Socio-economic profiling of tropical rivers

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April 2009

TRaCK
Tropical Rivers and Coastal Knowledge

CSIRO

Australian Government
Department of the Environment, Water, Heritage and the Arts
Land & Water Australia
National Water Commission

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TRaCK brings together leading tropical river researchers and managers from Charles Darwin University, Griffith University, University of Western Australia, CSIRO, James Cook University, Australian National University, Geoscience Australia, Environmental Research Institute of the Supervising Scientist, Australian Institute of Marine Science, North Australia Indigenous Land and Sea Management Alliance and the Governments of Queensland, Northern Territory and Western Australia.

TRaCK receives major funding for its research through the Australian Government's Commonwealth Environment Research Facilities initiative; the Australian Government's Raising National Water Standards Program; Land and Water Australia and the Queensland Government's Smart State Innovation Fund.

Larson, S. and Alexandridis, K. (2009) Socio-economic profiling of tropical rivers. Land & Water Australia, Canberra.

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Product ID: PN30095
Print ISBN: 978-1-921544-99-6
Printed by: Land&Water Australia

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Acknowledgements

We gratefully acknowledge the Tropical Rivers and Coastal Knowledge (TRaCK) and CSIRO Sustainable Division for funding this study.

We also thank Dr Natalie Stoeckl and Dr Peta Dzidic for their comments on previous drafts, Ms Michelle Esparon for her help with data collection and Ms Susie Warner for help with preparation of this report. Sincere thanks to Dr Bernardo Blanco-Martin for his help with data analyses.

Summary of the report

Tropical Rivers and Coastal Knowledge (TRaCK) consortium was established in 2007 under the Commonwealth Environment Research Facilities Programme with the aim of providing the science and knowledge that governments, communities and industries need for the sustainable use and management of Australia's tropical rivers and estuaries. This report has been written as a part of the Tropical Rivers and Coastal Knowledge (TRaCK) project 3.1, "People and economy".

Tropical rivers of Australia are defined as catchments stretching from Broome in Western Australia to Cape York in Queensland, draining into either the Timor Sea or Gulf of Carpentaria. Tropical rivers (TR) thus include 54 river catchments and cover an area of more than 1.3 million km^2. Key characteristic of the tropical rivers, in general, is that their hydrology is determined by a short and distinct wet season, followed by longer dry season. While water might be abundant during the wet season, it is generally ephemeral and becomes scarce during the dry season.

This document reports on four major objectives of stage (B) of the TRaCK project 3.1, "People and economy". The four objectives were: (a) to develop an integrated conceptual framework for the socio-economic profiling; (b) to update existing knowledge with data from the 2006 Census; (c) to develop profiles of individual catchments based on their individual socio-economic characteristics; and (d) to compare and contrast the TR catchments and to identify catchments which are socio-economically 'similar' or 'dissimilar'.

The conceptual framework developed for the study (objective a) was grounded in the social impact assessment theory but also reviewed literature from other related research areas, such as adaptive capacity, social resilience and institutional analysis. The original framework also included a "wish list" of variables that should ideally be populated in order to provide full profiles of socio-economic conditions across the north. The conceptual framework is presented in Section 2 of the report.

The data collection and updating process (objective b) has identified several important data gaps, discussed further in Section 5.1 of the report. A comparison of the "wish list" of variables developed at the start of the project with the list of variables for which we were able to find recent, readily available secondary data, revealed some important data gaps. As a result, the conceptual framework originally proposed could not be populated to the full extent and was thus collapsed into the following five domains: (a) population / demographic characteristics; (b) economic parameters; (c) infrastructure and housing; (d) human and social capital, combining institutional arrangements with individual wellbeing; and (e) environment, heritage and land use. The data were used to create GIS-linked maps of socioeconomic characteristics of all catchments across the north (Section 3), as well as to create profiles of each individual catchment (objective c, presented in Section 4.1 and Appendix 2).

Although the tropical rivers (TR) region represents around a quarter of the Australian land mass, it contains just two percent of the population. The region is characterised by disperse human settlement, with the only significant populations (more than 10,000 people) located in and around Darwin in the Northern Territory, Broome in Western Australia, and Mount Isa in Queensland. The Accessibility/ Remoteness Index of Australia (ARIA) indicates that large tracts of the TR region fall within the "very remote" category of ARIA as defined by ABS, with scores higher then 10.5.

The percentage of people speaking a language other than English at home is relatively high in TR region. Most of the languages, other than English, which are spoken at home are Indigenous languages. And the percentage of the population speaking non-

Indigenous languages at home is proportionally smaller (up to 15 percent per catchment) than populations speaking Indigenous languages at home (up to over 80 percent per catchment). For example, in Leichhardt River, only 74 percent of population was born in Australia, yet 82 percent speak only English at home. In contrast, the entire populations of both the Moyle and the Walker river catchments were born in Australia, yet only 12 and 10 percent, respectively, speak only English at home.

About 42% of all homes in TR region have an internet connection, while 65% of all homes have a motor vehicle. In addition, catchments closer to urban regions such as Adelaide River (near Darwin) tend to have higher rates of internet connection and homes with registered motor vehicle (56% and 95% and, respectively), while more remote catchments tend to have a very low percentage of homes with internet connection (such as, for example, 20% in King Edward River or 11% in Fitzmaurice River) and a low percentage of homes with a registered motor vehicle (34% in King Edward River and 38% in Fitzmaurice). Similar disparity appears in human capital data. To use the same catchments as examples, less than one percent of people in the Adelaide catchment never attended school, while 3% of people in the Fitzmaurice and 5.5% of people in the Kind Edward catchment have never received any formal schooling.

Combined government-provided services such as health, education, defence and public services were identified as the largest employer in the region, employing on average 25 percent of persons over 15 years of age in TR catchments in 2006. The second largest employment sector was agriculture and forestry, with an average of 11.5 percent across catchments, followed by mining, retail and construction, each employing around 4 percent of population over 15 years of age. Median weekly income per person varied greatly between catchments from around 150$ per person per week in the Blyth and Koolatong catchments, to around 700$ per person per in mining-dominated catchments like the Leichhardt and Embley. The majority of the labour force in the catchments across the TR region was concentrated in the Darwin region. The few other catchments with larger settlements, such as Mt Isa, Broome and Katherine, dominate the remaining numbers of total labour available in the TR region and the labour force across the majority of other catchments is very limited suggesting that this might be one of the limiting factors for potential developments in the future.

Basic infrastructure in the north is also limited. Transport infrastructure is limited to a weak network of all-weather sealed roads and airports, and very few ports. This is particularly true in the Kimberleys, Arnhem Land and Cape York Peninsula. Services are also limited to a few larger rural centres. For example, one third of 54 northern catchments profiled did not have any educational facilities. Similarly, the overwhelming majority of the community organizations across TR region registered in Australian Community Guide, 97 percent, were located within 10 catchments of the region.

Much of the land in the TR region is in its natural condition, with most land use following within the categories of ‘land under conservation’ ‘traditional Indigenous use’, and ‘land under production from a relatively natural environment’ (such as grazing of natural vegetation). Other land uses, such as land under dryland agriculture, irrigated land and land under intensive uses, are minimal across the region. Great differences however do exist between the catchments. For example, all of the land in Goyder River catchment is classified as in natural condition (under traditional Indigenous use), while only 2.5% of land in Gilbert River is classified as being in natural condition (under conservation), with no land under traditional Indigenous use. The majority of land in Gilbert River catchment, more than 95%, is under grazing.

To meet the last objective of this study, TR catchments were compared and contrasted in order to identify catchments which are socio-economically ‘similar’ (and, by corollary, socio-economically ‘dissimilar’). It is important to note that, given the complexity of

variation between the catchments, more good quality data is needed to reduce the uncertainty around the findings of this investigation. Nonetheless, distinct clusters of catchments have been identified and are discussed in Section 4.2 of the report.

For example, Settlement Creek, Staaten, Keep, Gilbert, Holroyd and Norman rivers were grouped together as relatively similar. This cluster is characterised by relatively high levels of employment in agriculture and a high percentage of land under grazing. Mobility is also relatively high, with a large proportion of people owning their homes. A medium to high proportion of residents speak English only. Catchments in this cluster have low numbers of homes with no vehicles or no internet connection, and a relatively low percentage of people with no schooling. Household sizes and numbers of people per bedroom are also low, as well as the percentage of women with 3 children or more and the percentage of one parent families. The percentage of Aboriginal people in those catchments is low to relatively low.

Another cluster identified in the analyses comprised of the Jardine, King Edward, Coleman and Watson rivers and Bathurst and Melville Islands. This cluster is characterised by a low mobility of population, low incomes and low employment in agriculture, manufacturing or mining. Employment by government is higher. In these catchments a low percentage of people are purchasing their homes, while most families are renting homes from the community organisations. An increased proportion of the population has no schooling. Catchments in this cluster also have medium to relatively high numbers of homes with no vehicles and no internet connection, and a relatively high proportion of women with 3 children or more. Household sizes and numbers of people per bedroom are higher than in the previous clusters described. The percentages of Aboriginal people in these catchments are medium to high, however, the percentage of land under Indigenous traditional use is not very high (except at Bathurst and Melville islands).

In summary, the socio-economic profiling identified considerable differences both between and within the catchments in the north. Biophysical and cultural differences, as well as differences in human, social and institutional capital and available infrastructure, will play a large role in determining both the opportunities for development (mining, agriculture, tourism) as well as capacities of the communities in those catchments to identify opportunities and take the advantage of the opportunities as they present themselves.

This study summarised data that might be of help to other researchers and communities in the north engaged in development of sustainable use and management options for the tropical rivers. Furthermore, identification of different types of catchments, that are not necessarily geographically linked but are similar in socio-economic terms, might aid in development of the management approaches that are more targeted, and thus more appropriate, than “one size fits all” approach; yet require lesser effort than targeting of individual catchments. Potential of this approach to be used for improved understanding and management of natural resources issues in other rural and remote regions of Australia warrants further research. Research into development of catchment typologies based on entire sets of data, that is biophysical characteristics as well as socio-economic characteristics of the catchments, also warrants further research.

1 Introduction

1.1 Structure of the report

This document reports on four major objectives of stage (B) of the TRaCK project 3.1: People and the economy. The four objectives were: (a) to develop an integrated conceptual framework for the socio-economic profiling; (b) to update existing knowledge with data from the 2006 Census; (c) to develop profiles of individual catchments based on their individual socio-economic characteristics; and (d) to compare and contrast the TR catchments and to identify catchments which are socio-economically 'similar' or 'dissimilar'.

The report first presents an integrated conceptual framework that was developed for the socio-economic profiling, followed by the methodological details of the study (Section 2). Main socio-economic characteristics of the tropical rivers (TR) region are presented in Section 3. Section 4 provides profiles of individual TR catchments and presents results of the analysis comparing and contrasting all the catchments. A brief discussion of some potential avenues for further research is presented in Section 5, with references used in this research listed in Section 6.

1.2 Background

The tropical rivers region of Australia is defined as including catchments stretching from Broome in Western Australia to Cape York in Queensland, draining into either the Timor Sea or Gulf of Carpentaria (TRaCK, 2008; Figure 1). The tropical rivers (TR) region thus include 54 river catchments and covers an area of more than 1.3 million km^2 (Stoeckl et al., 2006).

Figure 1. Tropical rivers of Australia (TRaCK, 2008)

A key characteristic of the tropical rivers, in general, is that their hydrology is determined by a short and distinct wet season, followed by a longer dry season. For example, average monthly flows for the Fitzroy River in Western Australia, for the period of 1965-1998, were between 1700 and 2500 gigalitres a month for the months of January, February and March. For the rest of the year, the average monthly flows were

under 400 gigalitres (ANRA, 2008). While water might be abundant during the wet season, it is generally ephemeral and becomes scarce during the dry season. This seasonal limitation of water makes the source unreliable and thus unsuitable for major urban and irrigation developments and has resulted in the northern river system being largely undeveloped and kept in near pristine condition.

As a further example, Figure 2 presents typical annual rainfall, humidity and temperatures for the region. The figure is based on data for Derby (WA) meteorological station (Larson and Herr, 2008, page 3). High monthly average rainfalls for January and February correspond with high average monthly flows. The rainfall drops significantly but is still considerable in March, with very little to no rainfall recorded for the rest of the year.

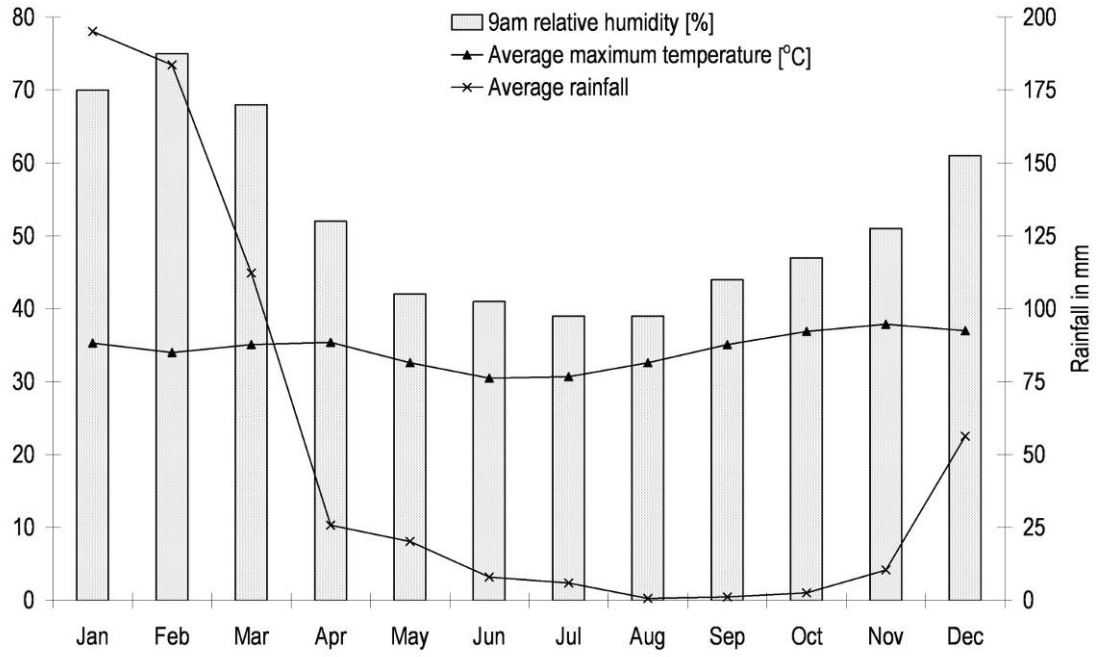


Figure 2. Typical regional climate averages for Derby, WA (Derby meteorological station)

Source: Larson and Herr, 2008, page 3

1.3 Tropical Rivers and Coastal Knowledge: People and the economy of the northern rivers

In 2004, the Board of Land and Water Australia declared the tropical rivers region as a priority area for major investments, and acknowledged the importance of understanding social and economic systems in this context.

Tropical Rivers and Coastal Knowledge (TRaCK) research hub was established in 2007 under the Commonwealth Environment Research Facilities Programme with the aim of providing the science and knowledge that governments, communities and industries need for the sustainable use and management of Australia's tropical rivers and estuaries (TRaCK, 2008). Tropical Rivers program was shaped to "undertake research and knowledge exchange to support the sustainable use, protection and management of Australia's tropical rivers" (Land and Water Australia, 2008).

This report has been written as a part of the Tropical Rivers and Coastal Knowledge (TRaCK) project 3.1, “People and economy”. The project is a component of TRaCK Theme 3, “River and coastal settings”. The overarching objective of Theme 3 is to classify and better understand river scapes of the TRaCK regions, based on their socio-economic, biophysical and ecological and flow characteristics.

Project 3.1, “People and economy”, seeks to improve our understanding of the demographic and socio-economic characteristics of the human populations within catchments. The project has been conducted in four stages described briefly below.

Stage (A) of the project developed tourism and population profiles and projections of catchments within the Tropical Rivers (TR) region, and also identified key issues affecting population (resident and tourism) growth for the period of 2006 to 2015. Findings of this stage of the project are reported in Carson et al. (2009).

Stage (B) developed socio-economic profiles of catchments within the Tropical Rivers (TR) region. An integrated conceptual framework for the socio-economic profiling was developed first, and then populated with the data available. Profiles of individual TR catchments based on their individual socio-economic characteristics were also developed, and then were compared and contrasted to identify catchments which are socio-economically ‘similar’ or ‘dissimilar’. Explorations of the stage (B) of the project are presented in this report.

In stage (C) of the project, an economic model capable of providing information about the aggregate and distributional socio-economic impacts of the population and tourism changes was identified. As a part of stage (D), this model will be populated with relevant data and used to make predictions about the likely changes that could occur in response to changes in key socio-economic variables in the region.

Further information on this and other projects under way in the tropical rivers region can be found at TRaCK website (http://www.track.gov.au/).

1.4 Overview of the water-related institutional arrangements in the north

The institutional history of water in Australia since colonisation is linked to the settlement policy and the economy of the country (Craig, 2007). The establishment of the Australian Constitution and the Federal system of government in 1901 left water resources largely within the jurisdiction of the states, and thus each state developed a rather narrow and isolated approach to water management, allocation and use (McKay, 1994). Growth in water demand was met over time by growth in water supply, through increased capture and development of water resources, and the water resources appeared endless (McKay, 2004). Powell (1991) describes a colonial vision for north Queensland where harnessing of surface and ground water was deemed to create the “plains of promise”. Where the vision failed to materialise by natural means, engineering interventions were embarked upon to “turn the water back” and thus prevent it from being “wasted into the sea” (Powell, 2000 as cited in Stoeckl et al., 2006, p91).

By the mid 1970s, concerns were voiced about increasing scientific and anecdotal evidence regarding the deterioration in the quality and quantity of water in Australia (Larson, 2006). The concerns grew and led to several key institutional developments in the early 1990s (McKay, 2005). The National Strategy for Ecologically Sustainable Development in 1992 and the Council of Australian Governments’ Water Reform Framework in 1994, among other institutional changes, have created a new era in approaches to water management. The new frameworks promote markets for water entitlements to improve efficiency but also promote allocation of water for environmental and social needs.

The renewed interest in tropical rivers stems from the 2004 declaration of the tropical rivers region as a priority area for major investment, by the Board of Land and Water Australia.

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 starting from 2004. The NWI incorporates some of the core principles of microeconomic reform, in particular, use of markets and trading, pricing regimes which reflect true economic costs and the assigning and reinforcing of property rights. The NWI, however, also involves provisions for community planning, which sit less well with the microeconomic reform paradigm (Stoeckl et al., 2006). Stoeckl and colleagues (2006) argue that this combination of market-based and community approaches may raise potential conflicts over an interesting set of issues, in particular, what aspect of water use should be determined by the market and what by the community, and the resolution of the differing views, in water use outcomes, between the market and community.

2 Conceptual framework and methods

2.1 Development of a framework

Agencies and organisations dealing with the management of natural resources are facing increased pressure to consider the social dimensions of resource management. And as a result, ecological, economic and social data are more frequently being included on resource status monitoring lists (Larson, in press). Methodological approaches that integrate social, economic and ecological concerns on an equal footing, and promote sustainable development, are gaining in popularity.

The conceptual framework developed for this project was grounded in the social impact assessment theory and methodologies. Social impact assessment is defined by the International Association for Impact Assessment as "processes for analysing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment." (Vanclay, 2003, p2).

Similar definitions have been adopted by government agencies in Australia, with the Queensland government defining social and economic impact assessment as “the process of predicting the social and economic impacts that are likely to follow from specific management or policy actions, allowing decision-makers to understand in advance the potential consequences on the human population from a proposed action or policy change” (Stanley et al., 2004a; p2). Social and economic impacts are acknowledged as potentially affecting employment, income, production, way of life, culture, community, political systems, environment, health and well-being, personal and property rights, and fears and aspirations of either communities, social groupings or individuals (Stanley et al., 2004a).

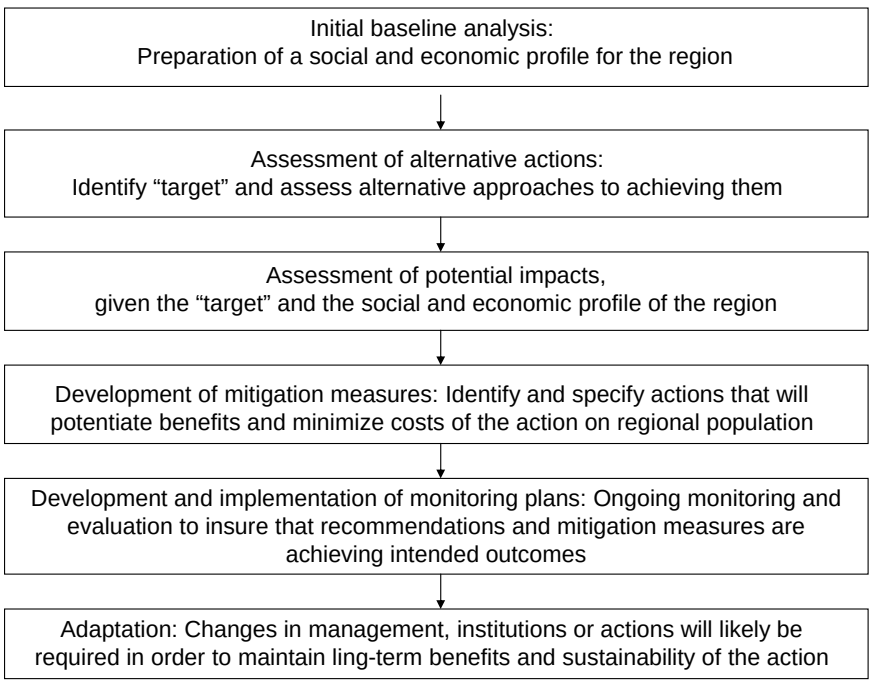


Figure 3. Steps in social impact assessment process

Social impact assessment is a process consisting of a number of steps that typically take several years to complete (Figure 3). The research presented in this paper could best be described as an analysis of a baseline socio-economic situation in the catchments prior to the potential planned intervention (Figure 3, first box from the top), and thus would form a starting point for the future social impact assessments of possible developments.

The review of social impact assessment literature identified several domains common to most of the frameworks and guidelines reviewed. Domains covering variables related to population, economy, services and some form of institutional arrangement considerations, were common in the literature (Table 1). Considerations of culture, land use, environmental risks to society, and attitudes, beliefs and values of stakeholders, were also included in some but not all of the frameworks (Table 1).

Table 1. A comparison of domains of interest in social impact assessment literature

Meta theme	Olsen and Mervin, 1977	Taylor et al., 2004	Burdge, 2004	Vanclay, 2003 (for IAIA)	Inter-organizational Committee, 1994 and 2003	International Finance Corporation IFC 2003	QLD NRM guidelines, Stanley et al. 2004b
Demography	Demography	Demography	Population impacts		Population change	Demographic profiles; History and distribution of population	Demographics Population movement; Household characteristics
Economy and livelihoods	Economy	Economy	Economies of communities in transition			Economic environment; Livelihood systems; Household incomes	Regional economic production; External linkages; Income; Employment;
Infrastructure and services	Public services	Health	Community infrastructure needs		Political and social resources; Infrastructure needs	Access to services	Natural and physical infrastructure; Social infrastructure; Housing
Institutional arrangement	Social structures; Collective responses	Social organization	Community and institutional arrangements	Political systems; Personal and property rights	Political and social resources; Community and institutional structures	Social organisations at communal level	Social capital
Health and lifestyle		Lifestyle; Health	Individual and family impacts	Way of life; Health	Individual and family changes	Quality of life; Health	(negative aspects under Social fragmentation)
Social capital	Social wellbeing			Community (cohesion, character)	Community resources	Vulnerable groups	Social capital, Social fragmentation
Perceptions and values		Attitudes, beliefs and values		Fears and aspirations	Identity and attitudes toward resource	Perceptions (of opportunities and impacts)	
Land use and environmental risks		Land use		Pollution; Waste disposal; Risks		Land use; Resources condition	Land tenure; NRM data
Indigenous and cultural considerations				Culture	Native peoples responsibilities	Cultural properties; Archaeological sites	Indigenous; Cultural diversity

Conceptual models developed for similar purposes in other research areas, such as adaptive capacity (Lemos, 2007; Brown and Bellamy, 2008; Bohensky et al., in press), social resilience (Gooch and Warburton, 2009), or institutional analysis (Larson, 2006; Ostrom, 2007;) also include domains contextually similar to those presented in Table 1. Most of these frameworks stem from the economic "five capitals" production model, which distinguishes between human, social, financial, produced and natural capital (Porritt, 2008), however, concerns specifically related to perceptions of the system by stakeholders are increasingly considered.

Based on this review, a conceptual framework for profiling of tropical rivers was developed, and included eight commonly identified domains. Each domain was then populated with a list of variables potentially of interest, thus creating a "wish list" of data to be included for each catchment (Figure 4).

Figure 4. Proposed framework for the assessment of the key socio-economic variables of the tropical river catchments

2.2 Data collection and analysis methods

Socio-economic profiling of tropical rivers was based on the collection and collation of, available, secondary data. The main source of data was the Australian Bureau of Statistics 2006 Census, however, several other data sources were also explored and included, such as: Australian Community Guide 2006, Bureau of Rural Sciences ACLUMP 2006, Australian Schools Directory 2008, Health Wiz 7.3 (2004), ICOLD dam register, Australian Natural Resources Atlas, Department of the Environment, Water, Heritage and the Arts data and specific data from relevant state / territory departments and agencies, as available (Stanley et al., 2004b; Smith and Sincock, 2004).

Data collection process has identified several important data gaps. A comparison of the "wish list" of variables developed at the start of the project and the variables that we were able to populate with the data readily available revealed some important data gaps, discussed in detail in section 5.1. It is however, important to note that although a greater variety of variables was available for some catchments, only variables that could be populated across all of the catchments of the TR region were relevant for the purpose of this study, and were taken into account for further analysis.

As a result, the conceptual framework originally proposed could not be populated to the full extent. A summary of the domains that could be included in the analysis is presented in Table 2, with a full list of the variables used presented in Appendix 1. For the purpose of the cross-catchment comparison data was further collapsed into five domains, as follows:

(A) Population / Demographic Characteristics;

(B) Economic Parameters;

(C) Infrastructure and Housing;

(D) Human and Social Capital, combining institutional arrangements with individual wellbeing; and

(E) Environment, Heritage and Land Use, combining

Table 2. Socio-economic characteristics of catchments across the north included in catchment profiling

Population / Demographic Characteristics
People and Settlements
Settlement Patterns and Mobility
Economic Parameters
Employment
Service Oriented and Mining Businesses
Land use
Remoteness Index
Infrastructure and Services
Roads and Airports
Educational facilities
Housing Infrastructure
Institutional Arrangements
Government Representation
Community Organisations
Social Cohesion
Individual Wellbeing
Families and households
Educational Status
Religion
Languages spoken at home
Crime profiles
Environment and Culture
Water as a resource
Soil Quality
Environmental Risks
Protected land areas of ecological importance
Register sites of cultural importance
Native Title

The data that was collected was geographically organised into relevant catchments, and variables were spatially linked to Geographic Information System (GIS) maps. Results of the mapping of available data across the catchments in the north are presented in Section 3 and in Appendix 1.

Data used for the mapping presented in Section 3 were also used to develop catchment profiles. Principle components analysis was used to inform the selection of key variables, included in the summary profile of each catchment. Individual profiles for all catchments of the TR region are presented in Appendix 2. Four of the catchments (Keep, Nicholson, Ord and Settlement) are shared between two states. As the socio-economic data is reported separately for each state, Appendix 2 contains two sheets for each of those catchments.

Catchment data was then analysed for similarities and differences between the catchments using principal components analysis, multidimensional scaling and hierarchical clustering methods.

The principal components analysis was mainly used to validate the conceptual framework. The analysis confirmed that variables selected for the framework indeed investigate and represent different aspects of the socio-economic system, with little correlation or redundancy. A total of 15 factors were identified as having initial Eigenvalues higher than 1, explaining 84% of the total variance. Nineteen factors were required to be included into analysis to explain more than 90% of the variance.

Cluster analysis is a data analysis method that allows for grouping or segmentation of data rows, into subsets or “clusters”, such that those within each cluster are more closely related to one another than objects assigned to different clusters. For the purpose of this study, several methods of both hierarchical and partitioning clustering were tested. The interpretations presented in this report are based on Ward’s agglomerative hierarchical clustering method. Key characteristic of Ward’s method is that it generates the partitions with aim of minimising the loss of data associated with each grouping. At each stage the combination of each cluster pair is analysed, and the two clusters whose union generates minimum increase in “information loss” are joined together.

Dendrogams for the relevant datasets were constructed using Euclidean distances and the Ward method. Plots also include the p-values for each cluster computed via multi-scale bootstrapping re-sampling (clusters with $p >= 95\%$ and those with $p > 90\%$ are indicated in the text). Clustering was performed both on the entire data set, including all the variables populated, and also on a sub-set of variables related to each of the domains from the conceptual framework. These dendrograms are available in Appendix 3.

Heatmaps combining catchment clusters and variable clusters were also developed. The clustering of the catchments is based on the previously described Ward’s methods, while clustering for the variables uses a distance method based on the Spearman rank correlations between variables. Heatmaps were produced as an aid in interpretation of the key cluster characteristics.

Multi-dimensional scaling analyses were also performed. The results of these analyses were in line with and confirmed the findings of cluster analysis.

These results are presented in Section 4.

3 Socio-economic characteristics of catchments across north

The conceptual framework developed for this study was used to organise this section. Results are presented as a comparison of data across the entire tropical rivers region. The section starts with a presentation of demographic characteristics for the catchments (3.1), followed by sub-sections on economic parameters (3.2), and infrastructure and services (3.3). Data on individual wellbeing is presented in sub-section 3.4, followed by data on institutional arrangements (3.5), and natural and cultural environment (3.6).

A brief overview of all catchments included in this analysis is presented in Table 3, organised in alphabetic order according to catchment name. The table contains the catchment name, the main settlements within the catchment, the total estimated population of the catchments for 2006 (based on Carson et al., 2009 or Census 2006 data), and the total estimated catchment areas.

Four catchments of TR region belong to more than one state. The Keep River and the Ord River catchments fall both within Northern Territory and Western Australia boundaries, while the Nicholson River and Settlement Creek have parts of their catchments in both Northern Territory and Queensland. Given that the majority of data presented in this report are collected based on administrative boundaries, data for those four catchments is presented separately for each territory/sate (Table 3).

Table 3. Overview of TraCK catchments described in this report

Catchments in alphabetic order (state)	**Main settlement***	**2006 population estimate****	**Area (km^2)**
Adelaide River (NT)	-	2,090	7,462
Archer River (Qld)	Coen	298	13,820
Bathurst and Melville Islands (NT)	Bathurst and Melville Islands	2,127	7,485
Blyth River (NT)	Ramingining	2,440	9,219
Buckingham River (NT)	Nhulunbuy Gove	8,321	9,600
Calvert River (NT)	Clavert River Homestead	44	10,033
Cape Leveque Coast (WA)	Broome	13,062	22,956
Coleman River (Qld)	Pormpuraaw	656	12,861
Daly River (NT)	Katherine, Pine Creek	9,162	53,197
Darwin / Blackmore Rivers (Qld)		1,653	816
Drysdale River (WA)	-	77	25,999
Ducie River (Qld)		54	6,745
East Alligator River (NT)	Jabiru, Minjilang, Kunbarllanjnja	2,474	15,875
Embley River (Qld)	Weipa	3,551	4,622
Finniss / Elizabeth / Howard Rivers (NT)	Darwin	103,458	8,672
Fitzmaurice River (NT)	-	176	10,375
Fitzroy River (WA)	Derby, Fitzroy Crossing, Looma	6,870	93,830
Flinders River (Qld)	Hughenden, Cloncurry, Richmond	5,990	109,377
Gilbert River (Qld)	Georgetown	849	46,411

Goomadeer River (NT)	-	431	5,684
Goyder River (NT)		702	10,391
Groote Eylandt (NT)	Angurugu, Alyangula	2,357	2,362
Holroyd River (Qld)	-	27	10,287
Horne Island (Qld)	Horne Island	578	53
Isdell River (WA)	-	114	19,996
Jardine River (Qld)	Bamaga	1,682	3,282
Keep River (NT)		62	6,003
Keep River (WA)		367	5,847
King Edward River (WA)	Kalamburu	456	17,621
Koolatong River (NT)	-	555	7,913
Leichhardt River (Qld)	Mount Isa	19,540	32,878
Lennard River (WA)	Mowanium	122	14,757
Limmen Bight River (NT)	-	120	15,938
Liverpool River (NT)	Maningrida	2,157	8,945
Mary River (WA)	-	213	8,074
McArthur River (NT)	Borroloola	963	20,023
Mitchell River (Qld)	Kowanyama, Mt Mulgrave, Chillagoe	5,656	71,471
Morning Inlet (Qld)	-	116	3,679
Mornington Island (Qld)	Mornington Island		1,001
Moyle River (NT)	Thamarrurr, Nganmarriyanga	2,443	7,085
Nicholson River (NT)	Domadgee, Burketown	63	15,773
Nicholson River (Qld)		1,578	35,728
Norman River (Qld)	Karumba, Normanton, Croydon	2,010	50,444
Ord River (NT)	Kununurra, Warmun	51	11,356
Ord River (WA)		7,075	44,121
Pentecost River (WA)	-	206	29,145
Prince Regent River (WA)	-	27	15,432
Robinson River (NT)	-	214	11,369
Roper River (NT)	Mataranka, Roper River	3,370	79,617
Rosie River (NT)	-	51	5,044
Settlement Creek (NT)	Wollogorang Homestead	20	5,493
Settlement Creek (Qld)		62	11,883
South Alligator River (NT)	Munmarlay	238	11,917
Staaten River (Qld)	Inkerman Homestead	53	25,732
Thursday Island (Qld)	Thursday Island	2,315	3
Towns River (NT)	-	15	5,432
Victoria River (NT)	Dagaragu, Timber Creek	1,808	78,144
Walker River (NT)	Numbulwar	847	9,731
Watson River (Qld)	Aurukun	1,033	4,679
Wenlock River (Qld)	-	152	7,525
Wildman River (NT)	-	106	4,818

*based on Stoeckl et al., 2006

** based on Carson et al., 2009 and Census data recalculations

3.1 Demographic Characteristics

This section will present basic characteristics of population in the TR region. A more detailed discussion on TR populations, population mobility and future projections can be found in a publication developed by Carson and colleagues (2009).

3.1.1 People and Settlements

Approximately 300,000 people were recorded as having their usual residence in the TRaCK region at the 2006 Census (Carson et al., 2009). Nearly two-thirds of these lived in urban centres and larger localities (Figure 5).

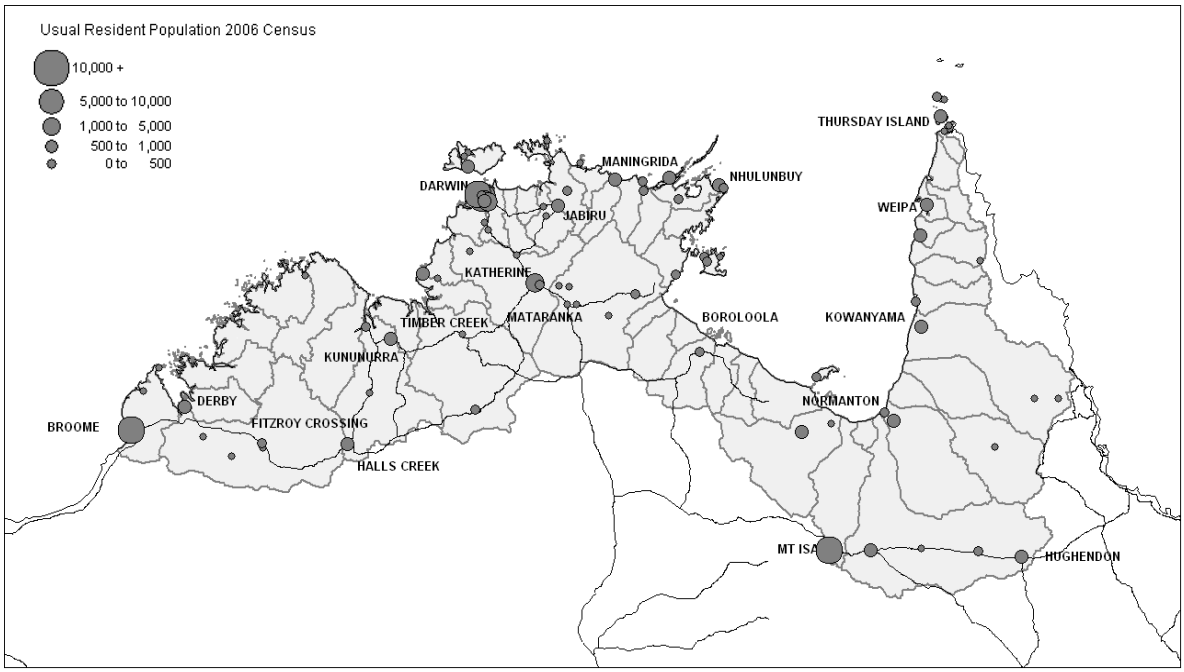
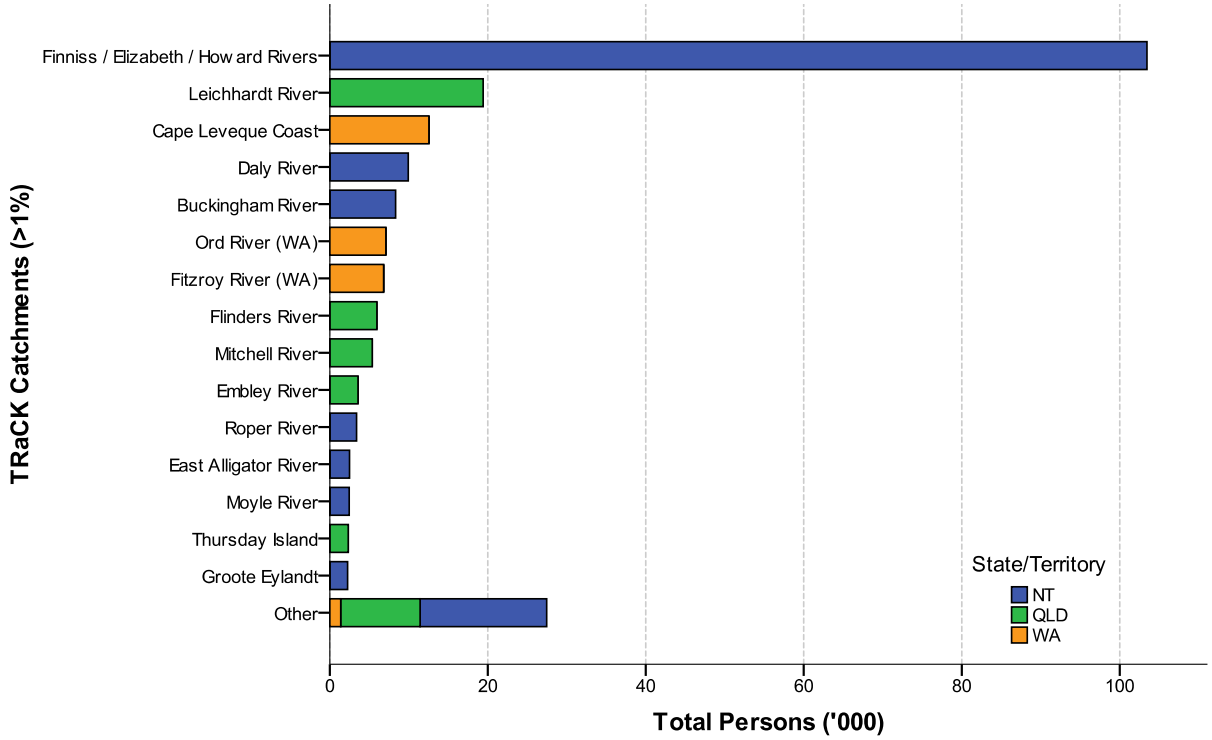


Figure 5. Populations of urban centres and larger localities in the TR region, 2006 Census

Source: Carson et al., 2009, based on Australian Bureau of Statistics, 2006 Census

By far the largest population centre in the region is Darwin. Greater Darwin, includes Darwin and the immediate surrounding areas of Palmerston and Litchfield, which recorded a population of over 100, 000, or one-third of the total TRaCK usual resident population at the Census (Carson et al., 2009). Throughout the rest of the region only Mt Isa in Queensland's Leichhardt River catchment and Broome in Western Australia (Cape Leveque Coast) had more than 10,000 residents (20,000 and 12,000 people, respectively, Figure 6).

According to Carson et al. (2009), the median age for the total region was 33 years, compared with a median age for Australia of 37 years. There were 107 males recorded in the TR region for every 100 females, compared to the national sex ratio of 97. One quarter of the usual residents in the TR region were Indigenous, compared with just two percent nationally.



Data Source: Australian Census of Population and Housing (ABS, 2006)

Catchments contributing less than 1% of the total population of the region are collapsed into a single category of 'other'

Figure 6. Total population numbers per catchments, TR region

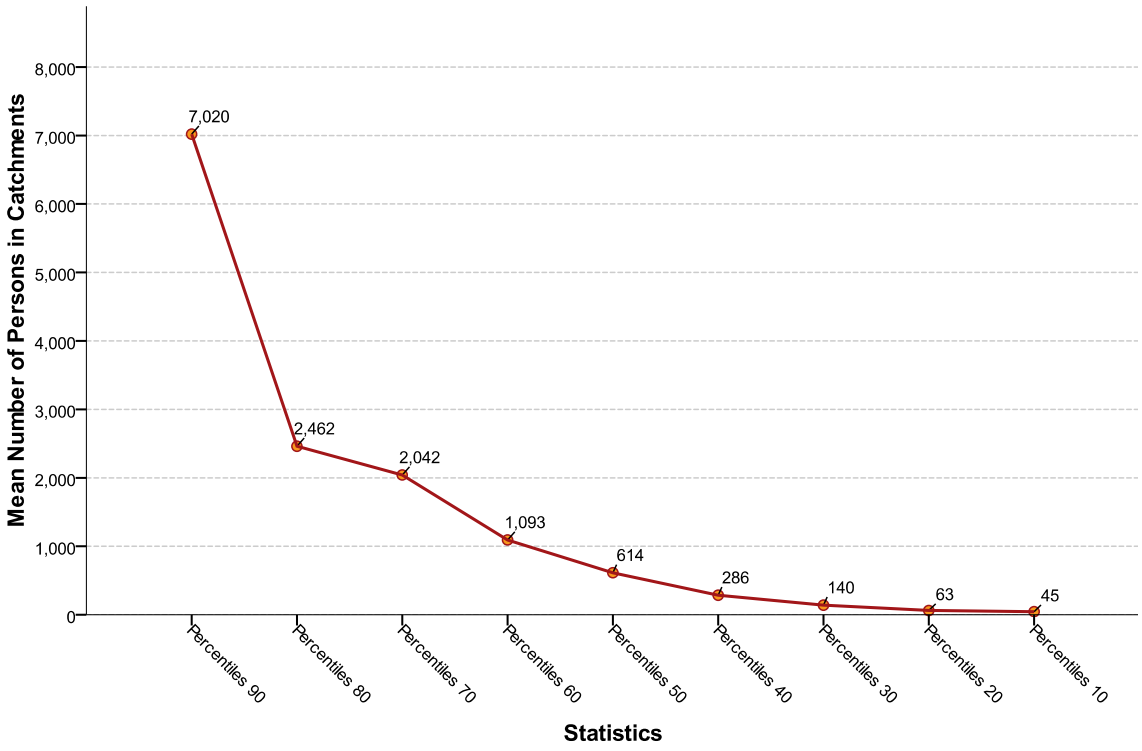
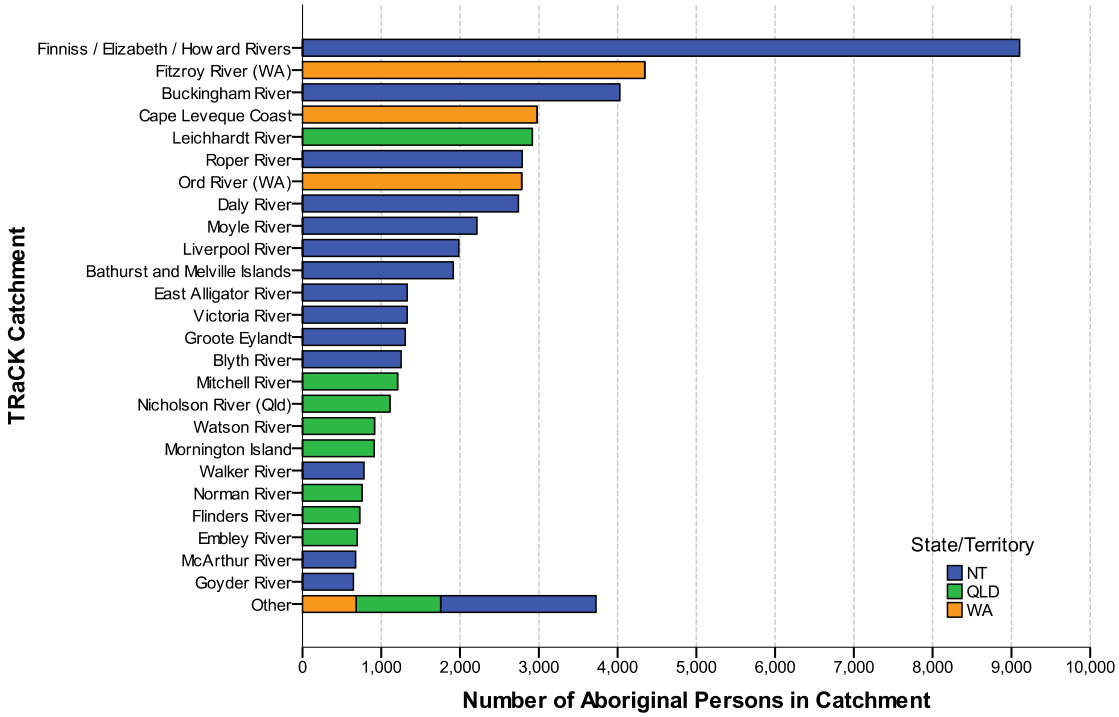


Figure 7. Mean number of persons for each decile (1/10) of catchments in TR region

The skewness of the population distribution by catchment is clearly demonstrated by plotting the mean number of persons for each decile (1/10 of catchments) in the region (Figure 7). The figure indicates that 90 percent of the catchments have populations below 7,000 persons, whilst 80 percent of all catchments in the TR region have populations below 2,500 persons. In essence, the top 10 percent of the catchments contain more than 70 percent of the total population of the region.

The largest numbers of Indigenous Australians in the TR region reside in the Greater Darwin area, although they represent only about 10 percent of total population of Darwin. Other catchments with large numbers of Indigenous people are the Fitzroy River and Buckingham River (Figure 8).



Data Source: ABS, 2006

Catchments contributing less than 1% of the total population of the region are collapsed into a single category (other)

Figure 8. Total number of Indigenous persons per catchment, TR region

In terms of percentages of the total population, several catchments, such as Bathurst and Melville Islands, Moyle, Fitzmaurice, Goyder, Walker, Liverpool and Blyth River have more than 90 percent Indigenous population (Figure 9).

The median age for each catchment in the TR region is presented in Figure 10. A higher median age was recorded in the Darwin region, around Derby in Western Australia and in the upper Cape York Peninsula in Queensland. A lower median age was typically recorded in catchments with high percentages of Aboriginal populations. For example, Moyle, Goomadeer and Fitzmaurice catchments that have Aboriginal people as 90% of total population have estimated median age of 20 (Table 4). On average, the Indigenous population of Australia is much younger (median age of 22 years) than the population as a whole (median age 37 years).

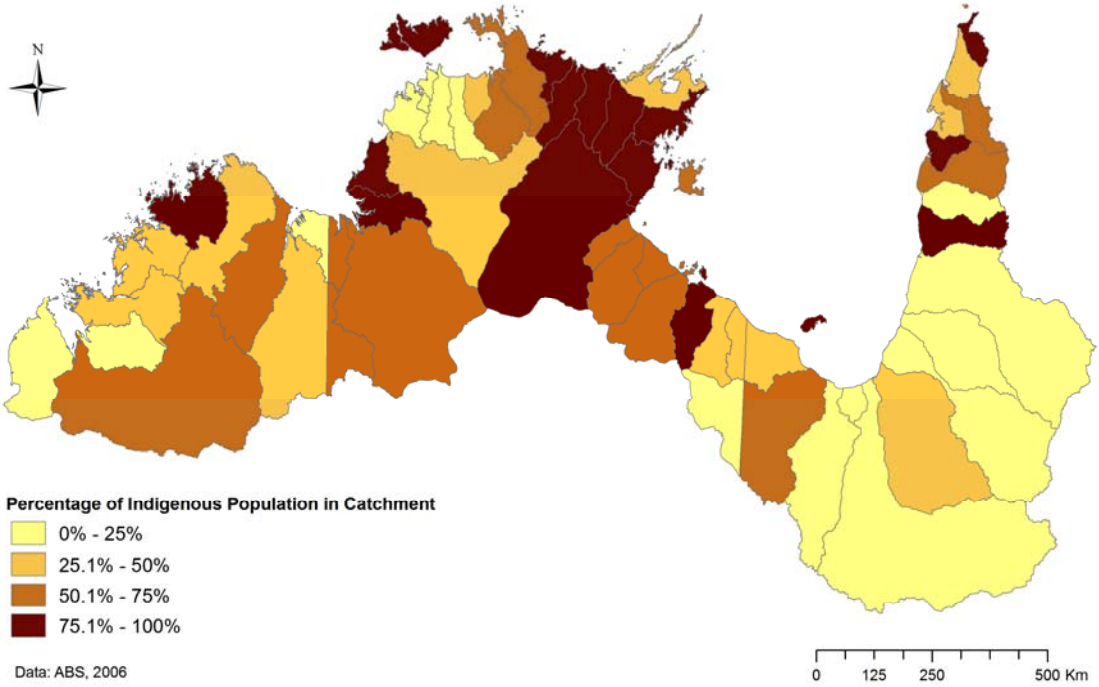


Figure 9. Indigenous population as % of total population, spatial distribution across catchments in TR region

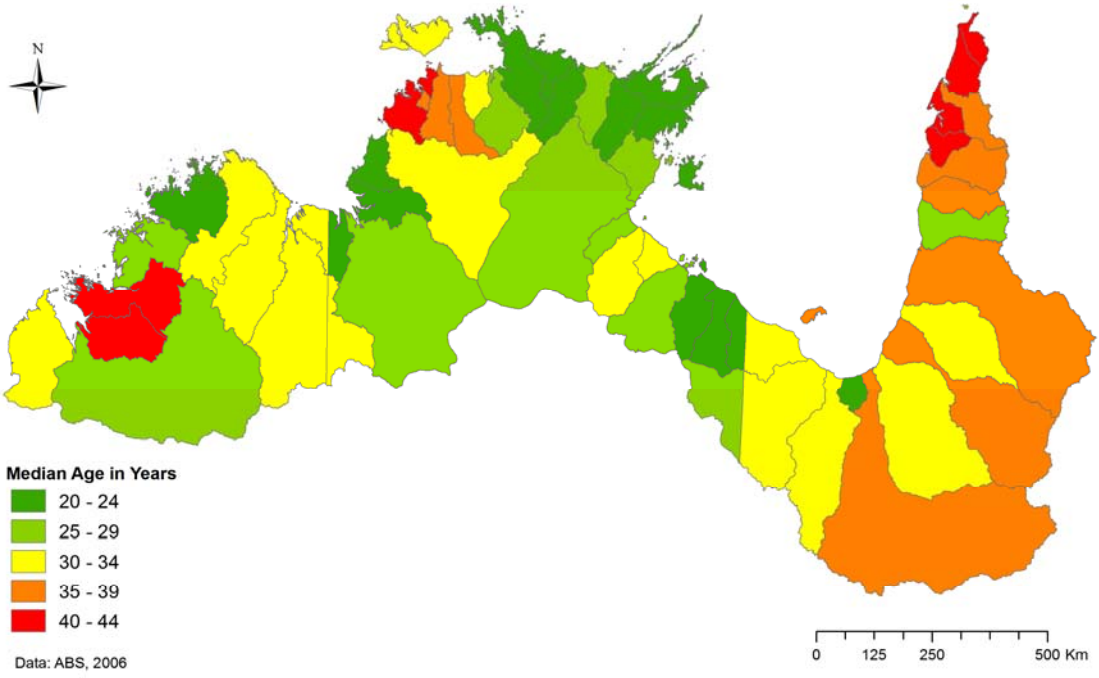


Figure 10. Median age of the population, spatial distribution across TR catchments

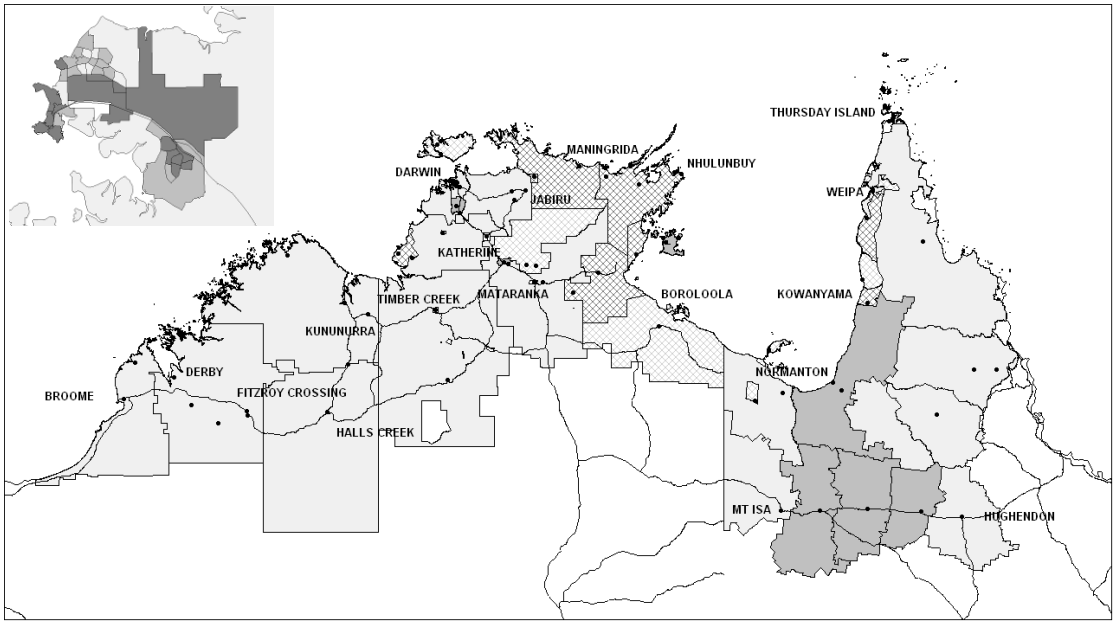
Table 4. Estimated percentages of Aboriginal population and median age in selected catchments of the TR region

Catchment	Main settlement	% Aboriginal population	Estimated median age
Moyle River	Thamarrurr, Nganmarriyanga	91	20
Goomadeer River	-	89	20
Fitzmaurice River	-	91	20
Robinson River	-	87	21
Koolatong River	Camburinga	88	22
Liverpool River	Maningrida	92	22
King Edward River	Kalamburu	85	23

Age distributions for Indigenous and non-Indigenous residents of the TR region are discussed in more detail in Carson et al. (2009).

3.1.2 Settlement Patterns and Mobility

A report by Carson et al. (2009) identified pockets of very high population turnover in Darwin and the southern Gulf parts of Queensland (between the Flinders and Mitchell River catchments). They also identified low levels of population turnover along the east coast of the Northern Territory, and between the Embley and Coleman River catchments, in Queensland (Figure 11, areas in hatched grey).



Solid gray = population turnover rates consistent with the national median,

Solid dark grey = high population turnover rates.

Hatched gray = low population turnover rates

Inset in the figure = Greater Darwin area

Figure 11. Population mobility, 2001-2006

Source: Carson et al., 2009, based on Australian Bureau of Statistics, 2006 Census

According to Carson and colleagues (2009), the highest population turnover rates for the period between 2001 to 2006 were above 100 percent and occurred in a number of Darwin suburbs, but also in the town of Jabiru in the East Alligator catchment and Nhulunbuy in the Buckingham River catchment. Weipa (94 percent) and Cloncurry (92 percent) experienced the highest population turnover rates of Queensland locations, while Broome (81 percent), and Wyndham (78 percent) experienced the highest rates in Western Australia. Rates under 20 percent were experienced in Aboriginal communities in the region including Angurugu and Numbulwar in the Northern Territory, and Kowanyama and Aurukun in Queensland. The lowest turnover rates in Western Australia were 47 percent in Halls Creek and 56 percent in Derby. Further details on population mobility can be found in Carson et al. (2009) report.

3.2 Economic Parameters

This section presents data on employment, including the largest sectors of employment in the north, information on various types of businesses operating in the region and major land uses.

3.2.1 Employment

Unemployment data presented in this section needs to be taken with caution due to issues related to the aspects of the Census methodologies, such as calculations of labour force and reporting of employment status by people on CDEP programs. In addition, unemployment percentages appear particularly high in catchments with relatively small populations (such as Drysdale River or Holroyd River) and it is difficult to determine whether this is a valid observation or a result of intentionally introduced errors in the Census data, which become very significant when dealing with small total numbers of people. The impact of fly-in-fly-out mining operations on the labour force and employment statistics is also unclear. Combined government-provided services (health, education and public services) employed on average 25 percent of persons over 15 years of age in TR catchments. The second largest employment sector was agriculture and forestry, with an average of 11.5 percent across catchments, followed by mining, retail and construction, each employing around 4 percent of persons.

Catchments with larger populations, where introduced error is less prominent, such as the Roper River, Victoria River, Mornington Island, Blyth River and Buckingham River have relatively high unemployment compared to other catchments across the region.

The majority of the labour force in the catchments across the TR region is concentrated in the Darwin region (Finniss, Elizabeth and Howard rivers catchments). The few other catchments with large settlements, such as Leichardt River (Mt Isa), Cape Leveque Coast (Broome) and Daly River (Katherine), dominate the remaining numbers of total labour available in the TR region. Thus, labour force across the majority of the regions is very limited and might be one of the limiting factors for potential developments in the future.

Labour force numbers across most catchments in the north are very small, and data reported in Census is thus not very reliable. However, it can be observed that only 9-10 catchments in the north are likely to have labour force numbers greater than 2,000 people: Embley, Mitchell, Flinders, Fitzroy, Ord, Buckingham, Daly, Cape Leveque Coast, Leichhardt and Finniss / Elizabeth / Howard Rivers.

To further demonstrate the problem of the availability of labour beyond certain highly populated catchments in the region the distribution of mean labour force across the TRaCK region was plotted using a decreasing ranking evolution of the mean method (Figure 12). The first point in the graph represents mean labour force size per catchment (2,249 persons), across all catchments. If we then remove from calculations the catchment with the largest numbers in the workforce (Finish/Elizabeth/Howard

Rivers catchment), the mean labour force availability for all catchments in the north drops from an average of 2,249 persons per catchment to almost half, 1,199 persons per catchment. Excluding the top-five catchments/contributors to the labour force, the remaining catchments only contribute slightly above 650 persons on average to the labour force availability in the region.

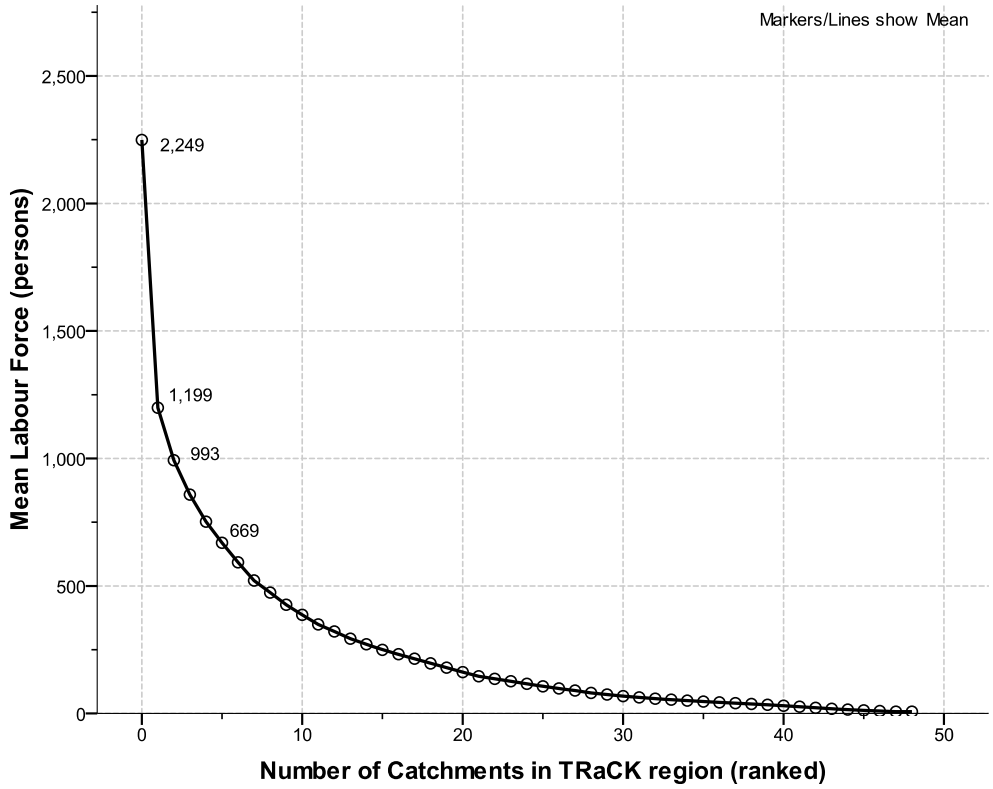


Figure 12. Distribution of the mean number of persons in labour force across decreasing ranking of catchments in the TRaCK region

Weekly incomes per person also vary substantially across catchments. Table 5 lists five catchments with the lowest weekly incomes per person, and five catchments with the highest weekly incomes. The data indicates the highest weekly income per person occur in catchments with high mining activity. The median weekly income per person across catchments in 2006 was A$392, ranging from an average of A$150 per person per week in Blyth River (Ramingining), to a weekly average of A$707 in Embley River catchment (Weipa) (Table 5). Catchments with very small populations were excluded from table as data for those catchments is particularly unreliable.

Table 5. Median weekly income per person, lowest and highest five catchments

Catchment*	Median weekly income per person, A$
Blyth River	150.55
Koolatong River	151.13
Walker River	164.78
Liverpool River	177.83
Roper River	203.35
Lennard River	577.00
Finniss / Elizabeth / Howard Rivers	587.90
Watson River	665.50
Leichhardt River	679.60
Embley River	707.54

*catchments with very small populations (under 100) excluded from the table

3.2.2 Service Oriented Businesses

The most significant business categories across the TR region are presented in Figure 13. The figure however needs to be interpreted with caution as data used to create Figure 13 was sourced from the Community Guide 2007 issue, and therefore does not represent the true number of businesses operating across the north. Instead it represents the total numbers of businesses registered in the Guide, the majority of which are service-oriented businesses.

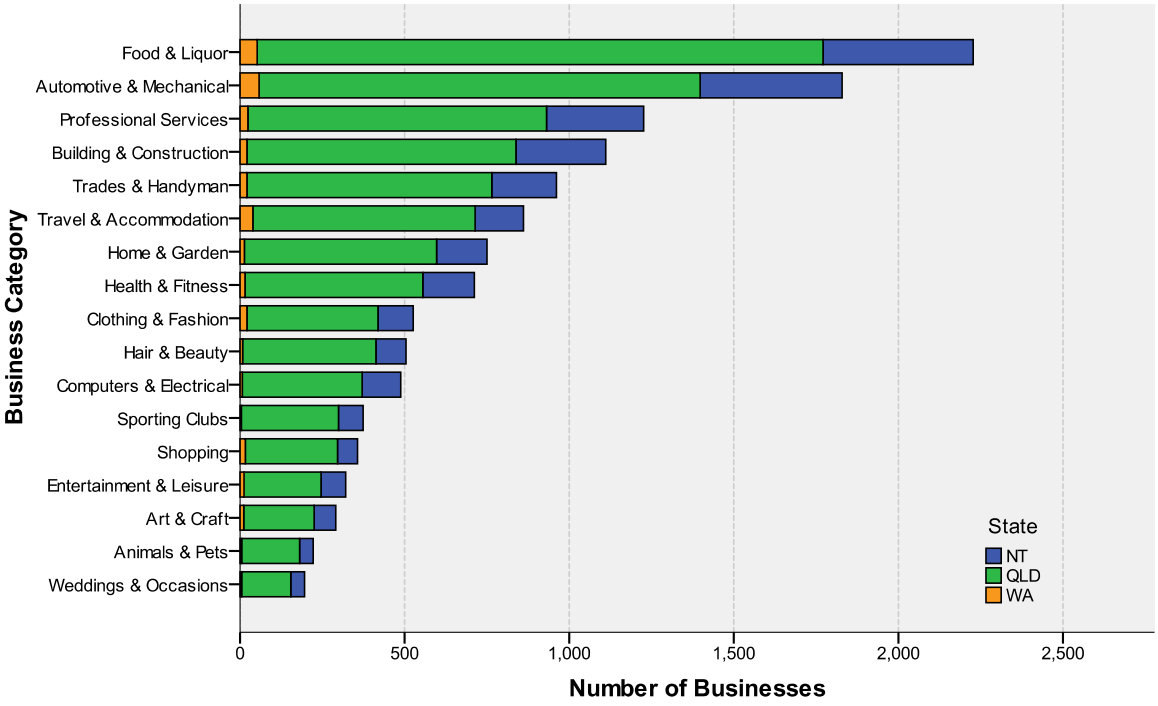
In terms of numbers of businesses registered per catchment, the top-ranking catchments are Finnins/Elizabeth/Howard, Mitchell, Flinders, Gilbert, Leichhardt, Cape Leveque, Daly and Ord, accounting for more then 97 percent of all businesses registered in the Guide.

3.2.3 Mining

Mining and exploration sites and the availability of resources at each site, in mega tonnes, are presented in Figure 14. The diameter and colour of the symbols vary by the resource value of the site (from small red mines to large green mines or exploration sites).

It is interesting to observe from the figure that mining activities within several catchments, in particular those in Queensland, are concentrated in the upper reaches of the catchment. Thus, employment prospects, weekly incomes, and other sociol-economic characteristics might differ considerably within those catchments.

Intra-catchment variability is thus an important consideration to keep in mind when discussing socio-economic data on a catchment level.



Data Source: www.communityguide.com.au

Figure 13. Numbers of businesses by general business category, TR region

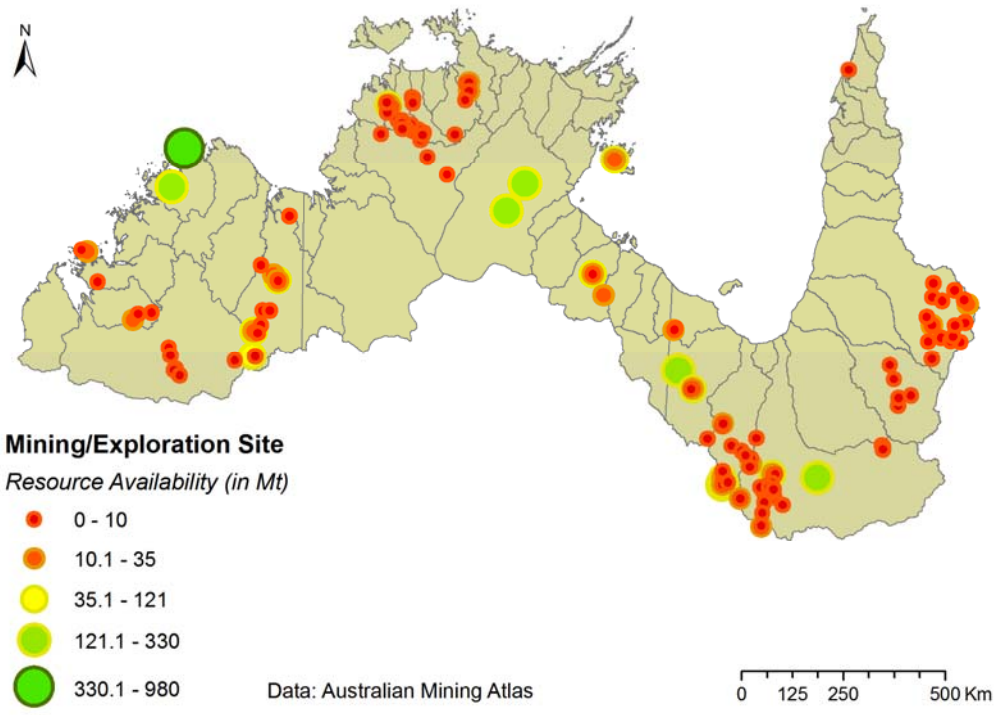


Figure 14. Mining and exploration sites, spatial distribution across TR region

3.2.4 Land use

The Australian Land Use and Management (ALUM) Classification, developed in the 1990's, is based on the level of human intervention in, or modification of, the landscape. ALUM has a three-level hierarchical structure, with five primary classes ranging from conservation and natural environments (no or minimal intervention) to intensive use. Water is included separately as a sixth primary class (Figure 15).

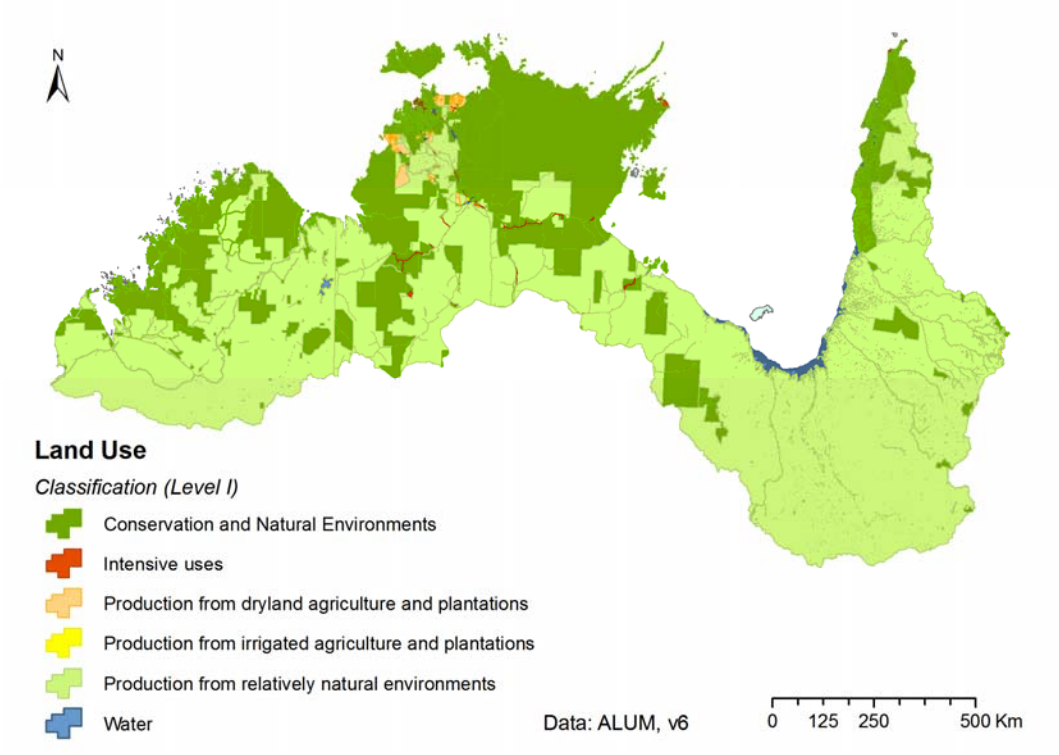


Figure 15. Land use in the TR region, primary level of ALUM classification

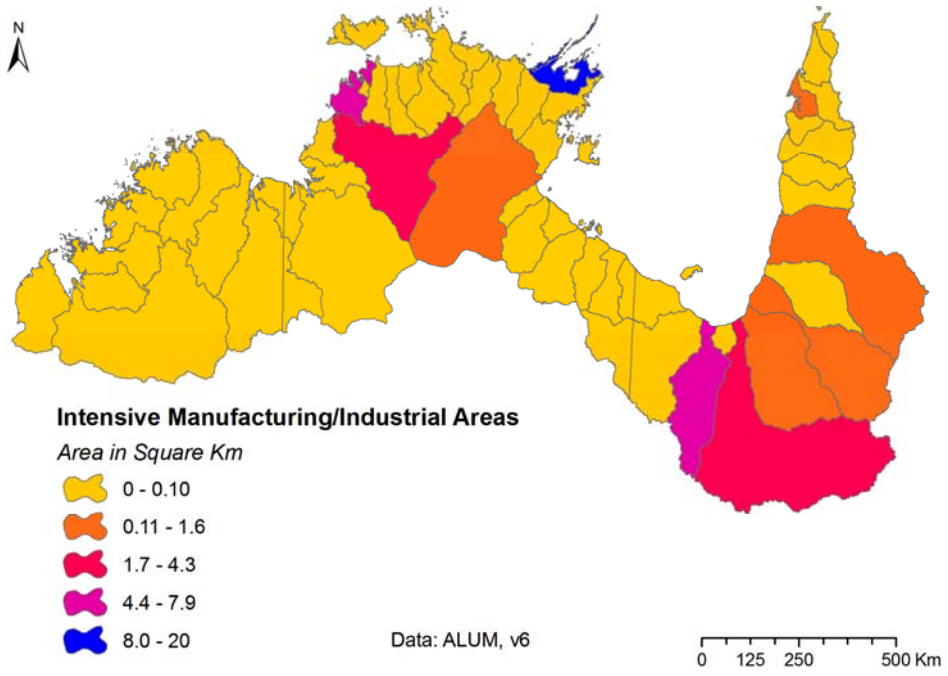


Figure 16. Land area classified as intensive manufacturing/industrial in the catchments of the TR region.

It can be observed from Figure 15 that categories characterised by least human interventions, that is conservation and natural environment and production from relatively natural environment (such as grazing of natural vegetation), dominate land use in the TR region.

The second and third levels of ALUM classification contain a more detailed breakdown of the primary classes. For example, the “intensive uses” class is broken down into residential, manufacturing, mining etc. Areas under intensive manufacturing or industrial uses are presented in Figure 16, as total areas in km^2 in each catchment. It can be observed that such areas are relatively small across all of the catchments in the TR region, although the main “mining” catchments are apparent. Interestingly, mining and manufacturing areas on Groote Island and in Kimberley region are not evident.

Land under conservation and natural environments is further presented in section 3.6.4 which discusses protected land areas of ecological importance.

3.3 Infrastructure and Services

This section presents the Australian Accessibility/ Remoteness Index (ARIA) data, followed by Information on basic infrastructure, such as roads, airports and educational facilities. The section continues with data on housing infrastructure, including dwellings, structure and tenure.

3.3.1 Remoteness Index

Accessibility/Remoteness Index of Australia (ARIA) is a continuous varying index with values ranging from 0 (high accessibility) to 15 (high remoteness). The index is based on road distance measurements from 11,879 populated localities in Australia to the nearest service centres. Service centres are broken down into five categories (depending on the extent of services available), and the distance to each category centre is measured (for example, distance to a city with primary school, distance to a city with primary and secondary school, distance to a city with primary, secondary school and TAFE etc).

According to ABS (2003), major cities of Australia tend to score an average ARIA index value of 0 to 0.2. “Inner Regional Australia” is recorded as having, on average, an ARIA index value greater than 0.2 and less than or equal to 2.4, while “Outer Regional Australia” centres tend to score an average ARIA index values between 2.4 and 5.9. Average ARIA index scores for remote Australia are between 5.9 and 10.5, with localities scoring greater than 10.5 being classified as very remote.

Based on the 2001 Census, more than 58,000 people in Queensland, 50,000 in Northern Territory, and more than 63,000 in Western Australia lived in very remote regions in 2001 (ABS, 2003).

Figure 17 presents continuous ARIA values for the Tropical Rivers catchments. It can be observed from the figure that large tracts of the TR region fall within the very remote category (defined as ARIA scores higher then 10.5). ARIA scores are lower in catchments closer to regional centres, such as Darwin, Mt Isa and Cairns. Also, parts of a single catchment closer to the service centre will have a lower ARIA score (be less remote) than part of the catchment further away from the centre (more remote). This is particularly evident with larger catchments parts of which are relatively close to the service centres, such as, for example, the Mitchell or Leichardt Rivers (Figure 18). In general, catchments with high remoteness index tend to have a limited range between the minimum and maximum value.

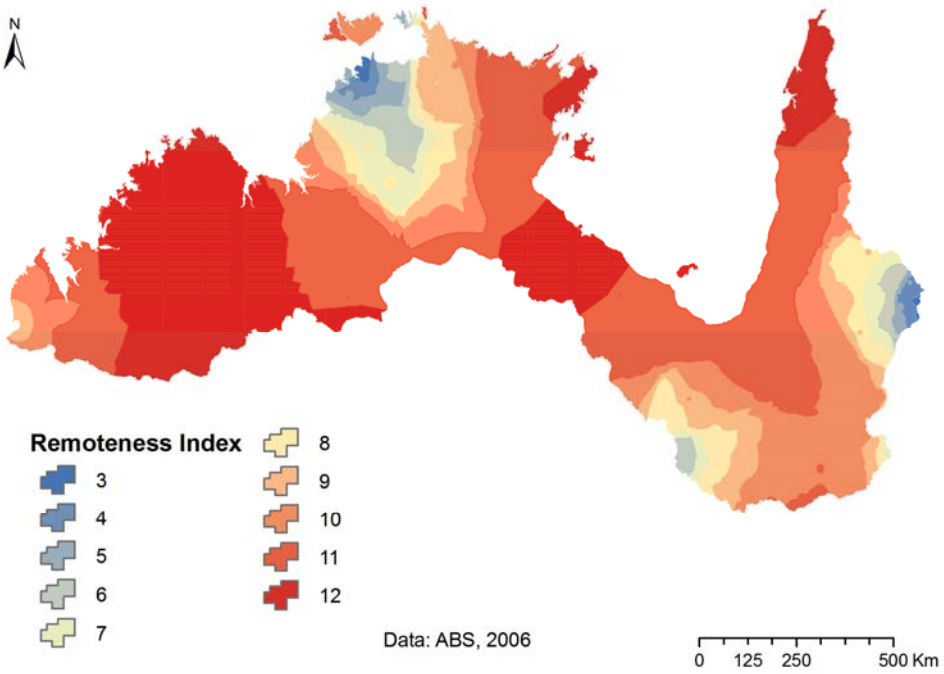


Figure 17. Continuous values of the ARIA index for the TR region

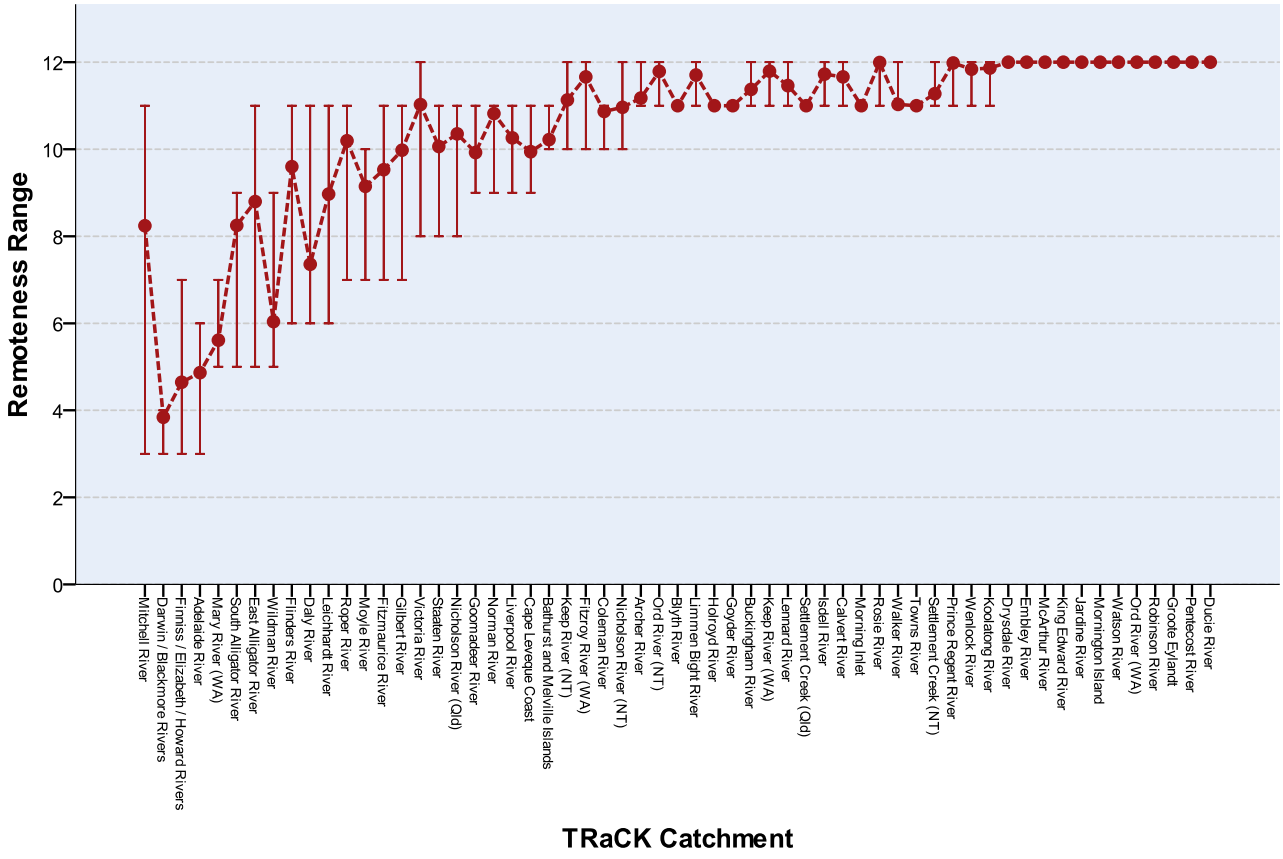


Figure 18. Distribution of remoteness index ranges (minimum, maximum, mean values) across the TRaCK region catchments.

3.3.2 Infrastructure and Services

Maps of the roads in the northern region are based on the Australian National Resources Atlas (ANRA) land use and management data base (Figure 19). It can be noted from the map that the road network of higher type roads (highways and major seal roads) is very limited, in particular in regions such as the Kimberley, Arnhem Land and Cape York Peninsula.

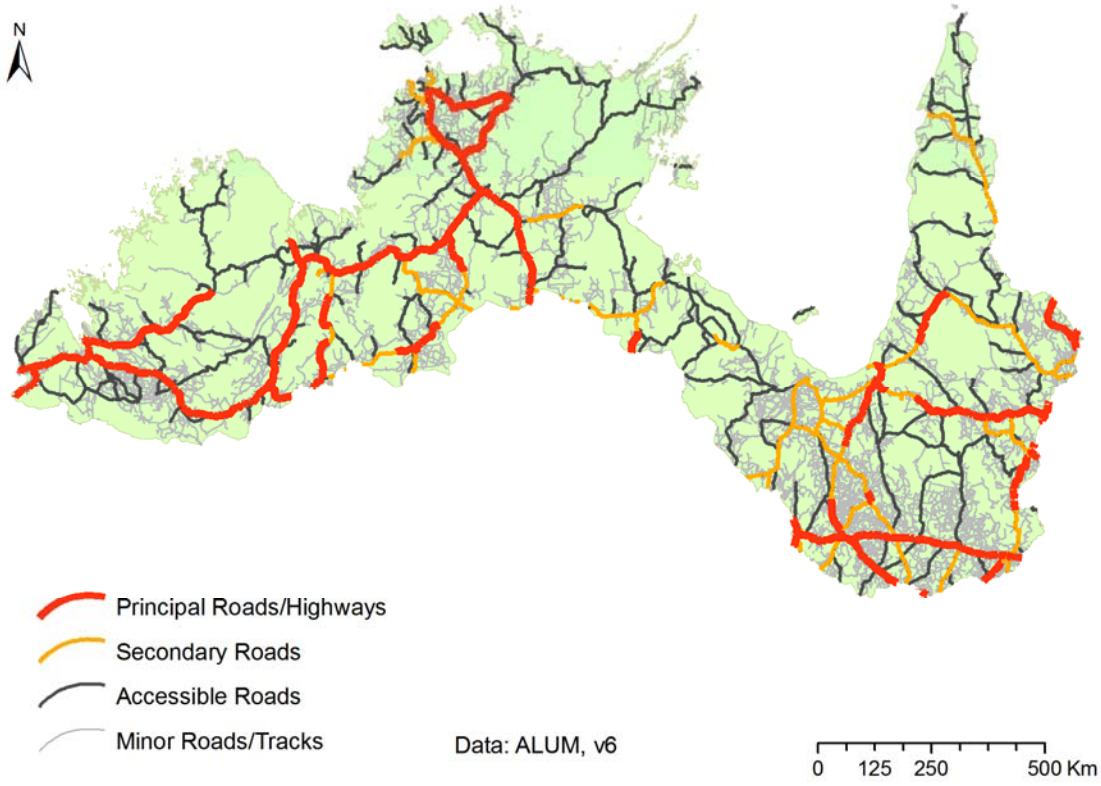


Figure 19. The road network of the TR region by type/class of the road

Airports of the TR region are presented in Figure 20. Although the formal airport network is clearly limited, it is important to note that the network of informal airstrips in this region is fairly extensive with most communities and large pastoral stations maintaining their own airstrip. However, the majority of those informal airstrips are susceptible to weather conditions and typically closed throughout the wet season. Comparable data on those airstrips across the north was not available.

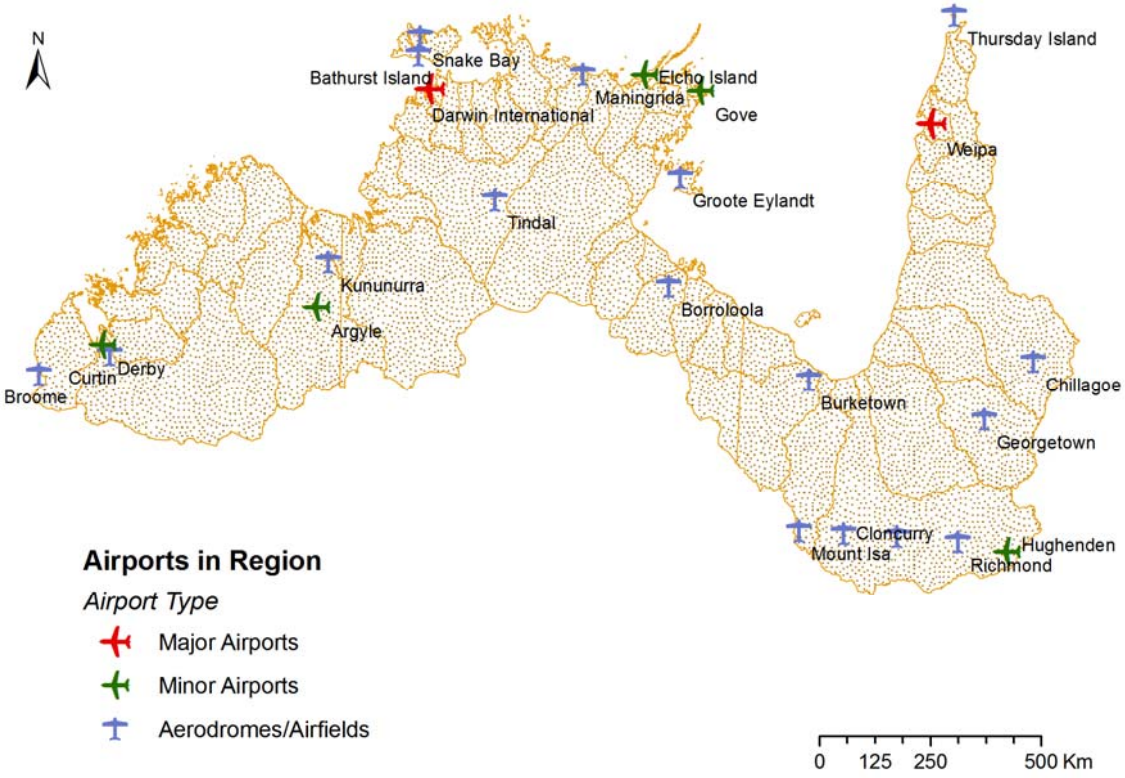


Figure 20. Airports of TR region by type

Data on the medical facilities across the TR region was difficult to collect in a comparable form. Data on education facilities is available, and catchments with no schools are listed in Table 6.

Table 6. TR region catchments with no school

Calvert River
Drysdale River
Ducie River
Fitzmaurice River
Goomadeer River
Goyder River
Isdell River
Keep River (NT part)
Koolatong River
Limmen Bight River
Mary River (WA)
Morning Inlet
Ord River (NT part)
Pentecost River
Prince Regent River
Rosie River
Settlement Creek (NT part)
South Alligator River
Staaten River
Towns River
Wildman River

3.3.3 Housing Infrastructure

Figure 21 presents a break-down of dwelling types, as recorded in the ABS Census, for each catchment. Slices of the pie chart represent dwelling types (separate houses; semi-detached houses; unit and flats; or other dwellings, such as caravans) and their proportion. The majority of people in the TR region live in individual (separate) houses, nonetheless, number of people living in the “other dwelling” category is also high in some catchments.

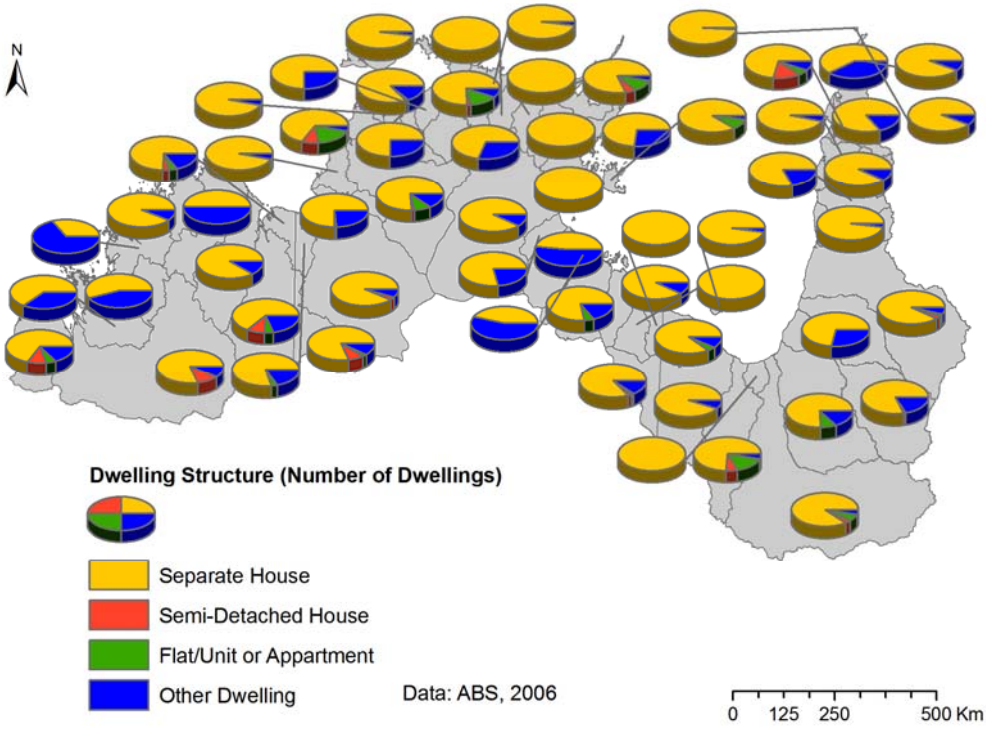


Figure 21. Dwelling structure, as percentage of households in the catchments of the TR region

Tenure arrangements are presented in Figure 22. Here, slices of pie represent different types of tenure (owned, being purchased or rented), with the size of the slice indicating population size in each segment. It can be noted from the figure that large percentages of people in the TR region rent their homes. Homes being purchased (under mortgage) tend to be located in larger urban centres.

The number of persons per household and number of persons per bedroom in a house vary considerably across catchments. Pie charts with average numbers of usual residents per household are presented in Appendix 1, while Figure 23 presents the average number of persons per bedroom for all TR catchments. High numbers have been recorded for catchments across Arnhem Land (up to 16 people per house), while western Queensland catchments, on average, have much lower number of persons per bedroom.

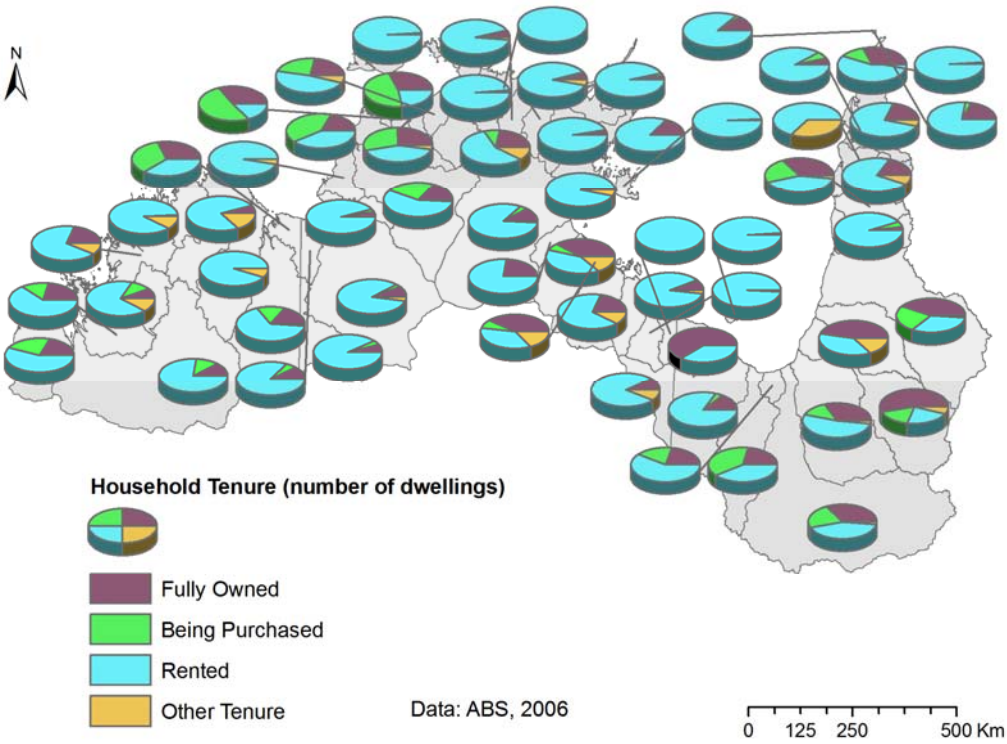


Figure 22. Household tenure arrangements, spatial distribution, TR catchments

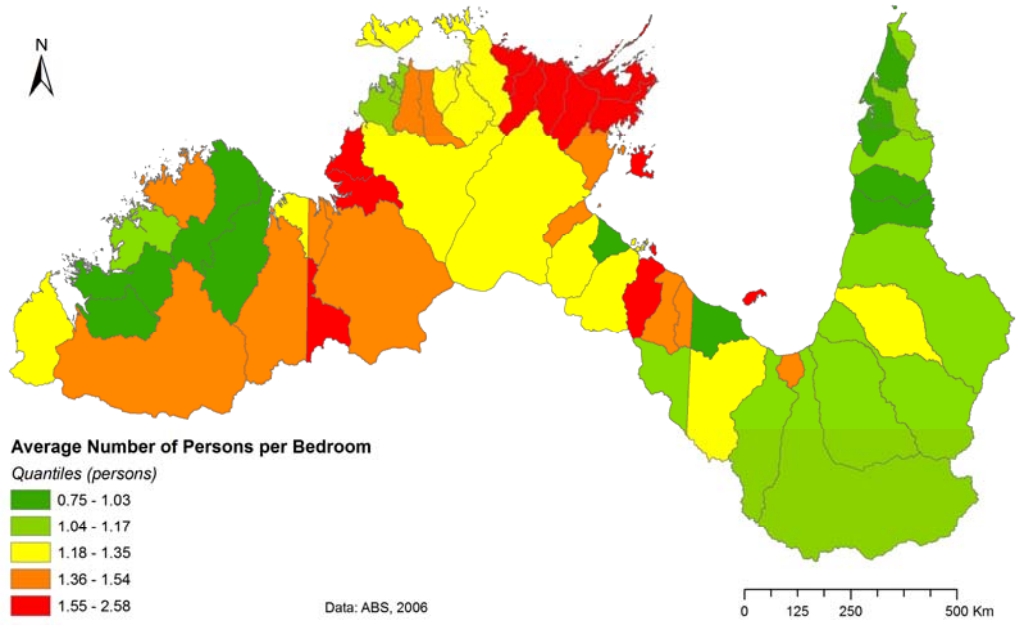


Figure 23. Average numbers of persons per bedroom, spatial distribution across catchments of TR region

3.4 Individual Wellbeing

This section presents insights into family structures and household arrangements across the north and data on the educational status of people living in the region. Religious affiliations and languages spoken at home are also discussed, followed by brief overview of crime statics for the TR region.

3.4.1 Families and households

On average, 27 percent of all women across the TR catchments have no children, while 32 percent have 3 children or more. The highest percentages of women with 3 children or more are on Mornington Island (45 percent of women), Robinson River (43 percent), McArthur River (42.5 percent) and Fitzmaurice and King Edward rivers (40.5 percent).

Average household size varied greatly across the TR region (Figure 24). Small households tended to be found around Derby in Western Australia and the upper parts of Cape York Peninsula in Queensland. On the other hand, parts of Arnhem Land and Fitzmaurice and Moyle rivers region, recorded a relatively high proportion of households with large numbers of people.

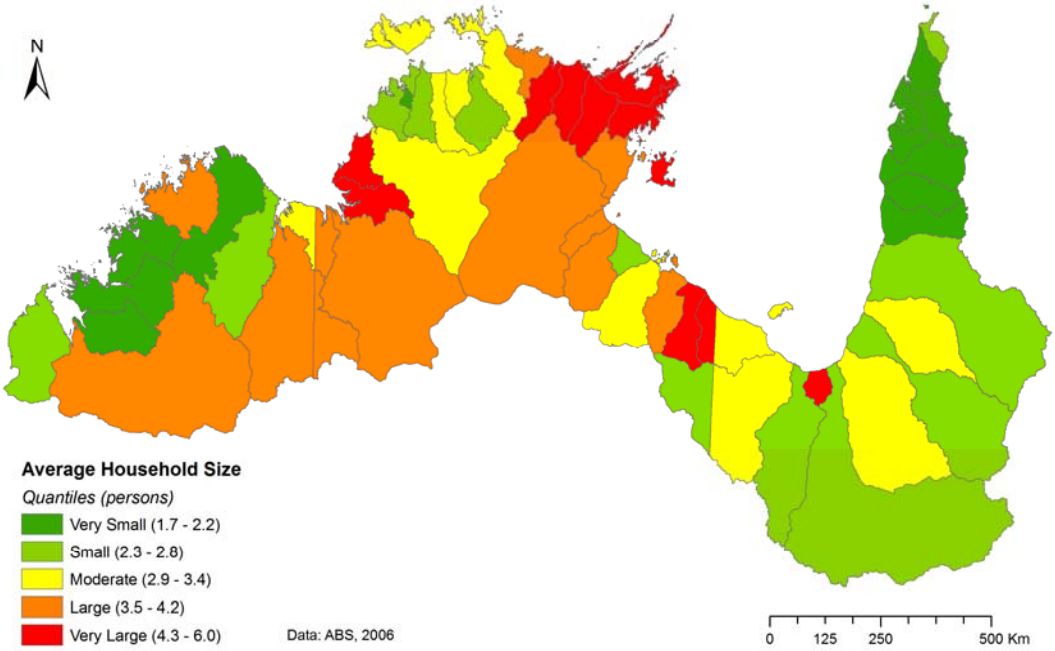


Figure 24. Average household size, spatial distribution across TR catchments

The ratio of one parent families to total families is presented in Figure 25. The highest percentage of one parent families were recorded for Prince Regent River and King Edward River (over 46 percent of all families), Watson and Koolatong River (40 percent), followed by Fitzmaurice River (37 percent) and Jardine River (36 percent).

Median household weekly incomes are presented in Figure 26. Higher household incomes are recorded around urban centres and in mining catchments (Darwin, Broome, Mt Isa, Cloncurry, Weipa, Gove etc).

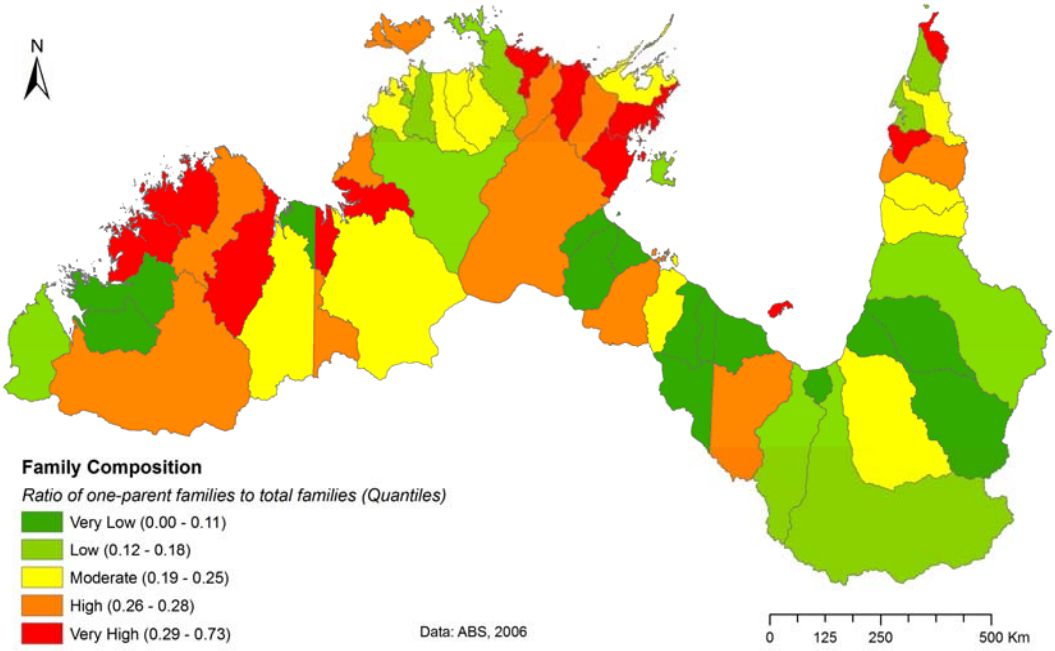


Figure 25. Mean ratio of one-parent families to total number of families, spatial distribution in the TR region catchments

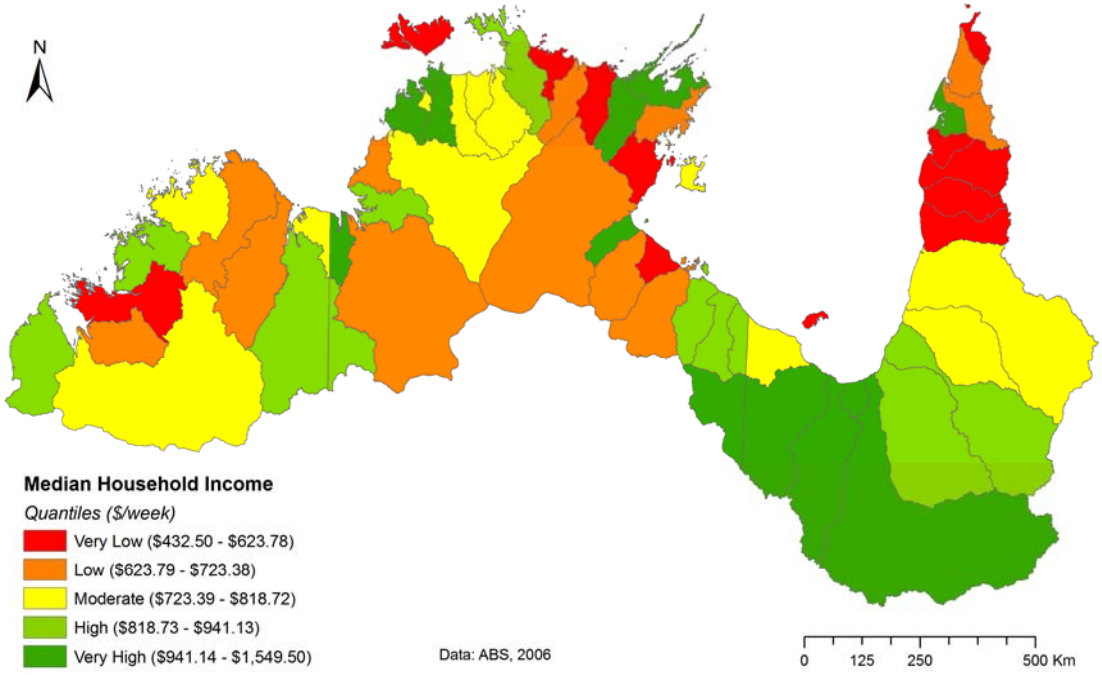


Figure 26. Median household incomes, spatial distribution across TR region

3.4.2 Educational Status

Education status is recorded in the ABC Census in two separate categories, schooling and education. Schooling represents the highest year of school completed by a person, while education represents post-schooling qualifications such as trade certificates and university degrees. Figure 27 presents a breakdown of the highest year of school completed for the population in each catchment. Slices of pie represent different segments of the population, with size of the slice indicating size of the population in each segment.

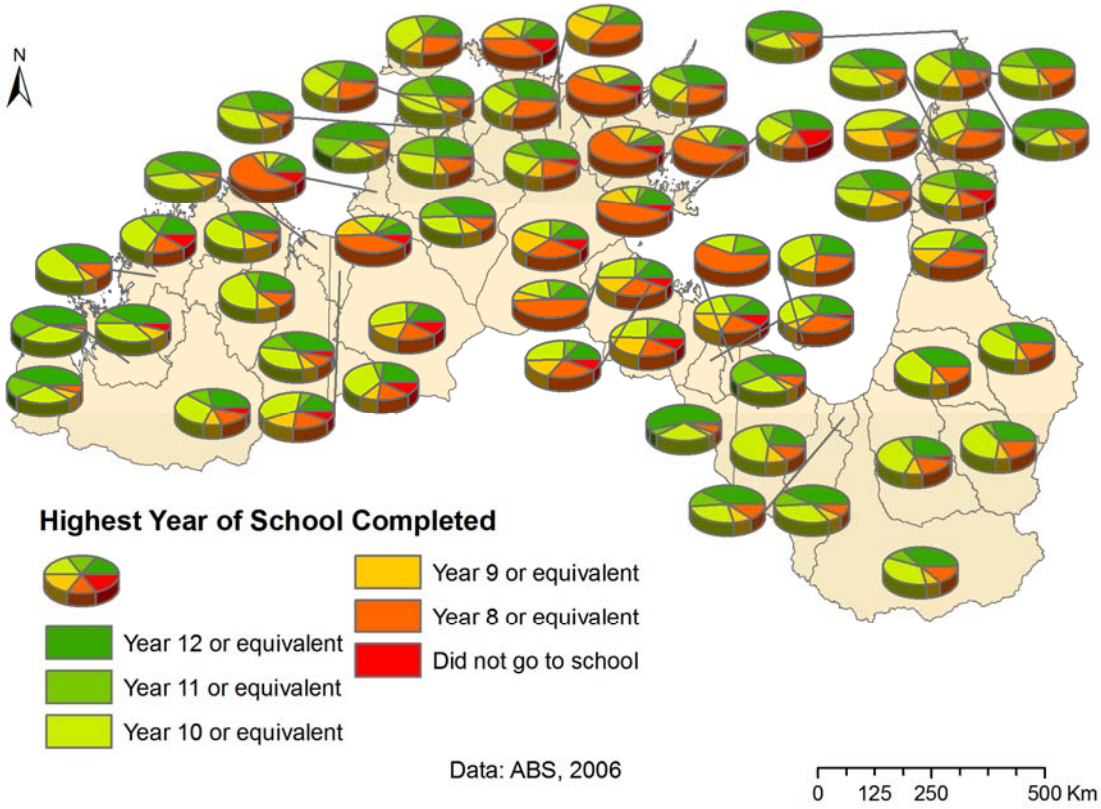


Figure 27. Highest year of school completed, spatial distribution across the TR catchments

3.4.3 Religion

The most predominant religion in the TR catchments is Christianity (57 percent of the population). It is however interesting to note that the second largest group are people who reported themselves as not being religious (22 percent of the total population across catchments).

3.4.4 Languages spoken at home

A high percentage of populations throughout the catchment have reported speaking languages other than English at home. The majority of languages, other than English, spoken at home are Indigenous languages (Figure 28). For example, in the Liverpool, Walker, Moyle and Blyth rivers catchments less then 20 percent of people reported speaking only English at home.

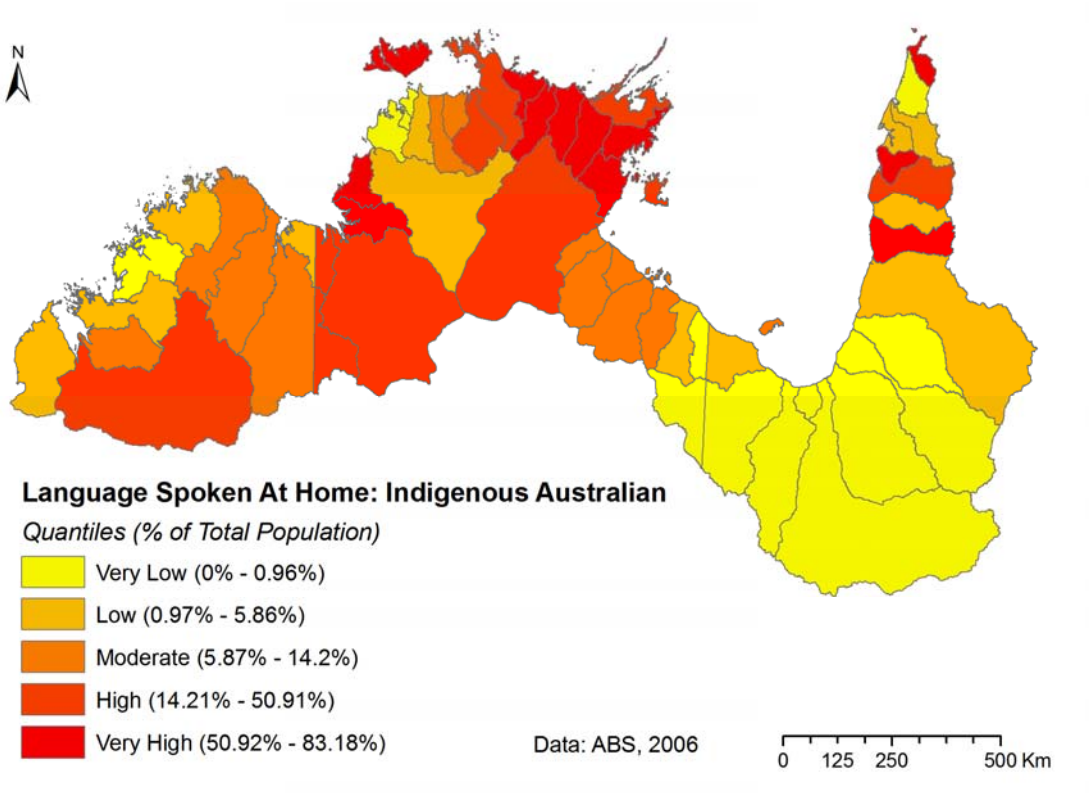


Figure 28. Percentages of population speaking Indigenous Australian languages at home, spatial distribution of persons in the TRaCK region

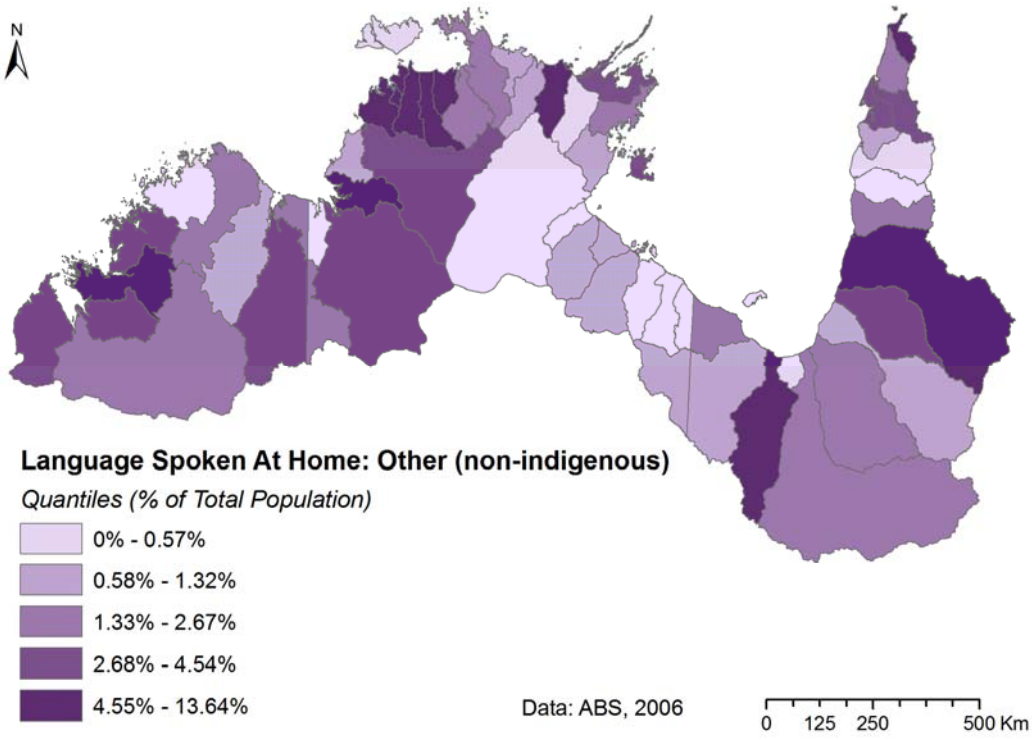


Figure 29. Percentage of population speaking non-Indigenous language other than English at home; spatial distribution in the TR region catchments

Figure 29 presents the percentages of the population speaking non-Indigenous languages at home. It can be noted from the figures that this population is proportionally smaller (up to 15 percent per catchment) than populations speaking Indigenous languages (up to over 80 percent per catchment), and tend to be higher in catchments that support larger urban centres.

For example, in Leichhardt River, only 74 percent of population was born in Australia, yet 82 percent speak only English at home. In contrast, entire populations of Moyle and Walker rivers were born in Australia, yet only 12 and 10 percent, respectively, speak only English at home.

3.4.5 Crime profiles

Crime statistics available for the TR region were not of a resolution that would allow for cross catchment comparison. Thus, an overview of basic crime statistics available for the region is presented in this section.

Crimes are typically reported in three main categories: offences against persons (such as assaults and sexual offences); offences against property (theft, robberies, etc); and other offences (such as drugs or weapons related offences, good order offences or traffic offences).

In Western Australia, rates of offences against persons (offence per 100,000 people) have increased in last 10 years, while all other major crime categories have recorded a decrease in crime rates (Figure 30). Data for the Kimberley Police District is reported only as total numbers of offences, and is not standardised into crime rates, thus it is not possible to compare it to other regions. In the year from June 2007 to June 2008, 2,396 offences against persons; 4,021 against property; and 7,077 “other offences” were reported in the Kimberley District.

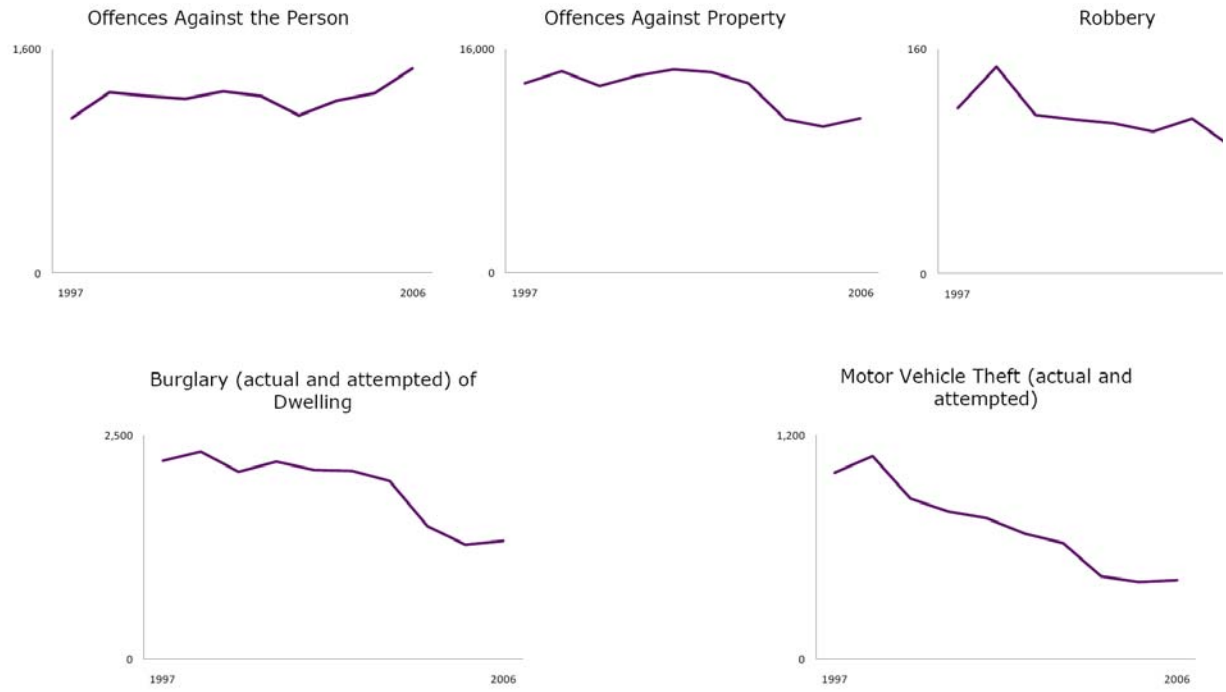


Figure 30. Crime rate trends in Western Australia, 1997-2006, selected crime categories

Source: Fernandez et al. 2008, p4

In the Northern Territory, the number of 'offences against the person' recorded by police in 2007 totalled 6,130 recorded offences, an increase of approximately 21% from 2006. However, the number of recorded property offences dropped by 1% during the same period, from 20,874 recorded property offences in 2006 to 20,673 in 2007 (ABS, 2008). Regional data for the Northern Territory is also available, however, offences are presented as total numbers only, not crime rates, and thus do not allow for comparison.

In Queensland, recorded offences are reported as crime rates (numbers of offences per 100,000 persons). Far Northern and Northern regions of Queensland (geographically relevant to this study) have the highest rates of offence for all Queensland districts for most of crime categories.

The Far North and Northern regions of Queensland had the highest rate of offences against persons in the entire State, and additionally, experienced the highest growth rate of crime in the State, for the period of 2006/07 to 2007/08 (Figure 31, from Queensland Police Service, 2008). The Far North and Northern regions also had the highest rates of “other offences” in the State. Rates of offences against properties were not the highest in the State (metropolitan region has highest rates), but were nonetheless still higher than the Queensland average for this category (Queensland Police Service, 2008).

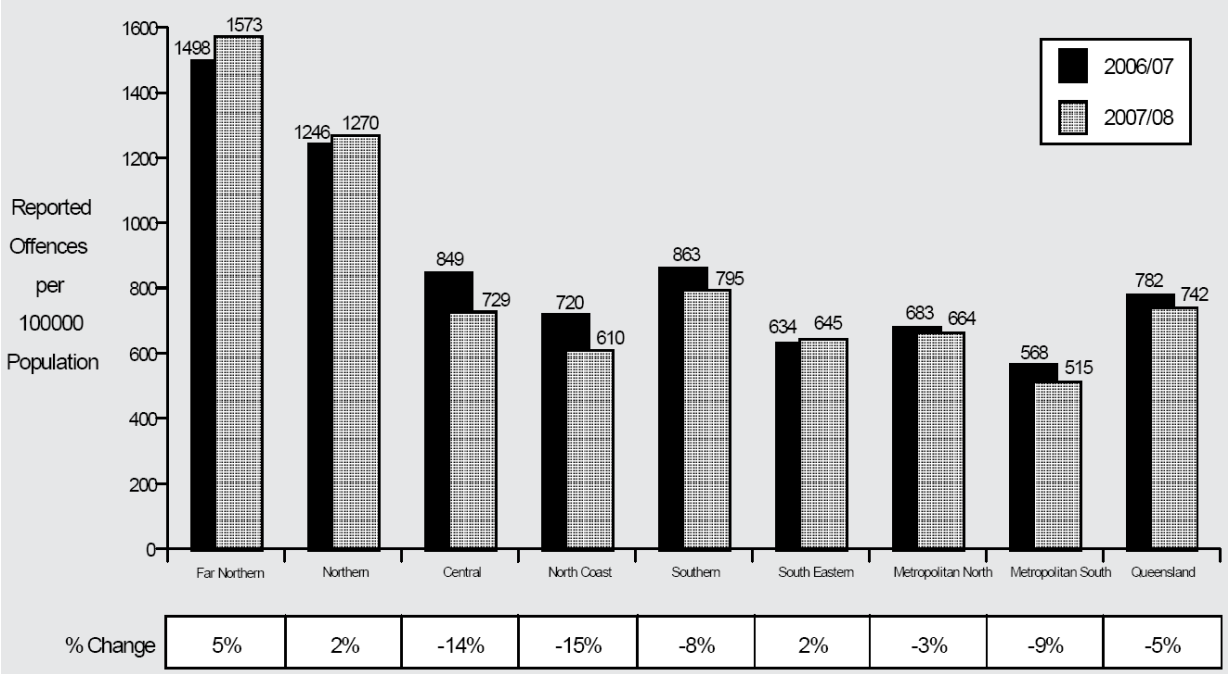


Figure 31. Offences against persons, Queensland districts

Source: Queensland Police Service Regional Comparison report, p45

3.5 Institutional Arrangements

This section provides an overview of various institutional arrangements across the TR region. Presence of both formal government agencies and organisations and community organisations is discussed, as well as aspects of social cohesion, such as volunteering.

3.5.1 Government Representation

The presence of various levels of government organisations (local, regional and state/territory) is mainly concentrated in larger urban centres. Figure 32 presents government organisations present across the TR region, listed according to the type of organisation. Overall, the numbers of organisations registered are very low across the whole of the TR region, with most organisations registered in the areas of community services and education.

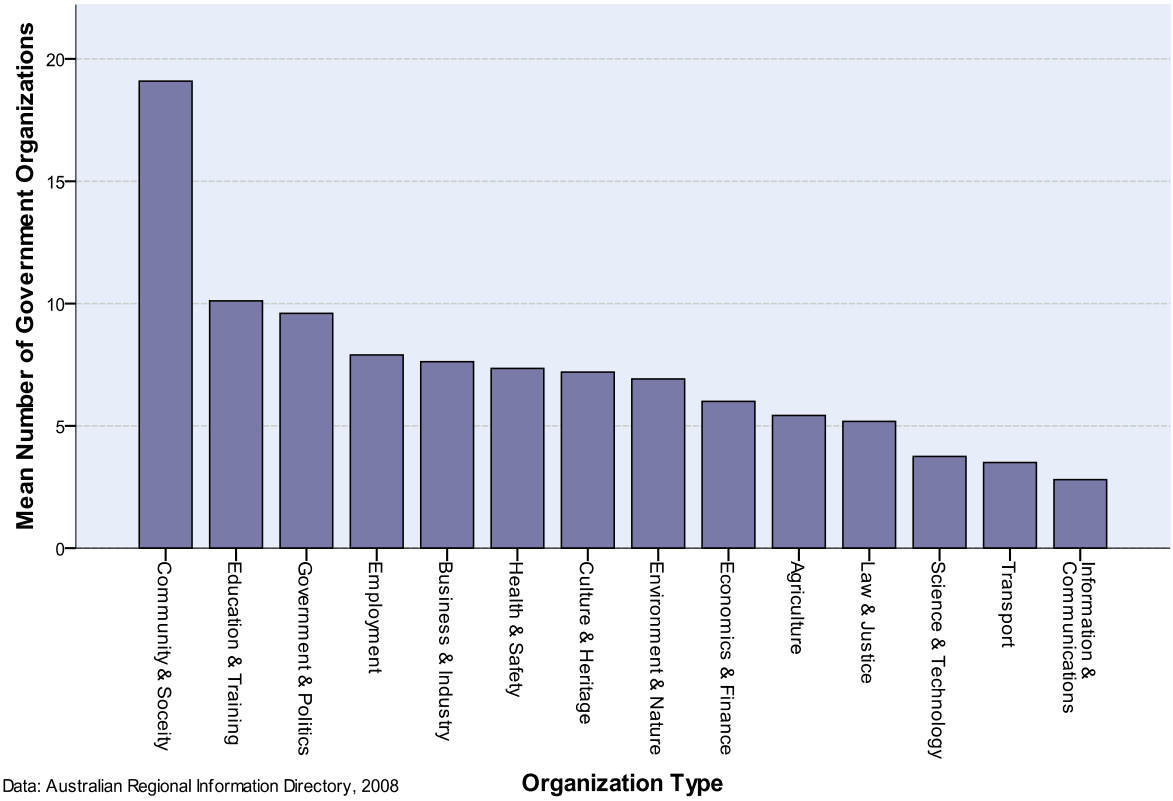


Figure 32. Government organisations registered in the catchments of the TR region, by type of organisation

3.5.2 Community Organisations

A total of 1,042 organizations from across the TR region were registered with the Community Guide in 2007. The overwhelming majority of the community organizations, 97 percent, are located within 10 catchments in the region, with Flinders, Mitchell and Finniss/Elizabeth/Howard rivers catchments topping the list in terms of number of community organisations registered (Figure 33, the darker colours denote higher number of community organizations registered in a catchment).

In terms of types of community organizations operating in the TR region (Figure 34), churches, other religious organisation and organisations related to child care and education, were the most numerous across the catchments.

However, caution is needed when interpreting this data as Community Guide in not a comprehensive register for all community organisations. Therefore, these numbers represent only organisations registered, not necessarily all the organisations that actually operate within the catchments.

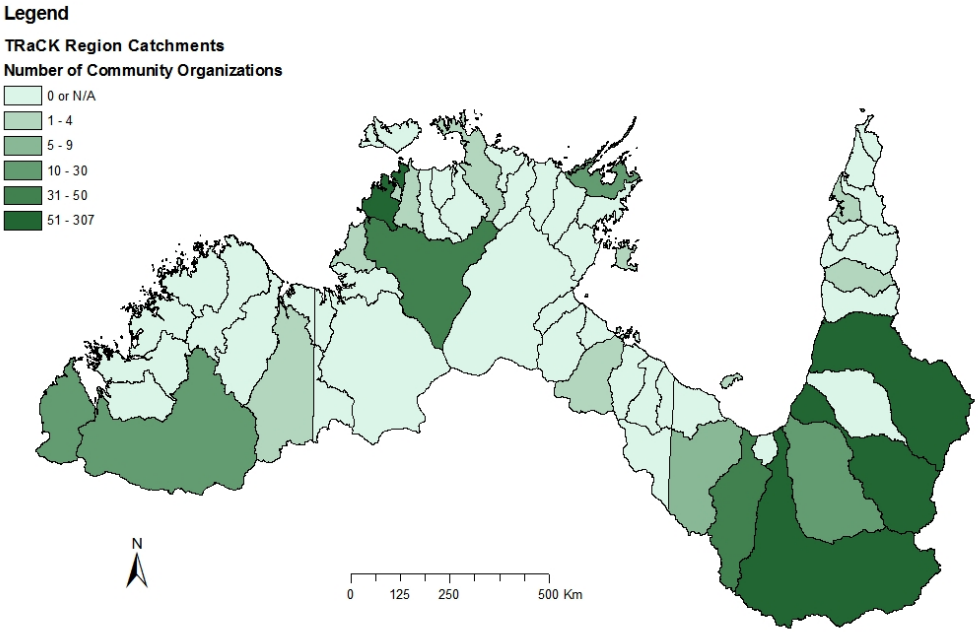
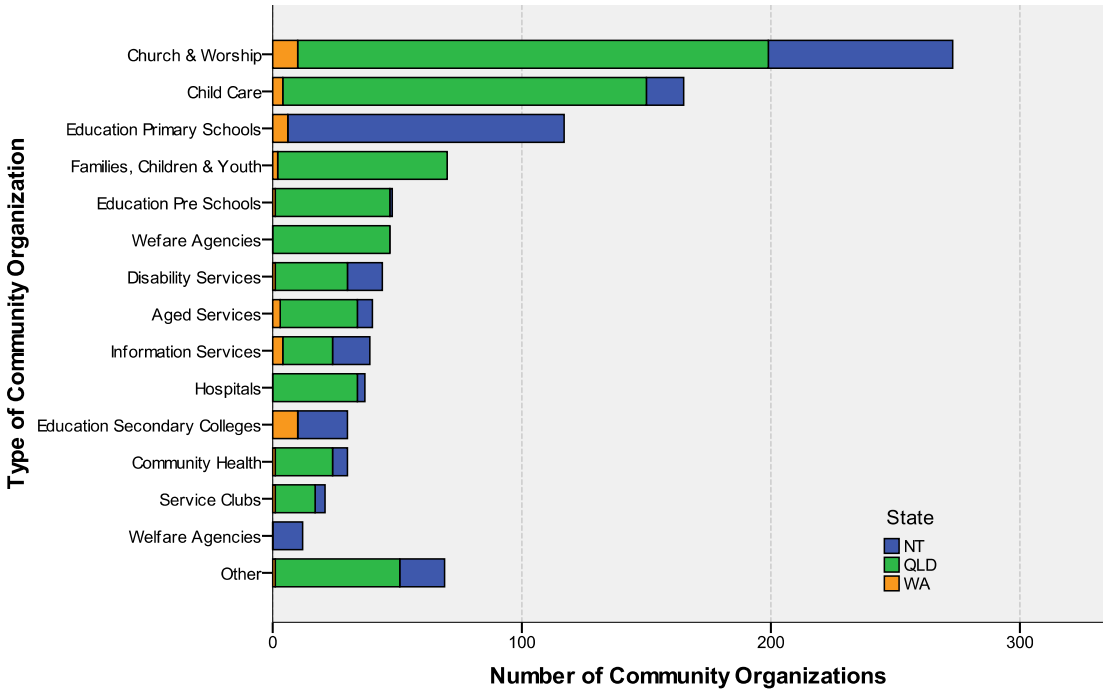


Figure 33. Number of community organizations in the TR region catchments.



Data Source: www.communityguide.com.au

Figure 34. Number of community organizations by organization type in the TR region catchments

3.5.3 Social Cohesion

Data on persons volunteering for an organisation or a group, as collected by ABS Census, is presented in Figure 35.

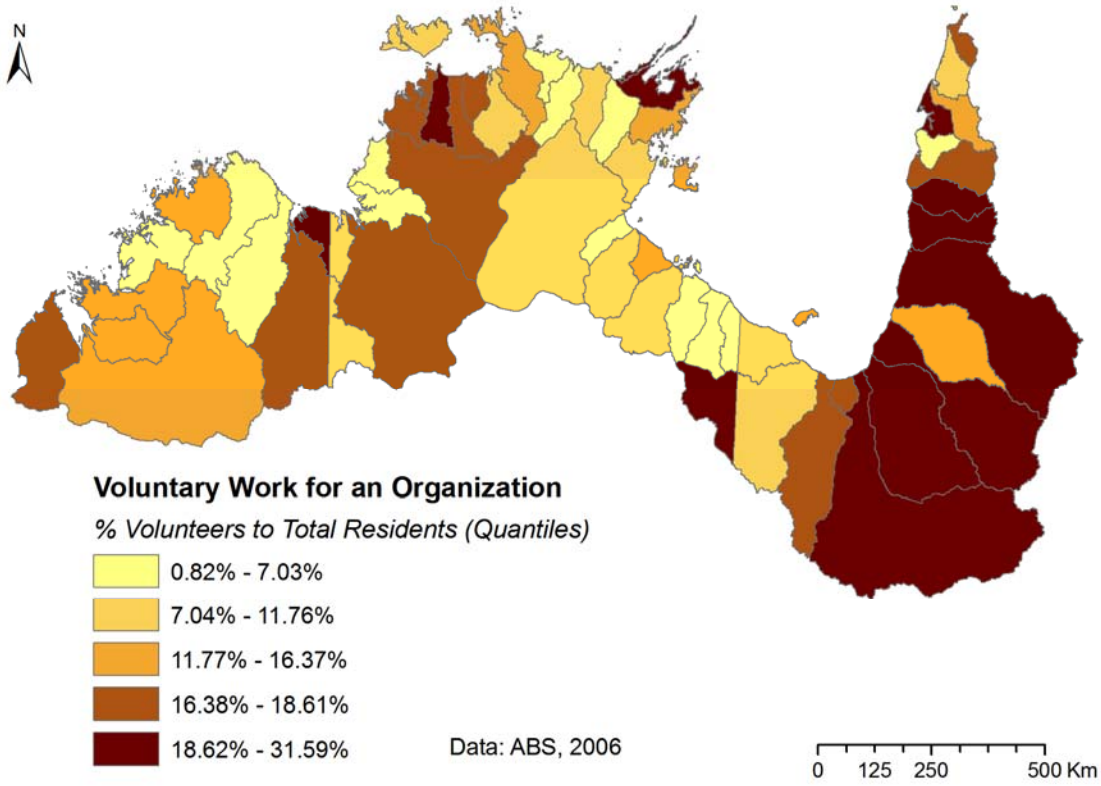


Figure 35. Percentage of population volunteering through organisation or a group, spatial distribution of TR

It has to be noted that the ABS Census Guide directs people to include records of volunteering through an organisation or a group only, such as help willingly given in the form of time, service or skills to a club, organisation or association. It is therefore to be expected that in communities with very few or no community organisations, such as the majority of the catchments in the TR region, volunteering numbers are likely to be low. Such low numbers however, might provide misleading information about the state of social cohesion as they do not include informal volunteering; such as helping your neighbours, extended family or other members of the community; as these forms of volunteering are not recorded in the Census.

In addition, no information appears to be available on the time, services or skills that are volunteered by Indigenous people to fulfil their obligations toward community or country.

3.6 Environment and Culture

3.6.1 Water as a resource

The estimated annual outflows per catchment and per person in each catchment are presented as a table in Appendix 1, based on data from Stoeckl et al. (2006) and the Australian Natural Resources Atlas (2008). The table also indicates the presence of perennial water in the catchment.

Data on current water allocations was both inconsistent and incomplete, and thus not available in a format that would allow for cross-catchment comparison.

3.6.2 Soil Quality

Data on soil quality and potential limitations to more intensive production is presented in Figure 36, based on data from the Bureau of Rural Science. Importantly, there are only few parts of land in the TR region that do not face either chemical or physical limitations to management. Low fertility and physical limits are the most common constraints, but chemical limits and salinity also occur (Figure 36).

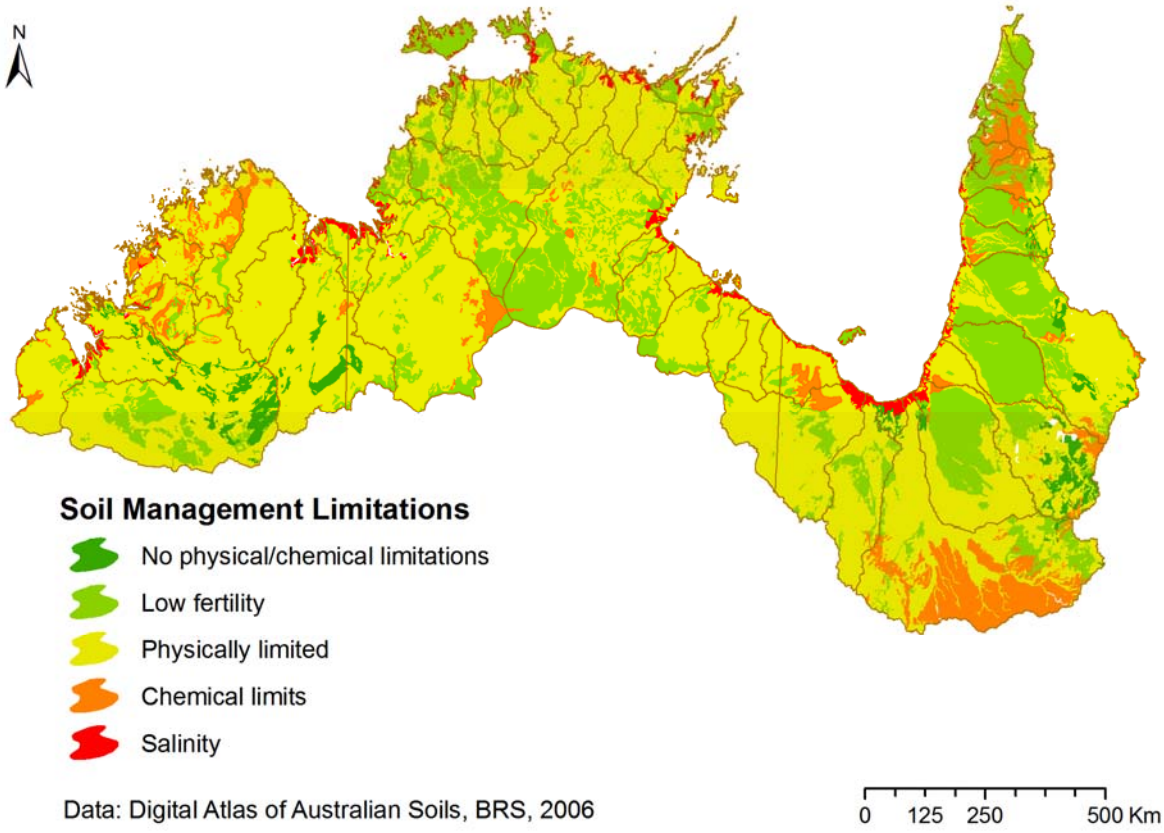


Figure 36. Soil management limitations, spatial distribution in the TR region

3.6.3 Environmental Risks

Potential hazards in the tropical rivers region include point source pollution from mining and other industry, as well as diffuse source pollution from agricultural developments. Several catchments with extensive mining and processing facilities, such as Flinders

River, Leichhardt River and Alligator Creek (Figure 16), are vulnerable to potential contamination. The few catchments with intensive agricultural systems, such as Ord and Daly rivers (Figure 15) on the other hand, have a potential for contamination from diffuse sources. However, the TR region, overall, does not appear to face great anthropogenic environmental risks.

A natural hazard inherent to this region is the tropical cyclones. Cyclones are an annual occurrence across the TR region. Although none of these regions are immune to the effects of tropical cyclones, the upper reaches of the catchments are less likely to be exposed than the lower reaches (Figure 37).

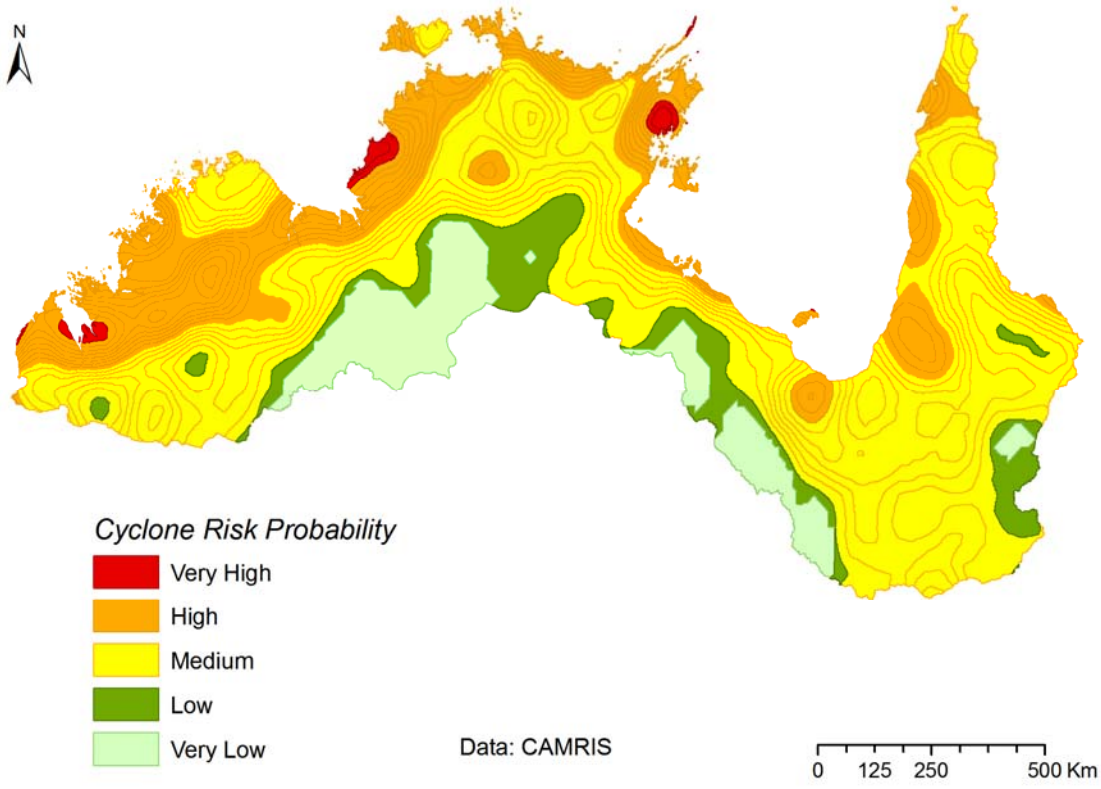
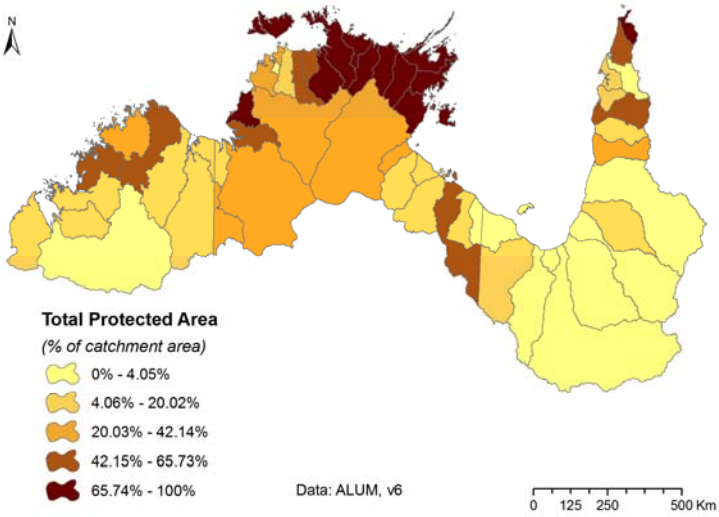


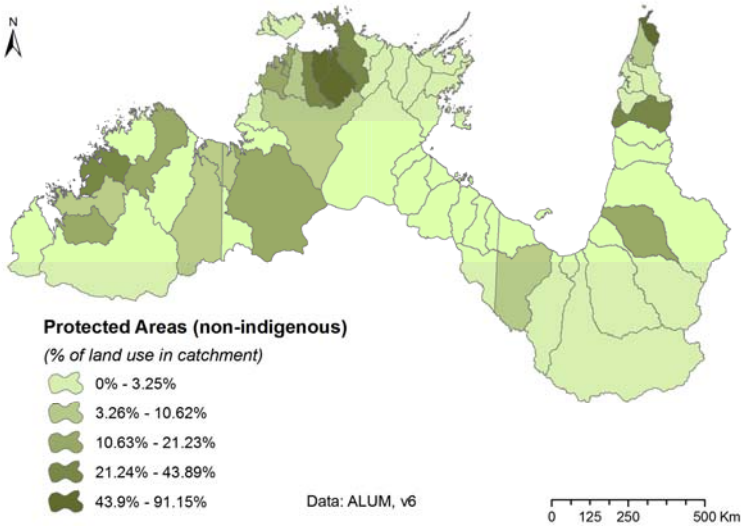
Figure 37. A risk probability map for cyclones in the TR region

3.6.4 Protected land areas of ecological importance

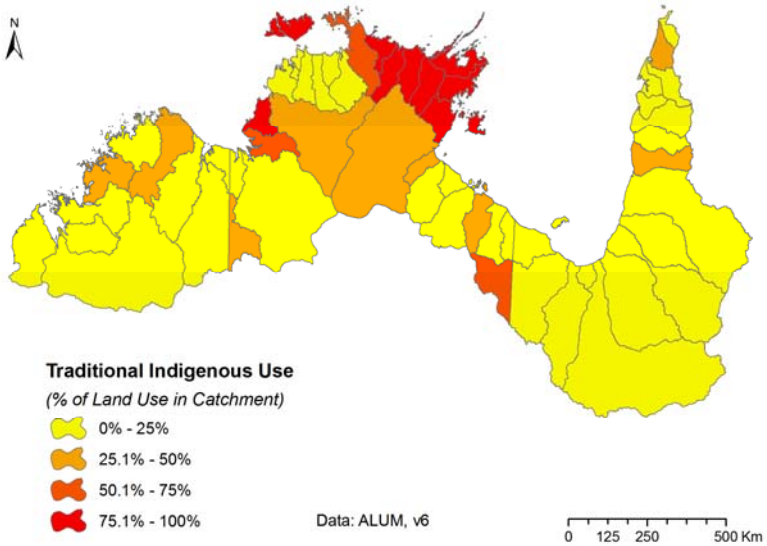
The Australian Land Use and Management (ALUM) Classification has been introduced in section 3.2.4, Land use. This section presents further details of Category 1 Conservation and natural environment lands. Category 1 (Figure 38, top figure), consists of lands under nature conservation (Figure 38, a), managed resource protection including land under traditional Indigenous uses (Figure 38, b), and lands under other minimal uses. It can be noted that large parts of some catchments are under either protection or traditional Indigenous use. Implications of this status should be kept in mind when considering further developments in such catchments.



Total natural areas; including



(a) protected areas (national park or similar); and



(b) traditional Indigenous use

Figure 38. Total natural areas, including land under conservation (a) and land under traditional Indigenous use (b), as a percentage of total catchment

3.6.5 Register sites of cultural importance

Provisions enabling the creation of national lists of sites of cultural importance came into effect on 1st January 2004 as a result of amendments to the Environment Protection and Biodiversity Conservation Act, to include national heritage as a matter of national environmental significance. Consequently, all states and territories have included heritage listings in their statutory planning systems. However, provisions differ among the states and territories, with some states including only historic heritage, some providing separate legislation for protection of Indigenous heritage, and some jurisdictions also including natural heritage (Lennon, 2006).

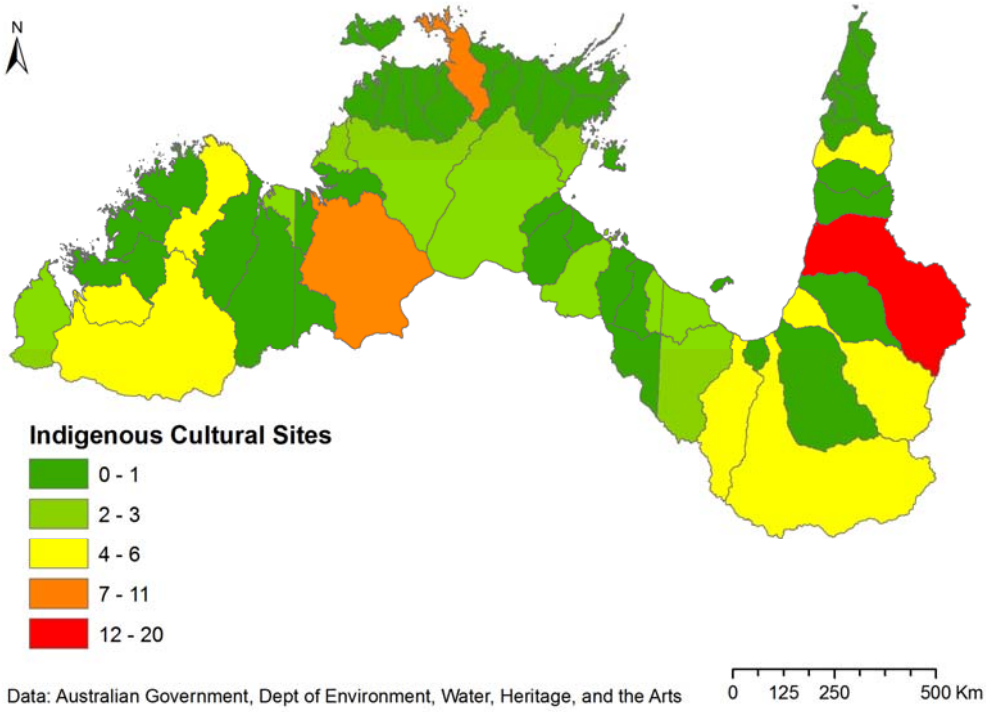
Figure 39 provides distribution of numbers of registered Indigenous sites (a) as well as overall numbers of registered heritage sites (b).

The lack of consistency in heritage recording makes uniform reporting very difficult, and it is acknowledged in the literature that it is impossible to have an overview of the knowledge of heritage places across Australia without using imprecise and surrogate data (Lennon, 2006). In addition, larger numbers of registered sites will occur in the regions that have been better researched and/or had a comprehensive systematic procedure for nomination. As an example, one-third of all registered places in Australia, as of 2001, were in New South Wales. Areas of new reporting and requests for listings are often linked to increased survey activity. For example, in Queensland, registrations are often associated with environmental impact assessments conducted for new mining operations (Lennon, 2006).

Both lack of consistency across jurisdictions, and lack of research and nominations are very important considerations in TR region. The following figure (Figure 39) therefore needs to be interpreted with caution: lack of registered sites in a given catchment by no means indicates that sites do not exist within that catchment; merely that they have not been recorded and registered through the state/commonwealth listing process.

Thus, catchments that had considerable research effort concentrated within them, such as Mitchell River (for example, work of Strang, 2005) appear as having a very large number of sites relative to other less researched catchments. However, the registration of sites of significance is a continuous process and numbers of sites registered are expected to increase across the board as survey efforts continue.

(a) Registered Indigenous sites:



(b) Total registered heritage sites:

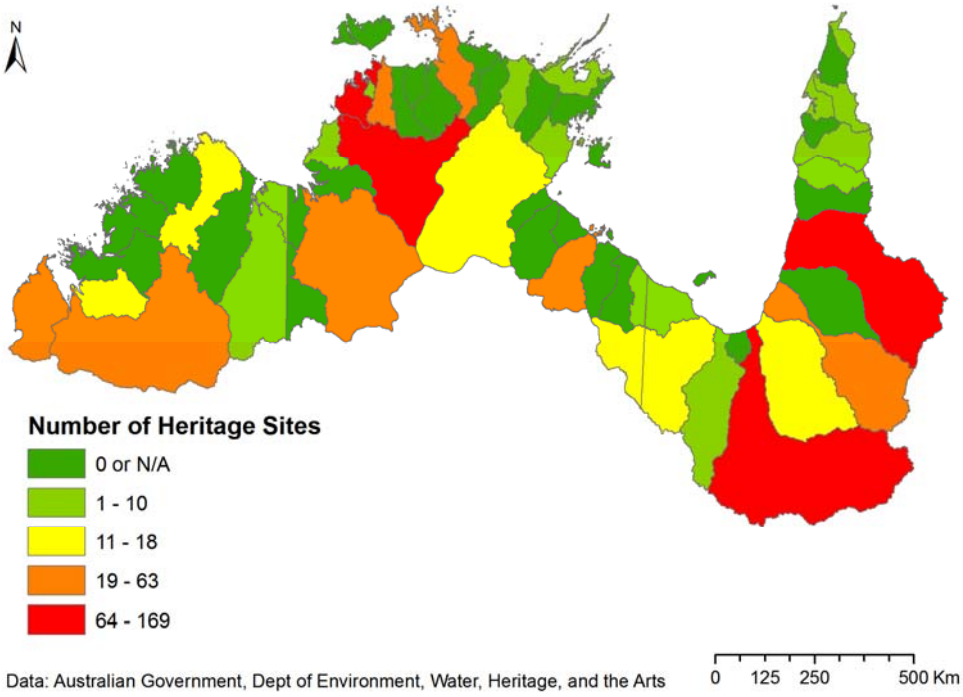


Figure 39. Spatial distribution of the numbers of sites registered under the EPBC Act provisions

(a) registered Indigenous sites; and (b) total registered heritage sites.

3.6.6 Native Title

Lands under Native Title Claims, as registered by the National Native Title Tribunal in November 2008, are presented in Figure 40. However, it needs to be noted that, in addition to Native Title determinations, considerable tracts of Aboriginal freehold and leasehold land exist in the TR region, such as for example Arnhem Land in the Northern Territory.

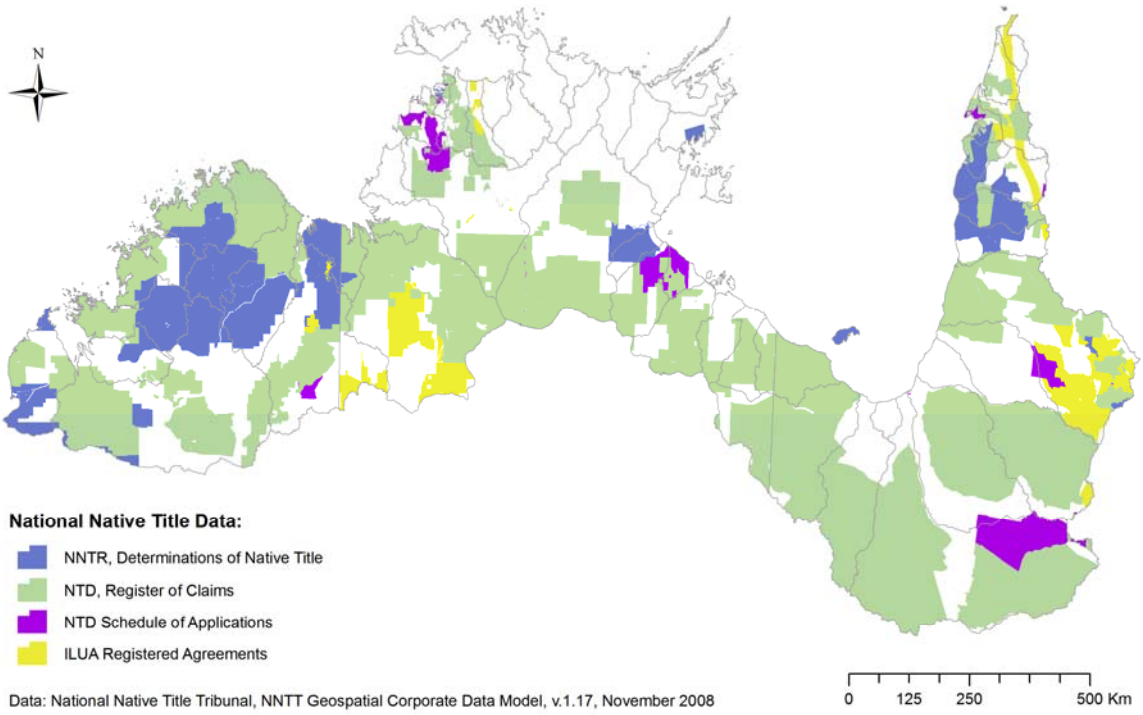


Figure 40. Spatial extend of Native Title determination, claims, applications and ILUA in the TR region

3.7 In summary

Results presented in this section indentified considerable differences between and within the catchments in the north. Biophysical and cultural differences, as well as differences in human, social and institutional capital and available infrastructure, will play a large role in determining both the opportunities for development (mining, agriculture, tourism) as well as capacities of the communities in those catchments to identify and take the advantage of the opportunities as they present themselves.

4 Cross-catchments comparison of socio-economic data

This chapter presents socio-economic data for the tropical rivers organised by catchment. Section 4.1 of the chapter presents an overview of key characteristics of the TR region. This section is accompanied by Appendix 2, which contains an individual profile of each of the 60 catchments analysed in this study. Section 4.2 presents results of the analysis of the similarities and differences between the catchments in the north, with accompanying Appendix 3 presenting details of the analyses.

4.1 Socio-economic profiles of catchments in the north

Socio-economic profiles of all northern rivers were developed for the purpose of this study and are presented in Appendix 2. The profiles contain an overview of the variables that were available in the format that allowed for the cross-catchment comparison.

Each profile collated presents basic catchment information, this includes, estimated total population in the catchment, area of the catchment (in km^2); annual outflow (in Gl) and ARIA (remoteness index) score for the catchment. Average household size, number of people per bedroom, median family income (in $ per week) and population density are also presented. Percentages of Aboriginal people and Torres Strait Islanders in the catchment are also included.

Each profile then presents three separate graphs, summarising: (1) key characteristics of people in the catchment, (2) economies of the catchment, and (3) land use. Data on people and economies is based on ABS 2006 Census information, while land use data was sourced from ALUM (Australian Land Use and Management) atlas version 6. With the data based on the ABS Census information, inaccuracies in data might have occurred due to (a) error introduced by ABS to protected privacy of the respondents - particularly significant in catchments with small total population numbers; and (b) re-calculation of data based on ABS collection districts into catchment boundaries. In addition, interpretation of the employment sector questions by Census respondents might also sometimes be erroneous.

The following three graphs, presenting data on averages across the TR region (Figure 41, Figure 42 and Figure 43), will be used as a “guide” to describing the contents of Appendix 2.

4.1.1 People

The following variables were included in the profiles:

- People who only speak English at home
- Women who gave birth to less than 3 children
- People who have 10 years of schooling or more
- People who have lived at the same address for the last 5 years
- Homes being purchased / under mortgage.
- Homes that have internet connection
- Homes that have motor vehicles.

Each variable is presented as a percentage of total population, thus allowing a cross-catchment comparison. Figure 41 presents an overview of data for the entire TR region.

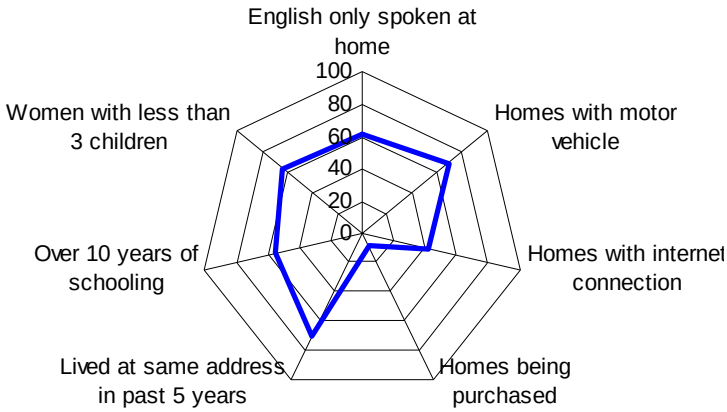


Figure 41. Key characteristics of populations across the TR region

4.1.2 Employment sectors

This profile is based on the percentage of total people employed in the following sectors:

- Agriculture, forestry and fishing
- Construction
- Mining
- Retail sector
- Utilities (electricity, water and gas sector)
- Government services (education, health and public services).

These particular sectors of employment were selected as they represent major sectors in the north, employing large percentage of the population. As an example, an overview of data for the entire TR region is presented in Figure 42:

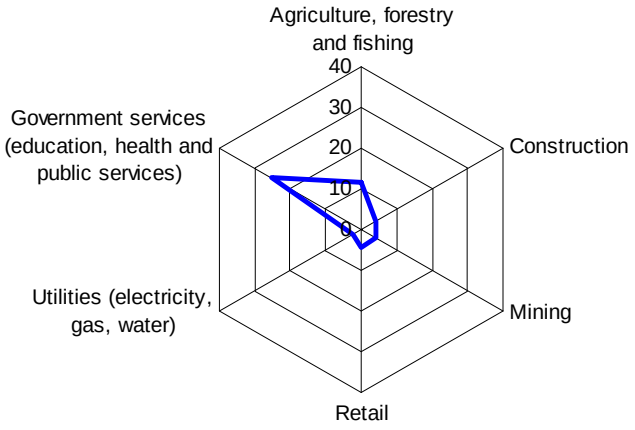


Figure 42. Key employment sectors across the TR region

4.1.3 Land use

Data in the land use profile presents the percentage of various categories of land use as determined by the ALUM classification. Five primary land categories are included in the profiles (Figure 43):

- Land in natural condition
- Production from unchanged land (i.e. grazing)
- Dryland agriculture
- Irrigated land
- Land in intensive use (i.e. urban, mining, industrial or other).

The following two categories are subcategories of Land in natural condition, however, they are presented in the figure as they correspond to a large percentage of land in the north:

- Land under conservation ; and
- Land in traditional Indigenous use.

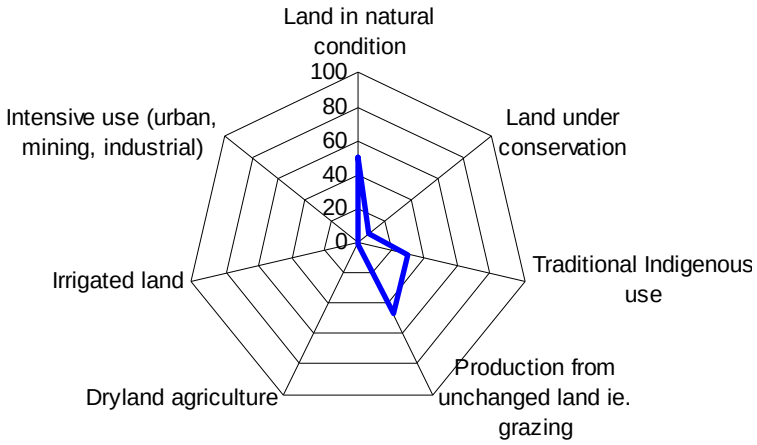


Figure 43. Major land use categories across the TR region

4.2 Similarities and differences between the catchments

An attempt was also made to cluster together catchments that appear similar overall, based on all of data available, or have some similar characteristics. Results of this analysis are presented here.

Results of the cluster analyses based on a combined set of variables from demographic, economic, human and social capital, institutional and environmental and cultural domains are presented in Figure 44. Table 7 presents a summary of the results, informed by the results of the clustering analysis, principle components analysis and the multidimensional scaling.

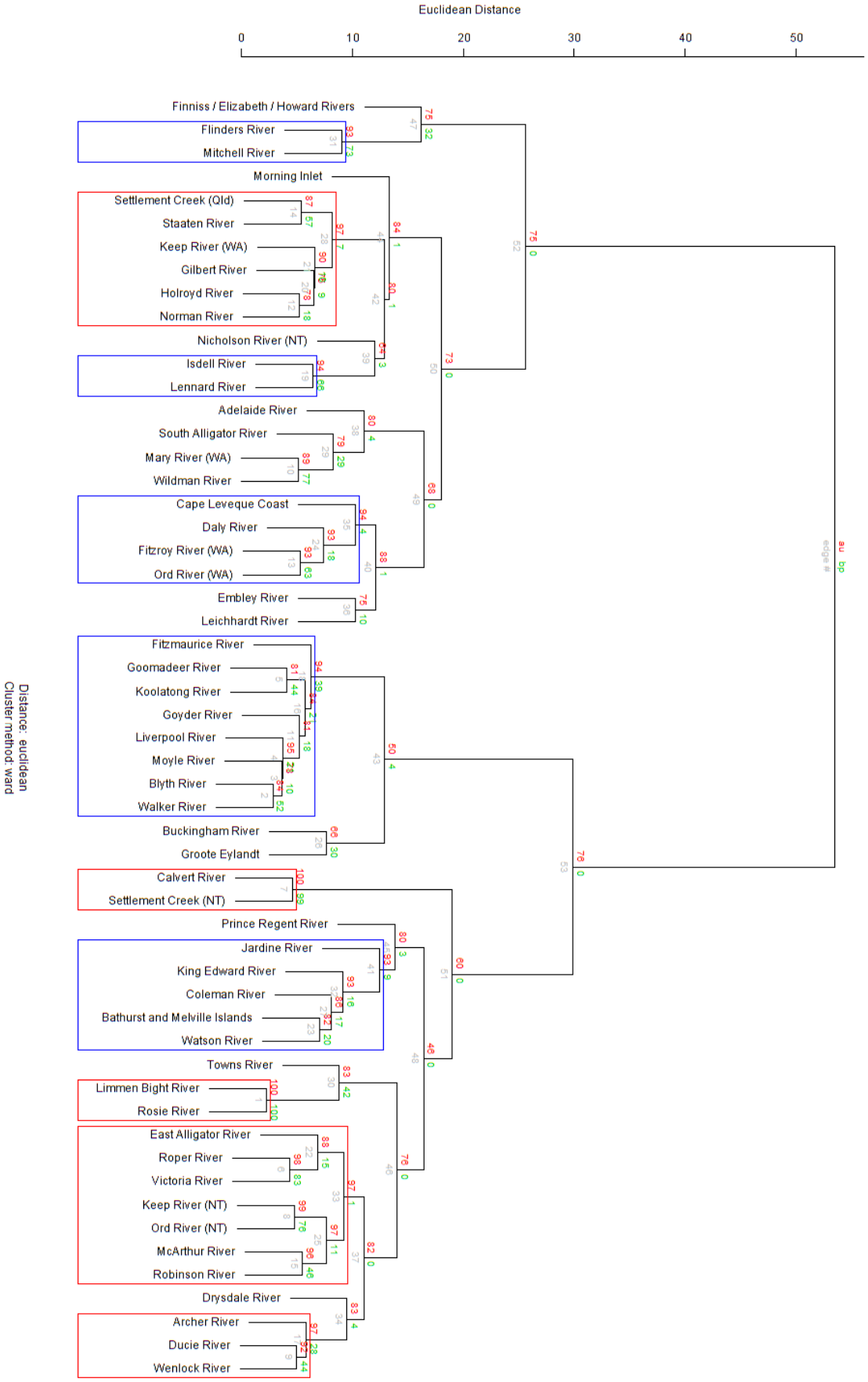


Figure 44. Cluster analysis of catchments in TR region

Table 7 presents key groups of catchments and the characteristics of key variables determining cluster membership. The left column of the table presents a given cluster of similar catchments, while the right column presents a short description of key variables determining the membership in the cluster. Statistical significance (strength of association) of each cluster is also indicated in left column, with TRaCK project focal catchments presented in bold letters.

Table 7. Clusters of catchments in TR region with similar socio-economic characteristics

	Clusters of catchments	Key variables determining similarities
	Finniss/Elisabeth/Howard **(Darwin area)**	Darwin metropolitan area is different from other catchments in the TR region. It is characterised by high population, a high number of businesses and community organisations, relatively high incomes and a high % of people employed in manufacturing, construction and utilities sectors. The percentage of land under dryland agriculture is relatively high. The region is relatively well surveyed so it hosts a number of registered heritage sites. Darwin's relative socio-economic advantage compared to the rest of the region is also supported by low numbers of homes with no vehicles or no internet connection, and a relatively low % of people with no schooling. Household sizes and numbers of people per bedroom are also low, as well as the % of women with 3 children or more and the % of one parent families. Aboriginal people are a relatively low % of total population.
*	**Flinders** **Mitchell**	These two catchments are characterised by relatively high % of land under natural production (grazing) and high levels of people employed in mining industry, as well as high mining reserves and numbers of mining sites. The number of businesses and organisations registered in the catchments is also relatively high. The regions are also relatively well surveyed and thus host a number of registered heritage sites. Medium to high % of residents speak English only. Both catchments have low numbers of homes with no vehicles or no internet connection, and a relatively low % of people with no schooling. Household sizes and numbers of people per bedroom are also low, as well as the % of women with 3 children or more and % of one parent families. Aboriginal people are a relatively low % of total population.
**	Settlement Creek (Qld) Staaten	This cluster is characterised by relatively high levels of employment in agriculture and high % of land under grazing. Mobility is also relatively high, with a large % of people owning their homes. Medium to high % of residents speak English only.

	Keep (WA) Gilbert Holroyd Norman	Catchments in this cluster have low numbers of homes with no vehicles or no internet connection, and relatively low % of people with no schooling. Household sizes and numbers of people per bedroom are also low, as well as % of women with 3 children or more and % of one parent families. The percentage of Aboriginal people in those catchments is low to relatively low.
* # 	Cape Leveque Coast **Fitzroy** Ord (WA) **Daly**	In those catchments mobility is relatively high, with medium to high % of people either owning or purchasing their homes. The regions are also relatively well surveyed and thus host a number of registered heritage sites, and the rivers are relatively large with large outflows. Medium numbers of people are employed in construction and utilities, compared to other TR catchments. Catchments in this cluster have low numbers of homes with no vehicles or no internet connection, and relatively low % of people with no schooling. Household sizes and numbers of people per bedroom are also low, as well as % of women with 3 children or more and % of one parent families. The percentage of Aboriginal people in those catchments is relatively low.
#	Embley Leichhardt	These two catchments are very close to the above cluster, however, they are separated by their heavy involvement in mining: that is, a large % of people employed in manufacturing and mining, large numbers of mines and large resource deposits.
**	East Alligator Roper Victoria Keep (NT) Ord (NT) McArthur Robinson	Production from natural environment (grazing) is present in these catchments. Employment by government is higher, and registered heritage sites are present in some of those catchments. Percentages of homes with no cars, household sizes and numbers of persons per bedroom are higher compared to first few clusters. The % of people with no school is relatively high and so too is the % of people renting their homes from the community. The % of women with 3 children or more and % of one parent families are also higher. Percentage of Aboriginal people in those catchments is medium to high, however, % of land under Indigenous traditional use is not high.
*	Jardine King Edward Coleman Bathurst and Malville Islands Watson	This cluster has low mobility of population, low incomes and low employment in agriculture, manufacturing or mining. Employment by government is higher. Low % of people is purchasing their homes, while most of the families are renting homes from the community organisations. An increased % of population has no schooling. Catchments in this cluster have medium to relatively high numbers of homes with no vehicles and no internet connection, and relatively high % of women with 3 children

		or more. Household sizes and numbers of people per bedroom are higher that in the previous clusters described. The percentages of Aboriginal people in these catchments are medium to high, however, % of land under Indigenous traditional use is not very high (except at Bathurst and Malville islands).
*	Fitzmaurice Goomadeer Koolatong Goyder Liverpool Moyle Blyth Walker	This cluster is characterised by low mobility of population, low % of people speaking only English, low incomes and low employment in agriculture, manufacturing or mining. A few people are purchasing their homes while a majority of families rent homes from community organisations. In these catchments, the percentage of people with 10 years of schooling or higher are relatively low, and the percentage of people with no school is high. Catchments in this cluster have medium to relatively high numbers of homes with no vehicles or no internet connection, and relatively high % of women with 3 children or more. Household sizes and numbers of people per bedroom are relatively high to high. The percentage of Aboriginal people in these catchments is medium to high, and a very large % of land is under Indigenous traditional use.

** p > 95%; * p > 90%; computed via multi-scale bootstrapping resampling

[#] In the multi-dimensional scaling analyses, those two clusters appeared more disperse than other clusters

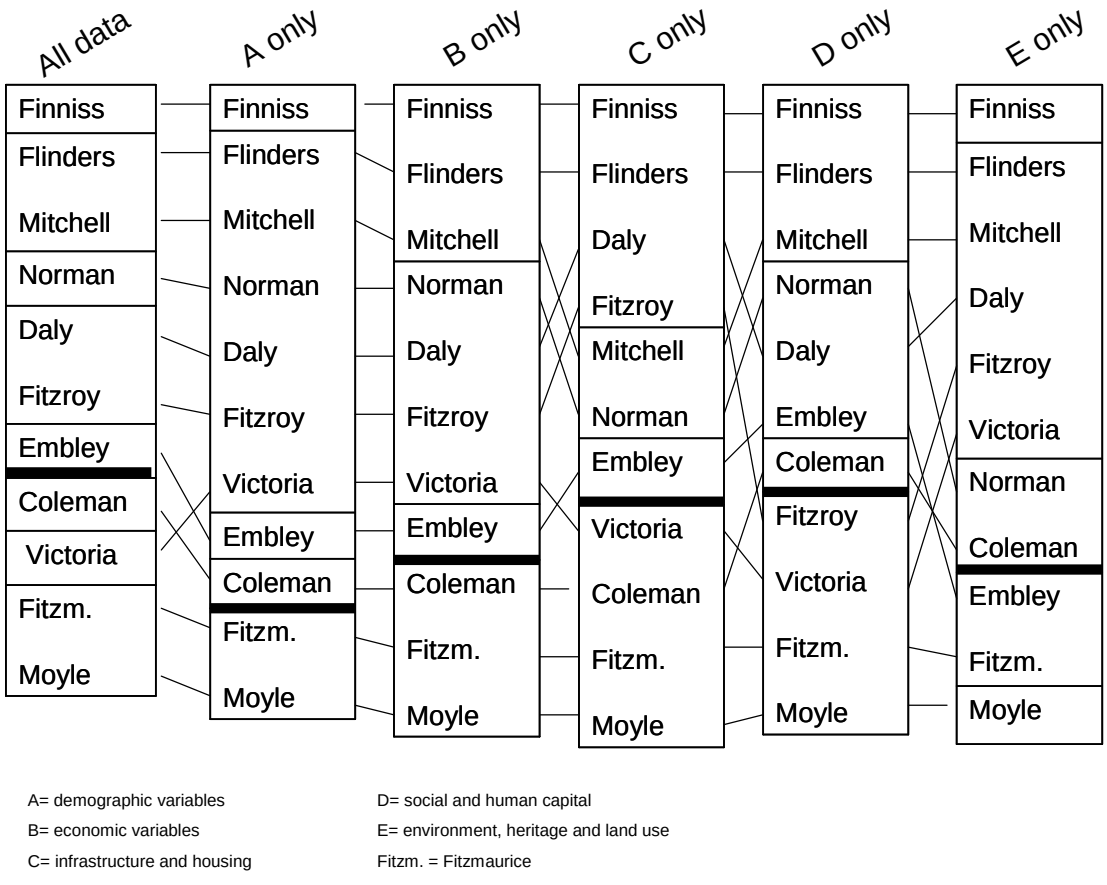
Results of the cluster analyses based on a combined set of variables, as presented in Figure 44 and described in Table 7, were then compared to the results of the cluster analyses performed using data for each specific domain only: demographic (A); economic (B); infrastructure and housing (C); human and social capital (D); or environment, heritage and land use (E) data. A schematic of this comparison, based on a representative sub-set of catchments (including focal catchments and at least one other catchment from each initial cluster), is presented in Figure 45.

The catchments of Finniss/Elisabeth/Howard, Flinders and Mitchell tend to stay close to each other regardless of nature of data used for clustering (entire data set of sub-sets only), with the Daly and Norman also remaining within the same larger cluster. Fitzroy has characteristics that cluster it into the same cluster with the above catchments in all instances except for social and human capital, when it drops to second cluster (Figure 45). This is probably due to higher household sizes, higher % of people with no schooling, lower median incomes and lower numbers of community organisations is Fitzroy compared to other catchments in the first cluster in this domain. Embley is another catchment from the first cluster that has changed cluster membership depending on type of data used for clustering. For all data sets except environment, heritage and land use, Embley remained in the first cluster, although typically separated from other catchments in that cluster. When data on environment, heritage and land use only was used for clustering, Embley changed its membership to second cluster, probably dues to low % of land under natural production (grazing) and relatively low numbers of registered heritage sites compared to other rivers in the first cluster.

In the second large cluster, Fitzmaurice and Moyle retained their proximity throughout the testing, regardless of types of data used for clustering, while Coleman and Victoria changed their cluster membership considerably depending on the nature of data used for clustering. Coleman clustered in the second group based on data overall, as well as based on economic variables and infrastructure and housing variables, while it was clustered in the first group based on demographic variables, social and human capital data and environment, heritage and land use data. Similarly, Victoria clustered in the second group based on data overall, as well as based on infrastructure and housing variables and social and human capital. Victoria however had a membership in the first cluster based on demographic variables, economic variables and environment, heritage and land use data (Figure 45).

Thus, it could be concluded that for a number of catchments their clustering membership at the first level is consistent for all types of data used for comparison. However, some of the catchments changed their cluster membership even at the first level of division, thus indicating that for such catchments it is vitally important to understand the types of variables that drive their similarities and differences.

Membership of clusters at finer levels of resolution (5-8 clusters, thin lines in the figure) changed considerably for the majority of catchments, depending on the type of data used for analysis.



Tick line indicates first split into two main clusters

Figure 45. Comparison of cluster memberships of selected number of catchments, based on data domain used for clustering

5 Discussion

This study summarised data that might be of help to other researchers and communities in the north engaged in development of sustainable use and management options for the tropical rivers. Furthermore, identification of different types of catchments, that are not necessarily geographically linked but are similar in socio-economic terms, might aid in development of the management approaches that are more targeted, and thus more appropriate, than “one size fits all” approach; yet require lesser effort than targeting of individual catchments. Potential of this approach to be used for improved understanding and management of natural resources issues in other rural and remote regions of Australia warrants further research. Further research into development of catchment typologies based on entire sets of data, that is biophysical characteristics as well as socio-economic characteristics of the catchments, is also warranted.

This section discusses further three observations developed during this study that also warrant further research effort.

5.1 Data gaps in the north

A comparison of the “wish list” of variables developed at the start of the project and the variables for which there were data readily available, reveals some important gaps.

Demographic characteristics

> The key issue with this domain was not in data gaps, as a number of relevant variables were collected via Census, but in the reliability of data. Sparse populations in the north result in low numbers in most data categories, which precipitate random adjustment of the data reported under the privacy protection laws. Thus, introduced error has a potential to escalate during the recalculation and agglomeration of the results. It is very important to keep the issue of data adjustments in mind when making absolute conclusions about some of the Census findings in remote regions (Herr, 2007; Larson and Herr, 2008).

Economic parameters

> There was limited data available on businesses operating in the region, and data available did not allow us to populate the majority of originally envisaged variables, such as number of years in business, ownership structure, number of employees, viability etc. Regional multipliers could also not be compared across the whole of the region. The role of government as a provider of social support payments and CDEP programs could also not be fully evaluated, due to the nature of Census questions.
>
> Furthermore, data was not readily available on levels of regional investment. Spatially explicit data was available for Envirofund grants, but government and private investment into communities and economic development could not be assessed across the board.

Infrastructure and services

> A significant gap was identified in data on the availability of some services. Data on educational and some health facilities were available from relevant government agencies, and major infrastructure was recorded in land use data sets. However, in the time frame available for this study, we could not obtain data on key utilities and services, such as percentages of households in the regions having main water supply, power supply, sewerage and rubbish

disposal or telephone coverage. Data on community-managed Indigenous communities in Australia is collected thorough the Community Housing and Infrastructure Needs (CHIN) Survey, however, it is time consuming to obtain this data on an individual community or catchment level due to privacy arrangements. Comparable data relating to non-Indigenous housing could not be sourced across all catchments.

Individual Wellbeing

Data on the health status of individuals was sourced through the HealthWiz data base. However, the majority of the data was dated, with some of the variables being based on primary data collected as early as 1997. Therefore, health data, a very important constituent of social impact assessments, could not be included for the purposed of this study.

Although we could not obtain data on alcoholism and drug use, we did manage to source data on reported crimes related to those afflictions. However, crime rates data was available at the larger resolutions only, such as statistical division level. Relevance of data at the statistical division level of aggregation for assessment of individual catchments and remote communities is questionable, and thus this information was not included for the purpose of cross-catchment comparison.

Institutional arrangements (formal and informal)

Data on formal institutions was obtained from the government and community directories. The extent of coverage of such directories was uncertain and thus the data needs to be interpreted with caution.

In addition, data on volunteering was sourced from the ABS Census. Data relating to informal and community decision making structures and arrangements could not be sourced across all catchments, and thus was not included in the profiling.

Environment and resources

The extent of data relating to various environmental resources in the north was poor. The data relating to water supply and use was dated, going back to primary data collected as early as 1995. This data is thus potentially unreliable in relation to water use particularly by the mining industry, which has boomed since then.

Data on agricultural productivity was available only at an aggregate level and was thus not relevant for catchment level profiling. We have therefore used soil quality data as a proxy for potential agricultural productivity levels.

No data on the use of natural resources such as forestry products and wildlife was found.

Most disappointing was the lack of data on water, soil or air pollution, either from industrial, mining, or agricultural diffuse sources. Although this type of information was available for some areas, specific localities and facilities, it was not sufficient to allow for a comparison across the regions and/or catchments. Data on water disposal was limited and included only a small percentage of users from mining, aquaculture, dredging and manufacturing that are licensed.

Cultural properties

Data on registered heritage sites, historic, Indigenous and natural, was available from the Environment Australia Registry list. However, the actual

extent and number of Indigenous cultural and sacred sites in northern regions is well beyond this list. This is an important consideration to keep in mind when making conclusions related to this domain.

Furthermore, there is no listing available for recreational and amenity sites of cultural importance to the general, local, populations in the northern regions (i.e. billabongs, fishing spots, vistas, popular camping spots etc.). Although data is available for certain individual catchments (for example, work by Strang (2005) in Mitchell River catchment), no comprehensive data exists across all catchments.

Perceptions of water

The original framework included a domain on economic and societal values of water as well as variables related to attitudes and perceptions of water. As for some of the variables discussed above, data on monetary values and perceptions were available for a few individual catchments, but did not allow cross-catchment comparison.

No data on non-monetary values of water were available, nor was there comprehensive information about the perception of current and proposed water-related arrangements in the regions. Therefore, this entire domain remained unpopulated and could not be included in the analysis.

In summary, a comparison of the "wish list" of variables developed at the start of this project and the variables that we were able to populate with the data readily available revealed some important concerns both in relations to data availability and reliability. Data related issues emerging in our study can be grouped as follows:

- data not available at all;
- data available but potentially not reliable;
- data available but dated; and
- data available in some catchments but unavailable in a comparative form across the whole region.

Overall, most of the data related to mining industry, from water use by industry, to economic parameters to pollution, was patchy at best and not available in most cases. Given that mining plays such a crucial role in the region (Burnside, 2007; Fargher et al 2003), the relationship between mining and water in the north should be explored in more detail. Several economic parameters, such as data on businesses operating in the tropical rivers region and information available on regional investment was minimal and did not allow us to populate a majority of originally envisaged variables.

A second issue related to reliability of data. A number of variables, in particular demographic characteristics and the regional economic information are readily available from the Australian Bureau of Statistics (ABS). However, both qualitative and quantitative issues stemming from the use of ABS Census data for NRM decision-making have been previously identified and discussed in literature (Herr, 2007; Larson and Herr, 2008). The key reliability issues previously identified by Herr (2007) and relevant to our study were:

- mismatch between socioeconomic data collection boundaries and biophysical information boundaries;

- use of enumerated data for population-based statistics;

- large size of collection districts in low populated areas; and
- the averaging of socio-economic information over the collection districts.

Two other trends also emerged during data collection: data that was available was either dated or unavailable in a comparative form across the whole region.

For example, some of data available on water supply and use in the north in based on primary data collected as early as 1995, and thus potentially unreliable, in particular in relation to water use by the mining industry which has boomed since this period. Data on the health status of individuals is also dated, with some of the variables available in the HelathWiz data base being based on primary data collected as early as 1997.

The proposed profiling framework (Figure 4) also included a domain on economic and societal values of water as well as variables related to attitudes and perceptions of water. Although data on values and perceptions is available or is currently being collected for a few individual catchments (for example, work by Strang, 2005 in the Mitchell or work by Jackson, 2006 in the Daly), no comprehensive data existed that would allow for a cross-catchment comparison. Information on informal and community decision making structures was also available for a few catchments. Where this type of data collection has been done in the past, however, was incomplete or missing for a great majority of catchments. Shortage of data in this particular domain will be further explored in the section below.

Findings of this report are in line with previous work from Nelson and colleagues (2006), who described existing data collection systems in Australia as fragmented across institutions, disciplinary perspectives and scales, and identified the need and the significant opportunities for greater collaboration and integration. Indeed, the Land and Water Australia resource audit found that many of the socioeconomic indicators for the north can not be completed as the data collections listed in protocols are either incomplete or do no yet exist (Australian Government, 2008).

Poor understanding of current situation is limiting the predictive capacity to estimate potential future adaptations, and thus the main objective of the social and economic impact assessments. Appropriateness, completeness and reliability of models developed, and conclusions reached by the researchers working in the regions with limited data availability, thus need to be evaluated and discussed in the context of given potential limitations of data inputs.

5.2 Values, perceptions and natural resources management in the north

Provisions for community planning, stakeholder participation and inclusion of local values and priorities are increasingly present in Australian legislative instruments. This section discusses some of the issues arising from such requirements, relevant to the north.

The key objective of the social impact assessment process can be summarised as a management of consequences of change, with the aim to bring about improved economic, social and biophysical conditions (Vanclay, 2003). Whether human condition in state of change worsens or improves, and by how much, largely depends on the capacity of individuals and communities experiencing the change to adapt, that is, their adaptive capacity. Values and perceptions and informal institutions are generally recognised as key elements of the adaptive capacity, defined more formally as the ability “to take advantage of opportunities, or to cope with the consequences” (IPCC 2001).

The common view held by adaptation scholars is that adaptive capacity can be created by: (1) investing in the creation and distribution of information and knowledge; (2) encouraging institutions that permit evolutionary change; and (3) increasing the level of

capitals (financial, social and other) that are presently lacking (Lemos et al, 2007). Thus, levels of knowledge, including attitudes and perceptions, and institutional arrangement, in particular informal ones that encourage self-organisation, are being increasingly explored alongside the more traditional five capitals considerations as determinants of current levels of adaptive capacity. Lack of information on those aspects results in poor understanding of the current situation and consequently provides little predictive capacity to estimate potential future adaptations – and ways of enhancing them. Understanding of informal arrangements is vital for understanding the resilience and adaptive capacity of the regions potentially facing change (Lemos et al, 2007; Bohensky et al, in press), and thus would have been valuable for this study.

Adger and Vincent (2005) consider adaptive capacity to be one of the key determinants of vulnerability, such that one is more vulnerable if one's adaptive capacity is low. Thus, two issues are of interest here, determining the current levels of adaptive capacity of region under investigation, and enhancing the existing levels as needed. Although adaptive capacity is considered relatively high for Australia as a whole (Haddad, 2005; Nelson et al, 2007), the Australian adaptive capacity index developed by Martin and colleagues (2007) does not include any of the regions relevant to this study.

Improved understanding of community views, values and priorities is recognised as one of objectives of the contemporary policy development in Australia (Stanley et al 2004a; Nelson, 2004; Nelson et al, 2006; Larson, 2006; Burnside, 2007). If the policy decisions over future actions related to water are to include such information, it would need to be available early in the planning process and incorporated and updated throughout the process. The potential implications of lack of this type of information, and the risks associated with the decisions made based on limited sets of data available, identified in this and other studies, warrant further investigation.

Thus, understanding the factors of importance to the people in the north, and their current satisfaction with the factors important to them is an essential future area of research. Furthermore, further research into areas of perceptions and values, and in particular non-monetary social and cultural values of water as well as other natural resources in the north, is also warranted.

5.3 Power-law distribution and its relevance to the north

A power-law distribution is a kind of relationship between frequency and size, where small occurrences are extremely common, whereas large instances are extremely rare (Figure 46). Many man-made and naturally occurring phenomena are distributed according to a power-law distribution, from city sizes to earthquake magnitudes (Watts, 2003; Adamic, 2008). Historic applications of the law go as far back as the beginning of the 20th century and include wide range of disciplines, from economics (Pareto principle or 80:20 rule in relation to the income distributions) to linguistics (Zipf's law or frequency of use principle). However, recent popularisation of the law is largely a result of the work of Barabasi and colleagues related to the social networks, including the world wide web (Barabási and Albert, 1999; Barabási, 2002; Watts, 2003; Newman et al, 2006). Work of Barabasi and colleagues indicates that power law distributions tend to arise in social systems where many people express their preferences among many options. Diversity plus freedom of choice creates inequality, they argue, and the greater the diversity, the more extreme the inequality.

The power law distribution exhibits two "counter-intuitive" characteristics, argues Shirky (2003). The first such characteristic is often termed "preferential attachment" (Barabási and Albert, 1999; Newman, 2001; Ormerod and Colbaugh, 2006). As the number of options rise, the curve becomes more extreme, that is, as the size of the system increases the gap between the number one spot and the median spot increases. This is a first of "counter-intuitive" characteristics of the power law, as one would expect a

rising number of choices to flatten the curve. The second “counter-intuitive” aspect of power laws summarised by Shirky (2003) is that most elements in a power law system will be below average, because the curve is so heavily weighted towards the top performers. We are so used to the evenness of the bell curve, where the median position has the average value, argues Shirky, that the idea of two-thirds of a population being below average sounds strange.

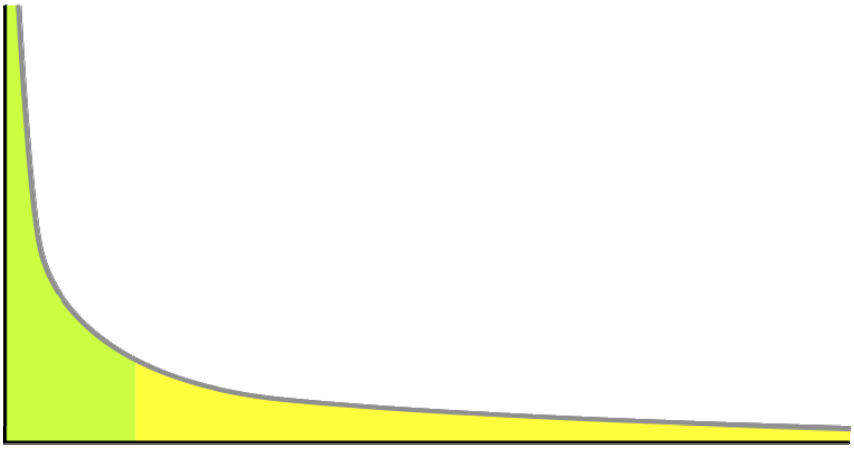


Figure 46. Classic power-law distribution curve where roughly 80% of frequencies account for 20% of magnitude or effect (yellow area)

Furthermore, power-law distributions are scale-free distributions (Barabási and Albert, 1999; Song et al., 2005), which in this case means that the distribution curve is not dependent on the number of catchments included in the analysis.

A number of graphs presented in Section 3 of this report bear close resemblance to distribution presented in Figure 46 above. If indeed the north of Australia exhibits the characteristics of power-law distribution, what are the potential consequences for the future of the north?

Preferential attachment is a class of processes in which some quantity (for example, income in $) is distributed among a number of individuals or objects according to how much they already have, so that those who are already wealthy receive more than those who are not. In the case of the north, this would mean that any benefit generated in the future, weather in terms of financial benefit, increase in the labour force, increase in numbers of community organisations etc, would disproportionally benefit already developed catchments such as Finniss, Mitchell and Flinders, thus widening the gap between them and smaller, poorer or less developed catchments.

Furthermore, negative exponential distribution of the mean in power-law distributions effectively means that, if one is to attempt to rise an object (catchment) currently below the mean to a current mean, the objects (catchments) with the values above the mean will rise exponentially (for example, one might hypothesise that the size of labour force in Darwin will have to increase 10-fold before size of labour force in one of smaller catchments doubles).

Improved understanding of power-law distributions across the social and economic systems in the north thus presents an interesting area of research that could improve our overall understanding of those systems.

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