Great Artesian Basin water), water collected in dams and weirs, and water flowing over the land. The plan allocates an additional 7 GL of water to meet future water demands in the catchment. It allows seasonal trading of licensed water in the Upper Mitchell area. Water has been allocated for Indigenous communities in the Cape York Peninsula to help them achieve their social and economic aspirations, as outlined in the *Cape York Peninsula Heritage Act 2007*.

### Fitzroy plans for future water demands in the Kimberley

The Fitzroy River is one of 30 major rivers of the Kimberley region in the north of WA. The Kimberley rivers are among the world's last remaining natural river systems but are under increasing pressure from weeds, feral animals, overgrazing, mining and tourism. Significant groundwater stores supply mining, pastoral, agricultural and other industrial operations. Current groundwater extraction licences total just over 20 GL a year. The water is used to supply water to small communities and large mining operations.

The Kimberley Regional Water Allocation Plan guides water allocation, planning, management and licensing policies. A water quality protection plan for the area around Fitzroy Crossing aims to protect the area's drinking water supply.

There are no plans to dam the Fitzroy River to meet water demands. Demand by small-scale irrigation is being met by groundwater supplies. Further development of water resources needs to assess the water resources available, consult with interested groups, and identify water extraction limits.

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## INTEGRATED RIVER BASIN MANAGEMENT: LESSONS FROM THE MURRAY-DARLING BASIN AND INTERNATIONAL EXPERIENCES

*Erin Bohensky and Bruce Taylor, CSIRO  
Sustainable Ecosystems and Daniel Connell,  
Australian National University*

**The management strategy for northern Australia's river basins needs to be well designed from the start, with clear, measurable objectives that consider the values of all stakeholder groups. Cooperation across government agencies needs to be coordinated by a central institution that incorporates existing local organisations, customs and agreements.**

### Clear and measurable objectives are needed from the start

River basins in northern Australia need to be managed to clear and measurable objectives. These objectives need to be established right at the beginning of the management process. This did not happen in the management of the Murray-Darling Basin (MDB) and the result was a highly dysfunctional management system that focused on the local and individual needs of each of the four state governments.

A comprehensive structure for policy and management needs to be in place from the start, rather than expecting it to develop in response to needs as they become apparent, as was the case in the MDB, with the result that particular stakeholders took hold early and overrode all others. These stakeholders became dependent on unsustainable levels of extraction, and so were determined opponents of water reform in the late 20th – early 21st century. Once money is fed into infrastructure and practices that do not meet the objectives of river basin management it is difficult and costly to revert to a management process that does.

Kruger National Park in South Africa is a good example of managing water under specific objectives. Park managers work to conserve biodiversity based on the concept of 'thresholds of potential concern'. Together, these thresholds are a set of indicators, each with an upper and lower level of acceptable change, and the goal is to keep within these. They can be measured and monitored, and management actions can be adjusted accordingly. The thresholds can be changed according to changing values and objectives.

The European Union's Water Framework Directive is another example, where the goal is for all major hydrological systems in the European Union to be of high ecological status by 2015.

### River basins need to be managed as whole systems

The National Water Initiative advocates a whole-of-system approach to management. This should be the goal from the start when developing a management process, rather than stakeholder groups debating their acceptable levels of sacrifice. Managing a river basin as a whole system makes it easier to see all the social, economic and environmental costs and benefits of different management actions. It also helps avoid the large social costs of poor management which inevitably get passed on to future generations.

### River basin the focus, not political and institutional boundaries

A major issue for rivers in northern Australia is the potential involvement of different government levels and departments. Coordinating the responsibilities of multiple government bodies operating in the same area is hard and is usually done badly. When designing policy and managing water use, the river basin should be the focus and management should be able to cross both political and institutional boundaries.

A process similar to an impact assessment should be undertaken to examine the potential outcomes of any policy and institutional proposals for the north's river basins. Past experience also suggests that it is critical for an institution that can make major basin-wide decisions to be in place from the start.

### Management should not rely on using water markets

Water trading markets have played a major role in transforming water use in the MDB over the past decade. Whether they can play a similar role in the north is unclear. Markets only work in situations where water is relatively scarce and where the water allocated never exceeds the amount needed. While that is unlikely to be the case in the north in the immediate future, river basin management needs to be designed so that it can be adapted to using markets if water does become scarce.

In the MDB, water markets halved the economic losses due to drought because they allowed water to be moved around the basin to find its most efficient

use. However, markets have some drawbacks: it is difficult to include many important costs in the water price; and people often approve of using markets in some situations but not others, which means the true value of the water is not always reflected in its price. Disputes over water sales between states, for example, highlight the complex cultural attitudes that surround water and which policymakers should take into account in planning for the north.

### Learning by doing can help deal with uncertainty

With adaptive management, or ‘learning by doing’, decision makers can draw on lessons learnt and new scientific knowledge to continually improve the management of river basins. People no longer think that technology alone can be used to manage water resources and control unexpected outcomes. We now recognise that water resources are embedded in complex and dynamic systems, and attempts to control these systems can result in unintended consequences. Instead, policies should be experimental hypotheses that are tested ‘by doing’ and then adapting management to ensure objectives are met. Giving the community a role in making decisions can incorporate the diverse and changing views of the public. However, adaptive management can be costly, and may not be economical in situations where there is little uncertainty about the how best to manage the waterways.

### All interest groups need to be included in decision making

The National Water Commission states that increasing public participation in water planning would improve it and lift community support for reform. However, the purpose of public participation needs to be well understood. Awareness of the various backgrounds, knowledge and reasons why different groups are willing to take part is also important. It is quite legitimate for groups to protect and promote their own interests, but this needs to happen within an institutional framework that can also take account of the wider interests of society, so that the consultation process is equitable. Stakeholder interests also need to be balanced with preserving the ecological integrity of the river system as required by the National Water Initiative.

The National Water Act 1998 of South Africa abolished all water rights except two: the right of every citizen to an adequate, safe supply of water for domestic needs and the right of ecosystems to the water required for their continued functioning. The policy’s success is partly because of a lengthy, extensive and genuine consultation and engagement process. Efficiency, equity and sustainability form the three pillars of the Act, reflected in its goal to provide “some, for all, forever”. Minimal acceptable flows (‘ecological reserves requirements’) were derived by first defining stakeholder values. The South African Government does recognise however, that achieving social equity may occur at a cost to environmental sustainability – both of which need to be defined. We can learn from watching how this policy is implemented in South Africa.

### Using existing local agreements, rules and customs improves acceptance of reform

River basin management does not simply require a strong centralised organisation. The best strategy is to develop, manage and maintain collaborative relationships for governance, building on existing organisations, customary practices, and administrative structures. The European Union program stressed that using existing networks helps build context (a sense of place) and increases the likelihood that the reforms will be accepted as legitimate.

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## MAKING THE MOST OF THE NATIONAL WATER INITIATIVE IN THE NORTH

*Daniel Connell, R. Quentin Grafton, Australian National University; and John Ward, CSIRO Sustainable Ecosystems*

**Northern Australia has a younger history of irrigation-based water development and less overuse and demand for water than southern Australia. These characteristics provide northern Australia with opportunities to apply the original intentions of the National Water Initiative by taking a long-term and holistic approach to water planning and by considering environmental and social needs for water along with economic needs.**

### Holistic approach to water planning needed

The National Water Initiative (NWI), as it was originally written, provides a good basis for water management in Australia. Under the NWI, the states and territories use water plans to identify the issues that threaten or limit water availability and quality, and resolve and manage these issues by negotiating with water users and others.

The NWI's aims include the need to allocate water to sustain the environment, to develop water markets and the need to change water management institutions. This holistic approach is necessary to avoid disjointed regulation where many small water users access too much water, depleting surface and groundwater supplies beyond sustainable limits. This problem, sometimes called the 'Tragedy of the Commons', is typical of water planning initiatives across the globe. Using a more holistic approach to water planning, the NWI requires that:

- water be returned to the environment when there is already too much water being extracted
- water extractions are set at a level which is environmentally sustainable – to keep rivers, wetlands, and groundwater healthy
- connections between surface water and groundwater are identified
- the whole water resource – surface and groundwater – is managed as a single resource

The NWI stresses the need for a long-term approach to water policy, planning and management. Such an approach can more realistically compare longer-term environmental costs of developing water resources

with the more immediate economic benefits from development.

The NWI is an attempt to move away from governments aggressively leading the way and controlling water allocation, to one where governments assist water users to reach agreement and, when necessary, enforce regulations.

In practice, the NWI has not been implemented in southern Australia in a holistic manner or in a way that would suit northern Australia. In particular, due to over allocation of water, implementation has focussed on the economic aspects of water policy, like water trading, rather than prioritising environmental and social needs for water.

### The advantages of implementing the NWI in the north

To date the implementation of the NWI in southern Australia has failed to manage water across state boundaries, allocate sufficient water for environmental needs, or to develop more effective and coordinated water management institutions.

Northern Australia does not have the same history of institutions and patterns of behaviour that have worked against an integrated approach in places like the Murray-Darling Basin. In the north, unlike southern Australia, water does not tend to cross state or territory boundaries, is less likely to be over used, and is less in demand by current extractive (or consumptive) users. These characteristics make it easier for water managers to take a broader view of water management, rather than having to make small incremental changes to existing policies and deal with historical over use of available water.

This means that northern Australia can apply the NWI principles to their water plans much more productively. But to realise these advantages will require water managers to equally consider economic efficiency, equity of access to water, and environmental sustainability in their planning.

### Delivering economic, environment and equity benefits from water management

Water managers can assess economic efficiency by comparing the economic benefits from a current water use with the benefits likely from an alternative

water use. This assessment requires water users to accurately disclose the value of the water they use, and may lead to the possibility of users being able to trade water. It also requires a monetary estimate of the value of water used for customary (customary means in accordance with custom or founded upon long-continued practices and traditions) and environmental purposes.

Any water markets need to consider the land and water needs of Indigenous groups and the environment, which are particularly important in northern Australia. Water markets currently treat water as a separate commodity from land. Water trading may face difficulties in the north, if they do not acknowledge the significance to Traditional Owners of the connection between land and water.

To be able to determine environmental sustainability, water managers need to know how much water is needed by the native animals and plants that depend on waterways and groundwater. This will require a good knowledge of the water habitats and how to maintain them.

To establish equity of access to water, water managers need to identify all water users and the costs and benefits to each user from changing their access to water. Equity needs to be planned cooperatively with water users and the processes must be seen to be fair and equitable. Water plans should be clear about the 'winners' and 'losers' from any immediate or likely changes to water access and allocation.

Indigenous people view land, water and culture as a single entity. Scientists agree that water should be managed with the surrounding land and local communities. Traditional knowledge should be considered along with scientific expertise when planning water access and use.

The debate about water use must change from 'what can we spare from production (e.g. agriculture, mining, etc) needs' to 'what can we reasonably take from the environment to use in production before it becomes degraded'. The NWI gives first priority to preserving water for the environment, but acknowledges that some negotiation between extractive water users and conservation needs will be required for water planning to be effective.



*Greg Rinder, CSIRO*

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## INDIGENOUS PEOPLE AND WATER MANAGEMENT

*Kimberley Institute*

**Indigenous communities are a defining feature of northern Australia's cultural, demographic and social character. Significant changes to water policy and management are needed for the genuine inclusion of Indigenous Australians in the future management of water resources in northern Australia.**

### Indigenous Australians historically excluded from development benefits

Although Indigenous labour has been central to economic development in northern Australia, Indigenous people have been largely excluded from material benefits, such as employment. This exploitation of Indigenous people has been accompanied by:

- dependence on support from the state
- lack of public investment in communities such as social and capital infrastructure development
- outmoded and inadequate ways of administering land

For Indigenous people, this has meant a decline in social, economic and cultural wellbeing and an exclusion from any development of water resources.

The fact that the Northern Australian Land and Water Taskforce inquiry exists means that the Australian government is beginning to recognise the potential future exploitation of northern Australia's water. This process must be accompanied by different values and policies from those that have been established in southern Australia over the last century. Historically, politics in the southern regions of Australia have not included Indigenous rights and interests — this method of governing is not appropriate for the management of northern Australian water resources.

### We can learn from our past mistakes

We can learn important lessons from our overuse of water and our failure to address ecological problems in southern Australia. We cannot allow ourselves to repeat the mistakes of the Murray–Darling Basin or the Ord River Irrigation Area that have left a legacy of environmental degradation and cultural destruction.

By not including Indigenous people in water resource management in northern Australia, we will lose the diversity of Indigenous knowledge from across the north. Not including this valuable knowledge will increase the risk that poor management decisions will be made and water will become even scarcer in the future.

We have an opportunity to apply new thinking and ways of land and natural resource management by forming partnerships with traditional land-owning groups.

We think that the elements of the National Water Initiative that concern Indigenous interests have not been effectively implemented, and that the ways of recognising Indigenous governance are seriously inadequate.

To improve, the National Water Initiative needs to:

- recognise the status of Indigenous people as the first peoples of northern Australia and as the largest group of landholders in the north and as such recognise their responsibilities in the management, use and protection of water resources of northern Australia
- make its requirements with regard to Indigenous interests mandatory, not optional
- recognise that Indigenous-specific interests in water planning can provide for Indigenous economic aspirations
- allocate water for all Traditional Owners, not just to those groups with Native Title
- include Indigenous cultural flows (water flows needed to protect cultural values) as a separate planning requirement, not just part of the flows needed for the environment

A national policy framework for water resources such as the National Water Initiative ignores the cultural and environmental differences between the north and south. It is important that the unique nature of northern Australia is acknowledged.

## Making better decisions with Indigenous knowledge

Indigenous knowledge of local water systems and how they fit in the natural environment is a valuable resource for water planning and management.

Water and land are essential to sustain life — they are not just economic assets to Indigenous Australians. In the Indigenous spiritual and physical world, land and water cannot be divided. Indigenous values assert that water is communally owned and shared. Indigenous knowledge and technical expertise in harvesting water has sustained their societies and the surrounding land, and plant and animal life, for thousands of years.

It is time to rethink the way we develop land and water resources, taking Indigenous interests and governance responsibilities into account. Indigenous people are not just stakeholders, but rather have status as first peoples with rights and responsibilities for land and natural resources.

There should be an agreement between Indigenous Australians in the north and the state and federal governments about the land and water governance arrangements in northern Australia.

Under the current model of managing water, northern Australian waters are grouped into an amount that can be consumed and is available for economic development and environmental and cultural flows. Considering the lack of information and knowledge of northern water and the danger that economic need might take water from environmental and cultural flows, we propose that a certain proportion of the total water in northern Australia be set aside for future unknowns. This could safeguard the northern Australian water resources in the long term. There means there would be three components that make up the total northern Australian water resources for management; a consumptive pool for economic and human settlement use, environmental and cultural flows and a safeguard reservoir.

We also propose that an amount of water is reserved under the consumptive pool for Indigenous economic purposes.

Policy and governance of northern Australia water resources should include:

- an Australian government-led body to make decisions in a collaborative way — such a collaboration should include state and territory governments, Indigenous people (at least two people from each jurisdiction), and industry and environment representatives
- a northern Australian association of Traditional Water Owners that would bring a partnership approach to managing water and administering Indigenous benefits
- an Indigenous Water Fund to address the past exclusion and dispossession, and to help Indigenous people to participate in cultural, social and economic development
- an Indigenous water reserve for Indigenous cultural, social and economic use as part of the total amount of water available for consumption
- independent monitoring of the environment and social impacts of water use
- consideration of Indigenous people's needs before other interests in water.

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## REDUCING GREENHOUSE GAS EMISSIONS WITH BETTER FIRE MANAGEMENT

*Scott Heckbert, Jocelyn Davies, Garry Cook, Adam Liedloff, and Gary Bastin; CSIRO Sustainable Ecosystems*

**Reintroducing traditional Indigenous fire management into northern savannas has the potential to reduce northern Australia's greenhouse gas emissions and lead to increased revenue and employment opportunities for Indigenous communities.**

### Reintroducing Indigenous burning practices will reduce emissions

Prior to European settlement, Indigenous people in northern Australia regularly burned their tropical savanna country. The burns were conducted throughout the dry season in a series of small, low intensity fires. The result was a mosaic of burned areas and unburnt areas. But now, many uncontrolled fires typically happen late in the dry season and carry across long distances. They are of higher intensity and burn larger areas of land than the Indigenous fire regime. The result is higher greenhouse gas emissions. Savanna fires account for approximately 3% of annual emissions in Australia.

An excellent example of fire abatement using traditional Indigenous fire management is the 28,000 km<sup>2</sup> of the Northern Territory under the West Arnhem Land Fire Abatement (WALFA) project. The WALFA project is under the direction of the North Australia Indigenous Land and Sea Management Alliance (NAILSMA).

The knowledge gained from this project was linked to science used to account for Australian greenhouse gases, to determine the potential of these types of projects at a broader scale. The results indicated that reintroducing Indigenous burning practices across the entire northern savanna landscape could reduce greenhouse gas emissions by 2.6 megatonnes (Mt) of carbon dioxide equivalent emissions per year. This estimation depends on the extent to which fire management can reduce fire frequency which varies depending on ecosystem types and human elements such as access to sites. This variation will affect the total reduction in emissions.

### Improved fire management supports biodiversity

Controlled burns help to manage habitat and create the sort of fire conditions that some species of plants and animals depend upon for survival. Indigenous people in many parts of Australia used fire for hunting and habitat management. There is considerable evidence that burning created habitat mosaics that promoted some vegetation types and animal species. With the movement of Indigenous people away from traditional lands, large regions of Australia became vulnerable to frequent large, high intensity fires which changed the distribution of species and reduced biodiversity. Many native populations of fire sensitive animal and plant species have declined. Projects such as WALFA have shown that Indigenous fire management practices can contribute to maintaining and improving conditions for biodiversity.

### Fire management could provide revenue and employment to Indigenous communities

Fire management could effectively produce 2.6 Mt of greenhouse gas offsets per year. These offsets could be traded under the Carbon Pollution Reduction Scheme and/or negotiated contracts with energy, mining or philanthropic funding sources. Assuming a carbon price of \$20 per tonne, this amounts to \$52 million annually in potential revenues from fire management on Indigenous lands. However, this revenue does not take into account the cost of burning programs.

There are three fire management techniques that would all provide opportunities for Indigenous employment through:

- Indigenous people on country and dispersed across large areas conducting local burns
- trained crews of Indigenous rangers with vehicles using mechanical equipment, maintaining fire breaks and managing fuel loads across large areas of relatively accessible country
- aerial teams conducting fire management across remote and sparsely populated areas with little vehicle access

Based on knowledge gained from the WALFA project, employment models suggest that approximately 350 full time equivalent jobs could be provided by fire management programs. In practice, employment would be seasonal, so over 500 rangers and 500 casuals, elders and traditional ecological knowledge experts could be employed in seasonal positions.

Savanna burning is particularly attractive for Indigenous communities because it involves Indigenous people on country being active in traditional land management activities. This is culturally important and also improves physical and mental health.

### Fire management requires training, resources and increased access to country

Conflicts have occurred when prescribed burns are undertaken without proper coordination and training. For fire management to be eligible for trading as emissions offsets, it would need to be well planned and executed across several properties, with all property owners involved in planning. Fire breaks would need to be created and maintained along property boundaries, making use of barriers such as rocky outcrops and roads. This fire management would require resources and training within Indigenous communities.

Depressed socio-economic conditions and the relocation of Indigenous communities into towns and large settlements make it difficult and costly for many Indigenous people to get out on country. The success of an offset scheme depends on making access to country easier. This could be done in two ways: by supporting land managers to travel to country if they live remotely, or supporting Indigenous communities in their aspirations to live and work on their traditional country. The latter would be the most effective, and outstation settlements on traditional country present an excellent opportunity to have the land managers doing the right type of management at least cost.

Conflict resolution processes should be included in fire abatement projects which acknowledge cultural norms of who has the rights to burn for what purpose, and where. Local Indigenous institutions would be required to manage the distribution of benefits and costs of an offset scheme, as with any other land management business venture.

### Need to know best timing, long-term effects, and costs of fire management

For fire-abatement programs to be most effective, we need to know more about the:

- best timing of burns for greenhouse gas abatement
- long-term effects of different burn regimes on biodiversity, including whether sensitive ecosystems can be maintained and invasive species excluded
- costs of different fire regimes, transport, personnel and equipment.



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MITCHELL RIVER CATCHMENT: *REGIONAL PERSPECTIVE*

*Sarah Connor and Tim Hoogwerf, Northern Gulf Resource Management Group; Bill Sokolich, Mitchell River Watershed Management Group; John Mackenzie, Griffith University; and James Butler, CSIRO Sustainable Ecosystems*

**While the amount of water flowing down the Mitchell River in north Queensland is among the largest in the north, development opportunities in the catchment are limited by inadequate infrastructure, poor soils and an extreme climate. Many waterways embody Indigenous cultural heritage. Any development could adversely affect ecosystems such as the Gulf fisheries. Above all, Traditional Owners and local natural resource management groups must be consulted about any development concepts, as they have clear goals for the future of the catchment.**

### Big river flows support cropping, horticulture and mining

The Mitchell catchment covers about 70 000 km<sup>2</sup> of Far North Queensland, from the western slopes of the Great Dividing Range to the Gulf of Carpentaria.

Unlike most rivers in the north, the upper Mitchell River and its tributaries flow year-round, mainly because of the high rainfall in the more elevated upper catchment, but they are also fed by water from underground stores ('groundwater'). Like other Gulf catchments, during the 'big wets' the catchment floods.

On average, the Mitchell discharges about 11 million megalitres of fresh water into the Gulf of Carpentaria each year, making it one of the largest river systems in the north in terms of average annual discharge.

Water allocated for consumptive use (as opposed to environmental or cultural use) supports a small-scale irrigation industry and small mines that vary in number from year to year.

Grazing on native pastures is the most extensive land use. Much of the land is under grazing leases which are mainly freehold in the upper reaches of the catchment. Most cropping and horticulture occurs in the headwaters of the Mitchell River in the Mareeba and Dimbulah areas. Agricultural production in the former Mareeba Shire is worth over \$100 million per

year, most of which is for crops grown with water supplied by the Mareeba Dimbulah Water Supply Scheme.

Apart from this, there is little development and use of water resources. Southedge Dam, also known as Lake Mitchell, is the only large dam in the catchment. It can hold up to 129 000 megalitres of water and has never been used. Surveys show that no other potential large dam sites exist.

Some groundwater from the Great Artesian Basin could be extracted, but not on a large scale. The sand and mud deposits ('alluvium') in the upper reaches of the Mitchell are also a potential source of groundwater but more investigation into quality and quantity is needed, and groundwater use would need to be managed.

### Lack of infrastructure, poor soils and extreme climate limit development

To be successful, any major development in the region would need significant infrastructure. Many of the roads in the Gulf are unsealed and in bad condition making them unreliable and unsuitable for major transportation. Expansion of agricultural production would require major improvements to infrastructure including transport networks, processing facilities and commodity storage. The labour force required would need housing, education and health services. New and expensive water supply infrastructure would be required, drastically reducing the economic potential of any development.

Most soils in the catchment are unsuitable for agriculture and horticulture. They are of poor quality, have limited drainage and could become saline or have too much available sodium. Those most suitable—the red and yellow earths and the cracking brown clays—are a long way from the main river channel.

The highly seasonal climate (almost all rainfall falls in the wet season), with high evaporation rates and extreme temperatures, means that few crops are suitable for the area.

## Many waterways embody our cultural heritage

There are seven Indigenous language groups in the region and at least 25% of the population are of Indigenous descent. The importance of cultural heritage and caring for country is part of everyday life for the Indigenous people of the Mitchell River catchment. Many of the places of significance to them are along watercourses, wetlands and waterholes. Protecting these places is paramount and, if development is to be considered, there needs to be significant consultation with the Traditional Owners.

## Healthy ecosystems rely on water

The catchment has melaleuca woodlands, tropical rainforest, Mitchell grassland, mangroves, mudflats and Wetlands of National Significance. Unsustainable agriculture could affect the health of these ecosystems. In the upper reaches of the catchment, rising saline groundwater could increase. In the lower reaches, acid sulphate soils could develop. Sediment is already building up in the river due to intensive land uses.

Aquatic pests and weeds could reduce biodiversity, especially if new water storages cross catchment boundaries. Weeds are usually found where there is human activity.

Major development upstream of fish habitats could affect the Gulf fishing industry which, while highly productive, is one of the least understood fisheries in Australia. Recent research has shown that the bigger the freshwater flow into the estuary, the bigger the catch. Around 90% of the estimated 50,000 tourists who visit the southern Gulf every year are recreational fishers.

## Regulations need to be considered

Under the *Water Act 2000*, the development of water storage, including diversion of water to dams, is restricted.

There are Native Title claims over various parts of the catchment. Any proposed development in these areas would need to consider these claims.

There are restrictions on clearing land along watercourses where clearing might degrade the land and reduce biodiversity.

The *Cape York Peninsula Heritage Act 2007* allows the designation of Indigenous community-use areas in Aboriginal land that is suitable for aquaculture, agriculture or pastoral production. The Minister is required to consider the impact that any development may have on the Cape York grazing industry.

Plans for cross-jurisdictional water use would require input from all levels of government. Advisory committees should be formed to advise and support a steering committee and members should represent:

- the local community, in particular the relevant Landcare and regional natural resource management bodies
- Indigenous communities
- industry groups
- science/research

## Local knowledge and time to communicate are important for planning

The potential for development in the north is varied but limited. Due to the remoteness of much of the country, formal information sources are lacking, so local knowledge is critical. Local communities must play a part in developing concepts, and identifying risks, constraints and environmental impacts.

The Mitchell catchment is one of the largest in Australia, making communication difficult. Any policy development or further investigation should allow adequate time to include the bodies with the experience, knowledge and community representation, such as the Northern Gulf Resource Management Group and the Mitchell River Watershed Management Group, who have established clear goals for the catchment's future.

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DALY RIVER CATCHMENT: *REGIONAL PERSPECTIVE*

*The Daly River Management Advisory Committee*

**The Daly River catchment is the most likely site for significant agricultural expansion in the Northern Territory. Water availability is likely to be the limiting factor. The people of the Daly strongly support the need to protect the catchment's natural and cultural values which they see as critical to its future. The catchment must be managed as a whole, with community participation and support from government.**

### Prospects good for primary industries but tropical challenges

The Daly River catchment is about 200 km south of Darwin and covers about 52,500 km<sup>2</sup> of the Northern Territory. Major rivers include the Katherine, Dry, Flora, Fergusson, Douglas, Fish and Daly. The catchment has a population of about 10,000 people, 27% of whom are Indigenous. There are at least nine Indigenous language groups whose land and water are within the catchment.

Around 60% of the land is farmed or grazed and about 30% is under traditional Indigenous use. Tourism, recreation, mining and defence are important to the economy. The Daly River is one of the most popular fishing areas in the north and the catchment has a number of registered heritage sites.

The catchment has the highest prospects in the Northern Territory for expansion of primary industries. Soils in the areas of high rainfall are suitable for improved pastures, cropping, and irrigated agriculture, and water resources could be made available for irrigation. Darwin and Darwin Port are close by. Katherine is a major centre.

Expansion is likely to be based on more intensive use of existing pastoral leases, more intensive irrigated agriculture and horticulture, and the subdivision of pastoral leases into smaller mixed farms.

Farming in the tropics, however, presents many difficulties. These include land speculation, under-capitalisation, farms growing too quickly, failure to manage the effects of the monsoonal climate, market fluctuations, and lack of farming skills and labour. For sustainable industries to develop (and the industries that support them), both the area of land farmed and the number of knowledgeable farmers needs to scale up.

### Room for development but water availability likely to be a limiting factor

Water allocation plans are in place or under development to make sure there is water for Indigenous use, the environment, and current and future consumptive use. Assessment of water availability as part of these planning processes has shown that, while there is room for more development, water availability is likely to be a limiting factor.

Economic development of land and water is of ongoing interest to Indigenous Traditional Owners and community groups. Indigenous people can see avenues for creating income and return on their natural resources. Significant Indigenous, commercial and legal issues would need to be resolved as part of any development.

Timber production has increased significantly in the past few years but whether timber enterprises will survive in the current economic climate remains to be seen.

Protecting areas of conservation significance is important for ecological, economic, social and cultural reasons, but many people and businesses need access to these areas. The people of the Daly strongly support the protection of the catchment's conservation values. Maintaining the region's natural and cultural values has been identified as critical to its future. Land clearing more or less stopped in 2003, via a moratorium, and licences are required to extract groundwater other than for stock and domestic use.

Agricultural production in the catchment is increasingly integrated. For example, farms contribute grazing and hay to allow preparation of cattle for live export. Live export is the largest agricultural industry in the Territory. Expansion of improved pastures could contribute significantly to this industry.

There are also mining opportunities in the catchment.

### Development means more jobs, more people, a healthier economy

Development of primary industry in the catchment has and will continue to result in population increases and jobs. According to the Daly River Community Reference Group, agricultural development in the catchment could contribute a further \$100 million

in 'gross value of product' to the Northern Territory economy. Economies of scale would be achieved in both production and in returns on investment in infrastructure and support services.

Water allocation planning will ensure that water-dependent developments are sustainable and will protect environmental flows in the Katherine and Daly Rivers.

Local Indigenous people and members of the Daly River Aboriginal Reference Group are exploring avenues for Indigenous economic development. The use and management of Katherine Gorge is an existing example of economic development that creates income and jobs without damaging social, cultural and environmental values.

Increases in tourism and recreational use of natural resources are very likely and, while they will require investment in infrastructure, they will significantly benefit businesses and the livelihoods of people in the catchment.

### The community needs to direct development

Any development has the potential for negative and unintended outcomes. In the Daly River catchment these include: increased pollution and contamination of sites and waterways; soil erosion; increased trespassing on private or culturally important land and waterways; site and amenity damage; and unsustainable harvesting of natural resources. Current planning processes and the participation of the community will reduce the likelihood of undesirable consequences of development.

Because of the interdependencies within and between people's interests, surface and groundwater, biodiversity and social systems, the catchment must be managed as a whole unit. People's livelihoods and lifestyles are dependent on the soil, plants, animals and water being healthy and being in healthy relationships with one another.

For the catchment to be managed as a whole, community participation processes must include all sectors in the catchment, and be resourced and supported by government. Currently, the Daly River Management Advisory Committee is undertaking this role.

An adaptive management approach ('learning by doing') to resource management and use is required, with joint responsibility by government, resource managers and the community. This requires a process of determining goals and targets, recording activities and outcomes, reporting the impacts, reviewing the consequences and responding in an appropriate way.

### Government leadership required

Government needs to provide policy, legislation and regulatory frameworks to guide land clearing, water allocation, regional development, land and water rights, and compliance with the National Water Initiative. Implicit in these policies and practices will be sustainable resource management and use, and equitable access to and allocation of resources.

Water allocation and management in the catchment will be done in the context of the National Water Initiative while considering territory government and local catchment constraints, such as conservative rates of use, annual recharge of aquifers and flexible annual allocations.

Water for Indigenous cultural use should be provided a distinct allocation, to support Indigenous wellbeing and livelihoods. Appropriate ways to link Indigenous cultural and social requirements with mainstream economic development are needed.



Stuart Blanch

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## SHARING WATER IN NORTHERN AUSTRALIA

*John Ward, Jim McColl, Bruce Taylor, CSIRO Sustainable Ecosystems and William Nikolakis and R. Quentin Grafton, Crawford School of Economics and Government, Australian National University*

**The north offers an opportunity to implement water planning that complies with the National Water Initiative, balancing environmental and consumptive needs in a way that is equitable and economically efficient. Crafting such plans remains a substantial challenge. We propose a framework that helps to develop robust institutions and balances water needs based on the benefits provided to vibrant communities and healthy plants, animals and habitats. Water planning needs time, resources and data, especially in the north; so basins will need to be assigned priorities.**

### The north offers an opportunity for a new approach to water planning

Northern Australia is characterised by a relative absence of the powerful historical legacy of institutions and the patterns of behaviour that have worked against whole-of-system policy implementation in the Murray-Darling Basin. Compared to southern Australia, it will be much easier to create the conditions in northern Australia for water management that complies with the National Water Initiative (NWI). Creating these conditions should be given priority, sooner rather than later.

### Water planning should reflect the value of benefits that water systems provide

A science-based and consultative water plan determines the level of accepted modification (such as extracting water from aquifers) to a water system. Choices are made that establish the environmental and consumptive pools, and volumes of water and extraction rates are assigned to different services.

Despite recent advances, crafting water plans that strike a judicious and equitable balance between the environmental pool and the consumptive pool remains a substantial challenge. Only four basins in the north have water plans. The others lack the data and analysis to develop water-sharing plans at the levels of detail prescribed in the NWI.

The NWI requires that water plans balance environmental and consumptive needs. To do so in a way that achieves environmental sustainability, equity and economic efficiency, we propose a framework that helps to develop robust water institutions. Under the framework, water is allocated to the environment based on the value of the benefits (goods and services) that communities receive through using the water system's plants, animals and habitats. The value of some goods and services, such as food and timber, can often be expressed in monetary terms (market prices). Others (such as photosynthesis, pollination and cultural heritage) generally can not.

Water planning based on the value of goods and services provided by the water system covers the four key areas of water management:

- policy objectives to determine separately managed environmental and consumptive pools
- the benefits to different water interests, and the values we place on plants, animals and habitats
- the public-good and private-good benefits of the two pools
- instruments and governance appropriate to these benefits

### Reserve pool can act as buffer to uncertain environmental and cultural needs

In addition to the environmental and consumptive pools prescribed in the NWI, we propose that water institutions determine a 'reserve pool'. The reserve pool is temporarily unassigned water that can be distributed to either future Indigenous, environmental or consumptive interests as required, without compromising environmental or cultural needs. It could be used to satisfy future native title claims and to cater for scientific uncertainty in understanding minimum river flows. To avoid over-allocating water, the reserve pool is temporarily subtracted from the consumptive pool. The balance of entitlements can be still be assigned to water users.

## Classifying basins can help the north avoid the pitfalls of the south

Robust institutional arrangements are capable of:

- independently managing different policy objectives through different governance arrangements
- managing water sustainably across basins that differ hydrologically and are at varying stages of development
- meeting the criteria of fairness and efficiency
- managing the circumstances of a changing world

Using these principles, we have classified northern water systems as being under customary management, open systems or closed systems:

- **Customary management:** The environment is in balance and there is limited water extraction. There may or may not be a water plan. The Fitzroy basin is an example of a customary management system.
- **Open:** There is a water-sharing plan, some water extraction and unassigned entitlements i.e. there is water remaining in the reserve pool. Initial assigning of water interests may take the form of licences specified as an irrigation-area basis or an extraction amount requiring measurement. The Katherine–Daly basin is an example of an open system, but it is likely to quickly become closed (and unsustainable) if all licences are granted and used. Its plan has declared 16 GL for extractive use; current extraction is around 1.5 GL; future licence applications amount to 75 GL. An additional 25 GL has been set aside for Indigenous use.
- **Closed:** Entitlements are fully assigned, so scarce water resources must be redistributed among competing interests, including the environment and Indigenous communities. The reserve pool has been exhausted. There may be opportunities to develop trading in entitlements and seasonal allocations.

When we use the classification to compare river basins in the north with the Murray-Darling Basin, we find compelling lessons that can be applied to the north:

- Avoid the pitfalls of the unplanned, ad hoc water development of the settlement phase.
- Be vigilant when basins approach closure to avoid the substantial social and economic costs of unsustainable closure i.e. an over-allocated water system.

## Water planning needs time, resources and data, especially in the north

The resource requirements of statutory planning processes—consultation, approval, implementation, monitoring, evaluation and review—are substantial and need to be adequately funded. Experience clearly shows that several years are required to progress a statutory plan to final approval. The extensive consultation required takes much of this time and is likely to take longer in northern Australia; so prioritising basins for water planning is essential. Here is a suggested ranking:

1. Basins already in the ‘open’ modification/development phase and requiring a statutory plan.
2. Basins where there is potential for development and water is available for extraction.
3. Basins likely to remain under customary management and that do not need a statutory plan. A co-management agreement with agreed responsibilities could be incorporated into a non-statutory plan.

Substantial research and monitoring is needed to provide planning data for most of the north’s river basins.

## Water planning ideas could be trialled in the Northern Territory

The potential exists for a closer working partnership between the federal government and Northern Territory water managers. The relationship could be used to trial implementation ideas which could then be proposed to Queensland and Western Australia as evidence-based working models.

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## BAUXITE MINING AT WEIPA, CAPE YORK

Summary by Econnect Communication

**Bauxite has been mined at Weipa in Queensland's Cape York for 45 years, and operations are likely to continue for at least another 40 years. The region's communities and economy rely heavily on it for infrastructure, jobs, business opportunities and services. New and/or expanded operations could significantly increase bauxite production from the region.**

### Weipa one of the largest bauxite mining sites in the world

In 1957 the Commonwealth Aluminium Corporation (Comalco) was formed to develop the bauxite deposit in the Weipa region of Cape York in Queensland. Under state government legislation, Comalco was granted an 84-year lease with an option to extend for a further 21 years. In 1977 the initial lease area of 6162 km<sup>2</sup> was reduced to 2590 km<sup>2</sup>. Rio Tinto bought out the minority shareholders in Comalco in 2000 and, after Alcan and Rio Tinto Aluminium joined forces in 2007, the operation became a Rio Tinto Alcan (RTA) operation. In 2007 RTA's combined mining lease extended over 3860 km<sup>2</sup>.

Bauxite ore is the chief source of aluminium. At Weipa, bauxite is mined, crushed and washed, and ore is handled through port facilities for transport to a number of locations globally, though most of it goes to RTA's refineries in Gladstone. Since the first year of commercial production in 1964, when less than half a million tonnes was mined, annual production has increased to about 20 million tonnes. The operation is now one of the largest bauxite mining sites in the world and is 'a jewel in Rio Tinto's crown'.

### The economic significance of bauxite mining

In 2006 RTA contributed \$364 million to the Weipa economy, representing 77% of Weipa's total economic output. Of this, \$316 million was direct contribution.

In the same year, RTA provided the equivalent of 86% of the jobs in Weipa; 25% (734 jobs) were created directly. Local industries such as retailing, manufacturing, construction and business services are particularly reliant on mining. Any withdrawal or decline of the mining industry would have fundamental repercussions for the Weipa economy and community.

### Affordable housing and growth

Weipa relies heavily on mining infrastructure such as the airport; road networks; a port; power, water and sewerage facilities; and housing. In 2007 RTA approved over \$30 million in infrastructure projects and in 2008 it spent almost \$20 million upgrading the power and sewerage facilities and developing land. The company is also a major sponsor of community services and manages an annual community investment fund. It operates a child-care facility, funds general practitioners and subsidises bulk billing.

The lack of available and affordable housing is a major issue affecting Weipa's future sustainability. Private housing and rental prices are extremely high, with non-RTA employees being the most affected. Unless the town boundary is expanded, future development for residential and industrial purposes will be limited.

### Demographic changes

The population of Weipa (about 3000) is becoming more diversified—an indicator of the town's evolution from a purely working mining town to a more diversified community. With RTA employees now able to buy dwellings from RTA, more employees are likely to retire in Weipa. This will put more pressure on health services and aged-care facilities, adding to the existing pressure on housing and child-care facilities.

Comalco established the township of Weipa and the Weipa Town Authority has managed the town on RTA's behalf since 1994. However, it is not a recognised local government body, and is not eligible to receive state or federal government funding (such as the recent stimulus packages) to support the expanding portfolio of social services.

### Indigenous relations

The mining operation at Weipa was established with little consultation of local Aboriginal people. It was not until 30 years later, after the introduction of the *Native Title Act 1993* (Cth), that Comalco sought to recognise Aboriginal interests and rights in the land, formally acknowledging them in the 1997 Ely Bauxite Mining Project Agreement and the 2001 Western Cape Communities Co-existence Agreement (WCCCA).

The WCCCA provides for a range of benefits to Traditional Owners in return for land access. Under the terms of the Indigenous Land Use Agreement, 60% of an annual \$2.5 million payment is placed in long-term investments. RTA also agreed to fund and run employment and training programs, set up a cultural awareness fund, transfer ownership of a pastoral property to the Traditional Owners, and relinquish to the government parts of mining leases no longer in use for return to Aboriginal ownership.

### Addressing Indigenous disadvantage

About 18.5% of Weipa's population are Indigenous. This is in stark contrast to the predominantly Indigenous populations of the nearby communities of Aurukun, Napranum, Mapoon and New Mapoon where at least 91–94% of residents are Indigenous. Greater collaboration between RTA and Indigenous communities has resulted in more jobs for Indigenous people onsite. The company's annual target for Indigenous employment is 17.4% of the total workforce. In 2008 Indigenous employees (181) made up 19.8% of the workforce.

In Western Cape communities, social barriers continue to limit people's readiness for work. As a result, RTA is taking a long-term approach to employment and training and is targeting specific communities rather than adopting a one-size-fits-all approach. As part of a Minerals Council of Australia initiative, the company has signed a regional partnership agreement to address socio-economic impediments to local Indigenous people engaging in the local economy.

RTA has worked closely with the state government to establish the Western Cape College which focuses on the school-to-work transition and has helped lift rates of school attendance and performance. Since 2000, the number of Indigenous students has increased from 160 to 450.

RTA sees itself as a facilitator of small business development, rather than a direct training provider and/or funder of Indigenous enterprises. In the late 1990s, it adopted a change in practice to enter into joint ventures with newly formed Aboriginal enterprises. As an example, under the WCCCA, sub-trusts can allocate funds to establish or support local Indigenous businesses. In 2007 the Weipa Multi Purpose Facility passed into the ownership

of the Mapoon, Aurukun and Napranum communities, becoming the Western Cape Centre Ltd—an accommodation, training and conference facility located in Weipa which provides cultural awareness training for all employees and contractors in the region, including RTA's workforce.

### Land and water management

RTA reports that almost 10,000 hectares have been disturbed since mining commenced, with about 9000 hectares under rehabilitation—a relatively small proportion of the total land holding of 264,667 hectares. The company's long-term rehabilitation target is a ratio of disturbed to rehabilitated area of as close to 1:1 as possible.

The primary uses of water at Weipa are for washing bauxite, suppressing dust on haul roads (particularly in the dry season) and for supplying the workforce and communities. In 2008, RTA used 19,553 megalitres (ML) of water, up by about 2000 ML from 2007. In the same year, it recycled 14,902 ML of water, up from 10,633 ML in 2007. RTA sources water first from tailings dams, then runoff storages, then shallow underground storages (aquifers), and lastly the Great Artesian Basin aquifers.

### The future of bauxite mining

In 2008 RTA began a feasibility study to develop a new bauxite operation about 50 kilometres south of Weipa. The new mine would take total annual production to 35 million tonnes, and expand the current operation's mine life by 40 years. New infrastructure required includes a plant, a power station, a warehouse, workshops, a barge, ferry facilities, and port and ship loading facilities. Chalco and Cape Alumina are also looking at new ventures in the area. This will inevitably place additional pressure on infrastructure and services in the region.









