FACT SHEET 8

Inland rivers and floodplains

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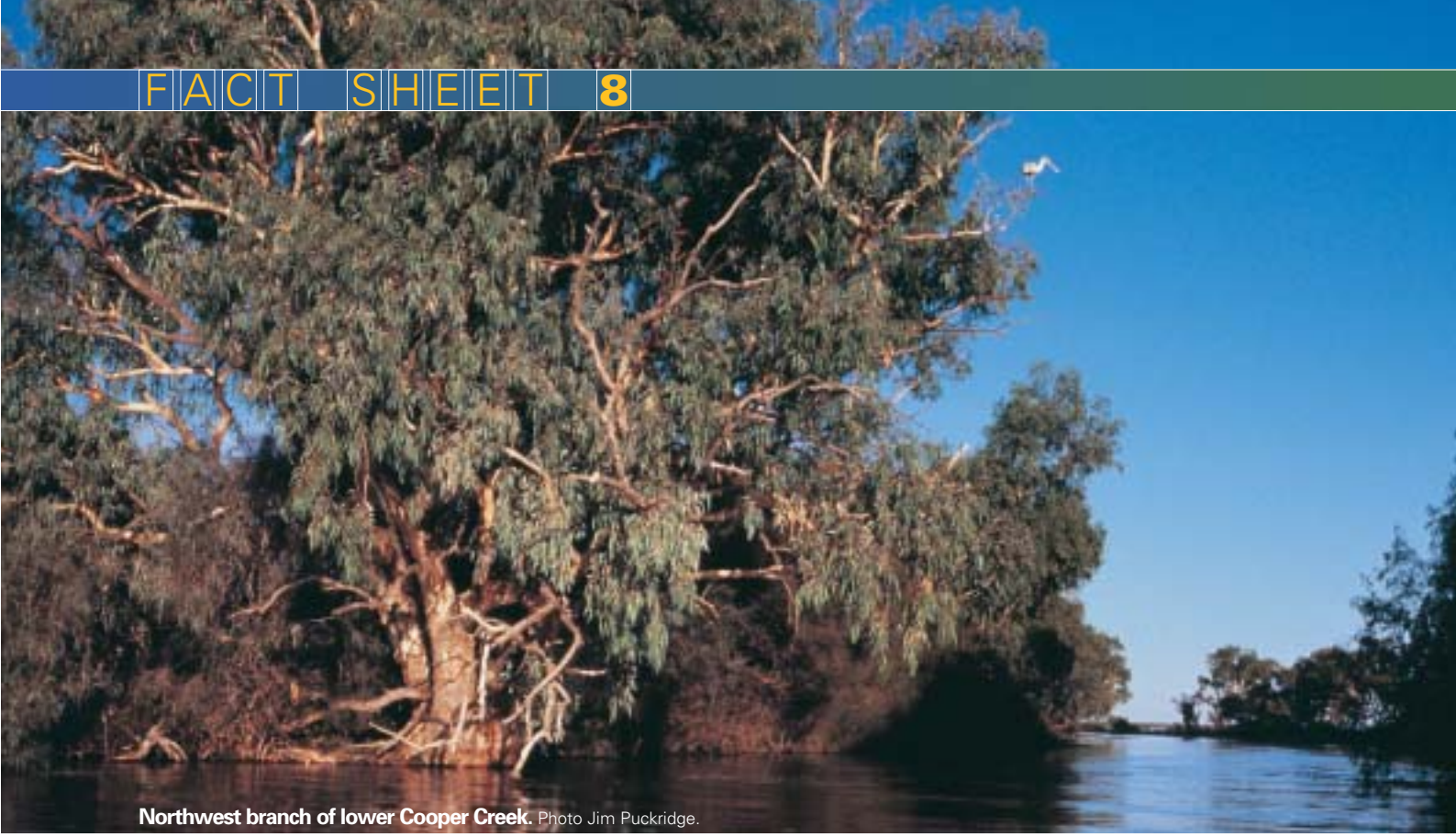
Australia's inland rivers occur across the vast, predominantly arid regions of the continent, comprising 70% of its land area. Some, like the Murray-Darling eventually flow out to sea, whilst others like the Diamantina and Cooper Creek, flow inland to Lake Eyre. These river systems have highly variable flows, they come and go, flood large wetlands or lakes, wet vast floodplains, create new watercourses and dry out to meandering braided channels, billabongs and waterholes. They are fed by thousands of small creeks, and these 'arteries' drive ecological processes, create habitat for plants and animals and provide water for industry, irrigation, electricity generation and domestic use.

River Landscapes

This Fact Sheet is the eighth in a series dealing with the management of rivers and riparian land.



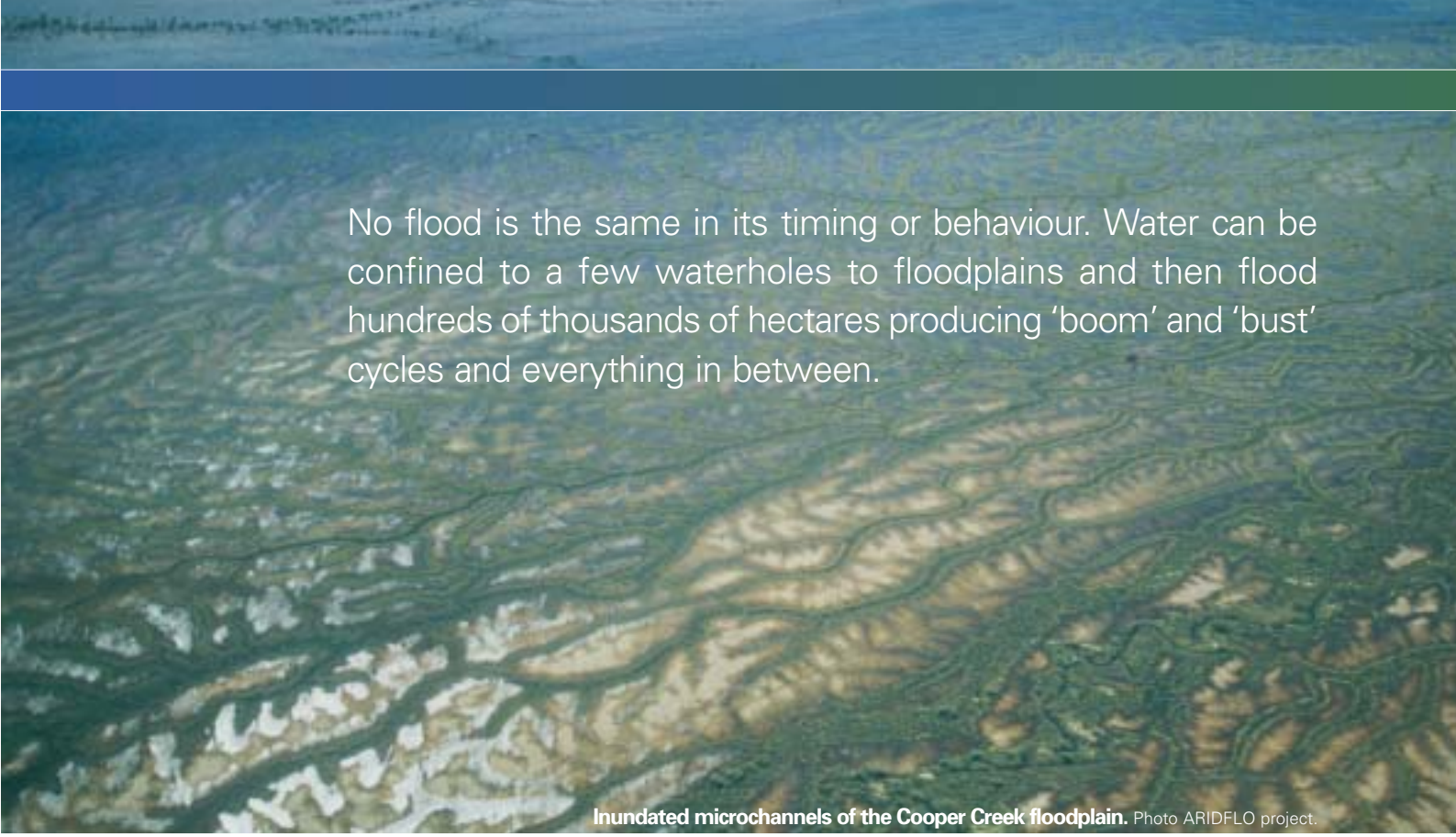
Northwest branch of lower Cooper Creek. Photo Jim Puckridge.

Inland river characteristics

All inland rivers have one thing in common: they lie at the low end of the river range in terms of flow quantity, but they are at the high end of flow variability. This means that these rivers are incredibly complex and unpredictable. The explorer Charles Sturt could not believe Cooper Creek was much more than a creek, yet it forms one of the most magnificent desert river systems of the world. Henry Lawson similarly summed up this 'perception problem' in his 1918 poem of the Paroo River, because he could hardly describe such a watercourse as a river. During dry periods, the Paroo River in Australia is limited to a series of waterholes and some permanent freshwater lakes, however, large floods may see the river inundate nearly 800,000 hectares.

Inland rivers of the Lake Eyre Basin. Courtesy ARIDFLO project.

Australia's inland rivers differ from most of the rest of the world's rivers because of their high flow variability. The seasonal influence on flows is much less for our rivers than others around the world, as most flows in inland rivers are dependent on the highly unpredictable climate that characterises Australia's inland.



No flood is the same in its timing or behaviour. Water can be confined to a few waterholes to floodplains and then flood hundreds of thousands of hectares producing 'boom' and 'bust' cycles and everything in between.

Inundated microchannels of the Cooper Creek floodplain. Photo ARIDFLO project.

Cooper Creek and the Diamantina River are the world's most variable major rivers. These inland rivers go through 'boom' (floods) and 'bust' cycles (dry periods), and everything in between. Inland rivers have long periods of low or no flow, followed by periods of extreme flooding. Some floods follow one after the other while decades may separate others. People living on the river tell visitors that no flood is the same, and scientists working in these areas monitoring the changes, agree.

Ever changing floodplains impose another level of unpredictability, for example, a fallen log can close off a channel and the river just moves to form a new channel nearby. Complexity in space and time create pathways of connectivity linking different parts of a floodplain to the river. Ever changing patterns of flooding produce wetlands with unique flooding and drying patterns. Whole inland rivers have their own 'signature' of variability, making them ecologically distinctive.

Floodplains

Inland rivers are much more than just the main river channel commonly defining the river. The 'rest' of a river is defined as 'floodplain', and is formed when the river breaks its banks and moves over the landscape. Floodplains occupy well over 90% of the river, and include swamps, channels, lakes, billabongs, wetlands and waterholes. These areas are permanently or temporarily flooded and support high biodiversity, with an abundance of plants and animals living in them. The flow in an inland river creates an amazing number of different habitats as it expands, contracts and fragments over different sized areas and over different time scales (daily, event, monthly, annual).

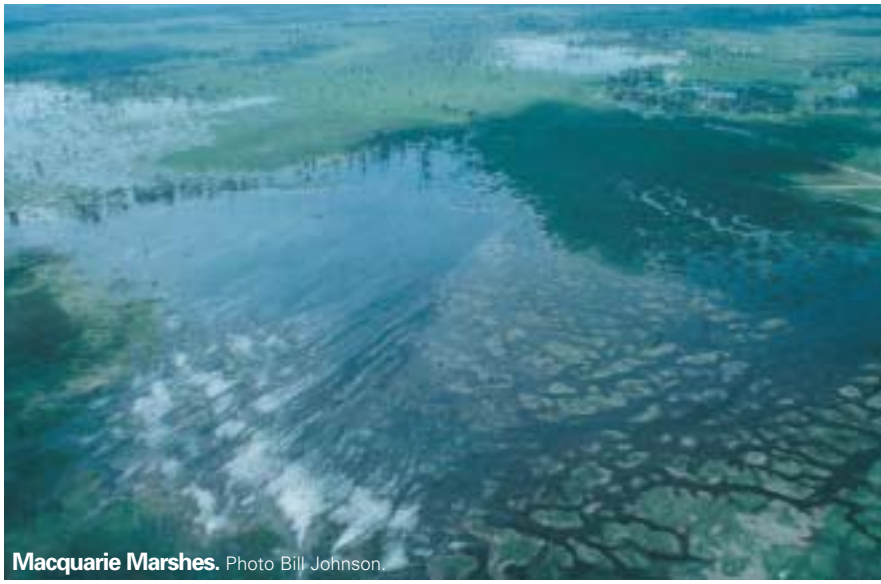
On some rivers, the inland river ends in wetlands (e.g. Lake Eyre, Gwydir wetlands, Lake Gregory system, lakes of the Barkly Tablelands) while on others, the river floods forests and billabongs on its way out to sea (e.g. Barmah-Millewa forest, Coorong, Macquarie Marshes).

The floodplains of inland rivers can be divided into some broad categories. There are freshwater lakes (Coongie Lakes, the Paroo River's overflow lakes, lakes of the Barkly Tablelands, Lake Gregory), saline lakes (Lake Eyre, Lake Torquinnie and Lake Wyara), large floodplain swamps (Macquarie Marshes, Great Cumbung Swamp, Barmah-Millewa Forest) and millions of hectares of floodplain that is seldom named. Many of these floodplains are now well recognised as important areas for conservation.

Floodplains are the habitats and 'hotspots' for biodiversity on a river system. They are usually the areas where the river breaks its banks and floods freshwater lakes, saline lakes or floodplains. Sometimes these floodplains lie at the end of a river, but many are located in the lowest part of the catchment.

Coongie Lake. Photo Roger Charlton.

Lake Wyara. Photo John Hunt.



Macquarie Marshes. Photo Bill Johnson.

Boom and bust cycles

An incredible number of plants and animals depend on inland rivers, and most can be found in the floodplain environments filled by the river. The plants and animals that live in our inland rivers systems are adapted to the 'boom' and 'bust' cycles that characterise the floods and dry periods of inland rivers. Some animals use these areas briefly, while others rely on a wetland for their entire life cycle. Fish use the floodplain as nursery areas for their young; frogs erupt from inactive burrows to engage in a frenzy of reproductive activity when floods inundate the land; and waterbirds collect in spectacular colonies, breeding in tens of thousands. Shallow water areas on inland rivers are particularly important for this peak of activity.

Birds and frogs are the 'obvious' organisms we think about, but they are supported by a food web of plants, animals, fungi and bacteria. Intermittent floods produce the highest diversity and abundance of insects, often hatching with other organisms from sediments on the floodplain. Plants grow and germinate — with regeneration cycles for some floodplain tree species only occurring with medium to high floods, at frequencies of fifty years or more. Even land-based (terrestrial) animals build on the bonanza of food brought by a flood. Kites and eagles increase dramatically when inland rivers flood, feeding on the abundant fish and waterbirds.

Red gum on a dry creek bed on the Paroo River where it depends on irregular floods for its survival, growth and reproduction.
Photo Alison Curtin.

The diversity of habitats from saline to freshwater, the variability of flows, high temperatures and plenty of sunlight result in high abundance and diversity of plants and animals on rivers and their floodplains.

Canegrass swamp at Nocoleche with water in the 'boom' cycle (above) and without water in a 'bust' cycle. Photos Richard Kingsford.

Inevitable 'bust' periods follow floods, restructuring plant and animal communities and their processes. Some plants can withstand long dry periods, while some frogs bury themselves during dry times. Many species die, leaving their eggs for the next flood. The tremendous diversity of floodplain habitats on an inland river creates floodplains that dry at different rates. Remaining pools may be filled with dense populations of mobile animals like waterbirds that feed on fish, and frogs. Some of these waterholes are permanent, providing refuges for those animals that can move when other areas of the floodplain dry out. These permanent waterholes are havens for plants and animals during dry periods. Other animals and plants will remain in the same location but become dormant until the next flood event occurs.

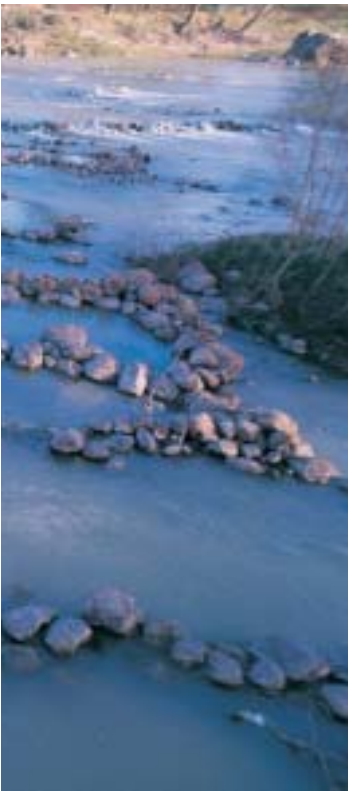
Humans and inland rivers

People have relied on inland rivers for tens of thousands of years for water, food, shelter and spiritual connection. Aboriginal people often centred their lives on an important waterhole or lake with mussels, crayfish, fish and wetland plants an important part of their diet. Water plants provided spring shoots of common reed that can be boiled or roasted, as well as Nardoo seed that is crushed for flour and baked. Floodplain eucalypts provided wood for shields, containers, weapons and canoes. Waterbirds were caught with nets or, when they were breeding, eggs were collected for food. Fish were also an extremely important food for Aboriginal people. These were caught in nets or intricate stone traps such as the famous Brewarrina fish traps on the Darling River.

Brewarrina fish traps. Photo by Michael Cufer.

Some Aboriginal groups still practise the traditional way of life that cycles with Australia's inland rivers. Rivers and wetlands also have deep spiritual significance, with many parts of a river identified as culturally important. It is important to recognise that Aborigines lived with the resources of the river. This was in stark contrast to the European colonists who arrived and primarily exploited rivers.

European colonists used inland rivers for navigation and water for agricultural enterprises and urban development. It is no accident that most country towns are built on the reliable waterholes of inland rivers. For example, Birdsville is close to a waterhole on the Diamantina River; Longreach lies on the banks of the Thomson River; Dubbo is on the Macquarie River and; Bourke is on the Darling River. In the late 18th and early 19th century, the large inland rivers of the Murray and the Darling were the main agricultural trade routes for inland produce, particularly wool. From the time of Federation, the ownership of water from inland rivers was vigorously argued. South Australians wanted the Murray and Darling maintained for river trade, while the upstream states of New South Wales and Victoria argued that irrigation would ensure remote areas were populated and contribute to the overall wealth of the colonies. These debates continue today.



Travelling irrigator. Photo MDBC.

Our inland rivers support many rural towns, providing water for drinking and industry. Most of the water used by us from our inland rivers is for the irrigation of a wide range of crops: citrus, grapes, rice, cotton and wheat. Without the water from inland rivers, profits for growing these crops would not be realised.

Where irrigation industries have developed, there are inevitable impacts to existing grazing enterprises. Graziers paid a premium for 'floodplain country' because this land sustains and produces more livestock during flood periods. Irrigation development upstream 'takes' much of the water that used to inundate the floodplains, and this has inevitably eroded incomes of graziers.

There are also 'passive' users of our inland rivers — the unaccounted numbers for whom the river contributes unmeasurable value to quality of life. These are the swimmers, canoeists, fishers, walkers, birdwatchers, campers or tourists. Their contribution to local, regional, state and even national economies often goes unmeasured, yet for most people, there is an intangible link between the health of our river systems and quality of life.

Inland river characteristics

Inland rivers:

- **are highly variable with boom and bust cycles**
- **function at different spatial and time scales**
- **have high biodiversity, particularly on the floodplains**
- **are mainly used for pastoral and rangeland grazing enterprises**
- **are in low population areas with scattered towns and settlements**
- **are strongly engrained in Australian culture**
- **are under threat by water resource development through the building of dams, weirs and levees for irrigation**
- **have had little research investment**
- **cross jurisdictional boundaries and present particular problems for management**

Threats to our inland rivers

Most, although not all, of the threats to the health of our inland rivers are of our own making. The most serious is the regulation of inland rivers with dams and weirs, as well as the extraction of water and construction of levee banks across the floodplain after water resource development. European carp, rising salinity, increased sedimentation from catchment development, increased pollution, grazing of riparian lands, erosion of river banks, de-snagging of rivers (taking all the logs and branches out) and other feral animals and weeds are some of the more prominent impacts that we know about. Climate change may be another threatening factor. Often these factors are related, with water resource development triggering unexpected interactive effects. For example, decreased flows and river regulation in rivers increases salinity, frequency of algal blooms, reduced water quality and increased populations of European Carp.

Water resource development

Water resource development, mostly for irrigation, has affected inland rivers, their floodplains and the human communities that depend on them. The boom and bust ecology of inland rivers does not equate with the economic gains and regular flows needed for irrigation. River regulation affects the flow patterns of a river, reducing flow variability and often distorting seasonal events. For example, on the upper Murray River, we capture snow-melt in spring and release it in the summer for irrigation, rather than leaving the water to flow through the system in the high spring flows needed for animal and plant breeding cycles to be triggered.

Hume Dam. Photo MDBC.

Most dams on inland rivers are built to divert water for humans, and they are often located upstream of major floodplain wetlands. These dams 'capture' the floods so the water can be released later for human use down the main channel of the river. This prevents many of the floods reaching the floodplain. About half the natural flow on the Murray River is currently extracted, and this has resulted in reduced flooding, with negative consequences for the ecology of inland rivers. Water plants reliant on irregular but reliable floods are gradually replaced by species more tolerant of dry periods, and this begins the process whereby the floodplain shrinks and biodiversity declines. Refuges can be lost, plant and animal breeding reduced and inland river ecosystems degraded.

The most developed major river basin in Australia is the Murray-Darling Basin, an area that covers 14% of Australia. The rivers feeding into this system sustain floodplain wetlands before eventually merging into the Murray River that flows out to sea in the south. Eighty percent of the total flow from river systems in the Basin is now diverted. Governments built major dams on the southern rivers (Murray and Murrumbidgee) early in the 20th century to meet the needs of irrigation industries. Governments then focussed water dam building on the more northern and inland rivers, with upper catchments in high rainfall areas (e.g. Border Rivers, Gwydir, Macquarie) having large dams built. Most (67%) large Government dams, potentially storing 85% of the water in New South Wales, were built after the 1950s. These included dams on the Macquarie-Bogan, Namoi, Gwydir, Border Rivers and Lachlan. Enlargement of Pindari Dam in 1995 on the most northerly river catchment, the Border Rivers was the last large dam to be built in the Murray-Darling Basin.

By the mid 1980s, attention had turned to water resource development opportunities on the northern rivers and those in more inland regions (e.g. Gwydir, Namoi, Border Rivers and Condamine-Balonne). Government sponsored water resource development was replaced by private water resource development. Large dams (some up to 80,000 ML storage capacity) were built on the floodplain. Earthen walls of five metres or more encircle these 'off-river storages', and these are filled during floods by pumps (>600 mm diameter) which can extract water quickly from the river. On the Gwydir River, the storage capacity of off-river storages (386,000 ML) occurred over less than 20 years.

Off river storage. Photo Richard Kingsford.

The ecological consequences of water resource development in the Murray-Darling Basin have been as profound, as in other arid regions of the world. The two case studies that follow demonstrate the difference between effective conservation compared with long-term degradation of our inland river systems.

The Narran and the Paroo

Narran Lakes

Environmental and cultural values

Narran Lakes is listed as a wetland of international significance and especially well known for its waterbird populations. The area is particularly important for Aboriginal people and graziers depend on floods for their livelihoods.

Water resource development and long-term environmental health

From a few off-river storages in the late 1980s upstream of Narran Lakes, storage volume increased to 300,000 ML by 1993; doubled again by 1997 to 600,000 ML, and in 1999 reached 950,000 ML. Flow diversions have now reduced median annual flows to Narran Lakes by 74%, with mean annual flows reduced by 57%. This will lead to the death of large areas of floodplain vegetation and reduced habitat for other plants and animals. Based on evidence from elsewhere, about half of the floodplain is expected to disappear or degrade.

Legislation and policy

Levees, large pumps and storages were rapidly built to capture variable flows in the absence of good regulation, poor environmental assessment and weak legislation. Floodwaters were not controlled by Government-built structures so the water was essentially free, apart from the capital cost of the infrastructure.

Communication

There was poor understanding in the community about the legislation and policy that allowed development, and little discussion of the long-term costs. Relatively little public pressure matched a strong pro-development ethos of Queensland governments in the late 1980s and 1990s. The irrigation industry was well established and exerted strong political pressure on decision-making.

The Narran and the Paroo

The Narran and the Paroo

Paroo River

Environmental and cultural values

The wetlands of the Paroo River are well known for their waterbird populations. Currawinya National Park is listed as a wetland of international significance. The area is particularly important for Aboriginal people, and graziers depend on floods for their livelihoods.

Water resource development and long-term environmental health

Very little water is diverted from the Paroo River. Irrigation licences proposed in the mid 1990s met considerable opposition. Subsequent legislation and policy frameworks should ensure that the flows of the river are protected.

Legislation and policy

Many of the poor mechanisms for protection that favoured water resource development upstream of Narran Lakes, were present for the Paroo. Legislative and policy frameworks were the same. However, better understanding of development impacts and public pressure resulted in a water management plan for the Paroo River that has an ecological focus and a draft interstate bilateral agreement that protects the river's flows.

Communication

A workshop held on the river was a catalyst for communication between floodplain graziers, conservation organisations and scientists. People living on the river became a powerful political force, assisted by conservation groups. Considerable publicity drew further support for protection from urban populations. The irrigation industry was poorly represented in the catchment, and exerted little political pressure, compared to the considerable opposition from the local community, conservationists and scientists. The Paroo experience shows that in the absence of adequate policy, legislative and management framework for the protection of rivers, communication and wide public debate about the future of rivers offers promise for their protection of whole river systems.

Paroo River at Hungerford. Photo Sam Davis.

Future river conservation and management

Human needs, particularly for irrigation, still govern river management priorities and objectives for most rivers in inland regions of the world. Agriculture accounts for 65% of the world's water use. Irrigation uses about 70% of all water used in Australia, including 95% of all water in the Murray-Darling Basin. Historically, river management focussed on conserving water 'lost' to floodplains in dams. This conflicts with river conservation that seeks to protect the inland river's flow regime and all its complexity.

Australia is one of the few countries in the world that is developing strong ecological policy frameworks for the protection of whole river systems (e.g. Cooper Creek, Paroo River). There is growing community understanding of the inevitable link between water resource development and poor ecological health of inland rivers and their floodplains. Unfortunately, much of this is focussed in parts of Australia where there is already considerable damage. In less developed parts of the continent, primary policy and management objectives are still to develop water resources of our inland rivers with little discussion of the long-term social and ecological impacts. Informed debate about the future of rivers involving all communities offers hope that protection of inland rivers and their floodplains will replace the historical path of dams and pumps for some inland rivers of Australia.

Principles for inland river management

A set of principles for inland river management may assist the community, policy makers and managers to make decisions for a sustainable future. Principles upon which to base inland river management and policies could include recognition that:

1. naturally variable flow regimes, the dry phase, and the maintenance of water quality are fundamental to the health of inland river eco-systems.
2. flooding is essential to floodplain ecosystem processes and makes a significant contribution to pastoral activities.
3. structures such as dams, weirs and levees can have a significant impact on the connectivity along rivers and between the river and its floodplain. Solutions are needed to either minimise these impacts or find alternatives.
4. water is essential to rural industries and communities, who have the responsibility at the local level to manage water resources.
5. catchment management, and integrated surface and groundwater management, are important concepts that need to be put into practice.
6. sufficient knowledge exists to ensure that water resource allocation decisions are made on a sustainable basis, and a strong commitment is needed to access and utilise best available scientific information.
7. new developments should be undertaken only after appraisal indicates they are economically viable and ecologically sustainable. Promoting greater water efficiency is essential to achieving sustainable industries.
8. high conservation value rivers and floodplains need to be identified, and in some cases protected in an un-regulated state.
9. stressed rivers need to be identified, and priorities established for their rehabilitation.
10. improved institutional and legal frameworks are needed to meet community river management aspirations.
11. with all parties making a commitment to work together, management regimes can be developed that are ecologically, economically, socially and culturally sustainable.

FACT SHEET 8
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These **Fact Sheets** are grouped according to whether they deal with riparian land, in-stream issues, river contaminants or other matters. They aim to set out the general principles and practices for sound management. Other information that focuses on local conditions and management issues is available from state government agencies, local governments, catchment management authorities, rural industry bodies and community organisations. Together, this information should assist users to understand the key issues in river and riparian management, and enable them to adapt general management principles to their particular situation, and to know where to go for advice specific to local conditions.

Other relevant Fact Sheets

1 Managing riparian land
2 Streambank stability
3 Improving water quality
4 Maintaining in-stream life
5 Riparian habitat for wildlife
6 Managing stock
7 Managing woody debris in rivers
9 Planning for river restoration
10 River flows and blue-green algae
11 Managing phosphorus in catchments
12 Riparian ecosystem services
13 Managing riparian widths

Further information on river and riparian management can also be found at the Land & Water Australia 'River Landscapes' website.

www.rivers.gov.au

This website provides access to projects, fact sheets, guidelines and other information designed to assist people to better manage river and riparian areas across Australia.

River Landscapes

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