An Assessment of Social and Economic Values of Australia's Tropical Rivers

A scoping report to Land and Water Australia's Tropical Rivers Program

Prepared by CSIRO and James Cook University

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Executive summary

Background

Covering an area of more than 1.3 million km^2, the tropical rivers (TR) region includes 55 river basins and extends across all catchments from the west side of Cape York to the Kimberley, through Queensland, the Northern Territory and Western Australia. It includes some of Australia's largest river systems, which are – by area size – the Flinders, Roper, Victoria and Fitzroy Rivers and – by volume – the Nicholson and Mitchell Rivers (NGIS Australia, 2004).

In 2004 the Board of Land & Water Australia (LWA) identified Australia's TR region as a priority area for major investment over the subsequent five years, and there has been explicit recognition of the important contribution that social sciences make to natural resource management. This report presents results from a scoping study – the primary objective of which was to conduct a 'preliminary' assessment of social and economic values associated with Australia's tropical rivers. This research project complements existing (NGIS Australia, 2004) and ongoing research on the tropical rivers region, with the following specific objectives:

1. To develop an integrated social and economic profile of the tropical rivers region, focussing on the collation and reporting of data relevant to rivers and river management;
2. To identify important social and economic values and issues relevant to rivers;
3. To explain significant processes and pressure points that will impact on future management of tropical rivers, including conflicting stakeholder aspirations;
4. To scope future research needs and priorities based on the identification of key social and economic management questions, and;
5. To recommend questions and approaches for further R&D that will generate an understanding of the social and economic processes and pressure points that will impact on the health of rivers, floodplains, wetlands and estuaries in the study area.

Methodology

A key assumption underlying this project's methodological approach is that the TR region is a large, complex system consisting of interlinked sub-systems (social, cultural, institutional, economic, biophysical, hydrological and ecological). Recognising that no single scoping study could investigate detailed aspects of such a complex system across a region as large as this, this investigation made several methodological simplifications as outlined below:

a) In this report, the term 'values' is not used to refer to a market-based price. Neither is it used to refer to a numerical or financial estimate of the magnitude of value. Rather this report defines "social and economic values" as those that contribute to human wellbeing – either directly (as when an individual uses water to drink, or when an individual gains benefit from living near their favourite river), or indirectly (as when businesses within the tourism industry are profitable because many visitors travel to the region to swim in local waterholes). Thus, this report uses both primary and secondary data to identify key social and economic values associated with Australia's tropical rivers, but it does not attempt to measure, compare or prioritise them (using dollars, 'utils', kilojoules or other).

b) Data relevant to the entire TR region was collected from a multitude of existing sources. Information was also collected during three separate focus group discussions – one each in WA, NT and QLD. The rich qualitative focus group

information was then used to supplement, compare, and contrast the 'coarser' desk-top information, the two approaches thus serving to enrich and 'ground-truth' each other.

Much of the research was conducted in an iterative process – where data/information gleaned in one part of the investigation, helped re-focus earlier thoughts and refine other avenues of investigation. However, final deliberations are – of necessity – presented sequentially. To that end, chapters 2 through to 6 of the report summarise key issues relevant to objectives 1, 2 and 3, whilst chapter 7 uses information from these preceding sections to meet objectives 4 and 5 – that is, to highlight future research needs and priorities, and to recommend questions and approaches for this R&D.

Findings

The study found that there are significant differences between many of the river systems in the TR region and others in southeast Australia. First, it is clear that most rivers in this region have episodic flows, whereas many in the southeast are perennial. Second, groundwater is an important substitute to surface water – for human and animal consumption, and for other purposes. Third, there are complex, yet poorly understood, relationships between ground and surface waters. (Chapter 2)

This highlights the fact that river management systems in the TR region must be able to cope with scarcity and with extremely variable water supplies – both geographic and temporal – and must simultaneously deal with both surface and ground water issues. The biophysical characteristics of the region also compel those charged with managing water resources in the TR region to be particularly vigilant in protecting 'basic' levels of both water quantity and water quality – not just on the surface but also underground. This is because scarcity has the potential to intensify the external effects that one person's activities has upon others (as when, for example, the only water hole for hundreds of kilometres runs dry).

The social and economic values of Australia's tropical rivers have changed through time (Chapter 3). So too have the theories of 'value', the frameworks for thinking about 'values' and the terminologies of managers and academics. These changes have, in turn, influenced the way in which values are conceptualised, identified, assessed, measured and – ultimately – used to make decisions about how to allocate resources to different and often competing uses. Managers and researchers, thus need to be aware of the fact that different approaches to thinking about 'values' may lead to quite different allocative outcomes. There is a need to develop and refine environmental management processes to allow for consideration of multiple values and diverse sources of knowledge.

Nowadays, it is clear that there are many different social and economic values associated with Australia's tropical rivers (chapter 4). Specifically, there is ample evidence to suggest that the TR region contains many rivers, estuaries and wetlands that have significant environmental, aesthetic, bequest, and option values associated with them. Not only are these areas of 'value' by, and of themselves, but they also provide many important ecological services which are used (and thus valued – if only indirectly) in other human activities. The 'values' associated with Australia's tropical rivers, therefore include, but are not limited to:

- Environmental, aesthetic, bequest, and option values that exist even when the rivers are not being 'used' – or used up.
- The value of water as a basic requirement of life.
- The direct – and indirect – use-values associated with rivers that accrue to the large number of Indigenous people for cultural purposes, for fishing, for recreation, for health and for a multitude of other reasons.

- The aesthetic, 'cooling' and recreational values (including fishing) of rivers provided to residents and to regional, national and international visitors.
- The 'value' of rivers for the eco-system services they provide to the fishing, agriculture and tourism industries.
- The 'value' of water extracted from rivers for use in industries, particularly agriculture and mining.

Many of the basins in the TR region have fewer than 500 persons, and very little industry (Chapter 4). In these basins, 'values' are almost exclusively non-market in nature, which poses some interesting management challenges in a policy environment that places much emphasis on 'market' solutions (since these systems typically work best when there are many participants).

Despite the relatively large number of basins with few people, there is ample evidence to suggest that most rivers within the TR region are likely to face increasing pressures in the near future. Specifically, more than half of the basins in the TR region had populations that increased by more than 10% between 1996 and 2001 – and the population of one basin grew by almost 76%. Likewise, there is evidence to suggest that agricultural practices will continue to intensify across the western and middle parts of the region, Australia is currently in the grips of world-wide minerals boom, and many local councils are looking to encourage the tourism industry, if only to diversify their regional economies.

As populations rise, the mix of values is likely to become more complex, and there will be an increasingly important role for policy, legislation and institutions to play in negotiating these values. Whilst many of the social and economic 'values' identified in this report are essentially complementary (e.g. some environmental, aesthetic, Indigenous and recreational values), many other values 'compete with' one another. Perhaps not surprisingly, 'conflicts' between different stakeholder groups are beginning to emerge, and these 'conflicts' are likely to intensify as populations rise. Examples of existing 'conflicts' include:

- Intensive agricultural practices. Some of these practices may compete with other values – as when, for example, landholders erect fences that block access to rivers; or when water is 'used up' for irrigation (or for stock), thereby reducing the amount available for other values. Other agricultural practices may not 'use up' a region's water resources, but are, nevertheless, degenerative in that they impact negatively on other 'values' (as when chemicals or land clearing practices affect water quality).
- Tourism. Although the use of rivers by the tourism industry is largely non-consumptive, some types of tourism clearly degenerate other values. And comments made in focus groups clearly indicate that locals are becoming frustrated at overuse of favoured places and the damage, mainly in terms of pollution, left behind by some tourists.
- Commercial fishing. This industry has vested interests in the region's rivers – and these interests are likely to complement many (but not all) environmental and/or Indigenous values. However, these values may compete with those of the agricultural sector (in cases where the agricultural practices affect either the quantity or quality of water) and with recreational fishermen. Access to Indigenous customary estates and sacred areas has also generated conflict.
- Mining. Many of the TR region's mines are concentrated in areas that have relatively unproductive aquifers &/or little perennial surface water. This places considerable pressure on scarce water resources, since much of a mine's use of both surface and ground water is consumptive or degenerative.

Oftentimes, policy makers stress the need to set aside water 'for the environment' before allocating the remainder to other users. But in the TR region, policy makers may also need to consider the idea of setting aside water for Indigenous communities, since these values –

like those associated with the environment – are typically non-priced. However, the exact amount of water to be set aside to support these values is unclear, particularly given the complementary nature of many (but not all) environmental and Indigenous values, and the difficulty of quantifying a flow sufficient to meet an intangible value.

Likewise, the fishing and the tourism industries have significant 'values' associated with the region's rivers. But these industries do not 'use water' in the traditional sense, and so these values may not translate neatly into a water-market. In the tourism industry, for example, businesses that earn money from tourists do not have to 'pay' for (or acquire) water, but the region's rivers help to attract visitors, and those visitors translate into business revenue. The fishing industry has similar, indirect 'links' with the rivers: fishermen do not generally have to 'buy' water, yet healthy rivers are nonetheless an essential input into their industry. This contrasts with situations where the relationship between rivers and the profitability of an industry is more clearly defined (for example a mining or agricultural company acquires water, uses it as an input to production and then sells output on the market at market prices).

Whilst this distinction is largely irrelevant when discussing 'value', it may become important if formal water markets are put in place within the region. Here too, policy makers who are keen to implement water markets may need to consider whether it is necessary to set aside 'water' and/or set water quality regulations that protect and/or give voice to those values.

As clearly recognised by current policy makers, pressures on Australia's water resources mean that it is important to look at both supply-side, and demand management solutions. While the National Water Initiative (NWI) has provided the focus for water policy changes across the Commonwealth, States and Territories, the policy, legal and administrative frameworks still remain extremely complex (chapter 5). Much of the reason for having such a complex set of policies, plans, acts, and institutions is that water policy must deal with the various and competing uses for water. Nevertheless few people are likely to understand the way in which this complex set of rules plays out. There also appears to be a significant knowledge gap pertaining to people's attitudes towards the NWI and other related policies and programs, and much concern over the possible distributional consequences of water and water-related policy.

Comments from the focus group discussions indicate that local government appears to be assuming greater responsibility for management of recreational sites, tourism and the environment. Yet anecdotal evidence suggests that areas outside towns that are not in national parks are not getting the management attention they deserve. Conservation values associated with these areas may not be met at present either (Chapter 6)

Related to this, is the question of how one can finance improvements in natural resource management, in the event that current management systems are deemed to be under-resourced. Specifically, it may not be possible to raise revenues from those who benefit from the region's water ways in an efficient and equitable manner – particularly when many of the values associated with Australia's tropical rivers are not at all, or only loosely, associated with the market. Further, there is a very sparse, or 'thin' resource base to be 'taxed' or asked to contribute to the cost of managing vast tracts of land and water, and a good proportion of that population base is relatively impoverished (chapters 4 and 6).

Whilst there may be technological solutions to existing or emerging water 'shortages' in some areas (eg building dams, recycling water, using of grey-water, installing water tanks and/or water purification systems, desalinisation, the use of dry-toilets), it is important to ensure that the benefits of such 'solutions' are carefully weighed up against the cost. In short, there is a need to ensure that existing infrastructure investments are 'efficient' and that future investment decisions are made on the basis of NET BENEFITS.

Amongst other things, the NWI aims to ensure that water is priced in manner that helps to achieve 'efficient' water use and service provision. Yet if water prices are not determined in a free market, they may need to be determined by other bodies – e.g. government or water corporations. And whilst the economics literature abounds with different examples of pricing systems that may help policy makers achieve multiple goals (eg covering costs whilst pricing efficiently in natural monopolies), there may be a need for more research in this area that specifically considers alternative water pricing options in the TR region.

In theory, the expansion of water trading is capable of bringing about more efficient use of water and the flexible recovery of water; however, there are many conditions which need to be met for this to occur. They relate to information used in decision making, monopoly power, externalities, transaction costs and property rights, and the provision of water infrastructure. The additional requirement of an equitable outcome will mean that the conditions of trading will have to ensure that the relatively poor are provided with adequate access to water (chapter 6).

Since water markets will not always work efficiently or equitably, there will still be a role for the non-market allocation of water. Non-market decision making, however, has its own set of problems. These include the need to ensure that the appropriate views are included in decision marking and that they are included in the appropriate way. Considerable attention will need to be paid to the incorporation of Indigenous needs and perspectives in planning and decision-making processes. Further, management resources required for non-market allocative systems are typically large by comparison with those required for market systems and governments must be prepared to provide those (chapter 6).

In the end, there is no guarantee that either market or non-market approaches will generate results that are effective, efficient or equitable – particularly when one considers that policy is implemented in a 'second-best' world – i.e. one where imperfect information, imperfect competition, externalities, high administrative costs and asymmetric distributions of income are the norm rather than the exception. The challenge for policy is therefore to determine how best to combine the approaches so as to get the best overall result. Importantly, one size is unlikely to fit all – different regions may require different policy combinations.

Suggested areas for future research

Our recommendations for future research have been divided into eight broad areas or 'themes' as listed below.

- Biophysical Systems
- Values
- Indigenous Issues
- Water for Pseudo-market Values
- Water Allocation Systems
- Social and Distributional Issues
- Implementation, Monitoring and Enforcement
- Pricing and Infrastructure

A more detailed discussion of each follows.

Research Theme 1: Biophysical Systems

As is widely recognised elsewhere there is an urgent need for future research on biophysical systems within the TR region, if only because it is exceedingly difficult to manage resources if one does not know what those resources are. Specifically, there is a need for research

into the extent, quality and environmental role of ground and surface waters in the TR region – with a focus on

a. the episodic nature of many flows;
b. the biophysical links between ground and surface waters; and
c. the relationships between tropical rivers' hydrological regime, geomorphology, material budgets and 'outputs' such as production and biodiversity.

Research Theme 2: Values

There is also a need for further research into the values associated with Australia's tropical rivers. Whilst many of the values identified in this report are essentially complementary, many other values compete with one another and as populations rise across the TR region, the mix of values associated with the rivers is likely to become more complex. There will be an increasingly important role for policy, legislation and institutions to play in negotiating these values and emerging conflicts – and there is an urgent need for more detailed information about those values.

Specifically, there is a need for research that

a. Reviews existing concepts of value, frameworks for and methods of valuation for their applicability to the conditions and management issues of tropical river systems (if none are suitable, further research will be needed to develop concepts, frameworks and methods that can incorporate Western and Indigenous perspectives of value); and then
b. Applies appropriate concepts, frameworks and methods to questions of the allocation of tropical river resources to different uses.

This research will assist resource managers, planners and community groups to develop visions, articulate underlying values, and consider the impacts and trade-offs of multiple scenarios.

Research Theme 3: Indigenous Issues

Whilst there is widespread recognition of the fact that there may be a need to set aside water for environmental purposes before implementing a water market, this report identified the fact that there may also be a need to set aside water for Indigenous cultural purposes. Furthermore, it is likely that Indigenous communities will have an economic interest in any growth in industries and enterprises reliant on increased water use. However, the exact amount of water to be set aside to support these values is unclear and whilst some of the changes brought about by the NWI are likely to impact upon Indigenous incomes, quality of life and welfare, the extent of that likely impact is unknown. More research is thus needed in this area.

Specifically, there is a need for research that

a. Investigates the extent to which Environmental and Indigenous Cultural values complement and/or compete with each other;
b. Seeks to determine whether water that is 'reserved' for environmental flows also satisfies other Indigenous needs (such as native title, aesthetic values, health improvements) and to explore further the nature of an Indigenous entitlement (especially how to define, allocate and account for an Indigenous entitlement);
c. Investigates the most appropriate and effective means of enabling Indigenous people to contribute their ecological knowledge to the assessment of environmental and other flows, and more equitably participate in water allocation processes generally; and
d. Seeks to determine the way in which the NWI is likely to impact upon Indigenous use of water and on Indigenous people's welfare.

Research Theme 4: Water for Pseudo-market Values

This report highlights the fact that the fishing and the tourism industries have significant values associated with the region's rivers - but these industries do not 'use water' in the traditional sense; they are non-priced use-values. Before attempting to set up water markets in the TR region, it may, therefore be necessary to find out more about the way in which such values might be given a voice within water-markets. Specifically, there is a need for research that

a. investigates the value of rivers to these industries; and
b. considers how such values could be pooled into a collective bid for water within a formal market system and/or compared with other values in a non-market system.

Research Theme 5: Social and Distributional Issues

As populations rise, some of the emerging conflicts identified in this report may intensify. Clearly, some mechanisms for negotiating conflicts regarding access, externalities, the allocation of water (etc) must be sought. Yet, as noted in chapter six, there are significant differences in the wealth and the bargaining power of stakeholders in the region's rivers; and some negotiating mechanisms may exacerbate those differences. Consequently, there is a need for research that investigates the way in which different market and non-market systems deal with and affect the distribution of income and wealth – at an individual and at a regional and/or basin level (as when cross-basin trading is considered).

Research Theme 6: Water Allocation Systems

As highlighted in the biophysical summary, water is relatively scarce in many parts of the TR region – particularly during the dry season. Sooner or later, it may, therefore, be necessary to ration scarce supplies between those values discussed in chapter four. As highlighted in chapter six however, there is no guarantee that either market or non-market allocative approaches will generate results that are effective, efficient or equitable. There is, therefore, a need for economic, legal and social research that seeks to identify the most effective and appropriate water allocation systems. Specifically, such research may need to investigate a range of different allocation systems (including those practiced by the region's traditional owners), the primary aim being to identify characteristics of systems that:

a. are able to cope with extreme temporal and geographic scarcity;
b. are able to include both ground and surface-waters;
c. are capable of dealing with externalities like those which typically occur in the TR region;
d. allow for the participation of non-market values (eg environmental or cultural);
e. facilitate the participation of sectors like tourism and fishing where many of the 'values' that are associated with water are not directly linked to the market;
f. work well for small populations;
g. facilitate the participation of 'disadvantaged' groups;
h. are equitable as well as 'efficient'; and
i. are PRACTICAL to implement in remote regions.

As noted earlier, one size is unlikely to fit all – and research like this may help identify different types of, or characteristics of, allocative mechanisms that suit different basins within the TR.

Research Theme 7: Implementation, Monitoring and Enforcement

As highlighted by the discussion of chapter 5, there are a multitude of different acts, plans, and institutions at the local, state and federal level that impact upon Australia's Tropical Rivers. Yet, as highlighted in the focus group discussions, there is often a significant

difference between the intent and the actuality of acts and plans. There is, therefore, a need for research that critically reviews the policies, plans, and acts that relate to water policy in the TR region – the primary aim being to determine how effectively they are being implemented 'on the ground'.
Specifically, there is a need for research that

a. seeks to determine the adequacy of resources used to implement, monitor and enforce the objectives of the NWI and reviews different methods of raising revenues to finance natural resource management practices in the TR region;
b. reviews the property rights systems that regulate access to water/rivers across land and looks into the efficacy of different mechanisms for dealing with conflicts between landholders, recreational fisherpersons, tourists and Indigenous people in remote areas;
c. assesses the efficacy of regional water plans in meeting stated objectives and the overall objectives of national water policy – with particular focus on issues such as efficiency, externalities and equity; and
d. evaluates newly implemented water allocation systems, looking at the way in which new allocation rules interacts with existing water management institutions, specifically local practises and norms.

Research Theme 8: Pricing and Infrastructure

As highlighted in chapter 6, if water is to be used efficiently, then water infrastructure must also be 'efficient'. Whilst an investigation of water infrastructure in the TR region was beyond the scope of this study, it is an area that requires further investigation. Specifically, there is a need for research into water infrastructure facilities in the TR region – the primary aims being to

a. determine if current facilities are economically efficient;
b. identify prospects for new (efficient) infrastructure investments; and
c. consider the efficiency and equity aspects of a range of different water pricing systems including, but not limited to: marginal cost pricing, average cost pricing, multi-part pricing, price discrimination and bundling).

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GLOSSARY AND ACRONYMS

ABS	Australian Bureau of Statistics
AIATSIS	Australian Institute of Aboriginal and Torres Strait Islander Studies
AIMS	Australian Institute of Marine Science
ARIA	Accessibility Remoteness Index of Australia
ASGC	Australian Standard Geographical Classification
AusRivAS	Australian River Assessment System
AWF	Australian Water Fund
BCA	Benefit cost analysis
BOM	Bureau of Meteorology
BRS	Bureau of Rural Sciences
CALM	Western Australia Department of Conservation and Land Management
CD	Collection district
CDEP	Community Development Employment Project
CLCAC	Carpentaria Land Council Aboriginal Corporation
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific & Industrial Research Organisation
DEH	Department of the Environment and Heritage
DSS	Department of Social Security
EIL	Ecological investigation levels
EPA	Environmental Protection Agency
eriss	Environmental Research Institute of the Supervising Scientist
FG	Focus group
FGP	Focus group participant
GBR	Great Barrier Reef
GIS	Geographic Information System
JCU	James Cook University
KALACC	Kimberley Aboriginal Law and Cultural Centre
KLC	Kimberley Land Council
LGA	Local Government Area
LWA	Land and Water Australia
MA	Millennium Ecosystem Assessment
MAUT	Multi-attribute utility analysis
MCA	Multi-criteria analysis
MDA	Multi-attribute decision analysis
NAIF	Northern Australia Irrigation Futures
NAILSMA	North Australian Indigenous Land & Sea Management Alliance
NAP	National Action Plan on Salinity and Water Quality
NCTWR	National Centre for Tropical Wetland Research
NHT	National Heritage Trust
NLC	Northern Land Council
NPI	National Pollution Inventory
NRM	Natural resource management
NRMP	National Resource Management Plans
NT	Northern Territory
NWC	National Water Commission
PRA	Participatory rural appraisal
QLD	Queensland
R&D	Research and development
SD	Statistical division
SEIFA	Socio-Economic Indexes for Areas
TEV	Total economic value
TR	Tropical rivers
TRACK	Tropical Rivers and Coastal Knowledge Consortium

UNCSD	UN Commission on Sustainable Development
WA	Western Australia
WBAA	Water Benefits Accounting and Assessment framework
WfHC	CSIRO's Water for a Healthy Country National Research Flagship

1 Project overview

1.1 The Tropical Rivers Region and Program

The tropical rivers (TR) region comprises the two major drainage divisions in Australia's north that drain into the Timor Sea and the Gulf of Carpentaria and is made up of 55 river basins in total. Covering an area of more than 1.3 million km^2, it extends across all catchments from the west side of Cape York to the Kimberley, through Queensland, the Northern Territory and Western Australia (Figure 1). It includes some of Australia's largest river systems which are – by area size – the Flinders, Roper, Victoria and Fitzroy Rivers and – by volume – the Nicholson and Mitchell Rivers (NGIS Australia, 2004).

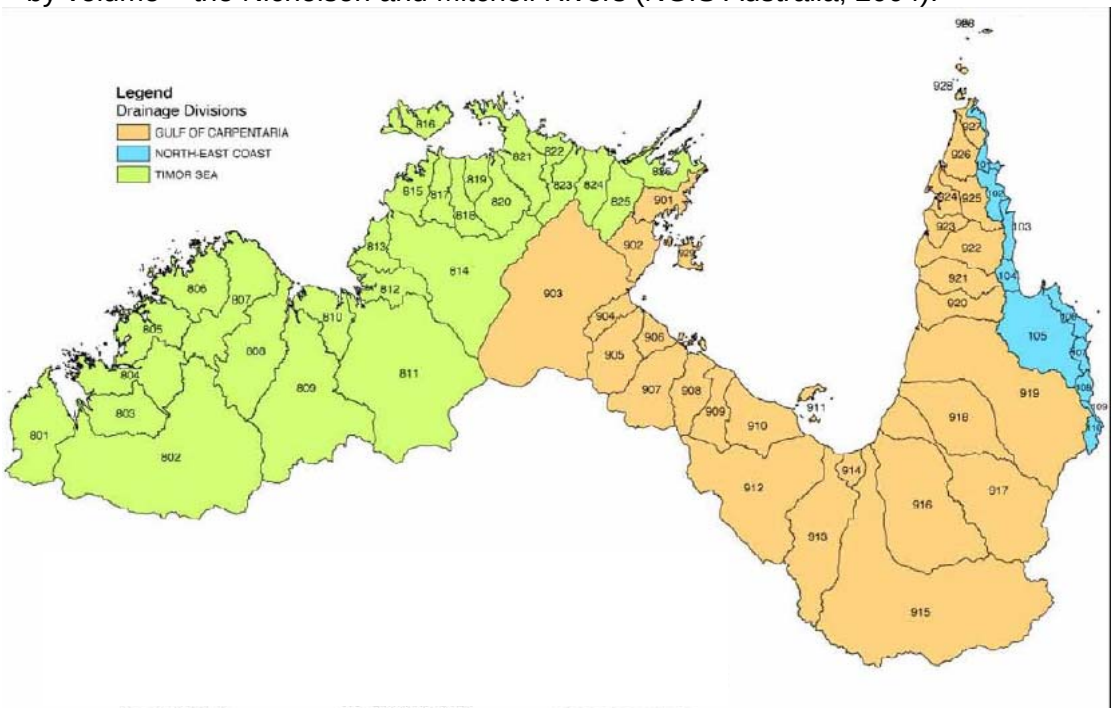

Figure 1– The tropical rivers region of Australia

The region is located within Australia's tropical savanna biome. It is characterised by wooded grasslands and a climate with pronounced wet and dry seasons and warm temperatures throughout the year. The result is a highly variable river flow pattern. Water may be abundant during the wet season, but in this part of Australia water is generally scarce and ephemeral.

Within the TR region the majority of land is leasehold (predominantly used for grazing) and/or held under Aboriginal title. Despite the fact that the region covers approximately 15% of Australia's mainland it is home to fewer than 2% of all Australians (approximately ¼ of a million people). Most of the TR region is therefore sparsely populated, with all but four basins having fewer than 1 person per km^2. In 2001 there were only three communities (Darwin, Mount Isa and Broome) with a population of more than 15,000 and almost half of the TR basins (24) had fewer than 500 persons. Notwithstanding this small and sparsely distributed population, the region accounts for around 30% of the nation's exports and over one third of Australia's export growth over the past 30 years (Greiner et al 2004a).

The predominant regional industries include pastoralism, mining, Aboriginal enterprises, fishing and tourism. All of these industries use and rely on the region's water resources in

different ways. These industries are thus linked by water: they all must consider issues of access to, quality of, implications of use and changes to the region's water resources. Increasingly non-consumptive values (for example those associated with culture and tourism) are gaining significance and recognition. So too are the down-stream implications of upstream land and water use (for example,salinity). Whilst there is a complex set of institutional arrangements governing the use of the region's natural resources, including a multitude of relevant policies at the Commonwealth, State/Territory and Local Government levels (Nursey-Bray *et al* forthcoming), growing demands for access to, use of and security over water is a source of conflict (see, for example, Jackson 2005; Hart 2004; Langton 2002).

In 2004 the Board of Land and Water Australia (LWA) identified Australia's TR region as a priority area for major investment over the subsequent five years. Later that year a process of dialogue, consultation, and negotiation with Indigenous communities, stakeholders, governments and researchers commenced to develop a shared vision for a "Tropical Rivers Program":

> To undertake research and knowledge exchange to support the sustainable use, protection and management of Australia's tropical rivers[1] (Land and Water Australia 2005a).

This research program has four main themes that seek to:

- Assess river assets and threats
- Support regional planning frameworks
- Assess social, cultural and economic values, and opportunities
- Understand river ecosystems.

Importantly, these themes explicitly recognise the contribution that the social sciences make to natural resource management, both in their role of investigating the relationships between people and their environments and through integration with bio-physical sciences in an effort to better understand complex socio-ecological systems (Mobbs & Dovers, 1999).

In northern Australian research contexts, Indigenous interests require particular consideration as – with the exception of key population centres – a very significant proportion of the population is Indigenous and large areas of land are held under some form of Aboriginal title. The third theme (which is most relevant to this project) thus explicitly includes these – and other – interests, focusing on research that sets out to:

- Determine what people value in rivers;
- Value ecosystem services;
- Understand Indigenous cultural and economic values;
- Analyse economic and resource development, river protection and management (Land and Water Australia 2005a).

This report is based upon research conducted as part of a scoping study, the primary objective of which was to conduct a 'preliminary' assessment of social and economic values associated with Australia's tropical rivers. The intention was to use the scoping study to

[1] Environments covered within the scope of the program include rivers, wetlands, floodplains and estuaries.

improve understanding of the social and economic processes and pressure points that impact on the health of rivers, floodplains, wetlands and estuaries in the program area, thereby informing future R & D plans.

1.2 Project Objectives

This project complements existing (NGIS Australia 2004) and ongoing research[2] on the tropical rivers region (see Appendix A), with the following specific objectives:

- To develop an integrated social and economic profile of the tropical rivers region, focussing on the collation and reporting of data relevant to rivers and river management;
- To identify important social and economic values and issues relevant to rivers;
- To explain significant processes and pressure points that will impact on future management of tropical rivers, including conflicting stakeholder aspirations;
- To scope future research needs and priorities based on the identification of key social and economic management questions, and;
- To recommend questions and approaches for further R&D that will generate an understanding of the social and economic processes and pressure points that will impact on the health of rivers, floodplains, wetlands and estuaries in the study area.

1.3 Methodological approach

A key philosophy underlying this research is that the TR region is a large, complex system consisting of interlinked sub-systems (social, cultural, institutional, economic, biophysical, hydrological and ecological). As elaborated on in chapter 3, each of these sub-systems operates over a different physical area and over a different time period, and each influences the other sub-systems, albeit in different ways.

The implication of this is that those interested in natural resource management (NRM) should not focus attention on just one sub-system. Ideally, thorough investigations should explore each sub-system individually and – perhaps most importantly – should also explore the complex interactions between each sub-system. The key problem here, however, is that our ability to map, model and/or understand the full extent of such systems is often beyond current capability. Therefore a balance must be found between the need for simplification and the need to understand essential dynamics that emerge from complex interactions.

In this scoping project the problem of having too few resources/capabilities to fully understand a complex set of systems is exacerbated by the sheer geographic size of the region under consideration. Even if researchers could (theoretically) map, model and understand the relevant systems, it is unlikely that they would be able to do so for a region as large and as socially diverse as this one.

[2] Ecosystem Processes in Tropical Rivers: conceptual models and future R&D (Douglas, Bunn and Davies); Assessing the potential for Algal blooms in clear water phase tropical rivers (Ganf and Rea); Biodiversity and cultural significance of fishes in King Edward River (Morgan and Casson); Understanding and managing the existing uses and their impacts on selected high valued waterways in the east Kimberley (Pasfield); Addressing Indigenous cultural requirements in water allocation planning (Jackson); Scoping study of Indigenous interests in tropical rivers (NAILSMA).

In short, the complexity of the issues under consideration and the size of the region under investigation require that some simplifications must be made – and the three key ones taken here are detailed below:

(1) In this report, the term 'values' is not used to refer to a market-based price. Neither is it used to refer to a numerical or financial estimate of the magnitude of value. Rather this report defines "social and economic values" as those that contribute to human wellbeing – either directly (as when an individual uses water to drink, or when an individual gains benefit from living near their favourite river) or indirectly (as when businesses within the tourism industry are profitable because many visitors travel to the region to swim in local waterholes). Thus, this report uses both primary and secondary data to identify key social and economic values associated with Australia's tropical rivers, but it does not attempt to measure, compare or prioritise them.

(2) Data relevant to the entire TR region was collected from a multitude of 'desk-top' (secondary) sources. Information was also collected during three separate focus group discussions – one in each of the states (WA, NT and QLD). The rich qualitative focus group information was then used to supplement, compare and contrast the 'geographically coarse' desk-top information, with the two approaches thus serving to enrich and 'ground-truth' each other.

(3) When compiling data and other sources of information researchers started by 'scoping' issues relevant to individual parts of the entire system. In the early stages of this project some of the research team focused their attention on the social sub-system, collecting information on social 'values', issues and perspectives relating to Australia's tropical rivers. Some members of the research team focused their efforts on the economic 'values', whilst others considered legal, policy and institutional issues associated with the management of these rivers. Still others focused their attention on the region's water resources. Information from these semi-separate investigations was then integrated, the aim being to look at some of the sub-system interactions so as to identify processes and pressure points that may impact on the future management of tropical rivers.

1.4 Content and structure of report

Much of the research was conducted in an iterative process – where data/information gleaned in one part of the investigation, helped re-focus earlier thoughts and refine other avenues of investigation. However, results are, of necessity, presented sequentially (see Figure 2).

In the first instance, the hydrological resources of the tropical rivers region are described – the main aim being to provide 'context' for ensuing discussions.

Chapters three and four then proceed to discuss issues relating to social and economic values. More specifically, chapter three starts by providing some historical background to values associated with the region's waterways defining the concept of 'value' as it will be used in this report (since it can have many different meanings and interpretations). It also discusses a range of different approaches to assessing, measuring, and 'using' information about, social and economic values. Existing records of the social and economic values of Australia's tropical rivers are then reviewed and summarised in chapter four – the primary aim here, being to identify key 'values' across the region as a whole and for specific basins within the TR region.

Chapters five and six are primarily concerned with the legal, institutional and policy issues. First, chapter five provides a summary of existing policy, legislation, plans and institutions governing water use in the TR region. Chapter six then discusses some of the arguments for and against the use of markets and non-market water allocation mechanisms, along with some problems which have been identified in current water management practices.

Finally, chapter 7 uses insights from the previous chapters to (a) outline key management challenges in the TR region; (b) identify knowledge gaps within the field; and (c) make recommendations for future research and development in the tropical rivers region.

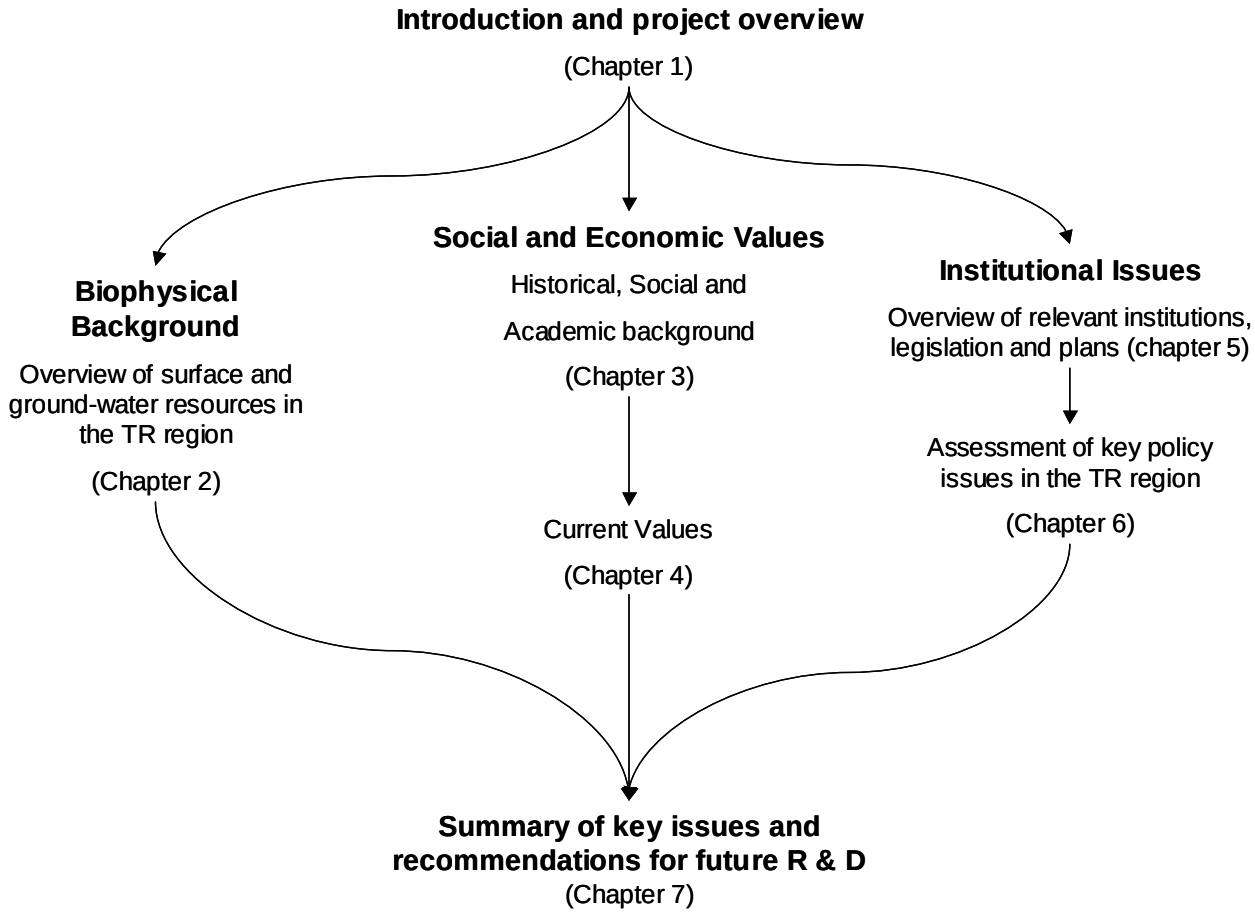

Figure 2- Structure of Report

Methodological details relating to the focus group discussions and the data-management system used to deal with the problem of inconsistent regional secondary data boundaries, are presented in the appendices (Appendix B and Appendix C, respectively).

2 Water resources

2.1 Water resources across the TR region

With relatively low rainfall and high evaporation rates Australia has the lowest percentage of rainfall to reach storages or streams in the world and has the least amount of water in rivers of any continent (Queensland Government Department of the Premier and Cabinet 2002). On average only 12% of Australia's rainfall enters the rivers, although this varies from less than 3% in drier areas to almost 24% in wetter regions (ABS 2003b). Thus, despite the fact that Australia's tropical rivers and groundwater systems are estimated to contain roughly 70% of Australia's fresh water resources (Land and Water Australia 2005b) and despite the fact that almost 50% of Australia's average annual run-off enters the Gulf of Carpentaria and the Timor Sea (ABS 2003b), relatively little perennial water exists in this region.

At least part of the reason for this is because rainfall in the TR region is both highly seasonal and highly variable. As shown in Figure 3, parts of the tropical rivers region receive on average more than 1200 mm of rain each year. Other areas receive less then 650mm per year. Regardless, the majority of this rainfall normally occurs during the summer wet – and many areas within the TR region go without any rain at all for months at a time during the winter dry.

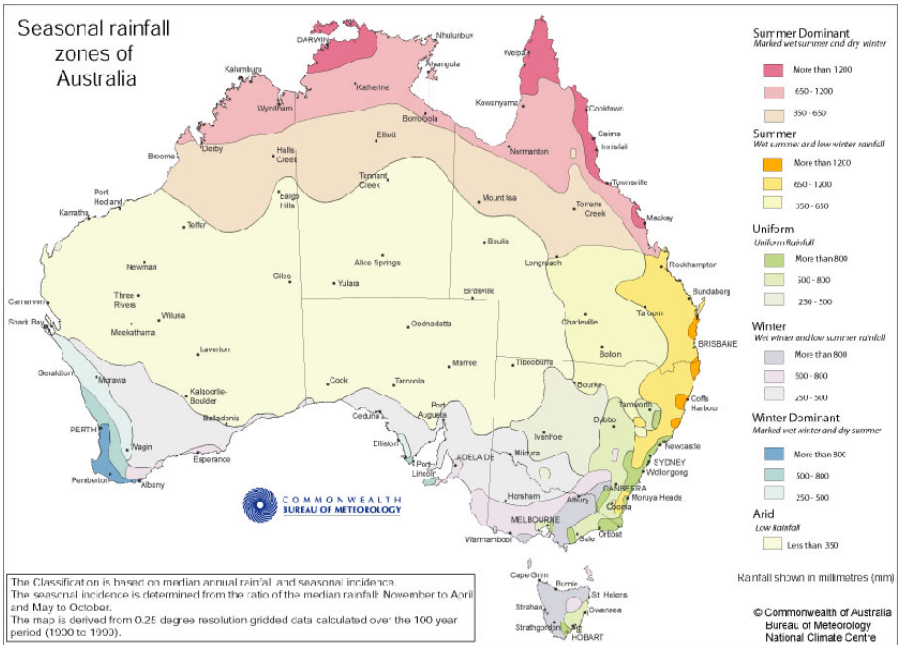

Figure 3- Seasonal rainfall zones of Australia

Source: Commonwealth Bureau of Meteorology (2006)

Clearly, the amount of water that is available for human use is not solely dependent upon annual rainfall. It also depends upon temperature, solar radiation and vegetation amongst other things, all of which affect the amount of water that subsequently flows into surface water sources and replenishes groundwater sources (Australian Bureau of Statistics 2004c). Nonetheless: highly variable rainfall leads to highly variable river flows and Australian river systems are the most flow variable in the world (McMahon 1992, Puckridge et al 1998). As illustrated in Figure 4, regions with summer-dominant rainfall have few perennial rivers (shown in blue), and a large proportion of the 'rivers' in the TR region are essentially dry, sandy creek beds for most of the year (shown in green), only flowing 'intermittently' during the wet.

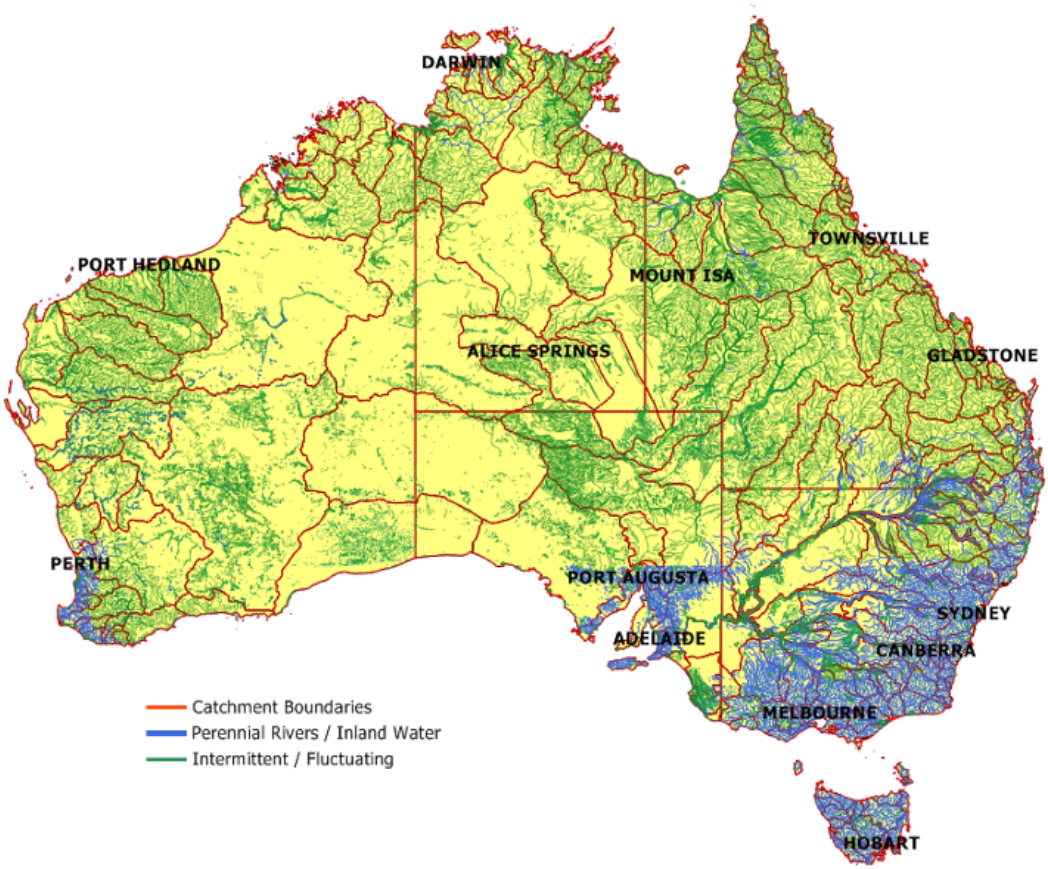

Figure 4 - Intermittent and perennial water – Australia[3]

Data Copyright Commonwealth of Australia 2006

Humans must have water to exist and, as illustrated in Figure 4, perennial surface water is relatively scarce across vast tracts of the TR region (particularly when compared to the south east corner of Australia). It is not, therefore, surprising to note that there is a close correspondence between the presence of perennial rivers and the concentration of population within Australia. As shown in Figure 5, there is a strong positive relationship between the population of each of Australia's mainland states (ABS 2005b) and the total quantity of water which residents extract from the environment (ABS 2004c).

[3] Data available from Geoscience Australia at https://www.ga.gov.au/oracle/. Copyright Commonwealth of Australia 2006.

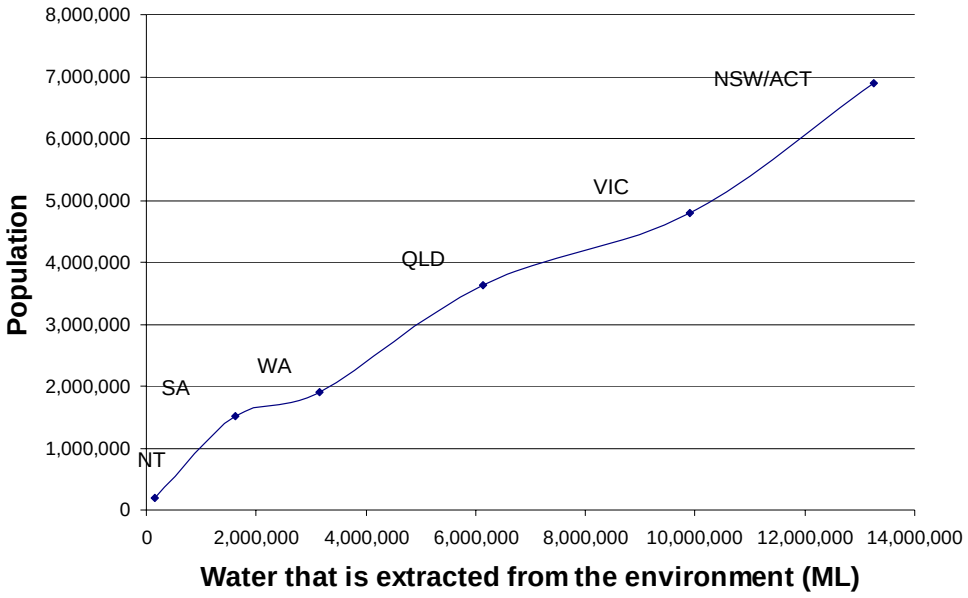

Figure 5- Water extraction and population – mainland states of Australia, 2001

Source: ABS 2004c , ABS 2005b

Thus, despite the fact that there is a long history of interest in developing and populating the north (Land and Water Australia 2005b), it seems that the "temporal and geographic scarcity of water has [almost certainly] acted as a constraint to development" (Bennett 2005, p.1).

In other parts of the world, the problem of water scarcity has often been dealt with by constructing dams. Yet whilst most of the catchments in New South Wales and Victoria have been identified as either overdeveloped or fully-developed, less than 30% of surface waters across most of the TR region are classified as 'developed' (Department of the Environment and Heritage 2001, p.59). With the exception of Lake Argyle, there are few large dams in the TR region. There are several dams supplying water to local towns (eg Darwin, Croydon), and mining companies have constructed 'medium'-sized dams that supply water for their operations and to the local town (eg. near Mt Isa). Likewise many property owners have dams on their property for private use. For the most part however the rivers in this region are largely unmodified and the hydrological changes that have occurred in the TR region are generally classified as either minor or moderate-minor[4] (see Figure 6).

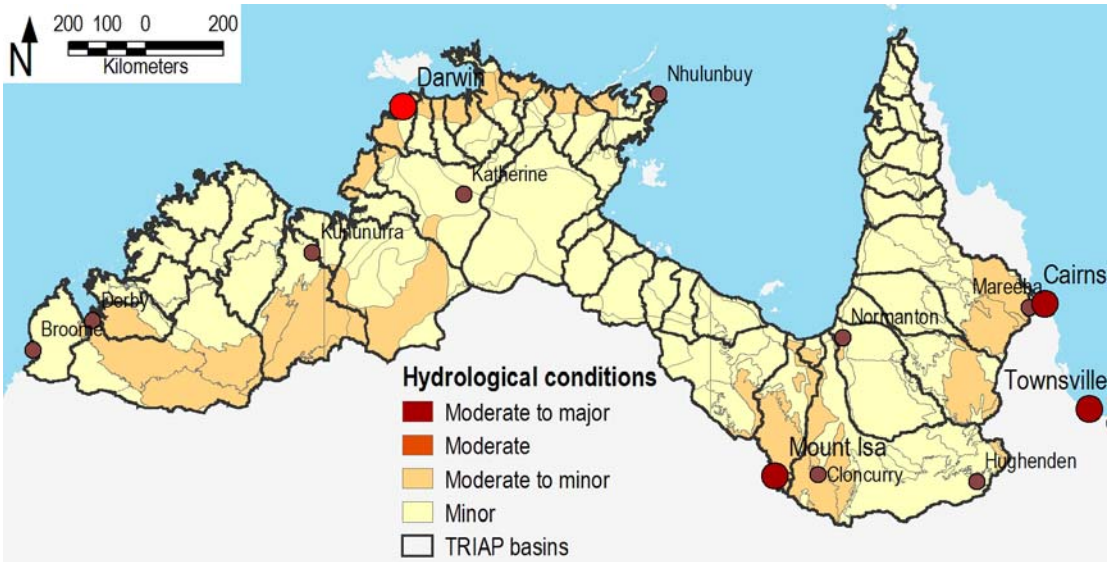

Figure 6 - Hydrological change

[4] This assessment of changed hydrological conditions applies only to the terrestrial component of the subregion and does not include aquatic environments, although the two are clearly connected due to the very nature of the measurement processes used. A change in hydrology may result from several factors such as soil degradation (caused by overgrazing or over-cultivation) or land surface change (due to excessive clearing of vegetation or the construction of dams and levees).

Despite the relative scarcity of perennial surface water, this has not prevented Indigenous owners from occupying the lands for thousands of years. Neither has it prevented migrants from settling in the tropical rivers region permanently. Some of this is attributable to the fact that at least some perennial surface waters do exist (eg as billabongs), but this tells an incomplete story. There are many underground aquifers throughout Australia – some of which are highly productive – and many of which are accessible by those living in the TR region. These are illustrated in Figure 7, where aquifers of different types and different levels of productivity are shown in different colours.

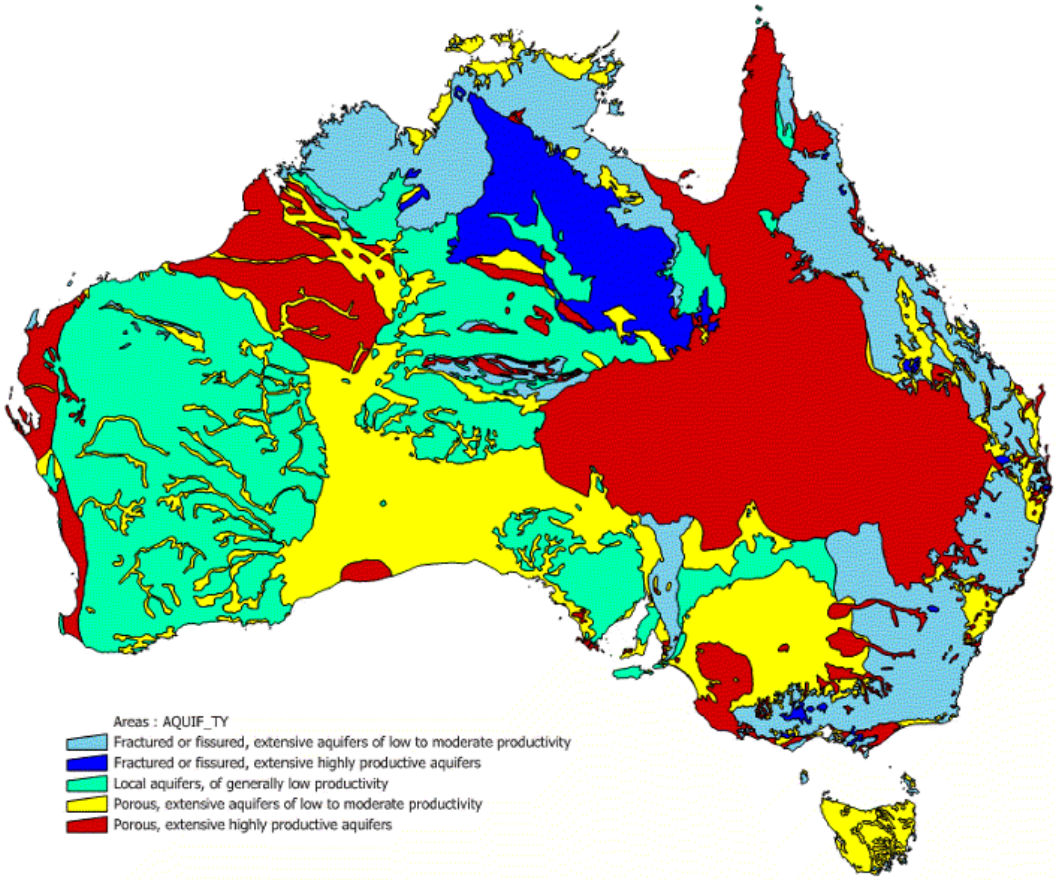

Figure 7 - Aquifer productivity – Australia

Source: GeoScience Australia 2000

Most relevant to this discussion are the aquifers shown in red and dark blue – both of which have been categorised as being highly productive. These aquifers offer themselves as a viable alternative to surface water and are often used as such (eg for stock, for urban irrigation, and even for human consumption). This is starkly evidenced in the 2001 Community Housing and Infrastructure Needs Survey (CHINS) collected by the Australian Bureau of Statistics (ABS 2001b), which found that bore water was the main source of drinking water for 62% of the total population of discrete Indigenous communities.

The key point to be made here is that the water resources of the TR region are not solely comprised of rivers, wetlands and estuaries. Underground aquifers can – and are – used to supplement surface water supplies and thus need to be considered as part of the region's total water resources. This is taken into account in Figure 8, where information about the perennial and intermittent waterways in the TR region (presented earlier in Figure 4) is combined with information about the productivity of underground aquifers. As previously, perennial rivers/water bodies are shown in blue and intermittent rivers are shown in green.

Aquifers which have been assessed as being highly productive (eg the Great Artesian Basin) are displayed in dark brown; those of medium productivity in a lighter shade of brown; and those of low productivity are shown in cream. The red boundaries are those which delineate the different river basins.

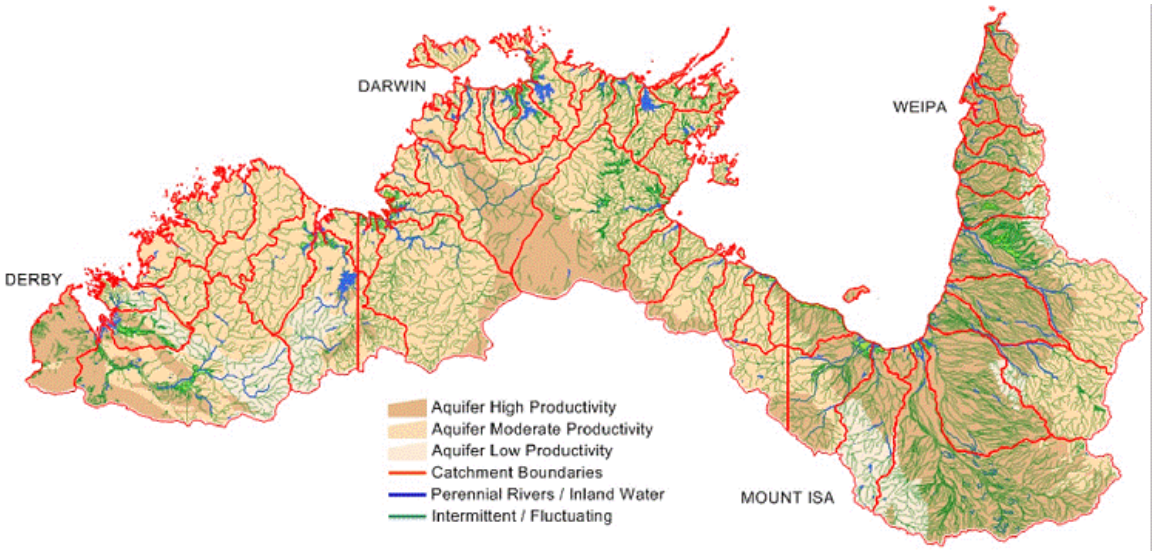

Figure 8 - Aquifer productivity, intermittent and perennial water – TR region

Source: GeoScience Australia 2000

Most evident from this figure is that there is considerable variation across the TR region. Some catchment areas are relatively small, whilst some are large. Some have relatively large tracts of perennial surface water, whilst others have little. And whilst some basins sit above aquifers of relatively high productivity, others are located above aquifers that are of moderate or low productivity.

Those points aside it must be acknowledged that even the most highly productive aquifers can 'run out': the presence of an aquifer does not automatically indicate the presence of an unlimited supply of water. Indeed, as illustrated in Figure 9, many of the highly productive aquifers in the tropical rivers region have been assessed as 'fully exploited'. This is particularly the case for those aquifers located in the Queensland Gulf area. In these regions the presence of highly productive aquifers may help to sustain existing activities, but there is little scope for further exploitation. In other words the absence of significant quantities of perennial surface water may still serve as a binding constraint for future development despite the presence of aquifers.

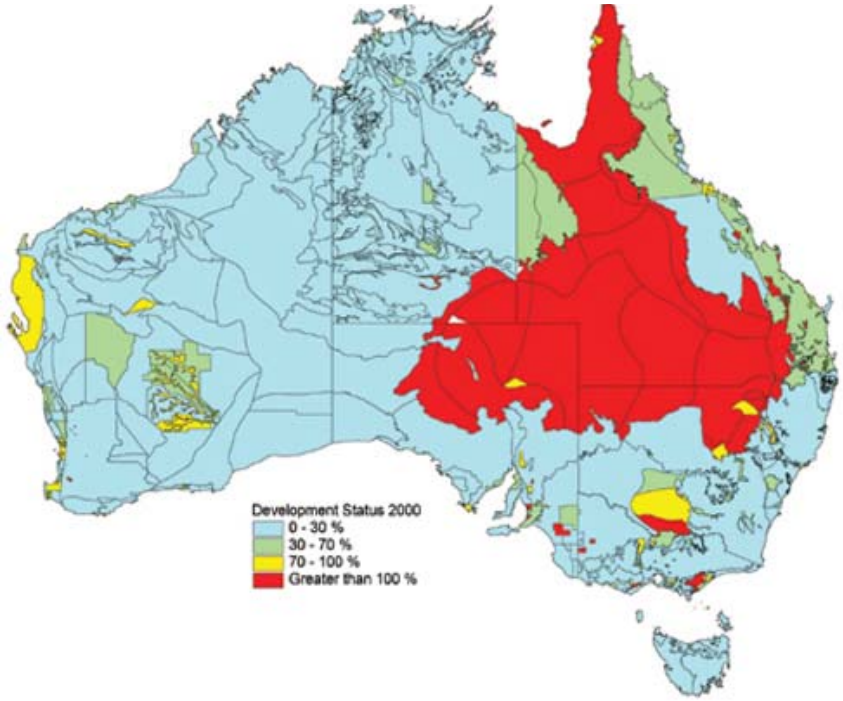

Figure 9 - Indicative ground water development status

Source: Department of the Environment and Heritage 2001

2.2 Water resources of individual basins within the TR region

As is evident from the foregoing discussion, a key characteristic of most river systems in tropical Australia is that flows are largely 'episodic'. While there may be an abundance of water during the wet there is a significant supply constraint in the dry, and underground water supplies do not always offer themselves as a viable alternative to surface water since many aquifers are already fully exploited. When assessing the abundance (or lack thereof) of water in individual basins it is therefore important to consider a full range of supply-side issues (such as river flows, river periodicity, aquifer productivity, and aquifer exploitation), as compared to demand-side issues.

Clearly, there are many different ways of doing this – the most accurate being to conduct a full audit of water use across the TR region and to compare that with data relating to water supply. Such an investigation would however be extremely costly and is well beyond the scope of this research. The approach taken here, therefore, is considerably less resource intensive and also less accurate, but it does allow one to identify specific basins where water scarcity *may* be particularly problematic.

The analysis starts by acknowledging that there is a clear relationship between population and water use (Figure 5). Given this relationship, it seems fair to assume that river basins with relatively high populations are likely to have higher levels of water demand than basins with relatively few people. Consequently, the quantity of water available per head of population can be used as a 'proxy' measure – albeit an imprecise one – and can be interpreted as follows: in the absence of 'mitigating' factors such as dams and productive aquifers, the lower the water flow per head of population within a given basin, the more likely are scarcity issues to arise.

Table 1 thus attempts to present data relating to each basin in the tropical rivers region in a manner that allows one to identify regions in which water scarcity is likely to be an issue. It

does this by summarising key pieces of information from the preceding sections and also presenting data on the estimated annual outflow of each river (NGIS Australia 2004) and on the estimated population of each basin[5].

It is important to stress that care must be taken when interpreting data from this table – since much of it is derived from imprecise measures of water availability. Nonetheless, it does highlight the fact that most basins within the TR region could be characterised as having a relatively low supply of water in at least one of four ways (low flow, low flow per person, little perennial water and/or low or exploited aquifers). Notable exceptions include basins 817, 818, 820-825, 901 and 903 – all of which are located in the north-eastern corner of the Northern Territory. Many of the basins located in Western Australia have little perennial water or relatively low outflows (in aggregate or per person), whilst most Queensland's basins are located in regions where aquifers are fully exploited and/or where rivers are predominantly intermittent.

[5] Calculated using data from the ABS in the method described in section 4.2.

Table 1 - Water flows, presence of perennial water and aquifer productivity by basin – TR Region

River basin	Major rivers	Condition of major rivers	Town	Estimated population	Estimated outflow (GL/year[6])	Outflow per person (GL/year)	Perennial water	Aquifer Productivity and degree of exploitation[7] (where relevant)
801	Cape Leveque Coast	n/a	Broome	16271	120	0.01	Little present	High
802	Fitzroy River	Largely unmodified	Derby, Fitzroy Crossing, Looma	8417	5500	0.65	Some present	Low, moderate and high
803	Lennard River	n/a	Mowanium	519	1130	2.18	Little present	Low, moderate and high
804	Isdell River	n/a	-	187	3200	17.11	Little present	Low and moderate
805	Prince Regent River	Near pristine	-	133	2930	22.03	Little present	Moderate
806	King Edward River	Largely unmodified	Kalamburu	514	3250	6.32	Little present	Moderate
807	Drysdale River	Modified	-	235	4450	18.94	Little present	Moderate
808	Pentecost River	n/a	Wyndham	443	N/a	-	Little present	Moderate
809	Ord River	Modified	Kununurra, Warmun	10473	5100	0.49	Lake Argyle - present	Low, moderate and high
810	Keep River	Near pristine		71	500	7.04	Little present	Moderate
811	Victoria River	Near pristine	Dagaragu, Timber Creek	1713	5000	2.92	Some present	Moderate
812	Fitzmaurice River	Near pristine	-	229	1600	6.99	Present	Moderate
813	Moyle River	Near pristine	Thamarrurr, Nganmarriyanga	2015	640	0.32	Some present	Moderate
814	Daly River	Near pristine	Katherine, Pine Creek	12649	6730	0.53	Present	Moderate and high
815	Finniss River	Largely unmodified	Darwin	103506	3000	0.03	Some present	Moderate
816			Bathurst and Melville Islands	2236	3300	1.47		
817	Adelaide River	Largely unmodified	-	1865	2000	1.07	Present	Moderate
818	Mary River	n/a	-	331	2400	7.25	Present	Moderate
819	Wildman River	Near pristine	-	261	800	3.07	Present	Moderate
820	South Alligator River	Near pristine	Munmarlay	676	6600	9.76	Present	Moderate
821	East Alligator River	Near pristine	Jabiru, Minjilang, Kunbarllanjnja	3267	6900	2.11	Present	Moderate
822	Goomadeer River	Near pristine	-	78	1140	14.62	Some present	Moderate
823	Liverpool River	Near pristine	Maningrida	1818	3810	2.1	Some present	Moderate
824	Blyth River	Near pristine	Ramingining	495	1860	3.76	Some present	Moderate
825	Goyder River	Near pristine		654	2120	3.24	Present	Moderate
826	Buckingham River	Near pristine	Nhulunbuy Gove	5224	2330	0.45	Little present	Moderate

[6] NGIS Australia 2004
[7] Department of Environment and Heritage 2001, p 5.

River basin	Major rivers	Condition of major rivers	Town	Estimated population	Estimated outflow (GL/year[6])	Outflow per person (GL/year)	Perennial water	Aquifer Productivity and degree of exploitation[7] (where relevant)
901	Koolatong River	Near pristine	-	487	1700	3.49	Some present	Moderate
902	Walker River	Near pristine	Numbulwar	723	3350	4.63	Little present	Moderate
903	Roper River	Near pristine	Mataranka, Roper River	3252	5000	1.54	Some present	Moderate and high
904	Towns River	Near pristine	-	36	500	13.89	Little present	Moderate
905	Limmen Bight River	Near pristine	-	141	1660	11.77	Little present	Moderate
906	Rosie River	Near pristine	-	51	540	10.59	Little present	Moderate
907	McArthur River	Near pristine	Borroloola	195	4200	21.54	Little present	Moderate
908	Robinson River	Near pristine	-	113	1000	8.85	Little present	Moderate
909	Calvert River	Near pristine	Clavert River Homestead	90	1000	11.11	Little present	Moderate
910	Settlement Creek	n/a	Wollogorang Homestead	56	2720	48.57	Little present	Moderate and high but fully exploited
911			Mornington Island	942	257	0.3		
912	Nicholson River	n/a	Domadgee, Burketown	2133	10040	4.71	Present	Moderate and high but fully exploited
913	Leichardt River; Gregory River	Near pristine	Mount Isa	21324	2010	0.09	Little present	Low and high but fully exploited
914	Morning Inlet	Near pristine	-	11	433	39.36	Little present	High but fully exploited
915	Flinders River	Near pristine	Hughenden Cloncurry Richmond	7658	3030	0.4	Some present	Mostly high but fully exploited
916	Norman River	Largely unmodified	Karumba Normanton Croydon	3234	2910	0.9	Some present	Mostly high but fully exploited
917	Gilbert River	Near pristine	Georgetown	1522	5580	3.67	Some present	Moderate and high but fully exploited
918	Staaten River	Near pristine	Inkerman Homestead	118	3600	30.51	Some present	High but fully exploited
919	Mitchell River	Largely unmodified	Kowanyama	5567	12000	2.16	Present	Moderate and high but fully exploited
920	Coleman River	n/a	Pormpuraaw	635	4200	6.61	Little present	Low and high but fully exploited
921	Holroyd River	n/a	-	59	3860	65.42	Little present	Mostly high but fully exploited
922	Archer River	n/a	Coen	417	4830	11.58	Some present	Mostly high but fully exploited
923	Watson River	n/a	Aurukun	986	3560	3.61	Some present	High but fully exploited
924	Embley River	Largely unmodified	Weipa	2546	3190	1.25	Little present	High but fully exploited
925	Wenlock River	Near pristine	-	138	3370	24.42	Present	High but fully exploited
926	Ducie River	Near pristine		75	3580	47.73	Little present	High but fully exploited
927	Jardine River	Near pristine	Bamaga	2058	2190	1.06	Present	High but fully exploited
928			Torres Strait Islands	9698	202	0.02		
929			Groote Eylandt	2426	2000	0.8		

2.3 Conclusions

One of the main points to draw from the preceding discussion is that there are significant differences between the TR region and the south-east of Australia – not the least of which being that most rivers in the TR region have episodic flows, whereas most in the south-east are perennial. During the wet, many TR catchments will be host to vast quantities of water. However, during the dry, many – if not most – of the rivers in this area cease flowing altogether, instead appearing as billabongs or sandy creek-beds.

Just as there are apparent differences in the availability of water between the north and south of Australia, so too are there differences across basins within the TR region. Many of the basins in the north-eastern corner of the Northern Territory, for example, seem to have access to relatively abundant supplies of water, whereas those in Western Australia and Queensland generally have fewer perennial rivers. Some basins (for example, river basin 801 containing Broome and river basin 913 containing Mount Isa) have little perennial water and low 'flows' per head of population. The implications of this are that people in those regions may need to rely on aquifers and/or dams for water during the dry season.

This issue of water scarcity is particularly important. When little permanent water is available anything that affects the quantity or quality of even one water hole may have a significant regional impact. A poisoned water hole in the middle of a desert could, for example, contribute to the death of any living organism within the area that depends on water for survival. To compound the problem summer dominant rainfalls may mean that there is no rain (to flush the system) for up to a year. Similarly, a dewatered aquifer in one area could potentially affect the livelihood of those that depend on bore water many hundreds of kilometres away. And these issues are complicated by the fact that although changes to either surface or ground waters may affect the quantity and/or quality of the other, the links between surface and groundwater systems are complex and not always well understood (Winter et al 2004, p.26).

This analysis thus highlights the fact that river management systems in the TR region must be able to cope with scarcity and with extremely variable water supplies – both geographic and temporal. Those charged with managing water resources in the TR region will thus have to be particularly vigilant to protect 'basic' levels of both water quantity and water quality, not just on the surface but also underground. Further, proposed developments in regions that have little perennial water may require proponents to consider strategies for ensuring a safe and continuous supply of water during the dry.

The analysis also highlights the fact that this project's "preliminary assessment of social and economic values of Australia's tropical rivers" needs to be done in context – explicitly acknowledging that;

- At least some social and economic values will vary according to water scarcity and function. That is, those living in near perennial rivers may 'use' and/or 'value' their rivers differently than those living in areas where rivers flow only intermittently. Likewise, other parts of the wider, complex system in which we live (including the eco-system) are likely to 'use' or 'value' rivers differently depending upon the scarcity or abundance of water and upon the functions rivers perform in the hydrological cycle.

- Inter-relationships between different parts of the system may be particularly strong when water is scarce: actions by individuals in region *x*, for example, may effect entire ecosystems in regions *x* and *y*, and the lives and livelihoods of individuals in regions *x*, *y* and *z*.

It is to these issues that the discussion now turns.

3 Historical, social and academic background

As noted in the introductory chapter, a key objective of this research is to conduct a preliminary assessment of the social and economic values associated with Australia's tropical rivers. Ultimately, this information will be used to identify some of the key issues and conflicts that may arise in the future given existing economic, ecological, social and institutional conditions and trends; and also some of the challenges and opportunities associated with the sustainable development of tropical rivers in Australia.

Underlying this assessment is the historical context in which we live, and a set of concepts, methodologies and ideas from the existing literature that has developed from that context. This forms the subject matter of this chapter, which is structured as follows.

Section 3.1 provides context – summarising the history of values expressed for the tropical rivers (TR) of Australia. Section 3.2 then goes on to discuss a range of different approaches to conceptualising, assessing and measuring social and economic values. Section 3.3 discusses frameworks for using information about 'values' for decision support, whilst key points relevant to this research project are summarised in the final section.

3.1 Changing values for tropical rivers

3.1.1 Historical attitudes to tropical rivers

Societal attitudes towards nature are constantly changing. Upon settlement, for example, Australia's native vegetation was seen as a resource of limited exploitative value and was replaced with introduced species. Australian landscapes were viewed as unproductive, harsh, incoherent, and inferior to those of England. Nadolny et al (1995, cited in Lambert and Elix 2000, p.9) suggest that native vegetation decline in rural NSW was driven by the notion that the "Australian bush is inferior and unproductive". As they have diminished in size, however, these environments have become highly valued and action has been taken to protect them.

Similarly, analysis of water management in the colonial era offers great insights into changing settler Australians' relations with the landscape. Powell's water resource histories (1991; 1997; 2000) detail the way in which "water and progress ran together" (2000, p. 59). Eastern rivers were chastised for flowing to the sea taking the water away from the inland. "Turning back" some of the more reliable eastern rivers preoccupied early development boosters and some government meteorologists (Powell 2000).

Early settlers anxiously sought to guarantee regular supplies of water with engineered modifications (for example, wells, tanks, and altered drainage courses). Water resource development was driven by social and political ideals sustaining the promotion of European settlement and "nationalistic hopes for extensions of white civilisation into Australia's 'vast empty spaces'" (Powell 2000, p. 56). By harnessing surface and ground water resources in regions such as north Queensland, the colonial society would generate the "plains of promise" (Powell 1991, p.xv). From the earliest explorers, there was a growing conviction that the Gulf rivers provided access to a "fabulous interior awaiting development" (Powell 1991, p. 14).

Powell explores the "investments of hope" in the regional development paths premised on the exploitation of surface and groundwater. He writes the following in relation to Queensland's early water management history (Powell 1991, p.xv):

> The expression 'Rivers of Destiny' belongs to a family of descriptive terms regularly employed by farmers and graziers, urbanites, politicians and water agency executives throughout Australia until the 1960s. It signalled their practical and romantic interpretations of the nation's watercourses. Australia's rivers might be *harnessed* – for the ambitious irrigation schemes which would declare suzerainty over Nature, or to supply the needs of growing towns and cities. They might be *tamed* – to reduce the risk of flood and so secure the footholds of an immigrant nation in a strange land. And of course the implication was that rivers *running to waste* carried away the dreams of security and prosperity in a new country.

In the Kimberley the first British explorer, Alexander Forrest, returned to Perth in 1879 with glowing descriptions of the Ord and Fitzroy valleys, each "capable of depasturing a million of sheep" and supporting tropical products like those being fostered in Queensland (Bolton 1953). Access to water and vital pasturage along river courses was a precondition to an expanding pastoral industry and explicit lease conditions sought to prevent the monopolisation of river frontages. Each frontage block had to be taken with a depth of three times its length along a major watercourse (Bolton 1953). Much land was taken up rapidly over the following decades. Although traversing the Kimberley was difficult due to flooding and the need to make long detours for want of water, the quality of the grazing country was considered adequate compensation (Bolton 1953).

Over the next thirty years pressure on the unfenced river frontage increased. During dry years the pressure was sufficient to cause a noticeable denudation. A number of stations put bores down to extract groundwater away from the watercourses (for example Upper Liveringa). However there were only a few such ventures because of the expense and uncertainty of the operation and, partly because of "alleged insecurity of tenure" (Bolton 1953, p. 152). This remained the case for some years until 1920-1923 (Bolton 1953, p. 208).

The effect of the expansion of the "hydrological frontier" on Indigenous societies is examined briefly by Langton (2002), who has also published papers on the contemporary significance of water to Indigenous societies (Langton 1996). In what has been termed "the battle for the waterholes", introduced animals (buffalo, cattle, and horses) all had a widespread negative effect on Aboriginal traditional life-ways (MacGrath 1987). Enormous ecological pressure was created as waterholes became watering points and the resulting social impact included severe anxiety from disturbance to sacred sites, and conflict over hunting of introduced animals, which had often displaced native game. MacGrath (1987, p.5) writes:

> The waterhole was a prime focus of land-use in the Aboriginal economy. Besides the resource of water itself for drinking and bathing, waterholes were the centres of many forms of edible life… They served as settings for big ceremonies. The waterhole was a focus, representing for respective individuals a birthplace, a symbol of creation and reproduction, of plants, and animals and people. Its religious and economic symbolism and social significance as camp and meeting place made loss or damage hurtful to the traditional owners.

According to MacGrath (1987) defending the waterholes from non-Aboriginal intruders was one of the shorter-lived phases of the conflict, which lasted many years. Violence was employed over a number of decades to ensure that Aboriginal people did not impede the colonising endeavour, including stocking the pastures and

struggling with agricultural schemes along various river systems such as the Adelaide, Daly, Ord and Fitzroy.

As industries, especially mining, expanded throughout the second half of the eighteenth century and as colonial centres grew, governments recognised the need for local environmental data and technical expertise in what Powell (2000, p.51) terms "the pursuit of foundational geographical knowledge". The environmental limits to growth slowly dawned upon the colonial intelligentsia.

The wider dissemination of these ecological parameters took longer for they took "second billing to a frenetic preoccupation with the perceived under-utilisation of comparatively well-watered fringes" (Powell 2000, p.51). For many influential colonial authorities water resources presented the biggest obstacle to increased security and prosperity (Powell 2000). Governments were seen to be responsible for meeting the costs of overcoming this shortcoming in Australia's environmental endowment. For the next few generations engineering knowledge and effort was devoted to overcoming Australia's water problems. Powell pinpoints the 1960s as the era in which the mindset that embraced dam construction and hard engineering solutions to water shortages and variability was seriously challenged in the public arena. Davidson's (1965) critique of irrigation projects and agricultural development in the tropics was an exemplary exposition on the problems inherent in subsidising inefficient and inappropriate land uses (see also Kelly 1966). During this period the Ord River project was characterised as a "white elephant" (Powell 2000).

Dissension over development scenarios, particularly for the north, has been more frequently aired since the 1960s and the environment movement played a significant role in challenging the "engineering culture" and colonial visions of settlement. A diffusion of ecological and aesthetic ideas (Powell 1991) now competes with "developmentalist" discourses (Walker 1973). Multiple voices, visions and values are now recognised and management efforts seek to grant them parity in decision-making. Notwithstanding the challenges to modernist water resource development visions, major water resource projects continue to capture the public imagination in the contemporary era and there have been a number of debates about the need to 'drought –proof' capital cities such as Adelaide and Perth by supplying water by canal or ship from the water abundant catchments of tropical Australia. At the time of writing an inquiry is being held into supplying Perth with domestic water from the Kimberley (Government of Western Australia Department of Premier and Cabinet 2006).

3.1.2 Irrigated agriculture

Early efforts to establish tropical agriculture in the Northern Territory, especially plantation systems, were unsuccessful. Many authors have analysed the problems encountered by these industries in the NT and elsewhere in the north (see for example, Courtney 1982; Davidson 1965).

The Ord river development dominates the literature on northern irrigation, water resource development and river regulation. Experiments in tropical agriculture were undertaken in the 1920s in the Kimberley, with cotton trialled at various sites near Wyndham and Derby (Millington 1991). The potential for other irrigated crops was explored throughout the nineteenth century. Post-World War II reconstruction efforts included tropical agricultural ventures and the Ord was mooted as a post-war settlement site.

In 1944 the Ord valley was examined in some detail and 50,000 hectares considered "potentially irrigable" land (Millington 1991). At that time Durack (1945, p. 248) wrote of the critical need to understand the "nature of the climate" of the Kimberley's for it was "of vital consideration in determining the trend of rural development". Furthermore, confusion about this issue "largely hinges on an inadequate or sometimes misleading interpretation of the climate" (Durack 1945, p.248). He emphasised the true character of the region, which is monsoonal and tropical with markedly seasonal variation in rainfall.

Durack (1945) was interested in the potential for improving pasture development with irrigation. The WA Department of Agriculture's experimental work was seeking to test the viability of profitable and healthy land use in a humid tropic environment. Regulation of the "all important factor, water" placed the Kimberley in a superior position to many of the world's tropical regions (Durack 1945).

In the 'improvement' discourse, availability of a regular water supply was considered essential, as Durack (1945, p.260) illustrates when referring to open range grazing lands:

> The provision of water to make such grazing land fully available has been one greatly important aspect of improvement; considerably more important than the only other recognised essential of improvement, fences and yards for stock control.

The Western Australian State Department of Public Works developed designs for the Ord irrigation scheme. In the late 1950s the Commonwealth granted Western Australia five million pounds for northern development projects (Hamilton 1991). Ord Stage 1 was approved in 1959. A town was proposed and established in late 1959. The name Cununurra was proposed, after the name applied to the black clay in the farm lands. Hamilton (1991) noted that Cununurra is reported to be the Aboriginal word for 'big waters'. Water storage commenced in 1963.

Davidson's critique of northern agricultural developments was published in 1965. This represented a rigorous assessment of agricultural and pastoral development in tropical Australia, with specific reference to the Ord. He argued that northern agricultural production was inefficient and any products could be produced more cheaply if grown in the south. According to Head (1999, p.141) Davidson attributed the popularity of inefficient schemes to a:

> …number of cultural and political motives for the development imperative in northern Australia, including defending the continent from Asian expansionism and utilising land, water and minerals that would otherwise be 'wasted'.

Many years later, a joint review by the WA and Commonwealth Governments conducted in 1978 confirmed that the Ord project had failed to fulfil expectations with the few farmers still operating and doing so at a marginal level of profitability. The high cost structure and poor understanding of local agronomy were responsible (Greiner and Johnson 2000). Social impacts were also becoming more evident. The marginalisation of Aboriginal interests in water resource developments can be seen clearly in the damming of the Ord River. According to the Federal Court Judge hearing the first native title claim to the area, Justice Lee, construction of two dams and lakes altered the landscape and "put lands flooded by those waters beyond the reach of native title holders" (cited in Langton 2002, p. 62). A number of commentators refer to the Ord River case in the literature on water resource development (e.g. Langton 2002; Powell 2000), Indigenous water valuations (Barber

and Rumley 2003) and northern Australian environmental change more generally (Head 1999).

Stephens (1991) describes the effect of the Ord on the 'national psyche'. The failure of the Ord scheme was pitched alongside other historical defeats such as the Eureka stockade and Gallipoli. Agricultural struggle in this region was, according to Stephens (1991), formative for the nation as a whole and for Western Australians in particular. It can be seen as the precursor to Western Australia's "development ethic" and the type of development projects characteristic of a frontier.

One of the greatest social impacts was felt by Aboriginal people. Stephens (1991, p.4) commented:

> That the Ord River scheme has had a significant and continuing impact on the social fabric of the Kimberley, particularly the Aboriginal community is clear. For the scheme which resulted in the formation of Australia's largest artificial lake, brought great changes to the area.

Arthur (1997) describes non-Indigenous attitudes to the Ord River region in the Kimberley revealed in commentary on the construction of Lake Argyle and the diversion dam. Prior to the dam the pre-irrigation environment is described in terms that suggest deficiency. For instance Arthur (1997, p.40) states:

> Its water is wasted and its major river only flows in the Wet and is reduced to a chain of pools in the Dry. It is located in a particular place – it is remote, a place of sheer isolation, lonely.

Arthur (1997) finds that within the texts there is an alternative construction of a landscape of excess, and lack of control. Water running through the region is described as "untapped", "vast", "wild", "superabundant" (Arthur 1997). The post-dam landscape, however, is invested with innovation, promise and potential – the land is opened up, or unlocked, the future is bright.

3.1.3 Multiple values, ecological and aesthetic considerations

In a study of the social values of native vegetation in NSW Lambert and Elix (2000) identify new sets of values oriented around notions of sustainability, community and belonging. Increased use of native bushland for recreational and inspirational places is evident, a trend they attribute to a shift away from materialism (Lambert & Elix 2000). It is arguable whether these developments represent new values or a shift in priorities. Other commentators, such as Holmes (1996), have documented the rise of amenity values and third party interests in the rangelands.

Recreational fishers, tourists and conservationists are placing increasing emphasis on the new amenity and lifestyle values associated with these locations and resources (Holmes 1996). Many coexisting values are complementary and do not necessarily require exclusive occupancy rights to satisfy or protect. This has generated conflict, usually over access to fishing locations or the impacts of development on water quality and flow.

Wasson (1991) traces the changing priorities and goals evident in catchment management practices in the Ord valley. The shift in the orientation of management aims was from maintenance of pastoral production to include land stabilisation and security of water supplies to irrigated agriculture, and maintenance of environmental quality for tourism and mining activity in the upper catchment. A further aim was

beginning to be formulated in the early 1990s: management of the catchment for subsistence purposes by Aboriginal groups.

Sustainability entered the northern Australia land use and development discourse in the early 1990s (see Fitzpatrick 1991). Environmental costs of irrigation schemes such as the Ord began to be discussed more openly, as did the notion of user pays and reductions in public subsidies through true cost pricing. In a paper to a conference on the Ord River scheme Fitzpatrick (1991, p.4) said:

> …governments are no longer prepared to provide 100% of the replacement cost of infrastructure which has already been provided to the industry free of charge in the initial construction of the scheme. There is a strong move for the users or beneficiaries to pay. This drives the need for a water pricing policy which ensures that reserves are progressively built up as a basis for the industry contribution.

3.1.4 Social values[8]

Social values are receiving increasing attention in natural resource management policy and practice and more recently the notion of *cultural values* has emerged, particularly in relation to water resources. Philosophers, environmental policy analysts and others with an interest in environmental valuation have critically analysed value concepts and theories. A popular focus is the commonly "bipolar" character of value construed as either an intrinsic or utilitarian concept (Norton 2000). The notion of values appears to be an increasingly popular means of addressing socio-economic considerations in natural resource management. Once limited to protected area management, particularly World Heritage management (McIntyre-Tamwoy 2004; Reser & Bentrupperbaümer 2000), the value construct has now been applied to a range of resource management arenas, and resource managers are slowly being required to take into account differences in human perspectives attributed to cultural background (English 2002).

In the academic literature values of a cultural nature are acknowledged as difficult to consistently define (Kahle 1983). Differences in environmental valuations may arise from personal differences affected by historical experience, for example, or cultural beliefs, practices and values embedded in social context (O'Brien & Guerrier 1995). In northern Australia, where the Indigenous population is so significant, particular attention should be given to cultural differences in environmental valuations.

Veroff (1983, p.xiii) defines values as the "goals a person selects to organise meaning in his or her life". Values are shaped by the complex problems of adaptation in a process that continues throughout a person's life. In turn, values also shape the settings in which adaptation takes place (Veroff 1983, p. xvii). The dialectical view of values sees them in constant flux generated by interactions between individual and environment, shaped and reshaped from internal and external dynamisms. They are endogenous to any planning context in which social groups seek to define what is important and what deserves recognition (see Jackson 2006). Thus there is contestation over defining what is 'valuable' (Strang 2005).

In a study of Indigenous water values in the Daly region Jackson (2005) observed the difficulty of incorporating the less tangible and measurable social values into contemporary water management that is driven by quantified objectives. Water-related ecological objectives need to be quantitatively defined in order to be integrated with other water management objectives (Richter et al 2003), as do social or cultural objectives. This quantification of water volumes and values for the

[8] The following draws on Jackson 2006.

purposes of sharing water amongst various users raises difficulties for Aboriginal people, and for others seeking to protect those values for which it is difficult to quantify a volumetric allocation.

The subjective, intangible and dynamic nature of water's social value gives rise to two problems. First, there is the difficulty of understanding the significance of water to different cultures and translating it into the resource management policy and planning institutions of Western society and culture. Second, in balancing the various values (social, economic, environmental and cultural) of a river system each particular choice about resource allocation and use will often involve conflicting objectives. Typically in such situations trade-offs are made where one aspect of one objective is given up in order to achieve more in terms of another. Social values can be elusive, nebulous and subjective, thus giving rise to great difficulty in determining a basis of comparison that enables objectives and consequences to be consistently evaluated. Within conservation biology Toussaint (2005) and others (e.g. Jepson & Canney 2003; Syme et al 2004) encourage the identification, acknowledgement and incorporation of the emotional, subjective, humanitarian values in resource or conservation conflicts. These areas represent "the real value and moral significance of biodiversity and people's motivations to conserve it" (Toussaint 2005, p. 390). Broad definitions of value that include spiritual and emotional dimensions are needed (Toussaint 2005).

Water also has symbolic meaning to different people. Strang (2001; 2002; 2005) has analysed the various meanings of water to different social groups in northern Queensland, with particular emphasis on Indigenous communities. The meanings encoded in water provide insights into water's different uses and to the resolution of conflicts over its ownership and management (Strang 2005, p. 367). According to Strang (2005, p.368), water 'carries powerful themes of meaning that are cross-cultural in substance, though these acquire considerable specificity in each cultural and sub-cultural context'.

For Indigenous people in northern Queensland their cosmology presents water as "the substance through which all aspects of life are generated, and inter-generationally recreated. Water sources are the most 'powerful' places in the landscape, acting as points of concentration for the ancestral forces that – like water, or one might say as water – permeate the landscape as a whole" (Strang 2005, p. 370).

Strang (2005) reports that non-Aboriginal residents in the Mitchell catchment rarely make an explicit association between water and its spiritual connotations (for example, as holy water or water as essence in baptism rituals). Rather they see the material environment as subject to the laws of physics and biological processes. Notwithstanding this secular view, according to Strang (2005, p.372):

> …even in these terms, people have a keen sense of water as a vital life source, common to all living creatures, and crucial to the survival of any ecological system. In a part of the country accustomed to intense wet and dry seasons, the regenerative power of water is amply demonstrated on an annual basis.

Strang (2005, p.374) identifies the core meanings of water in this region: "its symbolic role as social essence, and its potential to uphold communal wealth and health". Water is widely regarded as an element with regenerative capabilities that should be shared. These core meanings associated with water were evident in the focus group meetings conducted for this research.

3.2 Assessing Values: theories, methods and frameworks

As is evident from the foregoing discussion, there are a plethora of different values associated with Australia's TR region, all of which have changed through time and will undoubtedly continue to change into the future. Given this complex background, it is not surprising to find that assessing the social and economic values of Australia's tropical rivers is a non-trivial task. Some common methods for conceptualising and assessing values are discussed in the following sub-sections, the key point being that there is no single, correct approach that suits all instances.

3.2.1 The 'conventional' economic theory of value

Economic theory is currently dominated by modern 'neoclassical' economics, which is based on the 'subjective preference theory of value'. The starting point of this particular theory of value is "the individual endowed with tastes and talents and who calculates actions so as to maximise personal welfare or utility" (Cole et al 1991, p.7; emphasis in original). In this neoclassical conceptualisation, value is considered to originate in the minds of individuals, as revealed through their subjective preferences. This reflects the axiom that different individuals with different preferences are the best judges of the 'benefit' they will gain from having an additional (marginal) amount of a good or service. This benefit is measured through their 'willingness-to-pay' for that additional unit as this reflects how much of other goods and services they are willing to give up to get it (i.e. how many 'dollar-equivalents' a person would be willing to give up to obtain something if they were forced to make a choice).

All else equal, those who place a high 'value' on a good or service will be willing to pay more for it than those who do not. Thus, an individual's demand curve is thought to reflect 'value' in so much as it measures the individual's willingness to pay for each unit of a good. Since market demand is the aggregation of individual demands, it too, is related to 'value'. Theoretically therefore, the marginal economic value of a good or service is related to price since price is determined by the interaction of demand and supply.

Oftentimes non-economists interpret this as indicating that economists believe prices are a measure of 'value'. There are however several problems with this interpretation. First, price is the 'exchange value' of a good or service: i.e. the marginal value of the last unit of a good or service exchanged in a market. But the total value of a good or service is measured by the area under the demand curve (providing, of course, that the demand curve captures all types of values). Thus it may be possible for a good or service to have both a high (total) value and a low (marginal) price[9]. Second, price only provides information about the marginal value of the last unit consumed – which may differ markedly from the marginal value of the first unit. Third, price has historically failed to reflect critical information, especially about the state and quality of non-market goods and services (Georgescu-Roegen 1975). Part of the problem is that individuals consider only their own benefits and costs when determining their willingness to pay for a good or service, and many non-market goods and services infer external costs and benefits on society. Finally, demand curves reflect both willingness and ability to pay. Consequently when people attempt to measure social values with price, they are, unwittingly perhaps, measuring preferences that have been 'weighted' by the current income distribution.

[9] A famous example in economics compares diamonds and water. Diamonds have a low use value but a high exchange value, while water has a high use value but relatively low exchange value.

In short, price may provide good quality information about the marginal value of some goods (for example, apples). But it cannot be guaranteed to provide accurate information about the marginal or total value of all goods and services – particularly those that are rarely (if ever) traded in the market place[10].

THE TOTAL ECONOMIC VALUE FRAMEWORK

Economists have long recognised that 'value' is not synonymous with price. Likewise, economists have long acknowledged the existence of many non-financial benefits (or 'values') attributable to the environment. A framework that is often used for assessing and categorising values within the neoclassical approach is known as the total economic value (TEV) framework.

This framework (Figure 10) provides a way of categorising all of the possible values of a natural resource or landscape, such as a tropical river. Although the exact classifications vary from source to source, at the broadest level economists tend to divide these benefits/'values' into the broad categories of 'use' and 'non-use' benefits. Use benefits are those which are derived from direct use of the environment. Examples of these include the benefits of recreation and tourism, the value of goods produced, the benefits from maintaining and/or improving environmental quality and the benefits and value of biodiversity, education and research. Non-use benefits are those benefits that are derived from the environment without actually using it. Examples of these include the benefit of preserving the environment for future use (also known as 'option value'), the satisfaction derived from being able to pass the area on to other generations (also known as 'bequest value') and the benefit of 'knowing that the area is there', even if there is no intention of ever using it (also known as 'existence value').

[10] Further, price does not provide information about either the total or the net value of a good. Those interested in estimating the total value of a good need to be able to estimate the size of the area under the demand curve (not just price) and those interested in estimating the net value of a good need to subtract costs from total benefits.

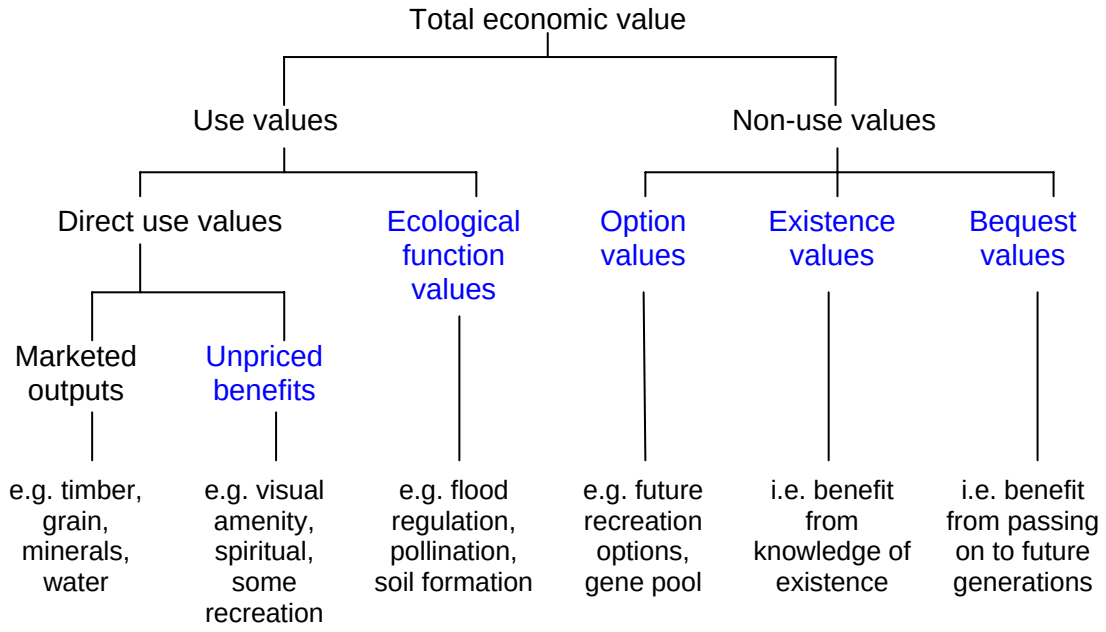

Figure 10 - Components of total economic value

Source: adapted from Hodge 1995.

The advantage of this TEV framework is that it highlights the distinction between values that are directly associated with the market (and may thus have an associated price or marginal value) and those for which a market may have to be simulated to estimate its 'shadow price' (so called because it reflects the price individuals would be 'willing-to-pay' if an operational market did exist for that good or service). Those values for which a market may have to be simulated to estimate a 'shadow price' are depicted in Figure 10 in blue. Specific examples of these non-market values include many of those discussed in section 3.1 as well as others such as the pollination of mango trees by insects, the benefit of knowing the Kakadu National Park will exist for future generations to visit or the spiritual and relaxation benefit received from spending time in natural settings.

METHODS OF NON-MARKET VALUATION

Over the years many different methods have been developed and tested for their ability to quantify the values discussed above in monetary terms. Interested readers are directed to Garrod and Willis (1999), Bateman et al (2002), Rietbergen-McCracken & Abaza (2000) and Willis et al (1999) for a detailed review. Here, we provide a brief overview of some of those techniques summarised in the list below which groups the approaches into three:

1. **Valuation techniques that use market prices**
   - **(a) Changes in the value of Output**
   - **(b) Loss of Earnings**
   - **(c) Preventive expenditures (mitigation costs)**
   - **(d) Replacement cost**
   - **(e) Cost effectiveness analysis**
2. **Revealed preference techniques**
   - **(a) Property or land value approach**
   - **(b) Travel cost approach**
   - **(c) Wage differential approach**

(d) Acceptance of compensation

3. **Stated preference techniques**
   - **(a) Contingent valuation**
   - **(b) Choice modelling (contingent rating, contingent ranking and choice experiments)**
   - **(c) Paired comparison**
   - **(b) Delphi technique**

Sources: adapted from Gregerson et al (1987), Driml (1994) and Grey (1996).

As the name suggests the first group of methods use market prices to draw inferences about non-market values. One can, for example, compare the per-hectare market value of agricultural production with and without irrigation, to draw inferences about the value of water in agriculture (as was done by Meyer, 2005, in the Murray Basin). Similarly, if one wishes to estimate the value of underground aquifers to agriculturalists, then one can calculate how much those agriculturalists would need to spend constructing dams (etc) that would be able to deliver a similar amount of water to stock.

Instead of using actual market prices (or costs) the second set of methods estimates inferred prices through actual market behaviour. Some of the recreational use values associated with a particular site can, for example, be estimated with the travel cost method. The travel cost method estimates how much people are willing to pay to travel to and from a recreational area and uses that to draw inferences about the recreational values associated with it. And one can compare the market value of river front houses with those of non-river front houses to draw inferences about the aesthetic value of water front homes (as has been done in many hedonic pricing studies). Similarly, one could compare the wages of those working in regions with plentiful water supplies with those in similar jobs in desert areas to draw inferences about the value of water to 'life-style', as is done with the wage–differential approach.

In most cases the first two groups of techniques are only capable of estimating values associated with a small sub-set of TEV (generally, productive use-values)[11]. This is because these approaches consider only one aspect of a relatively narrow problem and cannot, therefore, be applied across the full spectrum of values identified in Figure 10.

In contrast, the final set of methods, which asks individuals to 'state their preferences' is theoretically capable of generating monetary estimates of any type of economic value. The contingent valuation technique, for example, might ask people to state how much they would be willing to pay to ensure that they have access to water for drinking, or for recreation, or for stock; whilst choice modelling might ask people to state how much of one good they would be willing to forego to have access to water for drinking (or recreation, or other).

The key point to be made here is that different valuation studies of a similar area may derive two different estimates of value – if only because different techniques measure different aspects of TEV. For example, the recreation use value of tourism in Kakadu National Park was estimated to be $35.6 million in 1991 dollars using the travel cost method (Knapman and Stanley, 1990). In the same year Imber et al (1991) used the

[11] Although it is not always necessary to estimate the total value of an environmental area. For example, if one can establish that the net present value of a mine is $24 million, and that the recreation use value of the area which would be destroyed by the mine is $30 million, then one need not complicate the issue by attempting to estimate total economic value: total value MUST exceed the value of the mine (since a subset exceeds it).

contingent valuation method to estimate that the economic value to Australians of preservation of the Kakadu National Park was close to $647 million per annum in 1991 dollars. That the second estimate is so much larger than the first is consistent with the idea of TEV – the travel cost study estimated only one component of TEV.

The choice of which method to use to answer a specific valuation question is thus critical for the accuracy and relevancy of the results, and different methods will estimate value for different components of TEV.

3.2.2 Ecological concepts of value

In contrast to the economic concept of value, ecological concepts view something as having value in terms of how it contributes to the achievement of some system goal, such as the "value of a particular tree species in controlling soil erosion in a high slope area, or the value of fires in recycling nutrients in a forest" (Farber et al 2002, p.382). The value of that tree species will therefore be assessed and measured in relation to the goal of controlling erosion and the results of this valuation used to further evaluate its usefulness as part of an erosion control strategy.

3.2.3 The evolution of theories of value for natural resources

In response to a range of critiques of some of the tenets of neoclassical economics, and particularly of the methods of valuation mentioned above, other theories of value and approaches to assessing value are being developed. These new approaches tend to come from the perspective of two or more disciplines. For example, researchers are combining knowledge from psychology and sociology to incorporate learnings about how people deal with complex decision environments with conventional economic approaches to decision-making to account for factors such as temporal variability, task complexity, consumer effort, ability to choose and choice complexity (Swait and Adamowicz 2001; Swait, Adamowicz et al. 2004; Gomez-Lobo, Nunez et al. nd).

One of the more widely known alternative theories of value is the energy theory of value, in which energy is conceptualised as the primary input driving all economic and ecological systems. As it is solar energy specifically that is degraded and transformed to drive the circulation of mass this is the "primary input" and it satisfies the following criteria: (1) it is ubiquitous; (2) it is a property of all of the commodities produced in economic and ecological systems; and (3) its essential property cannot be substituted for. As such, the energy theory of value is a production-based theory similar to those of classical economics, the major difference being that solar energy is a more primary input than labour or any other substance.

The energy theory of value underpins attempts to specify prices for natural resources using solar energy as a *numeraire* (Odum 1971; Slesser 1973; Odum and Odum 1976; Costanza and Neill 1981; Costanza and Hannon 1989). Another approach is to calculate what Patterson (2002) calls *ecological prices*, being ratios that measure how much value one ecological commodity contributes to another commodity in the system (for example, solar energy per kilogram of apples). If the ecological commodity in question does not have a market, prices can be found by setting up "pseudo" markets in contingent valuation surveys (Patterson 2002, p. 459), which is recourse to a method based on the subjective preference theory of value.

3.2.4 Alternative methods for identifying values

Another conceptual approach that combines ecology, human decision-making and complex systems theories suggests that a plausible theory of the value of ecological

resources requires understanding and analysis of both the intrinsic, functional quality of ecological resources and a subjective evaluation by the consumer (Straton 2006). This approach has evolved partly from the increasing focus on the valuation of ecosystem services and partly from increasing knowledge of the interactions between social and ecological systems and their impact on dynamics, values, valuation and allocation.

Deliberative valuation and evaluation approaches are based on theories of social equity and procedural fairness. Interest in these approaches has arisen in response to calls for processes of decision-making, valuation and evaluation that can effectively include the range of multi-disciplinary, stakeholder, institutional and other system components that inevitably arise in matters of resource use and sustainability. Small-group deliberation is based on bringing between two and twenty-five people together around a common goal and with a coordinated task activity to complete. This activity can involve questions aimed at eliciting statements of "social willingness-to-pay" (Wilson & Howarth 2002, p.436):

> Ultimately, discourse-based valuation aims to elicit meaningful consensus-based value statements that are persuasive to all who are committed to the results of a free and reasoned assessment among citizens.

Methods used for small-group deliberation include participatory rural appraisal, interest/focus groups, consensus conferences, citizen's juries and public hearings. James and Blamey (2000) list the range of outcomes small-group deliberation can be used for:

1) Information gathering – where the views of participants are sought on a particular matter;
2) Assessment of support – where the level of support for a proposed action is determined;
3) Option choice (deliberative valuation) – where a choice is made between several alternatives in regard to a proposed development.

Deliberative valuation – where a value for described environmental changes, goods or services – is elicited from participants (often in monetary units). There are, however, a number of theoretical and practical issues raised with the concept of value as expressed by a group and with the use of deliberative processes to elicit this.

3.3 Values in decision support

As noted previously, a key reason for conducting this preliminary assessment of the social and economic values associated with Australia's tropical rivers is to provide researchers and managers with information about key issues and conflicts that may arise in the future and also about some of the challenges and opportunities associated with the sustainable development of tropical rivers in Australia. In short, the information should, ideally, provide some support for decision-making.

Those charged with making decisions about the sustainable development of Australia's rivers may want to compare or evaluate different values and/or consider how different values fit within and impact upon the broader system. This section discusses the role of values in mediating and allocating resources in that context, followed by brief descriptions of some decision-support frameworks useful for conceptualising the connections between social and ecological systems.

3.3.1 The role of values in resource allocation and decision-making

The TR regions under consideration are social-ecological systems consisting of interlinked systems-of-systems, being social, cultural, institutional, economic, biophysical, hydrological and ecological. Each of these sub-systems operates over a different physical area and each has processes operating at different time scales. Nonetheless, the dynamics of such systems are governed by several principles.

First, systems operating over larger areas often have slower-moving processes than systems operating over smaller areas. Second, key properties of systems emerge from the interactions between the slow- and fast-moving processes, and from interactions between processes with large spatial reach and those that are relatively localised (Holling, Gunderson et al. 2001) Third, the dynamics of the faster and more localised variables (from which use, utility and value are derived) are often determined by those of the more slowly changing variables (referred to as 'controlling variables'). As Scheffer et al (2001, p.596) state, the overall state of a system often depends on "slowly changing variables such as land use, nutrient stocks, soil properties and biomass of long-lived organisms". So, when considering where conflicts might emerge it is important to look at potential interactions between these fast- and slow-moving processes.

The key point to be made here is that the TR region is a social-ecological system, consisting of many inter-linked sub-systems – all of which can be influenced (either directly or indirectly) by values. Figure 11 illustrates where values enter the equation to influence the actual use of tropical rivers, and where they are themselves influenced. Individual and social values impact on the economic system, which in turn impacts on individual and social values. The same interaction occurs with the formal and informal institutions that guide and govern how tropical rivers can actually be used. These three components – people's values, economic conditions and trends, and institutional arrangements – drive how tropical rivers are actually used. This then impacts on the condition of the biophysical, hydrological and ecological systems that make up each tropical river system. The physical condition of tropical rivers impacts, in turn, on people's values and on economic conditions and trends.

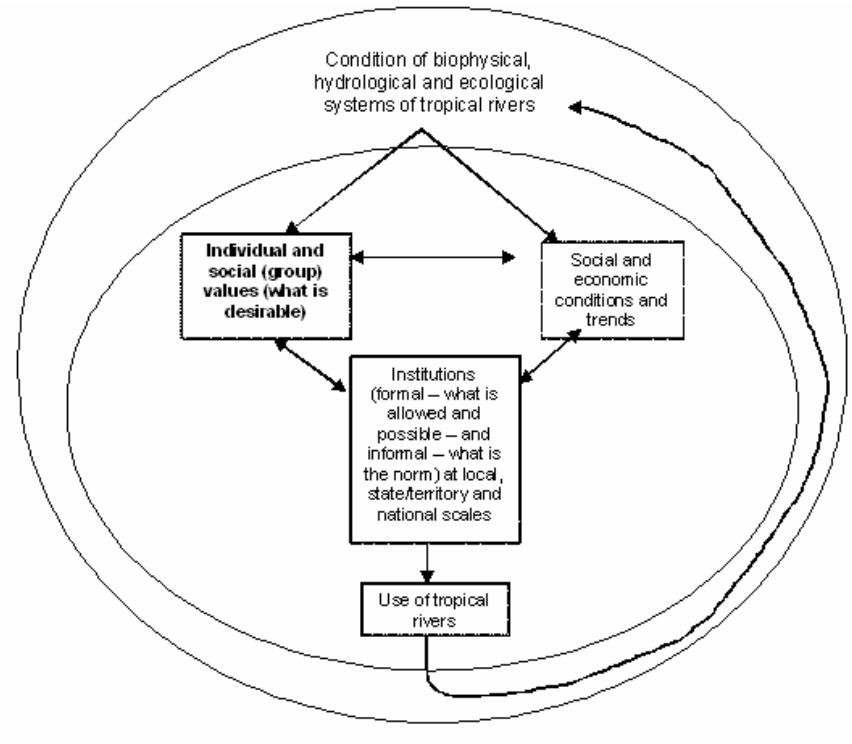

Figure 11 – How values influence social-ecological tropical river systems

This is a conceptual schematic, useful for emphasising the complex interactions between social and ecological systems. Values interpreted through economic value however and measured through the market are used in decision-making in quite specific ways. Benefit-cost analysis (BCA) is one of the most common techniques of evaluating or comparing a range of different costs and benefits. This method requires all values to be defined in one unit (for example in dollars). BCA and another common method, multi-criteria analysis, are discussed here along with other frameworks within which values, uses and system elements can be defined in terms relevant to the sub-system with which they are associated.

3.3.2 Benefit-cost analysis

A common evaluation framework is benefit-cost analysis (BCA), which describes a blueprint procedure for identifying, measuring and comparing the costs and benefits of different projects or variations of the same project (Campbell & Brown 2003). All benefits and costs are measured in financial terms and decisions in favour of a particular project are based on the net present value of the project's benefits being greater than the net present value of investment in the next best alternative. Costs and benefits are measured in terms of the incremental (decremental) impacts they have on human well-being, welfare or utility in dollar values.

A more complete treatment of benefit-cost analysis can be found in Campbell & Brown (2003) and Hanley & Spash (1993) . See also Boardman et al (2001) and Pearce (1971) for examples of past and current treatments.

3.3.3 Multi-criteria analysis

Multi-criteria analysis (MCA) or multi-attribute (or objective) decision analysis (MDA) has evolved partly in response to some of the concerns with using BCA to evaluate issues and projects of public importance that involve commodities with public good elements and/or externalities (in other words, that cannot easily be valued in monetary terms). Proponents of MCA techniques advocate its ability to mediate

between different objectives with different units of measurement. Contrary to BCA, MCA does not require that all things be measured in one unit.

MCA is based in the theory of multi-attribute utility analysis (MAUT), developed for dealing with problems involving multiple conflicting objectives where each objective can be described in terms of a number of sub-objectives or criteria. Decision-makers arbitrate between these sub-goals to find satisfactory rather than optimal solutions to problems (see O'Brien, Thornley et al. 1977; see Lane, Ascough et al. 1991; Robinson 1998 for descriptions and applications).

3.3.4 Environmental flow requirements

Evaluating values through the assessment of environmental flow requirements provides a framework for making decisions about ecologically sustainable water management (Richter, Mathews et al. 2003). An environmental flow requirement assessment involves the following steps:

(1) Develop initial numerical estimates of the key aspects of river flow necessary to sustain native species and natural ecosystem functions;
(2) Account for human uses of water, both current and future, through the development of a computerised hydrologic simulation model that facilitates examination of human-induced alterations to river flow regimes;
(3) Assess incompatibilities between human and ecosystem needs with particular attention to their spatial and temporal character;
(4) Collaboratively search for solutions to resolve incompatibilities;
(5) Conduct water management experiments to resolve critical uncertainties that frustrate efforts to integrate human and ecosystem needs; and
(6) Design and implement an adaptive management program to facilitate ecologically sustainable water management for the long term.

Decisions are then made about the allocation of water according to environmental and human flow requirements as negotiated between user groups. Human values of water are incorporated into the quantity and quality of water required for different uses.

3.3.5 Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment (MA) is an international program designed to answer the questions of decision makers and the public about the potential consequences of ecosystem change for human well-being and options for responding to those changes[12]. The program focuses on the benefits people obtain from ecosystems ('ecosystem services'), how changes in ecosystem services have affected human wellbeing, how ecosystem changes may affect people in future decades (cited in Lambert and Elix 2000, p.9) and options for responding that might be adopted at local, national, or global scales to improve ecosystem management and thereby contribute to human well-being and poverty alleviation (Figure 12).

[12] See http://www.millenniumassessment.org//en/index.aspx for further information.

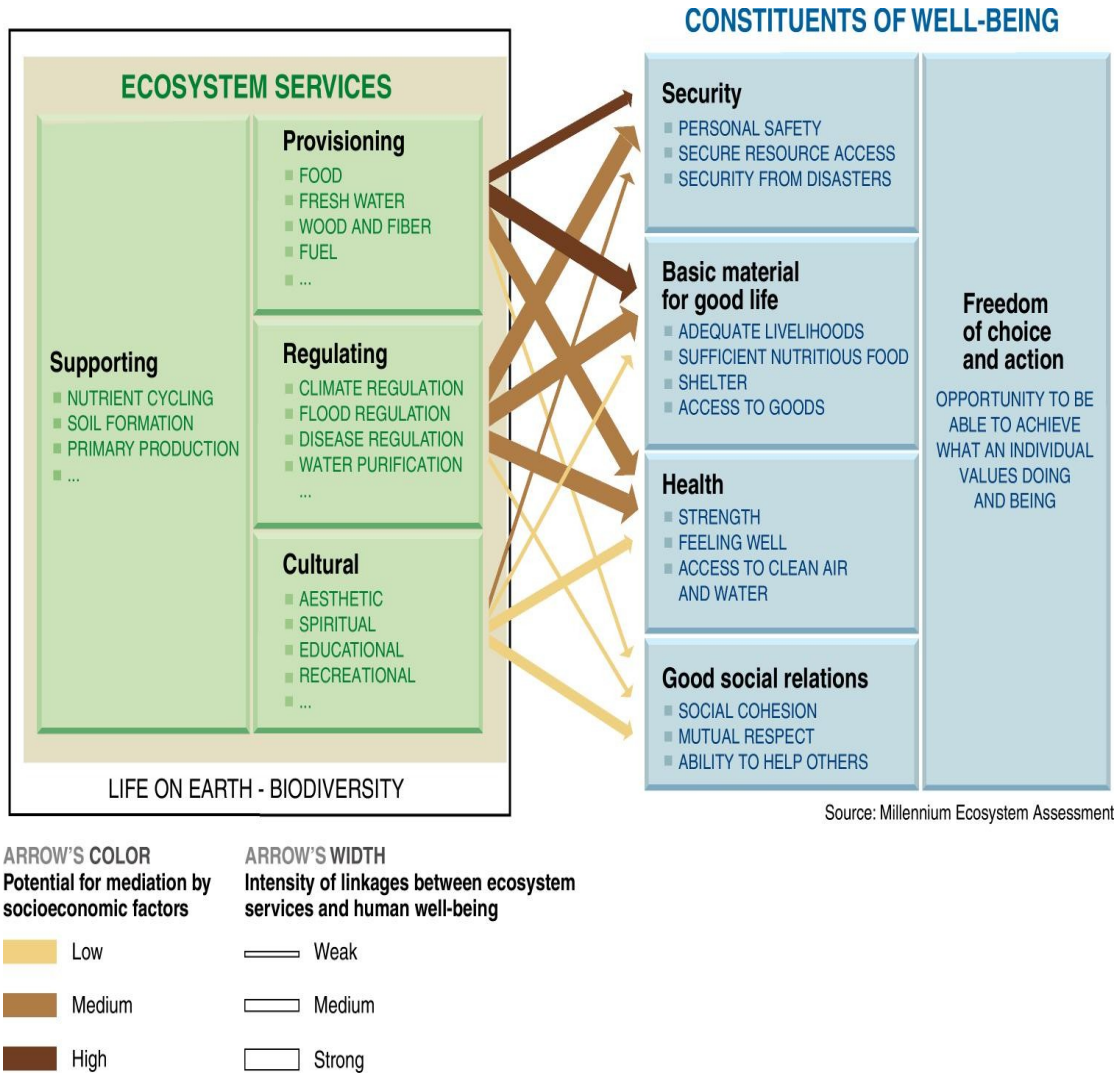

Figure 12 - Linkages between ecosystem services and human well-being

Source: Millennium Assessment (2005)

The general steps of the Millennium Ecosystem Assessment are to:

(1) Identify and categorise ecosystems and ecosystem services as:
   a. provisioning (e.g. food, water),
   b. regulating (e.g. climate, water, disease regulation),
   c. cultural (e.g. spiritual, aesthetic), or
   d. supporting (e.g. primary production, soil formation);

(2) Identify links between human societies and ecosystem services;

(3) Identify direct and indirect drivers;
   a. direct drivers e.g. changes in local land use and land cover, species introductions or removals, technology adaptation and use, external inputs (fertiliser use, pest control, irrigation), harvest and resource consumption, climate change, natural physical and biological drivers.
   b. indirect drivers e.g. biophysical, demographic, economic (globalisation, trade market, policy framework), socio-political (governance, institutional, legal framework), science and technology, values, culture and religion (choices about what and how much to consume).

(4) Select indicators of each;

(5) Assess conditions and trends of ecosystems and their services;
(6) Assess impact on human well-being in terms of the material minimum for a good life, health, good social relations, security, freedom and choice;
(7) Develop scenarios;
(8) Analyse response functions; and
(9) Analyse uncertainty (Alcamo, Ash et al. 2003)

In the MA framework values enter at step 1 in the identification of ecosystem services, at step 3 as a driver of human impacts on ecosystems and ecosystem services, and at step 6 in identifying the material minimum for a good life, health, good social relations, security, freedom and choice. Values thus play an important role at many stages of the dynamics of social-ecological systems.

3.3.6 Water Benefits Accounting and Assessment framework

The Water Benefits Accounting and Assessment (WBAA) framework[13] is part of the CSIRO's Water for a Healthy Country (WfHC) National Research Flagship[14]. WfHC focuses on water, its uses and values. The WBAA is an approach to assessing the benefits gained by the Australian community from our water resources and land management practices. 'Water benefits' refers to the aspects of water use or existence that promote or diminish human well-being.

The WBAA framework focuses on all of the values of water through six main 'benefit domains': (1) ecosystem health; (2) human health; (3) economics; (4) culture and identity; (5) social factors; and (6) choice and control. There are several 'benefit types' within each domain; for example, ecosystem health includes water quality and healthy riverine and coastal ecosystems.

The WBBA framework is operationalised through the following steps:

(1) Assess impacts of water use through analysing and modelling the impact of economic processes on observable water system processes. These models yield a set of variables of interest;

(2) Combine selected variables into a set of indicators to represent the benefits of water use as the six different domains mentioned above. This is the 'Indicator Account' containing the biophysical and economic values of water;

(3) Estimate the relative value of each indicator either through simple surveys of community members (community's value for biophysical and economic values), or through a method such as choice modelling (economic valuation of the community's values). This valuation process produces the 'Benefit Account', which assigns scores to each type of benefit according to the importance of the benefit and the degree of satisfaction with the level of the benefit;

(4) Aggregate benefit type scores into benefit domain scores; and

(5) Create an inventory of the biophysical and economic values of water, of the community's value for biophysical and economic values, and an economic valuation of the community's values.

[13] See http://www.cmis.csiro.au/healthycountry/updates/WBAAmay05/WBAAmay05.htm for further information.
[14] See http://www.cmis.csiro.au/healthycountry/ for further information.

3.4 Summary

The social and economic values of Australia's tropical rivers have changed through time as evidenced by the review presented in section 3.1. Changes in values are reflected through changes in land use, aspirations for development, recognition of cultural differences and increasing interest in conservation and the multiple uses of landscapes. And, importantly, values have changed as the discourse about water and land management has developed, and as different voices have come to the fore.

Knowing and understanding historical values associated with Australia's tropical rivers helps us to understand historical practices and policies. Likewise, it is important to understand current social and economic values since these underpin the ways in which people who live and work in these regions relate to and use their local river systems. Values also reflect the aspirations that people throughout Australia, and the rest of the world, hold for Australia's tropical rivers. Decisions made about tropical rivers can then incorporate and consider what people believe to be important, and what is required for tropical rivers to deliver the goods and services valued by the community and for the institutional arrangements that coordinate the use of tropical rivers.

However, as evidenced by the discussion of section 3.2, the concept of 'value' has multiple meanings, and it is important to be clear about which will form the basis of this study. In this report, the term "value" is NOT used to refer to a market-based price. Neither is it used to refer to a financial estimate of the magnitude of value. Rather this report defines a "social or economic value" as something that contributes to human wellbeing – either directly (as when an individual uses water to drink, or when an individual gains benefit from living near their favourite river) or indirectly (as when businesses within the tourism industry are profitable because many visitors travel to the region to swim in local waterholes)[15].

Defined in this manner, these social and economic values can be broadly associated with the concepts of direct use, indirect use and non-use that arise from the TEV framework, and it is this framework that provides an organisational structure to Chapter 4's discussion of the current-day social and economic values associated with Australia's tropical rivers.

Before continuing, however, it is important to note that the TEV framework has been criticised for defining non-market values in the 'negative', and that this mode of definition may impact on the way these values are treated within evaluation and allocation frameworks. This report is cognisant of this issue and will be as clear as possible about labels and meanings as these values are discussed.

[15] We note that this definition does not formally encompass many other, important concepts of 'value'', such as those used by ecologists (discussed above). The definition should thus be interpreted as a 'working definition' – one that is appropriate for this research, but may not be appropriate in other instances.

4 Evidence of social and economic values in the TR region

"People's perceptions of the river's value has increased – people don't use the river like a dump the way they used to"

Katherine focus group participant (FGP).

The overall aim of this chapter is to provide a social and economic profile of the region, focusing on the collation and reporting of data relevant to rivers and river management.

Following on from the discussion of chapter 3, the philosophy underlying this investigation is that the total economic value of a resource (in this case, the rivers, wetlands and estuaries in the TR region) is comprised of many different values – some of which have prices attached and some of which do not; some of which are directly associated with 'use' and some of which are not. Recognising that it is exceedingly difficult – if not impossible – to express ALL of these values in common, comparable units (e.g. dollars, utils, or kilojoules) this chapter seeks only to present data that allows one to identify different types of values that may (or may not) be present in the TR region. It does not attempt to measure, prioritise or evaluate those values in monetary (or other) terms.

More specifically, this chapter presents both primary (focus group) and secondary data that 'indicates' or provides evidence of the presence of different types of social and economic 'values' associated with Australia's tropical rivers. It is structured as follows.

Sections 4.1 – 4.3 present data and information that provide evidence of the existence of a range of different 'values', using the TEV framework discussed in the preceding chapter as means of grouping the data by 'themes' (e.g. existence and bequest values, Indigenous Values, Recreational Values). In section 4.4 data from the preceding sections are collated across basins and presented in a single table. This allows readers to consider the different types of values that are clearly evident in each of the river basins of the TR region. Section 4.5 (the conclusion) uses the preceding parts of the chapter to identify key issues, pressure points, and potentially conflicting stakeholder aspirations that may confront future managers of Australia's tropical rivers.

Before proceeding it is important to note that the tabular summary of values presented at the end of this chapter only compiles information that has been collected from a desk-top study of secondary data and from three focus groups. It may therefore 'miss' important values/issues or, equally problematic, it may overemphasize the presence of other values/issues. More will be said of this in the report's final chapter.

4.1 Non-use values

"It [the river] lifts your spirit"

Derby FGP.

As discussed in chapter 3, absence of price does not mean absence of value and areas (or resources) do not have to be 'used' to be of value. Setting aside for the moment the debate over intrinsic versus utilitarian value, it is evident that individuals gain personal benefit from areas/resources in a variety of ways that do not require 'use'. Some people, for example, gain pleasure from knowing that areas of great beauty exist, even if they have no intention of ever visiting them. And others may gain pleasure from knowing that they will be able to preserve areas of great beauty and/or spiritual significance for future generations (here too, the benefit/pleasure/'value' is not directly related to use).

These types of values probably exist for each and every region/resource in the world. A key question then is whether some regions/resources are of a higher value than others? Such a question may be impossible to answer and is, in any case, beyond the scope of this study. Consequently the approach taken here is to present data that allows us to draw inferences about the likely presence of at least some of those values, although this is preceded by a caution that the absence of such data in a specific region does not automatically equate to the absence of such values.

First, it is evident that the waterways in the TR area promote biodiversity and therefore have conservation 'values'. That is, they support "high levels of species diversity and endemism for many taxonomic groups such as aquatic plants, fishes and invertebrates" (Land and Water Australia 2005a, p.5). As noted in chapter 3, it is exceedingly difficult to try and measure these values – but some have, nevertheless, been documented.

In the Daly River catchment, for example, terrestrial conservation values have been formally recorded in Kennedy's (2004) desktop study. Amongst other values, Kennedy (2004, p 2) reports on the aesthetic and environmental significance of the Daly's dry season flow volume in providing habitat for a wide array of wildlife, noting that the river supports the "largest unbroken patch of rainforest in north-western Australia". And the aquatic conservation values of the Daly have also been the subject of a desk-top study. In their 2005 study, Blanch et al (2005) report on the high base-flow of the Daly, the limestone aquifers that discharge into the Daly and its tributaries and note the importance of these biophysical characteristics in contributing to the condition and extent of wetlands in the region that provide habitat for waterbirds[16].

Although these environmental and aesthetic values have no easily definable market price it is clear that the focus group participants derived some sort of value from the pristine nature of the resources. In Katherine, for example, participants listed the associated environments that the rivers in the area support, such as the billabongs and riparian areas, as one of the things they liked most about living near a tropical river. Participants in all FG discussions consistently acknowledged the aesthetic value of the tropical rivers region to those involved. A participant at the Derby focus group meeting, for example, stated that the rivers were '*special, pristine, beautiful, great'* and this sentiment was echoed in both the Mt Isa and the Katherine meetings.

"I like the seasonality – I look forward to it flowing but I also like the beautiful sand-beds, the waterholes only last a few months"

Mt Isa FGP.

[16] Other aquatic features include habitat for the pig-nosed turtle, a "near threatened" species that is an important food source and of cultural value to Aboriginal people in the region, and breeding ground and habitat for 48 species of freshwater or estuarine fish (Blanch et al, 2005 pvi).

"I like the floods that replenish the land"

Katherine FGP.

Importantly, it is not just local residents that derive these 'values' from the TR region as many areas of the study are considered to be of national and international significance. This is clearly evidenced by Figure 13, which shows Australian sites that have been identified as important to world heritage. Of most relevance to the TR region are Riversleigh's fossil sites, Kakadu National Park, Litchfield National Park[17] and Purnululu National Park. As noted by a Derby FGP "*the Kimberley is now recognised as a pristine area*".

Figure 14 shows wetlands that have been identified as being of international significance (Ramsar Sites[18]). These include the Coburg Peninsula Aboriginal Land and Wildlife Sanctuary, Roebuck Bay, areas around Kununurra, the Ord river floodplain and Kakadu National Park. Places that are listed on the Register of the National Estate are shown in Figure 15. Finally, Figure 16 shows the Queensland rivers that the Australian Heritage Commission's Wild Rivers Project have identified as being of special significance because of their relative lack of 'disturbance'. These include Settlement Creek, Gregory River, Morning Inlet, Staaten River, Coleman River, Archer River, Holroyd River, Watson River, Wenlock River, Ducie River and Jardine River.

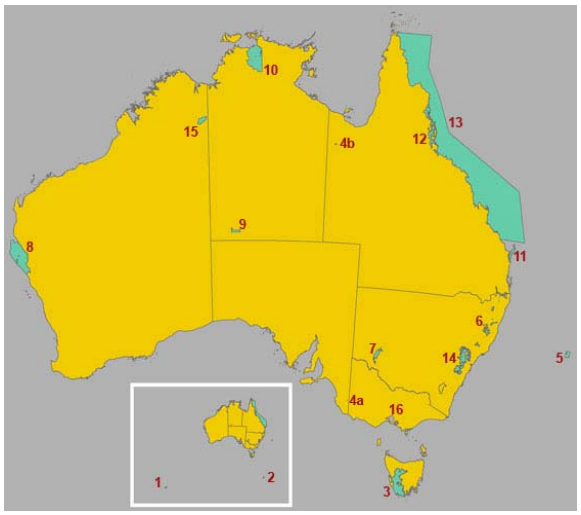

Figure 13 – World Heritage Areas of Australia

Source (Department of the Environment and Heritage 2006)

[17] Basins 816 & 817; not shown on map

[18] The Convention on Wetlands, signed in Ramsar, Iran in 1971 (more commonly known as the Ramsar Convention) is an intergovernmental treaty dedicated to the conservation of wetlands. The Convention's mission is: 'the conservation and wise use of wetlands by national action and international cooperation as a means to achieving sustainable development throughout the world'. The Convention encourages the designation of sites containing representative, rare or unique wetland types, or that are important for conserving biological diversity to the List of Wetlands of International Importance (Ramsar sites). These sites need to be managed to ensure their special ecological values are maintained or improved.

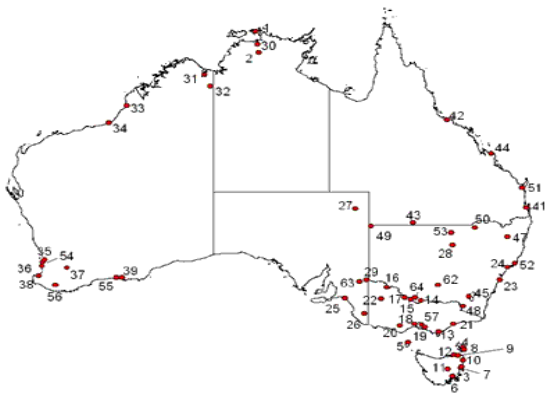

Figure 14 - Ramsar sites

Source: Department of the Environment and Heritage, 2004b

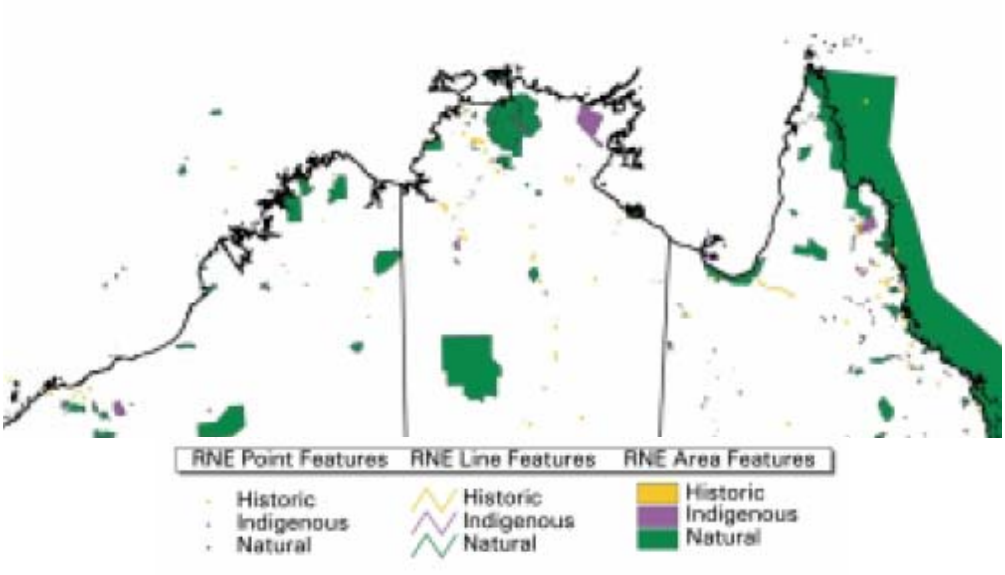

Figure 15 - Places listed on the Register of the National Estate 2000

Source: (Department of the Environment and Heritage 2001)

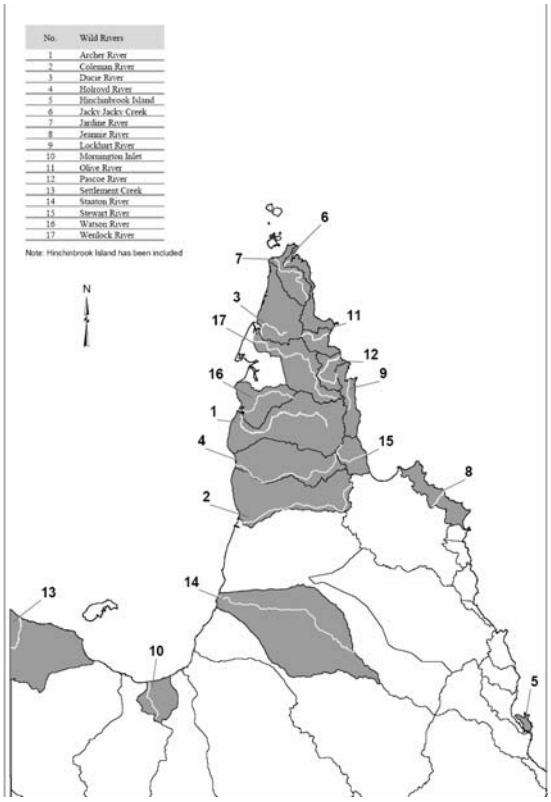

Figure 16 - Queensland's Wild Rivers

Source: (Australian Labor Party 2004)

Information from these maps has been summarised for each river basin in Table 5 (at the end of the chapter). Suffice to say here, there is ample evidence to suggest that the TR region contains many rivers, estuaries and wetlands that have significant 'non-use values' associated with them. Not only have local residents highlighted the importance of such values, but people throughout Australia and the rest of the world have recognised the importance of these values and have expressed a 'willingness to pay' for[19] their protection.

4.2 Use values

In 2004, the Australian Tropical Rivers Group[20] released a statement called, *Securing the North: Australia's Tropical Rivers*[21]. This statement refers to Australia's tropical rivers as 'the most biologically diverse and healthy aquatic ecosystems in Australia today' (Australian Tropical Rivers Group 2004, p.2), and highlights the role of the natural flows of these rivers in maintaining the habitats, biodiversity and productivity of river and marine ecosystems. The ecosystems provide many sources of food and items of cultural significance to Indigenous communities and 'support over 100 species of freshwater fish and millions of waterbirds that feed in wetlands and estuaries' (Australian Tropical Rivers Group 2004, p.2). The statement also

[19] When people set aside tracts of land for conservation they are forgoing the opportunity to use that land for production. The value of the forgone production thus offers itself as a MINIMUM estimate of the financial worth of those non-use values. The MAXIMUM estimate of such values may in fact be considerably higher.

[20] Convened by a Freshwater Manager with WWF Australia

[21] See http://wwf.org.au/publications/securing_the_north/

points out that 'significant recreational and commercial fisheries depend on rivers…they are worth tens of millions of dollars annually. Tourism based on rivers…earns hundreds of millions of dollars each year' (Australian Tropical Rivers Group 2004, p.3) .

In other words, whilst the data presented in the preceding section on non-use values highlights the fact that the rivers, wetlands and estuaries of the TR region have 'value' by, and of, themselves it is also important to note that the waterways provide important 'services' or 'functions' that have values above and beyond those previously discussed. Healthy river systems, for example, may help alleviate the negative effects of salinity thereby raising agricultural productivity. Similarly riparian vegetation can decrease sedimentation flowing into river ways, indirectly contributing to more productive commercial fisheries. And scientists have established a direct link between large-scale coastal farming (with associated runoff into rivers and waterways) and coastal algal blooms (Beman et al 2005). As noted by WaterWatch Australia (2005) 'a healthy waterway usually reflects that the local environment is in good shape', and it is the broader environment that sustains and supports us.

Like the many non-use values discussed in the preceding section the key point to be made here is that it is exceedingly difficult to estimate the value of ecosystem services in financial terms. Nevertheless, there are examples of relevant studies in the TR region.

For instance, studies have been conducted on the value of wetland functions in the NT to the various economic, social and cultural activities that they underpin. Focusing on the Daly and the Mary Catchments, Mabire (2005) reports the contribution of wetland ecosystem services to sand mining, agriculture, horticulture, buffalo production and hunting, pastoralism, crocodile production and hunting, nature conservation, carbon sequestration, tourism, recreational fishing and recreational hunting. In 2004, the Northern Territory Department of Infrastructure Planning and Environment commissioned a cost-benefit analysis of alternative approaches to mitigating salinity in the Mary River (Australian Greenhouse Office 2004). In that report they recognised the benefits of salinity mitigation to the following: agriculture, commercial fisheries, recreational fisheries, wild harvest of crocodiles, crocodile eggs and magpie geese, tourism associated with hunting, fishing and sightseeing, and other non-use or 'passive' values (Australian Greenhouse Office 2004, p. 66). Van Dam and Bartolo (2005) also attempted to estimate the value of ten ecosystem goods and services associated with the wetlands of the Mary River and Douglas-Daly River. Aggregation of the estimated values revealed the economic benefit of the wetlands in the Mary river catchment to be $50.7 million ($450/ha) whereas the economic benefit of the wetlands in the Daly river catchment was estimated at $82.4 million ($230/ha). As noted by Mabire (2005), however, Van Dam and Bartolo's study (2005) did not include the values of ecosystem services from the rivers and creeks in the system.

Admittedly, most research to date into the ecological function values of rivers and wetlands in the TR region has concentrated on just a few rivers including the Daly, the Mary, the Ord[22] and the Fitzroy. Ecological function values are however likely to

[22] Tropical Savannas Management CRC Project 2.3.1 – Integrated overview of values, uses and modifying processes in the Ord River's riparian zone
Project Leader: Dr Tony Start, Department of Conservation and Land Management WA, Kununurra

exist for each and every basin in the TR region, some as an undisturbed system functioning in a manner similar to that which has existed for thousands of years and some functioning in a way that has been 'modified' by human activity. At this point in time however many of those values have not yet been documented or 'researched' and significant scientific and academic 'gaps' exist in the literature.

The approach taken here, therefore, is to take the presence of ecological function values as a given for all basins within the TR region. The key problem then becomes the identification of variables that give indications of the strength of those values. As previously, this is done *indirectly.* Specifically, we present data that describes a variety of different human activities that are associated with ecological function values, using that data as prime facie evidence of the existence of ecological function values. Also as previously, readers are cautioned to remember that absence of data does not mean absence of value and that the material presented here is indicative only.

4.2.1 Sustaining human life: population and population change

"Without water there is no life and the presence of water is the reason that many of the settlements within the TR region are located where they are"

Derby FGP.

A key ecological service/value associated with water which to date has largely been unpriced is that of sustaining human life. As noted by a participant of the Derby focus group meeting *"There is a feeling of basic security from living near water – always knowing you have water available"*.

A key indicator of the value of water in this role is, therefore, the presence of humans. The following pages thus present data relating to the distribution of humans across the TR region in GIS 'maps'. Figure 17 shows the estimated total population of each basin from the 2001 census[23] and Figure 18 shows the estimated change in the persons enumerated in each river basin between the 1996 and the 2001 census[24]. The data is also summarised on a basin-by-basin level in Table 2.

Despite the fact that the TR region covers approximately 15% of Australia's mainland it is home to fewer than 2% of all Australians (approx ¼ of a million people as per Table 2). Most of the TR region is therefore sparsely populated (as evidenced by Figure 17) with all but four basins having fewer than 1 person per km^2 (Table 2).

In 2001 there were only three communities (Darwin, Mount Isa and Broome) with a population of more than 15000 (Table 2) and population counts from the 2001 census show that almost half of the TR basins (24) had fewer than 500 persons (8 had between 500 and 1000; 13 had between 1000 and 5000 and only 10 basins had more than 5000 persons). Broome has a population of 16271 however this may not reflect the actual number of people reliant on water sources within this area at any

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Start A.N and Handasyde T. (in press). The Ord: What have we done? - What can we do? In: Wise Use of Wetlands in Northern Australia. Grazing Management in wetlands and riparian habitats. Northern Territory University, Darwin

[23] Calculated by apportioning the population of each CD to each basin on an area-by-area basis, as described in Appendix C.

[24] As noted earlier, CD boundaries change between one census and another – hence estimated changes in population were calculated using SLA level.

one time as Broome attracts a large number of transient visitors (tourists). More will be said about this in a later section.

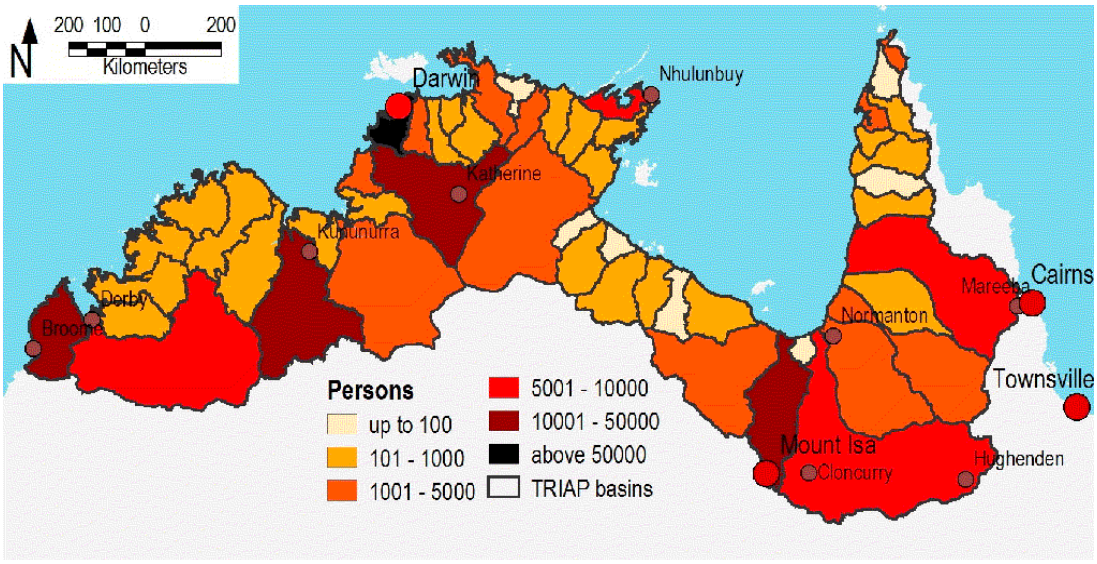


Figure 17 - Estimated population 2001 census enumerated persons by basin

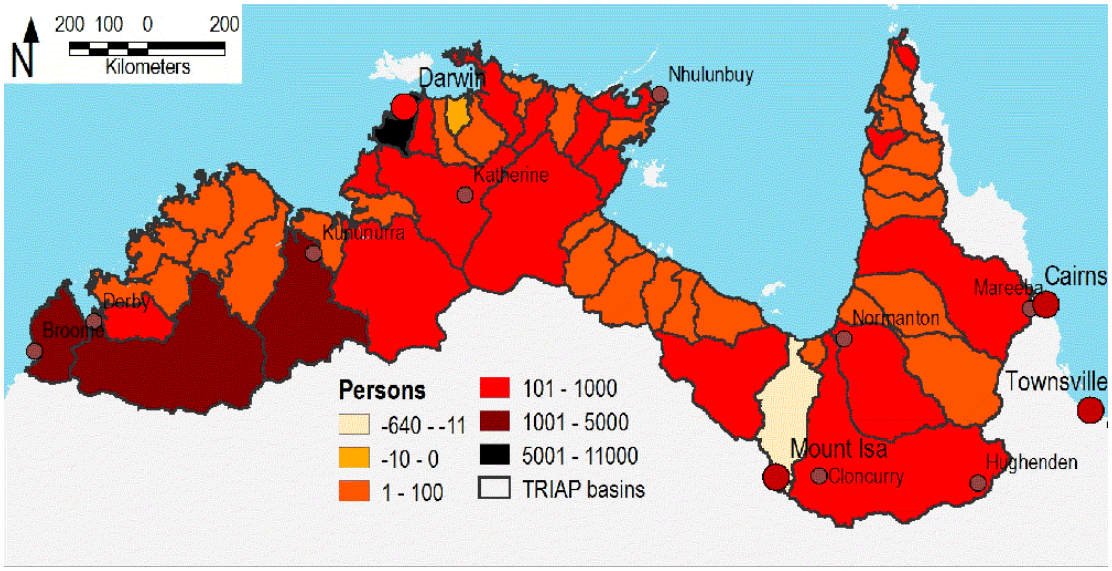


Figure 18 - Population change (persons) between the 1996 and 2001 census by basin

Table 2 - Population, population density and population change for the TR basins – sorted by population of basin

River basin	Main town / community within basin (if applicable)	Total population	Population density (persons per km^2)	Population change 1996 - 2001 (persons)	Population change 1996 - 2001 (percent)
815	Darwin	103506	10.54	10351	10
913	Mount Isa	21324	0.57	-640	-3
801	Broome	16271	0.65	3091	19
814	Katherine	12649	0.22	379	3
809	Kununurra	10473	0.17	1780	17
802	Derby	8417	0.08	2020	24
928	Torres Strait Islands	8372	0.22	1343	16
915	Hughenden	7658	0.06	153	2
919	Kowanyama	5567	0.07	223	4
826	Nhulunbuy Gove	5224	0.60	575	11
821	Jabiru, Minjilang	3267	0.20	229	7
903	Mataranka	3252	0.04	748	23
916	Karumba	3234	0.06	162	5
924	Weipa	2546	0.52	10	0.40
912	Domadgee	2133	0.04	384	18
816	Bathurst/Melville Islands	2129	3.52	312	15
927	Bamaga	2058	0.61	329	16
813	Thamarrurr,	2015	0.27	161	8
817		1865	0.24	112	6
823	Maningrida	1818	0.19	364	20
811	Dagarago	1713	0.02	582	34
917	Georgetown	1522	0.03	46	3
929	Groote Eylandt	1344	1.99	-49	-3.6
923	Aurukun	986	0.20	217	22
911	Mornington Island	845	1.45	-118	-14
902	Numbulwar	723	0.07	137	19
820	Jabiru	676	0.05	27	4
825		654	0.06	124	19
920	Pormpuraaw	635	0.05	83	13
803		519	0.03	125	24
806	Kalamburu	514	0.03	41	8
824	Ramingining	495	0.05	94	19
901	-	487	0.06	88	18
808	Wyndham	443	0.01	80	18
922	Coen	417	0.03	67	16
818	-	331	0.04	10	3
819		261	0.05	-3	-1
807	-	235	0.01	28	12
812	-	229	0.02	41	18
907	Borroloola	195	0.01	41	21
804	-	187	0.01	36	19
905	-	141	0.01	78	55
925	-	138	0.02	19	14
805	-	133	0.01	21	16
918	-	118	0.00	7	6
908	-	113	0.01	40	35
909	-	90	0.01	44	49
822	-	78	0.01	16	20
926		75	0.01	11	15
810		71	0.01	12	17
921	-	59	0.01	10	17
910	-	56	0.00	28	50
906	-	51	0.01	39	76
904	-	36	0.01	27	76
914	-	11	0.00	1	11
TOTAL		238359	23.26	24136	949.8
AVERAGE		4333.8	0.42	438.8	17.3

Source:(ABS 2001b)

Not surprisingly most of the TR region is classified as being either remote or very remote[25], with the exception of areas surrounding Darwin, Broome and Mount Isa. It is of interest to note, however, that very few areas within the TR region are suffering from population decline (see Table 2). Indeed our estimates indicate that only four basins experienced a population decline between 1996 and 2001. These were basin 913 (containing Mt Isa losing 640 people), basin 911 (Mornington Island losing 118 people), basin 929 (Groote Eylandt losing 49 people) and another small remote basin east of Darwin (basin 819 losing 3 people). More than half of the basins in the TR region grew by more than 10% between 1996 and 2001 – some growing by as much as 76%.

In short, whilst much of the area currently has few people these trends indicate that the region is likely to face increasing demands (values) for water for human consumption and for industry over future years.

Importantly some of these 'values' may complement (rather than compete with) some of the ecosystem and environmental values discussed earlier – since humans require clean water for drinking. However, other values associated with human activities (particularly those associated with industry) may not be complementary to those expressed above. More will be said of that later.

4.2.2 Indigenous values

"[The river is] … Home Sweet Home; Main place"

Derby FGP.

That there are many Indigenous stakeholders in the TR region is evidenced by the fact that there are more than 77 different Indigenous language groups associated with the area (Appendix E)[26]. Considerable tracts of Aboriginal freehold and leasehold land exist in the Northern Territory, and Native Title determinations have been made in parts of Western Australia and Cape-York Peninsula (Figure 19), despite the fact that most of the land in the TR region is given over to grazing (Figure 20).

[25]ARIA (Accessibility/Remoteness Index of Australia) is recognised as Australia's most authoritative geographic measure of remoteness. ARIA indexes are derived from measures of road distance between populated localities and service centres. These road distance measures are then utilised to generate a remoteness indicator for a given area. Values of the index range from 0 (very accessible) to 15 (very remote). See http://www.gisca.adelaide.edu.au/web_aria/aria/aria.html for further information.

[26] This list is not exhaustive and many more tribes and language groups may exist.

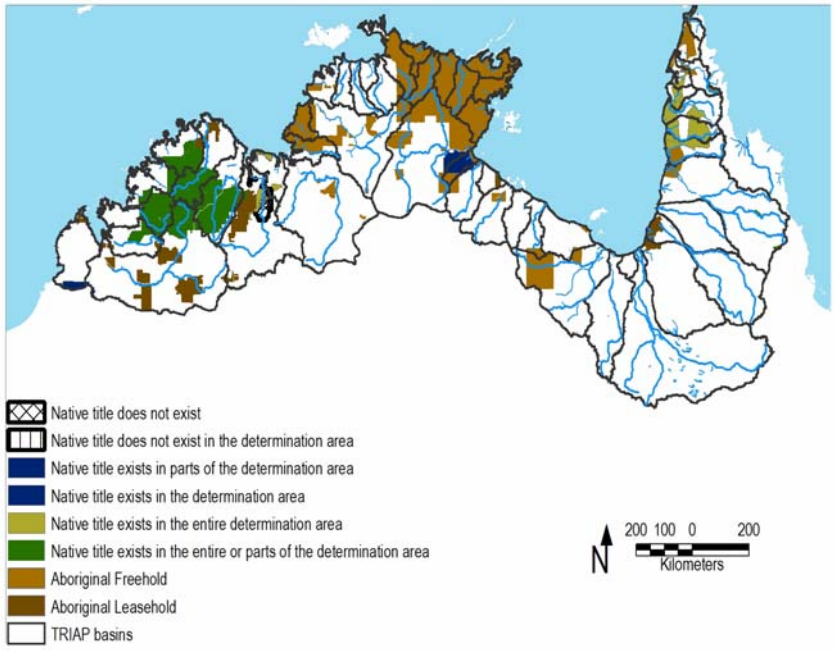


Figure 19 - Indigenous freehold, leasehold, and Native Title determinations

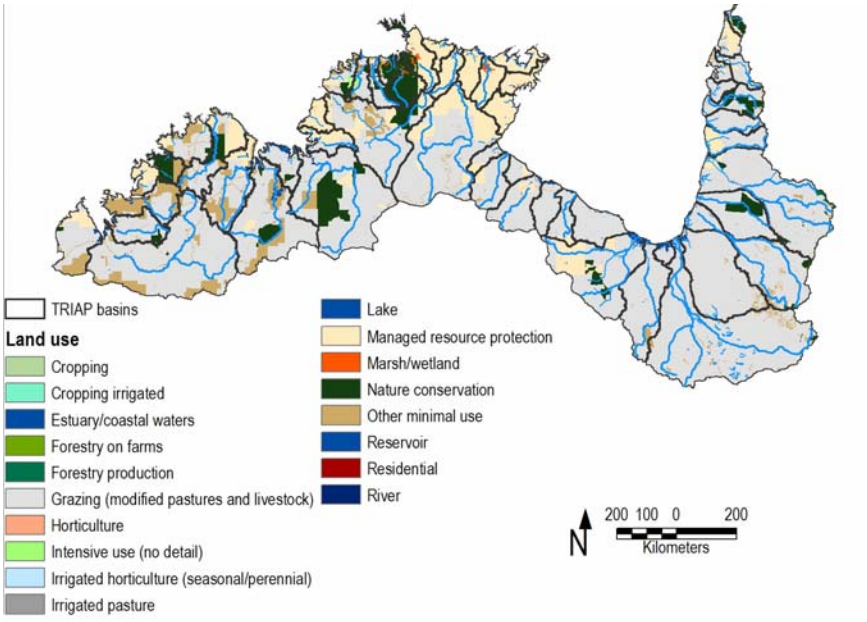


Figure 20 - Land use in the TR region

As documented in the research of Storey et al (2001, p.62) into values associated with the Fitzroy river, water is a source of culture for Indigenous Australians and is handed down from the Dreamtime:

> *The use and involvement of the environmental values of the river system, including the geomorphological and hydrological features, the vegetation and the diverse animal life, in the culture of TOs (traditional owners), including their Law, Dreamtime stories, medicine and hunting demonstrates an inextricable relationship between TO culture and lifestyle and the ecology of the river system.*

Toussaint et al (2001, p.15) looked at Aboriginal cultural values in the Fitzroy valley noting that "it is clearly the case that Fitzroy Valley Indigenous groups sustain extensive cultural affiliations to lands and waters…Indigenous narratives, beliefs and practices show these connections in a multitude of interconnected ways" . Specifically, this research documents the fact that rivers are used for:

- A source of nutrition – "Riverine resources such as fish (bream, barramundi, catfish, swordfish), freshwater eels, turtle, mussels and cherrabun (freshwater prawns) are a vital part of the Aboriginal diet, especially for those trying to live on social security (DSS) entitlements and Community Development Employment Project (CDEP) money" (Toussaint et al 2001, p.45).

- Fishing activities – "all along the rivers, adults and children go fishing whenever possible…On the weekends, most community and family vehicles set off for the river or a billabong, often to stay and fish all day and/or to camp overnight. Some 'moonlight' fishing also takes place, especially on weekends" (Toussaint et al 2001, p.45). This also corresponds with the comments made in Appendix F by the Executive Officer of the Amateur Fisherman's Association of the NT.

- A place for recreation – "Some sites have become important recreation areas known to be places where children can learn about the place, while also having some fun" (Toussaint et al 2001, p.48).

- A place to wash. Toussaint et al (2001, p.53) noted "the part the river often played in enabling local people to 'have a bogey' [wash] in high temperature conditions when community ablution facilities were not operating or accessible".

- Bush foods and medicines.

- Knowledge exchange through language, painting and film – "The river is also a site where children learn about cultural life from adults" (Toussaint et al 2001, p.45).

- The provision of resources for ceremony – "Smoked fish are commonly sought to accommodate food taboos [*jaminyjarti* or *jaginy*] on meat for relevant kin following the death of a loved one" (Toussaint et al 2001, p.3).

- And that there is a strong social etiquette attached to river use and protection – "Indigenous groups with affiliations to Fitzroy Valley lands, rivers and waters believe that it is their responsibility to look after 'country' to ensure the replenishment of seasonal resources on which they are ultimately interdependent" (Toussaint et al 2001, p.57).

Importantly, the story does not appear to be any different in other catchments. Jackson (2004, p.25) published a preliminary report on Aboriginal perspectives on land-use and water management in the Daly River, noting that the river is integral to "way of life, sense of identity, economy and cosmology". Jackson (2004) notes that this includes the responsibility Aboriginal people have to care for country and to share water equitably, their historical connection with the region and their knowledge of creation stories and interactions between the river and various aquatic and terrestrial species.

Further evidence for these important cultural connections is also given by the Northern Land Council and Aboriginal Areas Protection Authority [27], where it is noted that: there are many sacred sites in the region associated with the Daly River; "water is the source of life"; the formal introduction of visitors is often through water; meat, fish and vegetables are sourced from within and around water sources; and dreamtime stories associated with water are still vibrant.

Clearly, an important aspect of the Indigenous cultural values associated with water are those linked to fishing. In a study of coastal communities across the top of Australia, from Broome in Western Australia to Cairns in Queensland, the Department of Agriculture, Fisheries and Forestry (2003) found that fishing held great value for many Indigenous people. This value was identified as being not just for food and nutrition but also for ceremonial occasions, exchange, trade and barter, custodianship, cultural and spiritual attachments and for social cohesion. Fishing participation rates were between 89% and 93% of the Indigenous population within the area surveyed.

More specifically the study found that the greatest numbers of fishers resided in the Northern Territory, followed by northern Queensland and then northern Western Australia. While much of the fishing referred to in this report was marine fishing, in Western Australia specifically more than 50% of fishing effort occurred in rivers, lakes and dams. This is reflected in Figure 21, which gives a breakdown of the proportion of annual fishing effort by water type for Indigenous fishers.

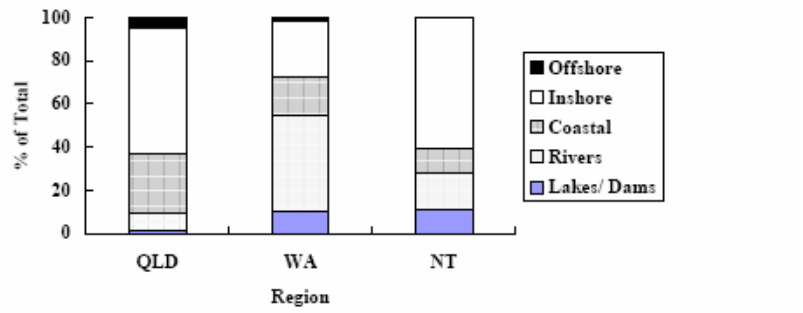


Figure 21 - Proportion of annual fishing effort by water type for Indigenous fishers, aged 5 years and older

Source: Department of Agriculture, Forestry and Fisheries 2003

Clearly, rivers are of significant 'value' to Indigenous persons and, as illustrated in Figure 22, a high proportion of the population within the tropical rivers region is of Indigenous descent. The 2001 census showed that most collection districts within the TR region had Indigenous populations that comprised more than 10% of the total population, while some collection districts had more than 80% Indigenous persons. This contrasts with the Australian average of 2.2% of population of Indigenous descent nationally (ABS 2001b). In fact, only 2 of the river basins within the tropical

[27] The Daly Region CRG also heard and received submissions from members of the public and from special interest groups relating to their various values and concerns about development in the region. These submissions and statements can be found in the draft report of the CRG to the Northern Territory Government and on a website set up for the purpose (http://www.nt.gov.au/nreta/naturalresources/plans/dalyregion/index.html).

rivers region have a proportion of population of Indigenous descent below the national average (basin 917 with 2% and basin 926 with 0.08%).

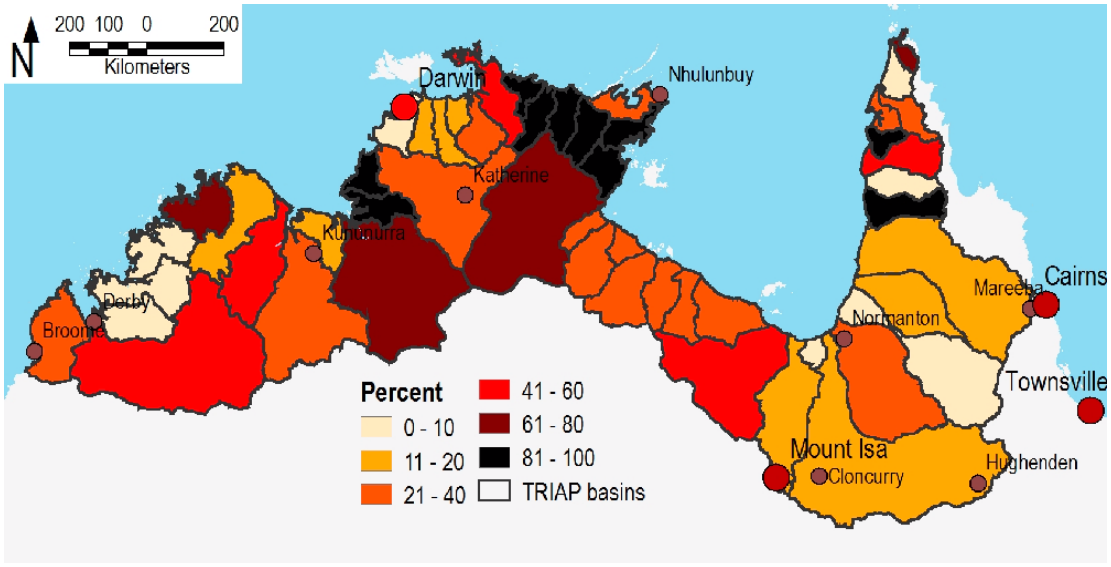


Figure 22 - Proportion of population of Indigenous descent 2001 census by basin

Importantly, this map should not be interpreted to mean that Indigenous cultural values only exist in areas that are 'controlled' or 'populated' by Indigenous people. As noted earlier, there are areas within the TR region that are of special significance to members of the international community who live tens of thousand of kilometres away (evidenced by the existence of 'World Heritage Areas', Figure 13). So too is it likely that Indigenous cultural values will not be limited to those living within the TR region. A most obvious example of this is when a non TR resident has historical or familial links to areas within the TR region – although, like non-Indigenous persons, values like these do not necessarily require such well-defined links to exist.

In addition to the cultural values, it is important to note that the United Nations Committee on Economic, Social and Cultural Rights has identified Australian Indigenous people as significantly disadvantaged in terms of employment, health and education, and that 'the Australian Government must increase resources and undertake steps to effectively and expeditiously improve the present appalling Indigenous health situation' (Aboriginal and Torres Strait Islander Commission 2000, p.34). To the extent that at least some of the 'appalling Indigenous health situation' may be attributable to a lack of access to good quality water (Henderson & Wade, 1996), this stands as further evidence of a 'value' for water in the TR region.

To be more specific, the ABS (2003d) notes that many Aboriginal and Torres Strait Islander peoples – especially those living in remote communities – do not have reliable supplies of water[28]. In the 2001 Community Housing and Infrastructure Needs Survey (CHINS) collected by the Australian Bureau of Statistics (ABS 2001b), bore water was reported as the main source of drinking water for 784 discrete Indigenous communities, representing 62% of the total population of discrete Indigenous communities. Additionally, more than one quarter of communities[29] that were not connected to the town water supply had failed water quality tests at least

[28] Nor do they have adequate housing, reliable electricity, or adequate sewerage and drainage systems.
[29] With a population of more than 50

once during the previous 12 months and more than one third had experienced water restrictions in the previous 12 months.

Not only is access to a reliable supply of clean water important for basic hygiene, but poor water quality has been associated with diseases such as gastroenteritis, hepatitis and typhoid fever (Edwards & Madden 2001). Evidently, it may be possible to improve Indigenous heath by improving access to good quality water (amongst other things). This therefore stands as yet another important 'value' associated with water in the TR region – it does not merely sustain life, but its presence makes an important contribution to the health of many.

It is, therefore, clear that the rivers, wetlands and estuaries of the TR region clearly provide considerable direct and indirect use-values to the Indigenous community for cultural purposes, for fishing, for recreation, for health and for a multitude of other reasons. These values are almost all un-priced, but they do exist. And they are important. As noted by Toussaint et al (2001, p 43) the "presence of adequate water is a present-day pre-condition for the establishment of Indigenous communities and outstations" and – significantly – many (but perhaps not all) of the Indigenous cultural values associated with water may complement (rather than compete with) the ecosystem and environmental values discussed earlier. As noted in the focus group discussion:

The 'river is healthy if there is respect for (Indigenous) culture'.

Derby FGP.

4.2.3 Recreational and non-Indigenous cultural values

Section 4.1 presented maps showing the presence of National Parks, World Heritage Areas, important wetlands and wild-rivers. As noted earlier, at least some of these places are likely to be of cultural significance to non-Indigenous persons – evidenced by people's willingness to identify and set-aside such regions for preservation. Consequently, many of those basins identified earlier as having 'non-use' values are also likely to have recreational and cultural use values associated with them.

But the lists presented thus far are unlikely to be either definitive or exhaustive, particularly given the climate of the area in question. Specifically, much of the TR region is very dry for months at a time, as evidenced by the summer dominant rainfall patterns (Figure 3) and the relative scarcity of perennial water (Figure 8). In places such as these, fresh-water swimming holes often serve an important recreational service irrespective of whether or not these have been identified as being of national or international significance. This is particularly so in remote regions where the presence of other recreational activities are fewer than in urban locales. Young (2004, p.i) conducted a series of focus group discussions to explore social values in the Daly region and noted amongst other things that rivers provide people with the opportunity to "escape from daily routine, spend time with family and friends, camp and fish, and generally enjoy nature". This was reinforced by comments made in the Derby focus group discussion, where one of the participants noted that rivers were places to '*escape from the heat*'.

"Water keeps you cool and comfortable"

Mt Isa FGP.

Perennial rivers and water-holes are therefore likely to be highly valued by local residents (both Indigenous and non-Indigenous) – not just for sustaining life, but also for cooling, and for recreation. Furthermore, these recreational values are not

solely the proviso of local residents. Some of the more well known areas (eg Kakadu National Park) serve as an 'attraction' for national and international tourists, clearly providing 'recreational' values to residents and non-residents alike.

And some of these recreational values are likely to complement (rather than compete with) the ecosystem and environmental values discussed earlier. This is not to say however that all of them do (for example, regional dams enjoy a high degree of recreational popularity however the building of these dams may disturb elements of the natural ecosystem).

4.2.4 Industry Values

The Australian Bureau of Statistics (2004c) presents data on water supply and water use across Australia. Notably, the industry that used the most water during that period was agriculture, accounting for 67% of all water consumption in Australia. Other large users of water identified by the ABS include: households (9% of Australia's water consumption); the electricity and gas supply industry (7%); manufacturing (4%); and mining (2%).

However, whilst this data is available at the state level it is not available at a fine geographic scale (eg for individual river basins). So rather than reporting state consumption figures which do not correspond closely to the regions under investigation, this section presents data that allows us to draw inferences about the likely levels of demand in the study area.

Specifically it presents information from existing studies about the value/revenues earned by high water-using industries within the TR region. This is generally at a coarse geographic scale. To gauge the importance of these industries to individual river basins, this section thus also presents data on the number of persons employed[30] in industries that have been identified as being 'high' water users (ie. agriculture, electricity and gas supply, manufacturing and mining). Data from Geoscience Australia is also used to show the location of mines that are currently operating and the location of sites that have been identified as having a mineral 'occurrence' or deposit.

Like the population figures discussed above, it is important to stress that this information does not provide us with a full and accurate estimate of the 'value' of water in various uses. However, it does allow us to draw inferences about the value of water in different regions and to identify specific areas where different types of industries are likely to require ('value') water for different uses.

4.2.4..1 Agriculture

As noted earlier the agricultural sector is one of the largest users of water in Australia, with most of that water being used in irrigation. Hence the reason for looking at the number of people employed in this industry across the TR region.

Although the Darwin area has the largest absolute number of persons employed in agriculture, fishing and forestry (Figure 23) it is not as heavily dependent upon the industry for employment as many other basins, where a significant proportion of the

[30] There is a need for caution when interpreting information from the ABS that is calculated from ENUMERATED data since this may not relate directly the employment levels of the resident population (particularly when a high proportion of those enumerated were visiting the area on census night).

workforce is employed in that sector (basins: 914 – 88.1%; 918 – 67%; 805 – 43.9%; 917 – Georgetown 35.2%; 919 – Kowanyama 29.8%; and 810 – 26.2%) (see Table 3). These figures are in stark contrast to those calculated for Australia as a whole, where approximately 4% of the workforce is employed in agriculture, forestry and fishing (Australian Bureau of Statistics 2001b). Evidently, residents of the TR region are more heavily dependent upon the agricultural, fishing and forestry industry for employment than Australian's as a whole.

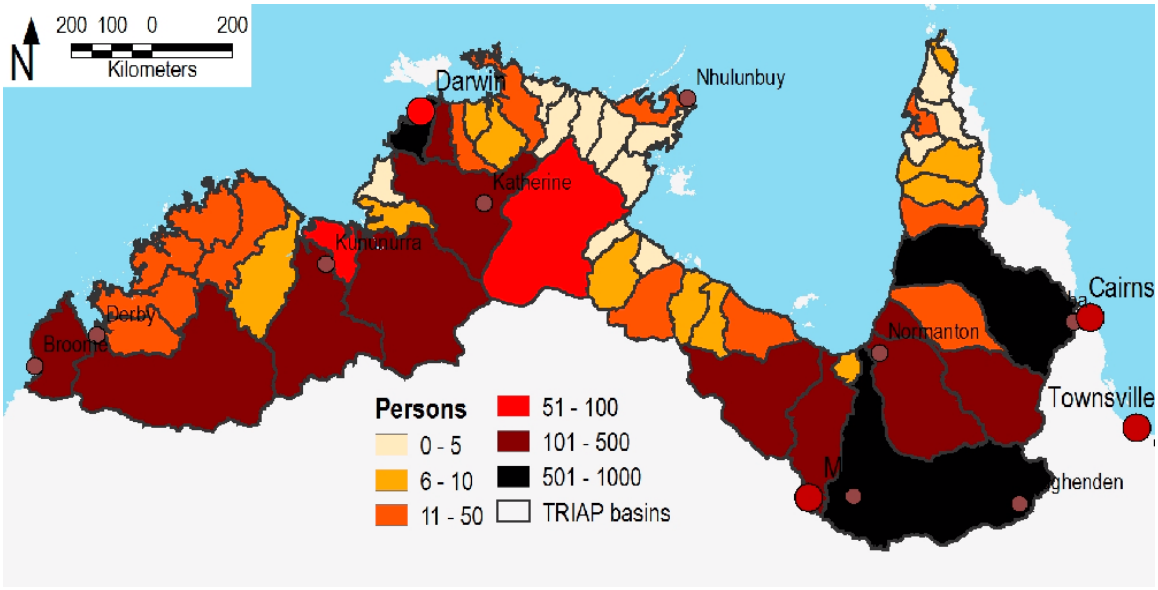


Figure 23 - Number of persons employed in agriculture, fishing and forestry 2001 census by basin

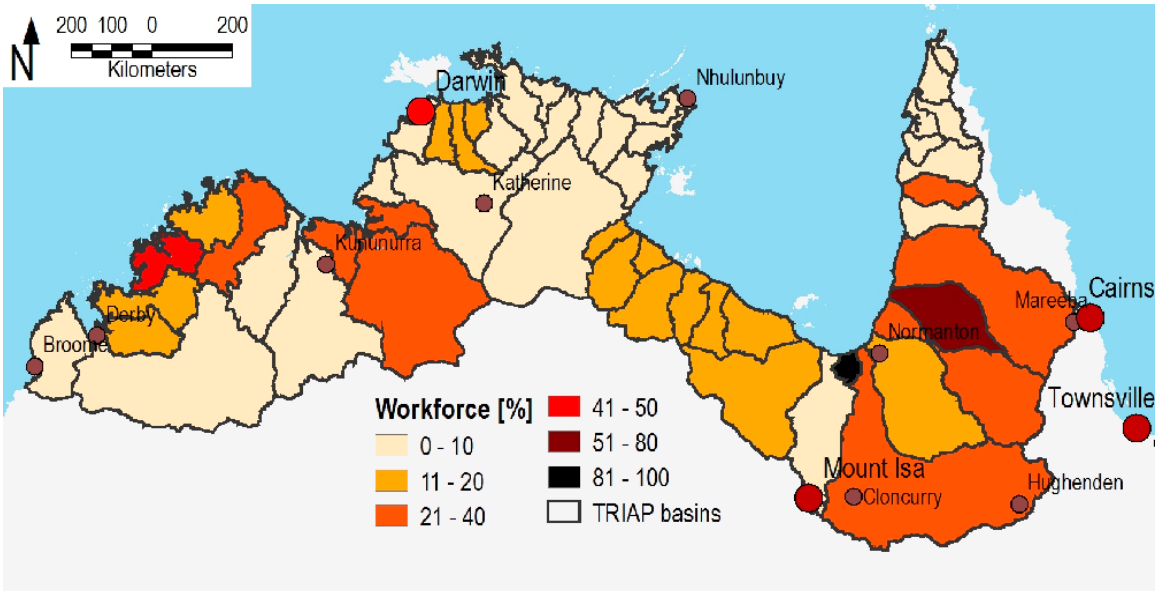


Figure 24 - Proportion of workforce employed in agriculture, fishing and forestry 2001 census by basin

This should not, however, be interpreted to mean that the main use of water in the TR region is, like the rest of Australia, agriculture. This is because most land in the TR region is used for grazing (Figure 20) and this form of agriculture uses relatively little water when compared to those that rely on irrigation (such as cotton, dairy farming and rice[31] (ABS 2004c, p.55)). As shown in Figure 25, less than 1% of all agricultural land in areas throughout the TR region (for which data are available) is irrigated. An important exception to this occurs in basin 809 (containing Kununurra), which records the highest average (irrigation) application rate for sugar cane crops (20.3 megalitres per irrigated hectare). By comparison, the average application rate on sugar cane in Queensland was 5.2 megalitres per irrigated hectare.

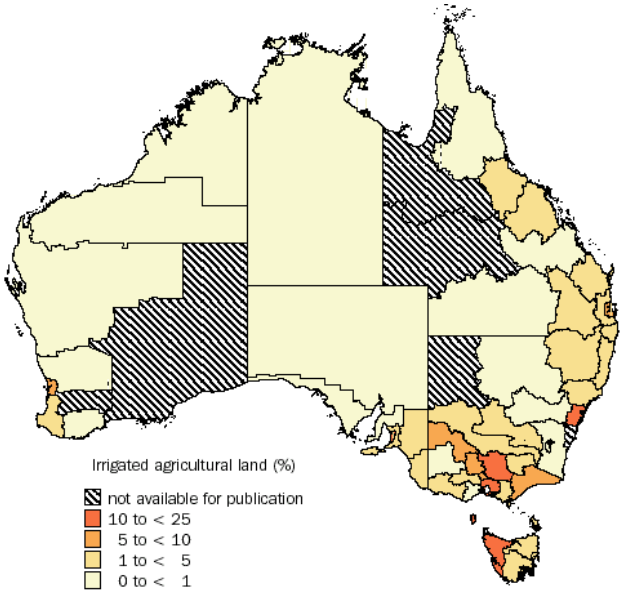


Figure 25 - Irrigated agricultural land, percentage, by statistical division

Source: (ABS 2002)

Despite the fact that there is relatively little irrigation occurring in the TR region at present, the financial incentives to use irrigation are significant. In his study of the irrigation industry in the Murray and Murrimbidgee basins, Meyer (2005) found that irrigated production generates a level of economic and community activity that is three to five times higher than would be supported from rainfed production alone. Similarly the CSIRO CRC for Irrigation Futures[32] found that revenue in irrigated areas is 13.1 times greater than in dryland areas[33] and Stoeckl and Inman-Bamber (2003) found that the marginal product of water was significantly higher in dry years than in wet. Therefore irrigation is likely to be of more value in Australia's dry TR region than in areas where water is abundant.

[31] The crop with the highest average application rate nationally was rice, with a rate of 14.1 megalitres per irrigated hectare. This is more than three times the average application rate across all crops and pasture. The next highest national average application rate was cotton, at 6.5 megalitres per irrigated hectare. (ABS 2004c, p.55)

[32] See http://www.cmis.csiro.au/healthycountry/reports/Irrigation_perspectiveV2.pdf for further information.

[33] To date, there does not appear to have been any research into the value of irrigation in the TR region, although one project is currently considering a broader systems analysis in considering ways of evaluating the sustainability of irrigation in northern Australia (Kellett et al. 2005).

Even if landholders are not seriously considering irrigation, there are pressures to intensify current agricultural practices. This is evidenced by the overview of pastoral industries across Australia's savannas compiled by the Tropical Savannas CRC[34] and summarised below:

- In the Kimberley region, 93 different pastoral leases occupied 23 million hectares and generated incomes of approximately $42.7 million during 1996-97. Recent years have however seen a decline in the number of leases and an increase in the corporatisation of those that remain.
- Properties in the Darwin-Kakadu region tend to be smaller than those in the Kimberly, with many family owned enterprises. However, areas around Darwin which have traditionally been used for cattle grazing are increasingly being converted to more intensive agricultural uses.
- The NT government is supporting the development of some 440 000 hectares in the Katherine-Daly region which is envisaged to provide opportunities for mixed farming (native and sown pasture grazing, dryland crop rotation and various complementary enterprises).
- Properties in the VRD-Sturt region are large, and stocking rates are fairly low. However there is a trend in this region, as in most of northern Australia, toward company ownership and the majority of properties in the VRD are now corporately owned.
- At present there is very little organised cattle grazing taking place in the Arnhem land region. There are a few small operations, such as those at Gumbulunya and Mawangi, which supply local abattoirs. However there is a growing interest from some communities in setting up pastoral enterprises and of managing more intensely the wild cattle populations in the area.
- Agricultural establishments in the southern Gulf and on Cape-York peninsula are reportedly hampered by low soil fertility, the poor nutrient value of pasture, isolation and limited infrastructure. Although there may still be pressures to corporatise properties in these regions, there may be little pressure to intensify production techniques in the near future.

In short, there is evidence to suggest that agriculture will continue to become more intensive across the western and middle parts of the TR region, placing increasing pressures on the region's rivers. As noted at the beginning of section 4.2, there is a strong link between land-use and water quality and quantity, so depending upon the nature of the intensification, such pressures may compete with, rather than complement, values discussed previously. This is starkly evidenced by comments in focus group discussions where it was frequently noted that some forms of agricultural intensification (specifically, fencing) was preventing people from using rivers for other 'valued' purposes.

"Access is probably one of the biggest issues between pastoralists and traditional owners (we see a fence and we can't go fishing)"

Derby FGP.

"Access provisions are a fishing issue –how do you negotiate with landholders for access?"

Katherine FGP.

[34] See http://savanna.ntu.edu.au/information/ar/ar_gr.html for further information.

Table 3: TR basin employment in agriculture, forestry and fishing; mining; manufacturing; electricity gas and water supply – sorted by size of labour force

River basin	Town	Labour force	Employment in agriculture, forestry and fishing		Employment in mining		Employment in manufacturing		Employment in electricity, gas and water	
		persons	persons	% of labour force	persons	% of labour force	persons	% of labour force	persons	% of labour force
ALL	**TR REGION**	**106370**	**5587**	**5.3**	**5112**	**4.8**	**5156**	**4.8**	**910**	**0.9**
815	Darwin	52650	943	1.8	441	0.8	2622	5.0	510	1.0
913	Mount Isa	10864	248	2.3	2057	18.9	796	7.3	115	1.1
801	Broome	7195	462	6.4	110	1.5	429	6.0	54	0.8
814	Katherine	5639	272	4.8	157	2.8	109	1.9	59	1.1
809	Kununurra	4392	443	10.1	352	8.0	172	3.9	37	0.8
915	Hughenden	3965	872	22.0	419	10.6	153	3.9	40	1.0
802	Derby	3588	175	4.9	183	5.1	85	2.4	24	0.7
826	Nhulunbuy Gove	2463	17	0.7	356	14.5	304	12.3	8	0.3
919	Kowanyama	2385	710	29.8	27	1.1	88	3.7	0	0.0
928	Torres Strait Islands	1819	12	0.7	3	0.2	9	0.5	3	0.2
924	Weipa	1355	41	3.0	334	24.7	53	3.9	0	0.0
916	Karumba	1223	200	16.4	29	2.4	58	4.7	6	0.5
821	Jabiru, Manjilang, Kunbarllanjnja	1200	38	3.2	201	16.7	35	2.9	6	0.5
903	Mataranka	1059	88	8.3	20	1.9	27	2.6	2	0.2
912	Domadgee, Burketown	1003	113	11.3	179	17.8	35	3.5	12	1.2
817		821	121	14.7	18	2.2	39	4.7	16	1.9
929	Groote Eylandt	798	0	0.0	232	29	6	0.7	3	0.4
927	Bamaga	781	6	0.8	1	0.1	13	1.7	3	0.4
917	Georgetown	741	261	35.2	83	11.2	27	3.6	6	0.8
816	Bathurst and Melville Islands	703	27	3.8	0	0.0	12	1.7	0	0.0
811	Dagarago, Timber Creek	675	141	20.9	2	0.3	4	0.6	0	0.0
823	Maningrida	452	0.09	0.0	7	1.5	0	0.0	0	0.0
923	Aurukun	416	5	1.2	4	1.0	0	0.0	0	0.0
911	Mornington Island	381	0	0.0	3	0.8	3	0.8	0	0.0
920	Pormpuraaw	355	19	5.4	0	0.0	0.05	0.0	0	0.0
813	Thamarrurr, Nganmarriyanga	343	0.3	0.1	0.02	0.0	0.01	0.0	3	0.9
810		286	75	26.2	7	2.4	16	5.6	2	0.7
808	Wyndham	192	9	4.7	4	2.1	4	2.1	0	0.0
806	Kalamburu	178	36	20.2	1	0.6	14	7.9	0	0.0
922	Coen	176	10	5.7	1	0.6	2	1.1	0	0.0
824	Ramingining	173	3	1.7	0	0.0	0	0.0	0	0.0
820	Jabiru	166	7	4.2	4	2.4	12	7.2	0	0.0
901	-	165	0	0.0	0	0.0	2	1.2	0	0.0
803		158	32	20.3	20	12.7	8	5.1	0	0.0
825		154	5	3.2	0	0.0	0	0.0	0	0.0
902	Numbulwar	118	0.08	0.1	0	0.0	3	2.5	0	0.0
807	-	113	25	22.2	3	2.7	10	8.9	0	0.0
818	-	112	22	19.7	6	5.4	3	2.7	2	1.4
804	-	101	20	19.9	8	8.0	5	5.0	0	0.0
910	-	88	14	15.9	30	34.0	5	5.7	1	1.2
907	Borroloola	78	16	20.4	11	14.0	0.8	1.0	1	0.8
805	-	73	32	43.9	1	1.4	9	12.4	0	0.0
819		71	8	11.2	3	4.2	4	5.6	1	0.8
918	-	69	46	67.0	0.06	0.1	1	1.5	0	0.0
925	-	60	4	6.6	2	3.3	1	1.7	0	0.0
905	-	56	9	16.0	8	14.2	0.5	0.9	1	0.9
908	-	45	7	15.5	7	15.5	0.4	0.9	0	0.9
812	-	37	8	21.8	0.3	0.8	0.3	0.8	0	0.0
909	-	36	6	16.7	5	13.9	0.3	0.8	0	0.9
926		27	1	3.8	3	11.3	3	11.3	0	0.0
921	-	26	6	23.4	0	0.0	2	7.8	0	0.0
906	-	20	3	14.8	3	14.8	0.2	1.0	0	0.9
904	-	14	2	14.0	2	14.0	0.1	0.7	0	0.9
822	-	7	0	0.0	3	43.7	0	0.0	0	0.0
914	-	7	6	88.1	0	0.0	0	0.0	0	0.0

4.2.4..2 Fisheries

Although the commercial fishing industry is not a significant 'user' of water, it is, nonetheless dependent upon rivers for its livelihood. This has been evidenced by the National Oceans Office's commission of a review of literature relevant to the Northern Planning Area (National Oceans Office 2003). This review noted the importance of understanding the impacts of tropical river use and functioning on marine-based industries.

As shown in Figure 26, there are three Commonwealth managed fisheries that operate in the drainage basins of the TR region: the North West Slope Trawl Fishery, the Northern Prawn Fishery and the Torres Strait Fisheries. In 2003-04, the North West Slope (Scampi) Fishery generated approximately $1.1m of revenue, whilst the Northern Prawn Fishery generated around $74 million – distinguishing itself as Australia's most valuable Commonwealth-managed fishery (Australian Bureau of Agricultural and Resource Economics 2005, p.2).

Clearly this industry is likely to place significant 'value' on the health of the regions river systems, since any significant problems with either the quantity or the quality of water flowing into the Gulf of Carpentaria or the Timor Sea has the potential to do great harm to these industries.

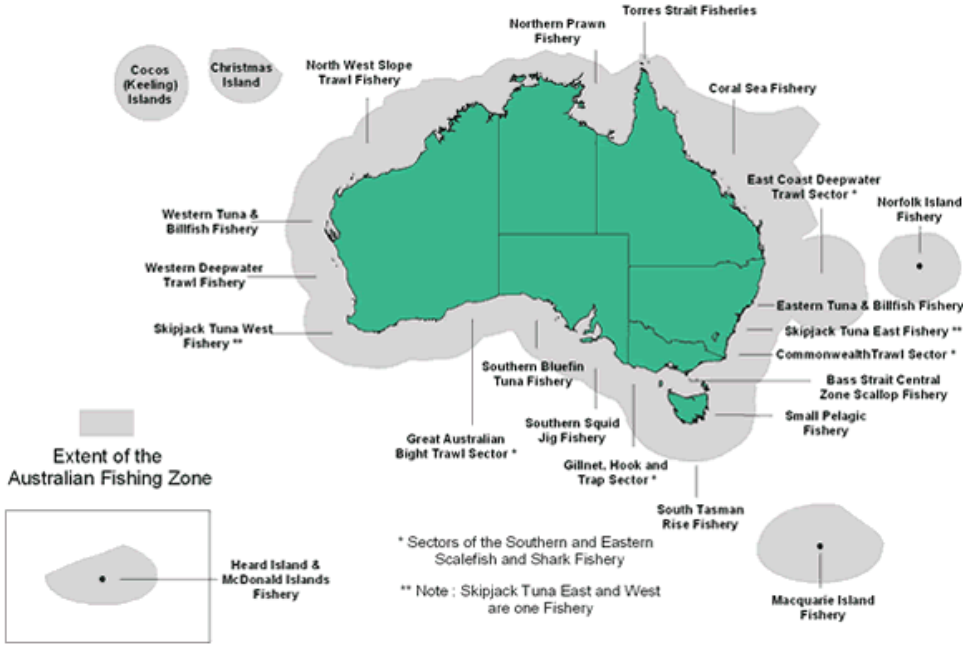


Figure 26 - Australian fishing zones

Source: (Australian Fisheries Management Authority 2005)

Specifically, a significant portion of the Northern Prawn Fishery's catch is comprised of banana prawns. These prawns enter shallow rivers and estuaries as part of their life-cycle, and are washed down-river into the ocean by flood events during the wet season (Grey et al 1983). A poor wet season is thus generally associated with a poor banana prawn season, the corollary to that being that anything (not just drought) that disrupts the natural flow of rivers in this region has the potential to affect that industry.

Prawn fisheries are also reliant on estuarine habitat areas for spawning and for the development of juveniles and on substantial fresh water flows to flush adult prawns into marine areas for commercial harvesting (OzEstuaries n.d.). Although adult tiger prawns are generally found in the deeper waters of the Northern Prawn Fishery,

juveniles are found in shallow waters generally associated with seagrass beds. Consequently, the health of tiger-prawn fisheries is indirectly linked to the health of the waterways in the TR region.

Similarly wild barramundi are sourced exclusively from the Northern Territory and Queensland and these fish rely on freshwater rivers and streams in largely unmodified ecosystem habitats. Because adults move downstream to estuaries and coastal waters for spawning it is important that their movement is not hindered by in-stream water structures such as dams or barrages (OzEstuaries n.d.). Therefore barramundi fishermen are also particularly reliant on tropical river health to ensure the availability of catches.

In short, a significant value associated with rivers in the TR region is the contribution that they make to the fishing industry.

Importantly this (fishing) value may complement many of the environmental and/or Indigenous values discussed in the preceding sections, but could compete with those of the agricultural sector (since some agricultural practices can have 'downstream' impacts on the fishing industry such as overgrazing which can lead to erosion and consequent sedimentation). Some evidence of emerging 'conflict' was found in the focus group discussions between commercial and recreational fishermen and between (agricultural) land-holders and recreational fishermen. This was also supported in the comments made by the Executive Officer of the Amateur Fisherman's Association of the NT (Appendix F).

"Commercial and recreational fishers are also competing for fish and access to the rivers"

"The recreationals are saying that the commercials are impacting on their ability to catch fish"

Katherine FGP's.

'People come in from Karumba and try to fish our fish. Our rivers – our fish. They shouldn't be able to take them away. There are major conflicts and it comes to property being damaged'.

'There are problems with multi-licensing. People can get a license for three fish and go anywhere. In the old days there was a gentleman's agreement – you'd only fish in your own territory. It's changed because of the commercial pressures. Now the fish are worth more and the rules no longer hold'

Mt Isa FGP's.

Whilst most of these conflicts were expressed in terms of 'access' or 'catch' they are essentially about competing values associated with Australia's tropical rivers.

4.2.4..3 Tourism

Like the fishing industry, the tourism industry is not a high 'consumer' of water. Nevertheless waterfalls, lakes, wetlands and fishing opportunities often serve the important role of attracting tourists to a destination. Consequently whilst the industry may not 'use-up' water it is nevertheless somewhat dependent upon it for its livelihood. And these livelihoods are not insubstantial. As documented in Greiner et al (2004b), most visitors to the Shire of Carpentaria are attracted to the region for the purpose of 'fishing' and those visitors inject an estimated $14 million per annum into

the local economy (comprising fewer than 1500 permanent residents)[35]. Those who earn their livelihoods from tourism may therefore place a relatively high 'value' on the presence of water, and should thus be considered in this profile.

One method of attempting to gauge the importance of tourism in a region is to look at visitor statistics. In 2004 the NT was host to approximately 1.5 million visitors – although numbers were down from previous years (between 2001 and 2004 there was a 10% fall in the number of visitors to the NT (Northern Territory Tourist Commission 2004)). Tourism generated $657 million dollars in expenditure for the Top End in 2003-04, with $70 million of expenditure generated in the Katherine region.

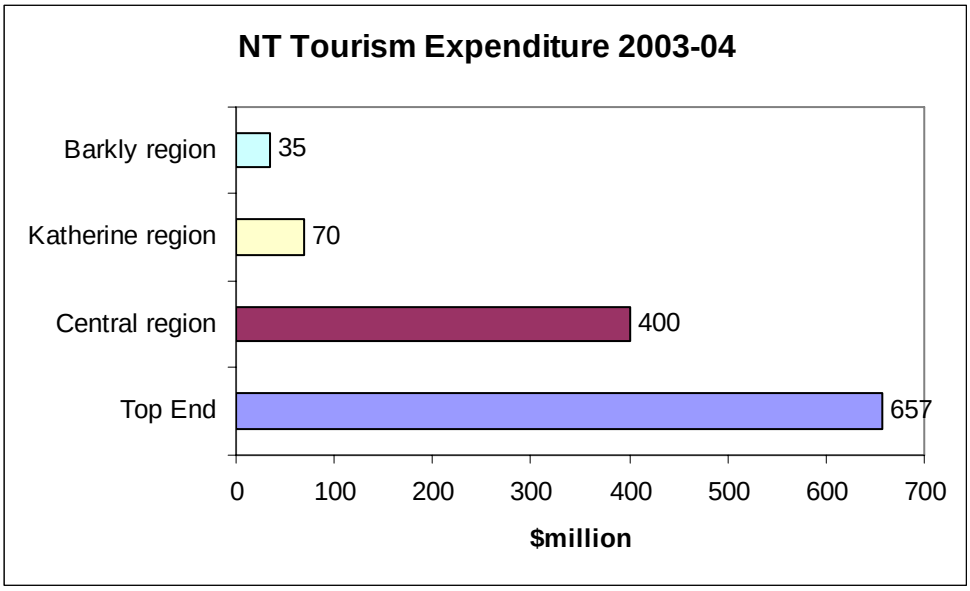


Figure 27 - NT tourism expenditure 2003-04

Source: (Northern Territory Tourist Commission 2004)

In 2004, outback QLD was host to almost 500,000 visitors, up 2.4% since 2001 (Tourism Queensland 2004), and domestic and international tourism is reported to account for 5.1% of regional product in that area (Queensland Government Office of Economic and Statistical Research 2002).

The Pilbara, Kimberley and all inland areas north of Newman in Western Australia directly value added $196 million to the Western Australian economy in 2002. This equates to approximately a 9% share of Western Australia's tourism revenue for the year for this region specifically (Access Economics 2003, p.29).

The key problem here, however, is that these statistics are collected at too coarse a geographic scale to provide information specific to the TR region. The 'outback Queensland' region, for example, incorporates all of western Queensland from the Gulf of Carpentaria to the NSW border. Similarly, data for the NT tends to be segmented between the Top End, Katherine, the Central region and the Barkly region, with many of these areas interlapping to form the TR area.

[35] Although Young (2004) conducted a series of focus group meetings in the Daly region, where the tourism value of the river was noted, but participants commented that the 'benefits' of that tourism largely accrued outside the region.

Consequently, the data is not particularly useful for those only interested in a subset of that region. Another way of attempting to gauge the value of tourism at a regional level is to look at the number of people employed in that sector (as has been done for the other industries). In Australia as a whole almost 4.9% of the workforce was employed in industries associated with the tourism sector: the cafes, accommodation and restaurant sector (410,589 people). As shown in Table 4, employment in that same sector is similar across the TR region as a whole but there is considerable variation across the basins. In basins 807, 808 (Wyndham), 818, 821 (Jabiru), and 801 (Broome), the café, accommodation and restaurant sector accounts for more than 15% of all employment, and in absolute terms, the industry accounts for more than 500 jobs in basin 913 (Mt Isa), and more than 2633 jobs in basin 815 (Darwin).

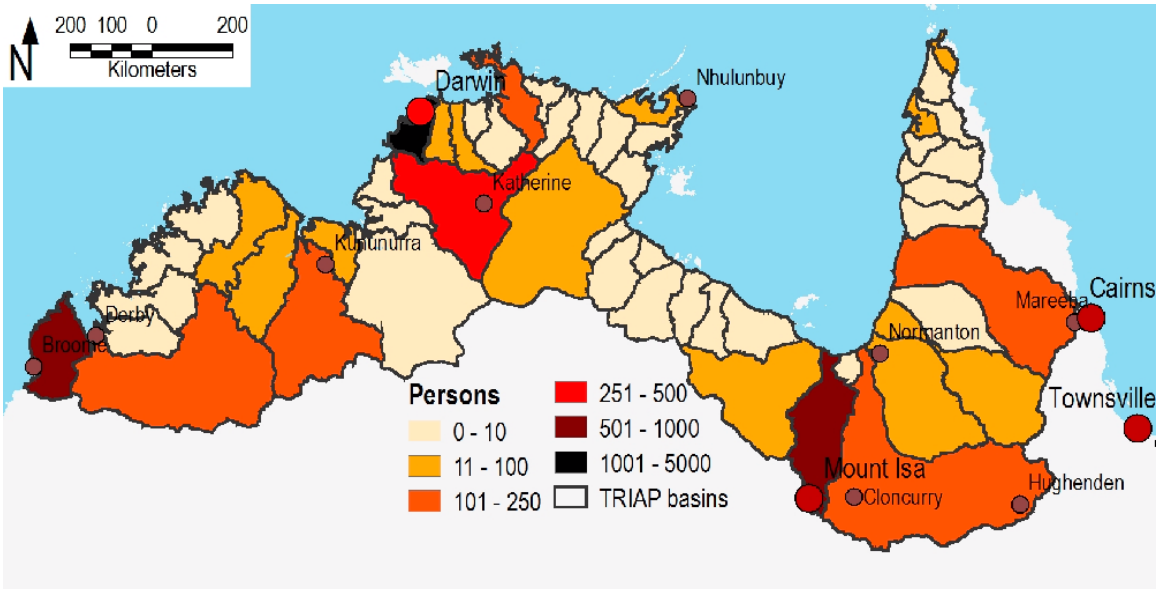


Figure 28 - Number of people employed in accommodation, cafes and restaurants 2001 census – by basin

The problem here, however, is that many businesses associated with the tourism sector are not associated with the accommodation, cafes and restaurant sector (for example, tour operators). It is therefore useful to look at the industry from a different perspective. Specifically, when the ABS conducts its census it counts all persons – noting whether they are residents, visitors from elsewhere in Australia or visitors from overseas. It is, therefore, possible to get an indication of how important tourism is to some regions by looking at the number of visitors. Like the workforce data this information is also available at the CD level, meaning that it is possible to estimate the total number of visitors in each basin of the TR region (Figure 29).

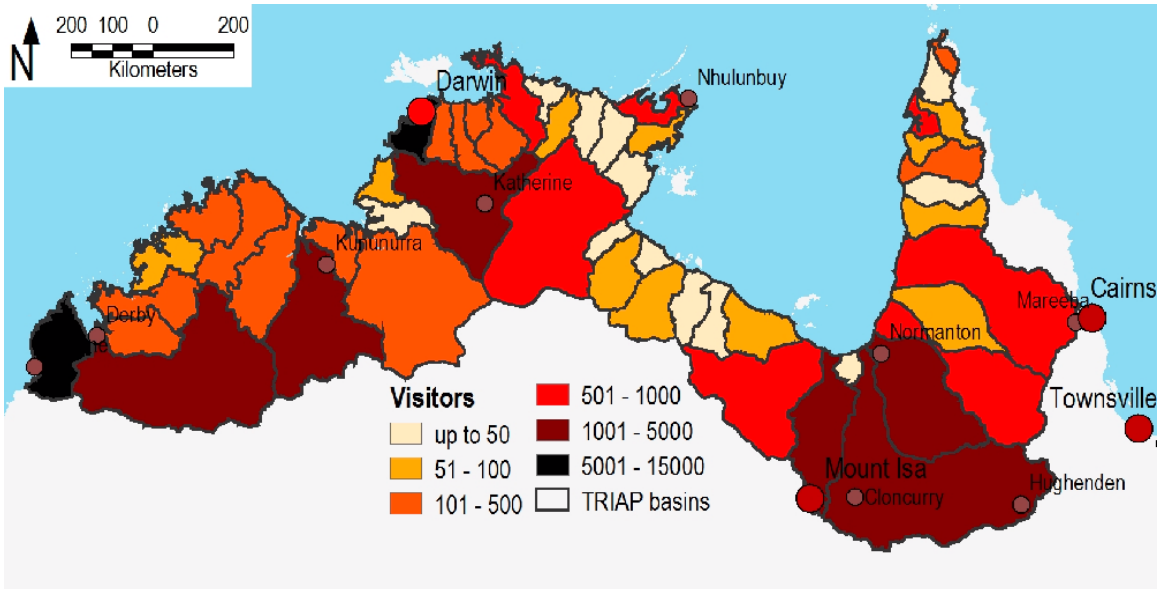


Figure 29 - Total number of 'visitors' enumerated during the 2001 census by basin

Here it is evident that tourism is relatively important to several communities within the TR region, including the basins containing Darwin, Broome, Katherine, Kununurra, Derby, Mt Isa, Hughenden, Kakadu, Kowanyama, Karumba and Mataranka which respectively, had 16,000, 7000, 5917, 4610, 3584, 3385, 2884, 2403, 1866, 1604 and 1565 visitors enumerated on census night 2001 (Table 4).

Irrespective of the data one looks at, it is, therefore evident, that the regions rivers are of value to the tourism industry. And whilst some of these values will complement values already discussed in this report (e.g. 'eco tourism' and environmental values) it is evident that conflicts are emerging.

'Tourists are staying (for) long periods on river sites' and recreational fishers are staying 'for three weeks and filling their freezers'.

'The Kimberley is now recognised as a pristine area which brings more tourists and also more damage and this has galvanized the community'.

'Increased tourist numbers has caused more damage to water holes and roads etc. There is competition between places that locals use and ones that tourists use. e.g. bus company coming in to an area that locals only used.'

Derby FGP's

'The council has trouble with recreational users, visitors, tourists, long grass people. There is broken glass and litter left around. It is hard to get those people to respond and this kind of thing degrades the river'.

Katherine FGP's

There has been increased tourism within the area but no increase in management of these tourists by the state government'

'Take the Gregory River. Locals are camping and using it for recreation but it is also the drinking supply for Gregory. Camping is very intensive in May and it's resulting in pollution. There is some farming, irrigated from the river, increased rubbervine. And

the local community is waiting for the government to get proactive. There is a lack of management of tourism and recreation and environmental impacts'.

Mt Isa FGP's.

In short, an 'insiders versus outsiders' mentality seems to be developing as locals become more and more frustrated at the damage, mainly in terms of pollution, left behind by some tourists who appear to contribute little to the local economy and management effort. Although the use of water by tourism is largely non-consumptive this clearly demonstrates that the impact of such uses can still have widespread effects. More will be said on these important issues in chapter 6.

Table 4: TR basins employment in accommodation, cafes and restaurant sector and numbers of visitors – sorted by size of labour force

River basin	Town	Labour force No. of persons	Employment in tourism sector No. of persons	Employment in tourism sector % of labour force	Total number of overseas visitors enumerated 2001 census No. of persons	Total number of visitors enumerated 2001 census No. of persons
ALL	**TR REGION**	**106370**	5498	5.2	9650	65243
815	Darwin	52650	2633	5.0	2937	14642
913	Mount Isa	10864	514	4.7	186	3199
801	Broome	7195	628	8.7	712	6960
814	Katherine	5639	354	6.3	1186	4731
809	Kununurra	4392	227	5.2	459	4151
915	Hughenden	3965	204	5.1	146	2738
802	Derby	3588	121	3.4	245	3339
826	Nhulunbuy Gove	2463	91	3.7	35	638
919	Kowanyama	2385	130	5.5	194	1672
928	Torres Strait Islands	1819	9	0.5	28	410
924	Weipa	1355	52	3.8	15	643
916	Karumba	1223	86	7.0	48	1556
821	Jabiru, Manjilang	1200	125	10.4	673	1730
903	Mataranka	1059	47	4.4	150	1415
912	Domadgee, Burketown	1003	28	2.8	70	1036
817		821	55	6.7	126	1034
929	Groote Eylandt	798	55	6.9	8	103
927	Bamaga	781	24	3.1	6	553
917	Georgetown	741	55	7.4	77	866
816	Bathurst and Melville Islands	703	12	1.7	6	39
811	Dagarago, Timber Creek	675	8	1.2	76	466
823	Maningrida	452	0	0.0	0	96
923	Aurukun	416	0	0.0	0	121
911	Mornington Island	381	6	1.6	0	32
920	Pormpuraaw	355	0.5	0.1	49	550
813	Thamarrurr, Nganmarriyanga	343	0.06	0.0	30	301
810		286	17	5.9	105	934
808	Wyndham	192	27	14.1	46	398
806	Kalamburu	178	2	1.1	39	310
922	Coen	176	4	2.3	9	284
824	Ramingining	173	0	0.0	0	28
820	Jabiru	166	3	1.8	433	1015
901	-	165	4	2.4	0	106
803		158	6	3.8	56	806
825		154	0	0.0	0	25
902	Numbulwar	118	0	0.0	3	26
807	-	113	17	15.1	92	685
818	-	112	13	11.6	473	1257
804	-	101	4	4.0	82	590
910	-	88	4	4.5	22	748
907	Borroloola	78	2	2.6	83	594
805	-	73	0.3	0.4	49	299
819		71	5	7.0	433	994
918	-	69	0.6	0.9	15	301
925	-	60	0	0.0	9	282
905	-	56	2	3.6	28	364
908	-	45	1	2.2	65	524
812	-	37	0	0.0	85	452
909	-	36	1	2.8	65	524
926		27	0	0.0	3	401
921	-	26	2	7.8	9	215
906	-	20	0.6	3.0	10	294
904	-	14	0.4	2.8	10	294
822	-	7	0	0.0	0	30
914	-	7	0	0.0	6	26

4.2.4..4 Mining

Like agriculture, mining is relatively more important to communities within the TR region than to Australia as a whole. In 2001, only 0.9% of Australia's entire workforce was employed in the mining sector (75, 178 persons)[36] – whereas almost 4.8% of those employed in the TR region worked for that industry.

As shown in Table 3 many basins in the TR region are heavily dependent on mining, with the industry accounting for more than 10% of employment in at least 17 basins. And when expressed in these terms, the basins that are most dependent on mining include numbers 910, 924 (Weipa), 913 (Mount Isa), 917 (Georgetown), 821 (Kakadu / Jabiru), 906, 908, 826 (Nhulunbuy) and 929 (Groote Eylandt) – although in terms of absolute numbers of those employed basin numbers 815 (Darwin), 915 (Hughenden), 809 (Kununurra), 802 (Derby), 814 (Katherine) and 801 (Broome) also gain much from employment from the mining sector (see also Table 3).

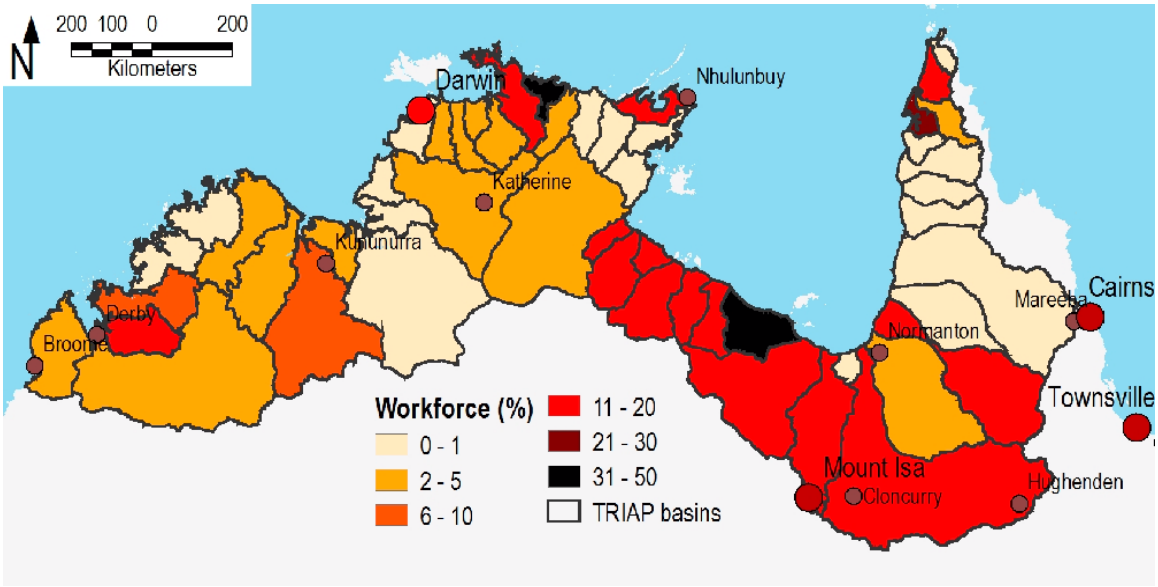


Figure 30 - Proportion of workforce employed in mining industry 2001 census

Data copyright Geoscience Australia

Importantly, employment figures do not always provide a full and accurate picture of the importance of mining in remote areas. This is because many mines employ workers on a 'fly-in fly-out' basis – i.e. workers and their families may live hundreds of kilometres away from the mine, the workers flying to the site for work on a rotational basis. It is, therefore, of interest to look at the location of mines that are operational (Figure 31) and at the location of 'deposits and mineral occurrences' that have been identified, but are not yet being exploited (Figure 32).

[36] See: http://www.abs.gov.au/ausstats/abs@census.nsf/ddc9b4f92657325cca256c3e000bdbaf/7dd97c937216e32fca256bbe008371f0!OpenDocument#Industry for further information

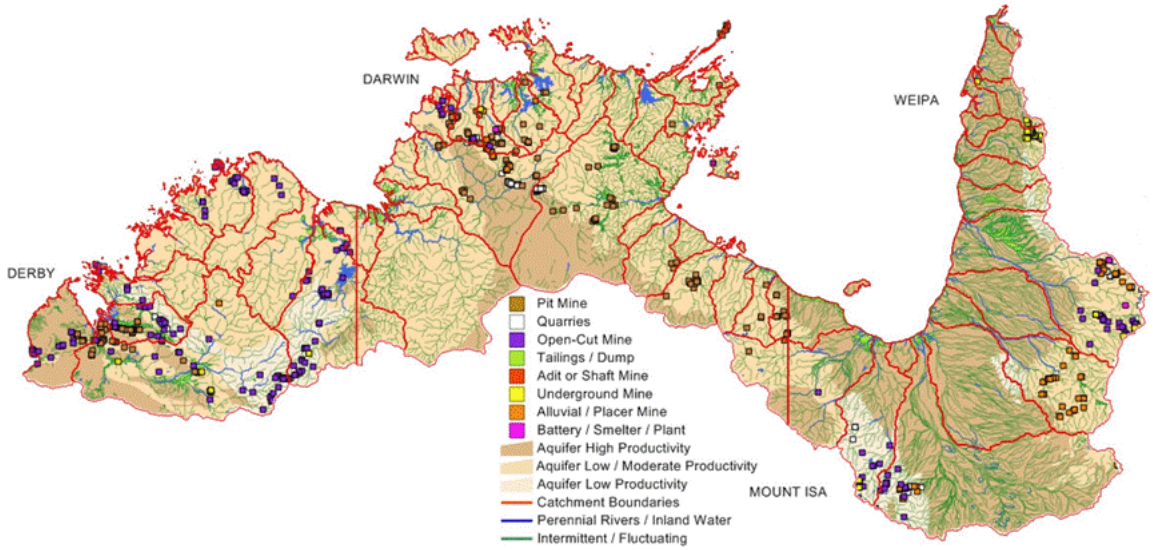


Figure 31 - Location of mines 2000

Data copyright Geoscience Australia

Clearly, the mines and mineral deposits are not scattered evenly across the TR region. Whilst there are many mines and deposits around Mt Isa, Darwin, and in the Kimberley, there is very little mining activity in the basins around the southern Gulf of Carpentaria. Interestingly, it is clear from these maps that relatively few of the mines are located in regions that have either productive aquifers or perennial rivers. This places considerable pressure on scarce water resources – a pressure which is unlikely to be alleviated whilst the current mining 'boom' continues.

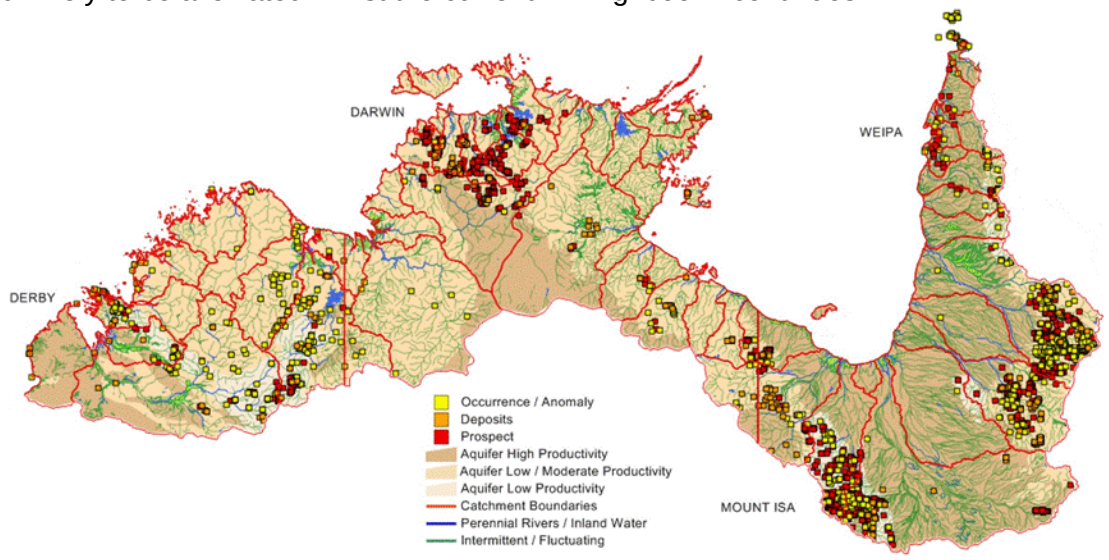


Figure 32 - Location of mineral prospects, occurrences and deposits (non-operational) as at 2000

In short, the mining industry is clearly likely to place high 'values' on the region's rivers primarily because water is an important factor of production. This water is not just of 'value' for current ventures, but also for future developments and the current worldwide minerals boom is likely to place great pressure on those values. As previously, it is also important to note that these 'values' may compete with (rather than complement) existing values. This has been evidenced by comments made during the focus group discussions:

'There are issues with mining above the town water supply. It's a big worry for the community because of potential contamination'.

Katherine FGP.

'Mining companies are dewatering aquifers to gain access to minerals, and this is affecting agriculturalists who use bore water for their stock'.

Mt Isa FGP.

'Uranium mining could take place in the area and use a lot of water and pollute the river. Deposits are close to the river'.

Derby FGP.

4.2.4..5 Manufacturing

Across Australia as a whole, an estimated 1,010,179 people (12.2% of the labour force) were employed in the manufacturing industry during 2001. In the TR region fewer than 5% of the workforce is associated with this industry making the manufacturing sector, relatively speaking, much less important to the far north than to Australia as a whole (Table 3). As shown in Figure 33, the manufacturing industry provides employment to more than 15% of the labour force in some areas of the TR region – the far northern cape, west of Cairns in the upper reaches of basin number 919, east of Normanton in basin number 916, and north west of Kununurra in basins 816 and 817. The basins that include Darwin (815), Mount Isa (913), Broome (801) and Nhulunbuy (826) have the highest number of people employed in this industry – with 2262, 796, 429 and 304 workers respectively (Table 3).

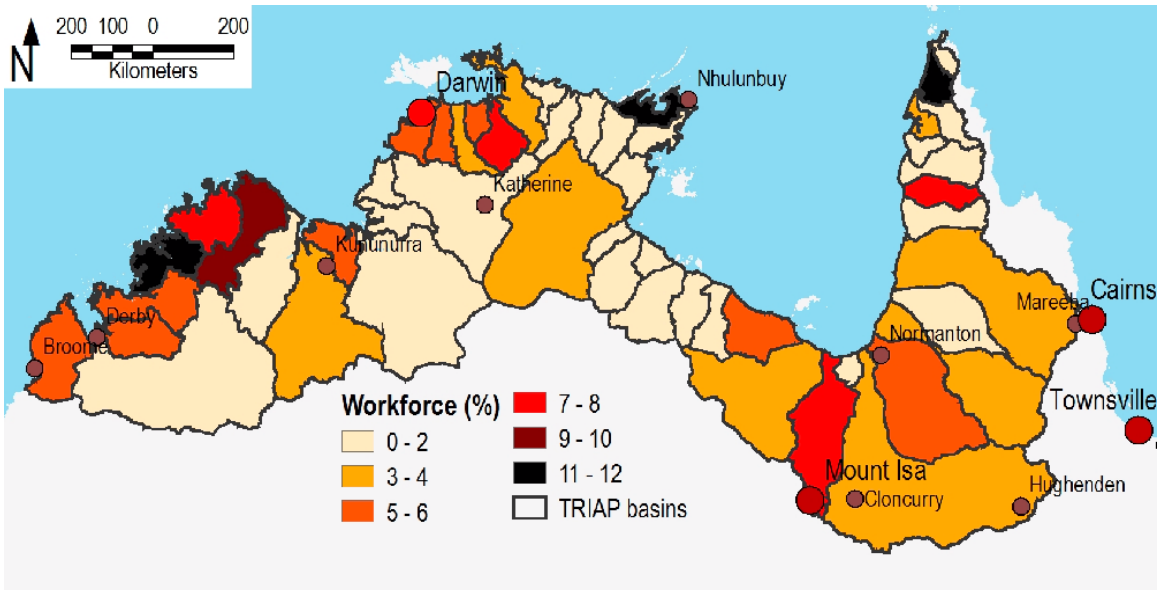


Figure 33 - Proportion of workforce employed in manufacturing 2001 census – by basin

4.2.4..6 Gas, Electricity and Water

The ABS's water accounts (Australian Bureau of Statistics, 2004c) also identify the electricity, gas and water supply industry as a relatively heavy user of water. Throughout Australia, fewer than 60,693 people (0.7% of the workforce) were employed in that industry in 2001. Employing 0.9% of the workforce (910 persons) the industry appears to be marginally more important to the TR region than to Australia as a whole – although fewer than 7 basins (including: 815 – Darwin; 913 –

Mt Isa; 814 – Katherine; 801 – Broome; 915 – Hughenden; 809 – Kununurra; and 802 - Derby) employ more than 20 people in this sector.

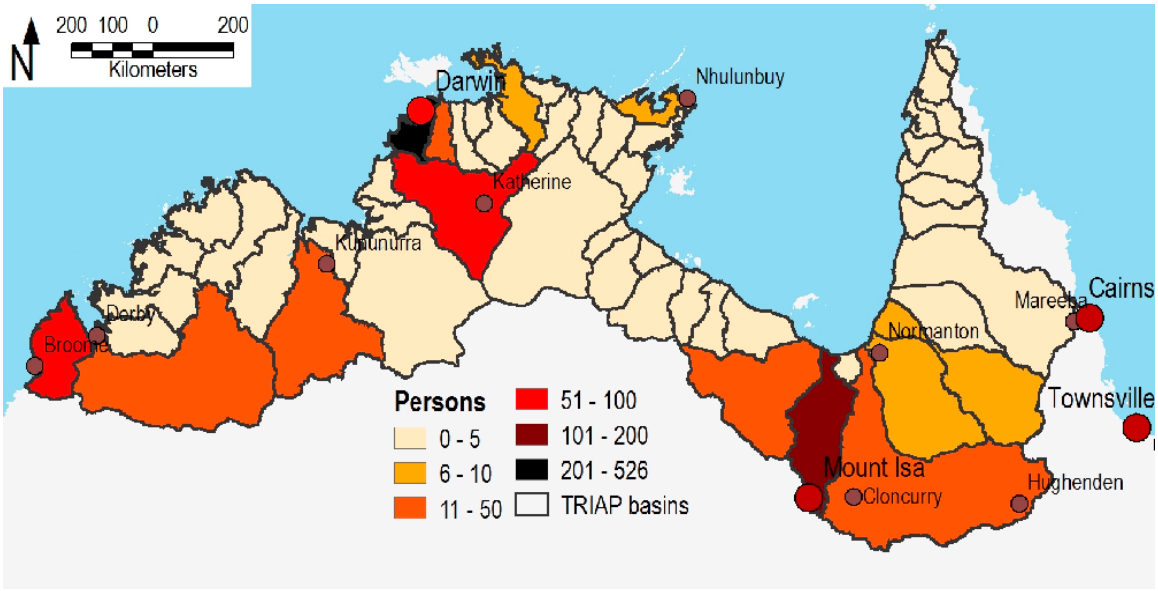


Figure 34 - Number of people employed in electricity, gas or water supply industry 2001 census – by basin

4.3 Basin-by-basin summary of key values

The information presented thus far clearly highlights the fact that there are many different social and economic 'values' associated with Australia's tropical rivers. Importantly, the information also draws attention to the fact that there may be significant differences in the relative importance of different 'values' across the basins contained within the TR region.

Some river basins, for example, have very few residents (eg basin 914 where only 11 people were enumerated during the 2001 census). Others have many. And basins with few residents are less likely to place significant 'value' on water for human consumption, than basins with many. Similarly, the population of some basins is largely dependent upon mining for its employment, whilst other basins are largely dependent upon tourism – and it would not be surprising to find that a basin that depends upon mining for employment places a higher 'value' on water for use in mining, than a basin that depends upon tourism.

Table 5 thus attempts to summarise some of the information already presented for each basin in the TR region, noting the existence of 'evidence' (based on the data and discussion of the preceding section) of different types of 'values'. Also noted, are evidences of emerging pressures in each basin (eg rapidly growing population, significant mineral deposits, etc).

Here, the 'values' are grouped into three: environmental and Indigenous values; recreational and 'human consumption' values; and values associated with industry/production. Values associated with fisheries are assumed to exist in ALL basins. The first set of values (environmental and Indigenous) have been grouped together as it appears that they are for the most part 'complementary'. In other words, it may be possible to 'satisfy' both environmental and (some – but not all)

Indigenous cultural values simultaneously[37]. As noted in the earlier discussions, however, the same cannot be said of many of the other values. Emerging conflicts between recreational fishermen and agriculturalists; between mines and agriculturalists; between local residents and tourists (etc) were all clearly identified in the focus group discussions. The 'values' associated with industry have therefore been grouped together in a single column, as have the 'values' associated with local residents.

Grouped in this way, it is possible to identify regions (a) with different multiple, possibly competing uses (or 'values') associated with water; (b) with predominately non-market values associated with water; and (c) where high rates of population growth may place extra strains on the region's rivers.

For example, river basins 801, 802, 809, 814, 815, 821, 912 and 913 all have multiple and conflicting values associated with rivers. Most of these basins have relatively high and/or growing populations (801, 802, 809, 814, 815) and include industries such as tourism, mining and agriculture. All of these basins (with the exception of 802) contain areas of environmental significance. The rivers within these basins are also likely to have high Indigenous cultural values – if only because a large proportion of the population is of Indigenous origin.

In contrast, there are also a significant number of river basins within the tropical rivers region with predominantly, but not necessarily exclusively, non-market environmental and/or Indigenous cultural values (as when, for example, very few people within the basin have formal employment in agriculture, mining or tourism). These basins include 805-807, 812, 813, 816, 822-825, 901-911, 914, 918, 926, and 927.

Notably, *current* activity within basins 808, 810, 818, 819, 820, 920-923, 925, and 927 suggests that most values associated with the rivers are environmental and/or Indigenous, although these basins also contain mining 'prospects', indicating that there may be pressures from market-based water uses in the future.

Finally, basins 803, 811 and 904 – 910 have relatively little association with 'the market' (in so much as there are relatively few residents employed in agriculture, fishing, tourism or mining). However, each of these basins have had relatively large increases in population between 1996 and 2001, indicating that there may be pressure for other water uses in the future. Similarly, basins 801 (Broome), 802 (Derby) and 809 (Kununurra) – where there are already multiple 'values' associated with water – have also had relatively large increases in population between 1996 and 2001.

[37] For example, environmentalists may object to Indigenous fishing and hunting in some protected areas

Table 5 - Indicators of the likely existence of different types of 'values' - TR basins

Basin	Town	Evidence of environmental and Indigenous values (mainly non-market)	Evidence of consumption and non-Indigenous recreational values (loosely associated with the market)	Evidence of values associated with production (generally associated with the market)
801	Broome	RAMSAR site – Roebuck Bay 20% Indigenous population	Large, growing population	Agriculture, manufacturing, mining and tourism
802	Derby	Endangered species present (spear toothed shark, fresh water sawfish) Register of the National Estate 50% Indigenous population	Large, growing population	Mining, agriculture and tourism
803			Small but growing population Many 'visitors'	Mining 'prospects'
804				Mining 'prospects'
805		Areas set aside for conservation Register of the National Estate		Mining 'prospects'
806	Kalamburu	Register of the National Estate 60% Indigenous population		
807		Areas set aside for conservation and managed protection Register of the National Estate	Small population but many visitors	
808	Wyndham	50% Indigenous population Register of the National Estate		Mining 'prospects'
809	Kununurra and Falls Creek	Nationally important wetlands Riversleigh World Heritage Area Register of the National Estate RAMSAR site – Lakes Argyle and Kununurra 30% Indigenous population	Large, growing population	Agriculture, mining, manufacturing, tourism Mining 'prospects' Pressure for more irrigation
810		RAMSAR site – Ord River floodplain	Small population but many visitors	Mining 'prospects'
811		Areas set aside for conservation Register of the National Estate 65% Indigenous population	VERY rapid population growth Many visitors	Agriculture, tourism
812	Dagarago, Timber Creek	90% Indigenous population	Many visitors	
813	Thamarrurr, Nganmarriyanga	Nationally important wetlands Register of the National Estate 90% Indigenous population		
814	Katherine	Nationally important wetlands; Litchfield National Park Register of the National Estate Endangered species – freshwater sawfish, northern spear-toothed shark. 22% Indigenous population	Relatively large population	Agriculture, manufacturing mining, tourism.
815	Darwin	Areas set aside for protection/managed resource protection Register of the National Estate	Large population	Manufacturing, agriculture, mining and tourism Mining 'prospects'
816	Bathurst and Melville Islands	91% Indigenous population		
817		Register of the National Estate		Agriculture Mining 'prospects'
818		Kakadu National Park Register of the National Estate		Tourism Mining 'prospects'
819		Kakadu National Park Register of the National Estate		Tourism, Mining 'prospects'
820	Jabiru	Kakadu National Park Register of the National Estate 21% Indigenous population		Mining, tourism Mining 'prospects'
821	Jabiru, Manjilang, Kunbarllaninja	Kakadu National Park Register of the National Estate 41% Indigenous population		Mining, tourism. Mining 'prospects'
822		95% Indigenous population		
823	Maningrida	84% Indigenous population		
824	Ramingining	97% Indigenous population		
825		Register of the National Estate 91% Indigenous population		
826	Nhulunbuy, Gove	32% Indigenous population		Mining and manufacturing

Basin	Town	Evidence of environmental and Indigenous values (mainly non-market)	Evidence of consumption and non-Indigenous recreational values (loosely associated with the market)	Evidence of values associated with production (generally associated with the market)
901		89% Indigenous population		
902	Numbulwar	91% Indigenous population		
903	Mataranka	67% Indigenous population		
904		39% Indigenous population	Growing population	
905		39% Indigenous population	Growing population	
906		39% Indigenous population	Growing population	
907	Borroloola	38% Indigenous population		
908		39% Indigenous population	Growing population	
909		38% Indigenous population	Growing population	
910		Wild river Endangered species – Carpentarian rock rats 21% Indigenous population	Growing population	
911	Mornington Island	88% Indigenous population		
912	Domadgee, Burketown	Purnululu National Park World Heritage Area Register of the National Estate 55% Indigenous population		Agriculture, mining Mining 'prospects'
913	Mount Isa	Wild river Register of the National Estate		Agriculture, mining, manufacturing and tourism. Mining 'prospects'
914		Wild river Register of the National Estate Significant area for shorebirds and migratory shorebirds		
915	Hughenden, Cloncurry, Richmond			Agriculture, mining, manufacturing and tourism
916	Karumba, Normanton	28% Indigenous population		Agriculture, tourism.
917	Georgetown			Agriculture
918		Wild river Register of the National Estate		
919	Kowanyama	64% Indigenous population		Agriculture, tourism. Mining 'prospects'
920	Pormpuraaw	Wild river 82% Indigenous population		Mining 'prospects'
921		Wild river RAMSAR site – Coburg peninsula		Mining 'prospects'
922	Coen	Wild river Register of the National Estate 60% Indigenous population		Mining 'prospects'
923	Aurukun	Wild river Register of the National Estate 86% Indigenous population		Mining 'prospects'
924	Weipa	Register of the National Estate 26% Indigenous population		Mining Mining 'prospects'
925		Wild river Register of the National Estate 37% Indigenous population		Mining 'prospects'
926		Wild river Register of the National Estate		
927	Bamaga	Wild river Register of the National Estate 80% Indigenous population		
928	Torres Strait Islands	74% Indigenous population		Mining 'prospects'
929	Groote Eylandt	62% Indigenous population		Mining, Mining 'prospects'

4.4 Summary

There is ample evidence to suggest that the TR region contains many rivers, estuaries and wetlands that have significant environmental, aesthetic, bequest, and option values associated with them. Not only are these areas of 'value' by, and of themselves, but they also provide many important ecological services which are used (and thus valued – if only indirectly) in other human activities. The 'values' associated with Australia's tropical rivers, therefore include, but are not limited to:

- Environmental, aesthetic, bequest, and option values that exist even when the rivers are not being 'used' – or used up.
- The value of water as a basic requirement of life
- The direct – and indirect – use-values associated with rivers that accrue to the large number of Indigenous people for cultural purposes, for fishing, for recreation, for health and for a multitude of other reasons.
- The aesthetic, 'cooling' and recreational values (including fishing) of rivers provided to residents and to regional, national and international visitors.
- The 'value' of rivers for the eco-system services they provide to the fishing, agriculture and tourism industries.
- The 'value' of water extracted from rivers for use in industries, particularly agriculture and mining.

Many of the basins in the TR region have fewer than 500 persons, and very little industry. In these basins, 'values' are almost exclusively non-market in nature, which poses some interesting management challenges in a policy environment that places much emphasis on 'market' solutions (since these systems typically work best when there are many participants).

Nevertheless, there is ample evidence to suggest that most basins within the TR region are likely to face increasing demands for water – from multiple, oftentimes competitive, sources. Specifically, more than half of the basins in the TR region had populations that increased by more than 10% between 1996 and 2001 – and the population of one basin grew by almost 76%. Likewise, there is evidence to suggest that agricultural practices will continue to intensify across the western and middle parts of the region, Australia is currently in the grips of world-wide minerals boom, and many local councils are looking to encourage the tourism industry, if only to diversify their regional economies.

Whilst many of the social and economic 'values' identified in this report are essentially complementary (e.g. some environmental, aesthetic, Indigenous and recreational values), many other values 'compete with' one another. The competitions may centre on differing attitudes towards resource use rather than consumption rates. Perhaps not surprisingly, 'conflicts' between different stakeholder groups are beginning to emerge. Specific examples of existing 'conflicts' include:

- Intensive agricultural practices. Some of these practices may compete with other values – as when, for example, landholders erect fences that block access to rivers; or when water is 'used up' for irrigation (or for stock), thereby reducing the amount available for other values. Other agricultural practices may not 'use up' the regions water resources, but are, nevertheless, degenerative in that they impact negatively on other 'values' (as when chemicals or land clearing practices affect water quality).
- Tourism. Although the use of rivers by the tourism industry is largely non-consumptive, some types of tourism clearly degenerate other values. And comments made in focus groups clearly indicate that locals are becoming

frustrated at overuse of favoured places and the damage, mainly in terms of pollution, left behind by some tourists.

- Commercial fishing. This industry has vested interests in the region's rivers – and these interests are likely to complement many (but not all) environmental and/or Indigenous values. However, these values may compete with those of the agricultural sector (in cases where the agricultural practices affect either the quantity or quality of water) and with recreational fishermen. Access to Indigenous customary estates and sacred areas has also generated conflict.
- Mining. Many of the TR region's mines are concentrated in areas that have relatively unproductive aquifers &/or little perennial surface water. This places considerable pressure on scarce water resources, since much of a mine's use of both surface and ground water is consumptive or degenerative.

As populations rise across the TR region, the mix of values associated with the rivers is likely to become more complex, and the emerging conflicts are likely to intensify. There will be an increasingly important role for policy, legislation and institutions to play in negotiating these values and conflicts – issues discussed more thoroughly in chapter 5 and 6.

Oftentimes, policy makers stress the need to set aside water 'for the environment' before allocating the remainder to other users. But in the TR region, policy makers may also need to consider the idea of setting aside water for Indigenous communities, since these values – like those associated with the environment – are typically non-priced. However, the exact amount of water to be set aside to support these values is unclear, particularly given the complementary nature of many (but not all) environmental and Indigenous values, and the difficulty of quantifying a flow sufficient to meet an intangible value.

Likewise, the fishing and the tourism industries have significant 'values' associated with the region's rivers. But these industries do not 'use water' in the traditional sense, and so these values may not translate neatly into a water-market. In the tourism industry, for example, businesses that earn money from tourists do not have to 'pay' for (or acquire) water, but the region's rivers help to attract visitors, and those visitors translate into business revenue. The fishing industry has similar, indirect 'links' with the rivers: fishermen do not generally have to 'buy' water, yet healthy rivers are nonetheless an essential input into their industry. This contrasts with situations where the relationship between rivers and the profitability of an industry is more clearly defined (for example a mining or agricultural company acquires water, uses it as an input to production and then sells output on the market at market prices).

Whilst this distinction is largely irrelevant when discussing 'value', it may become important if formal water markets are put in place within the region. Here too, policy makers who are keen to implement water markets may need to consider whether it is necessary to set aside 'water' and/or set water quality regulations that protect and/or give voice to those values.

It is to these important policy issues that the discussion now turns.

5 Institutional and legal framework

Institutional arrangements are the sets of rules and guidelines that govern people's use of resources, rights and responsibilities. They include legal documents – legislation and regulations – policies, and in some cases social 'rules-of-thumb' (or norms). These arrangements frame what is possible and how actions can take place, and as such have a role in shaping the social and economic values of Australia's tropical rivers. This chapter presents an overview of the legal, policy and institutional framework relating to tropical rivers, thereby providing background information and context for the following chapter (which focuses on the policy management challenges likely to face those in the TR Region). It is structured as follows:

Section 5.1 provides a brief historical background discussion, before Section 5.2 outlines the current policy 'context' in which water managers work – the National Water Initiative (NWI). Section 5.3 outlines the legal, policy and administrative frameworks currently in place, while section 5.4 briefly discusses some of the current institutions that are associated, either directly or indirectly, with the NWI (specifically including Indigenous institutions); section 5.5 reviews some of the many regional water plans relevant to the TR region, whilst the conclusion (section 5.6) highlights some of the challenges created by this complex institutional framework.

5.1 Background

Water legislation in Australia was first introduced in the 1880's and at that time was intended to promote use in production, especially in irrigated agriculture. It did so by creating an administrative system for water rather than by assigning rights to water. This approach was partly intended to limit the application of the common law rights in relation to water use. Those rights relate to the right of access to the flow of water and are as follows (Butt 1996):

> *A landowner with a river running through his or her land* has the right *to the uninterrupted flow of water in the river, subject only to reasonable use by upper riparian owners…However, there is no right to the flow of water percolating under the surface; and so a landowner, A, cannot prevent a neighbour, B, from drawing off percolating water under B's land, even where this interferes with the percolation into A's land and thus causes A's land to subside*.

The application of this doctrine severely limited the development of irrigated agriculture and the use of water for industrial and urban purposes and early legislation in relation to water provided exemptions to the application of this principle.

Over the next 100 years legislative and policy changes in relation to water were incremental and the implementation of the law and policy relied largely on administrative discretion. With the exception of the Northern Territory rights to water are still not owned by the Crown, but are vested for the purposes of management. Rights to the access and use of water were granted by the State to individual users, with the range of entitlements for holders varying in their degree of security. Overall, legislation and policy within and across jurisdictions has become fragmented, difficult to apply and has not reflected the more recent concern for ecological values that are becoming more accepted by the national and international community (Marsden 2002).

In recent years the Commonwealth Government has become increasingly concerned about the use of water in Australia overall. The Australian Constitution, however, places severe limits on the Commonwealth's ability to have a direct impact on water use. In particular, Section 100 states that:

> *The Commonwealth shall not, by any law or regulation of trade or commerce, abridge the right of a State or of the residents therein to the reasonable use of the waters of rivers for conservation or irrigation.*

The powers of the Commonwealth in this area are further restricted by the fact that under the Constitution the States retain control of land, and minerals with it. Obviously land use and development has a major impact on water resources and use.

Despite these restrictions water policy has become a major area of policy concern for the Commonwealth Government and it has recently encouraged and initiated major changes in its own and in State and Territory water policies.

At the level of international agreements, the Australian Commonwealth is a signatory to the UN Commission on Sustainable Development (UNCSD) (which has implications for water policy) and the Ramsar Convention on Wetlands of International Importance. At the domestic level, the Commonwealth has attempted to encourage and organise major changes to State and Territory policy.

5.2 The National Water Initiative

The major instrument of current reform to water policy in Australia is the National Water Initiative (NWI), which was created by the Council of Australian Governments (COAG). The Commonwealth and the States and Territories, with the initial exception of Western Australian and Tasmania, signed up to this agreement on 25 June 2004. WA signed the agreement in April 2006 and Tasmania signed on in June 2005. The NWI is intended to be a comprehensive strategy that will encourage the more efficient and environmentally responsible use of water.

Philosophically the NWI incorporates some of the core principles of microeconomic reform. In particular it involves the use of markets and trading, pricing regimes which reflect true economic costs and the assigning and reinforcing of property rights. All of these are intended to employ markets to improve efficiency in water use. The NWI, however, also involves community planning, which sits less well with the microeconomic reform paradigm. Therefore the reforms cannot be pictured as a simple application of pure microeconomic reform. This combination of market-based and community approaches may raise an interesting set of issues particular to the context of the TR region. These issues are discussed in Chapter 6. The mix of the privatisation of water and community input in water use through planning mechanisms is likely to lead to conflict over such issues as:

- What aspect of water use should be determined by the market and what aspect by community views?

- How will differences between the market and community views in the water use outcomes be resolved?

These types of problems always occur whenever markets and community planning are used to allocate resources and mechanisms will need to be developed to handle these problems.

According to the COAG, the NWI will result in:

- An expansion of permanent trade in water bringing about more profitable use of water and more cost-effective and flexible recovery of water to achieve environmental outcomes;

- More confidence for those investing in the water industry due to more secure water access entitlements, better and more comprehensive registry arrangements, better monitoring, reporting and accounting of water use and improved public access to information;

- More sophisticated, transparent and comprehensive water planning that deals with key issues such as the major interception of water, the interaction between surface and groundwater systems and the provision of water to meet specific environmental outcomes;

- A commitment to addressing over-allocated systems as quickly as possible and in consultation with affected stakeholders. A commitment to addressing significant issues where appropriate; and

- Better and more efficient management of water in urban environments, for example through the increased use of recycled water and storm water.

Clause 23 of the Intergovernmental Agreement on a National Water Initiative states:

OBJECTIVES

23. Full implementation of this Agreement will result in a nationally-compatible, market, regulatory and planning based system of managing surface and groundwater resources for rural and urban use that optimises economic, social and environmental outcomes by achieving the following:

i) clear and nationally-compatible characteristics for secure *water access entitlements*;

ii) transparent, statutory-based water planning;

iii) statutory provision for *environmental and other public benefit outcomes*, and improved environmental management practices;

iv) complete the return of all currently overallocated or overused systems to *environmentally-sustainable levels of extraction*;

v) progressive removal of barriers to trade in water and meeting other requirements to facilitate the broadening and deepening of the water market, with an open trading market to be in place;

vi) clarity around the assignment of risk arising from future changes in the availability of water for the *consumptive pool*;

vii) water accounting which is able to meet the information needs of different water systems in respect to planning, monitoring, trading, environmental management and on-farm management;

viii) policy settings which facilitate water use efficiency and innovation in urban and rural areas;

ix) addressing future adjustment issues that may impact on water users and communities; and

x) recognition of the connectivity between surface and groundwater resources and connected systems managed as a single resource.

A number of provisions of the National Water Initiative also relate to Indigenous access to water, particularly the requirement that water planning processes take account of the existence of native title rights to water.

As part of the NWI the Commonwealth established the National Water Commission (NWC) in December 2004, which is an independent statutory agency within the Prime Minister's portfolio. Its role is to drive national water reform by assisting with the implementation of the NWI and by investment in efficient water use using funds from the Australian Water Fund (AWF).

The AWF is a Commonwealth fund with an allocation of $2 billion over five years and its purpose is to improve water infrastructure, improve knowledge and water management and to improve water use practices. The fund has three programs:

- Water Smart Australia – aimed at encouraging the introduction of smart technologies and practices in water use. Examples of such projects are those designed to improve river flows, more efficient on-farm use of water, more efficient water storage and transmission and more effective use of urban water.
- Raising National Water Standards – aimed at increasing Australia's capacity to measure, monitor and manage water.
- Australian Water Fund Communities – aimed at assisting communities to promote wise water use.

5.3 Policy, legislation, plans, and institutional arrangements

While the NWI has provided the focus for water policy changes across the Commonwealth, States and Territories the combinations of policy, legal and administrative frameworks are complex. Various reports have attempted to summarise these (see for example, Schofield et al 2003, Maher et al 2000). The most complete summary of these frameworks for tropical rivers is provided by Hegarty et al (2005) who found that there are over 20 policies and programs impacting on water use for tropical rivers across the Commonwealth, States and Territories and 26 pieces of legislation relating to the use of tropical rivers. Details of these policies and programs are given in Table 6 and Table 7.

Table 6 – Summary of legislative framework

Source: (Hegarty et al 2005)

COMMONWEALTH			
Legislation	**Objectives**	**How Objectives Achieved**	
Environmental Protection and Biodiversity Conservation Act 1999	To protect the environment, particularly matters of national environmental significance To promote a cooperative approach to Environmental management. To assist in the implementation of Australia's international environmental responsibilities. To promote ecologically sustainable development and conservation of biodiversity.	Focusing Commonwealth involvement on matters of national significance; focusing on Commonwealth Actions and Commonwealth areas. Strengthening intergovernmental cooperation while minimising duplication through bilateral agreements. Protection, conservation and presentation of world heritage properties, and conservation of wetlands. Enhancing Australia's capacity to ensure the conservation of its biodiversity by protecting native species and ecosystems.	The Act does not apply to the Commonwealth Native Title Act 1993 and does not apply to States or Territories except so far as any contrary intention appears.
National Environmental Protection Council Act 1994	To establish the National Environmental Protection Council (NEPC) which is to ensure protection from air, water, soil or noise pollution. The NEPC ensures that business communities and markets are not distorted or fragmented by each individual state or territories' environmental protection measures.	The Act provides NEPC with the statutory powers to make National Environmental Protection Measures (NEPMs) relating to ambient air quality, fresh water quality, and noise pollution affecting amenities.	
National Environmental Protection Measures (Implementation) Act 1998	Aims to protect, enhance and restore the quality of the Australian environment by having regard to the need to maintain ecologically sustainable development	The Act is responsible for articulating how protection measures created by the NEPC are to apply. The Act also ensures that the community has access to relevant and meaningful information.	

COMMONWEALTH			
Legislation	**Objectives**	**How Objectives Achieved**	
Natural Heritage Trust of Australia Act 1997	Aims at conserving, repairing and replenishing the natural capital infrastructure of Australia. A core objective of the Act is an expansive approach to ecological sustainability	The Act created a National Land and Water Resources Audit to assess land and water degradations; promotes Natural Resource Management relating to the management and use, development or conservation of water, soil and vegetation; promotes sustainable agriculture.	Controlled by the Natural Heritage Trust Advisory Council. The Act has led to the creation of Regional Natural Resource Management bodies throughout Northern Australia.
Water Efficiency and Labelling Standards Act 2005	Aims to conserve water supplies by reducing water consumption; provide information for purchasers of water use and water-saving products; promote the adoption of efficient and effective water-use and water-saving technologies.	The Commonwealth Parliament intends that this Act form a cooperative scheme between the Commonwealth, States and Territories to provide for national Water Efficiency Labelling and Standards (WELS).	A proactive legislation that creates a national labelling scheme for water-efficient products and technology. The Act applies to all trade and commerce in Australia. The Act is awaiting adoption by Qld, NT and WA.
National water Commission Act 2004	To establish the National Water Commission, as an independent statutory body, as required by the National Water Initiative.	To undertake activities promoting the objectives and outcomes of the NWI. The Act created the Australian Water Fund Account, to provide financial assistance to projects relating to Australia's water resources.	
Natural Resources Management (Financial Assistance) Act 1992	To make funding and administrative arrangements to facilitate and develop integrated approaches to natural resource management in Australia. Aims to promote community, industry and governmental partnerships in NRM.	The Act allows the Commonwealth to enter into agreements with the States and Territories to provide funding for the purpose of achieving efficient, sustainable and equitable NRM.	
Water Act 2000	To provide for the sustainable management of water and other resources, a regulatory framework for providing water and sewerage services and the establishment and operation of water authorities	Vesting all rights to the use, flow and control of all water in Queensland to the State. Create the regulatory framework under which water is controlled, the procedures for achieving efficient management of water, and the penalties and enforcement of any contraventions of the Act.	

COMMONWEALTH			
Legislation	**Objectives**	**How Objectives Achieved**	
Water Regulations 2002	A modern innovation created by the Water Act and Water Regulations is the ability to transfer the rights of water to another. The Water Act separates water allocations from land ownership to allow water to be traded as a commodity.		A table of the water sharing rules is found in Schedule 10 of the Water Regulations.

QUEENSLAND			
Legislation	**Objectives**	**How Objectives Achieved**	
Environmental Protection Act 1994	To protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends	Integrated management program that is consistent with ecologically sustainable development. Act operates as a mitigation mechanism by restricting development that will cause a serious detriment, present or future, to the environment.	Legislation is largely procedural based.
State Development and Public Works Organisations Act 1971	To provide for State planning and development through a coordinated system of public works organisation, for environmental coordination and related purposes.		The Act overrides the general provisions of the Environmental Protection Act, in many circumstances.
Integrated Planning Act	To seek to achieve ecological sustainability.	Coordinating and integrating planning at the local, regional and State levels; managing the process bv which development occurs; managing the effects of development on the environment.	The IPA establishes the Integrated Development Assessment System (IDAS) which integrates the state and local government assessment and approval process.

NORTHERN TERRITORY			
Legislation	**Objectives**	**How Objectives Achieved**	
Water Act 2004	Vests ownership and the rights to the use, flow and control of all water in NT. Thereafter, all water use is theoretically regulated and permits/licences are required. Considerable powers to the Controller of Water Resources and the Minister. Act has no 'object'.	Extensive penalty provisions are created with the Act to deal with breaches of licensing, altering of water flow, pollution and the unauthorised taking of water.	The NT's primary legislative tool controlling the use of, and rights attaching to, water. The Act lacks many environmental sustainability provisions.
Water Supply and Sewerage Services Act 2002	Establishes a framework to protect the Northern Territory's water providers and ensure sewerage is managed correctly.	Promote safe and efficient provisions of water supply and sewerage services; Facilitate the provisions of viable water supply; protect the interests of customers; establish and enforce standards of service.	
Environmental Assessment Act	Aimed at ensuring that matters affecting the environment in a significant way are fully examined and considered.		
Environmental Assessment Administrative Procedures	Operates concurrently with the Commonwealth's Environmental Protection and Biodiversity Conservation Act 1999 (Cth) through a bilateral agreement between the NT and the Commonwealth government.	Adopts the existing Commonwealth procedures and mechanisms relating to environmental assessment procedures and protection.	Bilaterally operating Acts generally have minimum impact upon irrigators and industry unless they require a license to add abnormal amounts of contaminants or pollutants to a waterway.
Environmental Offences and Penalties Act 1996	Establishes a punitive regime whereby environmental offences are punishable by way of fines.	Creates a 4-tiered system of categorising environmental offences, ranging from the most serious 'Environmental Offence Level 1' to the less serious 'Environmental Offence Level 4.	

WESTERN AUSTRALIA			
Legislation	**Objectives**	**How Objectives Achieved**	
Rights in Water and Irrigation Act 1914	To provide for the management of water resources in a sustainable manner.	Promote orderly, equitable and efficient use of water resources; integrate water resource management with the management of other resources; encourage local participation in the administration of water resources.	Is WA's primary legislative tool used to control water and water rights. The Act vests all property in water to the Crown, and then proceeds to distribute various water rights to people, irrigators and industry.
Environmental Protection Act 1986	To protect the environment of WA via five principles, creating an integrated approach to environmental sustainability: Value, pricing and incentives; intergenerational equity; precaution; conservation; and waste minimisation.	The Act includes provisions for environmental regulation and creates civil, and in certain circumstances, criminal liability for offenders. Creates environmental impact assessments, aimed at minimising environmental danger for significant and strategic proposals.	The Act establishes the Environmental Protection Authority (EPA) for WA.
National Environmental Protection Council (WA) Act 1996	To protect people from water, soil, air and noise pollution and to facilitate major environmental protection measures being introduced into WA, so long as such decisions do not distort or fragment the markets or business.	The Act allows the appropriate government body to make National Environmental Protection Measures (NEPM's) and to assess and report on any that have been implemented.	Created in reaction to the Intergovernmental Agreement on the Environment from the Council of Australian Governments. The Act established the National Environmental Protection Council, now integrated into the WA Department of Environment.
Water Conservation Act 1971	Provides for the conservation and management of certain waters and land, and provides part of the legislative base for the Department of Environment (which incorporates the merged Waters and Rivers Commission of WA).	The legislation imposes liability on people, irrigators and industry not to pollute any water covered by the Act.	The Act is largely overshadowed by the greater and broader protections offered to water by the Environmental Protection Act 1996 (WA)
Water Corporation Act 1995	Provides part of the legislative basis for the Department of Environment (DOE)	The powers of the DOE given by the Act include the power to acquire, store, treat, distribute and market the supply of water for any purpose, the ability to dispose of water, responsibility to provide information to other like-minded organisations, the requirement to develop technology to help its operations and to ultimately create a profit.	Accountability is a major establishment for the DOE under the Act, with the board of directors required to lodge a strategic plan annually

WESTERN AUSTRALIA			
Legislation	**Objectives**	**How Objectives Achieved**	
Water and Rivers Commission Act 1995	Establishes a legislative body for the protection of water and rivers which is now under the administration of the WA DOE. Provides functions and powers to the DOE to conserve, manage and protect water and water resources in WA.	Seeks to amalgamate a wide range of powers covered by various other statutes, to allow a single body to take control of protecting water supply, providing for adequate drainage and pollution prevision as well as providing a licensing scheme to cover irrigators' water needs and requirements.	
Water Boards Act 1904 and Water Agencies (Powers) Act 1984	Establishes water boards for every Water Area who are responsible for providing for the construction, maintenance and management of works for the storage and distribution of water	The Water Boards Act and the Water Agencies (Powers) Act 1984 apportion certain powers to water boards and water authorities regarding officer's rights to enter property, the right to charge for the volumetric supply of water, the powers relating to creating by-laws and the powers to acquire land and the power to carry out certain works.	
Water Services Licensing Act 1995	Creates a statutory licensing scheme to regulate, monitor and control the various types of water providers in WA.	Licenses are required for irrigation providers and water supply services.	

Table 7 – Summary of policy, plans and programs

Source: (Hegarty et al 2005)

COMMONWEALTH			
Policy, Plan or Program	**Objectives**	**How Objectives Achieved**	
National Water Initiative (NWI)	Provide Australia with a comprehensive strategy, driven by the Commonwealth Government, to improve water management across all States and Territories. Objectives: • Water markets and trading; • Best practice water pricing; • Integrated management of water; • Water resource accounting; • Urban water reform; • Knowledge and capacity building; • Community partnerships and adjustment; • Water access entitlements and planning.	Provide a overarching system of water management and reform based on market mechanisms, regulatory solutions and water resource planning.	The NWI was agreed to and signed at the COAG meeting in June 2004 → received effect in all states and territories except WA and TAS.
Water Efficiency Labelling System (WELS) Scheme	A statutory initiative that aims to save more water than is in the Sydney Harbour, and over $600 million, through reduced water and energy bills by 2021.	Create a nationally ecognizable 'WELS' label to be applied to approved water-use or water-saving products.	Only NSW, VIC and the ACT have adopted the WELS scheme.
Water Smart Australia Program	To target large-scale projects (irrigation, on-farm water management, water storage, efficiency in housing design) that will have a significant impact on creating a more efficient and innovative water industry in Australia.	Overseen by the National Water Commission, the initiative offers $1.6 billion in funding for eligible projects.	
Raising National Standards Program	Established by the National Water Commission to help achieve the National Water Initiative goals	Provides funding to projects that will invest in Australia's national capacity to measure, monitor and manage its water resources.	

COMMONWEALTH			
Policy, Plan or Program	**Objectives**	**How Objectives Achieved**	
Community Water Grants Program	Administered by the Department of Environment and Heritage (DPEH) as well as the Department of Agriculture, Fisheries and Forestry (DAFF). Promotes a culture of wise water usage to encourages best practice measures and provide a means of support and means for community involvement in water wise activities and initiatives.	Provides grants of up to $50,000 to eligible community organisations to encourage water wise use.	
National Irrigation Skills Initiative	Aims to raise the standards of 'best Natural Resource Management practice' b developing the skills and knowledge of the Australian irrigation industry, and creating a framework to recognise irrigation achievements.	Creates a nationally recognisable certification used to denote a common recognition of skills acquisition, experience and continuing professional development.	Cooperative project between the Australian National committee on Irrigation and Training, the Irrigation Association of Australia and the Australian Government.
National Action Plan for Salinity And Water	To target Australia's growing problems of salinity and deteriorating water quality.	A seven year plan which commits over $1.4 billion to applying regional solutions to issues of salinity and water quality. Plan is implemented in all States and Territories through bilateral agreements aimed at achieving the Plan's objectives and will help raise the standards and sustainability of rural and regional communities, the environment and industry.	Created in 2000 and endorsed by COAG.
Water Resource Plans	Water Resource Plans, one for each catchment, provide a blueprint for future sustainability by establishing a framework to share water between human and environmental needs. They are developed through detailed technical and scientific assessment as well as extensive community consultation to determine the right balance between competing requirements for water.		

QUEENSLAND			
Policy, Plan or Program	**Objectives**	**How Objectives Achieved**	
Queensland Water Plan 2005	To ensure that water needs are secured for towns, agriculture and industry, while protecting the environment for a sustainable future. Aimed at ensuring Queensland's water resources remain sustainable and help underpin continued economic prosperity.	Strategic mechanisms in compliance with the National Water Initiative: • securing water; • planning for the future; • using current water smartly; • water pricing; • protecting water quality; • ensuring compliance; • investing in science and technology.	Queensland's premier policy aimed at meeting future water needs for consumption by individuals, irrigators and industry.
Environmental Protection (Water) Policy 1997	Aims to achieve the objectives stated in the Environmental Protection Act, through incorporating environmental values and water quality objectives, applying to all Queensland waters.	Policy sets a framework of achieving water that sustains ecosystems, maintaining water that is suitable for recreational use, and ensuring water remains suitable for agricultural, irrigation and industrial use. Policy sets guidelines, indicators and protocols for quantifiably measuring and monitoring water quality.	As with the EPA, authority rests with the State Government, Chief Executive, Local Councils and authorised environmental authorities. Policy is applicable to all Queenslanders and is of particular importance to the irrigation industry.
Meter Watering Extraction Policy 2005	Aimed at installing 16,000 water meters over Queensland's unsupplemented commercial water users and irrigators in order to more effectively and efficiently account, monitor and manage Queensland's water resources.	Policy creates a basis for obligations and compliance, and creates statutory triggers that dictate when a water meter is to be installed upon a person's land. The triggers include: • where water allocations are created • where water licenses are volumetric • for the taking of floodwater • in 'at-risk' areas • where there is community demand • in water sharing disputes	The metering policy will provide a valuable on farm management tool to monitor water usage and where to apply the resources for the greatest economic yields and benefits. Breach of policy may result in a contravention to the Water Act 2000 (Qld) and Water Regulation 2002 (Qld).

QUEENSLAND			
Policy, Plan or Program	**Objectives**	**How Objectives Achieved**	
Policy & Code for Preserving Water Quality in Declared Catchment Areas 2003	To adhere to sustainable development requirements in catchment areas as declared under the Water Act 2000 (Qld). To achieve protection of catchment areas from commercial users and irrigators by making the protection of catchments and natural waters a core issue of development to be considered by all sate and local government planning schemes under the Integrated Planning Act 1997 (Qld).	The policy provides a code that , for declared catchment areas to do the following: • create guiding principles for preserving the quality of water; • set the bounds of the assessment interests, including the use of land; • provide suggestions on how preserving water quality can be incorporated into planning schemes as a State interest.	Policy tabulates 28 Queensland catchment areas that the policy applies to.
Self Assessable Code for the Development of Water Access 2002	To ensure minimal damage is caused to waterways, vegetation, surrounding properties and any changes flood conditions. The Code applies to an owner of land adjoining a watercourse, lake or spring, who takes water for stock or domestic purposes using a pump, spear, well, gallery or gravity diversion.	Code guidelines: • who is allowed to take water; • limiting the volume of water that is to be taken and stored; • registration requirements; • minimisation protocols for riverine protection; • site rehabilitation and maintenance; • standard forms to be submitted.	The Integrated Development Assessment System (IDAS), created by the Integrated Planning Act 1997 (QLD), has created a compliance system for developments that will cause environmental harm. Self-assessable developments, under the IDAS, are the lowest risk projects that will have limited impact on the environment and the community.
Queensland Water Quality Guidelines (Draft) 2005	Aims to address the needs identified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 as part of Australia's National Water Quality Management Strategy.	Creates different levels of protection, over the various types of waters in Queensland, including high ecological, slightly to moderately disturbed systems and highly disturbed systems. Irrigators and developers must be conscious of, and adhere to, the protection imposed on various waters under the policy.	Administered by the Environmental Protection Agency. Provides tailored guideline values and frameworks for Queensland's water, and will be the primary source of guideline material for water quality management purposes in Queensland.

NORTHERN TERRITORY			
Policy, Plan or Program	**Objectives**	**How Objectives Achieved**	
Beneficial Users Policy	To apply the Northern Territory's legislative framework to protect water from pollution while allowing economic development to continue through a system of licensing.	Integrates community values into a legislated process aimed at reducing water pollution while enhancing water resource management. Beneficial Users categories: agricultural; cultural; aquaculture; public water supply; environment; riparian; manufacturing industry. When a water resource has been allocated a Beneficial Use and its values have been identified, a water quality management plan, waste discharge licensing and monitoring programs are created for each water resource area.	Policy licenses waste discharge where 'Beneficial Users' have been declared.

WESTERN AUSTRALIA			
Policy, Plan or Program	**Objectives**	**How Objectives Achieved**	
State Water Strategy 2004	Objectives: • creating a 14% reduction in water consumption per person per year by 2012; • establishing 20% reuse of treated wastewater by 2012; • planning a major new water source for the state; • establishing broad-based community eduction programs focusing on water conservation, a requirement of water conservation management plans for large water users, particularly aimed at irrigators and industry.	Policy has adopted 4 key tasks to be performed, and has delegated those tasks to 10 various government and non-governmental agencies and organisations. Tasks allocated to following areas: • water conservation and efficiency; • water reuse; • new supplies and total water cycle management; • innovation, research and education; • resource protection and management.	The SWS sets clear direction for the future of WA water policy, and support by irrigators and industry in implementing best management practices aimed at reducing total water consumption and increasing water resource efficiency.

WESTERN AUSTRALIA			
Policy, Plan or Program	**Objectives**	**How Objectives Achieved**	
State Water Quality Management Strategy	To achieve sustainable use of the Nation's water resources by protecting and enhancing their quality while maintaining economic and social development.	The State's water management strategy adopts supporting strategies that form a type of action plan to ensure that the aims and objectives are carried into affect. Supporting strategies include: an all-encompassing integrated management approach, a determination of environmental values and beneficial users, the preparation of water quality management guidelines, using a mixture of regulatory and market measures, focusing on a 'polluter-pays' approach as well as keeping the community and stakeholders informed.	The policy creates a framework for cooperation between State and Federal Governments, as well as industry and the community to ensure economically sustainable development can be achieved in WA.

WESTERN AUSTRALIA			
Policy, Plan or Program	**Objectives**	**How Objectives Achieved**	
State Water Strategy: Irrigation Review	To ensure that irrigators, like domestic consumers, use water as efficiently as possible.	Joint Steering Committee has devised nine key recommendations from the irrigation review: • creating a new state government department for water resources; • devising a long-term strategic plan for water (announcing the current State Water Strategy as generally ineffective); • changing the water entitlement system to further separate water rights from land rights; • integrating land and water planning to provide long-term certainty to irrigators; • increasing self-management by creating irrigation cooperatives to encourage water efficiency; • investing in water use efficiency by improving water supply to reduce water distribution losses; • implement water metering; • facilitate water trading by withdrawing the current system and creating a new package of initiatives; • introducing water resource management charges to recover the share of management costs attributable to water users.	The Irrigation Review, conducted by the Irrigation Review Steering Committee, has preferred a deregulated market-based approach to irrigation to water management in favour of a heavily regulated approach.

WESTERN AUSTRALIA			
Policy, Plan or Program	**Objectives**	**How Objectives Achieved**	
Use of Operating Strategies in the Water License Process 2004	To create guidelines for how operating strategies will apply to water services and irrigation license holders. Operating strategies are aimed at increasing the licensee's awareness of their responsibilities, increasing participation in water resource management and ensuring water is used in the most efficient manner that is viable.	Where water resource management issues are not satisfactorily addressed by specific license conditions alone, the powers of the Rights in Water and Irrigation Act 1914 (WA) will compel water licenses to comply with approved Operating Strategies.	Operating strategies are documents that state the license holder's commitments and responsibilities in managing the impacts of taking and using water on the environment and on other users.
Transferable (Tradeable) Water Entitlements for Western Australia Policy 2001	Aims to provide a consistent and comprehensive policy foundation for the implementation of Transferable Water Entitlements.	To ensure water rights are tradeable to allow water to migrate to higher economic uses, create new water uses and industries and encourage the efficient use of water.	TWE's can be traded on a temporary or permanent basis, and any license holder is potentially able to trade their entitlement. Trades are limited to the consumptive part of an allocation, and other conditions also apply to water trading, which are regulated by the Water Resource Management Unit. A register will be established so that irrigators, industry and other license holders can register their interest, and thus protect their interest legally.
Management of Unused Water Entitlements Policy 2004	Strives to optimise the use of water held under water allocations and licenses.	The Policy allocates unused water entitlements to new or existing license holders to ensure maximum economic prosperity in that water resource area. Unused water will be identified through compliance inspections, regular reporting and upon application to renew or transfer the license.	The Water and Rivers Commission is charged with allocating and managing water licenses, and this Policy is aimed at utilising underused water entitlements. Policy will generally apply where a water entitlement has not been fully-used for three or more consecutive years, or in extenuating circumstances as the Minister deems fit.
Environmental Water Provisions for Western Australia Policy 2000	To provide for the protection of water dependent ecosystems while allowing for the management of water resources for their sustainable use and development to meet the needs of current and future users.	To protect the ecological values when allocating water entitlements, to create a foundation for ensuring water regimes remain a low risk to water and the environment, to create environmental water provisions by weighing economic requirements against environmental needs as well as involving the community in all necessary processes.	Policy ensures that any water provisions given to irrigators, industry or government do not adversely affect the environment to any great level.

Table 8 – Institutions involved in water policy and implementation

Jurisdiction	Government	Non-Government
Commonwealth	National Water Commission Land and Water Australia Department of Agriculture, Fisheries and Forestry Department of Environment and Heritage CSIRO Land and Water Natural Resource Management Framework	The Irrigation Association of Australia National Program for Sustainable Irrigation Australian Water Association Australian National Committee on Irrigation and Drainage Committee for Economic Development of Australia Water Services Association of Australia Australian Conservation Foundation The Wilderness Society
Queensland	Department of Natural Resources Environmental Protection Agency Regional Natural Resources Management	SunWater Queensland Irrigators Council Rural Water Use Efficiency Initiative (Phase 2) Water For Profit Queensland Water Recycling Strategy 2001 Queensland Conservation Council
Western Australia	Department of Environment Environmental Protection Authority Department of Agriculture Regional Natural Resource Management	Water Corporation Premier's Water Foundation Our Water Future Waterwise Rebate Program Western Australia Farmers Federation Conservation Council of WA
Northern Territory	Department of Natural Resources, Environment and the Arts	Power and Water Waterwise Alice Springs Top End Waterways Project Environment Centre of Northern Territory

Source: (Hegarty et al 2005)

5.4 Institutions

As is evident from the foregoing tables, the institutions that that are involved in water policy are diverse and include Commonwealth, State and Territory government agencies. The most important intergovernmental organisation involved is the Council of Australian Governments (COAG). At the Commonwealth level the institutions include the National Water Commission, Land and Water Australia, the Department of Agriculture, Fisheries and Forestry, the Department of Environment and Heritage, CSIRO and the National Resource Management Framework. There are also a number of industry organisations and associations involved.

At the State and Territory levels there are also a large number of departments and non-government organisations that are involved in the development of policy and in the planning and implementation of this policy. These are summarised in Table 8, which lists some of the major government and non-government institutions involved in water policy by the Commonwealth and States and Territories.

5.4.1 Indigenous institutions

Many Indigenous people in the tropical rivers region continue to live on their land and to engage in customary activities that rely on interactions with riparian environments and the use of riparian resources (Jackson & O'Leary 2006). Fulfilling responsibilities to country and kin gives Indigenous groups the chance to observe their own custom (Sharp 1998). Indigenous resource management practice draws 'mostly on long-standing customary knowledge and skills' (Altman and Whitehead 2003, p.3) and considerable emphasis is placed on traditional resource rights and ownership as the basis for local and regional community planning (Davies and Young 1996). Anthropological studies provide evidence of complex systems of rights to access and utilisation of wetland and riparian resources under Indigenous law. These systems reveal differing degrees of exclusivity (Tan 1997, p.172).

Within an Indigenous domain, property rights and influence over management decisions are intertwined, as observed by the authors of a paper on Indigenous interests in NSW rivers (Behrendt & Thompson 2004, p.64):

> *For Indigenous people, having involvement in the manner in which resources are managed is as much an incident of ownership as the recognition of ownership of the soil itself. It is also a crucial component of the enjoyment of many traditional activities… A right to be involved in the management of country clearly falls within the fields of operation of international instruments relating to the protection of property interests and the right to enjoy Indigenous cultural heritage.*

A number of customary practices contribute to the achievement of natural and cultural resource management goals, not least the obligations to care for country. Some may be unrecognised by the formal resource management sector. Practices include:

- living on country at outstations and moving throughout the landscape to exploit resources;
- hunting and gathering;
- conducting ceremony and ritual;
- fire management, and
- obtaining and distributing resources according to local rules.

In addition to the organisations listed by Hegarty et al (2005) there are a number of Indigenous organisations that have interests in the use and management of tropical rivers. The main ones are listed below (all of these descriptions have been taken from Jackson & O'Leary 2006).

The North Australian Indigenous Land and Sea Management Alliance (NAILSMA)

The North Australian Indigenous Land & Sea Management Alliance (NAILSMA) was formed in 2001 to 'aid Indigenous land and sea management activities across north Australia and foster Indigenous led thinking in relation to the management of the north's Indigenous estate' (Morrison pers comm., December 2005). It represents an alliance of northern Australian Indigenous organisations that have partnered with the Cooperative Research Centre for Tropical Savannas Management to 'act as an agent of change in supporting practical natural and cultural resource management activities and initiatives across the wet/dry tropics of north Australia' (Morrison and Binge 2004, p.1). NAILSMA operates within the broader socio-economic context of Northern Australia, where Indigenous people have historically been marginalised and dispossessed and continue to experience economic and political marginalisation. The alliance is linked to an ongoing movement that seeks to redress this marginalisation (Morrison pers comm., December 2005).

NAILSMA's current core members are:

- Northern Land Council
- Kimberley Land Council
- Balkanu Cape York Development Corporation.

The Carpentaria Land Council Aboriginal Corporation (CLCAC) is also involved in NAILSMA activities and relations are building with Queensland Gulf Indigenous communities. CLCAC may become a core member, as may the Torres Strait Regional Authority.

NAILSMA is currently focused on a number of projects concerning dugong and marine turtle management, the development of Australia's first Indigenous Knowledge Strategy, Indigenous youth leadership, a scholarship program, better communication for Indigenous land and sea managers and an Indigenous fire management initiative. NAILSMA is also convening a north Australian Indigenous Water Policy Group and are in the early stages of creating a Business Development Unit with the aim of connecting business and entrepreneurship with management of land and seas. Linking NAILSMA projects to sustainable business opportunities on Indigenous lands, and to the creation of a more sustainable economy for Northern Australia as a whole is a strategic goal of NAILSMA. This evolving vision is being discussed in terms of a 'culture based economy' – an economy that builds on Indigenous culture, knowledge and connection to country and that supports their ongoing maintenance whilst creating genuine opportunities for employment, income and business development (Morrison pers comm., December 2005).

NAILSMA seeks to support Traditional Owners with 'on-country management of natural and cultural resources, developing support structures for future managers of the Indigenous estate, development of effective communication' (Armstrong 2004). It also aims to support Indigenous managers in the development and conduct of research programs. NAILSMA sees opportunities to:

- Support capacity building among, and increase communications between, Indigenous land and sea managers;
- Advocate for the rights and interests of Indigenous land and sea managers across the north of Australia;
- Support economic development opportunities that are based on land and sea management, and

- Support the transfer of customary knowledge and practices across generations (Armstrong 2004, p.3).

To further these aims, NAILSMA seeks to expand its membership to include more Indigenous land management agencies over coming years.

Armstrong (2004) details the objectives of NAILSMA in her discussion paper. The objectives directly relating to research are as follows:

- Facilitate development of appropriate collaborative working arrangements between Indigenous and non-Indigenous land management agencies and research bodies.
- Promote wider understanding of the land management needs of Indigenous landowners (2004, p.24).

The Kimberley Land Council's Land and Sea Management Unit
The Kimberley Land Council (KLC) supports a range of projects involved with Indigenous land and sea management in the Kimberley through the Land and Sea Management Unit. The Land and Sea unit works with a number of partner groups including government agencies, research institutions, Indigenous representative bodies nationally and in other states and Territories, and local Kimberley Indigenous and non-Indigenous organisations. Among 26 projects currently being supported are ones on the following topics:

- Planning and management projects for Saltwater Country including dugong and turtle management.
- Cultural and biological river research projects focused on freshwater fish and threatened sawfish species.
- Investigating Indigenous knowledge of land and sea to ensure its survival and where possible to use this knowledge for Indigenous economic benefits[38]

The Northern Land Council's Natural and Cultural Resource Management Programs: Caring for Country and Caring for Sea Country
The Northern Land Council (NLC) represents Indigenous people in the northern half of the Northern Territory. It was established under the Aboriginal Land Rights Act 1976 to represent Indigenous owners to claim and manage their land. It is a representative body under the Native Title Act 1993 (Commonwealth). In 1995 the Land Council established the Caring for Country Unit to assist Indigenous landowners with land management and sustainable development projects. Threats to wetlands arising from weeds, particularly *Mimosa pigra* (mimosa), served as a significant impetus to the establishment of this Unit within the Land Council (Storrs et al 2001).

In 1996 the NLC's Caring for Country Unit established the Top End Indigenous People's Wetland Program with funds from the Australian Federal Government. The initial focus of the program was the wetlands within the catchment of the Blyth and Liverpool Rivers in central Arnhem Land. In a planning report prepared by Thurtell et al (1999), the original choice of this site was attributed to the enthusiasm of the local community rangers, the Djelk Community Rangers and the ability of the Bawinaga Indigenous Corporation to provide administrative support to the program and planning activities. The program adopted a strategy of total catchment management, and where necessary coordination across catchments.

Carpentaria Land Council

[38] See www.klc.org.au for further information.

The Carpentaria Land Council Aboriginal Corporation (CLCAC) is a native title representative body under the *Native Title Act 1993* for the Queensland west region. It was established in 1984 as a community organisation to represent, protect, and secure the rights and interests of Indigenous people in northwest Queensland.

On the 30th of June 1994 the CLCAC was recognised under the *Native Title Act* as the native title representative body for the Gulf Region. This region included land and waters from the Northern Territory border to north-east of Normanton, and the islands and seas of the lower Gulf of Carpentaria. On 1 July 2001, the Federal Minister for Indigenous and Torres Strait Islander Affairs enlarged CLCAC's area of recognition to include the new Queensland West region, with its Native Title Representative Body boundaries extended to include an area to the South Australian border and east to Julia Creek. This region now forms the CLCAC's Greater Mount Isa Region. The organisation has offices in Mt Isa, Burketown and Normanton and Cairns. The Carpentaria Land Council has not yet developed the capacity to assist in land and resource management shown by the Land Councils in the Northern Territory or the Kimberley.

The Land Council is located in the Southern Gulf NRM region which covers an area of 230,000 square kilometres, with a population of 35,000 living in the municipalities of Mount Isa City Council, Cloncurry Shire, McKinlay Shire, Richmond Shire, Flinders Shire, Burke Shire, Doomadgee and Shire of Mornington.

Unlike the Northern Gulf region, in the Southern Gulf, there is no formalised Indigenous sub-group or consultative structure. Arrangements for involvement of Indigenous people in the region are currently being negotiated with the Carpentaria Land Council and other relevant bodies.

Southern Gulf Catchments Ltd, the regional NRM group, has been responsible for developing the draft Southern Gulf regional plan, currently available for comment[39]. Key problem areas identified by the group include:

- Weeds (prickly acacia, mesquite, rubber vine, etc)
- Livestock overgrazing
- Feral animals displacing native species
- Insufficient water storage facilities
- Unregulated camping and 4WD use.

Northern Gulf Savanna Indigenous Group

The Northern Gulf Resource Management Group was formed in 1999 to embody representative members of a diversity of interests and expertise associated with Gulf land and sea management[40]. An Indigenous sub-group of the Northern Savannas NRM group was formed by Indigenous communities of the Northern Gulf in 2002. It was designed to take account of traditional 'governance structures' and to improve communications between various groups and communities (McDonald & Dawson 2004, p.135). It consists of nominated members from the traditional tribe and or language groups of Tagalaka, Kurtijar, Euwamiam, Wakamin, Mbarbarrum, and Djungan. According to the Plan, "two nominated representatives of each traditional owner group work together for an integrated cooperative approach to Indigenous resource management for the region"(Northern Gulf Regional NRM Plan 2004, p.136). Since 2002 it has been involved in developing targets and implementing priorities for NRM in the region. An accredited plan for NRM exists for the Northern Gulf region with a biophysical theme dealing with water. The Plan discusses environmental conditions, issues and current management responses.

[39] See www.nrm.gov.au/state/qld/southern-gulf/publications/report-card/ for further information.
[40] See www.northerngulf.com.au for further information.

Land and Sea Management Centres are seen by Indigenous communities as a successful means of coordinating resource management. The centres also play a large role in community development and training. Traditional Owners in the Northern Gulf NRM region wish to continue the operation of the Land and Sea Management Centre at Kowanyama and to establish a new centre in the Karumba area.

Balkanu Cape York Development Corporation
Balkanu[41] is a corporation rather than a representative body under the Native Title Act. In the Cape York region it is the Cape York Land Council that performs the functions of a representative body.

Balkanu was established in 1996 and is owned by the Cape York Indigenous Charitable Trust, on behalf of the Indigenous people of Cape York. Balkanu is committed to supporting Indigenous people of Cape York through initiatives which deliver positive outcomes for the economy, society and culture of Cape York people. This is achieved through a number of programs/business units including the Caring for Country Unit, which promotes land and sea management through traditional knowledge recording.

Balkanu is one of a number of key regional organisations in Cape York which are working together to bring about sustainable long term outcomes to improve the lives of the Indigenous people of Cape York communities. These organisations include Cape York Partnerships, Cape York Institute of Policy and Leadership, Cape York Land Council and Cape York Health Council. To maximise the opportunities and potentials available to the Indigenous people of Cape York Balkanu will work with governments, industry and non-government organisations. The Caring for Country unit of Balkanu currently employs ten staff who are involved in marine and coastal planning amongst other activities.

5.5 Natural Resource Management Plans

There is a great deal of planning involving water in the TR region which is taking place at both Commonwealth and State/Territory levels. Under Commonwealth programs there are two major types of planning. They are the National Resource Management Plans (NRMP) and the National Action Plans (NAP) for salinity and water quality.

The Commonwealth Government, in conjunction with the States and Territories, has identified fifty-six regions throughout Australia for which natural resource management plans will be developed. This program is part of the integrated implementation of the National Action Plan for Salinity and Water Quality (NAP) and the Natural Heritage Trust (NHT). Some $1.4 billion is available from the NAP and $3 billion from the NHT to help improve the management of Australia's natural resources including water. One aim of the program is to protect and enhance biodiversity, the vitality of regional communities and agriculture.

Five of the fifty-six regions to have NRMP's are in the area of interest. There are only two areas in the region for which National Action Plans will be developed. The following table and maps show the areas in the tropical rivers regions covered by NRMP's and NAP's.

NRM region	River basins located in NRM region	NAP regions
QUEENSLAND		
Cape York	921, 922, 923, 924, 925, 926, 927	
Northern Gulf	920, 919, 918, 917, 916	

[41] See www.balkanu.com.au for further information.

Southern Gulf	910, 912, 913, 914, 915	
NORTHERN TERRITORY		
Northern	All river basins located in the NT	Darwin/Katherine
WESTERN AUSTRALIA		
Rangelands	801, 802, 803, 804, 805, 806, 807, 808, 809, 810	Ord

Table 9 - Areas covered by the National Resource Management Plans and National Action Plans

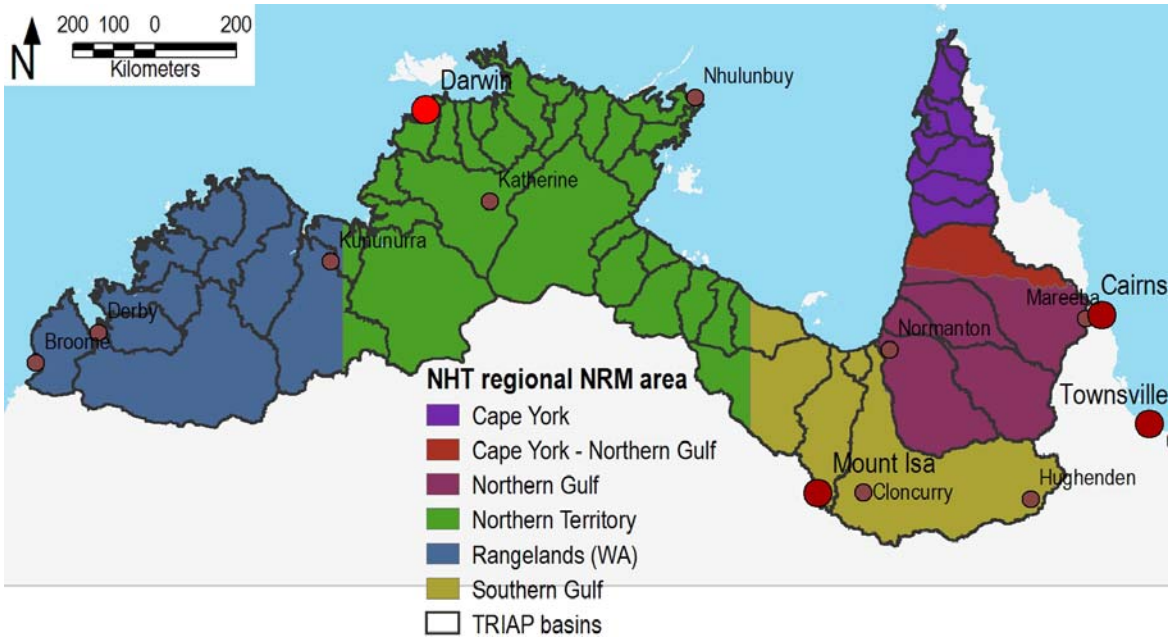


Figure 35 – NRM regions located in the tropical rivers area

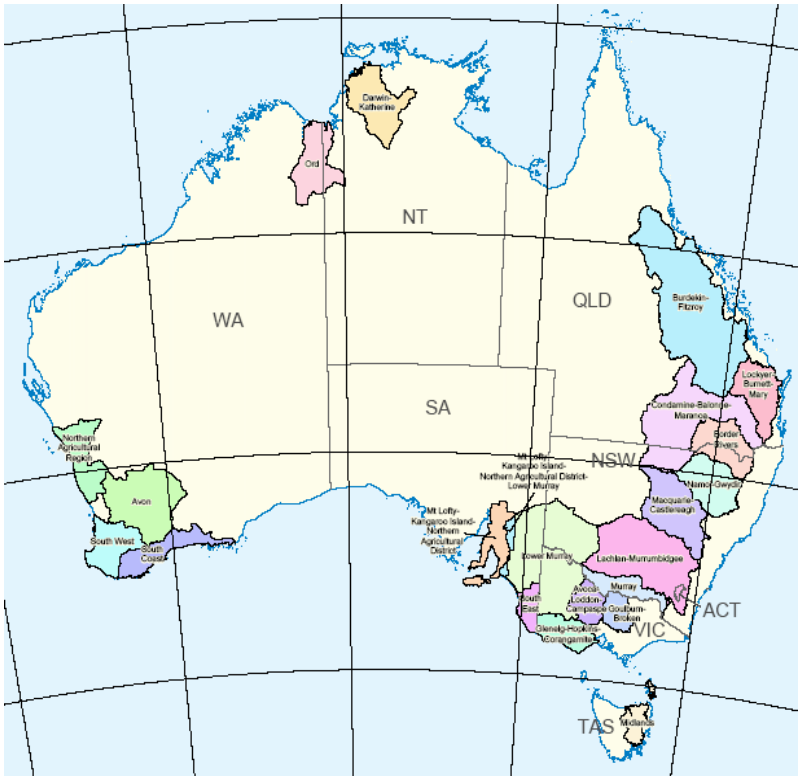


Figure 36 – The National Action Plan regions of Australia

Source: Commonwealth of Australia 2004

The following is a brief description of the main plans for the tropical rivers region, much of which has been taken directly from government web-sites and is therefore copyright of the Commonwealth of Australia 2006. No attempt is made here to assess the efficacy of these plans because it is too early to make judgements on them and some are still in draft form. Such an assessment is however an important project for a later date.

5.5.1 Queensland

In Queensland, plans to be considered here have been or are being developed for Cape York and the Northern and Southern Gulf of Carpentaria regions. The following is a brief summary of them.

CAPE YORK

(1) *Cape York Peninsula Landcare Program*

The Cape York Peninsula Landcare Program has recognised the special natural and cultural values of the Peninsula and is working towards protecting those values while supporting the economic, cultural and social needs of land managers.

This program will complement other programs including future Cape York Property Planning and Indigenous Land and Sea Management programs to be guided by the outcomes of the regional plan and regional arrangements.

Cape York Peninsula is developing a regional capacity to tackle natural resource management issues. Industry, Indigenous communities, conservationists, land managers and state and local governments will all have a role in developing and implementing the integrated natural resource management regional plan and associated investment strategy.

The regional plan will be based on a 'whole of region' approach and address significant natural resource management issues incorporating social, environmental and economic aspects. The investment strategy is essentially the business plan which attracts investment from the Australian and State Governments and will detail the specific actions, costs and timeframes required to implement the regional plan. The Australian Government has approved $2.68 million to the Cape York region to tackle its environment and natural resource management issues (copyright Commonwealth of Australia 2006).

(2) *Draft Cape York Natural Resource Management Plan*
The draft Cape York Natural Resource Management Plan identifies the following as aspirational targets for the region's water resources:

- Continued flow of all known surface springs subject to natural seasonal variation;
- Surface water quantity meets community and environmental needs (subject to natural climatic variations);
- Water quality processes maintained in a manner that supports all of the ecological processes normally expected of such systems;
- Riparian vegetation in all locations throughout the region remains substantially intact and is not significantly impacted by weed species or feral animals;
- All major aquatic habitats of the region continue to retain their 2004 morphological integrity (eg, control erosion) and support healthy and productive populations of naturally occurring native species;
- The biodiversity, values, condition and basic ecological processes of all types of aquatic environments of Cape York Peninsula are well understood and managed; and
    - *There remains equitable access to appropriate watering points for stock and domestic supplies* (Cape York Interim Advisory Group 2004, p.xii).

NORTHERN GULF

The Northern Gulf Natural Resource Management Group has been responsible for developing the Northern Gulf Regional Natural Resource Management Plan, in consultation with the local community. This plan will be based on a 'whole of region' approach and address significant natural resource management issues incorporating social, environmental and economic aspects.

Once the plan is accredited the Management Group will be responsible for developing the regional investment strategy. This is essentially the business plan which attracts investment from the Australian and State Governments and details the specific actions, costs and timeframes required to implement the regional plan.

While the plan is being prepared, the Northern Gulf Resource Management Planning project is encouraging the maintenance of healthy pastures.

Local community organisations are working to promote sustainable agricultural and land practices and correct a broad range of problems including threats to native plants and animals, declining water quality, feral animals, weed infestation and protection of the cultural heritage.

The Australian Government has approved over $1.6 million to the Northern Gulf region to tackle its environmental and natural resource issues (McDonald & Dawson 2004).

SOUTHERN GULF

The Southern Gulf Catchments Ltd has been responsible for developing the draft Southern Gulf regional plan, which has been distributed for consultation with the local community. This

plan is based on a ‘whole of region’ approach and addresses significant natural resource management issues incorporating social, environmental and economic aspects.

Once the regional plan is accredited, the Southern Gulf Catchments Ltd will be responsible for developing the regional investment strategy. This is essentially the business plan which attracts investment from the Australian and State Governments and details the specific actions, costs and timeframes required to implement the regional plan. The Australian Government has approved over $1.7 million to the Southern Gulf region to tackle its environmental and natural resource issues.

5.5.2 Northern Territory

The Landcare Council of the Northern Territory is the regional body responsible for developing and implementing the integrated natural resource management plan for the whole of the Territory, in consultation with the local community. The Council comprises representatives from industry, Aboriginal Land Councils, local government, non-government organisations, research bodies and the Territory Government and has an independent community chairperson.

This plan is based on a 'whole of region' approach and addresses significant natural resource management issues incorporating social, environmental and economic aspects. Once the regional plan is accredited later this year the Landcare Council of the Northern Territory will be responsible for developing the regional investment strategy. This is essentially the business plan which attracts investment from the Australian and State Governments and details the specific actions, costs and timeframes required to implement the regional plan.

While the population of the Northern Territory is comparatively small relevant to its large landmass, a large number of community groups throughout the region are dedicated to natural resource management. Of these, six are Territory-wide organisations supported by more than 80 community and regional groups.

Since June 2002 the Australian Government has approved over $10 million in funding for the Northern Territory to tackle its environmental and natural resource issues (Landcare Council of the Northern Territory 2005).

5.5.3 Western Australia

THE RANGELANDS

The Rangelands Regional Natural Resource Management Coordinating Group has been responsible for developing the Rangelands Natural Resource Management Strategy, in consultation with the local community. This Strategy is based on a 'whole of region' approach and addresses significant natural resource management issues incorporating social, environmental and economic aspects.

Once the Strategy is accredited, the Rangelands Regional Natural Resource Management Coordinating Group will be responsible for developing the regional investment plan. This is essentially the business plan which attracts investment from the Australian and State Governments and details the specific actions, costs and timeframes required to implement the Strategy.

The integration of individual strategies across this immense region is the major focus of the foundation funding from the Australian Government. Shortfalls and gaps in the scientific information to support planning are being highlighted and addressed so a regional framework can be established for managing its natural resources assets.

The Rangelands have been administered within four distinct geographical sub-regions; the Kimberley, Pilbara, Gascoyne-Murchison and Goldfields-Nullarbor. The characteristics of these sub-regions will provide direction for involving stakeholders in the Natural Resource Management Strategy.

There are common stakeholder categories across the Rangelands region and represented in sub-regions. These include: community groups; regional development commissions; industry and business associations; peak body advisory councils; coastal zone councils; State government agencies; local government authorities; and academic institutions.

The Australian Government has approved $5.1 million to the Rangelands region to tackle its environmental and natural resource issues and support improved long-term management of natural resources.

KIMBERLEY REGION

The draft Natural Resource Management Plan for the Kimberley region recognises the following values relating to land use, waterways, wetlands and groundwater:

- land use – good water quality for irrigated land; soil health; bush tucker, art, natural healing, traditional sites, sacred places and sites; habitat, beauty of the region, aesthetics, wilderness, open and relatively unmodified; tourism.
- waterways – free of chemicals, drinking water, cooking and food preparation, high rainfall – seasonal dynamics, industrial use, pastoral use, water re-use, aquaculture, clean water flows, water availability Fitzroy River, Ord River, riparian areas, wild rivers, environmental flows, species abundance, swimming, fishing, boating, water falls, tourism, water holes, meeting place, calming.
- wetlands – bird and migratory patterns, fish stocks, availability of plants and animals.
- groundwater – drinking water, irrigation (Interim Kimberley NRM Group 2004).

5.5.4 Assessment of the plans

Whilst it is too early in the planning process for an assessment of these plans to take place, some comments can be made here about how an assessment may take place. McDonald et al (2003a) provide an interesting discussion as to how plans might be evaluated. They highlight two approaches. As can be seen there is considerable overlap in the contents of the evaluations and the main differences are in the frameworks used.

The first is the framework used by the Commonwealth Department of Finance when evaluating government programs and this can be adapted to evaluation of plans being discussed here. It involves four types of evaluation:

- *Appropriateness of the plan* – the extent to which plan objectives correspond to clients' needs.
- *Cost effectiveness of the program* – measured in terms of the money cost of achieving the plan's objectives.
- *Effectiveness of the plan*- the extent to which the plan achieves it objectives.

- *Efficiency of the program* – the extent to which the program inputs are minimised for a given level of program outputs, or outputs maximised for a given set of inputs.

One of the advantages of this approach to evaluating plans is that the method is used widely to evaluate government programs and thus should produce results which are comparable with other plans and programs.
Another approach outlined by McDonald et al (2003a, pg 52) is that by Knaap and Kim (1998), who suggest an evaluation of a plan or program in terms of the following:

- *Process evaluations* – this examines how the program was implemented to see why the program did or did not achieve its goals
- *Program impact evaluations* – this measures whether the program goals were achieved
- *Efficiency evaluations* – considers whether the resources used in the program were used efficiently or whether improvements could have been made. Cost-benefit analysis is one technique which can be used in this assessment.

5.6 Summary and Conclusions

While the NWI has provided the focus for water policy changes across the Commonwealth, States and Territories the combinations of policy, legal and administrative frameworks are complex. As clearly identified in Hegarty et al (2005) there are over 20 policies and programs impacting on water use for tropical rivers across the Commonwealth, States and Territories and 26 pieces of legislation relating to the use of tropical rivers.

Part of the reason for the complexity is that water policy must deal with the various and competing uses for water. These include water for urban use, for irrigation, agricultural and farming use, water for the environment and recreational, tourism and Indigenous uses (as discussed in the preceding chapter). There are also jurisdictional issues between local government and state/territorial governments and, unlike most commodities, everyone in Australia has a vital interest in water. This is because it is the only resource which is necessary in all production and consumption activities, is limited in supply and provides the limits to economic growth in many regions. The interaction of Indigenous institutional arrangements, whether they be governed by customary law and practice or by statute, adds a further layer of complexity. The issues that are raised by this complexity of institutions and the multiple uses and particular conditions of TR are the subject of the following chapter.

6 Policy Approaches

6.1 Introduction

The previous chapter described the institutional arrangements that guide and govern the use of tropical rivers. This chapter examines some of the issues that these arrangements, and future changes to these arrangements, might raise in light of the social and economic values identified in chapter 4.

As discussed in chapter 5, there is a diverse set of organisations that have a role in water management and there is a complex mix of arrangements governing water use. The National Water Initiative (NWI) is heralding some significant changes in these institutional arrangements. Other drivers of change are socioeconomic and demographic changes, social aspirations, economic development and potential demand from southern regions for either water or farming capacity.

Tensions often arise in natural resource management situations when sets of rules intersect and interact, especially sets of formal and informal rules. If those crafting or changing formal rules do not understand how particular sets of rules affect actions and outcomes in a particular ecological and cultural setting, these rule changes may result in rapid, unexpected and possibly perverse outcomes (Ostrom 2006). Thus the effectiveness and durability of a new set of formal rules, such as a water market, depends on the degree of integration with existing institutions and the capacity of mechanisms enabling people to adjust to new and changing circumstances.

Until now the main tools of government policy in relation to water have been “non-market” mechanisms such as prohibition, regulations, quantitative allocations and direct supply. Prices have been used, but in general prices have been uneconomically low (such as for urban and irrigation water). It is proposed under the NWI and other changes that markets will become much more important as a tool for the allocation of water. In this chapter of the report the arguments for and against the use of markets and non-market mechanisms will be discussed, along with some problems which have been identified in current water management practices. Not all of the problems discussed here will always apply and it is acknowledged that the NWI and other recent changes in water policy are intended to overcome many of these existing and potential problems. In almost all cases, however, it is too early to decide whether these policy changes are or will be successful in solving the problems and the success or otherwise of the new policies is more properly the topic for further study.

While until recently policy has tended to use regulation rather than markets as a means of allocating water, the discussion here will follow the usual approach in policy theory which discusses the market approach first and other approaches later. The chapter is structured as follows. First, key problems associated with water – namely property rights - are discussed in section 6.2. This leads to the discussion of market and non-market policy approaches in sections 6.3 and 6.4. Key points from this chapter are then summarised in the conclusion.

6.2 Property Rights

6.2.1 Cross-border and jurisdictional issues

As noted previously, many rivers, river basins and aquifers overlap the boundaries between states and territories. This fact causes complications in the management of rivers because

states and territories have different policies and laws. In particular, it limits the ability of any one target for water use being achieved because it may require all of the jurisdictions involved to agree and make the appropriate and coordinated effort to achieve the target.

This problem has been a major issue in relation to the Murray River because it forms the boundary between two states and because its water is used for urban use, farming, power generation and irrigation on both sides of the river. In a major attempt to develop a coordinated approach to achieving environmental outcomes for the river the new *Murray-Darling Basin Water Agreement* was signed by the governments of New South Wales, Victoria, South Australia and the ACT at the June 2004 COAG meeting. The main purpose of the agreement is to undertake an investment of $500 million over five years to reduce the over-allocation of water and to achieve specific environmental outcomes.

In the north there are a number of water basins that are crossed by state and territory borders. These include the Nicholson River (NT and Qld), the Ord River (WA and NT), the Keep River (WA and NT) and Settlement Creek (NT and Qld). In each case any proposal for the use or conservation of water from these catchments is likely to require cooperation and joint action by two jurisdictions, which may be difficult to achieve.

In many cases local government may be the best level of government to deal with the conflicts and problems associated with water use. Local government, however, has no power to deal directly with surface or ground water use or the river beds and it must refer these problems to the State and Territory level of government. This problem is compounded in the Northern Territory by the fact that local government has no power over land use. Further, state and territory governments may not understand the issues as well as local government does.

6.2.2 Diverse property rights

The diversity of property rights can act as a barrier to trade, to efficient investment and also to improvements in environmental outcomes. The diversity of rights and complications associated with the use of various terms in different ways (for example, 'licences', 'entitlements' and 'rights') increases the challenge Governments face in coordinating the use and conservation of water within and between their jurisdictions.

Rights to use water vary considerably across and within States and Territories and this means that their abilities to control the use and conservation of water within their jurisdictions vary also. This makes coordinated policy in relation to one river system or to water in general difficult to achieve. There are, for example, 438 types of regulated surface water entitlements for the southern connected River Murray system alone. Recent changes to legislation in Queensland and the Northern Territory have attempted to make the crown's management of water easier. Both the *Water Act 2000* of Queensland and the *Water Act 2004* of the Northern Territory vest all rights to the use, flow and control of all water in the state/territory in the crown. The crown then has the ability to allocate rights as it sees fit. In the case of Western Australia the *Rights in Water and Irrigation Act 1914* vests all property in water in the crown and allows for the crown to allocate rights of use.

Despite these powers existing rights are likely to provide political and legal constraints to the ability of governments to manage water. Titles to land vary from freehold, leasehold, native title or short term permits for use. There is also a range of lands reserved for crown use. Figure 37 shows the distribution of land tenure over the study area. Each of these tenures has a legal or implied on-going right to use water at some level. In addition State and Territory development approvals often grant the developer rights to use surface or ground water, especially in the case of mining or agricultural developments. All of these existing

commitments mean that the ability of the States and Territories to change water use immediately is restricted.

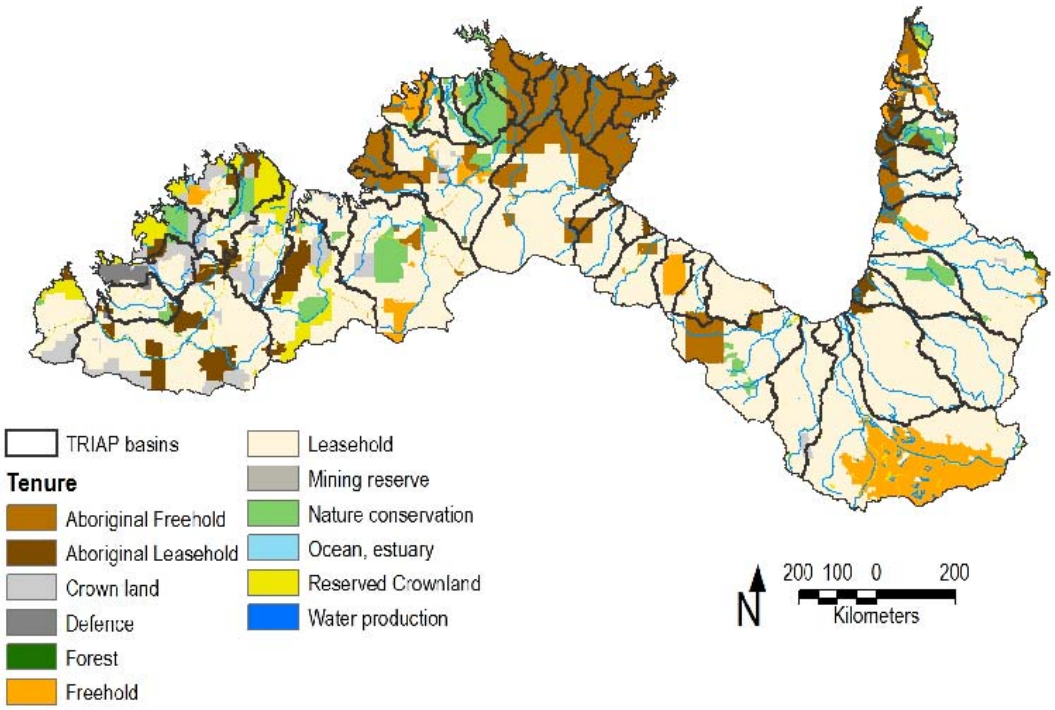


Figure 37 - Land tenure in the TR region

The case of Indigenous land owners deserves special mention. In the Northern Territory traditional owners under the *Aboriginal Land Rights Act* have substantial rights to control the use of their land, including a right of veto to mining and other types of development. There is still legal uncertainty whether a grant of land confers the rights to water on or under that land. Under South Australian land rights legislation property rights are similar to those under the Northern Territory, while in New South Wales Indigenous landowners hold rights to all minerals except gold, silver, coal and petroleum. Rights under Native Title legislation are substantially weaker than those under land rights legislation and revolve around the rights to negotiate, though this can be an important tool which can be used to change the nature of development. Rights over water can be recognised under the Native Title Act but they are restricted to rights to continue the customary use of water. For Indigenous groups who acquire land through purchase property rights and obligations are the same as those of non-Indigenous landowners. The same is true for Indigenous groups who acquire a pastoral lease (Jackson & O'Leary 2006).

Indigenous people are a group who may be disadvantaged by developments under the NWI involving the introduction of new water rights because, despite the intention of legislators, they are unlikely to recognise fully the existing pattern of customary water use. If this happens, Indigenous people will lose access to water which they have enjoyed in the past and which has been important in sustaining their economy, culture and society. For a detailed discussion of the legal and management issues involving Indigenous interests and tropical rivers see Jackson and O'Leary (2006).

6.2.3 Water resources as "common resources"

In discussions of resource policy economics classifies resources according to two main properties. The first is whether the access to a resource can be prevented by imposing a price or by imposing a law. This is characteristic of a resource's "excludability". The second is whether the use of a resource by one person reduces the amount available for other potential users. Where this is the case, such resources are said to be "rival" in use. Ordinary goods, such as cars, are both excludable and rival and are called "private goods". Some goods, such as pay television, are excludable but not rival and are "natural monopolies". National defence is non-excludable and non-rival and is a "public good". Fish in the sea, which are beyond national sea regulation, are considered to be "common resources" because they are non-excludable and rival.

Common resources provide special problems for government policy. Typically, common resources become used excessively by comparison with what is best for society, and may even become inadvertently extinct. In the literature this phenomenon is known as the "tragedy of the commons", after the degradation which took place to the British common lands due to their rival but non-excludable nature. The policy response was to "enclose" them (making them excludable) by converting the commons to private land (the "Coase" solution). This solved the problem. Other examples of common resources which are or have been threatened are whales, African elephants and north American bison.

Despite common law, statute law and regulations in relation to water use, entitlements in Australia are often incomplete, confused and unenforced (such as in the case of fishing permits and irrigation permits, or the illegal prevention of access to rivers), and in those cases water may be regarded as a common resource. Policy theory forecasts that in those circumstances:

- water and water resources will be over-used.
- water will not be reserved for "external purposes" such as for environmental or ecological purposes.
- water will be used inefficiently, including being polluted.

There is evidence that all of these have occurred.

There are two appropriate policy responses to this. The first is to have government action or community based collective action which will control the use of water resources so as to prevent these problems occurring. The regional planning and government regulation in water use which is taking place now is an example of an appropriate response.

The second is to change the status of water from that of a common resource to that of a private good, by creating rights to water use which give the holder exclusive access to use it. The NWI attempts to do this in some contexts. Neither of these approaches is likely to be without problems (to be discussed later) nor complete in its coverage and the challenge for policy is to have as complete and trouble-free coverage as possible.

In practice, both market and non-market (government or collective action) allocative mechanisms will be used, and the real question is "when should one be used and not the other?" There is no simple answer to this question, since neither will work perfectly. More will be said of that in sections 6.4 and 6.5.

6.3 The use of markets in water policy

6.3.1 Water trading and price-based allocation of water

The introduction of new markets and the use of prices to allocate water are the policy changes which are most likely to have an effect on the way in which water is used. Water trading is being considered as part of the NWI and has been on the table in various forms in different parts of Australia since 1983. As mentioned in the previous chapter the NWI has several aims, including the removal of barriers to trade, the facilitation of market development and the enhancement of rural water use efficiency. So as well as providing a coordination mechanism for common resource use, water trading also creates incentives to improve water use efficiency through realising its market value.

These changes were expressed as a source of major concern amongst the focus groups consulted for this study. Some of their concerns were that:

- Water would be used only on the basis of financial interests and values and the many non-financial benefits to society of its use would be lost.
- Average local citizens would lose access to rivers to large developments, mining, urban and agricultural interests.
- Access to rivers now is largely a public goods access and this will change so that only the rich will have access. In this case the poor will lose out.
- Overseas commercial interests could buy these entitlements and rivers could be used by them in a way that meets the needs of multinational interests but which is adverse to Australian interests.

These objections are concerned with both the economic efficiency and the equity consequences of the use of markets and pricing and they have justification in the theory of economic policy. The following is an elaboration of some of these issues.

In the theory of economic policy it is argued that, under certain circumstances, markets can be used to ensure that the allocation of the nation's scarce resources is efficient (where 'efficient' means that resources are used to create the greatest benefit for society). This idea now underlies much of government policy and is embodied in the term 'microeconomic reform', being a process that was started by the Whitlam government in the early 1970s (Quiggin 1996).

The basic idea is that if markets are used to allocate water, then two things will happen:

- Water will be used by producers and consumers who are prepared to pay the most for it. They will be prepared to pay the most because, in turn, they will be using water to produce commodities for which the market or individuals (and society?) are prepared to pay the most. At a practical level, the market would eliminate the wasteful use of water and would redirect water from activities with low value added to activities with high value added.
- Water will be supplied from areas and by suppliers where the costs are lowest. Ideally these "costs" would include all the costs to society of supplying water, including external costs (to the environment for example).

A recent Treasury report concerning the concept of the national water market provides a good example of this type of argument. Treasury is reported to argue that "rather than letting the roses wither because of water restrictions, urban gardeners in St Kilda should be able to buy water rights from cotton farmers in Bourke" (*The Australian* 27 March 2006, p.8). It further reports that "industries, such as mining and manufacturing, produce $80,000 of value added for every million litres of water used, whereas agriculture yields about $1200".

The creation of a proper national water market would result in a single price for all users and this would ensure that water is used to "maximum efficiency" because the value added for water would be about the same in all of its uses. The major problem with water trading at the moment is that it is generally restricted to within-water-basin trade and the big gains are expected to be obtained from between basin trade because the differences between the demand-supply conditions will be greatest.

There are, however, two broad problems that arise when using a market in this way:

- The underlying conditions which are required to be met in order that the market work efficiently may not be met, and
- Even if the market operates efficiently, the outcome may not be equitable or fair.

The underlying conditions that are required for a market to allocate water resources efficiently are:

1) Perfect knowledge. That is, both suppliers and demanders in the water market must have sufficient knowledge and foresight to make decisions which are truly in their own interest.
2) No element of monopoly. That is, both the suppliers and demanders must be competitive as demanders and suppliers of water.
3) No externalities. That is, there must be no flow-on effects from water use or interests in water use beyond those represented in the market.
4) There must be effective and low cost enforcement of property rights, and transaction costs associated with trade must be low.
5) Investment in water infrastructure and other related goods must be economically efficient and the outputs must be efficiently priced.

Many of these ideas are reinforced by Ward & Tisdell (2006) who identify a set of preconditions for a functioning and effective cap and trade scheme. They specifically note the need for credible and reliable science (an aspect of perfect knowledge); sufficient numbers of buyers and sellers (a pre-condition for no monopoly or monopsony rights); and also several other conditions relating to point 4 above, namely the need for low transaction costs, sufficient differences between individuals' costs, transferable, enforceable and tradeable private property rights, monitoring schemes that are transparent, consistent, credible and cost effective, adequate and effective administrative institutions, effective regulatory agencies; and political feasibility.

There are almost no market situations in which all of these conditions hold. Thus the real policy issue is whether the distortions caused by the existence of imperfect knowledge, monopoly, externalities, inefficient infrastructure investment and pricing, or by the lack of the preconditions identified by Ward & Tisdell (2006) are great enough to offset the efficiency benefits of a user pays approach. This issue is known generally as the 'problem of the second best'. The problem is this: if one (or more) of the required efficiency conditions does not hold, how can other conditions be varied so as to minimise the loss of efficiency? For example, suppose water use causes unwanted negative externalities (for example, damage to the environment). The solution may be to charge higher than efficient prices for pumping in order to reduce the overall water use back to the optimal level.

In the case of tropical rivers, the degree of distortions may be considerable – as discussed in section 6.3.2.

6.3.2 Problems associated with market-based allocation systems

IMPERFECT KNOWLEDGE

There are large gaps in society's understanding of the long-term consequences of changing natural water flows on systems and variables, such as the general ecological system, fish stocks, the spread of weeds, wildlife populations and the productivity of land where water is used for irrigation.

Another significant deficit of knowledge exists in relation to the scientific understanding of the nature and extent of many TR resources, and particularly of the connections between groundwater and surface water. This is one of the preconditions mentioned above as being critical for viable and effective cap and trade systems. Also important is some degree of agreement between user groups and management groups about this science.

Further, there are likely to be large gaps in people's understanding of the way in which the institutions, acts, plans and policies that affect water use 'play out' in practice - the behaviour of individuals with non-market and social motivations may be substantially different from theoretical predictions (Ostrom, Walker et al. 1992; Ostrom 1998; Gintis 2000; Poe, Schulze et al. 2004; Tisdell, Ward et al. 2004). Agencies implementing markets may need to take into consideration limitations on the information processing capacity of individuals (Braga and Starmer 2005). In short, the assumption of perfect knowledge means that this computational reality currently lies outside conventional market analysis (Simon 1972; Sterman 1987; Smith 2002). This problem may be particularly acute in some of the region's remote Indigenous communities.

MONOPOLY POWERS

Under most circumstances, people will be trading the access to specific volumes of water or parts of river flows. There is necessarily an element of monopoly in this and suppliers, who are governments or private individuals/organisations, may well exercise their monopoly power to increase price above what it should be from an efficiency viewpoint in order to increase income.

EXTERNALITIES

'Externalities' are the uncompensated benefits or costs of an action which are not incurred by the person undertaking the action. Many of these correspond to the 'non-market values' of the discussion in earlier chapters. Water pollution is one obvious example of an externality. The polluter causes costs to be incurred by the rest of society, but does not compensate those people for those costs. Externalities are an important issue when considering resource management policy because they create a difference between what is good for the individual and what is efficient for the nation. This is turn means that the reliance on existing markets to allocate resources may lead to inefficient outcomes. And – as noted in chapter 2 – when water is scarce these issues become ever more important (for example, as when the only water hole for hundreds of kilometres is degraded).

Some examples of externalities costs or diseconomies in relation to water use are:

1) **Upstream water use resulting in inadequate or polluted water downstream, thus reducing the amenity and production value of water in lower reaches of the river.** Whilst common law rights to water (mentioned above) are intended to minimise the upstream-downstream conflicts over access to and use of water, their application does not always do so. And more importantly, these rights have often been replaced by water rights under statute law which are the source of conflict. Examples of this include the use of water for irrigation or urban use, the potential for pollutants from mining,

manufacturing, agriculture or other activities entering the waterways and – in recent times – proposals for the damming of rivers and the transporting of water to distant urban centres. The Derby focus group were very concerned by the proposal that the Fitzroy River could be dammed to supply water for Perth, and as noted in chapter 4 other focus group participants expressed concerns about the possibility of mines allowing pollutants to enter the waterway.

2) **Water use may result in insufficient water flow and quality to maintain the downstream ecosystem services**. Rivers perform an important range of ecosystem services. These include soil formation, nutrient cycling, waste treatment and the provision of habitat for a range of plants and animals. These and many other ecosystem services interact to provide source materials for production and consumption. These functions are vital to human wellbeing, especially in the long run. They are however unlikely to be known to users or are undervalued by them. Regulations in water use that aim to reserve 'environmental flows' are an attempt to deal with the negative externalities that can arise from overlooking environmental water requirements (as have been observed in the Murray-Darling system and for which $500 million has been allocated in the 2006-2007 Australian Government Budget).

3) **Water use may result in insufficient water flow and quality to maintain Indigenous cultural values.** Whilst regulations in water use commonly reserve water for "environmental flows" there is little explicit recognition of the fact that there may also be a need to reserve water for 'cultural' or 'social' flows.

4) **Land use in areas adjacent to rivers preventing people gaining access to rivers.** One particular problem concerning property rights is that the ownership of land adjacent to rivers may prevent people from gaining access to these rivers. In the focus group meetings both Indigenous and non-Indigenous participants strongly expressed the view that their access was restricted because of "developments" on the edge of rivers or because access was prevented by fences. In the case of non-Indigenous participants this limited their ability to enjoy the rivers for sight-seeing, camping, and fishing. The Indigenous participants had additional uses which they were prevented from enjoying. These included traditional fishing and hunting, visiting sites of historical significance and dreaming sites, using the river as a meeting place and as a place where the old educated the young.

5) **The use of underground water by one party reducing the amount available for other users.** As discussed previously the common law does not provide a landowner with an exclusive right of access to water under his/her land. This means that other persons who have access to the aquifer may use this resource to the detriment of the landholder. In some cases this has resulted in the wasteful use of underground water (because the person is using "someone else's water" – for free and as well as his/her own); and in other cases a major user of underground water (such as a mine, processing plant or town) may make other land uses (such as grazing and cropping) unviable because the bores and springs become dry. Some focus group participants expressed concerns over the fact that mines were "de-watering" aquifers to access minerals, noting that this may affect the viability of graziers that rely on the water for stock. This is an area where a market that deals only with surface waters will almost certainly fail and where government regulation may need to be considered instead.

6) **Land use, particularly soil degradation and erosion, leading to reduced water quality.** As discussed in chapter 2 agriculture, pastoralism, mining and other land uses impact on water quality through vegetative clearing, erosion, soil degradation and water runoff. This point was elaborated on in chapter 4, where it is noted that the 'value' of ecosystems services provided crucially depends on the quality of the health of the

ecosystem. Consequently, land-use activities that affect the ecosystem indirectly also affect other 'values'.

6.3.2..1 Some evidence of externalities in relation to water resources

There is much research that substantiates the existence of negative externalities including:

- Silberstein et al (2003) and Silberstein et al (2004) establish the relationship between the rise in stream flow and water tables which followed land clearing, and the falls after reaforestation.
- Brodie & Mitchell (2005) found that vegetative clearing, beef cattle grazing and fertilised cropping on northern Australian river catchments have led to greatly increased nutrient loads to downstream receiving waters and ecosystems. Further, the changed nutrient inputs in combination with other impacts such as hydrological modifications, exotic weed introductions and global climate change have caused a variety of types of eutrophication in receiving systems. Finally, they found that further land clearing and expansion of fertilised cropping in northern Australia is likely to exacerbate these problems.
- Taylor et al (2003) examined the urban and river environments around Mt Isa, Queensland, for the purpose of ascertaining how metal mining from the Mt Isa mine has affected soils and sediments. They found that the mean concentrations of soil and sediment samples in the urban area were above background values and a significant proportion exceed Australian government specified ecological investigation levels (EIL) for copper, lead and zinc. River sediments adjacent to the mine site also exceeded EIL, but generally declined downstream of the mine area. Urban samples show a weak but distinctive negative relationship between copper and zinc concentrations and distance from the mine. Values exceeding EIL are of concern to residents and land use managers because they may pose a risk to land and water quality and to human health.

The following provides further illustration of this through presenting some data on the health of tropical rivers.

Figure 38 uses data from the National Pollution Inventory (NPI) 2004 to show the location of a range of economic activities and the possible contaminants associated with each across the TR region. While the number of projects shown is small considering the size of the area, the scale and potential impacts of many of these projects are large. Not surprisingly, many of the 'facilities' identified in this inventory are mines – which were also discussed (and mapped) in chapter 4. Importantly, many potentially polluting facilities and mines occur in the upper reaches of some catchments highlighting the fact that upstream/downstream impacts are possible. The fact that such facilities are included in the NPI does however indicate that policy makers are aware of such potentialities.

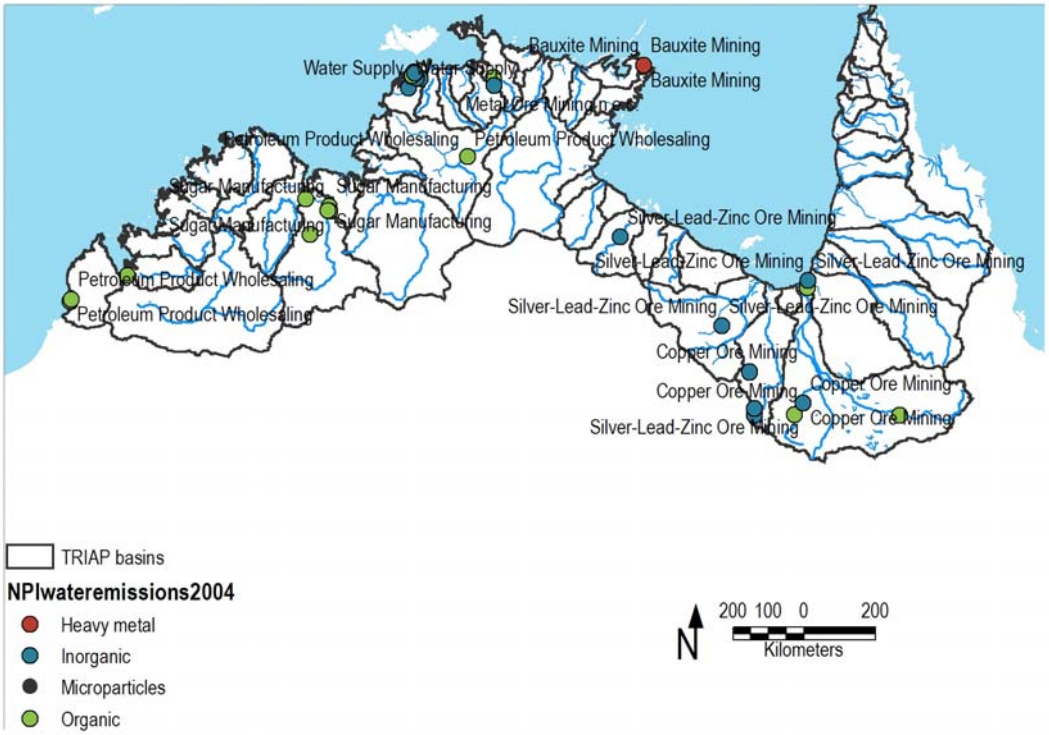


Figure 38 - NPI 2004 Water emissions from facilities in the TR region

Source: Department of the Environment and Heritage 2004c

Figure 39 shows the landscape stress of basins in the TR region, whilst Figure 40 presents evidence on 'river disturbance'. Here it is clear that large knowledge gaps exist (particularly through the northern parts of WA), although there is evidence of moderate landscape stress in some of the gulf catchments and in areas in and around Darwin and Weipa.

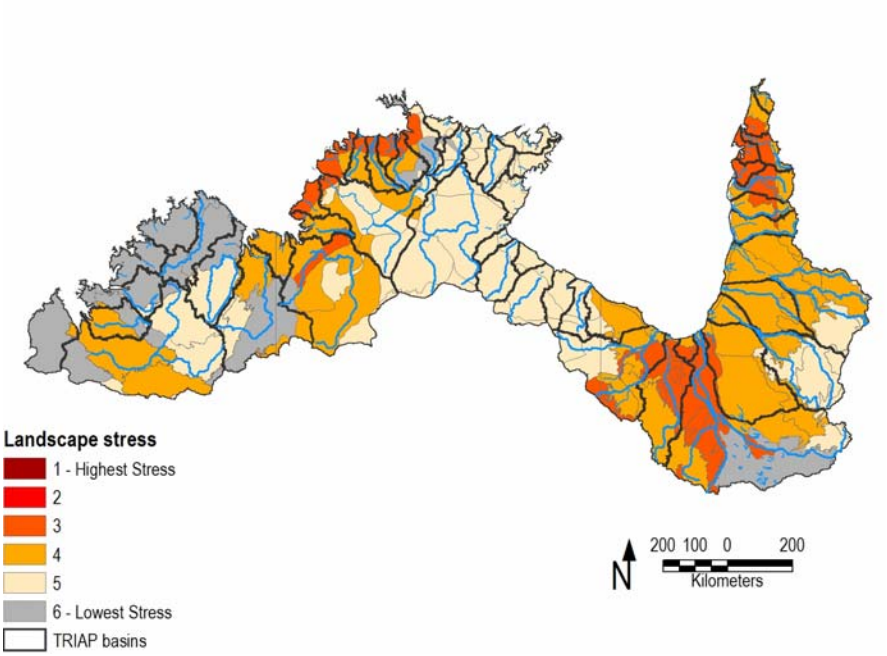


Figure 39 - Landscape Stress in the TR region

Cattle grazing caused severe erosion on parts of the Ord catchment at the start of last century, leading to commencement of partial de-stocking and a rehabilitation program in the 1960s (Fitzgerald 1968). Grazing has also had detrimental effects on the floodplain of the Fitzroy River (Payne et al 1979). These problems are apparent in Figure 39 and Figure 40: the rivers showing greatest disturbance in the Kimberley are the Ord and Fitzroy (too few sites in the Keep were sampled to be representative of its whole catchment, most of which is in the Northern Territory, but it too appears to be degraded).

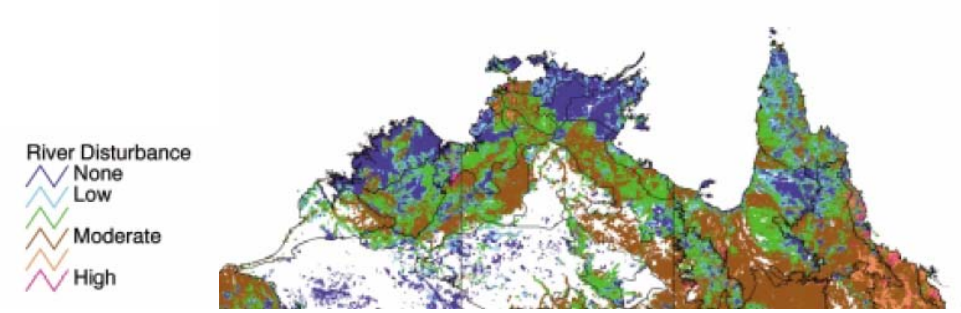


Figure 40 - River Disturbance in Australia's North

Source: Department of the Environment and Heritage n.d.

Further, it is possible to examine the potential threat to the area of environmental contamination by three weeds (Figure 41). There are, of course, many more weeds which are of concern, but the basins with recognised weed problems include 916, 917 and 919 – 927.

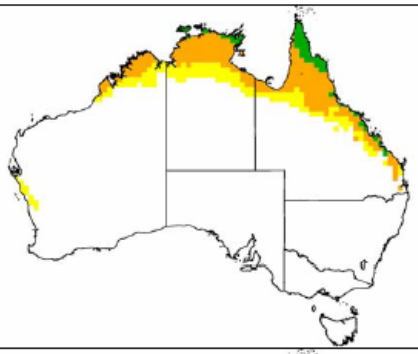
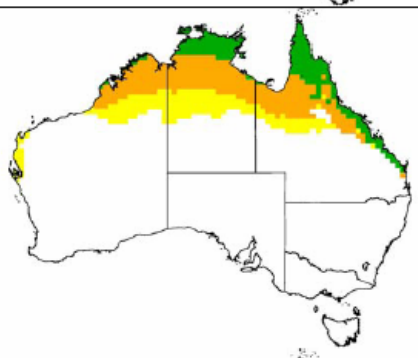
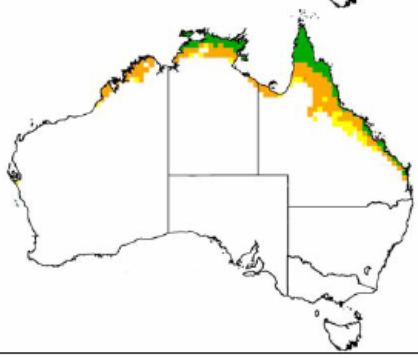
Species	Potential distribution in Australia Low Moderate High	1996 landuse (commodities)*	Area of 1996 landuse at high risk of weed spread (km^2)**	Approximate 1996 commodity value for landuse in the area at high risk of weed spread
Pannicle jointvetch *Aeschynomene paniculata*		Grazing (cattle)	45,997	$41 million
Blainvillea gayana		Grazing (cattle)	181,804	$125 million
Brillantaisia lamium		Irrigated cropping (sugar cane, sunflowers, cotton & coffee)	906	$685 million
		Irrigated & non-irrigated horticulture (fruit & vegetables)	102	$220 million

Figure 41 – Agricultural sleeper weeds in Australia.

Source: (Brinkley & Bomford 2002, p.13*)*

While the evidence that is available suggests that the condition of the tropical rivers is reasonably good, there are threats from activities such as mining and farming and from the spread of weeds. Given that the rivers in this area are few and often dry for most of the year even minor changes in land and water use could have dramatic effects on the rivers and the people and environment of the region. By 2050 an estimated area of over 500,000 hectares, mainly within the Mitchell river catchments, will be affected by dryland salinity (Australian Government 2004). In short, the problem of externalities is very real in the TR region.

Policy theory suggests that an appropriate response to this problem may be:

- Allocation of private property rights to produce the externality or to impact on a common pool resource and then use of markets to obtain the efficient outcome (this follows from Coase's Theorem);
- Voluntary action by members of the community to overcome externalities through the negotiation of social contracts; or

- Government subsidies for production that produces external benefit, or taxes on activities that produce external costs (i.e. a Pigovian tax[42]). In principle the government would calculate the costs to society of the pollution being caused by an activity and impose a tax equal to that value on the person responsible, thus forcing the person to 'internalise' those costs. The consumer or producer causing the pollution would then change his/her behaviour so as to reduce the undesirable activity and he/she would also compensate the rest of society through the tax for the damage. The opposite case also holds. That is, a person whose activities produce external benefits could be subsidised. That person would then increase the level of activity and would be compensated for doing so.

To some extent, the NWI has initiated or plans the application of all of these approaches.

INEFFECTIVE OR HIGH COST INSTITUTIONAL ARRANGEMENTS

Markets in TR regions may be 'thin' due to low population levels. Not only does this hamper the effective operation of a market, since markets generally work best when there are many buyers and sellers, but it also poses multiple challenges associated with the monitoring and effectiveness of regulatory agencies. As noted in chapter 4 most river basins in the TR region are sparsely populated, indicating that thin markets may be the norm rather than the exception in this area.

These challenges may be compounded by the harsh climate and large distances, and transaction costs may be higher than in more populated or accessible areas due to additional transport or communication costs. Further, disputes over entitlements and rights may increase transaction costs. Altman (2004) discusses this in relation to the uncertainty associated with native title rights to water.

As with all market-based instruments water trading schemes may have many advantages and may bring about desired economic, social and environmental outcomes however there are a range of considerations (Ward and Tisdell 2006):

> For example a market based instrument may be cost effective, but may not perform well in the dimensions of adoption rates, administrative and transaction costs, concentration of environmental consequences and political feasibility.

As highlighted at the beginning of this chapter the investigation of the viability of new institutional arrangements within particular social and ecological contexts is critical to their effectiveness and durability.

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[42] A recent Staff Working Paper by the Australian Productivity Commission (Dwyer et al 2006) considered how Pigovian taxes could be used to improve economic efficiency in water where there are external costs in relation to water use. This is interesting but preliminary work and will not be discussed here other than to provide the primary conclusion of the study that was:

"Where there is a water trade and where restrictions on water allocations result in scarcity rents (*pure profits*), a charge (*Pigovian tax*) will only reduce water use (and consequent environmental costs) if it exceeds the scarcity rents. If water use does not change, there will be no short run improvement in efficiency from such a charge, although it might encourage long run efficiency improvements." (Dwyer et al 2006, pg xii)

In other words, when water is scarce (as is often the case in parts of the TR region) Pigovian taxes will not always provide one with an efficient means of dealing with externalities. This conclusion does not mean that Pigovian cannot be used to increase efficiency in other contexts, however, and taxes and subsidies may be suitable for dealing with a wide range of externality problems.

INEFFICIENT INVESTMENT IN WATER INFRASTRUCTURE

Water supply facilities have for a long time often been exempt from the standard investment criteria. In the 18th and 19th centuries it was realised that great improvements in public health could be achieved in cities by improving the quality and quantity of water available for citizens. This is discussed in some detail in chapter 4, in relation to Indigenous health and non-market values associated with water. At that time it was also noted that water supply would limit population growth for countries like Australia, and dams and irrigation systems became national development priorities. For these reasons water supply facilities have had a priority status.

If water markets are to work efficiently, however, investment in infrastructure (and related goods and services) and the provision of water services must also be efficient. If this is not the case water may be efficiently priced at source however it may then be too cheap in the final market (especially if there is under pricing of the transport of water) or over priced in the final market (especially if transport charges are too high). Either of these outcomes would cause the allocation of water to be economically inefficient. It is likely that services from much of Australia's water infrastructure are not efficiently priced.

In principle efficient investment in infrastructure requires that all investment proposals should provide a rate of return on the investment, taking into account all externalities, at least equal to the rate of return which could have been earned on the next best investment proposal (the 'social opportunity cost of capital' and again taking into account all externalities associated with that investment). In cases where 'capital rationing' exists (that is, where there is not enough capital available to undertake all of the investments which pass the above test) the authority should select the projects with the highest returns until the capital available is exhausted.

Generally in the past major water infrastructure has not been subject to this type of evaluation. If the NWI is to improve efficiency in water use through markets then this will be required.

The theory underlying the way in which infrastructure services should be priced is more controversial than that on investment principles for infrastructure investment. The basic principle which determines the efficient price for a commodity is that the price should equal the 'marginal social cost' (called the 'marginal cost pricing principle' and being the extra cost to society of providing the extra unit of the commodity). Externalities are included in this calculation. This is the 'efficient' price, because if the price was above the marginal cost society would be preventing consumers gaining the commodity even though they are prepared to fully compensate all people involved in the supply of the commodity. If the price was below the marginal cost society would be encouraging consumers to consume the commodity even though they are not prepared to fully compensate all people involved in the supply of the commodity (Mc Taggart et al 2003).

When applying this principle to water infrastructure services, such as the supply of water from a river to a town or irrigation area, there are particular problems. Most water infrastructure assets are considered to be 'natural monopolies'. That is, they are composed of very large pieces of capital equipment such as dams, aqueducts, pipelines and purification plants and having more than one supplier would involve the inefficient duplication of that equipment. Further, most of the costs of providing the service are fixed costs (composed of cash and opportunity costs of the equipment) and only a small proportion of total costs vary with the volume of the service (largely pumping, purification and labour costs).

This fact means that the marginal cost of production will be below the average cost of production, so that an authority following the marginal cost pricing rule is likely to make substantial losses. There are two standard approaches to this problem (Mc Taggart 2003):

- The first involves the use of 'multipart pricing', where the authority imposes charges on consumers in addition to price (set at marginal cost) in an attempt to cover losses. These are normally fixed charges (not dependent on water volume consumed). These may be efficient in themselves and may solve the loss problem.
- If multipart pricing does not cover the losses or cannot be instituted, then it is often argued that it is better to allow the authority to charge prices equal to the average cost (and so cover its total costs) rather than require it to charge at marginal cost. This is because in the latter case the government may decide not to undertake the investment at all or to under invest in the project. Thus the choice for government is: insist on (efficient) marginal cost pricing (with the possibility of underinvestment in infrastructure) or allow (relatively inefficient) average cost pricing to avoid underinvestment.

The following is a summary of a study by a Western Australian government committee chaired by Professor Reg Appleyard into the options for transporting water in the Kimberley for use in Perth (Government of Western Australia Media Statement 2006). Without making judgements about the detail of the calculations presented the report provides an example of one way in which such a study could be conducted. The committee examined three options for transporting the water from the Kimberlies to Perth: a canal, a pipeline and ocean transport. According to the report the canal option would cost $14.5 billion for construction and $6.50 per kilolitre, the pipeline option would cost $11.9 billion and $5.10 per kilolitre and the tanker option would cost $6.2 billion with the cost of super tankers and towing bags costing $5.3 billion and water costing $6.70 per kilolitre. The best option was the Kwinana Desalination Plant which would cost $387 million to construct and would deliver 45 gigalitres of water per year at a cost of $1.16 per kilolitre. The external costs associated with the other options just reinforced the superiority of the desalination plant.

DISTRIBUTIONAL ISSUES

Clause 23 of the *Intergovernmental Agreement on a National Water Initiative* states that full implementation of the agreement will be achieved by addressing ten separate but related goals, one of which is to "[address] future adjustment issues that may impact on water users and communities". One can assume this relates broadly to distributional issues associated with new institutional arrangements, one of the two broad problems associated with the use of markets as discussed above.

Evaluation of the 'distributional fairness' or equity of a new allocative arrangement requires a value judgement as to what is meant by fair or equitable. While there is an active debate about this, it generally refers to outcomes in which there is no increase in the disparity between the rich and the poor in terms of income or access to resources. Clearly a person's ability to gain access to water resources when a market is used depends partly on his/her income (or resources) by comparison with the incomes of other people and institutions that may bid for water. That is, the distribution of income has a large impact on the equity outcomes from using the market to allocate water.

How important the equity issue is in a water market depends on two factors. The first is the market rules which determine who is allowed to bid for water, and the second is the disparity of income between these participants. In principle, bidders could include:

- Governments or their agencies
- Urban centres
- International and Australian mining and development companies

- Agribusinesses
- Farmers and pastoralists
- Individuals
- Environmental or fishing organisations
- Aboriginal communities.

Clearly, competition for water between some of these groups could be compromised by power and income differentials, with governments, urban centres and large corporations potentially dominating. Such inequality will need to be dealt with by such measures as reserving water for the poor (and the environment) or by confining competition to interests with similar market power.

Within the tropical rivers region and even within river catchments, there is considerable disparity in the levels of economic power. This problem is illustrated in Figure 42 and Figure 43, two of the ABS' Socio-Economic Indexes for Areas (SEIFA)[43] across the TR region. Specifically:

- The first figure shows the data for the index of economic resources. The score on the SEIFA index shows how a district compares with the national average in terms of the same index. Thus an area which scores 10 per cent or below in terms of the economic resources index means that the people who reside in the area are in the bottom 10 per cent of the nation in terms of access to resources. This means that the population has low family incomes, mortgage or rental payments, poor housing, a low level of home ownership and few motor vehicles. In other words, people in that area are relatively poor. It can be seen that, overall, people of the tropical rivers region are relatively poor.
- Another index which may be used to look at the socio-economic status of individuals in different parts of Australia is the index of relative socio-economic disadvantage. A low percentage indicates that the district has a high level of disadvantage. This is measured in terms of the percentage of the population with qualifications, level of income, the unemployment rate, the age of leaving school, the number of one parent families, the number residing in rented accommodation, the number of bedrooms in a dwelling and the ownership of cars. Again, much of the data are missing for the region. Nonetheless, it can be seen that there are large sectors of the TR region where people are at a relative socio-economic disadvantage.

[43] Although a range of SEIFA indices are available this report focuses on the index of economic resources and the index of relative socio-economic disadvantage only. More information on these SEIFA indices can be found in Appendix H.

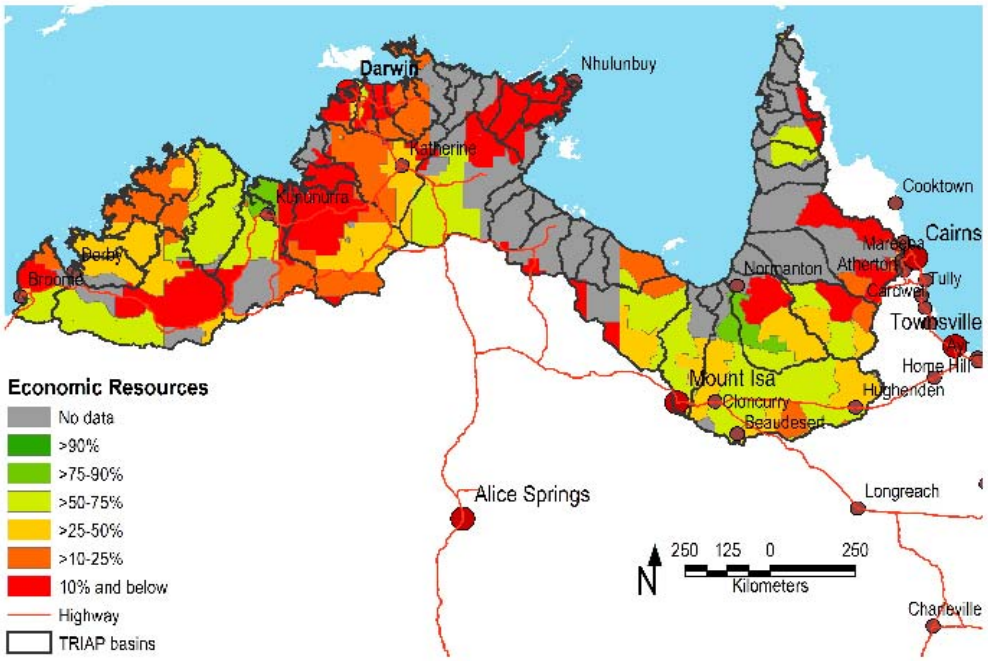

Figure 42 - SEIFA 2001 – Index of Economic Resources by CD

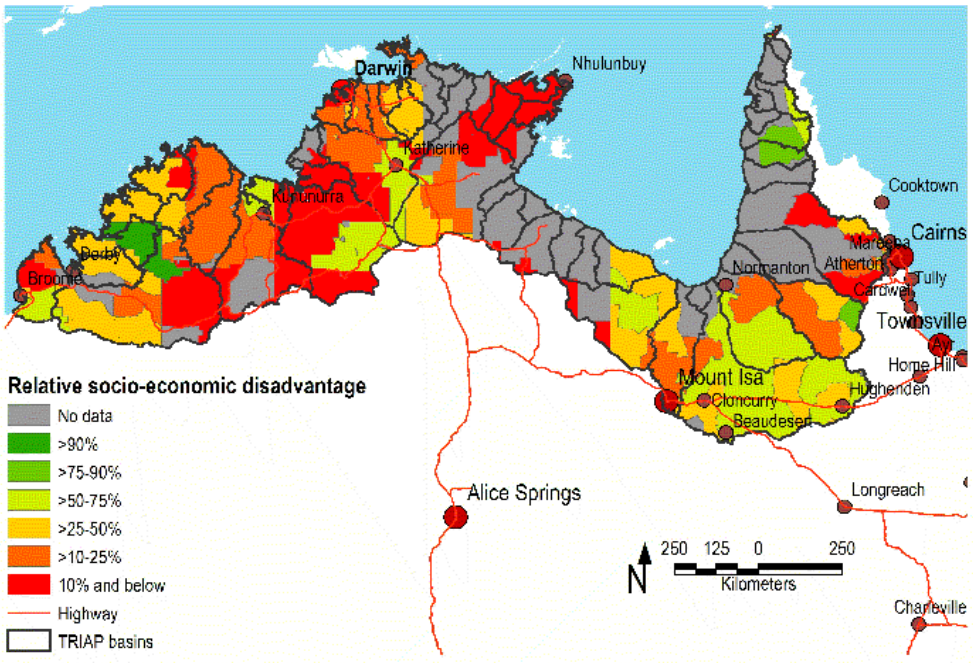

Figure 43 - SEIFA 2001 – Index of Relative Socio-economic Disadvantage by CD

In short, both indices clearly show that many people within the TR region are at a relative socio-economic disadvantage (when compared to other parts of Australia) and there are river basins in which there are relatively rich collection districts and others which are relatively poor. Consequently, up-stream/downstream distributional issues are likely to arise with water trading.

As noted above, however, water trading will not just occur between individuals; bidders include a wide range of potential stakeholder groups. Consequently basins with many different types of stakeholder groups, with differing levels of economic resources, are more

likely to experience 'difficulties' relating to the distributional effects of water trading. More will be said of this in the following section.

6.3.3 Basin-by-basin summary of problems with water markets

Table 10 attempts to indicate basins with characteristics that may make it difficult for water markets to function effectively, efficiently and equitably. The first two columns identify the basin, whilst columns 3-5 repeat information relating to 'values' from chapter 4. This gives some information about the likely 'stakeholders' in any potential water market. The next column provides a measure of the basin's population density (which gives an indication of the 'thinness' of the market), whilst the last column reports on information relating to the SEIFA indices (specifically identifying basins where most residents are at a relative socio-economic disadvantage and/or where there are significant differences in the SEIFA indices relating to different CD's within the same basin).

As noted in chapter 4, there are many basins within the TR region with predominantly non-market values associated with water and these include river basins 805-807, 812, 813, 816, 822-825, 901-911, 914 and 918. In these basins there are likely to be few participants in a water market, thus making it difficult for the market to operate effectively. Most of the basins with predominantly non-market values also have low population densities – again leading to the conclusion that markets will be 'thin' in many parts of the TR region.

Importantly, some of the basins with low population densities (less than 1 person per km^2) were also identified in the previous chapter as having mineral 'prospects' (specifically basins 804, 805, 810 and 921). Depending upon the viability of these 'prospects' it may be difficult to facilitate effective water markets if the mines begin operations, since it would mean that basins like these would have relatively few individuals – most of whom are at a socio-economic disadvantage – competing for water with a multi-national mining company.

Basins 808-10, 814-5, 817-21, 826, 912-3, 916 and 924 all contain collection districts with both high and low SEIFA indices. There may, therefore, be some distributional issues to consider when/if water markets are introduced in these areas. Similarly, most of these basins contain regions that have low SEIFA indices and also have 'values' associated with industry. Residents of these basins may thus be required to bid for water against agriculture, mining, tourism and other developers.

It is also evident that externalities may prove to be of concern in many of the basins within the TR region – particularly those where agriculture, tourism and mining are an important industry. These include, but are not limited to, basins 801-2, 809, 811, 814-5, 817-21, 826, 912-3, 915-7, 919, 924 and 929.

In sum there is a high level of disadvantage overall in the region and considerable variation in economic advantage/disadvantage within some basins. The local people are thus unlikely to be able to compete with developers on fair terms in a prospective water market. This means that policy makers will need to be careful when setting the rules for water trading to ensure that competition is fair in terms of the ability of the competing stakeholders, or they will need to reserve water for those who simply cannot compete. Policy makers will also need to maintain vigilance over a range of potential externalities – bearing in mind that some 'market' solutions to externalities may not be particularly effective in the presence of scarcity.

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Table 10 - Basin-by-basin characterisation of potential stakeholders in water markets

Basin	Town	Evidence of environmental and Indigenous values (mainly non-market)	Evidence of consumption and non-Indigenous recreational values (loosely associated with the market)	Evidence of values associated with production (generally associated with the market)	Population density (person per km^2)	Socio-economic indices indicating that citizens have limited bargaining power
801	Broome	RAMSAR site – Roebuck Bay 20% Indigenous population	Large, growing population	Agriculture, manufacturing, mining and Tourism	0.65	
802	Derby	Endangered species present (spear toothed shark, fresh water sawfish) Register of the National Estate 50% Indigenous population	Large, growing population	Mining, agriculture and tourism	0.08	
803			Small but growing population Many 'visitors'	Mining 'prospects'	0.03	
804				Mining 'prospects'	0.01	
805		Areas set aside for conservation Register of the National Estate		Mining 'prospects'	0.01	
806	Kalamburu	Register of the National Estate 60% Indigenous population			0.03	Low SEIFA indices
807		Areas set aside for conservation and managed protection Register of the National Estate	Small population but many visitors		0.01	
808	Wyndham	50% Indigenous population Register of the National Estate		Mining 'prospects'	0.01	Disparity in SEIFA indices
809	Kununurra and Falls Creek	Nationally important wetlands Riversleigh World Heritage Area Register of the National Estate RAMSAR site – Lakes Argyle and Kununurra 30% Indigenous population	Large, growing population	Agriculture, mining, manufacturing, tourism Mining 'prospects' Pressure for more irrigation	0.17	Disparity in SEIFA indices
810		RAMSAR site – Ord River floodplain	Small population but many visitors	Mining 'prospects'	0.01	Disparity in SEIFA indices
811		Areas set aside for conservation Register of the National Estate 65% Indigenous population	VERY rapid population growth Many visitors	Agriculture, Tourism	0.02	Low SEIFA indices
812	Dagarago, Timber Creek	90% Indigenous population	Many visitors		0.02	Low SEIFA indices
813	Thamarrurr, Nganmarriyanga	Nationally important wetlands Register of the National Estate 90% Indigenous population			0.27	Low SEIFA indices

Basin	Town	Evidence of environmental and Indigenous values (mainly non-market)	Evidence of consumption and non-Indigenous recreational values (loosely associated with the market)	Evidence of values associated with production (generally associated with the market)	Population density (person per km^2)	Socio-economic indices indicating that citizens have limited bargaining power
814	Katherine	Nationally important wetlands; Litchfield National Park Register of the National Estate Endangered species – freshwater sawfish, northern spear-toothed shark. 22% Indigenous population	Relatively large population	Agriculture, manufacturing mining, Tourism.	0.22	Disparity in SEIFA indices
815	Darwin	Areas set aside for protection/managed resource protection Register of the National Estate	Large population	Manufacturing, agriculture, mining and Tourism Mining 'prospects'	10.54	Disparity in SEIFA indices
816	Bathurst and Melville Islands	91% Indigenous population			3.52	
817		Register of the National Estate		Agriculture Mining 'prospects'	0.24	Disparity in SEIFA indices
818		Kakadu National Park Register of the National Estate		Tourism Mining 'prospects'	0.04	Disparity in SEIFA indices
819		Kakadu National Park Register of the National Estate		Tourism, Mining 'prospects'	0.05	Disparity in SEIFA indices
820	Jabiru	Kakadu National Park Register of the National Estate 21% Indigenous population		Mining, Tourism Mining 'prospects'	0.05	Disparity in SEIFA indices
821	Jabiru, Manjilang, Kunbarllaninja	Kakadu National Park Register of the National Estate 41% Indigenous population		Mining, Tourism. Mining 'prospects'	0.20	Disparity in SEIFA indices
822		95% Indigenous population			0.01	
823	Maningrida	84% Indigenous population			0.19	
824	Ramingining	97% Indigenous population			0.05	
825		Register of the National Estate 91% Indigenous population			0.06	
826	Nhulunbuy, Gove	32% Indigenous population		Mining and manufacturing	0.60	Disparity in SEIFA indices
901		89% Indigenous population			0.06	
902	Numbulwar	91% Indigenous population			0.07	
903	Mataranka	67% Indigenous population			0.04	
904		39% Indigenous population	Growing population		0.01	
905		39% Indigenous population	Growing population		0.01	
906		39% Indigenous population	Growing population		0.01	

Basin	Town	Evidence of environmental and Indigenous values (mainly non-market)	Evidence of consumption and non-Indigenous recreational values (loosely associated with the market)	Evidence of values associated with production (generally associated with the market)	Population density (person per km^2)	Socio-economic indices indicating that citizens have limited bargaining power
907	Borroloola	38% Indigenous population			0.01	
908		39% Indigenous population	Growing population		0.01	
909		38% Indigenous population	Growing population		0.01	
910		Wild river Endangered species – Carpentarian rock rats 21% Indigenous population	Growing population		0.01	
911	Mornington Island	88% Indigenous population			1.45	
912	Domadgee, Burketown	Purnululu National Park World Heritage Area Register of the National Estate 55% Indigenous population		Agriculture, mining Mining 'prospects'	0.04	Disparity in SEIFA indices
913	Mount Isa	Wild river Register of the National Estate		Agriculture, mining, manufacturing, and Tourism. Mining 'prospects'	0.57	Disparity in SEIFA indices
914		Wild river Register of the National Estate Significant area for shorebirds and migratory shorebirds			0.00	
915	Hughenden, Cloncurry, Richmond			Agriculture, mining, manufacturing and Tourism	0.06	
916	Karumba, Normanton	28% Indigenous population		Agriculture, Tourism.	0.06	Disparity in SEIFA indices
917	Georgetown			Agriculture	0.03	
918		Wild river Register of the National Estate			0.00	
919	Kowanyama	64% Indigenous population		Agriculture, Tourism. Mining 'prospects'	0.07	
920	Pormpuraaw	Wild river 82% Indigenous population		Mining 'prospects'	0.05	
921		Wild river RAMSAR site – Coburg peninsula		Mining 'prospects'	0.01	
922	Coen	Wild river Register of the National Estate 60% Indigenous population		Mining 'prospects'	0.03	

Basin	Town	Evidence of environmental and Indigenous values (mainly non-market)	Evidence of consumption and non-Indigenous recreational values (loosely associated with the market)	Evidence of values associated with production (generally associated with the market)	Population density (person per km^2)	Socio-economic indices indicating that citizens have limited bargaining power
923	Aurukun	Wild river Register of the National Estate 86% Indigenous population		Mining 'prospects'	0.20	
924	Weipa	Register of the National Estate 26% Indigenous population		Mining Mining 'prospects'	0.52	Disparity in SEIFA indices
925		Wild river Register of the National Estate 37% Indigenous population		Mining 'prospects'	0.02	
926		Wild river Register of the National Estate			0.01	
927	Bamaga	Wild river Register of the National Estate 80% Indigenous population			0.61	
928	Torres Strait Islands	74% Indigenous population		Mining 'prospects'	0.22	
929	Groote Eylandt	62% Indigenous population		Mining, Mining 'prospects'	1.99	

6.4 Non-market water allocation mechanisms

From the above discussion, it is clear that there are many circumstances when it is likely that the market will fail to allocate water resources efficiently or equitably and hence there may be an argument for investigating other ways to deal with water.

The alternatives which are discussed in the theory of policy are:

- The use of moral persuasion to change behaviour – it may be possible through education to change behaviour towards water use (to be more conserving, extracting less, not polluting, etc).
- Encourage charitable actions by persons and companies – to preserve wetlands, allow access, clear weeds, etc.
- Cooperative behaviour by users.
- Direct government expenditure.
- Government regulation of water use – this has been the main way in which governments have influenced water use in the past.
- Taxes imposed to discourage inefficient use of water and subsidies to encourage good water use behaviour.

The fact that governments, groups and individuals realise that there needs to be changes to water use and that they undertake programs to achieve that effect does not ensure that these changes are any better than what would occur with a market solution. That is, the outcomes under a non-market approach may be even less efficient and less equitable than those achieved by using markets. The following discussion is concerned with some of the problems which may arise when using non-market methods to allocate water.

6.4.1 Problems associated with non-market allocative systems

NON-COMPARABLE OUTCOMES

Non-market allocative systems (for example water rationing) do not normally generate prices and costs for water. This creates a problem for policy makers when assessing the efficiency in water use across Australia. There may be great differences, for instance, in the efficiency of water use between basins and the extent of this is difficult to discover. In principle, a complete market system for water would result in one price for water net of transport costs to markets and regardless of the location of the basin and the efficiency of this outcome could be assessed by examining the importance of externalities associated with each basin. No such (in principle) simple assessment can be undertaken if prices for water do not exist.

The lack of prices also makes the task of comparing the efficiency of water use with the efficiency in the use of other resources and other activities in the economy difficult. This in turn makes it difficult to assess how much more policy reform is needed.

In theory such a comparison could be done using some other common unit of measurement (rather than price), however an acceptable alternative is yet to be found.

WHOSE VIEWS ARE IMPORTANT?

One of the problems with government and collective action is deciding whose views should be including in decision making. Regardless of the legal property rights in water people in the communities tend to believe that they possess a strong moral right and interest in water. Even people beyond the catchment, but within Australia, are inclined to do the same. This is

not surprising since water is a resource which is used in virtually all production and consumption and it is likely to provide clear limits to possible development in a region or a nation.

An example of this problem is that members of local communities often claim their views are ignored when State and Territory governments consider approvals for mining developments which consume large amounts of river or underground water, or when they consider proposals to dam rivers and use them to supply water-short urban areas. Inherent in this objection is the idea that local people have some moral property right in local rivers. This is not of course supported by law, but at a broader level the idea that local people should have significant control over what is done with local resources is at the heart of Federalism.

Since Indigenous people in the TR region own approximately 51% of the land in the NT and own land covering 75% of the coastline it is essential that they be effectively and appropriately included in information-sharing, decision-making and the planning processes. Indigenous people require engagement that goes beyond that which might be considered 'appropriate' with many other stakeholder groups. This is for a number of reasons including: historical disadvantage, cultural misunderstanding and institutional barriers, differences in world views and knowledge of human-nature interactions, and barriers to understanding, negotiating and communicating in the same way and with the same power as non-Indigenous people.

COMPETING USER GROUPS

Even in small rural communities there can be great diversity of views about the use of water. Within the local community there may be pro-developers, environmentalists, ecotourism interests, people with neutral views and Indigenous people with their particular views about nature. There may be no possibility of consensus that could lead to collective action by the community.

The issue then is how should differences between these groups be dealt with in the decision making process? Simple majority voting, for example, may enable a large number of voters with relatively 'weak' preferences to out vote a small number of people for whom the issue is very important (and who, in Kaldor-Hicks terms, could over compensate the others). However, if choices are not made using votes some other system must be found and as yet no single system stands as a viable solution in all situations.

Whilst it may be possible for each community to adopt a different system of negotiating outcomes, the benefits of such an approach must be weighed against the costs. The negotiation costs may be small for small populations – for example in the 24 basins of the TR region with fewer than 500 residents – but are likely to rise as the number of stakeholders increase.

MANAGEMENT ISSUES

The very best policy can be made useless if its management procedures and resources are inadequate. There is some evidence that these are problems with existing policy.

Lack of management coordination

The focus groups in Derby and Mount Isa felt that while there were often good policies in place to manage rivers, there was lack of coordination of management with no agency providing a lead or coordinating role.

A particular example of lack of coordination is the case of tourism. While government tourism agencies are keen to encourage tourism to an area, there is little attempt to control the adverse consequences for the rivers which tourists visit. These problems include:

- Increased litter, including toilet paper
- Pollution of rivers caused by visitors washing in them
- Depletion of fish stocks
- Crowding that reduces the enjoyment of waterways by local residents
- Damage to access roads

In wilderness areas many of these tourists are self contained travellers and purchase little from the local economy.

Lack of management personnel and lack of enforcement

Focus groups in Derby and Mount Isa said that there was also a lack of resources and personnel (including inspectors) to implement policy and enforce regulations (in the area of fishing, for example). The focus group in Mount Isa was also concerned about the general lack of compliance and enforcement. The main example was the dumping of rubbish in rivers. It was also felt that even more resources will be needed for management as population and/or visitor numbers continue to grow.

6.5 Conclusion

The expansion of water trading is capable of bringing about more efficient use of water and the flexible recovery of water; however, there are a range of conditions which will need to be met for this to occur. They relate to information used in decision making, monopoly power, externalities, transaction costs and property rights, and the provision of water infrastructure. The additional requirement of an equitable outcome will mean that the conditions of trading will have to ensure that the relatively poor are provided with adequate access to water.

Since water markets will not always work sufficiently, efficiently or equitably there will still be a role for the non-market allocation of water. Non-market decision making, however, has its own set of problems. These include the need to ensure that the appropriate views are included in decision making and that they are included in the appropriate way. Considerable attention will need to be paid to the incorporation of Indigenous needs and perspectives in planning and decision-making processes. Further, management resources required for non-market allocative systems are typically large by comparison with those required for market systems and governments must be prepared to provide those.

In the end, there is no guarantee that either market or non-market approaches will generate results that are effective, efficient or equitable. The challenge for policy is, therefore, to determine how best to combine the approaches so as to get the best overall result. Importantly, one size is unlikely to fit all – different regions may require different combinations of policy approaches.

7 Summary and Recommendations for further research

The key objectives of this scoping study are:

1) To develop an integrated social and economic profile of the tropical rivers region, focussing on the collation and reporting of data relevant to rivers and river management;
2) To identify important social and economic values and issues relevant to rivers;
3) To explain significant processes and pressure points that will impact on future management of tropical rivers, including conflicting stakeholder aspirations;
4) To scope future research needs and priorities based on the identification of key social and economic management questions, and;
5) To recommend questions and approaches for further R&D that will generate an understanding of the social and economic processes and pressure points that will impact on the health of rivers, floodplains, wetlands and estuaries in the study area.

The conclusions of chapters 2 through to 6 summarise key issues relevant to objectives 1, 2 and 3. The focus of this final chapter of the report is therefore to use information from these preceding sections to meet objectives 4 and 5. That is, to highlight future research needs and priorities and to recommend questions and approaches for this R&D.

This chapter thus presents a concise summary of key points that have been raised in separate chapters of the report, using insights from those summaries to identify specific research needs. Where appropriate, disciplines that have the potential to contribute to this research topic are noted and potentially valuable case-study basins are identified. There has not, however, been any attempt to recommend specific methodological approaches (eg. recommending focus group discussions, participatory research or empirical modelling) – it being reasoned that such issues are best decided by the experts selected to conduct the research.

An important issue raised in chapter 2 is that there are significant differences between many of the river systems in the TR region and others in southeast Australia. First, it is clear that most rivers in this region have episodic flows whereas many in the southeast are perennial. Second, groundwater is an important substitute to surface water – for human and animal consumption and for other purposes. Third, there are complex yet poorly understood relationships between ground and surface waters.

It is also evident that river management systems in the TR region must be able to cope with scarcity and with extremely variable water supplies – both geographic and temporal – and must simultaneously deal with both surface and ground water issues. The biophysical characteristics of the region also mean that those charged with managing water resources in the TR region will need to be particularly vigilant to protect 'basic' levels of both water quantity and water quality – not just on the surface but also underground. This is because scarcity has the potential to intensify the external effects that one person's activities has upon others (as when, for example, the only water hole for hundreds of kilometres runs dry).

In chapter 3 it was noted that the social and economic values of Australia's tropical rivers have changed through time. So too have the theories of 'value', the frameworks for thinking about 'values' and the terminologies of managers and academics. These changes have, in turn, influenced the way in which values are conceptualised, identified, assessed, measured and – ultimately – used to make decisions about how to allocate resources to different and often competing uses. Managers and researchers thus need to be aware of the fact that different approaches to thinking about 'values' may lead to quite different allocative outcomes.

Most evident from the discussion of chapter 4 is the fact that there are many different social and economic values associated with Australia's tropical rivers. Whilst many of these 'values' are essentially complementary (e.g. some environmental, aesthetic, Indigenous and recreational values), many other values 'compete with' one another, and conflicts are beginning to emerge. Further, there is evidence to suggest that most basins within the TR region are likely to face increasing demands for water – from multiple, oftentimes competitive, sources. 'Conflicts' like those identified in this report are thus likely to intensify over time.

Many of the basins in the TR region have fewer than 500 persons and very little industry. In these basins 'values' are almost exclusively non-market in nature. This poses some interesting management challenges in a policy environment that places much emphasis on 'market' solutions. In these basins it may not be feasible or sensible to introduce a market system for allocating water (since these systems typically work best when there are many participants).

Oftentimes policy stresses the need to set aside water 'for the environment' before allocating the remainder to other users. In the TR region, however, water 'managers' may also need to consider the idea of setting aside water for Indigenous communities, since these values – like those associated with the environment – are typically non-priced. The exact amount of water to be set aside to support these values is unclear, particularly given the complementary nature of many (but not all) environmental and Indigenous values and the difficulty of quantifying a flow sufficient to meet an intangible value.

Likewise, it is clear that both the fishing and the tourism industries have significant 'values' associated with the region's rivers. But these industries do not 'use water' in the traditional sense, and so these values may not translate neatly into water prices. Here too, policy makers who are keen to implement water markets may need to consider whether it is necessary to set aside 'water' and/or set water-quality guidelines that protect and give voice to these values. Here too, it is difficult to determine how much water should be set aside for these purposes.

As clearly recognised by current policy-makers pressures on Australia's water resources mean that it is important to look at both supply-side and demand management solutions. Yet as noted in chapter 5, while the NWI has provided the focus for water policy changes across the Commonwealth, States and Territories, the policy, legal and administrative frameworks still remain extremely complex. Much of the reason for having such a complex set of policies, plans, acts, and institutions is that water policy must deal with the various and competing uses for water. There are also jurisdictional issues between local government and state/territorial governments and, unlike most commodities, everyone in Australia has a vital interest in water. Nevertheless, to quote from Ostrom (2005, p. 1):

> "If the individuals who are crafting and modifying rules do not understand how particular combinations of rules affect actions and outcomes in a particular ecological and cultural environment, rule changes may produce unexpected, and at times, disastrous outcomes."

Hegarty et al (2005) found that there are over 20 policies and programs impacting on water use for tropical rivers across the Commonwealth, States and Territories and 26 pieces of legislation relating to the use of tropical rivers. Even if each and every one of these pieces of legislation had only one 'rule' there would be 325 different (paired) combinations of rules to investigate, leading one to the inevitable conclusion that few people are likely to understand the way in which this complex set of rules plays out 'on the ground'. Perhaps

not surprisingly, there appears to be a significant knowledge gap pertaining to people's attitudes towards the National Water Initiative and other related policies and programs.

Further, comments from the focus group discussions indicate that local government appears to be assuming greater responsibility for management of recreational sites, tourism and the environment. Yet anecdotal evidence suggests that areas outside towns that are not in national parks are not getting the management attention they deserve. Conservation values associated with these areas may not be met at present either.

Related to this is the question "how can one finance improvements in natural resource management in the event that current systems are deemed to be under-resourced"? Specifically, it may not be possible to raise revenues from those who benefit from the region's water ways in an efficient and equitable manner – particularly when many of the values associated with Australia's tropical rivers are not at all, or only loosely, associated with the market. Further, there is a very sparse (or 'thin') resource base to be 'taxed' or asked to contribute to the cost of managing vast tracts of land and water. And a good proportion of that population base is very poor. It is therefore, vitally important for policy makers to consider the distributional effects of any programs implemented under the NWI.

It is also important to note that there may also be technological solutions to existing or emerging water 'shortages' in some areas (eg building dams, recycling water, the use of grey-water, installing water tanks and/or water purification systems, desalinisation, the use of dry-toilets) but the benefits of such 'solutions' must be carefully weighed up against the costs. Thus, whilst the NWI acknowledges the need to price water according to its cost there is also a need to ensure that investment considers benefits. Specifically, the NET BENEFITS of proposed water infrastructure investments should be considered, taking into account both the market and non-market values discussed above.

Finally, it is important to note that amongst other things the NWI aims to ensure that water is priced in a manner that helps to achieve 'efficient' water use and service provision. If water prices are not determined in a free market they may need to be determined by other bodies (e.g. government or water corporations). And whilst the economics literature abounds with different examples of pricing systems that may help policy makers achieve multiple goals (eg covering costs whilst pricing efficiently in natural monopolies) there may be a need for more research in this area that specifically considers water in the TR region.

Suggested areas for future research

Our recommendations for future research have been divided into eight broad areas or 'themes' as listed below.

Biophysical Systems
Values
Indigenous Issues
Water for 'Pseudo-market' Values
Water Allocation Systems
Social and Distributional Issues
Implementation, Monitoring and Enforcement
Pricing and Infrastructure

A more detailed discussion of each follows.

Research Theme 9: Biophysical Systems

As is widely recognised elsewhere there is an urgent need for future research on biophysical systems within the TR region, if only because it is exceedingly difficult to manage resources if one does not know what those resources are. Specifically, there is a need for research

into the extent, quality and environmental role of ground and surface waters in the TR region – with a focus on

a. the episodic nature of many flows
b. the biophysical links between ground and surface waters; and
c. the relationships between tropical rivers' hydrological regime, geomorphology, material budgets and 'outputs' such as production and biodiversity.

Research Theme 10: Values

There is also a need for further research into the 'values' associated with Australia's tropical rivers. Whilst many of 'values' identified in this report are essentially complementary, many other values 'compete with' one another and as populations rise across the TR region, the mix of values associated with the rivers is likely to become more complex. There will be an increasingly important role for policy, legislation and institutions to play in negotiating these values and emerging conflicts – and there is an urgent need for more detailed information about those values.

Specifically, there is a need for research that

a. Reviews existing concepts of value, frameworks for and methods of valuation for their applicability to the conditions and management issues of tropical river systems (if none are suitable, further research will be needed to develop concepts, frameworks and methods that can incorporate Western and Indigenous perspectives of value); and then
b. Applies appropriate concepts, frameworks and methods to questions of the allocation of tropical river resources to different uses.

This research will assist resource managers, planners and community groups to develop visions, articulate underlying values, and consider the impacts and trade-offs of multiple scenarios.

Research Theme 11: Indigenous Issues

Whilst there is widespread recognition of the fact that there may be a need to set aside water for environmental purposes before commencing a 'water market', this report identified the fact that there may also be a need to set aside water for Indigenous cultural purposes. Furthermore, it is likely that Indigenous communities will have an economic interest in any growth in industries and enterprises reliant on increased water use. However, the exact amount of water to be set aside to support these values is unclear and whilst some of the changes brought about by the NWI are likely to impact upon Indigenous incomes, quality of life and welfare, the extent of that likely impact is unknown. More research is thus needed in this area.

Specifically, there is a need for research that

a. Investigates the extent to which Environmental and Indigenous Cultural values complement and/or compete with each other.
b. Seeks to determine whether water that is 'reserved' for environmental flows also satisfies other Indigenous needs (such as native title, aesthetic values, health improvements) and to explore further the nature of an Indigenous entitlement (especially how to define, allocate and account for an Indigenous entitlement.
c. Investigates the most appropriate and effective means of enabling Indigenous people to contribute their ecological knowledge to the assessment of environmental and other flows, and more equitably participate in water allocation processes generally.
d. Seeks to determine the way in which the NWI is likely to impact upon Indigenous use of water and on Indigenous people's welfare.

Research Theme 12: Water for 'Pseudo-market' Values

This report highlights the fact that the fishing and the tourism industries have significant 'values' associated with the region's rivers - but these industries do not 'use water' in the

traditional sense; they are non-priced 'use-values'. Before attempting to set up water markets in the TR region, it may, therefore be necessary to find out more about the way in which such 'values' might be given a voice within water-markets. Specifically, there is a need for research that

a. investigates the 'value' of rivers to these industries; and
b. considers how such 'values' might could be pooled into a collective 'bid' for water within a formal market system and/or compared with other values in a non-market system.

Research Theme 13: Social and Distributional Issues

As populations rise, some of the emerging conflicts identified in this report may intensify. Clearly, some mechanisms for negotiating conflicts regarding access, externalities, the allocation of water (etc) must be sought. Yet, as noted in chapter six, there are significant differences in the wealth and the bargaining power of stakeholders in the region's rivers; and some negotiating mechanisms may exacerbate those differences. Consequently, there is a need for research that investigates the way in which different market and non-market systems deal with and affect the distribution of income and wealth – at an individual and at a regional and/or basin level (as when cross-basin trading is considered).

Research Theme 14: Water Allocation Systems

As highlighted in the biophysical summary, water is relatively scarce in many parts of the TR region – particularly during the winter dry. Sooner or later, it may, therefore, be necessary to 'ration' or 'allocate' scarce supplies between those values discussed in chapter four. As highlighted in chapter six however, there is no guarantee that either market or non-market allocative approaches will generate results that are effective, efficient or equitable. There is, therefore, a need for economic, legal and social research that seeks to identify the most effective and appropriate water allocation systems. Specifically, such research may need to investigate a range of different allocation systems (including those practiced by the region's traditional owners), the primary aim being to identify characteristics of systems that:

a. are able to cope with extreme temporal and geographic scarcity;
b. are able to include both ground and surface-waters;
c. are capable of dealing with externalities like those which typically occur in the TR region;
d. allow for the participation of non-market values (eg environmental or cultural);
e. facilitate the participation of sectors like tourism and fishing where many of the 'values' that are associated with water are not directly linked to the market;
f. work well for small populations;
g. facilitate the participation of 'disadvantaged' groups;
h. are equitable as well as 'efficient'; and
i. are PRACTICAL to implement in remote regions.

As noted earlier, one size is unlikely to fit all – and research like this may help identify different types of, or characteristics of, allocative mechanisms that suit different basins within the TR.

Research Theme 15: Implementation, Monitoring and Enforcement

As highlighted by discussion chapter 5, there are a multitude of different acts, plans, and institutions at the local, state and federal level that impact upon Australia's Tropical Rivers. Yet, as highlighted in the focus group discussions, there is often a significant difference between the intent and the actuality of acts and plans. There is, therefore, a need for research that critically reviews the policies, plans, and acts that relate to water policy in the TR region – the primary aim being to determine how effectively they are being implemented 'on the ground'.

Specifically, there is a need for research that

a. seeks to determine the adequacy of resources used to implement, monitor and enforce the objectives of the NWI and reviews different methods of raising revenues to finance natural resource management practices in the TR region.

b. reviews the property rights systems that regulate access to water/rivers across land and looks into the efficacy of different mechanisms for dealing with conflicts between landholders, recreational fisherpersons, tourists and Indigenous people in remote areas.
c. assesses the efficacy of regional water plans in meeting stated objectives and the overall objectives of national water policy – with particular focus on issues such as efficiency, externalities and equity.
d. evaluates newly implemented water allocation systems, looking at the way in which new allocation rules interacts with existing water management institutions, specifically local practises and norms.

Research Theme 16: Pricing and Infrastructure

As highlighted in chapter 6, if water is to be used efficiently, then water infrastructure must also be 'efficient'. Whilst an investigation of water infrastructure in the TR region was beyond the scope of this study, it is an area that requires further investigation. Specifically, there is a need for research into water infrastructure facilities in the TR region – the primary aims being to

a. determine if current facilities are economically efficient;
b. identify prospects for new (efficient) infrastructure investments
c. consider the efficiency and equity aspects of a range of different water pricing systems including, but not limited to: marginal cost pricing, average cost pricing, multi-part pricing, price discrimination and bundling).

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Appendix A – Related research and links to this project

To date relatively little research has been conducted on the social, economic and institutional characteristics and features of the TR region. Instead, most research effort has focused on the bio-physical characteristics of rivers draining into the Great Barrier Reef lagoon and on the rivers and wetlands of the Alligator Rivers region of the Northern Territory. Hamilton and Gehrke (2005) report on the areas that have received the greatest emphasis in previous and current biophysical research efforts, but note:

a) the patchy research coverage of such a geomorphologically diverse region precludes development of a robust synthesis of ecosystem processes and functions (2005, p.245); and

b) that there are several knowledge gaps, including information about:

- sustainable human appropriation of fresh water
- hydrological, biogeochemical and ecological linkages at landscape scales
- ecosystem processes and services afforded by tropical river systems
- climate change (2005, p.248).

The authors go on to nominate three key measures to advance the knowledge base for tropical river management:

- better institutional arrangements (partnership, collaboration, the inclusion of local communities);
- capacity-building within the tropics, combined with collaborative research contributions from organisations outside the region; and
- the development of an integrative capacity to assess system-wide implications of changes in land use and water development.

Hamilton and Gehrke (2005) also confirm the value of traditional ecological knowledge to enhance scientific understanding of tropical ecosystems. Anthropological studies on Indigenous resource management systems and social organisation provide a relatively rich source of information on human interactions with freshwater and riparian environments. Most of that body of knowledge has been produced for land claims processes (including Native Title claims) and is therefore not held in the public domain.

Efforts are being made by the Governments of Queensland, the Northern Territory and Western Australia to establish a Tropical Rivers and Coastal Knowledge Research Consortium[44] (TRACK) to address these and other knowledge gaps. The consortium has identified ecological processes, Indigenous values and Indigenous enterprise development as key research themes, alongside the need for research on social and economic values and decision-support mechanisms and tools.

[44] A consortium of Australia's leading tropical riverine and coastal researchers has been working for the past 18 months to develop a co-ordinated program of research that will underpin the sustainable management of northern Australia's tropical rivers and coasts. The Tropical Rivers and Coastal Knowledge (TRACK) consortium includes over 50 researchers from 15 agencies including Charles Darwin University, Griffith University, University of Western Australia, James Cook University, CSIRO, AIMS, *eriss* and the Northern Territory, Queensland and Western Australian Governments.

As mentioned above Land and Water Australia has recently identified Australia's tropical rivers and associated wetland environments as a priority area for investment over the coming years. During recent years it has commissioned a number of projects pertaining to tropical rivers under its various programs (including the Tropical Rivers Research Program, the Social and Institutional Research Program, the Environmental Water Allocation Program, the National River Contaminants Program, the National Rivers Consortium and the National Riparian Lands R&D Program[45]).

For instance, a large project designed to develop an inventory of biophysical and socio-economic characteristics has been funded by the Tropical Rivers Program. Entitled the *Tropical Rivers Inventory and Assessment Project*, it has been conducted over two years (2004-2006) by the National Centre for Tropical Wetland Research (NCTWR). The project is of relevance to this scoping study for it seeks to, *inter alia*, trial a framework for the evaluation of goods and services provided by wetlands. Case studies undertaken as components of the project include the Fitzroy River of the Kimberley region and the Daly River catchment in the Northern Territory. As this project also engaged with stakeholders, effort was made to coordinate the scheduling of focus groups and stakeholder meetings[46].

A better understanding of the state of current knowledge may be obtained from LWA's Tropical Rivers Program[47] Plan and Prospectus (LWA 2005a) and from the 2005 special edition of *Marine and Freshwater Research* (Volume 56). Land and Water Australia's Tropical Rivers Program prospectus acknowledges that the values and aspirations of Indigenous communities relating to tropical rivers need to be integrated into research and natural resource management. Furthermore, research on Indigenous land use needs to be meaningfully incorporated into the program and be driven by Indigenous people (LWA 2005a, p.13).

To that end, in 2005 Land and Water Australia commissioned a scoping study of Indigenous interests in tropical rivers (Jackson and O'Leary 2006). The scoping study was overseen by the North Australian Indigenous Land and Sea Management Alliance (NAILSMA) and has been used to inform the analysis undertaken in this socio-economic study.

There are several other broad research programs that cross all three State and Territory jurisdictions where tropical rivers exist. These include:

- The Northern Australia Irrigation Futures project[48], which is aimed at developing a set of tools and processes for making decisions about where and how irrigation in the tropical rivers regions can be sustainable. It should be noted that this project compiled an institutional analysis of NRM in the tropical rivers region, which has been used to inform this scoping project.

- The Conservation Management Guidelines for Wild River Values, which was developed by the Wild Rivers Project of the Australian Heritage Commission[49]. The Wild Rivers Project is identifying Australian river systems that have been relatively unchanged since European settlement. Coordinated by the Australian Heritage Commission, the project uses input data from the States on various indicators of disturbance to establish a level of "wildness" for each river.

[45] See http://www.rivers.gov.au/about/index.htm for further information.
[46] See http://www.nctwr.org.au/publications/tropical-rivers.html for further information.
[47] See http://www.rivers.gov.au/research/tropical/index.htm for further information.
[48] See the NAIF website at http://www.clw.csiro.au/naif/index.html for further information.
[49] See http://www.heritage.gov.au/anlr/wild_riv/guide/home.html for further information.

- The National River Health Program and AusRivAS[50]. AusRivAS is a computer based program aimed at assessing river health by predicting aquatic macroinvertebrate fauna that would be expected at a site in the absence of environmental stress.

There are also numerous research programs being conducted in specific regions within each state/territory. For example,

- ***Daly River region, NT:*** The Top End Waterways Project commenced in 1995 as an initiative of the Northern Territory Government and seeks to examine the current status of the Daly River, Roper River and Victoria River catchments. Substantial research effort has been directed towards the determination of environmental flows in these catchments. More recently CSIRO has commenced research into Indigenous values, water trading and water resource management and ecosystem services (funded by LWA and the Tropical Savannas CRC). NHT, NAP and NWC funding are all being channelled into addressing knowledge gaps in NRM in this region. The Daly region is also currently a case study in a number of the north Australian studies mentioned above (e.g. NAIF and TRIAP).
- ***Ord-Bonaparte, WA:*** The Ord River Irrigation Scheme was established 38 years ago and regulates the flow of the river system to establish fairly constant water levels. A major interdisciplinary multi-agency R&D program commenced in 1999. It was designed to support regional governance in the East Kimberley region by providing relevant data and understanding and building capacity, particularly that of Indigenous communities (Greiner and Johnson 2000). More recently the Kimberley Land Council has conducted research on social and economic impacts associated with the Ord River Irrigation Scheme (2004) and on Indigenous cultural and heritage values (Barber and Rumley 2003).
- ***Mary River, Northern Territory:*** Mary River wetlands are unique as they have a smaller outlet to the sea than other NT wetlands and thus retain freshwater more readily. This has lead to an abundance of wildlife in the area. Mitigation actions have been undertaken to stop salinity problems since the 1980's. The Mary River Salinity Mitigation report[51] undertook a cost-benefit analysis of salinity mitigation options.

[50] See http://ausrivas.canberra.edu.au/ for further information.
[51] See http://www.greenhouse.gov.au/impacts/publications/pubs/maryriver-chapter1.pdf for further information.

Appendix B – Focus Group Research Methodology

As is apparent from the discussion in chapter 3, if one wishes to understand and assess people's values, the first stage is to identify them. Whilst it is theoretically possible to identify 'values' using literature reviews, surveys, interviews or small-group discussions, care must be taken when interpreting results since they are, of necessity, somewhat dependent upon the methods used.

A literature review, for example, is a particularly useful means of collecting large amounts of data relating to many different variables for a multitude of regions. However caution must be taken not to report the identified values out of their original context and it is advisable to ensure that the data (and subsequent interpretations) are tested for consistency and relevance.

One way of doing this is to conduct a survey of the relevant population[52]. Surveys can be administered in a variety of different ways including: direct observation, diaries, face-to-face interviews, mail, by telephone and online. Those that are self-administered (ie where the respondent answers a series of questions themselves) are relatively cheap and have standardised answers that can be easily codified for statistical analysis. However, response rates are often lower than for verbal or telephone questionnaires, respondents may become frustrated by standardised answers and the written format may alienate some respondents and be inappropriate in cross-cultural situations. Telephone and face-to-face surveys have a number of advantages, but can also mean that bias may be introduced through the verbal and non-verbal cues of the interviewer.

Face-to-face interviews are distinct from face-to-face surveys in that they are often more in-depth, do not require standardised answers and can be less structured than a survey. This type of approach allows the researcher to explore issues in more detail, to clarify questions and to ask for further explanation on particular topics. Interviews are often semi-structured to allow the goals of the research to be achieved, but to allow for flexibility in exploring certain

[52] Since it is rarely practical to ask each and every stakeholder for their opinion, survey data is often collected from a representative sample.

issues in more depth. This approach to gathering information is thus capable of obtaining a richer range of responses than broad scale surveys but is, as a consequence, much more expensive to administer.

Another method of collecting information from relevant stakeholders is to use small-group deliberative sessions – hereafter referred to as focus group discussions. An advantage of this approach (over and above those that use large meetings) is that small group meetings can be used to make it easier for quiet people to have their say and questions can be posed in certain ways and using particular words to suit the audience.

This method was used effectively by Wilson and Howarth (2002), who summarised the basic procedural rules in relation to deliberation over ecosystem goods and services as follows:

(1) Each participant is allowed to participate in discourse.
(2) Each participant is allowed to place issues on the agenda.
(3) Each participant is allowed to introduce his or her own assessment of an ecosystem good or service.
(4) Each participant is allowed to express their own attitudes, needs and preferences for an ecosystem good or service.
(5) No speaker is hindered by external compulsion or pressure.
(6) The goal of discourse is to reach a consensus value among participants.

The key point to be made here is that there are many different ways to collect data, some more practical than others. Researchers must therefore choose the 'best' method possible, subject to resource constraints (time, money etc). The approach taken in this scoping report was therefore to:

a) collect as much relevant information as possible from secondary sources; and

b) supplement that data with information collected during a series of focus-group-discussions.

Importantly, method (a) provides researchers with relatively 'shallow' data across a wide range of issues, whilst method (b) provides researchers with a rich source of information in a narrower context. When fused together, the end result is a source of information that has both breadth and depth.

Thus, whilst most of the data/information used in this report derives from secondary sources (e.g. the Australian Bureau of Statistics), some of the information was collected during a series of consultative meetings in Mount Isa, Katherine and Derby. These meetings revealed important information about the social and economic values of Australia's tropical rivers. And they also revealed important information about emerging issues and conflicts relevant to rivers management, and about some of the existing institutional arrangements associated with rivers. The outcomes of these meetings are, therefore, reported in relevant sections throughout this report; whilst this appendix provides methodological detail about the data gathering process.

THE FOCUS GROUP DISCUSSIONS

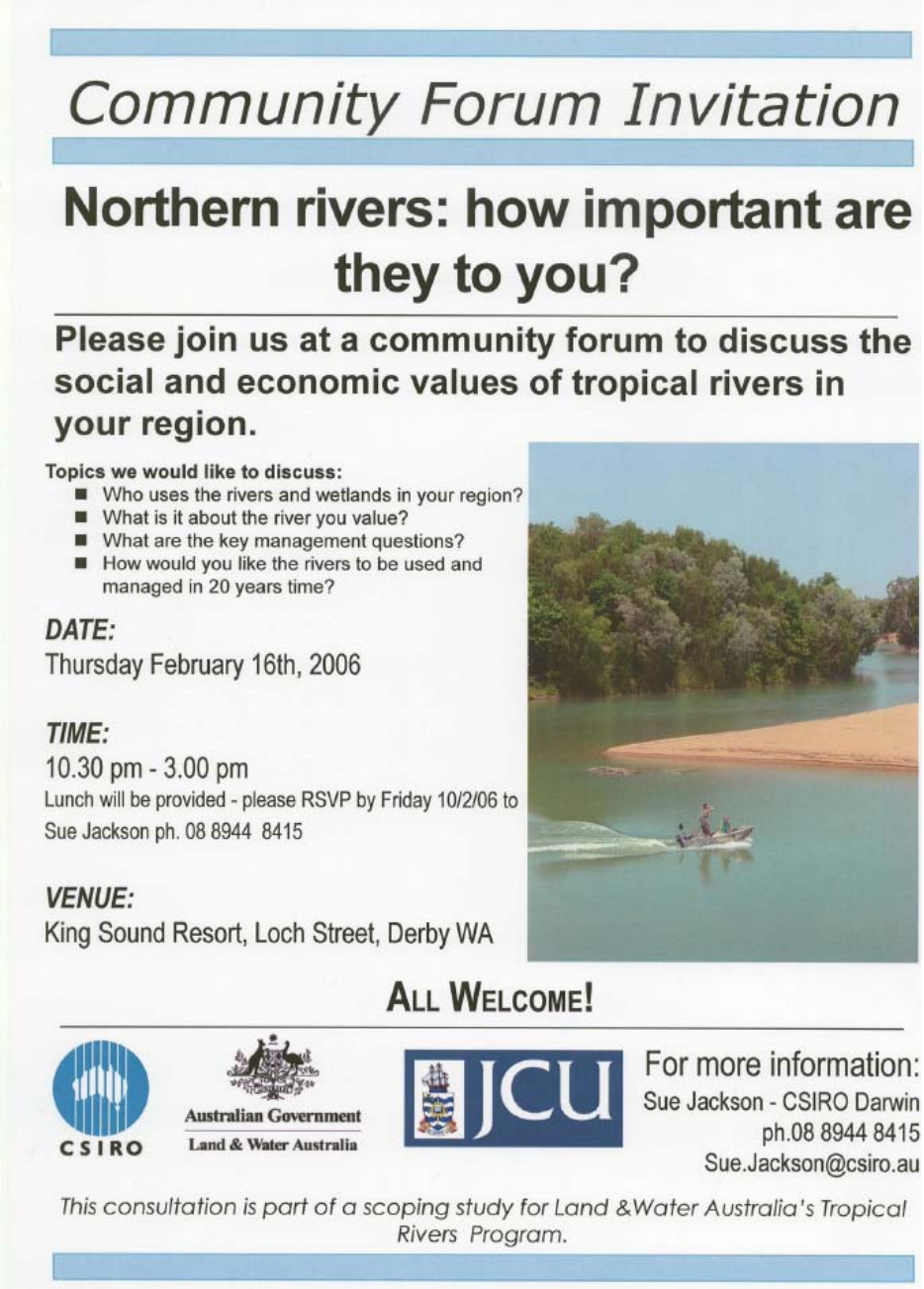
The central role that consultation plays in this project reflects an approach that is based on principles of Participatory Rural Appraisal. Participatory Rural Appraisal (PRA, also sometimes known as Rapid Rural Appraisal) emerged in the 1970's as an approach to and philosophy of engaging with farming communities in more effective ways. It provides an alternative to fast, 'development tourism' approaches to research and appraisal that only consult with the most readily available people at the most readily available times and that tend to not recognise or to devalue local knowledge. PRA recognises the critical roles of people in the landscape to any research or decision-making about achieving sustainable development[53].

Katherine, Mt Isa[54] and Derby[55] were selected as appropriate sites for the meetings according to the following criteria:

- Known water use pressures;
- Likely community interest and an absence of 'consultation fatigue' (for example, as has been reported for the Ord (WA) and Daly (NT) regions);
- Major population centres; and
- Contrasting social and biophysical characteristics (eg. tourism town located in region with perennial river, mining town located in region with little perennial water, town with a variety of important industries and an active Indigenous community).

The process for identifying stakeholders was as follows. In April 2005 the study team met in Darwin. The group identified the stakeholders relevant to the project in preparation for consultations and focus group meetings. Stakeholders were nominated across categories such as *government* (local, regional, State, Federal); *industry* (agriculture, fishing, mining, hydro-electric power, domestic/industrial water providers, aquaculture, tourism and recreation, commercial and residential development); *non-government organisations* (environment, Indigenous); and *significant land owners* and *researchers*.
This list was used to identify who should be specifically targeted with an invitation to the focus group meetings, using a 'flyer' like that below:

[53] PRA is often defined as "a qualitative survey methodology using a multi-disciplinary team to formulate problems for agricultural research and development" (Conway, 1986; adapted from Ison & Ampt, 1992). 'Qualitative' means that data collected may involve insights described in the most relevant terms and units rather than only in numbers or dollar values. PRA seeks to define research problems with local people and engages multi-disciplinary teams to ensure that many aspects of an issue are considered when the problem is defined. Thus, PRA does not try to 'reduce' a problem into measurable, scientifically testable and controllable parts, and it recognises that the way in which the research is done will have an impact on the phenomena that are observed.
[54] Originally, Georgetown had been identified as an appropriate site, primarily because of existing research links between CSIRO's Romy Greiner and key stakeholders in that community. However, when Dr Greiner departed those links became less tenable and Mt Isa was substituted in its place.
[55] After consulting with key people in the Kimberley region we were alerted to a perception that the Fitzroy Crossing community had been consulted frequently on river issues over the past year or two. Hence, the choice of Derby.



Community Forum Invitation

Northern rivers: how important are they to you?

Please join us at a community forum to discuss the social and economic values of tropical rivers in your region.

Topics we would like to discuss:

- Who uses the rivers and wetlands in your region?
- What is it about the river you value?
- What are the key management questions?
- How would you like the rivers to be used and managed in 20 years time?

DATE:
Thursday February 16th, 2006

TIME:
10.30 pm - 3.00 pm
Lunch will be provided - please RSVP by Friday 10/2/06 to Sue Jackson ph. 08 8944 8415

VENUE:
King Sound Resort, Loch Street, Derby WA

ALL WELCOME!

CSIRO
Australian Government
Land & Water Australia
JCU

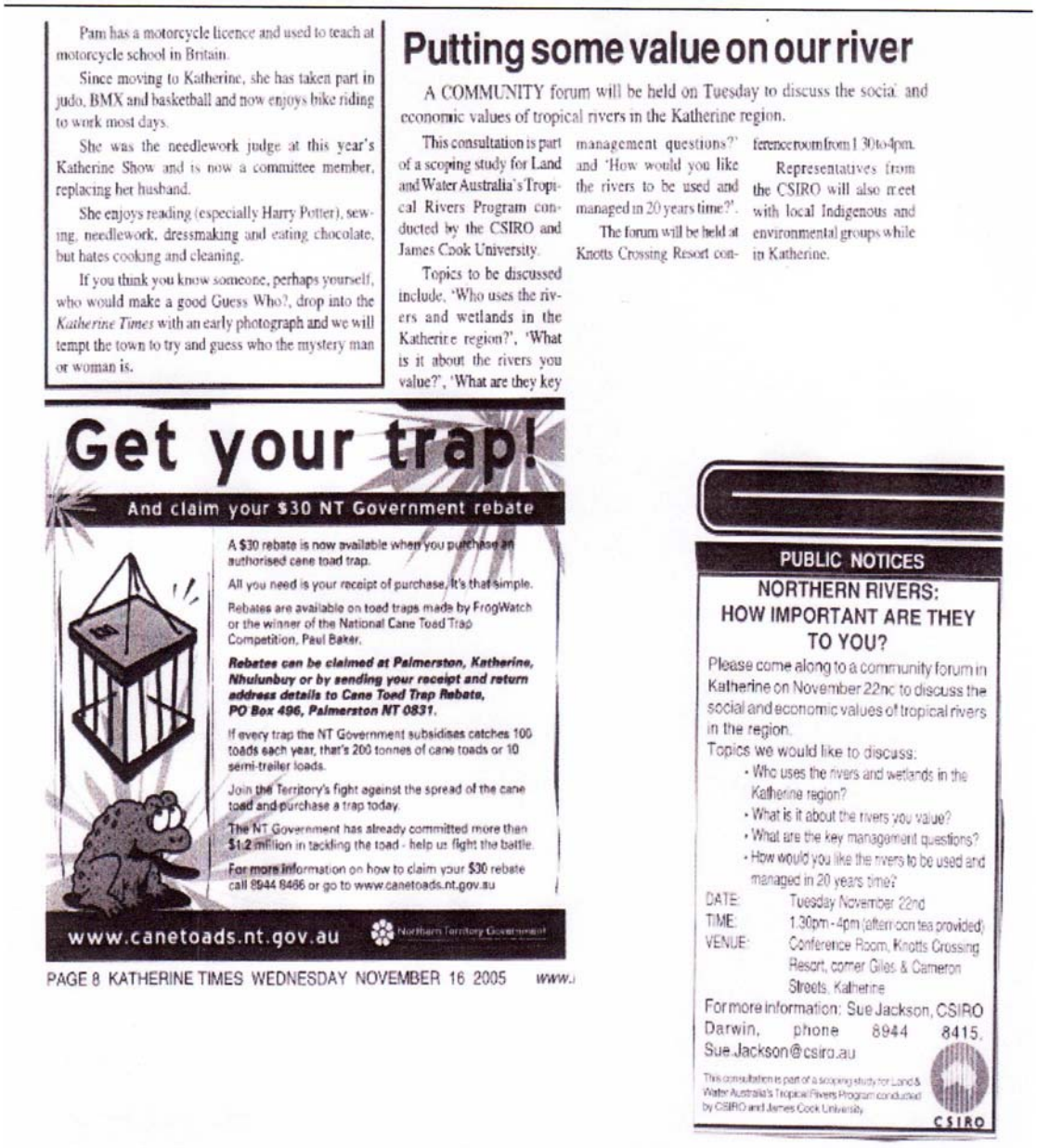
For more information:
Sue Jackson - CSIRO Darwin
ph.08 8944 8415
Sue.Jackson@csiro.au

This consultation is part of a scoping study for Land &Water Australia's Tropical Rivers Program.

It was hoped that many of the stakeholder groups would be represented at the forums thus eliminating the need to consult directly[56]. Advertisements were also placed in local media outlets and distributed through stakeholder networks (for example, Kimberley Pastoralists Association, Mt. Isa Shire):

[56] The Amateur Fisherman's Association of the NT requested an interview in November 2005 as they were unable to attend the Katherine focus group meeting.

Advertised in the *Katherine Times* 16 November 2005



Pam has a motorcycle licence and used to teach at motorcycle school in Britain.

Since moving to Katherine, she has taken part in judo, BMX and basketball and now enjoys bike riding to work most days.

She was the needlework judge at this year's Katherine Show and is now a committee member, replacing her husband.

She enjoys reading (especially Harry Potter), sewing, needlework, dressmaking and eating chocolate, but hates cooking and cleaning.

If you think you know someone, perhaps yourself, who would make a good Guess Who?, drop into the *Katherine Times* with an early photograph and we will tempt the town to try and guess who the mystery man or woman is.

Putting some value on our river

A COMMUNITY forum will be held on Tuesday to discuss the social and economic values of tropical rivers in the Katherine region.

This consultation is part of a scoping study for Land and Water Australia's Tropical Rivers Program conducted by the CSIRO and James Cook University.

Topics to be discussed include, 'Who uses the rivers and wetlands in the Katherine region?', 'What is it about the rivers you value?', 'What are they key management questions?' and 'How would you like the rivers to be used and managed in 20 years time?'.

The forum will be held at Knotts Crossing Resort conference room from 1.30 to 4pm.

Representatives from the CSIRO will also meet with local Indigenous and environmental groups while in Katherine.

Get your trap!

And claim your $30 NT Government rebate

A $30 rebate is now available when you purchase an authorised cane toad trap.

All you need is your receipt of purchase, it's that simple.

Rebates are available on toad traps made by FrogWatch or the winner of the National Cane Toad Trap Competition, Paul Baker.

Rebates can be claimed at Palmerston, Katherine, Nhulunbuy or by sending your receipt and return address details to Cane Toad Trap Rebate, PO Box 496, Palmerston NT 0831.

If every trap the NT Government subsidises catches 100 toads each year, that's 200 tonnes of cane toads or 10 semi-trailer loads.

Join the Territory's fight against the spread of the cane toad and purchase a trap today.

The NT Government has already committed more than $1.2 million in tackling the toad - help us fight the battle.

For more information on how to claim your $30 rebate call 8944 8486 or go to www.canetoads.nt.gov.au

www.canetoads.nt.gov.au Northern Territory Government

PAGE 8 KATHERINE TIMES WEDNESDAY NOVEMBER 16 2005 www.

PUBLIC NOTICES

NORTHERN RIVERS: HOW IMPORTANT ARE THEY TO YOU?

Please come along to a community forum in Katherine on November 22nd to discuss the social and economic values of tropical rivers in the region.

Topics we would like to discuss:

- Who uses the rivers and wetlands in the Katherine region?
- What is it about the rivers you value?
- What are the key management questions?
- How would you like the rivers to be used and managed in 20 years time?

DATE: Tuesday November 22nd
TIME: 1.30pm - 4pm (afternoon tea provided)
VENUE: Conference Room, Knotts Crossing Resort, corner Giles & Cameron Streets, Katherine

For more information: Sue Jackson, CSIRO Darwin, phone 8944 8415, Sue.Jackson@csiro.au

This consultation is part of a scoping study for Land & Water Australia's Tropical Rivers Program conducted by CSIRO and James Cook University

CSIRO

Follow-up phone calls were made to key organisations, such as Land Councils and NRM regional coordinators.

Qualitative data was then collected though a series of three half-day group discussions with members of the public at Katherine (Northern Territory), Mt Isa (Queensland) and Derby (Western Australia). A total of 67 people attended the three forums (16 in Katherine, 10 in Mt Isa and 41 in Derby). The breakdown of participants at each focus group discussion is given in Figure 44.

Workshop	Industry & Local Government	Environment focus	Communication/ community capacity building	Aboriginal interests	No representation
Katherine	7	6	0	2	1
Mt Isa	6	3	1	0	0

Derby	7	7	2	18	7

Figure 44 – Focus group participants: Katherine, Mt Isa and Derby

The general approach taken in this research was to run consultations as a combination group interview and focus group. The facilitator had a set of questions to prompt and guide discussion (see below) yet there was also some scope for participants to interact and talk freely, raising a range of issues and expressing a range of opinions.

Questions used to guide discussion at the community forums

1. What do you use rivers and wetlands for?
2. What do you like about living near a tropical river?
3. On a separate sheet of paper could you list the three most important things you like about living near a tropical river?
4. Have you seen any changes to the way that rivers here are used?
   If so, what changes and when did they occur?
5. In this area do you see tensions and conflicts over river use? If so, where do these occur and between which groups
6. Have you seen changes to the health and condition of the river's here? If so, what changes and when did they occur?
7. On a separate sheet of paper could you list which three changes concern you most?
8. How do you judge the health of the river? What do you look for in judging whether the river is healthy or not?
9. (Breaking into smaller groups) I'd like you to describe how local rivers are managed. What is working well and what is not?
10. (Still in groups). Could you describe what you think are the Katherine community's attitudes towards river management.

Scenarios – a different scenario was presented to each group

Katherine

(Still in groups) Thinking about the future, imagine a time when your 5 year old child is an adult with his or her own young children. I'd like you to consider the following scenarios and write down how you would react. From the list of uses and values we drew up earlier, which ones would be affected and how?

a) The Katherine River is to be dammed to supply water to many cotton farms and hydro electric power to the massive city of Darwin which has finally, after years of struggling to grow, taken off as the Gateway to Asia.
b) Sea levels have risen and Kakadu is under water. People have given up real-time fishing in southern Australia – they log on to throw a line. Nature based tourism has been growing in popularity every year during the past thirty years, so much so that the Katherine Gorge is the most popular place in north Australia and the fishing here is the envy of the world.

Mt Isa

(Still in groups) Thinking about the future, imagine a time when your 5 year old child is an adult with his or her own young children. I'd like you to consider the following scenarios and write down how you would react. From the list of uses and values we drew up earlier, which ones would be affected and how?

a) The Gregory River is to be dammed to supply water for cotton and other farming and power to a new mine over the border in the Northern Territory.
b) Sea levels have risen and the Gulf coastal towns are under water. Nature-based tourism has grown strongly every year for the past 30 years. Tourists are now flocking to the Isa region to camp along rivers, fish and swim.

Derby

(Still in groups) Thinking about the future, imagine a time when your 5 year old child is an adult with his or her own young children. I'd like you to consider the following scenarios

and write down how you would react. From the list of uses and values we drew up earlier, which ones would be affected and how?

a) Broome continues to grow rapidly and urban land use occupies the entire southern half of the Dampier Peninsula. Broome becomes a city. The Fitzroy is to be dammed to supply water to this large city, the cotton farms surrounding it and to meet Perth's growing demands for water.
b) Climate change brings extremely hot temperatures to Queensland and the Northern territory. Darwin and Kakadu are destroyed by a cyclone. The Kimberley becomes the most popular tourist destination in Australia with visitors flocking to the region: to the Fitzroy River and the Gibb River Road to camp, swim and fish. The fishing here is the envy of the world.

This provided the team with an opportunity to explore uses, interactions and meanings associated with rivers, management issues, changes in these over time and issues of conflict and tension amongst various groups or sectors. Insights were thus also gained from interactions between participants, which is the key distinguishing characteristic of the focus group method

On departure, participants were provided with a pamphlet providing more information about the research project:

Pamphlet given to participants at focus group meetings

CSIRO

Australian Government
Land & Water Australia

JCU
JAMES COOK UNIVERSITY

Land Water Australia (LWA) Tropical Rivers Program
Community forum on social and economic values of tropical rivers

What is Land Water Australia?

Land and Water Australia (LWA) is an Australian Government body that provides money for research into better management of the Australian environment and its natural resources, like water, groundwater, rivers and wetlands.

What is The Tropical Rivers Program?

The Program was established in 2004 when the Board of LWA identified Australia's unique tropical rivers and associated catchments and estuaries as a priority area for investment over five years from July 2005. The goal of the program is to:

> *Undertake research and knowledge exchange to support the sustainable use, protection and management of Australia's Tropical Rivers.*

The program is aimed at river systems across Northern Australia (see map over page). It extends across all the catchments from the west side of Cape York to the Kimberley. Across Queensland, the NT and Western Australia.

There are 4 research themes within the program:

1. Assess river assets and threats
2. Support regional planning frameworks
3. Assess social, cultural and economic values and opportunities
4. Understand river ecosystems

LWA has commissioned a number of studies to inform the development of its Tropical Rivers program. One of these is a socio-economic profile and scoping study which we are here to discuss today.

Why do more research about rivers?

- River and Groundwater in tropical Australia have roughly 70% of Australia's freshwater.
- There will be continual pressure to use water from Australia's tropical rivers for activities like irrigation, dams, mining, drinking water and other uses.
- Proposals to extract water from rivers need to be managed carefully and from a strong information base to ensure the best decisions are made.
- Already a number of industries depend heavily on water. Some depending on extracting water from rivers for consumptive use such as irrigation, others might depend on water but not use it up such as tourism.
- In different areas there are often different pressures on rivers and different ideas about what kind of management or development is needed. Opinions will vary a lot depending on which interest group is involved and so better information will help to make sure the discussion is based on sound knowledge *(Continued over page))*

About the Tropical Rivers Socio-Economic Scoping Study

On behalf of Land & Water Australia, CSIRO and James Cook University are undertaking a scoping study of the socio-economic values of Australia's tropical rivers. This forum is part of that study. LWA is aware of the importance of social and economic research to understanding how people use and value the river systems of the north. They are also aware of the large number of Aboriginal people living in north Australia and the need to understand their perspective on river use and management. A separate study of Indigenous interest in tropical rivers is being conducted by the North Australian Indigenous Land and Sea Management Alliance (NAILSMA) based at Charles Darwin University.

How do I found out more?

For more information about either the Tropical Rivers Program or the Socio-Economic Scoping Study contact:

- **Brendan Edgar or Alice Roughley** at Land and Water Australia – 02 62636000
  brendan.edgar@lwa.gov.au
  Website: http://www.rivers.gov.au/research/tropical/index.htm

- **Sue Jackson** at CSIRO Darwin – 08 89448415 or sue.jackson@csiro.au,
  OR
- **Natalie Stoeckl** at James Cook University, 07 4781 5393 or natalie.stoeckl@jcu.edu.au

Figure 1. Map of Tropical Rivers program catchment areas.

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Forum discussions were recorded and a draft sent to each participant enabling them to correct comments as well as add further this document chapters.

Focus group participants at work

Appendix C – Methodological approach to 'solving' the problem of inconsistent regional boundaries from secondary data sources

One problem associated with the use of secondary data is that data boundaries between different sources do not always coincide. Demographic and economic statistics, for example, are commonly presented for defined administrative and/or statistical areas, such as local government areas. Yet other types of socio-economic data are sometimes collected for other geographical boundaries. Specific examples include Queensland's tourism data – where 'tourism regions' do not always coincide with the statistical divisions of the ABS (Tourism Queensland 2005) – and employment data – where 'employment regions' do not always coincide with the boundaries used by other agencies. The problem is further compounded when considering natural resource management issues since administrative boundaries only rarely coincide with biophysical boundaries.

In short, it is difficult for researchers who wish to collect, compare and evaluate data pertaining to a particular region from a variety of different sources – if only because each source may define the region differently.

The Australian Bureau of Statistics is currently developing a new method of reporting socio-economic data, which is likely to mitigate some of those problems. This new method is called the "mesh block technique"[57] and further information on this new development is given in Appendix D. At the time of writing however the mesh block technique was not adequately developed at the geographical level necessary for use in this study. Consequently, this report illustrates social and economic aspects of the TR region by displaying statistical data at the finest geographical resolution available, and – where possible – 'converting' the boundaries of the finest resolution ABS data to catchment-scale boundaries. More specific details of that process are provided below.

In many cases data used within this report originates from the Australian Bureau of Statistics (ABS). Listed in order of geographic size (largest to smallest), ABS data are generally available for *states*, *statistical divisions* (SD's), *statistical subdivisions* (SSD's), *statistical local areas (*SLA's) and – in some cases - *collection districts* (CDs).

CDs are the smallest units for which the ABS releases census-based statistical information. In urban areas, there are about 225 dwellings in each CD but in rural areas the number of dwellings declines as population densities decrease[58]. SLA's consist of one or more CDs. They can be based on local government areas (LGAs), or parts thereof, or any unincorporated area. SSD's consist of one or more SLA's, SD's consist of one or more SSD's, and states consist of one or more SD's.

Figure 45 shows CD boundaries across the TR region for the 2001 Census of Population and Housing, with 570 CD's sitting wholly or partly within the boundaries of the TR basins. These were distributed throughout 76 different statistical local areas, in 5 different statistical divisions of three different states.

[57] See http://acsr.anu.edu.au/APA2004/papers/3C_Blanchfield.pdf for further information

[58] CDs are defined and current only for each census, therefore posing difficulties for comparisons between census years at that level.

Figure 45 - Misaligned boundaries: river catchments, statistical local areas and CD's

As the boundaries between CD's and actual river basins within the TR region rarely coincide, the data was manipulated to provide information specific to each basin. This was done by calculating the proportion of each CD's total area lying within each river basin and allocating socio-economic data accordingly. If, for example, the ABS had recorded that the population of CD*x* was 100, and if 30% of CD*x* lay within river basin A, then river basin A was recorded as having a population of 30 people (possibly more, if other CD's also lay within that basin's boundaries).

Whilst this approach allows information to be presented on a basin-by-basin level, it is important to note that this technique implicitly assumes that the spread of population, using the previous example, is uniformly distributed across the entirety of CD*x*. Although this is unlikely to be the case within these river basins it is thought that the use of this method is valid in giving rough approximations of demographic and economic information across the TR region.

Appendix D – The mesh block technique

The "mesh block" technique is a new spatial building block being developed by the Australian Bureau of Statistics. In the future mesh blocks will replace census collection districts (CDs) as the smallest unit of the Australian Standard Geographical Classification (ASGC).

A mesh block will consist of one city block in urban areas (i.e. the region defined by the intersection of four roads). In rural areas mesh blocks will be based on locality boundaries that will further be divided, where possible, into different land uses. Each mesh block will contain either zero population or a minimum of thirty households.

A major advantage of the mesh block technique is that it will allow spatial analysts to form customised regions to suit specific research purposes. Mesh blocks will be on a much finer

scale than the current CD's and therefore will provide a greater level of accuracy when manipulating data to use in smaller geographical areas. Conceptually all statistical data will be collected on the mesh block level and then aggregated and disseminated on whatever combination of mesh blocks provided confidentiality safeguards and suited the individual user or analysis.

At present the ABS has released a draft of the digital boundaries and is currently seeking comments from expert users and key stakeholders. The draft blocks will then be estimated in the 2006 census, to ensure that the required minimum dwelling counts are maintained. Once the digital boundaries have been finalised (probably in 2007) mesh block boundaries will be maintained on an annual basis and will formally replace collection districts (ABS 2005c).

Appendix E – Indigenous tribes/language groups by river basin*

Basin	Aboriginal tribal/language group	Basin	Aboriginal tribal/language group
801	Yawuru, Jukun, Ngumbarl	901	Yolngu, Ngandi
802	Nyikina, Punuba, Worla	902	Mara, Ngandi
803	Warwa	903	Mara, Alawa, Mangarayi, Yangman
804	Unggarangi, Umida, Ungguni	904	Mara, Binbinga
805	Wordra	905	Binbinga, Alawa
806	Wunambul	906	Binbinga
807	Miwa, Ngarinyin	907	Garawa, Gunindiri
808	Kwini, Yiji, Ngarinyin	908	Garawa, Gunindiri
809	Kija, Minwoong	909	Garawa, Waanyi
810	Kadjerong, Doolboong	910	Ganggalida
811	Ngarinman, Bilinara, Ngaliwuru	911	Gayardilt
812	Murrinh-patha	912	Waanyi, Mayi-Kutuna, Mingin
813	Ngangikurunggutt	913	Kukatj, Mayi-Yapi
814	Wagiman, Malak, Wardaman	914	Kuthant
815	Woolna, Larrakia	915	Mayi-Kulau, Ngawun, Mbara
816	Tiwi	916	Walangama, Kurtjar
817	Limilngan	917	Agwamin, Kurtjar
818	Ngombur	918	Koko-bera, Koknar, Yir Yoront
819	Kundjey'mi	919	Kunjen, Kokomini, Thaayorre
820	Wuningangk	920	Bakanh
821	Amarak, Iwaidja	921	Wik, Kaantju
822	Maung	922	Wik, Kaantju
823	Gunwinggu	923	Winda Winda
824	Nakara, Burarra	924	Yinwum
825	Dangbon	925	Mpalitjanh
826	Yolngu	926	Anggamudi
		927	Yadhaigana
		928	Torres Strait Islanders
		929	Anindilyakwa

Source: (Arthur & Morphy 2005)

*This list is by no means exhaustive and other indigenous groups may exist within these areas.

Appendix F – Notes from meeting with Chris Makepeace, Amateur Fisherman's Association of the NT.

Meeting with:
Chris Makepeace

Executive Officer
Amateur Fisherman's Association of the NT
03 May 2006.

- We spoke for some time about the 2000 recreational fishing survey that Ann Coleman produced. It has the best data around for direct expenditure on recreational fishing. According to Chris, in 2000, recreational fishing was worth $26 million. As this is all river based it is a figure that is very relevant to our study. He says it would now be considerably higher. This data can be broken down to specific fishing regions. Eg Kakadu. He says that similar data on the Kimberley and north Queensland should be available.

- Fisheries hopes to re-run the survey although there is no date set yet.

- There is no other data. No government monitoring of recreational effort in NT. AFANT runs their own programs to monitor catch at specific tournaments. They want to see more money come into recreational fish management yet there is no licensing of fishers or boats in NT, unlike Qld, and so revenue base is limited. User-pay in Qld – a levy on fish and boat licences goes into improving the recreational fishery (e.g. management, monitoring etc). He is unsure what the WA situation is.

- He considers that there is no useful data on contribution of recreational fishing to tourism expenditure. The above mentioned recreational survey put the figure at $9 million. There are problems with the scale at which it is collected.

- He understands that the tourism commission asks people if they have fished when they conduct their exit surveys. – could not refer me to a specific report.

- Recfish Australia (national body representing State recreational fishers) is working with the Fisheries R&D Corporation to develop some capacity to examine the social and health benefits of recreational fishing. This includes the benefits of spending time outdoors, with family etc. They are cultivating relationships with social researchers.

- He spoke of the environmental attitudes, associations and ethics –describing the healthy environment as one of the reasons non-Indigenous people are up here, and that fishing in a pristine, tropical environment is a 'mind-set'.

- Very interesting point about the protein/nutritional value of fish to this sector. Very few fish are eaten nowadays. Most of them are caught and released. For example, 13% of the river fishing for barramundi takes place in Kakadu and 85% of that is put back. 81% of all fish caught in Kakadu are released. He says the 'seafood' value is getting less and less as people change the way they fish. Sport fishing is of great importance.

- I asked him how useful he thought social research would be to his organisation, to which he replied:

  The first question is a biological one – are the current fisheries sustainable? The Commonwealth and others seem to now agree that they're not. Our ability to do what we do, depends on the sustainability of the fishery. The second thing is that we believe that a barra is worth vastly more to the NT if available to a recreational fisher than if it's on a table in Sydney. Every kilo of barra we (recreational fishers) harvest is

worth $87 per kilo in NT expenditure. This can be compared to the $7 per kilo if it's harvested from the wild by the commercial sector. If you add on top of that the other non-quantified benefits (social, health etc) then we believe that these fish are too valuable to be doing what they are doing with them.

- There is further evidence of increasing recreational value and consequent reduction in commercial fishing value. One can observe the significant reduction of commercial fishing licences, especially in the barra sector which fishes in the estuaries, in the NT at least. During the past 15 years the number of commercial barra licences have decreased from 86 to 24. There are now only 11 NT rivers that can be fished. Another 7 barra licences have been recommended for buy-back. Chris says:

  There is no argument that recreational fishing is valuable because successive Governments have spent millions buying out licences for the benefit of the recreational fishing. In Qld there is a similar trend.

- Chris confirmed the importance of access to fishing sites. It was described as the no. 1. issue. Described the failure of NTG to enforce the public access to perennial waters provisions of the Pastoral Land Act which has been under review for a couple of years. '*We continue to argue the access issue. So little of the NT is readily accessibly. Aboriginal people will probably provide better access than the pastoralists'.* This represents a shift in attitudes from a few years ago when access to Aboriginal land was a major concern.

- We discussed their concerns about the environmental impacts of their own activities. Currently feel that recreational fishing is having little negative impact, except perhaps in Borroloola/MacArthur River where there are hundreds of inter-state fishers with freezers. As the numbers of recreational fishers grow they will need to give increased attention to reducing bag limits and other conservation mechanisms.

Appendix G- Variables included in the SEIFA Indices

Index of Economic Resources

Weight between 0.2 and 0.4:

- Households owning or purchasing dwelling (%)
- Dwellings with 4 or more bedrooms (%)
- Families with family structure other than two parent or single parent with dependent offspring or consisting of a couple only, and income greater than $77,999 (%)
- Families consisting of a two-parent family with dependent offspring, and income greater than $77,999 (%)
- Families consisting of a couple only, and with income greater than $62,399 (%)
- Families consisting of a single parent with dependent offspring, with income greater than $31,199 (%)
- Mortgage greater than $1,300 per month (%)
- Rent greater than $249 per week (%)

Weight between 0 and 0.2:

- Households purchasing dwelling (%)
- Households owning dwelling (%)
- Dwellings with 3 or more motor cars (%)
- Average number bedrooms per person

Weight between -0.2 and 0

- Households in improvised dwellings (%)
- Households renting (government authority) (%)
- Households renting (non-government authority) (%)
- Dwellings with 1 or no bedrooms (%)
- Rent less than $74 per week (%)

- Families consisting of a single parent with dependent offspring, with income less than $15,600 (%)

Weight between -0.3 and -0.2

- Families consisting of a couple only, and with income less than $15,600 (%)
- Families with family structure other than two parent or single parent with dependent offspring or consisting of a couple only, and income less than $26,000 (%)
- Families consisting of a two-parent family with dependent offspring, and income less than $26,000 (%)
- Dwellings with no motorcars (%)

Index of Relative Socio-Economic Disadvantage

Weight between 0.2 and 0.3:

- Persons aged 15 and over with no qualifications (%)
- Families with income less than $15,600 (%)
- Families with offspring having parental income less than $15,600 (%)
- Females (in labour force) unemployed (%)
- Males (in labour force) unemployed (%)
- Employed Females classified as ‘Labourer & Related Workers’ (%)
- Employed Males classified as ‘Labourer & Related Workers’ (%)
- Employed Males classified as ‘Intermediate Production and Transport Workers’ (%)
- Persons aged 15 and over who left school at or under 15 years of age (%)
- One parent families with dependent offspring only (%)
- Households renting (government authority) (%)

Weight between 0.1 and 0.2:

- Persons aged 15 and over separated or divorced (%)
- Dwellings with no motorcars at dwelling (%)
- Employed Females classified as ‘Intermediate Production & Transport Workers’ (%)
- Employed Females classified as ‘Elementary Clerical, Sales & Service Workers’ (%)
- Employed Males classified as ‘Tradespersons’ (%)
- Persons aged 15 and over who did not go to school (%)
- Aboriginals or Torres Strait Islanders (%)
- Occupied private dwellings with two or more families (%)
- Lacking fluency in English (%)

Appendix H – Contacts database

NAME	POSITION	AREA/S OF EXPERTISE	CONTACTS
Baker, Joe	Chief Scientist QDPIF		
Bandias, Susan	Charles Darwin University	Business development	susan.bandias@cdu.edu.au
Bayliss, Peter	Eriss	Wetland ecology, ecological modelling	
Bennett, Jeff	Director, Graduate Studies in Environmental Management and Development, ANU.	Environmental economics, natural resource economics, agricultural economics and applied micro-economics.	jeff.bennett@anu.edu.au
Blaber, Steve	Scientist CSIRO Marine Research	Coastal fisheries research	steve.blaber@csiro.au
Boggs, Guy	Charles Darwin University	Geomorphology, hydrology, GIS analysis and modelling	guy.boggs@cdu.edu.au
Brooke, Brendan	Program Leader Coastal CRC GeoScience Australia	Coastal geomorphology, including tropical Queensland estuaries	brendan.brooke@ga.gov.au
Brookes, Andrew	Centre for Riverine Landscapes Griffith University	River geomorphology	andrew.brooks@griffith.edu.au
Buckworth, Rik	NT PIFM	Fisheries research, fish ecology	
Bunn, Stuart	Griffith University	Aquatic ecosystem processes, food webs	stuart.bunn@griffith.edu.au
Burford, Michele	Griffith University	Phytoplankton ecology	michele.burford@griffith.edu.au
Campbell, Bruce	Director School for Environmental Research Charles Darwin University	Community development	bruce.campbell@cdu.edu.au
Carson, Dean	Tourism Research Group Charles Darwin University	Indigenous enterprise development	dean.carson@cdu.edu.au
Choy, Satish	QNR&M	Aquatic biodiversity, river health monitoring	
Davies, Peter M.	University of WA	Aquatic ecosystem processes, benthic production	peter.davies@uwa.edu.au
DeLestang, Paul	NT PIFM	Fisheries research, fish ecology	
Douglas, Michael	Aquatic ecologist Charles Darwin University	Aquatic ecology, floodplain vegetation dynamics, fire ecology	michael.douglas@cdu.edu.au
Drucker, Adam	Senior Research Fellow Charles Darwin University	Natural resource economics	adam.drucker@cdu.edu.au
Finegan, Adam	Charles Darwin University	Remote area logistics	adam.finegan@cdu.edu.au
	Professor of Tropical Knowledge	Tropical natural resource management, micro-	stephen.garnett@cdu.edu.au

NAME	POSITION	AREA/S OF EXPERTISE	CONTACTS
Garnett, Stephen	Charles Darwin University	business governance	
Gehrke, Peter	Principal Research Scientist CSIRO Land & Water	Zoology, freshwater fish ecology Rivers and Coasts CSIRO Research Theme	peter.gehrke@csiro.au
Gordon, Iain	Group Leader CSIRO Sustainable Ecosystems	Rangeland management and community development	iain.gordon@csiro.au
Greiner, Romy	Ecological economist	Ecological Economics	
Haese, Ralf	Program Leader Coastal Research and Management GeoScience Australia	Estuarine biogeochemistry, including tropical Queensland estuaries	ralf.haese@ga.gov.au
Halliday, Ian	QDPIF	Fisheries research	
Herr, Alexander	Spatial and Statistical Analyst CSIRO Sustainable Ecosystems	Sustainable NRM, wildlife conservation and ecological sustainable development, ecology and conservation.	alexander.herr@csiro.au
Humphrey, Chris	Eriss	Aquatic invertebrate ecology, river health assessment	
Hutley, Lindsay	Charles Darwin University	Hydrology and plant physiology	lindsay.hutley@cdu.edu.au
Jolly, Peter	NT NRETA	Hydrology	
Jones, David	Eriss	Environmental chemistry, chemical limnology	
Makepeace, Chris	Executive Officer Amateur Fisherman's Association NT		chris.makepeace@afant.com.au
Marsh, Nick	QEPA		
Marshall, Jon	QNR&M	River health monitoring	
McTainsh, Grant	Griffith University	Aeolian contributions of sediments to aquatic systems	grant.mctainsh@griffith.edu.au
Meekan, Mark	AIMS Scientist	Coastal fish ecology	m.meekan@aims.gov.au
Morris, Leon	NT DBERD	Indigenous enterprise development	
Oakey, Tom	Scientist CSIRO Marine Research	Coastal ecosystem processes, northern prawn fishery	tom.oakey@csiro.au
Olley, Jon	Research Director CSIRO Land and Water	Sediment sourcing and transport	jon.olley@csiro.au
Parry, Dave	Environmental Analytical and Bioinorganic Chemist Charles Darwin University	Environmental chemistry, experience in aquatic nutrients and sediments.	dave.parry@cdu.edu.au
Pusey, Brad	Griffith University	Freshwater fish ecology	brad.pusey@griffith,edu.au
Robertson, Alistar	University of WA	Floodplain river and coastal ecosystem processes	alistar.robertson@uwa.edu.au

NAME	POSITION	AREA/S OF EXPERTISE	CONTACTS
Robins, Julie	QDPIF	Fisheries research, fish ecology	
Roebeling, Peter	Environmental Economist CSIRO Sustainable Ecosystems	Environmental economics, natural resource economics, agricultural economics	peter.roebeling@csiro.au
Ross, Helen	Professor, Rural Community Development University of Queensland, Gatton.	Community participation in natural resource management, collaborative planning and management processes, social impact assessment	hross@uqg.uq.edu.au
Rothlisberg, Peter	Chief Scientist CSIRO Marine Research	Fisheries, oceanography and coastal ecology	peter.rothlisberg@csiro.au
Russell, John	QDPIF	Fisheries research, fish ecology	
Smajgl, Alex	Research Scientist CSIRO Sustainable Ecosystems		alex.smajgl@csiro.au
Sithole, Bev	Senior Research Scientist CSIRO Sustainable Ecosystems	Community scenario development and analysis	bev.sithole@csiro.au
Steven, Andy	Stream Leader CSIRO Land and Water	Ecosystem health assessment, coastal water quality	andy.steven@csiro.au
Strang, Veronica	University of Auckland	Cultural valuation of water	
Tirendi, Frank	Manager Analytical Services AIMS North Queensland	Research group leader, coastal processes	f.tirendi@aims.gov.au
Toussaint, Sandy	University of WA	Indigenous values of water	sandy.toussaint@uwa.edu.au
Townsend, Simon	NT NRETA	Tropical river health assessment and algal ecology	
Trayler, Kerry	DOE Western Australia	Manager, the Ord River Environmental Flows Initiative	kerry.trayler@environment.wa.gov.au
Van Dam, Rick	Eriss	Ecotoxicology and risk assessment	
Valentine, Eric	Chartered engineer Charles Darwin University	Sediment dynamics and hydrodynamic modelling	eric.valentine@cdu.edu.au
Vink, Sue	Scientist CSIRO Land and Water	Carbon fluxes in river ecosystems	sue.vink@csiro.au
Walker, Dan	Resource Futures research program leader, CSIRO Sustainable Ecosystems	Research management, natural resource management, human ecology, indigenous and scientific knowledge integration.	
Wasson, Bob	Depute Vice Chancellor Research Charles Darwin University	River geomorphology and sediment dynamics	bob.wasson@cdu.edu.au
Wasson, Merrilyn	Policy Analyst Charles Darwin University	Policy analysis	merrilyn.wasson@cdu.edu.au

NAME	POSITION	AREA/S OF EXPERTISE	CONTACTS
Webster, Ian	Research Scientist CSIRO Land and Water	Aquatic ecosystem processed and modelling	ian.webster@csiro.au
Whitehead, Peter	NT NRETA	Indigenous enterprise development	
Williams, David	NT NRETA	Hydrodynamic modelling and sediment transport	
Wilson, Tom	Senior Research Fellow Charles Darwin University	Demography	tom.wilson@cdu.edu.au
Wolanski, Eric	Senior Principal Research Scientist AIMS North Queensland	Sediment dynamics and hydrodynamic modelling	e.wolanski@aims.gov.au

Appendix I - Attendance at focus group meetings – stakeholder representation

Workshop	**Industry & Local Gov't** (agriculture, mining, tourism, development councils, community councils; non-Aboriginal)	**Environment focus** (government agencies, community groups, NRM)	**Communication/ community capacity building**	**Aboriginal interests** (councils, representative agencies)	**No representation**
Katherine	7	6	0	2	1
Mt Isa	6	3	1	0	0
Derby	7	7	2	18	7