Socio-Economic Activity and Water Use in Australia's Tropical Rivers: A Case Study in the Mitchell and Daly River Catchments

TRaCK Tropical Rivers and Coastal Knowledge

Prepared by Natalie Stoeckl[1], Michelle Esparon[1], Owen Stanley[2], Marina Farr[1], Aurélie Delisle[1] and Zulgerel Altai[1]

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[1] School of Business, James Cook University
[2] School for Environmental Research, Charles Darwin University

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

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For further information about this publication:
Natalie Stoeckl, James Cook University
natalie.stoeckl@jcu.edu.au

Or to find out more about TRaCK
Visit: http://www.track.gov.au/
Email: track@cdu.edu.au
Phone: 08 8946 7444

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Final Report for
The Tropical Rivers and Coastal Knowledge Research Consortium

March 2011

Natalie Stoeckl[1], Michelle Esparon[1], Owen Stanley[2], Marina Farr[1] Aurélie Delisle[1], and Zulgerel Altai [1]

Data caution

Every effort has been made to collect regionally relevant data from robust samples of people and industries in the Daly River and Mitchell River catchments.

Some of the data used in the models were collected by members of the research team. As is almost always the case when conducting surveys, one cannot be 100 per cent sure that the sample data are truly representative of the underlying population, and this document discusses some of the data collection problems encountered during this project.

Much of the data used in the models is secondary, having been collected by the Australian Bureau of Statistics (ABS) during the 2006 Census, and by the ABS for their water accounts. Two problems are particularly pertinent to this report:

1) One of the most significant problems associated with ABS Census data on Indigenous persons is that of 'undercount'[1], and our models use ABS data on employment and incomes of Indigenous and Non-Indigenous people, by sector, in each catchment. As such, it is important to acknowledge that the absolute numbers reported in this document would be different if more accurate employment data were used. The most likely scenario, is that our models overstate the extent of Indigenous disadvantage. But it is extremely unlikely that 'more accurate' data would alter any of the main 'punch-lines' findings of our research (namely that: there is a significant, and asymmetric divide between Indigenous and Non-Indigenous economic systems; that different industries generate quite different income, employment and water-use outcomes; and that Agriculture, and perhaps also mining are key sectors to monitor if concerned with consumptive water use in these regions - see comments in point 2, below).

2) Estimates of water use by industry/sector were obtained from the ABS Water accounts. However, as noted by the Northern Australia Land and Water (NALW) taskforce (2009, p 23) "mining and resource projects are generally excluded from water resource accounting, exact water use estimates for this industry are not readily available". We thus encourage users to treat our estimates with caution unless, and until, the water use estimates associated with the mining sector can be verified.

Those caveats aside, it is important to note that alternative sources of data, suitable for analysis in these types of models, at this scale, in these regions, do not exist. So whilst it must be openly acknowledged that the data used in this research are imperfect, they are, arguably, better than the alternative (nothing). Moreover, as detailed in relevant sections of this report, there is at least some accord/consistency between the employment and water use data collected in our household survey and that collected by the ABS. This gives some credence to the numbers. As such, this project represents a step forward. But it is a very modest step. There is considerable room for improvement: until that occurs, results must be taken as indicative only, and not interpreted as precise estimates.

[1] There are significant problems with the quality of data relating to Indigenous people (Australian Human Rights Commission, 2008). For a good discussion of these issues, see http://www.hreoc.gov.au/social_justice/statistics/index.html

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- Gerry Turpin - Treasurer and *Mbabaram* TO
- The people of *Western Gugu Yalanji, Kuku Juungan, Mbabaram and Wokomin.*

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- Valemina White

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Executive Summary

Section 1, Project overview:
Tropical Rivers and Coastal Knowledge (TRaCK) is a research hub that was established in 2007 under the Commonwealth Environment Research Facilities Program. Its aim is to provide the science and other knowledge that governments, communities and industries need for the sustainable use and management of Australia's tropical rivers and estuaries.

One of the research activities undertaken by TRaCK is the description and analysis of the ways in which the components of the socio-economic system interact with each other, and with the environment in the tropical rivers (TR) region. The report presents the results of that research. While some of the research was concerned with the TR region overall, more intensive analysis was conducted for the two focal catchments of the Daly River (NT) and the Mitchell River (Qld).

Section 2, Background to the Tropical Rivers Region and to the two focal catchments:
The TR region is approximately 15 per cent of Australia's mainland but it is home to fewer than 2 per cent of all Australians. Most of the TR region is sparsely populated, with two-thirds of the population living in urban centres and larger localities, of which Darwin is the largest. The population composition is unusual, by comparison with the rest of Australia: with a higher than average Australian male/female ratio, and a younger average age. Almost one-third of the usual residents in the TR region are Indigenous, compared with just two per cent nationally. In terms of the catchment under study, 28 per cent of the Daly River population is Indigenous while 23 per cent of the Mitchell River catchment population is Indigenous.

While the average population turnover rate between 2001 and 2006 is about the same as that for Australia overall, it was very high for Darwin and the Southern Gulf parts of Queensland and lower along the east coast of the Northern Territory and between the Embley and Coleman River catchments in Queensland. Generally, Non-Indigenous people are much more mobile than rural Indigenous people.

Overall land use in the TR region is dominated by conservation and natural environments. In the Daly catchment, for instance, grazing makes up 54 per cent of land use and 39 per cent of the land remains under what is formally classified as being in "natural condition": of which 27 per cent is specifically designated as traditional Indigenous use and 5 per cent is set aside for conservation. The remaining land uses are divided among dryland agriculture (5 per cent), intensive uses such as urban, mining or industrial (1 per cent) and irrigated land (1 per cent). In the Mitchell catchment, 95 per cent of land use is directed towards production from unchanged land (i.e. grazing); 3 per cent of the land is in natural condition and almost exclusively under conservation, and land under intensive use (including urban, mining, industrial) is minimal at 0.03 per cent. Interestingly, there is no natural land solely reserved for Indigenous use in the Mitchell as opposed to the Daly.

Across the entire TRaCK region the Government Services sector accounts for 25 per cent of employment. The next most significant sector of employment is Agriculture, Forestry and Fishing (11.5 per cent), while Mining, Retail and Construction each comprise around 4 per cent. The same general pattern of employment is true in both the Daly and Mitchell catchments. However, in the Daly catchment, the importance of the Government Services sector is much more noticeable. By comparison to the Mitchell catchment, fewer people are employed in the Agriculture, Forestry and Fishing sector (4 per cent in the Daly, as opposed to 15 per cent in the Mitchell).

Sections 3 and 4 – Identifying an appropriate modeling technique, and refining the methodological approach:

After extensive consultation with stakeholders and other researchers, and a thorough examination of existing models that could be used or adapted, it was decided to build an Input-Output (IO) model for each catchment that would differ from the usual IO model in two ways. Firstly, the household sector in each model was divided into Indigenous and Non-Indigenous households. The Indigenous/Non-Indigenous split allows the impacts of change to be measured for those two groups separately. Secondly, the IO models involved the modeling of water use for individual industries and households.

Section 5 – Operationalising the models and populating them with data:

Data for Non-Indigenous households were obtained from a mail-out survey in the two focal catchments, while most of the data for the Indigenous households were obtained from during face-to-face interviews. Other data required for this modeling were obtained from the ABS and from an earlier, associated, survey of businesses in Northern Australia. Much of the data had to be 'transformed' prior to use, and where ever possible, data were compared with other related data sources (e.g. the ABS's household expenditure survey) to test plausibility prior to inclusion in the model.

Section 6.1 – using the models to estimate income, employment and water multipliers:

The models were used to estimate Type I and Type II income multipliers (defined in section 4), and also employment and water multipliers. In addition to considering aggregate impacts, the analysis looked at the distributional impacts of change, providing the following insights:

- A one-dollar increase in final demand in almost any business sector generates a net increase in regional income of between \$1.60 and \$2.40, depending upon the sector. Most of that money (i.e. at least \$1.00) stays within the sector that is initially stimulated, but there are flow-on effects to other sectors.
- In most cases, it is the Finance sector (which, in this model, includes property and business services), the Retail sector (including both retail and wholesale trade) and Non-Indigenous households which benefit most from 'flow-on' effects. In most cases, these sectors receive approximately \$0.20 each. In stark contrast, Indigenous Households generally receive just a few cents in flow-on effects; approximately one-half of one per cent of the total regional stimulus, and just one per cent of the total flow-on effects.
- The largest flow-on increase in Indigenous incomes occurs if one stimulates the Government sector, but even there, the flow-on effect is just \$0.05 following a \$1.00 initial increase.
- When Indigenous incomes are increased exogenously (which could occur, for example, via an increase in royalty payments or an increase in Centrelink payments), Non-Indigenous people capture more of the flow-on effects than do Indigenous people. A \$1 exogenous increase in Indigenous incomes results in Indigenous people gaining a flow-on benefit of just \$0.01 - \$0.03, whereas Non-Indigenous people gain a flow-on increase of \$0.18 - \$0.26.
- Stimuli affect the labour market in a similar manner: economic growth always creates significantly more jobs for Non-Indigenous householders than Indigenous householders. These differences are not entirely attributable to differences in population.
- Although there is relatively little variation in Type I and Type II income multipliers across sectors, there are significant differences in employment multipliers. For example, a \$1 million expansion of the Accommodation sector creates, in aggregate, more than four times as many new jobs in the Daly River catchment than an equivalent expansion of the Mining sector.

- There are also significant differences in water multipliers across different industries. Water multipliers in the Agricultural sector are orders of magnitude larger than those in other sectors, although care must be taken when interpreting data relating to the Mining and Manufacturing sector: as noted by the NALW taskforce (2009, p 23) "mining and resource projects are generally excluded from water resource accounting, exact water use estimates for this industry are not readily available". Consequently, the estimates presented here may understate – perhaps grossly – actual figures for the mining sector.
- There is a marked difference between the water-use multipliers that have been estimated using upper and lower-bound water use coefficients. To the extent that water is at least partially substitutable with other resources (e.g. it is possible to reduce water use and still grow certain types of plants by, for example, mulching, or applying water at critical phases of a plant's growth cycle), these results clearly illustrate the importance of water-saving technologies and research, particularly in the agricultural sector.

<u>Section 6.2 – using the models to explore various growth scenarios:</u>
The models were also used to examine the possible impact of different types of economic growth in the catchments. The models were used to calculate results for one year, and then extrapolated for the next 20 years. The results were as follows:

1. The 'balanced' growth scenario (of 1.5 per cent per annum across all industries) significantly out-performed all other scenarios for employment and income in the Daly. It was one of the top two generators of income and employment in the Mitchell (alongside the 5 per cent growth in Agriculture scenario). Within 20 years, this scenario increased Industry Income and Non-Indigenous Employment to levels that were close to 1.6 times greater than in 2006. Indigenous employment outcomes were more modest – rising to between 1.4 and 1.5 times the 2006 levels. This balanced growth scenario was also associated with moderate increases in consumptive water demand – rising to between 1.2 and 1.7 times 2006 levels depending upon whether one used lower or upper bound estimates.

2. In the Mitchell River, growth in the Agricultural sector generated substantial increases in business/industry incomes and in Non-Indigenous employment. Outcomes for Indigenous people were much more modest. If growth in Agriculture is achieved using water-efficient techniques ('mimicked' here, with the lower-bound water use coefficients), then in 2026, our models predict that consumptive water demand would be just 1.6 times greater than 2006 levels; but consumptive water demand could be more than double 2006 levels in less than a decade if higher water-use coefficients prevail.

3. Income and employment outcomes associated with the Agricultural scenario were more modest in the Daly than in the Mitchell, but pressures on consumptive water demand were similar in both catchments. Outcomes for Indigenous people (incomes and employment) were also very modest in both regions – rising by less than 10 per cent, in total, over a 20 year period.

4. The tourism scenario delivered the smallest 'returns' to income and employment for both Indigenous and Non-Indigenous households, in both catchments. This is a consequence of the fact that tourism currently makes a relatively small contribution to these economies (just 3 and 2.3 per cent of the Mitchell and Daly River's Gross Value Added, respectively). Consequently, 5 per cent growth in tourism represents a very small increase in economic activity (5 per cent of 3 per cent is not much at all!).

5. The mining scenario delivered marginally better household income and employment outcomes to both Indigenous and Non-Indigenous households than did the tourism scenario, but the returns were still quite small. In contrast, the associated increase in industry output/incomes were relatively good and even out-performed those of the agricultural scenario in the Daly River. The predicted increases in consumptive water demand were similar for the mining and tourism scenarios. However, as noted earlier, these simulations may under-estimate (perhaps substantially) the amount of consumptive water demand associated with the mining sector.

Section 7 – Discussion and concluding comments:

These results are important to anyone involved in, or interested in, northern economic development. They provide an indication of the downstream benefits from the stimulation of any industry, though not, of course the costs of such stimulation. Whilst the results of our analysis are only directly associated with two focal catchments, many other catchments in the region are socioeconomically 'similar'. As such, the key messages (if not precise estimates) may be relevant across many northern regions. These key messages are:

1) There is an asymmetric divide between Indigenous and Non-Indigenous economic systems in Northern Australia. Given the lack of employment and business opportunities, workplace skills, and the other infrastructure prerequisites for development, local Indigenous people are very unlikely to benefit from the stimulus of any of the north's existing industries. This situation is likely to persist unless, or until, there is structural change.
2) Some industries may be able to generate significant business income and/or incomes for some householders, but will not necessarily deliver significant localised benefit in terms of, for example, employment (be it Indigenous or otherwise). Development strategists may thus need to explicitly acknowledge these tradeoffs and make conscious decisions about what it is they wish to 'develop' (e.g. Regional income or regional employment? Regional income or Australian income?). Moreover, strategists may need to think about innovative methods of redressing some of the potential problems arising from such tradeoffs, ensuring that the methods allow for the structural idiosyncrasies of these small northern economies (i.e. the asymmetric divide noted above).
3) Water multipliers differ by orders of magnitude depending upon assumptions made about the numbers of litres of water consumed per dollar output particularly in the Agricultural sector. This clearly highlights the fact that water-saving technologies are vitally important.
4) Both Agriculture and mining are capable of generating significant income flows. But, unlike growth in the government, health or educational sectors, growth in the agricultural sector[2] is associated with significant growth in consumptive water demand. Development strategists may thus also need to explicitly acknowledge some of the non-monetary impacts of different development options (not all of which will be negative), seeking to identify ways in which to exploit synergies, redress tradeoffs, and thus capitalise on opportunities that do not place un-due strain upon the region's natural resources (water being but one of many important examples).

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[2] Possibly also in the mining sector, but we cannot be sure (this is a significant information gap).

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ABBREVIATIONS AND ACRONYMS

ABS	Australian Bureau of Statistics
ANZSIC	Australian and New Zealand Standard Industrial Classification
CDEP	Community Development Employment Project
CGE	Computable General Equilibrium model
CPI	Consumer Price Index
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DRMAC	Daly River Management Advisory Group
EIO	Environmental Input-Output
EPA	Environmental Protection Agency
GRP	Gross Regional Product
GVA	Gross Value Added
HES	Household Expenditure Survey
IO	Input-Output
JCU	James Cook University
LWA	Land and Water Australia
MRTCAG	Mitchell River Traditional Custodial Advisory Group
NALW	Northern Australian Land and Water
NGO	Non Government Organisation
NT	Northern Territory
NWI	National Water Initiative
OGS	Office of the Government Statistician
QLD	Queensland
SAM	Social Accounting Matrix
TO	Traditional Owners
TR	Tropical Rivers
TRACK	Tropical Rivers and Coastal Knowledge
WIO	Water-use Input-Output model
US	United States
Accommodation	Accommodation, Cafes, Restaurant
Agriculture	Agriculture, Forestry and Fishing
Communications	Communications Services
Construction	Construction and Trade Services
Culture	Cultural and Recreational Services
Education	Educational Services
Electricity	Electricity, Gas and Water Supply
Finance	Finance and Insurance
Government	Government Administration and Defense
Health	Health and Community Services
Manufacturing	Manufacturing
Mining	Mining, Quarries and Related Services
Personal	Personal and Other Services
Property	Property and Business Services
Retail	Retail Trade
Sewerage	Sewerage and Drainage Services
Transport	Transport, Travel and Storage
Wholesale	Wholesale Trade

1 Project overview

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

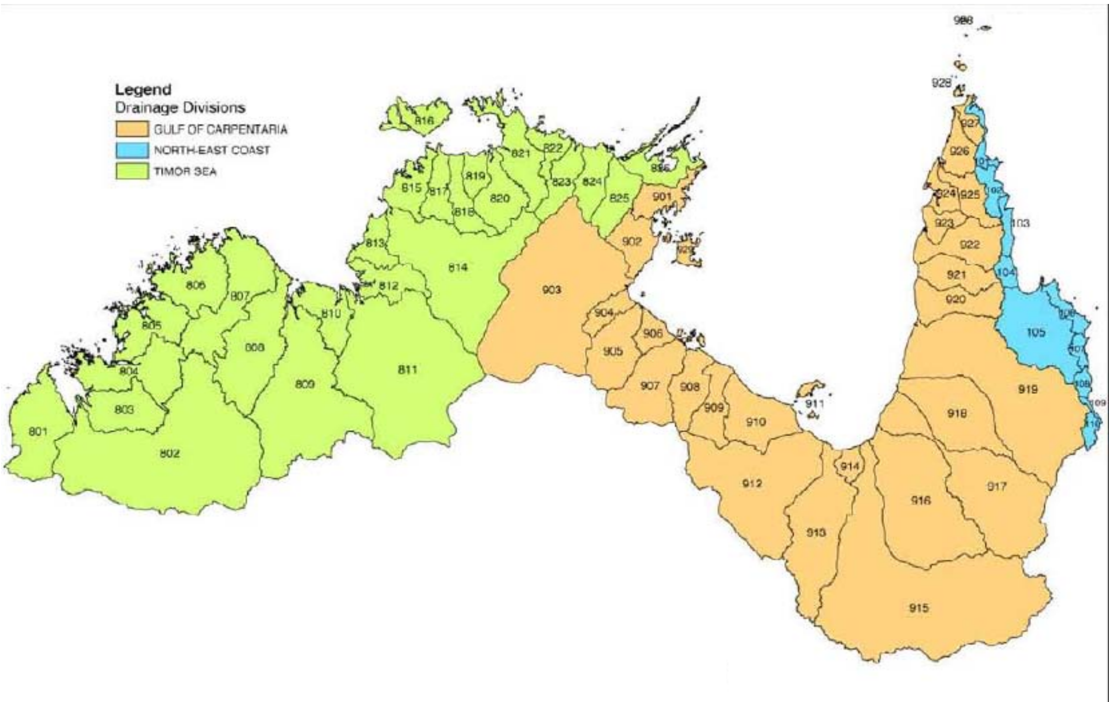


Figure 1 - The tropical rivers region of Australia

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

The aim was:

> "To undertake research and knowledge exchange to support the sustainable use, protection and management of Australia's tropical rivers"[3]
>
> (Land and Water Australia, 2008)

Subsequently, the Tropical Rivers and Coastal Knowledge (TRaCK) research hub was established in 2007 under the Commonwealth Environment Research Facilities Program. Its aim was to provide 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).

The TRaCK research program has seven main themes exploring the environmental, social, cultural and economic consequences for rivers, coasts and communities of potential developments and climate change. (See the TRaCK website for a detailed description of the themes)

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

- Theme 1: Scenario evaluation
- Theme 2: Assets and values
- Theme 3: River and coastal settings
- Theme 4: Material budgets
- Theme 5: Foodwebs and biodiversity
- Theme 6: Sustainable enterprises
- Theme 7: Knowledge and adoption

The research about which this report is written was undertaken by those involved in TRaCK Project 3.1, “Socio-economic activity and water use in the TR region”. The project is a component of Theme 3, the overarching objectives of which are to:

i. develop a physical template based on hydrological regime and geomorphology to characterise, classify and understand the formation of riverscapes and estuaries;
ii. understand the demographic and social character of human populations within catchments and the relationship with the physical template; and
iii. relate the potential of biophysical character to attract and sustain different development pressures.

Project 3.1 focuses primarily on objective (ii) and seeks to improve our understanding of the demographic and socio-economic character of the human populations within catchments and their relationship with the physical template. It also contributes to objective (iii) in that it explores the potential consequences (on incomes, employment and consumptive water demand) of a variety of different development ‘options’.

The conceptual model underlying this project (adapted from Common and Stagl (2005), p 87) is shown in Figure 2 below. It hypothesises that there are multiple economic systems which are embedded within social systems which are, themselves, embedded within the broader environment (i.e. within an ecological system) and that there are multiple ways in which the systems interact.

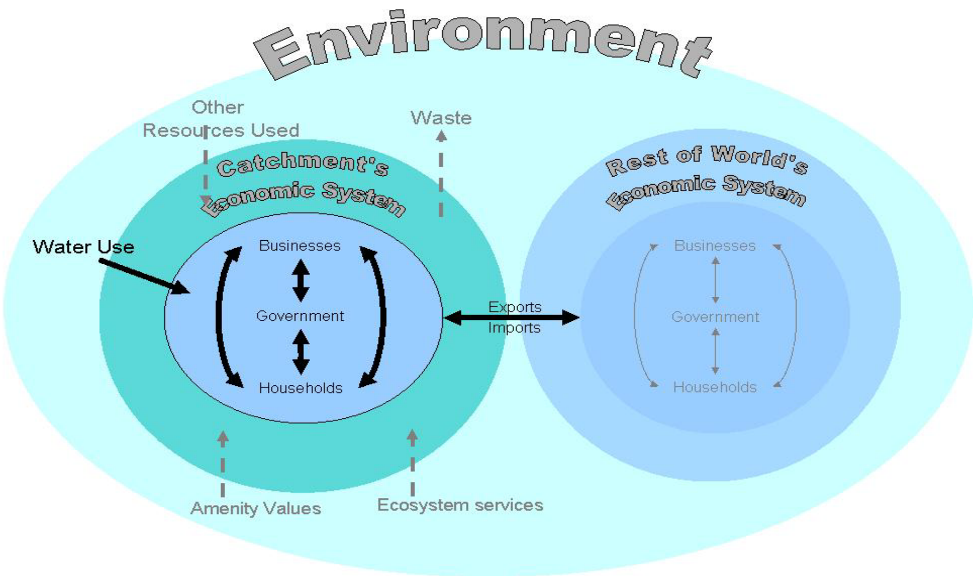


Figure 2 – Conceptual model underpinning the investigations of Project 3-1

The research work related to Project 3.1 was divided into three ‘activities’, with each investigating a different aspect of that conceptual model.

At the risk of oversimplifying things, the first activity basically sought to examine (i) the size of socio-economic systems within the TR region, and (ii) their rate of growth. This activity developed tourism and population profiles and projections for the entire TR region, and for each individual catchment within the TR region. It also identified key issues affecting population (resident and tourism) growth for the period of 2006 to 2015. Section 2.1 of this reports presents a few key highlights from that investigation, but readers are encouraged to peruse the full set of results in Carson et al. (2009).

The second activity set out to describe the 'contents' of the region's socio-economic systems. It compiled data on key socio-economic characteristics of the region as a whole, and developed profiles of individual TR catchments (based on their socio-economic characteristics). Individual catchment-level profiles were compared and contrasted to identify socio-economically 'similar' and 'dissimilar' catchments. Section 2.2 presents a few key highlights from that investigation, and interested readers are encouraged to see the full results in Larson and Alexandridis (2009).

The final activity (and the one on which this report focuses) set out to describe the way in which different components of the socio-economic systems interact with each other, and with the environment. Focusing on just two catchments within the TR region, researchers working on this part of the project developed a Water-Use Input-Output (WIO) model for the Daly River Catchment in the Northern Territory, and the Mitchell River Catchment in Queensland (Figure 6). They used the models to make predictions about the likely changes to Indigenous and Non-Indigenous incomes, employment and to water demand that could occur in response to different types of economic growth (e.g. an increase in mining, agriculture and/or tourism). This activity thus focused primarily on the economic interactions between households and businesses, and on one type of economic/environmental interaction, namely: the amount of water 'used' (or, more precisely, 'demanded')[4].

This report describes the research undertaken to develop those WIO models, and presents some results from a small number of 'simulations' derived from them. It is structured as follows.

Section two provides a brief overview of some of the key socio-economic characteristics of the TR region and the two focal catchments, drawing mainly, although not exclusively, upon material published in the final reports of the other two activities that were undertaken as part of project 3.1. Section three briefly describes the investigations undertaken when seeking to identify a modeling approach capable of meeting the project's objectives, while section four provides some methodological details of the selected modeling approach. Section five carefully describes the way in which the models were populated with data. It presents secondary data, describes the household survey that was undertaken to collect primary data and explains the way in which data (primary and secondary) were converted for use within the models. Section six presents results from the modeling exercises undertaken in this project, while section seven offers some concluding remarks.

[4] It is, however, important to note that the WIO models were built in a manner that allows for the inclusion of more sophisticated economic functions and additional economic/environmental interactions (e.g. energy use, the generation of pollution, the use of other wild resources), should the need, or desire, to incorporate them at a later stage occur.

2 Socio-economic Background

2.1 The TR region

Despite the fact that the TR region covers approximately 15 per cent of Australia's mainland, it is home to fewer than 2 per cent of all Australians. Indeed just 310,000 people, (approximately) had their usual residence in the TR region at the time of the Australian Bureau of Statistics (ABS) 2006 census (Carson et al., 2009). Two-thirds of these people live in urban centres and larger localities (Figure 3).

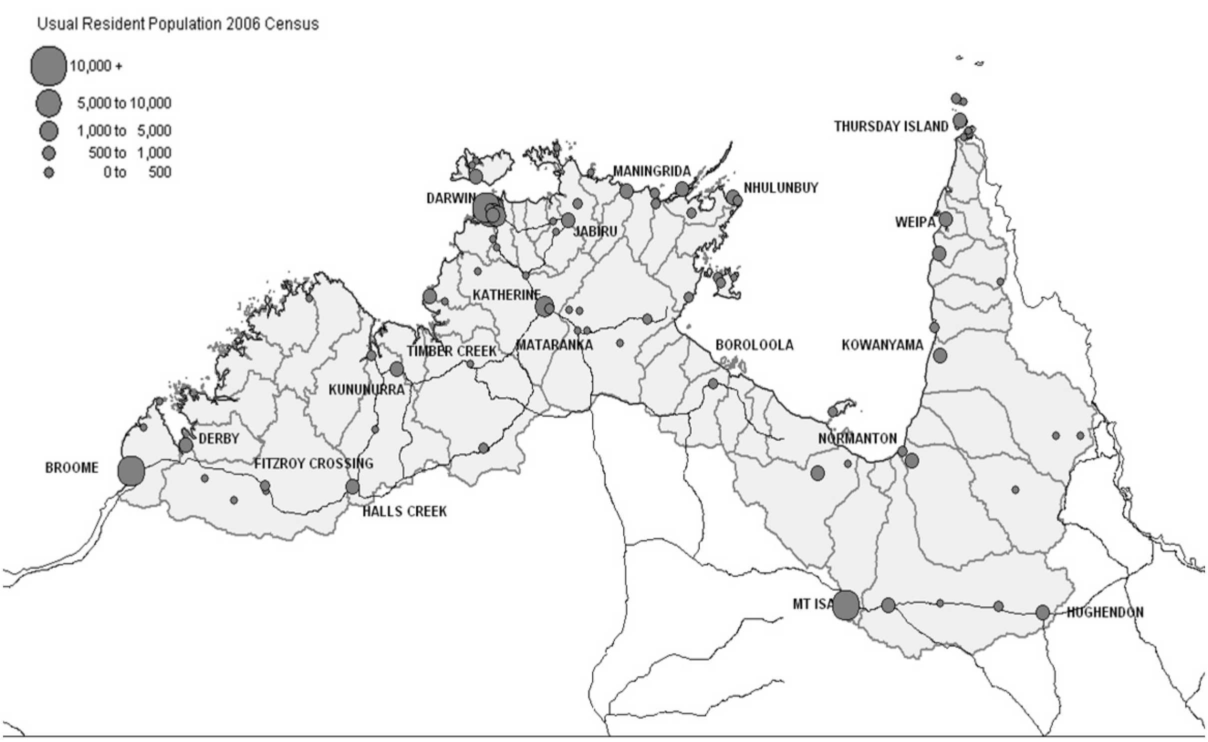


Figure 3 - Populations of urban centers and larger localities in the TR region
Source: Carson et al., (2009) based on ABS 2006 Census

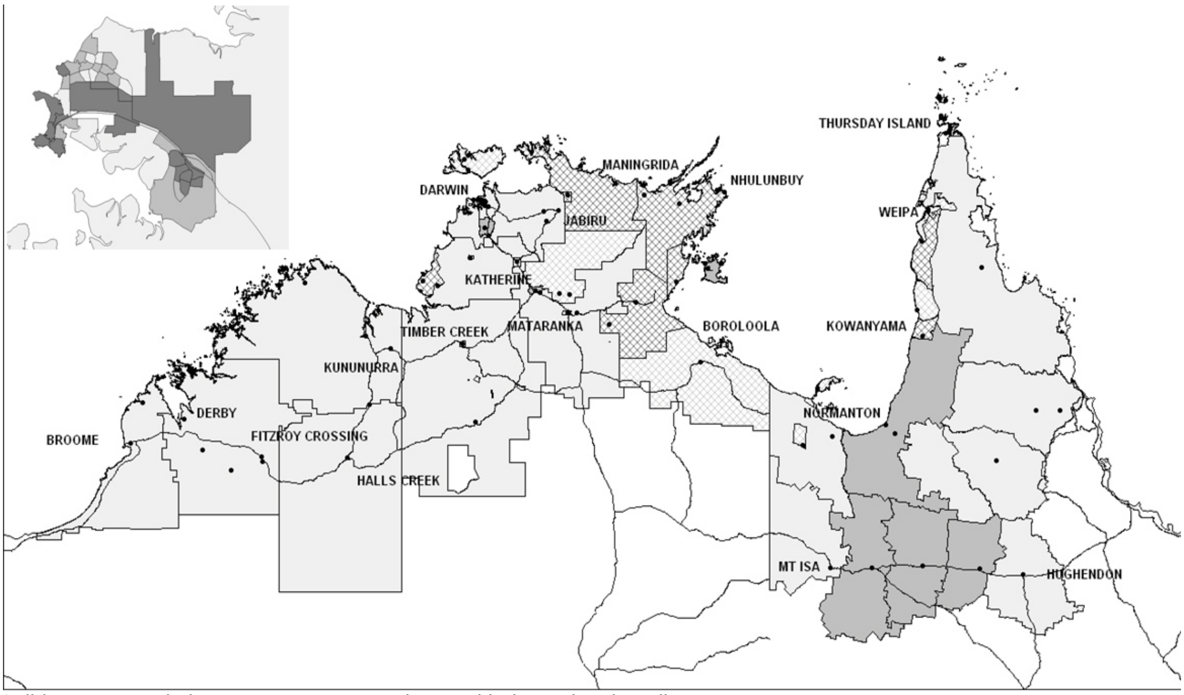
Most of the TR region is therefore sparsely populated, with all but four basins having less than 1 person per km^2. By far, the largest population centre in the region is Darwin. Greater Darwin[5] recorded a population of over 100,000, or one-third of the total TR usual resident population at the census (Carson et al., 2009), and in 2006 there were only three communities (Darwin, Mount Isa and Broome) with a population of more than 10,000 and almost half of the TR basins (i.e. 24 basins) had fewer than 500 people.

Carson et al., (2009) noted that the population mix in the region is unusual in comparison with the rest of Australia. 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 (16 per cent of Australia's Indigenous population), compared with just two per cent nationally.

With regard to the rates of population turnover experienced in the TR region, it was found to be consistent with those reported across Australia as a whole. There were nearly 2000 more people who moved out of the region between 2001 and 2006 than who moved in to the

[5] which includes Darwin and the immediate surrounding areas of Palmerston and Litchfield

region. However, population turnover rates were not consistent across the region. 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), and low levels of population turnover along the east coast of the Northern Territory and between the Embley and Coleman River catchments in Queensland (Figure 4).



Solid grey = population turnover rates consistent with the national median,
Solid dark grey = high population turnover rates,
Hatched grey = low population turnover rates,
Inset in the figure = Greater Darwin area.

Figure 4 - Population mobility, 2001-2006
Source: Carson et al., (2009) based on ABS 2006 Census

As a whole, Carson et al., (2009) found that urban Non-Indigenous people were much more mobile than rural Indigenous people. They noted that the highest population turnover rates were above 100 per cent, experienced in a number of Darwin suburbs, as well as in the towns of Jabiru in the East Alligator catchment and Nhulunbuy in the Buckingham River catchment. Weipa (94 per cent) and Cloncurry (92 per cent) experienced the highest population turnover rates of Queensland locations, and Broome (81 per cent) and Wyndham (78 per cent) experienced the highest rates in Western Australia. Rates under 20 per cent were experienced in Aboriginal communities in the regions including Angurugu and Numbulwar in the Northern Territory, and Kowanyama and Aurukun in Queensland. The lowest turnover rates in Western Australia were 47 per cent in Halls Creek and 56 per cent in Derby. Further details on population mobility can be found in Carson et al., (2009) report.

The region as a whole has experienced comparatively rapid growth in resident populations throughout the late 1990s and into the 2000s. According to census data, the TR region experienced substantial growth of about 7 per cent between 1996 and 2001, and Carson et al's (2009) population projections indicate that the population of the region might grow from around 310,000 in 2006 to around 450,000 by 2026 at an annual average growth rate of 1.83 per cent. The Indigenous population is expected to continue to grow at a faster rate (1.97 per cent per annum) than the Non-Indigenous population (1.78 per cent per annum) – particularly in the Northern Territory regions where growth of more than 40 per cent is projected over the 20 year period. Relatively low rates of growth are expected for the Non-Indigenous populations of the Queensland and Northern Territory regions whereas high growth rates (2.13 per annum) are projected for the Non-Indigenous population of the Western Australian regions.

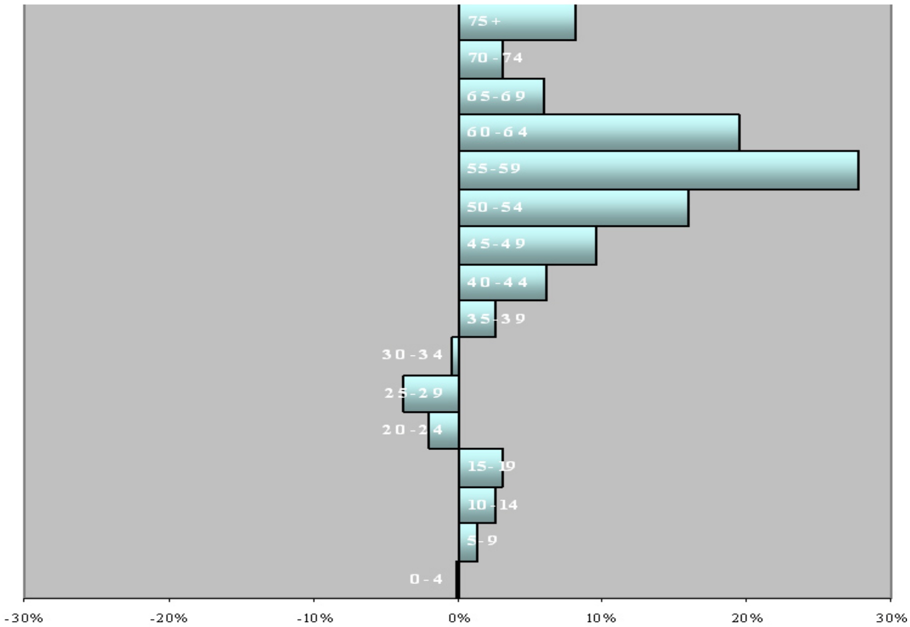


Figure 5 - Projected age-specific contribution to growth for the TR region, 2006 to 2026 (%)
Source: Carson et al., (2009).

Almost all of the expected future growth (in absolute terms) is likely to be contributed by those aged 40 years and above, particularly by those aged 50 to 64 years (Figure 5). Negative growth in the working age cohorts of 20 to 34 years is expected with only minor growth in the infant cohort (birth to four years). These cohorts are projected to increase their share of the population significantly as the 40 years plus population grows from 38 per cent to 56 per cent.

Notwithstanding the relatively small and sparsely distributed population, the region accounted for around 30 per cent of the nation's exports and over one third of Australia's export growth over the past 30 years (Greiner, Nursey-Bray, Smajgl, and Leitch, 2004). Traditionally, agriculture and mining have been the most predominant regional industries, but as noted by Jackson and Murphy (2006), employment in these industries declined from 5.7 per cent of the total workforce to 4.9 per cent between 1991 and 2001. In contrast, employment in tourism-related fields increased from 5.8 per cent to 7.3 per cent of the workforce over that same period. Clearly, the economic structure of many communities within regional Australia is undergoing significant change and one cannot assume that the future pattern of economic growth and development will simply follow patterns from the past.

Moreover, as highlighted by Stoeckl and Stanley (2007), it is important to note that communities in the TR region – particularly those in remote and very remote parts – are not just 'smaller versions' of larger, Australian communities. Their economic structure differs, sometimes significantly, from that of Australia as a whole, and the economic structure of one regional community may differ significantly from that of another, adjoining region. Many remote communities, for example, rely almost entirely on one sector for employment – and that sector, is frequently the Government. In addition, sectors which are 'important' to Australia as a whole (in terms of total income earned) are not always important in this region. For example, in 2001, Manufacturing, Wholesale and Retail were considered the most 'important' sectors across Australia. Yet ABS employment data indicates that some of these sectors are all but non-existent in Australia's North (e.g. Wholesale and Electricity). This is particularly evident in the remote parts of the region.

2.2 The case study catchments

2.2.1 **General description**

The two catchments selected for analysis in this project were the Daly and the Mitchell; depicted in Figure 6.

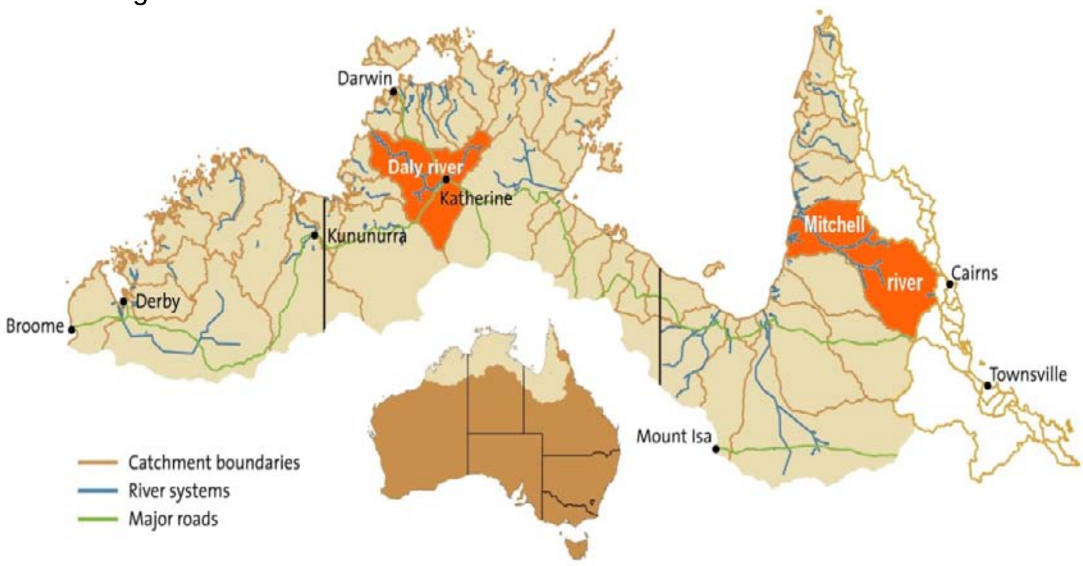


Figure 6 - The two focal catchments of the modeling activity

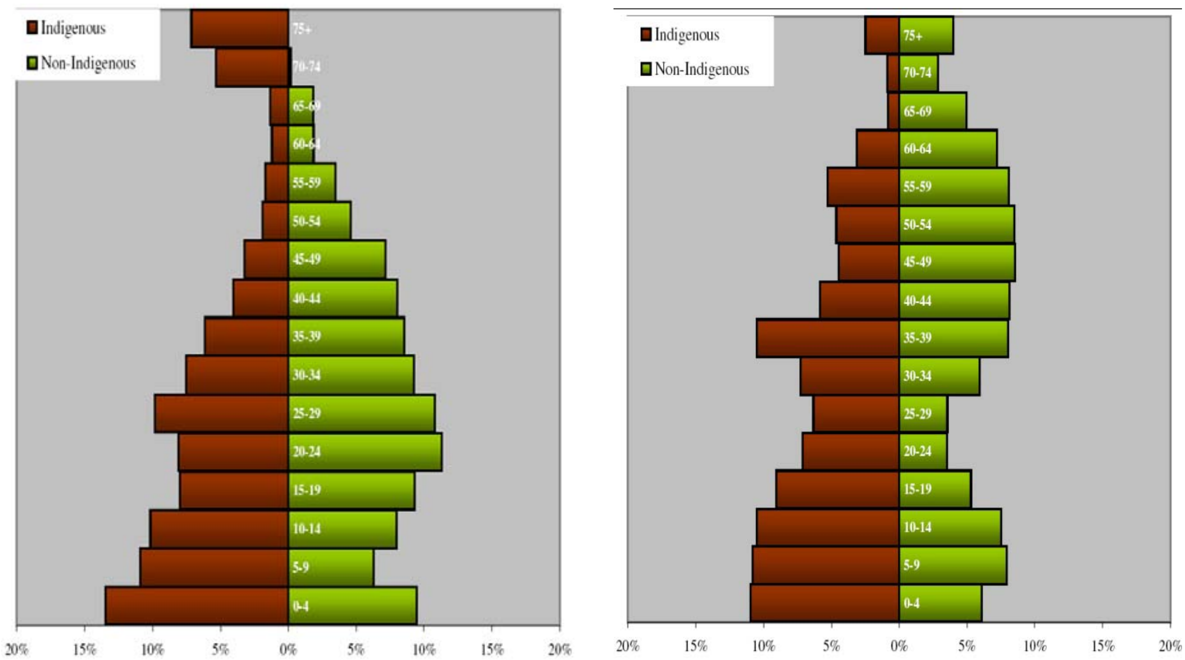
Both the Daly and the Mitchell River catchments cover vast areas, both being larger than the 'average' catchment in the TR region. Both catchments are well provisioned in water (in terms of annual outflows which are, on average, greater than the 'average' river in the TR region). There is, however, considerable seasonal variation in water flows, and – like most of Northern Australia – both are sparsely populated (see Table 1). The catchments resemble the average TRaCK region in terms of average number of people per bedroom and overall sex ratio: in all cases, there are more males than females. In comparison to an average family in the TRaCK region, families in the Daly and Mitchell enjoy a higher weekly median income. There is however a significant difference in population turnover – from 2001 to 2006, population turnover in the Daly almost doubled that of the average population turnover in the TRaCK region, but the same was not observed in the Mitchell.

Compared to the 'average' TRaCK catchment, there are relatively few Indigenous people living in the focal catchments – although both catchments have more Indigenous people aged under 15 years and over 70 years, than Non-Indigenous people (Figure 7). The proportion of older Indigenous people is higher in the Daly than in the Mitchell catchment.

The total population of both catchments fell between 1996 and 2006 – by 4 per cent in the Daly and by 7 per cent in the Mitchell. Overall, the population of those aged 50 years and above increased, but there was a decline in the number of people aged 44 years and under living in these regions (Figure 8). The most significant reductions in population were observed in the 20-34 age categories – potentially a cause for concern as this group is particularly important to the working population.

Table 1 – The focal catchments' profile

	Daly River Catchment	Mitchell River Catchment	Average across all catchments in TRaCK Region
Estimated population (approximate)	10,000	5,500	
Area of the catchment (km2)	53,197	71,471	
Population density	0.2	0.1	0.6
Annual outflow (GL)	6,730	12,000	
ARIA (remoteness index 1-15)	7	8	10
Median family income ($/weekly)	900	888	774
Ave. household size	2.9	2.6	3.2
Ave. number of people per bedroom	1.3	1.2	1.3
Aboriginal people (% population)	27.6	22.5	47.8
Torres Strait Island people (% population)	0.4	0.9	2.6
Sex ratio Indigenous	93	88	97
Sex ratio Non-Indigenous	110	114	109
Sex ratio overall	104	109	106
Population turnover 2001-2006	118%	50%	64%

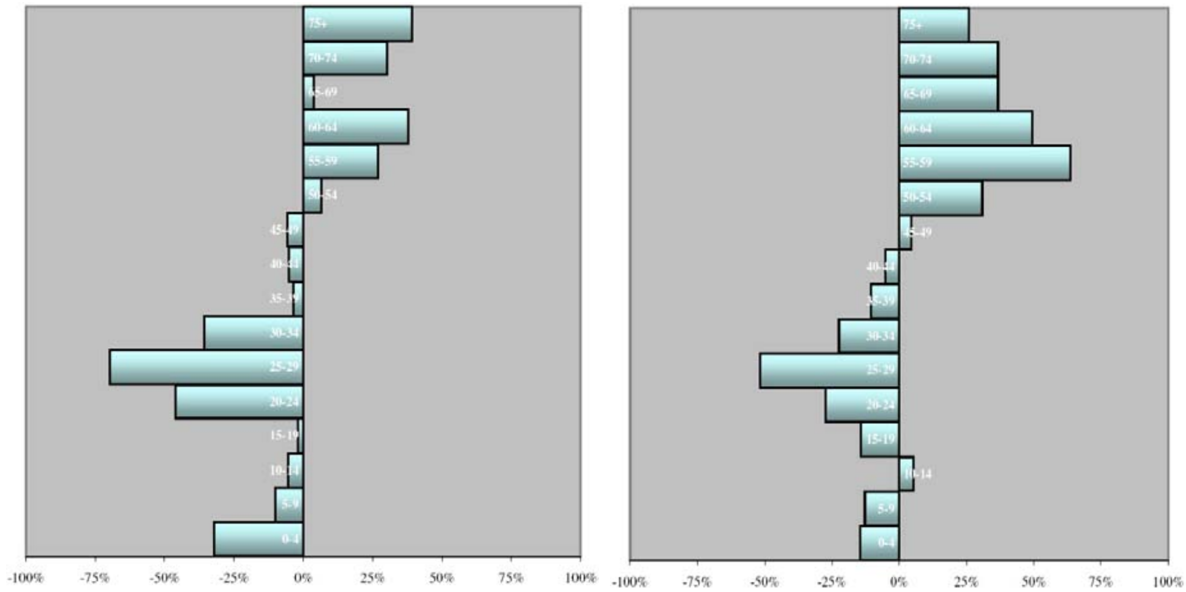


(a) Daly River **(b) Mitchell River**

Figure 7 - Age-sex pyramid in the Daly and Mitchell River catchments by Indigenous status, 2006.

Source: Carson et al., 2009

Demographic changes were also different among Indigenous and Non-Indigenous people. On average, the Indigenous population in the Daly River catchment grew by almost 25 per cent during 1996-2006; during that same period, the Non-Indigenous population decreased by 18 per cent. In the Mitchell catchment both the Indigenous and Non-Indigenous population decreased – by approximately 26 per cent and 7 per cent respectively (Carson et al., 2009).



(a) Daly River (b) Mitchell River

Figure 8 - Changes in age cohorts in the Daly and Mitchell River catchments from 1996 to 2006 (%)

Source: Carson et al., 2009

2.2.2 **Land Use**

As depicted in Figure 9, overall land use in the TR region is dominated by conservation and natural environments. In the Daly catchment, grazing makes up 54 per cent of land use and 39 per cent of the land remains under natural condition: of which 27 per cent is specifically designated as traditional Indigenous use and 5 per cent is set aside for conservation (Larson and Alexandridis, 2009). The remaining land uses are divided among dryland agriculture (5 per cent), intensive uses such as urban, mining or industrial (1 per cent) and irrigated land (1 per cent).

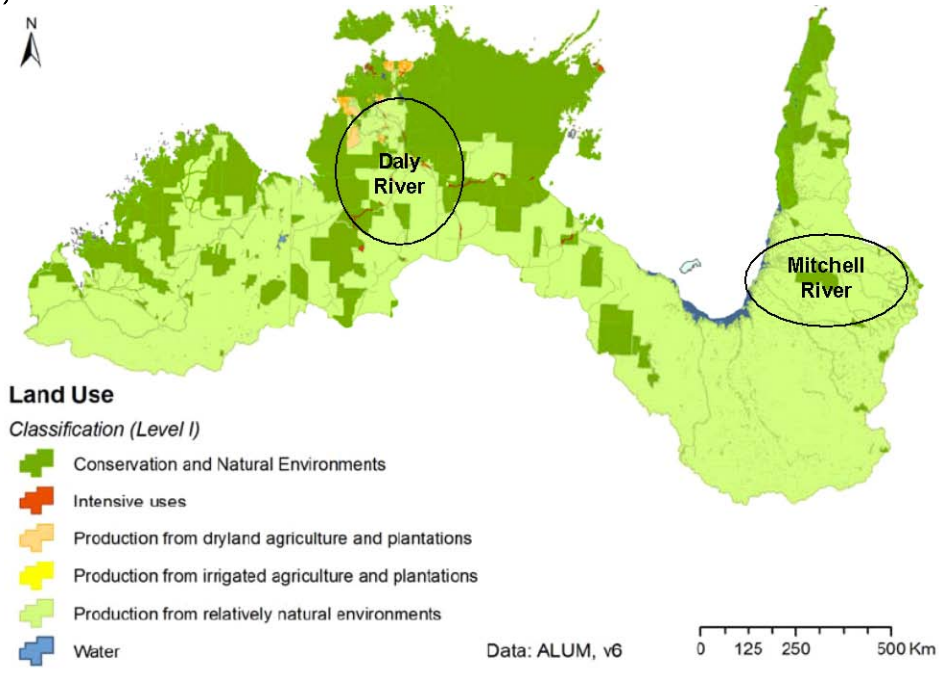


Figure 9 - Land use in the TR region, primary level of ALUM classification

Source: Larson and Alexandridis, 2009

In the Mitchell catchment, 95 per cent of land use is directed towards production from unchanged land (i.e. grazing) 3 per cent of the land is in natural condition and almost exclusively under conservation, and land under intensive use (including urban, mining, industrial) is minimal at 0.03 per cent. Interestingly, there is no natural land solely reserved for Indigenous use in the Mitchell as opposed to the Daly.

2.2.3 **Employment**

Across the entire TRaCK region, the Government Services sector accounts for 25 per cent of employment; the next most significant sector of employment is Agriculture, Forestry and Fishing (11.5 per cent), while Mining, Retail and Construction each comprise around 4 per cent of the labour force (Larson and Alexandridis, 2009). The same general pattern of employment is observed in both the Daly and Mitchell catchments (Larson and Alexandridis, 2009; see also Table 8). However, in the Daly catchment, the importance of the Government Services sector is much more notable. In comparison to the Mitchell catchment, fewer people are employed in the Agriculture, Forestry and Fishing sector (4 per cent as opposed to 15 per cent).

2.2.4 **Similarities and Differences between these, and other catchments**

Using 5 different data sets, and three different statistical methods, Larson and Alexandridis (2009) clustered catchments across northern Australia, based on their socio-demographic and economic characteristics. Figure 10 provides a pictorial summary of key results from the clustering exercise that used a full set of data. It shows catchments which were identified as being socio-economically 'similar' in 'similar' shades/colours, and catchments which were identified as being socio-economically 'dissimilar' in contrasting shades/colours. Full details of their analysis are contained within their report – suffice to say here, some catchments which are 1000's of kilometers distant have more in common with each other, than with their 'next door neighbours'.

As regards the Mitchell River – its socio-economic characteristics are similar to those of the Flinders; the Daly River is most similar to the Fitzroy and the Ord. It is, therefore, possible, that the models described in this report could provide information relevant to a larger group of catchments (and people) than just those in the Daly and the Mitchell.

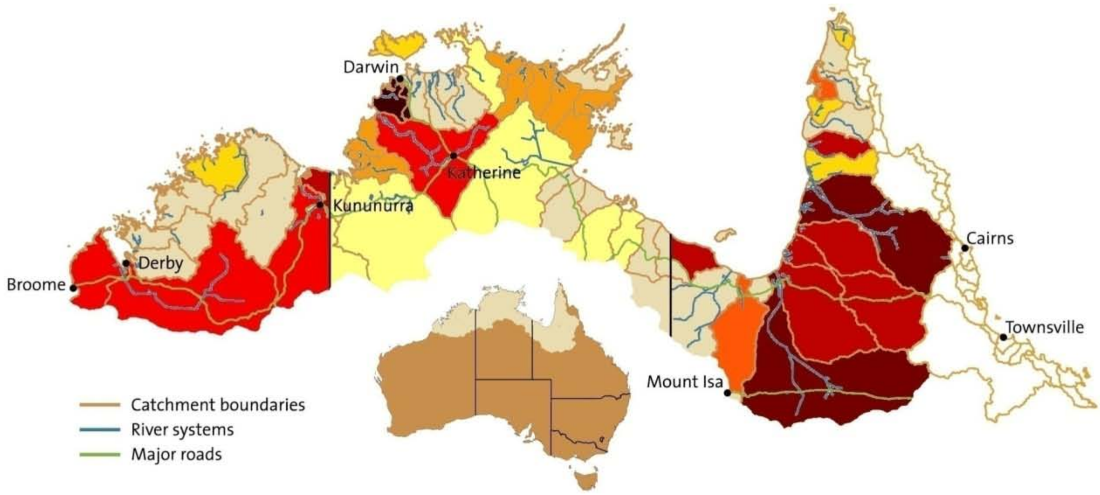


Figure 10 – Similarities and differences between the focal catchments and other catchments in the TR region.

Source: map produced by Aurélie Delisle using data from Larson and Alexandridis (2009)

3 Identification of an appropriate modeling approach

As noted in the introduction, researchers involved in this part of the project were tasked with the job of developing a model that could be used to describe the way in which different components of the socio-economic system interact with each other, and with the environment. It was also deemed desirable to develop a model that could be used to 'simulate' the outcomes of different types of development (e.g. more Agriculture, more Mining).

In the first instance, this required researchers to identify the most appropriate type of economic model(s) to use. Specifically, they needed to:

(a) identify the types of socio-economic <u>variables</u> that stakeholders would like to have information about when considering the 'impacts' of different types of development; and the <u>'changes'</u> (to variables) that stakeholders would like to model the impact of;and

(b) determine which economic model(s) could best meet those needs.

There was an initial literature search that identified generic modeling options. This was followed by discussions with other TRaCK researchers and TRaCK's Knowledge and Adoption team which helped determine which 'generic' modeling option seemed most promising. Finally, there was a more detailed search of the literature and available data – the primary aim of which was to determine how best to build the desired model (given the many available approaches, and the time-frames involved in the project). Further details are given below.

3.1 Stakeholder consultations

In April 2008, Prof Stephen Garnett and Neil Collier, met with the Daly River Management Advisory Committee (DRMAC), and sent other researchers a summary of key issues discussed during that workshop. The summary identified general development scenarios that were of interest to DRMAC. Furthermore, researchers involved in Project 3.1 consulted with several TRaCK researchers – gaining particularly valuable insights with respect to key issues confronting those living in both the Daly and the Mitchell River catchments. Researchers involved in Project 3.1 had also been involved in a previous study – funded by the Tropical Savannas Cooperative Research Centre (CRC) which canvassed the views of 148 different individuals associated with a broad range of stakeholder groups (local, state and federal government departments; non-government organizations (NGO's), Indigenous associations, etc) across Australia's North with respect to their socio-economic modeling needs (Stoeckl and Stanley, 2005). This background information thus allowed for the following observations:

a) There was clear interest in information about incomes and jobs. Most interest seemed to be at a fairly broad sector/industry level (e.g. Mining, Tourism) but there was an indication that stakeholders would like more detailed information in some sectors, particularly for Agriculture and for the household sector (specifically looking for Indigenous / Non-Indigenous split).
b) Additionally, there was clear interest in economy/environment interactions – e.g. in water consumption, water pollution, cultural and recreational water use, aquifer use, etc.

Point (a) suggested that researchers should look at macroeconomic models – i.e. ones that work with sectors, rather than with individuals, households, or individual businesses. It also clearly suggested that researchers should ensure that the sectors included within the model were relevant to the region. Furthermore, point (b) clearly indicated that the macroeconomic (sectoral) models selected for development must also be able to deal with economy/environment interactions.

3.2 Overview of macroeconomic models

The economy-wide impact of a change (say ‘growth’ or extra expenditure) in a particular sector is often greater than the initial amount of ‘growth’ or expenditure. The process by which this happens can best be explained by use of an example. Let us suppose that a visitor to a regional town spends some money that had been earned outside the region at a local grocery store. As such, the owner of the store sees their business ‘grow’ by $100. He/she may put aside some money for savings/profit (say $10) and for taxation (say $20). He/she may also spend money importing stock from outside the region, e.g. Cairns (say $30), and may spend the rest on wages or on fresh produce from the local gardener (say $40).

Figure 11 depicts the process diagrammatically – clearly showing that the total regional stimulus of the $100 of tourist expenditure is greater than $100: it is equal to the $100 earned by the grocer, plus the $40 earned by the gardener. Indeed the final regional stimulus may even be higher than $140, depending upon how much money the gardener spends within the local economy.

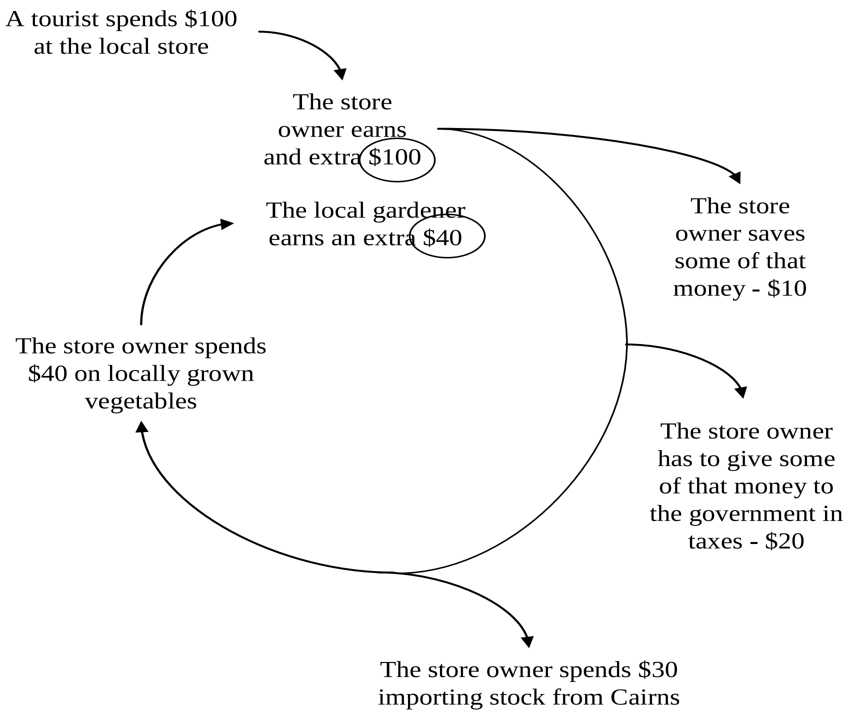


Figure 11 - Conceptualization of the circular flow of income – importing stock from outside

The advantage of looking at the process conceptually is that it is easy to see that the size of the final economic stimulus generated by the ($100) ‘growth’ of the tourism sector depends, at least in part, on the spending pattern of those within the region of enquiry. The larger the proportion of any ‘extra’ income re-spent within the local region, the greater the overall regional benefits of that initial tourist expenditure (or, in economic terminology, the greater the regional *multiplier*). Consequently, those wishing to explore the macro-economic consequences of different types of development (e.g. growth in tourism, mining, agriculture or some other sector) need information about the financial links and expenditure patterns of local firms and households.

The ‘theoretically preferred’ way to explore development options is to build a *Computable General Equilibrium* (CGE) model – although many researchers use Input-Output (IO) models. Further details concerning IO models are provided in section 4, but suffice to say here, IO models are basically simplified CGE's. They use historical data about the way in which different types of businesses (or sectors) have previously spent money to make predictions about what might happen across an entire region if there were an increase or decrease in economic activity. An IO model that contained data like that in Figure 11, would, for example, predict that an increase of $100 in tourist expenditure would generate an increase in regional incomes of at least $140 (more, if the local gardener spends some of his/her money locally).

'Standard' IO models (and some of the simple CGE's) require researchers to accept many questionable assumptions, but there are more sophisticated models and techniques available. For example, IO analysis has been adapted to allow for dynamic relationships (Leontief and Duchin, 1986; Nabors, Backus, and Amlin, 2002; Robinson and Duffy-Deno, 1996). The models can also be extended to consider distributional impacts – using what is termed a Social Accounting Matrix (SAM) – see Berck and Hoffman, (2002), and they are also able to allow for multiple regions – e.g. the Core-Periphery models of Hughes and Holland (1994). Furthermore, models can allow for non-linear relationships between inputs and outputs (Liew, 2000; Wang, 2001).

Most pertinent to this project, is the fact that IO models (and, CGE's) can also be extended to include economy-environment interactions (Eder and Narodoslawsky, 1999; Gustavson, Lonergan, and Ruitenbeek, 1999; Hawden and Pearson, 1995; Huang, Anderson, and Baetz, 1994; Lenzen and Foran, 2001; O'Doherty and Tol, 2007). These 'interactions' are important because – as noted in the introduction – economic systems are essentially sub-systems of socio-economic systems which are sub-systems of the broader natural environment, and there are many ways in which the economic system affects, and is affected by, the broader environment. Figure 2 (presented in the introduction) provides examples of different types of economic/ environment interactions, including situations where the economic system:

(a) uses the environment as a 'dump' (e.g. emitting pollution);
(b) extracts resources from the environment (e.g. water);
(c) benefits from the environment's ecosystem services (e.g. recreation); and
(d) benefits from the (non-consumptive) use of the environment's amenities (e.g. beauty).

The first attempt to incorporate economic/environment interactions into an IO model occurred in the late 1960s, when the 'standard' IO model was extended to allow for the environment by simply adding a row that measured pollution emissions per sector. Although criticized in some quarters, this "simple method of adding a set of row vectors in the Input-Output table has been widely adopted for investigating the environmental emissions or resource consumption triggered by economic development" (Guan and Hubacek, 2008, p 1301).

Since the 1960s there have been several attempts to develop IO models that could account for a wide variety of economic/environment interactions – like those associated with (a) – (d) above. However, most have been severely hampered by lack of data, particularly when dealing with ecosystem services and/or amenity values. Indeed it seems that the successful investigations have, by and large, restricted themselves to accounts of (a) resource flows from the environment to the economy, and/or (b) the flow of wastes from the economy to the environment (Victor, 1972; Jin et al., 2003[6]). Interestingly, the law of thermodynamics suggests that in the long run, the resources used by the economic system must equal the wastes generated. Consequently, many researchers have focused on just one of those flows (most often 'energy use'), reasoning that it provides a means of measuring both the

[6] Cited in Guan and Hubacek, 2008.

resources extracted from the environment and the environmental damage caused by the economy (Common and Stagl, 2005, p104)[7].

3.3 Selection of modeling approach

Table 2 provides an indicative list of a range of different applied macro-economic models currently in use in Australia. Although this country is host to many world-class models, none provide information at a fine geographic scale in the North. There is only one model that explicitly accounts for consumptive water use – but it is highly aggregated (looking at all of Australia). Even the most regionally detailed model (TERM) only provides data for statistical divisions. These are geographically large in Northern Australia; encompassing, for example, almost all of Northern Territory (except the area in and around Darwin).

Table 2 - Overview of Applied Australian Models (non-exhaustive list)

MODEL NAME	REGION	TYPE OF MODEL	GENERAL DESCRIPTION
GRIMP[8] (Grit Impact Program)	Australia	Input-Output	An Input-Output model using cross sectional data by industrial sector. Can simulate impact on output (or employment or energy etc) of a change in final demand.
Lenzen and Foran (2001)	Australia	Input-Output with Water Use	An Input-Output model that explicitly accounts for the consumptive water use of each sector.
ORANI[9]	Australia	Comparative static single region CGE	An applied general equilibrium model first developed in the 1970's. It has largely been superseded by the MONASH suite of CGE models.
ORANI-NT	Australia and the NT	Comparative static multi-region CGE	A comparative static multi-region model based on ORANI.
QGEM[10] (Queensland General Equilibrium Model)	Australia and Queensland	Comparative static multi-region CGE	A CGE model developed by Queensland Treasury to assess the impacts of policy changes and shocks. The QGEM-T model variation specifically looks at the tourism sector.
MMR[11] (Murphy Model Regional)	Australia	Comparative static multi-region CGE	MMR is a CGE model of the Australian economy used for regional policy analysis. It can be used to examine the effects of a policy on a specific state or region.
MONASH[12]	Australia	Dynamic multi-region CGE	A dynamic computable general equilibrium (CGE) model of the Australian economy designed for forecasting and for policy analysis. MONASH is a development of the ORANI model, providing greater forecasting opportunities due to a more detailed specification of inter-temporal relationships and enhanced use of up-to-date data.
MMRF-GREEN[13]	Australia	Dynamic multi-region CGE with Energy Use	A dynamic CGE model of Australia's states and territories. Has been used to forecast energy usage and to analyse greenhouse issues.
TERM (The Enormous Regional Model)	Australia	Multi-region CGE with Energy Use	A "bottom-up" CGE model of Australia which can treat specific regions as separate economies. Can handle greater numbers of regions or sectors, in comparison to its predecessor MMRF-GREEN. The original version is a static model, however a dynamic model is being developed.

Source: Stoeckl and Stanley (2009), p257

Researchers involved in Project 3.1 could have used an 'off the shelf' model – and the model could have provided good quality information for those living in the more densely populated parts of Northern Australia (e.g. Darwin). However, as noted in the preceding sections, the

7 Energy use is associated with the transformation of matter and often requires the burning of fossil fuels (hence CO_2).
8 Developed by West - referred to in Berck and Hoffman (2002).
9 Developed by the Centre of Policy Studies Largely superseded by the MONASH suite of CGE models
10 Developed by Queensland treasury, 1994 – (Woollett, Townsend, and Watts, 2003)
11 See http://www.econtech.com.au/07_Murphy_Models/01_Introduction.htm
12 Derived from ORANI – see http://www.monash.edu.au/policy/monmod.htm
13 Derived from the comparative static MMRG model and the MONASH model - with energy sectors

economic structure of remote economies differs, sometimes substantially, from that of urban and or regional centres – and the clustering analysis undertaken by Larson and Alexandridis (2009) suggests that there are significant socio-economic differences between the Daly, the Mitchell and Darwin. Consequently, researchers decided that information produced from models that describe urban/regional economies was unlikely to be relevant to those living in our key focal catchments: a separate and regionally relevant model was clearly preferred.

In an 'ideal' world, researchers would, therefore, have set out to build a regionally specific "Green" CGE. Unfortunately it can be extremely costly, in terms of both time and money, to develop such models. For example, the ORANI-NT model (based upon ORANI – a widely used Australian model developed by Peter Dixon in the 1970s[14]), comprised more than 7983 variables, in 3249 equations (Knapman, Stanley, and Lea, 1991) and the Monash model (which used ORANI as its base) took nine years to develop. The time frame associated with this project precluded that as an option. Nevertheless, it did NOT rule out the option of developing an IO model.

Furthermore, CGE's use IO tables *as their base*. In fact, most of the CGE models that are in existence today, started 'life' as simple IO models; they were subsequently refined and embellished upon over the course of time. Researchers thus decided to build an IO model, reasoning that it could be refined and/or 'embellished' in future projects, perhaps transforming it into a genuine CGE that could consider price effects, and non-Leontief technologies (i.e. technologies where inputs are at least partially substitutable).

Having settled on an IO model, researchers had to make a decision regarding which measures of economy/environment interactions to include in the model. The Irish Environmental Input-Output (EIO) developed by O'Doherty and Tol (2007) included 19 variables to allow for the environmental 'impact' of different sectors of economic activity – e.g. water use per sector; CO_2, SO_2; measures of solid waste. In the US, there are several examples of models that are able to predict the multiple different types of environmental 'impact' of economic activity. However, these models are very data hungry: the US based Economic Input Output Life Cycle Assessment Software[15], for example, uses data from the following sources:

- Input/Output Matrix: 1992: commodity/commodity Input-Output (IO) matrix of the US economy as developed by the US Department of Commerce. The matrix includes 485 commodity sectors. 1997: industry by industry IO matrix (491 sectors).
- Electricity Use includes manufacturing and mining sectors developed from the 1992 Census of Manufacturers. Service sector electricity use is estimated using the detailed IO workfiles and average electricity prices for these sectors.
- Fuel and Ore Use is calculated from commodity purchases (contained in the IO workfiles) and average 1992 prices.
- Energy Use is calculated by converting fuel use per sector (contained in the IO workfiles) and 31% of electricity use into Terrajoules (31% is the amount of electricity produced in 1992 from non-fossil fuel sources).
- Fertilizer Use is calculated from commodity purchases (contained in the IO workfiles) and average 1992 prices.
- Conventional Pollutant Emissions are from the U.S. EPA AIRS web site, using a concordance to the Input-Output sectors.
- Greenhouse Gas Emissions are calculated by emissions factors from fuel use using U.S. EPA AP-42 emissions factors for CO_2 and Methane. N_2O emissions are estimated to be 10% of NOx emissions.
- Toxics Releases are derived from the US EPA's 1995 toxics release inventory (TRI) and 1995 value of shipments from the 1995 Annual Survey of Manufacturers.
- Hazardous Waste Generation was derived from the 1993 biannual US EPA report.

[14] Breece et al., (1994)
[15] Economic Input Output Life-cycle Analysis from http://www.eiolca.net/methods.html accessed 12 Mar, 2008

- Water Data are taken from the U.S. Department of Commerce, "Water Use in Manufacturing," 1982 Census of Manufactures[16].

Whilst researchers would have, ideally, liked to build similar EIO models for TRaCK's focal catchments, such a goal was deemed unobtainable, primarily because there are almost no comparable data sets of this type for individual sectors of the economy at the geographic scale required for this project. Reasoning that "time is better spent focusing on a small number of indicators which can be linked at fairly aggregate spatial levels" (Gustavson, Lonergan, and Ruitenbeek, 1999), researchers involved in this project therefore decided to focus exclusively on consumptive water use. Nevertheless, they note that a very important task for future research is to extend the model, allowing for a more comprehensive analysis of the likely environmental impact of development scenarios. The model has been built in a manner that ensures such extensions can be done with relative ease.

[16] Department of Commerce (1986)

4 Methodological Details

4.1 Conceptualizing the model

4.1.1 The basic IO model

IO models are based on transactions tables which describe the economic structure of an economy. Set out in matrix format, the columns of the table show how a particular industry spends its money, whilst the rows tell where an industry sells its output to.

Each element $\boldsymbol{x_{ij}}$ tells one how much industry *j* (the column) spends with industry *i* (the row). By adding all elements in a column, one can estimate the total expenditure of a particular industry, *j.*

Looked at the other way, each element of each row $\boldsymbol{x_{ij}}$ tells one how much industry *i* (the row) earns from (or sells to) industry *j* (the column). By adding all the elements of a row, one can thus estimate the total value of sales of a particular industry, *i*.

By definition, total expenditure (which includes provisions for profits) equals total income (sales). Hence, for any given industry, the sum of its column equals the sum of its row.

If, for example, one had a simple economy which comprised just two industries (agriculture and manufacturing), then one could compile an IO table that describes the financial flows within that region which could look something like that below:

	Goods purchased by businesses for use in production (*Intermediate Demand*)		**Goods purchased by consumers, government and/or foreigners for final 'consumption' (*Final Demand*)**	
	Agriculture	**Manufacturing**	**Final demand**	**Total Sales of Industry**
Agriculture	**100 ≈ x_{11}**	**200 ≈ x_{12}**	700 ≈ F_1	1000 ≈ X_1
Manufacturing	**400 ≈ x_{21}**	**x_{22}**	F_2	X_2
Other out-goings (e.g. imports, profits, taxes)	500 ≈ x_{31}	x_{32}	F_3	X_3
Total expenditure by industry	1000 ≈ X_1	X_2		

If one were interested in determining how the agricultural sector spends its money, then one would look down the column – ascertaining that the sector spends $100 purchasing goods from within the agricultural sector; $400 on manufactured goods; and $500 on householders (e.g. wages). If one were interested in determining where the agricultural sector earns its money, one would look across the row – ascertaining that it earns $100 from selling products to other agricultural businesses (e.g. manure sales to fruit growers); $200 from selling products to the manufacturing sector; and $700 selling 'final' goods (e.g. eating apples to consumers).

While this information allows one to DESCRIBE an economy, it does not allow one to make predictions about the way in which that economy is likely to change in response to, for example, an increase in demand for agricultural products (more apples). To do this, one must first convert the "transactions table" into a "table of technical coefficients" (A).

A table of technical coefficients reports the amount that each industry spends in other parts of its economy as a proportion of that Industry's total expenditure. Continuing on from the example above, the industry transaction table for this economy would be:

	Agriculture	Manufacturing
Agriculture	0.10 = $a_{11}= x_{11}/ X_1$	a_{12}
Manufacturing	0.40 = $a_{21} = x_{21}/ X_1$	a_{22}

By definition:

$$a_{11}*x_{11} + a_{12}*x_{12} + F_1 = X_1$$
$$a_{21}*x_{21} + a_{22}*x_{22} + F_2 = X_2$$

Which can be re-written using matrix algebra:

$$(Ax)+(f)=(x) \qquad \text{Equation 1}$$

Where:

A is a block matrix of direct input coefficients
f is a vector of final demands
x is a vector of sectoral outputs

Which implies that final demand (F) is equal to:

$$(f)=(x)-(Ax)=(I-A)(x) \qquad \textbf{Equation 2}$$

Where:

I is the identity matrix

Hence, the total change in final demands that is generated by a change in demand for the final output of just one sector is:

$$\Delta(f)=(1-A)\Delta(x)$$

Equation 3

This means that the total regional change in output (Δx) that occurs as a result of the change in final demand (Δf) will equal:

$$\Delta(x)=(1-A)^{-1}\Delta(f) \qquad \text{Equation 4}$$

Where:

$(1\text{-}A)^{-1}$ is often referred to as the Leontief (inverse) matrix

4.1.2 Differentiating between Indigenous and Non-Indigenous Households

One problem with the approach outlined above, is that if wishing to use the results of IO analysis to draw inferences about the population in general, one needs to assume that each sector within the model is essentially homogenous. However, when it comes to Indigenous and Non-Indigenous communities, there is clear evidence to suggest this is not the case.

For example, the economic structure of Indigenous communities is quite different from that of Non-Indigenous communities. Many Indigenous people derive at least a portion of their ‘livelihood’ directly from the environment, as when, for example they hunt and/or gather and the Indigenous economy has been described as following the hybrid model (Altman, 2001) with three principal components; i.e. market (private), state and customary. According to Altman (2001) “the market (or the private sector) is at best small, at worst non-existent”, within many Indigenous remote communities.

As such, Indigenous people are less likely to have formal employment than their Non-Indigenous counterparts (Figure 12) and many of those who are employed are on CDEP (i.e. the Commonwealth government’s ‘Community Development Employment Projects’ program) - essentially working for the “dole”, and earning money from ‘outside’ the region. Moreover, the employment patterns of Indigenous people differ from those of Australia as a whole. They are much more likely to be employed within the Government and Health sectors, and much less likely to be employed elsewhere (Australian Bureau of Statistics, 2006a).

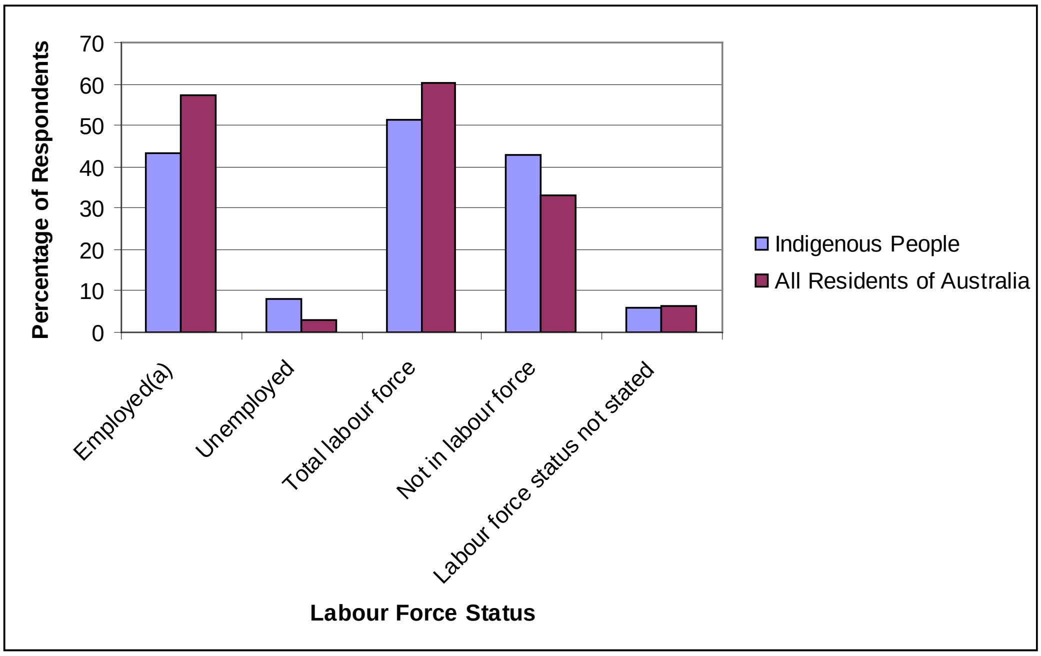


Figure 12 - Indigenous versus Non-Indigenous labour force status
Sources: Australian Bureau of Statistics (2006b, 2006c)

Common and Stagl (2005, pp. 135-136) present sample IO tables for three different types of economic systems: hunter-gatherers; agricultural societies; and industrial economies. The most important point made by that exercise was that the structure of the IO tables is quite different. Clearly, those which are frequently used to represent modern day economies are not going to provide an adequate representation of at least some remote, Indigenous communities. This is primarily because the ‘non-market’ activities are not captured by the traditional IO models; and most IO models only account for incomes earned through the process of production.

In short, one does not expect Indigenous and Non-Indigenous householders to have similar earning and spending behaviors, leading one to question the efficacy of models which fail to differentiate between the groups – particularly models in regions like these, where Indigenous people comprise close to 25 per cent of the population.

Fortunately, there are numerous techniques for adapting traditional IO analysis to suit a variety of different circumstances, and the one which is most pertinent in this instance is Miyazawa's extended [IO] framework. Miyazawa's model allows one to analyze the structure of income distributions, by endogenising consumption demands in the standard Leontief model (Miyazawa, 1976). Conceptually, this is equivalent to the idea of 'enlarging' the matrix of technical coefficients described above, to include coefficients that describe the earning and consumption patterns of different types of households (rather than only focusing on intra-industry expenditures as per the example above).

More formally, the model can be depicted by re-writing Equation 1:

$$\begin{pmatrix} A & C \\ V & 0 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} f \\ g \end{pmatrix} = \begin{pmatrix} x \\ y \end{pmatrix} \qquad \text{Equation 5}$$

Where:

x is a vector of output
y is a vector of total income for the different household groups (Indigenous and Non-Indigenous, in this instance)
A is a block matrix of direct input coefficients
V is a matrix of value-added ratios for the different household groups
C is a corresponding matrix of consumption coefficients for the household groups
f is a vector of final demands – <u>except</u> for household consumption
g is a vector of exogenous income for the household groups

Solving this system yields:

$$\Delta\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} B(1+CKVB) & BCK \\ KVB & K \end{pmatrix}\Delta\begin{pmatrix} f \\ g \end{pmatrix} \qquad \text{Equation 6}$$

Where:

B = $(I-A)^{-1}$ is the Leontief matrix
BC is a matrix of production induced by endogenous consumption
VB(= *VxB)* is a matrix of endogenous income earned from production
L = VBC is a matrix of expenditures from endogenous income
K = $(1-L)^{-1}$ is a matrix of the Miyazawa inter-relational income multipliers

Researchers involved in this project, thus used this approach, since it allows one to explicitly consider the effect on both industry and household incomes (Indigenous and Non-Indigenous) of changes in final demand. Consequently, the model produces what is often referred to as TYPE II multipliers[17].

As regards to other 'non-market' activities within Indigenous communities: it would be conceptually possible to extend *Miyazawa's* model, by, for example, letting the vector *y* represent both market and non-market 'incomes' for particular groups of householders (e.g. Indigenous consumption of magpie geese). Such an extension however would add little to the model, unless the 'production' of magpie geese was endogenous. While the 'production'

[17] "There are two 'types' of each multiplier. Type I multipliers follow the intuition described above. They include the 'direct' effect on output in the industry which experiences an exogenous increase in demand and the 'indirect' effect resulting from the need for all other industries to produce more inputs for that industry. Type II multipliers include an additional effect, the so-called 'induced-income' effect. This arises because as firms produce more output, households receive more income (i.e. workers receive wages, investors receive dividends, proprietors receive a return to their management skill, etc), which they in turn spend on food, cars, holidays, TVs and a range of other things. So total output in the industries that produce all these other goods also rises as final demand has increased. Hence, increased output means increased income for households which *induces* yet more consumption and therefore output, which creates additional income. Like the Type I multiplier, the Type II multiplier measures the impact at the point at which a new equilibrium is reached." (Harris, Clough, Walton, and Taylor, 2004, p. 96).

of magpie geese is endogenous to the broader environmental ‘model’, it is not endogenous to IO and there is simply not enough information within the matrix to trace the environmental consequences of economic activity through to the ‘production’ of magpie geese. Consequently, these non-market incomes have not been explicitly included in the model.

4.1.3 **Incorporating Water Use**

The ABS publishes data on the national and state-wide water use of sectors within the economy (which, for the most part, coincide with the ANZSIC sectors + the Household sector).

These data clearly show that some sectors – for example the Agricultural sector, are higher ‘consumers’ of water than other sectors, say Retail, or Household. But these figures do not give a complete story. To see why, note that some households use water to grow their own fruit and vegetables. But many household do not – instead choosing to purchase their fruit and vegetables from a store. While these households are not *direct* consumers of water for vegetable gardens, they are, nonetheless, *indirect* consumers of water for this purpose. So if one only considers the *direct* uses of water (like those reported in the ABS accounts), one will be omitting some important pieces of information. Fortunately, IO models allow one to take account of both these types of water uses (direct and indirect).

As noted above, one can use Equation 6 to calculate the total regional change in output (and household incomes) that occurs as a result of the change in final demand. In a similar vein, it is possible to calculate both the direct and the indirect changes to water demand (ΔW) that are likely to occur in response to a change in final demand by multiplying the TOTAL change in regional output by a vector that describes sectoral (direct) water use (w):

$$\Delta \mathrm{W} = \mathrm{w}' \Delta \begin{pmatrix} x \\ y \end{pmatrix} = w' \begin{pmatrix} B(1+CKVB) & BCK \\ KVB & K \end{pmatrix} \Delta \begin{pmatrix} f \\ g \end{pmatrix} \qquad \text{Equation 7}$$

Where:

w is a vector of direct sectoral water use requirements (w′ is the transpose of w),
W is a vector of total sectoral water use requirements

It is this general approach that was used here.

4.1.4 **Allowing for employment**

Just as it is possible to define a vector of direct sectoral water-use requirements from which one can calculate the total water requirements of a change in final demand, so too is it possible to do this for employment. Specifically, it is possible to define a direct vector of sectoral employment requirements (*e*) which can be used to estimate the total change in employment (ΔE) likely to arise in response to change in final demand:

$$\Delta E = e' \Delta \begin{pmatrix} x \\ y \end{pmatrix} = e' \begin{pmatrix} B(1+CKVB) & BCK \\ KVB & K \end{pmatrix} \Delta \begin{pmatrix} f \\ g \end{pmatrix} \qquad \text{Equation 8}$$

Where:

e is a vector of direct sectoral employment requirements, (e′ is the transpose of e),
E is a vector of total sectoral employment requirements

This general approach was used here, although researchers distinguished between Indigenous and Non-Indigenous employment, thus working with a matrix of employment requirements, rather than a vector (as is done with water).

4.2 A caution about the interpretation of results

When one uses IO tables to estimate the impact of an increase in demand in one sector, one is implicitly assuming that the extra revenues received by that sector will be distributed according to the current, observed (average) expenditure patterns[18]. This is equivalent to assuming that inputs are always used in fixed proportions (i.e. Leontief technologies – where, for example, a car is always made using one chassis and four tyres) and that production technologies are constant across time. Importantly, IO analysis also assumes (even if only implicitly) that prices are constant. This is not valid in the medium-to long term, since changes in one market may generate changes in price, which may cause changes in demand for other products, which then generate changes in that market (etc).

Conceptually, it is as if these 'limitations' mean that IO models provide one with information about the maximum, likely, outward shift of a demand curve – similar to predicting a move from point A to point B in Figure 13. However, IO analysis is unable to allow for the fact that subsequent changes in price and/or production methods may 'erode' some of that initial impact with the economy thus settling at point "C".

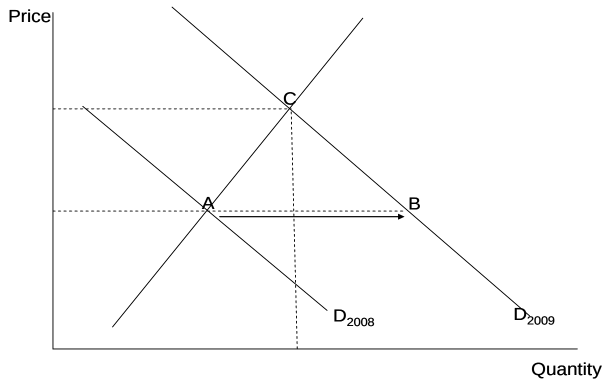


Figure 13 - IO, Demand, Supply and Price

In other words, IO models are demand-driven. Without supply-side information (like that collected for full-scale CGE models), one cannot 'add a supply curve' to the model, so one cannot use IO to make accurate predictions about the 'final' impact of a change on either prices or quantity.

Although some argue that these limitations mean that IO analysis is more suited to short-term analysis than to long-term analysis, such an interpretation is not strictly correct. As clearly argued by Wilting et al., (2004), one can still produce valid long-term projections with IO, providing that one is (a) modeling exogenous changes (the development 'scenarios'), and (2) using a reference base.

To be more specific, when used for longer term policy analysis, one should not present final estimates generated from IO models as if there are 'precise' predictors of the future (e.g. one should not say that scenario A increases employment by 50, whereas scenario B increases employment by 25). Instead, one should present final outcomes as they compare to each other. This is conceptually equivalent to saying that scenario A moves the demand curve out twice as far as scenario B, and it is that general approach which is used when reporting results in section 6.

[18] From the perspective of a householder, using observed expenditure patterns to predict changes in expenditure that may result from changes in income is tantamount to assuming that the marginal propensity to consume (MPC) is equal to the average propensity to consume (APC). Ceteris paribus, if consumption (C) is a linear function of income (Y), comprised of both an autonomous (CA) and an induced component that increases with income (CI), then the higher is the MPC and/or the smaller is CA relative to Y, the closer will the APC be to the MPC, and the more 'palatable' will be the assumptions underlying IO analysis.

5 Operationalizing the model

5.1 Defining sectors

Charged with running the country's five yearly censuses, the ABS is, arguably, one of the most important sources of region-specific data across Australia. Consequently, it was important to ensure that the sectors used within the WIO models coincided with those of the ABS – as set out in the *Australian and New Zealand Standard Industrial Classification* (ANZSIC) system[19]. The ANZSIC structure comprises four levels: Divisions (the broadest level – with 17 different divisions), Subdivisions, Groups and Classes (the finest level) – although we did not use that exact structure for several important reasons.

First, there is evidence to suggest that "statistical modeling techniques that focus on and rely on extensive disaggregated data series will be expensive to support and, in the end, will have questionable reliability" (Gustavson, et al., 1999). Since the IO literature indicates that final multiplier estimates are not biased by aggregation (Richardson, 1985, p. 629), we chose to limit the number of sectors considered in this project – particularly given the small population of the regions under consideration (approximately 5,500 and 10,000 persons, respectively, in the Mitchell and Daly – see section 2.2).

Second, many sectors/divisions which are vitally important to the overall Australian economy are all but non-existent in remote parts of the North (Stoeckl and Stanley, 2007) – these are: Manufacturing; Electricity; Sewerage; Wholesale; Finance; and Communications. Consequently, it was not essential to include each and every sector, commonly included in the ANZSIC system.

Third, we were cognisant of the fact that it was important for the model to include 'key' regional sectors; those which may be relatively unimportant to the overall Australian economy – in terms of aggregate income and/or employment – but which are vitally important in the North. These sectors include: Agriculture; Mining; Construction; Tourism; Government; and Health.

Finally, when determining which sectors should (or could) be included, it was also important to be mindful of the fact that the ABS Water Accounts do not report water usage for each and every ANZSIC sector. Instead, "the industries discussed in the Water Account have been adapted from the ANZSIC 1993 and have been grouped according to user demand" (ABS, 2001, p 21), as per the listing below.

- Agriculture, which is subdivided into
  - Livestock, pasture, grains and other
  - Dairy farming
  - Vegetables
  - Sugar
  - Fruit
  - Grapes
  - Cotton
  - Rice
- Forestry and Fishing
- Mining
- Manufacturing
- Electricity and Gas Supply
- Water Supply, Sewerage and Drainage Services
- Households
- Other industry, comprising
  - Other Agriculture
  - Construction
  - Wholesale + Retail
  - Accommodation, Cafés and Restaurants
  - Transport and Storage
  - Finance + Communication + Property and Business Services
  - Government Administration
  - Education
  - Health and Community Services
  - Cultural and Recreational Services + Personal Services

[19] See: http://www.abs.gov.au/ausstats/abs@.nsf/0/8AD985A70F2DA2F0CA25697E00184C94?Open&Highlight=0,ANZSIC (ABS, 1998)

Given this background, and since it was not possible to differentiate consumptive water-use requirements for some sectors (e.g. Wholesale + Retail; and Finance + Communications + Property), researchers involved in this project chose to develop a 12 sector model as specified below:

1. ***Households***, subdivided into
   a. Indigenous Households
   b. Non-Indigenous Households
2. ***Agriculture***
3. ***Mining*** + Manufacturing
4. ***Retail*** Trade + Wholesale Trade
5. ***Government*** + Education + Health
6. ***Accommodation***
7. ***Construction***
8. ***Transport***
9. ***Electricity***
10. ***Culture*** + Personal
11. ***Finance*** + Communications + Property

Unless otherwise specified, from this point onwards, these aggregated sectors will be referred to using the word in *italics,* above (i.e. *Retail* refers to the sector comprising both Wholesale and Retail Trade).

5.2 Populating the model with data

Equation 7 clearly identifies the data required and the following sub-section provides details on how the data were obtained.

5.2.1 **The (Leontief) matrix B: Business and organizational expenditure**

The ABS does not fund the compilation of IO tables at either the state or regional level (Beer, Maude, and Pritchard, 2003, p. 95), although the Queensland Government does. In 2004, the (Queensland) Office of the Government Statistician (OGS) released a set of regional IO tables that were derived from data collected in 1996/97 (OGS, 2004). However the boundaries of the Statistical Divisions, for which the Queensland regional tables were built do not match the biophysical boundaries of our focal region: the Mitchell River catchment spans part of both the North West and the Far North Statistical Divisions. A similar problem arises for the Daly: there is an (unpublished) IO table for the entire Northern Territory that was developed by Prime Research and ACIL Tasman, using 2001/02 data, but the region for which the table applies does not match our region of enquiry. In other words, there were no existing IO tables that could be used in this instance. The Leontief matrix had to be either 'built' from scratch, or 'borrowed' from another region and adapted to suit local conditions.

There are numerous techniques for building IO tables from the 'top-down' – essentially using both employment and other survey data to alter IO tables that have been built for larger regions (e.g. the GRIT[20] and the GRITSSIC[21] techniques discussed in detail in Richardson (1985). Stoeckl (2007) on the other hand, suggested an inexpensive, survey-based approach to estimating multipliers from the 'bottom up' (see also: Stoeckl, forthcoming). By collecting data on (a) the proportion of total revenues spent on particular goods and services; and (b) the proportion of total monies spent on particular goods and services that go to 'local' businesses, this approach essentially allows researchers to build a matrix of technical coefficients, without constructing a full IO table. Admittedly, one cannot use the

[20] Generation of Regional IO tables
[21] Generalised Regional IO tables with Survey-based Sums of intermediate coefficients

matrix of technical coefficients alone to glean a true picture or 'portrait' of the structure of a regional economy (as per Jensen, West, and Hewingst, 1988), but it is possible to use that table to estimate the impact of regional changes (i.e. to estimate regionally relevant multipliers). This project was not primarily aiming to describe the structure of the regional economy – the most important information required was, instead, the matrix of technical coefficients. For this particular application, it was thus apparent that the survey-based approach would suffice.

Researchers had access to a database containing information on the purchasing and import behaviours of almost 1000 private businesses and government organizations located across Australia's far North (full details are available in Stoeckl, Stanley, Brown, and Stoeckl, 2007)[22]. However, only 37 of these 1000 'observations' were found to have been collected from firms located within the Mitchell catchment while 107 had been collected from firms within the Daly catchment. As such, the number of observations per sector, in some cases, was very small – particularly within the Mitchell catchment (Table 3). In an effort to reduce standard errors, researchers therefore used data that had been collected from ALL firms within the TR region, except those in the Darwin area[23] when the total number of 'observations' within any one catchment and sector was less than five (those highlighted in Table 3).

Table 3 - Number of 'observations' on business expenditure per sector in the Mitchell, Daly and TR regions

Sector	Daly River Catchment	Mitchell River Catchment	TRaCK Region
Accommodation	11	21	63
Agriculture	2	3	10
Construction	4	15	33
Culture	3	6	20
Electricity	0	3	4
Finance	4	11	23
Government	11	23	68
Mining	0	6	12
Retail	1	8	18
Transport	1	11	22
TOTAL	37	107	273

The data were then used to build the matrix (A) for each catchment. This could be done because the data set contained firm-level information about:

(a) the proportion of total income (output) from each firm *k* in industry *j* which was spent within industry *i* (θ_{kij}); and

(b) the propensity of each firm *k* within industry, *j*, to purchase goods provided by industry *i* from within the 'local' area (λ_{kij}).

Multiplying θ_{kij} by λ_{kij} thus gave researchers an estimate of firm-level technical coefficients (A_{kij}): the proportion of total income which firm *k* in industry *j* spends on 'locally' produced goods and services from industry *i*. These firm-level coefficients were subsequently averaged across all firms within each sector within each catchment (noting the 'substitutions' of data from the TR region in place of data from the Mitchell and/or Daly for sectors with small N), to obtain the individual components (a_{ij}) of the matrix A for each catchment:

[22] A decade more recent than the data used in the IO tables produced by OGS (2004)
[23] Darwin based firms were excluded on the grounds that the production techniques and import behaviours of firms in regional centers are likely to differ from those located in remote areas like the Mitchell and Daly river catchments.

$$a_{ij} = \theta_{ij}\lambda_{ij} = \frac{\sum_{k=1}^{n}\theta_{kij}\lambda_{kij}}{n}$$

Equation 9

Where:

n = number of firms within sector *j* that were included in the micro-level data set for the particular region of enquiry.

5.2.2 **The matrix C: Household expenditure**

To the best of our knowledge, there is no publicly available information about the spending patterns of Australian Indigenous people in our regions of enquiry. Moreover, there is almost no publicly available information about the expenditure patterns of remote Australian householders (be they Indigenous or otherwise). The ABS's Household Expenditure Survey, for example, takes its sample from regions where there are more than 0.6 dwellings per square kilometer (Australian Bureau of Statistics, 2005) thereby excluding most regions that are relevant to this study. Even if the ABS did collect household expenditure data in remote areas, their questionnaire does not seek information about the Indigenous status of respondents, so they are unable to look for differences in the expenditure patterns of Indigenous and Non-Indigenous people.

Researchers involved in this project, were thus required to collect their own data on the expenditure patterns of householders. Details of the data collection process – and of the way in which the data were used to construct the matrix C are provided below.

5.2.2.1 Mail-out survey of Non-Indigenous households

A database with the names and addresses of more than 9,000 householders with postcodes that lay either partially or entirely within the Mitchell and the Daly River catchments was purchased from Media M Group[24]. Households with addresses that were clearly outside the focal catchments were removed, leaving a total 'population' of just over 4000 households (1966 in the Daly and 2172 in the Mitchell). Recognizing that response rates as low as 10 per cent are not uncommon in social surveys, researchers decided to try to contact 2500 households – randomly selecting them from the 'population' of householders identified in the database.

Following the guidelines of Dillman (2000), households that had been selected for inclusion in the survey were sent an initial, introductory letter informing them about the study (March 2009 – see Appendix 3), followed by a questionnaire in April 2009. In May 2009, a reminder letter and replacement surveys (see Appendix 4) were sent to those who had not yet responded.

5.2.2.2 Interviews with Indigenous householders

Mail-out surveys are not a particularly effective means of gathering information from some groups of households, and researchers recognised that this was likely to be the case for Indigenous householders. They therefore decided to work with local Indigenous people to collect household expenditure and water-use information via interview in the focal catchments (See Appendix 2 for a copy of the Indigenous household's interview).

[24] See http://www.dame.com.au/ for further information

5.2.2.2.1 Kowanyama

In early 2009, researchers contacted Viv Sinnamon – manager of the Kowanyama Lands office. They sent detailed project plans and plain-English factsheets (see Appendix 5) that described the project; and received information about research protocols in Kowanyama. Owen Stanley and Natalie Stoeckl visited Kowanyama from the 10th to the 12th of March to meet with Viv and others in the community. During those meetings, Owen and Natalie sought – and received – support for the project. In June, 2009, Owen returned to Kowanyama, and with the help of a local Indigenous research assistant (Darren Birchley) collected data on the household expenditure patterns of 45 households (more than 20 per cent of the total number of households in that community, estimated at 222).

5.2.2.2.2 Upper and Middle reaches of the Mitchell

Researchers participated in the TRaCK Indigenous Forum from 14 Nov 08 to 16 Nov 08 at the Mt Carbine Caravan Park and Camp Paterson. During that forum they were able to talk to some of the traditional owners about the project – seeking to determine whether or not the group was interested in participating. A key (whole of TRaCK) outcome of the forum was the formation of the *Mitchell River Traditional Custodial Advisory Group (MRTCAG).*

Over the next twelve months, MRTCAG developed documents which laid out the processes for working with Indigenous communities within that part of the catchment. These were finalized in November 2009, after which researchers were able to submit a formal research proposal to MRTCAG. After having attended a cultural awareness program run by MRTCAG (January 2010), Owen and Natalie were able to return to the region (April 2010), working with four separate local Indigenous research assistants from four separate language groups (Sharon Brady, Eddie Thomas, Eddie Turpin and John Grainer) to conduct interviews with 25 Indigenous households in the upper and middle reaches of the Mitchell.

5.2.2.2.3 Daly River

While at the 2008 Mitchell River Forum, researchers were able to meet with two TO's from the Daly River: Mona Liddy and Valemina White who were both on the Daly Aboriginal Reference Group (ARG). Over the next few years, the relationship between TRaCK researchers and the Daly ARG slowly developed, and on July 6th, 2010, permission was granted for researchers to collect data from Indigenous householders in this catchment. In October, 2010, Owen Stanley and Hmalan Hunter visited the Daly Rver, working with three Indigenous research assistants (Agnes Page, Kathleen Perry and Bridget Kikitin) to collect data from 6 householders in that region. In November 2010, Pippa Featherstone returned to the region, working alongside an Indigenous research assistant (Lizzie Sullivan) to collect data from an additional 25 householders.

5.2.2.3 Response and response rates

In total, researchers received 510 completed questionnaires from their mail-out, giving an overall response rate of just over 20 per cent. Interview response rates in the Indigenous communities were almost 100 per cent: just two of the 70 Indigenous householders approached by research teams in the Mitchell River catchment declined to participate; similarly for the 31 Indigenous householders in the Daly River.

All respondents (both mail-out and interview) were asked about the total number of people living in their household, and the total number of Indigenous residents. If the number of Indigenous residents >0, the household was deemed to be 'Indigenous'. Consequently, the information about the spending patterns of Indigenous households was collected from both the mail-out survey and the interviews.

The 318 mail-out surveys received from residents of the Mitchell River Catchment provided information about the expenditure patterns of 775 people – although some of these surveys (10) were, under the classification system described above, 'Indigenous'. Allowing for information collected from both the mail-out and from the interviews, the Mitchell River sample is thus thought to cover approximately 18 per cent of the population of Non-Indigenous people and almost 31 per cent of all Indigenous people in that catchment (Table 4). However, the estimate for Indigenous people is likely to overstate the true representativeness of the sample since, as noted previously, ABS Census counts tend to underestimate the actual number of Indigenous residents.

In the Daly River, information was collected from 219 householders, 49 Indigenous (18 in response to the mail-out, and an additional 31 via interview). As such, the Daly River sample was smaller – not just in total numbers but also as a per cent of the estimated 2006 population. This sample is thought to cover 6.42 per cent and 8.70 per cent, respectively, of the Non-Indigenous and Indigenous population in this catchment. Readers are thus cautioned to be a little careful when using the Daly River sample data to draw inferences about the population at large – particularly given the 'undercount' problem associated with Indigenous households.

Table 4 – Number of householders covered in survey compared to estimated population – by Indigenous status and catchment

	Daly River Catchment		Mitchell River Catchment	
	Indigenous	Non-Indigenous	Indigenous	Non-Indigenous
Number of respondents (households)	49	170	80	308
Total number of people living in houses of respondents	240	465	383	749
Estimated population of catchment at the time of the 2006 Census	2760	7240	1238	4262
Estimated % of population covered by sample	8.70	6.42	30.94	17.57

5.2.2.4 Characteristics of respondents

As shown in Figure 14, Indigenous households were generally larger than Non-Indigenous households, and were likely to contain more people under 20 years of age, and fewer people aged over 65 (Figure 15). Relatively few Indigenous households in the Mitchell had a member of the household with post-school qualifications (either University or Trade) – 6.25 per cent compared with 44 per cent for Non-Indigenous households (see Table 5). In the Daly, almost 34 per cent of Indigenous households had at least one person with post-school qualifications although the rate was, as expected, much higher for Non-Indigenous householders where almost 70 per cent of respondents came from households were at least one person had post-school qualifications.

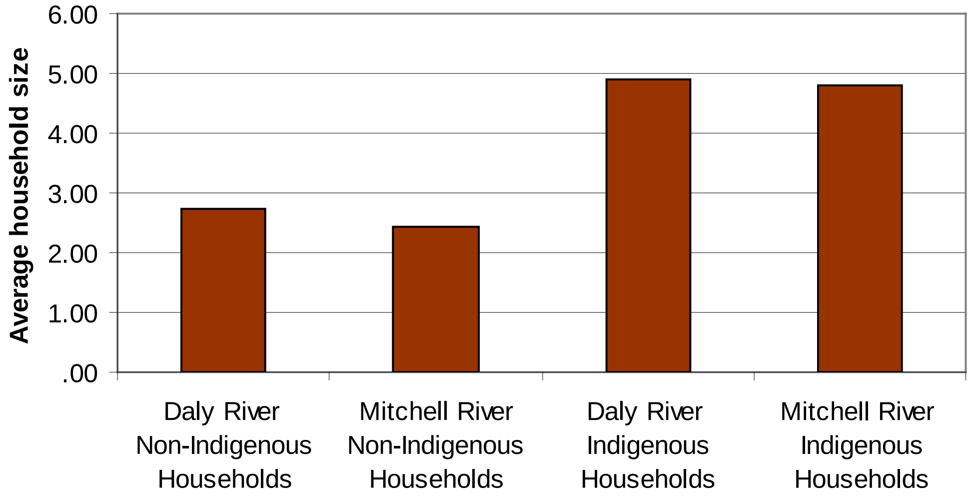


Figure 14– Average household size – by catchment and Indigenous status

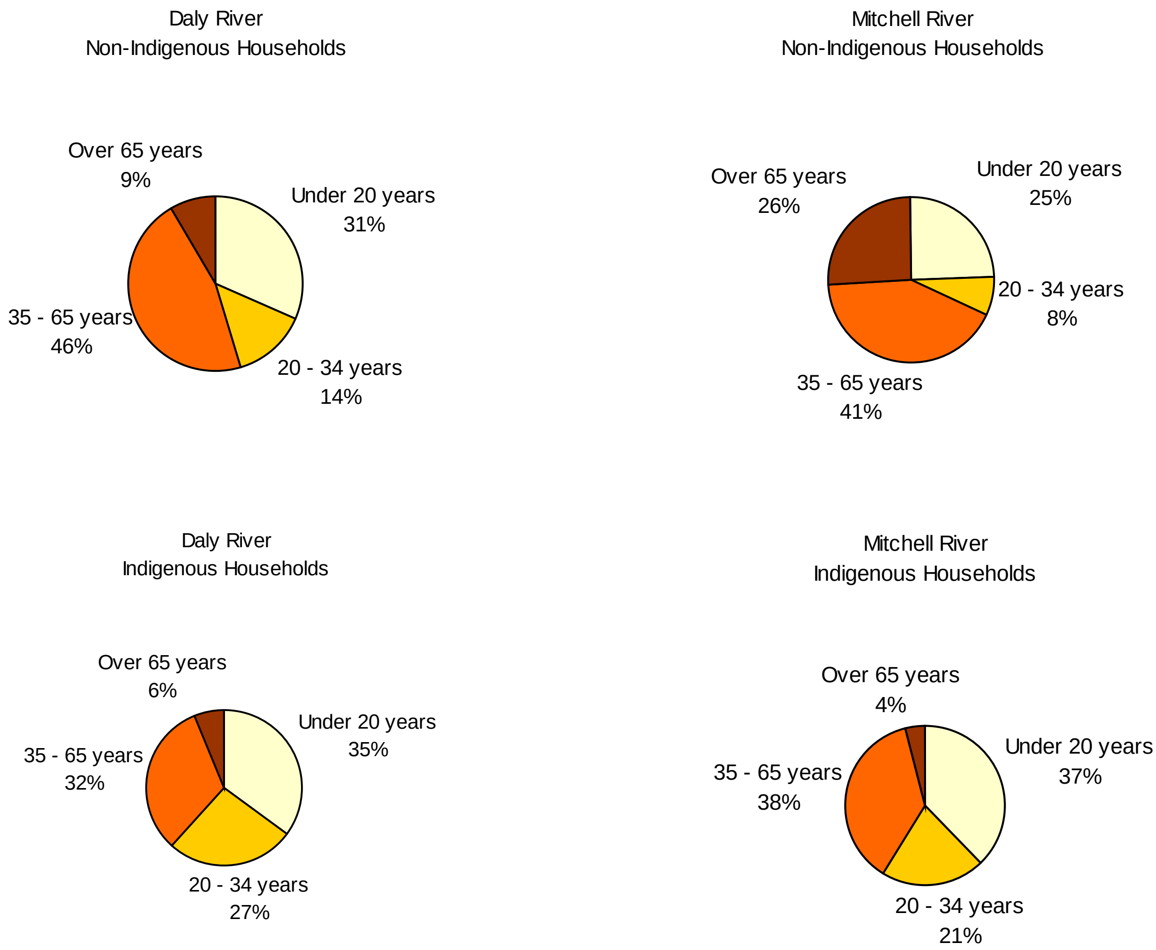


Figure 15 – Age composition of household – by catchment and Indigenous status

Table 5 – Highest level of education completed by any member of the household – per cent of households by Indigenous status and catchment

	Daly River Catchment		Mitchell River Catchment	
	Indigenous	Non-Indigenous	Indigenous	Non-Indigenous
Did not complete primary	0.00	0.00	7.50	0.33
Primary	14.89	2.96	18.75	16.33
High School	51.06	26.04	67.50	37.33
University	23.40	43.79	5.00	23.00
Retail	8.51	26.63	1.25	21.00
Other	2.13	0.59	0.00	2.00

In an effort to further gauge the representativeness of the sample, researchers compared employment data collected from the household survey with that collected by the ABS during the 2006 census – see Figure 16. In the Mitchell, the employment patterns are not identical, but they are very similar. This tends to suggest that the sample data may be reasonably representative of the general population. As expected, the Government sector (which, in this case, also includes Education and Health), was the single largest employer of respondents – and the only significant employer of Indigenous people. The Agricultural sector was also a relatively significant employer for Non-Indigenous householders (and, to a lesser extent, of Indigenous people). Very few Indigenous householders were employed by other sectors.

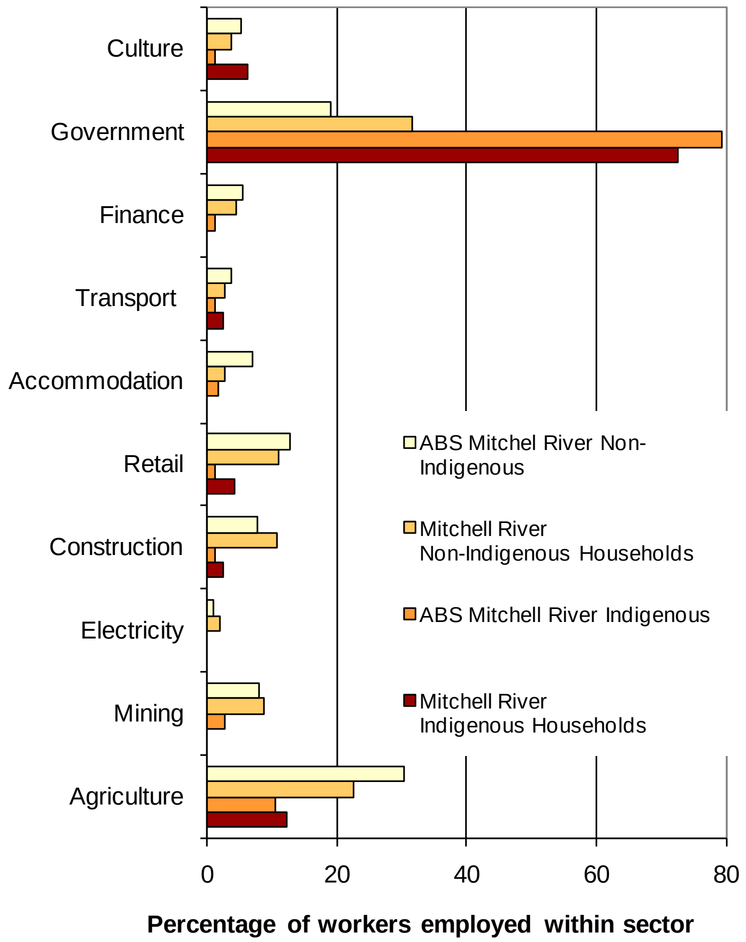


Figure 16 – Mitchell River Employment by sector and Indigenous status – ABS and Household Survey data compared

A similar comment can be made for the Daly with respect to the similarity between ABS employment data for Non-Indigenous households (see Figure 17) – there are differences, but these could plausibly be attributable to changes over time. Here too, the similarities suggest that the sample is reasonably representative of the population at large (to the extent that the ABS data represents the broader population). In this case, it is clear that the Government sector was the only significant employer within the catchment during 2006.

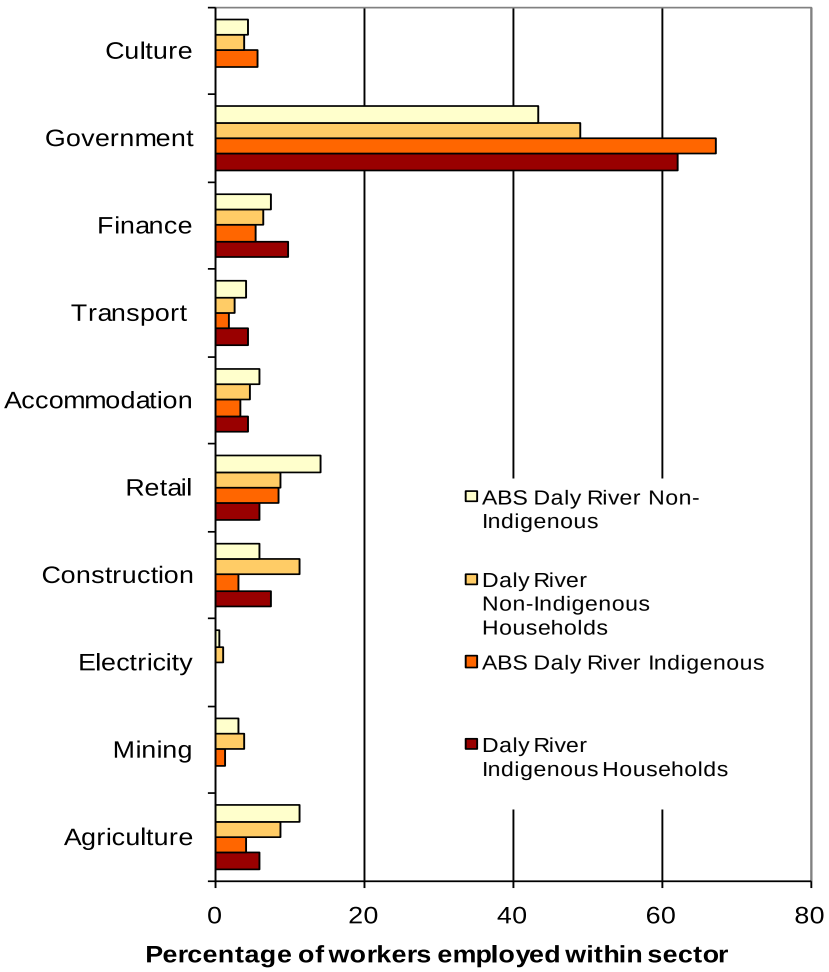


Figure 17 – Daly River Employment by sector and Indigenous Status – ABS and Household Survey data compared

5.2.2.5 Using the household expenditure data to calculate coefficients for C

When completing the survey, respondents were asked for information about

(a) their total, weekly expenditure on a variety of different goods and services (ϖ_h); and
(b) their propensity to purchase each of those goods and services from within the 'local' area (λ_h),

and this information was used to calculate the consumption coefficients in the IO model by following a series of related steps.

To be more specific, respondents were asked to provide information about the amount which they spent on a variety of different types of goods and services, as per the questionnaire excerpt below (a full copy of the questionnaire is provided in Appendix 1):

Please tell us approximately how much <u>all the people in your household</u> (added together) spend on each of the following goods and services <u>each WEEK</u>. ***Please tick appropriate box.*** *If your spending is high in some weeks e.g. $400 and low in other weeks e.g. nothing, please give an 'average' – e.g. $200 PLEASE* **only tell us about DOMESTIC (Household) expenditure; e.g. if you live on a property, then please ignore business expenses such as fencing, stock, etc.**

	Approximate dollars PER WEEK									
	$0	$1 - 20	$20-50	$50-100	$100-150	$150-200	$200-300	$300 - 400	$400 - 500	Other *(specify)*
Clothing and footwear	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Fuel	☐	☐	☐	☐	☐	☐	☐	☐	☐	$

The midpoint of each expenditure category was taken as an indication of the amount spent on each type of good[25] (ϖ_j), thus enabling researchers to estimate weekly household expenditure for different household types (Indigenous and Non-Indigenous) in different catchments – as shown in Figure 18.

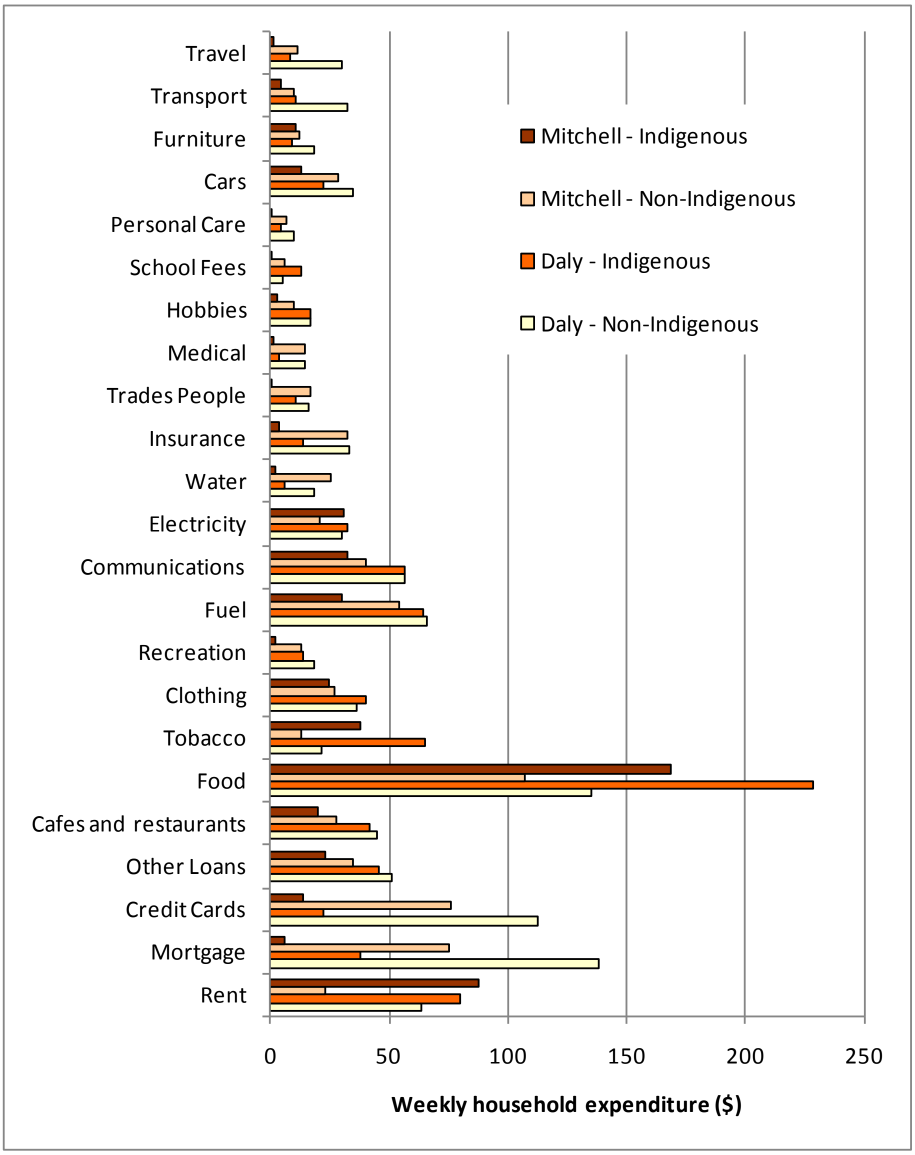


Figure 18 – Weekly Household expenditure on different goods and services – by Catchment and Indigenous Status

[25] For example, if the respondent indicated that they spent between $50 and $100 each week on fuel, then ϖ_{fuel} = $75 (some questions asked about annual expenditures – in this case numbers were divided by 52).

The data largely accord with *a priori* expectations: most money is spent on food and accommodation (whether it be via rent or mortgage) with other significant expenditure items including fuel and communications (mostly mobile phone charges). Moreover, relatively few Indigenous households had a mortgage (12 households in total across both catchments), credit card or other loans – either out of choice, or because of difficulties accessing finance. A relatively large number of householders in the Mitchell River Catchment had already paid off their home-loans; hence the low average mortgage payments in this region.

In an attempt to gauge the efficacy of the survey data using other than *a priori* expectations, researchers compared it with that collected by the ABS in their 2003-04 Household Expenditure Survey (HES). It was not, however, possible to do a direct comparison without first transforming data collected in this survey. This is because the way in which the ABS collects and categorises data is somewhat different to the way in which it was collected and categorised in this project.

Specifically, the ABS collects and publishes information about household weekly expenditure on the following items:

- Tobacco Products
- Personal Care
- Domestic Fuel and Power
- Clothing and Footwear
- Medical Care and Health Expenses
- Household Furnishings and Equipment
- Miscellaneous
- Recreation
- Transport
- Food and Beverages
- Current Housing Costs and Household Services
- Mortgage Principal Component Of Weekly Repayments

In the first instance, researchers needed to determine how much of the mortgage, loan, and credit-card repayments that were reported in this survey (see, for example, Figure 18) were attributable to interest. They were able to do so using other information collected in the survey[26]. They also needed to group expenditure items into categories matching those of the ABS, and to adjust the ABS data for CPI[27]. After having made those adjustments, it was possible to look for similarities and differences in spending patterns – illustrated in Figure 19.

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[26] Specifically, for each type of loan held, respondents were asked to provide information on the interest rate (*r),* the term of the loan (N), and the total amount borrowed (T). Required monthly repayments (*M),* which may differ from the amount actually paid, were estimated as:

$$M = r/12 \times \frac{1}{1-(1+r/12)^{12N}} \times T$$

And the total interest paid for the length of the entire loan (R) were calculated as:

$$R = M \times N \times 12 + (r/12 \times T - M) \times \frac{(1+r/12)^{12N} - 1}{r/12}$$

Indicating that the proportion of total monthly repayments going towards interest (rather than paying of the principal) = R/12/N
For credit cards, researchers estimated the interest rate component by noting that those paying the
a) minimum amount were paying only interest, so for them, R = interest component
b) maximum amount: r(1+r) x R is the interest component

[27] CPI = 166.2 in March 2009; 142.8 in Dec 2003. So ABS figures multiplied by 166.2/142.8

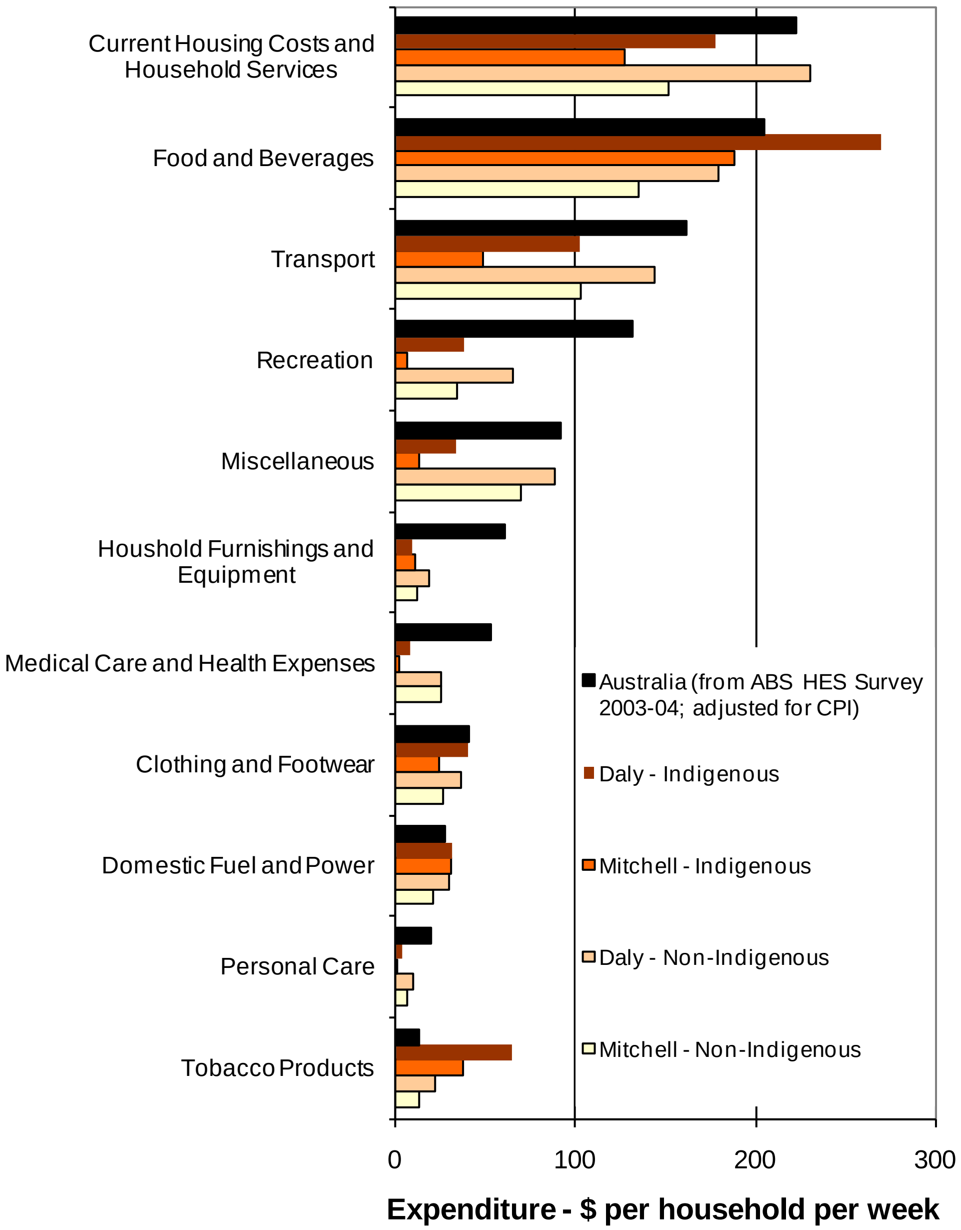


Figure 19 – Household Expenditure patterns in the Daly and Mitchell catchments compared with national data

The comparison indicates that the survey data are ‘plausible’. For example, the overall spending patterns of households included in this survey and of those included in the ABS’s HES are similar, with most money being spent on housing and food. Indigenous people in the Daly spend more per week on food and beverages than the average Australian household – at least partially attributable to the fact that the average Indigenous household is larger than the average Non-Indigenous one. For Non-Indigenous people, housing costs also are higher in the Daly than in Australia as a whole, and Indigenous households spend more on Tobacco than the average Australian household – both expected, and plausible observations.

That said, there appear to be clear differences in the spending patterns of Indigenous and Non-Indigenous households: an observation which, hitherto has not been possible to make given that the ABS HES does not include an ‘Indigenous flag’ that facilitates such comparisons. It is, however, difficult to discern the significance of those differences by examining this graph, alone, primarily because the data underlying the graph refer to household expenditure and Indigenous households are generally larger than Non-Indigenous households. Researchers therefore divided reported expenditures by household size to estimate the average per person expenditure within each ABS category. They then divided the total expenditure per person on any individual category of goods and services, by the total expenditure per person on all goods and services – as is frequently done by the ABS when presenting data from the HES.

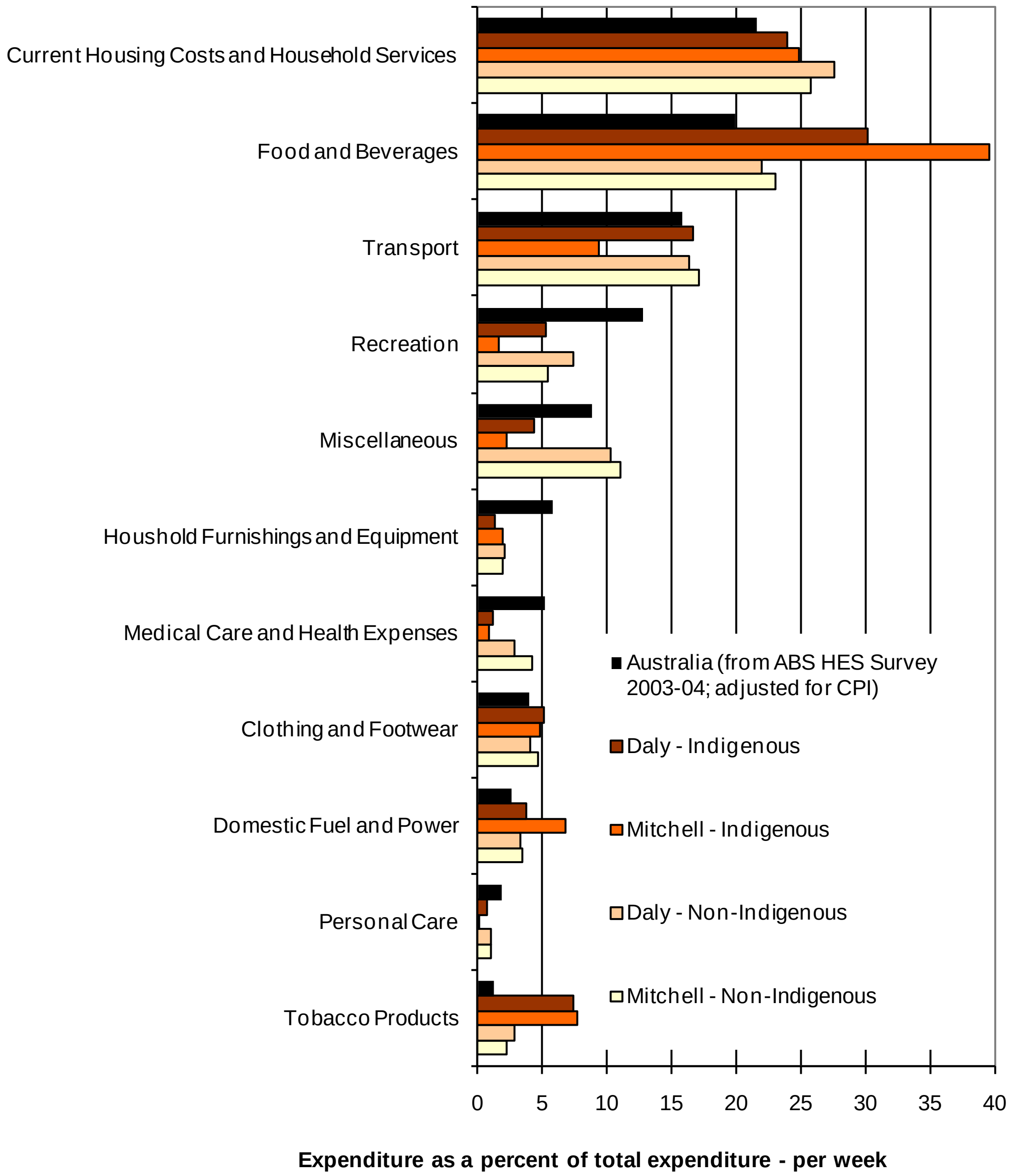
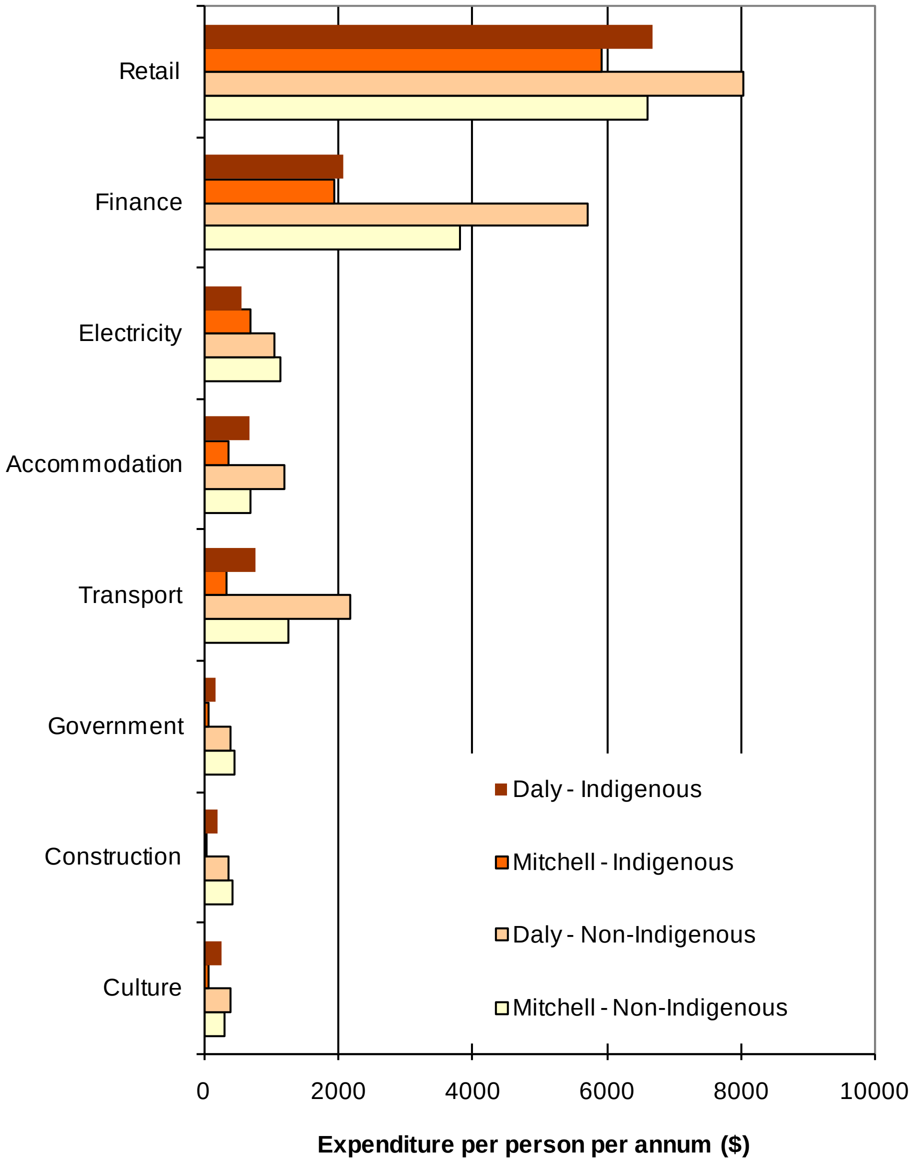


Figure 20 – Per person expenditure patterns in the Daly and Mitchell catchments compared with national data

This analysis again lends support to the hypothesis that the survey data are robust: expenditure patterns for Non-Indigenous households in the Mitchell and the Daly, are similar – albeit not identical – to those collected by the ABS (see Figure 20). But the analysis also allows one to make a striking observation: Indigenous households spend a much higher proportion of their total monies on food and beverages than do their Non-Indigenous counterparts. This is particularly evident in the Mitchell River Catchment; in this region almost 40 per cent of all Indigenous expenditure is on food and beverages compared to 20 per cent across all Australians. Part of this is likely to be attributable to the fact that Indigenous incomes are so much lower than those of Non-Indigenous Australians –

particularly in the Mitchell River – so that larger share of monies must go towards the purchase of necessities (see Table 6). Some of this may also be due to the relatively high price of food in remote areas.

Comparisons aside, before the expenditure data could be used within the WIO, it had to be grouped into sectors matching those of the model (see section 5.1). Expenditures on groceries, for example, had to be added to expenditures on fuel – contributing to expenditure within the retail sector. Figure 21 shows the total amount spent, per person, within each of the model's sectors, clearly demonstrating that most household expenditure occurs within the retail and finance sectors and that Non-Indigenous expenditure is greater than Indigenous expenditure.



* Retail includes Groceries, Tobacco, Clothing, Furniture, Fuel, Communications, Personal Care; ** Finance includes Insurance, Interest payments, Rent; *** Accommodation includes Accommodation, Cafes, Restaurants; ^Transport includes Cars, other transport, travel; ^^ Government, Education and Health includes School fees, Medical expenses; ^^^Construction includes Tradesperson

Figure 21 - Annual expenditure per person - by ANZSIC sector and catchment

Not only do the WIO tables need data that has been grouped according to ANZSIC sector, but they also need data on the proportion of total (household) income which is spent 'locally' within each ANZSIC sector (as compared to expenditure within and outside the region). Hence, the data underlying Figure 21 had to be transformed for use in the model. This was done using other information collected in the survey. Specifically, respondents were asked to provide information about how much of each type of good or service they purchased 'locally' by responding to the following question: (again, this is but an excerpt – see Appendix 1 for a complete copy of the questionnaire).

	Approximately how much of the money you spend on these goods and services, is spent with 'local' businesses? *Please tick appropriate box*							
	We buy **ALL** of these things from '**local**' businesses	We buy more than 75% of these things from 'local' businesses		We buy about half of these things from 'local' businesses		We buy less than 25% of these things from 'local' businesses	We **NEVER** buy any of these things from '**local**' businesses	**Where else do you buy these things? e.g. Darwin, Melbourne** (*please specify)*
Clothing and footwear	☐	☐	☐	☐	☐	☐	☐	
Fuel	☐	☐	☐	☐	☐	☐	☐	

Responses to this question were used to calculate λ_h – the proportion of goods and services purchased locally[28]. This information was then combined with information about weekly expenditure, to generate an estimate of weekly, local expenditure. As an explicit example, if the respondent indicated that they bought about half of their fuel locally, then $\lambda_{fuel} = 0.5$. If the respondent also indicated that they spent approximately $75 each week on fuel, then these amounts were multiplied to generate estimates of the amount of money which that householder spent 'locally' on fuel each week, e.g. $\omega_{fuel} = \varpi_{fuel} \times \lambda_{fuel}$ = $75 x 0.5 = $37.5. Different categories of expenditure were subsequently added to generate an estimate of the total amount of money which each household spent, locally, within each of the model's sectors (e.g. $\omega_{Retail} = \omega_{fuel} + \omega_{clothing\ and\ footwear} + \ldots$), and multiplied by 52, to generate an annual estimate of expenditure[29] – see Figure 22.

What is most interesting here, is the fact that in the Mitchell River Catchment the amount which the 'average' Indigenous person spends each year in local retail outlets (i.e. those within the Mitchell River Catchment) is greater than the amount which the 'average' Non-Indigenous person spends in local retail outlets. This is in spite of the fact that Non-Indigenous retail expenditure (per person, per annum) is greater than Indigenous expenditure (as shown in Figure 21). This occurs because Indigenous people spend a very large proportion of their money within their local community (particularly residents of Kowanyama, a community which can only be accessed by air during the wet, and whose residents do not have the option of travelling elsewhere to make purchases). This is not such a significant issue in the Daly River Catchment, where householders in Indigenous Communities (particularly those in the Daly River Community) can travel to Darwin for shopping with relative ease

[28] If they ticked the box on the far left hand side, λ_h was set equal to 1; if the next one along, λ_h = 0.875; then 0.75, 0.5, 0.25, 0.125, and 0.

[29] Questionnaires relating to 25 of the 49 Indigenous households in the Daly River were not completed with sufficient detail to allow one to calculate λ_h. These missing values were, therefore, replaced with the corresponding mean values of all other Indigenous Households in that catchment.

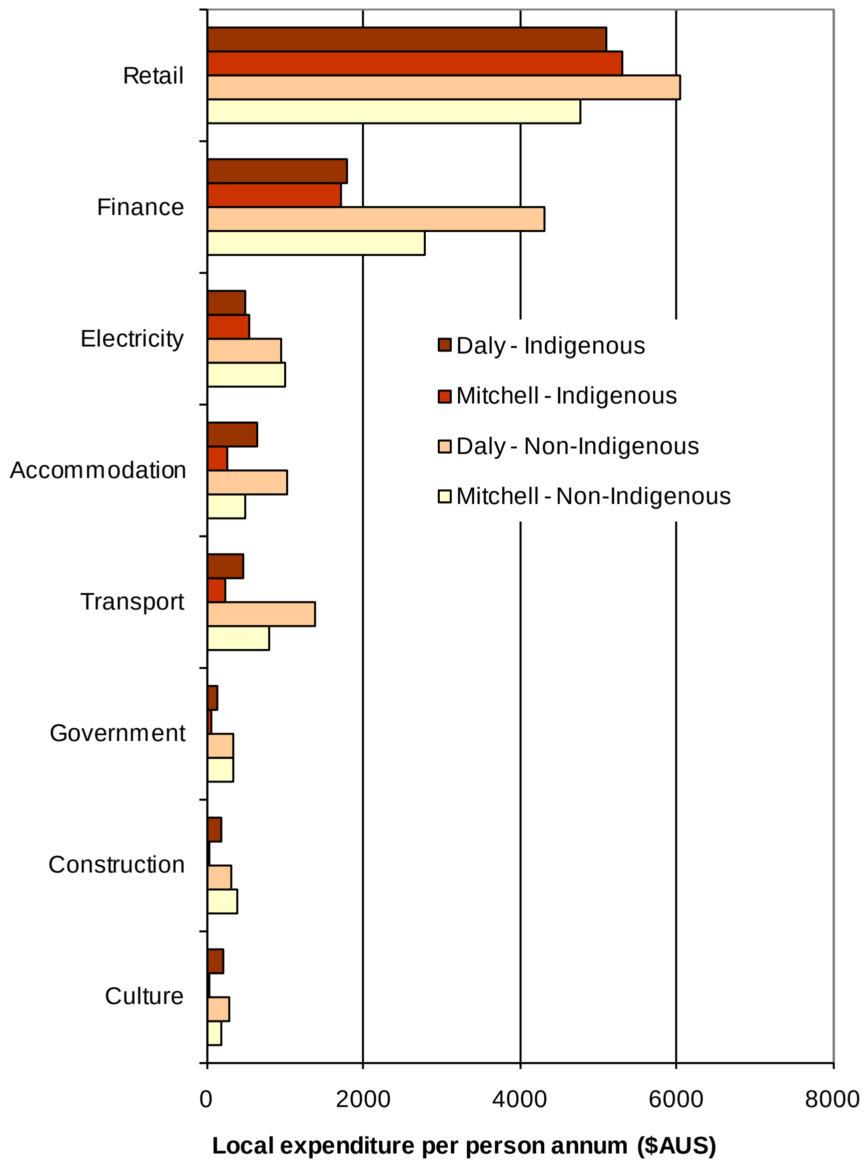


Figure 22 – 'Local' expenditure per person per annum

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As a final step in the preparation of expenditure data, researchers needed to divide (per person) annual local expenditure within each sector, by (per person) annual income to derive the consumption coefficients for use in the WIO tables. This required researchers to also look at household income (Table 6).

Table 6 – Mean Household Income and Mean Income per person – by Indigenous status and catchment (A$ per annum)

	Daly River Catchment		Mitchell River Catchment	
	Indigenous	Non-Indigenous	Indigenous	Non-Indigenous
Mean household income	75,071	88,994	34,697	55,346
Mean income per person	19,265	38,278	11,051	24,316

Both average household and average per-person income is greater for Non-Indigenous householders in the Daly, than in the Mitchell. This largely accords with expectations given the differences in sectors of employment (a higher proportion of government employees in the Daly than in the Mitchell) and in educational attainment (larger proportion of post-school qualifications in the Daly than in the Mitchell). Within each catchment, Indigenous people have individual incomes that are approximately half that of their Non-Indigenous counterparts.

Finally, consumption coefficients were calculated for each individual household, *k*, by dividing each household's local sectoral spending by their annual household income (Y^k): $C^k_{Retail} = \omega_{Retail} / Y^k$. The catchment-level consumption coefficients (c_{ij}) for each sector, *i*, for each type of household (*j* = 1, 2 for Indigenous and Non-Indigenous households) were calculated as the average consumption coefficient for each type of household:

$$c_{i1} = \frac{\sum_{k=1}^{n} C_{ki1}}{n} \qquad c_{i2} = \frac{\sum_{l=1}^{m} C_{li2}}{m} \qquad \textbf{Equation 10}$$

Where:

n = number of Indigenous households included in the survey for the particular region of enquiry.

m = number of Non-Indigenous households included in the survey for the particular region of enquiry.

These consumption coefficients are shown, in percentages, in Table 7.

Table 7 – Per cent of total income spent with LOCAL industries – by Indigenous status and catchment (%)

	Daly River Catchment		Mitchell River Catchment	
Sector	Indigenous	Non-Indigenous	Indigenous	Non-Indigenous
Agriculture	0.00	0.00	0.00	0.00
Mining	0.00	0.00	0.00	0.00
Electricity	2.52	2.46	4.75	4.12
Construction	0.93	0.83	0.08	1.55
Retail	26.44	15.83	47.91	19.57
Accommodation	3.32	2.67	2.32	2.02
Transport	2.44	3.59	1.99	3.26
Finance	9.26	11.23	15.35	11.49
Government	0.67	0.84	0.56	1.32
Culture	1.00	0.76	0.16	0.76
Total	**46.59**	**37.55**	**72.95**	**43.28**

Most evident here is the fact that in the Mitchell River, more than 70 per cent of Indigenous incomes are spent 'locally'. Of that, most expenditure (48 per cent of total income) goes to the retail sector (mainly on food purchases – as per Figure 18), with a relatively large share of income also going to the Finance sector (housing costs). This contrasts markedly with the expenditure patterns of Non-Indigenous households and of both types of households in the Daly River, where more than 50 per cent of all income 'leaks out' of the system (in the form of taxes, savings, and/or imports). Of the monies spent locally, the largest share of expenditures is within the Retail sector, followed by Finance – as is the case for Indigenous householders in the Mitchell. As noted earlier, it is thought that a large part of the 'unusual' spending patterns observed amongst Indigenous Householders in the Mitchell River is likely to be due to the fact that these communities are often 'cut off' from larger centres for long periods each year when the (gravel) roads are impassible as a result of wet-season rains.

5.2.3 **The matrix V: Value added ratios**

Information about the sector of employment for Indigenous and Non-Indigenous workers is collected in the ABS census every five years at a relatively fine geographic scale (collection districts). Researchers therefore identified collection districts that lay either partially, or entirely within each focal catchment, and ordered specialized tables[30] from the ABS, detailing the number of Indigenous and Non-Indigenous people employed in each of 25 different sectors (E_j^I and E_j^{NI} – see Table 8) as well as the median incomes obtained (Y_j^I and Y_j^{NI} – see Table 9).

Table 8 – 2006 Persons Employed – by ANZIC sector, catchment and Indigenous Status

Sector	Daly River Catchment		Mitchell River Catchment	
	Indigenous	Non-Indigenous	Indigenous	Non-Indigenous
Agriculture	34	398	43	861
Services to Agriculture; Hunting and Trapping		29	6	37
Forestry and Logging			3	6
Commercial Fishing				18
Mining	7	34	7	96
Manufacturing	3	81	6	149
Electricity, Gas and Water Supply		17		26
Construction	25	228	6	233
Wholesale Trade	20	96		93
Retail Trade	49	438	6	297
Accommodation, Cafes and Restaurants	28	226	8	214
Transport and Storage	15	159	6	116
Communication Services	4	32		24
Finance and Insurance		52		25
Property and Business Services	40	195	6	114
Government Administration and Defence	242	911	319	129
Education	48	352	23	209
Health and Community Services	266	388	51	244
Cultural and Recreational Services	14	47		57
Personal and Other Services	32	121	6	100
Non-Classifiable Economic Units	31	23	11	40
Not stated	66	48	42	45
Total	**924**	**3875**	**549**	**3133**

Source: Australian Bureau of Statistics (2009)

[30]To maintain respondent confidentiality, the ABS introduces small random errors in the data. When working with large numbers, this is clearly not an issue, but this can be a problem if working with small numbers. So rather than attempting to build the tables themselves (adding, possibly random, numbers from each relevant collection district), researchers decided to have tables custom built.. The ABS could thus work with small numbers, aggregating them into sectors for this project, without needing to introduce random errors to protect confidentiality. Readers can thus be reasonably confident that the large numbers are 'robust'. They are however cautioned to be careful when using numbers from these tables for sectors in which the number of employees is relatively small (e.g. less than 5).

Table 9 – 2006 Median weekly Income – by ANZIC sector, catchment and Indigenous Status[31]

Sector	Daly River Catchment		Mitchell River Catchment	
	Indigenous	Non-Indigenous	Indigenous	Non-Indigenous
Agriculture	543	606	426	444
Services to Agriculture; Hunting and Trapping		774	200	513
Forestry and Logging			900	849
Commercial Fishing				450
Mining	1562	1329	774	1106
Manufacturing	1150	766	325	539
Electricity, Gas and Water Supply		966		766
Construction	574	817	274	786
Wholesale Trade	369	741		549
Retail Trade	367	537	433	426
Accommodation, Cafes and Restaurants	414	577	737	478
Transport and Storage	566	653	700	638
Communication Services	1150	819		378
Finance and Insurance		661		700
Property and Business Services	716	723	999	522
Government Administration and Defence	272	1083	265	674
Education	822	949	411	663
Health and Community Services	238	748	443	549
Cultural and Recreational Services	719	687	0	466
Personal and Other Services	516	973	533	711
Non-Classifiable Economic Units	245	433	433	427
Not stated	222	627	194	265
Total	**338**	**797**	**309**	**537**

Source: (Australian Bureau of Statistics, 2009)

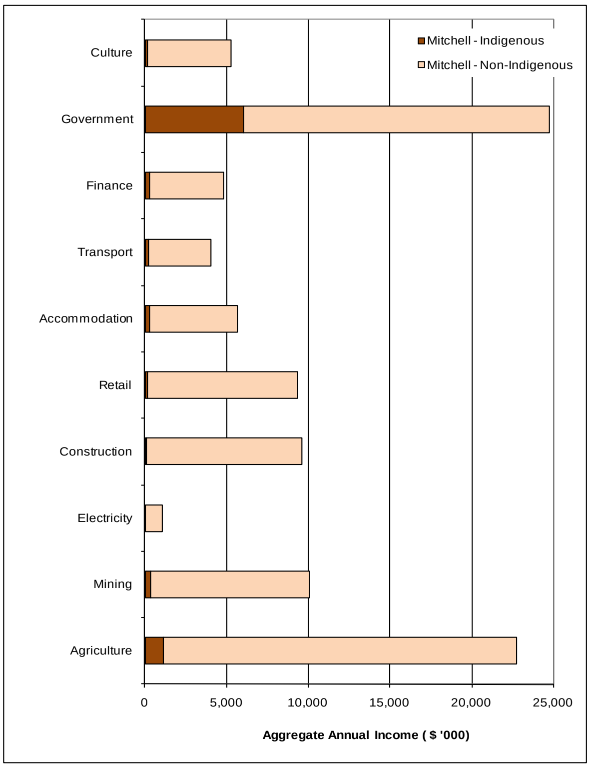
Researchers then generated an estimate of the total annual income going to each household group in each sector by multiplying the number of employees, by the weekly median income, by 52. These estimates were then aggregated into the 11 sectors relevant to the WIO – see Figure 23 and Figure 24.

The share of total income going to each household type from each sector (S_j^I and S_j^{NI}) was then calculated as:

$$S_j^{\ I} = \frac{E_j \times Y_j^I}{E_j^I \times Y_j^I + E_j^{NI} \times Y_j^{NI}}$$

$$S_i^{NI} = \frac{E_j^{NI} \times Y_j^{NI}}{E_j^I \times Y_j^I + E_j^{NI} \times Y_j^{NI}} = 1 - S_j^{\ I} \qquad \textbf{Equation 11}$$

[31] Interestingly, there are only three cases where Indigenous incomes are higher than Non-Indigenous incomes. And in all three cases, the relevant number of employees is 'small'. It thus seems likely that these cells have been 'randomized'; leaving some doubt as to whether these Indigenous employees really are paid more than their Non-Indigenous counterparts (or, indeed, whether those employees really exist). That said, the numbers are small – and are thus unlikely to bias results when aggregated and used within the WIO table.



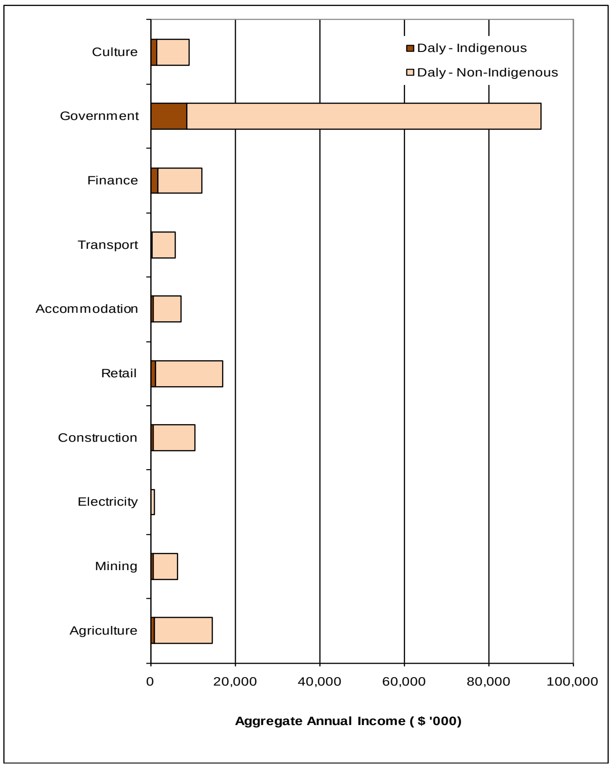


Figure 23 – Estimated aggregate income received from different business sectors by Indigenous Status – Mitchell River

Figure 24 – Estimated aggregate income received from different business sectors by Indigenous Status – Daly River

Estimates of the proportion of total sectoral income paid to Indigenous (and Non-Indigenous) households in the form of wages within each industry/sector, *j*, were then obtained by multiplying S_j^I (and S_j^{NI}) with the corresponding technical coefficient (estimated as per section 5.2.1)[32].

As is apparent from both Figure 23 and Figure 24, within each catchment the estimated share of income accruing to Indigenous Households is small – in the order of 9-10 per cent of all household income. This is despite the fact that Indigenous people comprise almost 30 per cent of the population in these regions. For the reasons discussed earlier, these estimates are unlikely to be exact measures of the true population parameters, primarily because of the 'undercount' problem associated with Indigenous people in the ABS Census. As such, these estimates are likely to understate the true incomes accruing to Indigenous people in these catchments. But whilst it is true to say that more accurate data from the ABS would, most likely, alter these estimates, such alternations are unlikely to substantively alter the key findings 'punchlines' here: namely that Indigenous people earn a disproportionately small share of total household incomes in these catchments.

5.2.4 **The vector w: Direct water use**

Considerable data exists regarding the water use of key industries at a national and state level, and there is clear guidance on methods for calculating water-use factors from IO tables (e.g. Kondo, 2005; O'Doherty and Tol, 2007). Guan and Hubacek (2008), for example, provide a very good framework for considering both water consumption and water availability within an IO model and, closer to home, Lenzen and Foran (2001) have published an IO analysis of Australian water usage. But although the ABS Water Account (2001 and 2005) reports on the sectoral water use at the state level, similar information was not available for our focal catchments[33].

[32] i.e. the proportion of total sectoral income which each sector *j* pays to the household sector.
[33] An important task for future research therefore, would be to collect regionally relevant data.

So in this project, water use coefficients had to be estimated 'from scratch'. This was done differently for households and industry: researchers used ABS water use data in conjunction with ABS industry output data to draw inferences about the plausible range of water-use coefficients for each sector; and survey data was used to estimate corresponding water use requirements in the Indigenous and Non-Indigenous household sector. Details of the way in which that was done are provided below.

5.2.4.1 Direct water use requirements - Industry

The Australian government has been publishing Water Accounts at the national and state level since 2000. The data provide information about state and territory level use and supply of self-extracted and mains waters as well as effluent reuse and the regulated discharge of household and industries (Australian Bureau of Statistics, 2004). The information released in the Water Accounts is sourced by the ABS from a range of state, territory, and local government agencies, water authorities and private enterprises (Australian Bureau of Statistics, 2004), and the accounts are compiled using the *International System of Integrated Environmental and Economic Accounting* (UN, 2003).

The ABS Water Accounts differentiate between (2004, p 4):

Total water use = Distributed water use + Self-extracted water use + Reuse water use

and

Water consumption = Distributed water use + Self-extracted water use + reuse water use – Water supplied to other users - in stream (non-consumptive) use.

Researchers involved in this project are primarily interested in consumptive water use, and therefore focused on the latter measure since the first measure includes water that an industry or household sector uses temporarily, and then returns to the environment (or elsewhere) for use by other sectors – e.g. water that is used to turn a water-mill, but which then continues on down-stream.

Water Accounts are available for 1993-94, 1996-97, 2000-01, and 2004-05. However the 2004-05 study only focused on four industry sectors; namely Agriculture; Mining; Manufacturing; and Electricity. As such, the 2004-05 publication did not have up-to date information on all sectors. Researchers therefore chose to use data from the 2000-01 National Water Accounts for both Queensland and the Northern Territory.

Table 10 summarizes the water consumed by industry sectors in both Queensland and the Northern Territory for the 2000-01 period – with data aggregated so as to align with the sectors used in our model (as per the discussion in section 5.1). In 2000-01, total water consumption in Queensland was 4.21GL while the total water consumption in the Northern Territory was 0.116GL. As can be seen from Table 10, the Agriculture sector is the greatest consumer of water in both regions accounting for 82 per cent and 61 per cent respectively, of total water consumption. This is consistent with national data where the Agricultural sector was also identified as the main water user, accounting for 67 per cent of all water consumption in 2000-01 (Australian Bureau of Statistics, 2004). Other large national consumers of water identified by the ABS include Households, Electricity, Manufacturing and Mining (Australian Bureau of Statistics, 2004). These sectors are also identified as the main water consumers in QLD and the NT.

Table 10 – 2000-01 Water consumption (ML, 2000-01) – by sector and state

Sector	Queensland	Northern Territory
Agriculture	3,456,159	70,377
Mining	290,028	13,687
Electricity	287,287	9,607
Construction	890	26
Retail	19,283	1,742
Accommodation	11,399	433
Transport	12,825	1,474
Finance	16,044	599
Government	35,432	16,001
Culture	75,998	1,593
Total	4,205,345	115,539

Source: Australian Bureau of Statistics (2004)

The water-use IO model requires data to populate the vector *W,* which gives details on the water use per $ of output for each sector. So the next step of the analysis required researchers to collect data on the $ value of each sector's output. Here, researchers used 2000-01 data (so as to be consistent with water use data) on industry Gross value added[34] at current prices - see Table 11.

Table 11 – Gross Value Added ($M, 2000-01) – by sector and state

Sector	Queensland	Northern Territory
Agriculture	5,201	380
Mining	18,662	3,508
Electricity	2,584	177
Construction	6,903	390
Retail	12,066	492
Accommodation	4,124	265
Transport	6,802	421
Finance	18,621	1,013
Government	20,475	1,751
Culture	3,527	252

Source: Australian Bureau of Statistics (2004)

Researchers could then derive the individual components of the water vector (w) for use in the model = total water consumption (Table 10) divided by GVA (Table 11) for each individual sector (see Table 12).

As one can see, water use per dollar of income varies greatly by industry sector. The Agriculture sector uses more water to produce one dollar of output than any other sector in both states while the Construction sector uses the least.

[34] Gross value added is the sum of wages, profits and indirect taxes and is the standard measure used in Australia used to represent the size of an economy or sector of the economy.

Table 12 – Litres of water consumed per $GVA – by sector and state

Sector	Queensland	Northern Territory
Agriculture	664.52	185.20
Mining	15.54	3.90
Electricity	111.18	54.28
Construction	0.13	0.07
Retail	1.60	3.54
Accommodation	2.76	1.63
Transport	1.89	3.50
Finance	0.86	0.59
Government	1.73	9.14
Culture	21.55	6.32

There are also differences across states. Agricultural producers in Queensland for example, use more than three times as much water per $ GVA as their Northern Territory counterparts. This is likely to be at least partially attributable to different climatic and rainfall conditions and partially attributable to differences in agricultural practices since different types of Agriculture have vastly different water-use requirements (see, for example, Lenzen and Foran, 2001). Queensland, for example, has more land with irrigated cropping and irrigated horticulture in contrast to Northern Territory (>10,000sqkm and <200sqkm respectively). QLD also has more intensive animal and plant production (see Table 13).

Table 13 – Land use in the Northern Territory

Land Use	Northern Territory square km	Queensland square Km	Northern Territory - % of total land area	Queensland - % of total land area
Nature conservation	69,289	79,501	5.1	4.6
Other protected areas	577,388	18,088	42.8	1.0
Minimal use	94,077	36,767	7.0	2.1
Grazing native vegetation	594,389	1,486,497	44.1	86.0
Production forestry	5	32,088	0.0	1.9
Plantation forestry	4	2,093	0.0	0.1
Grazing modified pastures	2,507	1,841	0.2	0.1
Dryland cropping	1,449	27,284	0.1	1.6
Dryland horticulture	3	208	0.0	0.0
Irrigated pastures	5	2	0.0	0.0
Irrigated cropping	73	9,820	0.0	0.6
Irrigated horticulture	102	1019	0.0	0.1
Land in transition	136	127	0.0	0.0
Intensive animal and plant production	74	2,544	0.0	0.1
Intensive uses (mainly urban)	2,673	3,798	0.2	0.2
Rural residential	352	3,086	0.0	0.2
Mining and waste	377	1,206	0.0	0.1
Water	4,630	23,342	0.3	1.3
Total	1,347,535	1,729,312	100.0	100.0

Source: Bureau of Rural Sciences (2009)

The most important point to be made here is that water consumption per dollar of output can, and does vary across sectors and regions. One cannot therefore assume that the water-use coefficients which apply to Queensland as a whole will also apply to the Mitchell, nor that those which apply to the Northern Territory as a whole will also apply to the Daly (although they are, perhaps, more likely to 'match' than the water use coefficients for Tasmania). Furthermore, one expects water use coefficients to vary over time, and in response to a wide range of external drivers such as climate, policy, and technology.

When conducting simulations, researchers therefore chose to use the state-wide water-use vectors from Table 12 to define a 'plausible' *minimum* and *maximum* water-use coefficient for each sector, within each catchment. In most cases, the *minimum* water-use coefficient was that of the Northern Territory estimates, the three exceptions being for the Retail, Transport and Government sectors – see Table 14. These coefficients were used in both the Daly River and the Mitchell river models.

Table 14 –Industry water Use Coefficients for WIO models

Sector	**Lower-bound water use coefficient** **(lowest water per GVA from** Table 12**)**	**Upper-bound water use coefficient** **(highest water per GVA from** Table 12**)**
Agriculture	185.20	664.52
Mining	3.90	15.54
Electricity	54.28	111.18
Construction	0.07	0.13
Retail	1.60	3.54
Accommodation	1.63	2.76
Transport	1.89	3.50
Finance	0.59	0.86
Government	1.73	9.14
Culture	6.32	21.55

5.2.4.2 Direct water use requirements - Households

As noted above, the ABS Water Accounts provide estimates of household water consumption at the national and state level. In their survey, household water use is based on the amount of water supplied to households by water providers as well as self-extracted water use. Self-extracted water use by household is calculated by applying average state and territory coefficients on the kilolitres of water used per person and applying this to the population known not to be served by water providers[35].

Rather than using these estimates, researchers involved in this project noted that they had to collect expenditure data from households. They therefore decided to include extra questions within that survey that allowed them to calculate household water consumption. As such, they used primary data to generate estimates of household water consumption, rather than secondary, ABS data, although the survey-based estimates were compared with ABS data to check 'plausibility'.

For the purposes of this report researchers used the ABS's definition of domestic water use, namely water used by households for human consumption (such as for drinking and

[35]Most of the data used by the ABS is collected through surveys of main water providers (i.e. Councils), although the post 2001 surveys have included a question on the prevalence of rain water tanks The uses of rain water tanks are currently poorly understood and are included as part of self-extracted water use. The ABS does recognize that its estimates on household self-extracted water use should be used with caution - and this could, potentially, be more of a problem in rural / remote areas where a larger proportion of households rely on bores and water tanks than in urban settings.

cooking) as well as water used by households for cleaning or outdoors (such as water for gardens and swimming pools). Recognizing that few respondents would be able to provide precise information about the water used by their household each year (particularly those living in regions without water meters), researchers designed a series of questions eliciting information about the extent to which various water-using appliances were used, as illustrated below[36]:

What type of washing machine do you have? ***Please tick appropriate box. If you do not have a washing machine, but use a Laundromat instead, then please tell us about the type of washing machine at the Laundromat***

☐ We do not have a washing machine – and wash our clothes by hand. ***(Please go to question 9)***

☐ Twin Tub ☐ Front Loader ☐ Top Loader

How many times per week does your household use a washing machine? ***Please tick appropriate box. If you do your washing at a Laundromat, please tell us how many times you use a washing machine at the Laundromat***

☐ We rarely use a washing machine (or do not have one)

☐ Once a week	☐ 4 times a week	☐ 7 times a week (approx once a day)
☐ Twice a week	☐ 5 times a week	☐ 14 times a week (approx twice a day)
☐ 3 times a week	☐ 6 times a week	☐ More than 3 times a day

This information was combined with information about the average water used by a range of different appliances compiled from the Melbourne's Household Water Use Calculator, Water Wise and Brisbane Water (Melbourne City Council, 2003; Waterwise Brisbane, 2008) (Table 15) to generate an estimate of total household water consumption. For example, if the respondent indicated that their washing machine was a front-loader and that they did approximately 3 loads of washing each week, then researchers were able to conclude that the household used approximately 300 litres per week of water for washing (3 x 100 litres). This information, was combined with other information about the number of people living in the house and the type of toilet for example, (which allowed researchers to generate an estimate of the amount of water used for the toilet per annum) to generate an estimate of the total water used per household per week <u>inside the home</u>.

Table 15- Calculation of average water use consumption per household

Appliance	Average litres of water consumed each time appliance is used	Frequency
Dual toilet	5	35 flushes/week on average
Non-dual toilet	11	77 flushes/week on average
Leaking toilet	308	Per leaking toilets weekly
Water saver showerhead	7.5	Per shower per minutes
Non water saver shower head	12.5	Per shower per minutes
Bath	96	Per bath
Running tap	5	Per running tap per minute
Leaking tap	200	Per leaking tap per day
Dishwasher	30	Per load
Handwashing dishes	40	Per day
Twin tub washing machine	40	Per load
Front loader washing machine	100	Per load
Top loader	150	Per load
Garden	1000	Per hour
Hosing paths/ driveways/cars	1200	Per hour

Householders were also asked about their water usage <u>outside the home</u> – using the question below (which also differentiates between wet season and dry season use, since that is likely to vary):

[36] see Appendix 2 for a copy of the survey.

Approximately how many hours per week do you use water to … (***Please fill a separate number for the wet and the dry season***)		
	In the wet season	In the dry season
Hose the driveway or wash the car	____hours per week	____hours per week
Water the garden *(please leave blank if you do not have a garden or if you live in an apartment)*	____hours per week	____hours per week
Fill a swimming pool *(please leave blank if you do not have a swimming pool or if you live in an apartment)*	____hours per week	____hours per week
Other ***(Please specify)***	____hours per week	____hours per week

Responses to this question were then combined with information from Table 15 to generate an estimate of the total quantity of water used per week by each household during the wet and the dry season.

Table 16 shows data on household water consumption in the Mitchell and Daly catchments. It is in the order of 200-260 litres per person per day during the wet season (with most water consumption for internal household use). In the dry season, this increases to between 370 and 790 litres per person – the extra consumption largely due to the extra water used outside the house (in the garden, for the swimming pool, etc). These estimates seem 'plausible' in so much as our lower, wet-season estimates roughly accord with household water consumption figures from the ABS's Water Accounts for Australia's South East – where rainfall has a more even temporal dispersion than Australian's North and may entice fewer householders to use significant quantities of water outside (e.g. Victorian water consumption was approximately 220 litres per person per day in 2001). Our upper estimates of household water consumption relate to the dry season in a hot climate (the Daly) and exceed the ABS's estimates of the average estimate of household water consumption in the Northern Territory (420 litres per person per day). This is not surprising, since the ABS's figures are a 'whole of year' estimate; one would expect dry-season consumption to exceed that of the wet.

Interestingly, in the Mitchell River Catchment daily inside water use is higher in Indigenous households than in Non-Indigenous households and most of the 'excess' is attributable to the use of water for showers. As clearly shown in the preceding sections, in that region Indigenous households earn substantially less than their Non-Indigenous counterparts and spend most of their income on 'basics' such as food and shelter. Qualitative information collected during interviews suggests that electricity is something of a luxury good in these communities: consequently many Indigenous people shower several times a day, as a way of keeping cool during the summer months.

Recognising that household water demand is every bit as likely to vary across a range of factors as industry water demand, researchers generated a range of per-person water consumption estimates:

Minimum annual water consumption = (Total daily water use during the wet) * 365

Maximum annual water consumption = (Total daily water use during the dry) * 365

Dividing these minimum and maximum estimates of household water consumption by per-person income, thus allowed researchers to estimate minimum and maximum water-use coefficients for each individual. This information was then grouped by Indigeneity, and averaged, to generate appropriate lower and upper bound estimates of household water-use coefficients for use in the WIO model – see Table 17. These coefficients were used in both the Daly River and the Mitchell river models.

Table 16 - Average litres of water used per person per day – by catchment and Indigenous status

Type of use	Daly River Catchment		Mitchell River Catchment	
	Indigenous	Non-Indigenous	Indigenous	Non-Indigenous
General Water Use	20.00	20.00	20.00	20.00
Wash Water Use	24.49	32.65	29.93	33.31
Dishwater Use	11.46	14.67	16.12	18.74
Shower Water Use	104.90	68.96	133.82	62.87
Toilet Water Use	50.63	50.61	50.16	48.43
Leaking Toilet Water Use	27.50	14.26	13.29	19.90
Leaking Taps Water Use	84.78	125.17	93.00	118.61
Bath Water Use	3.99	4.10	3.87	1.59
Total Inside Water Use	152.53	183.11	215.49	165.11
Outside water use during the dry	285.33	604.07	156.59	393.55
Outside water use during the wet	51.01	75.94	9.23	66.39
Total daily water use during the dry	437.86	**786.05**	372.08	**558.10**
Total daily water use during the wet	203.54	**259.05**	224.72	**230.94**

Table 17 – **Household water Use Coefficients for WIO models**

Household Sector	**Mean annual litres water used per $income – Mitchell River**	**Mean annual litres water used per $income – Daly River**	**Lower-bound water use coefficient (lowest of a, b)**	**Upper-bound water use coefficient (lowest of a, b)**
Indigenous Households			**3.70**	**14.45**
Wet season	7.42	3.70		
Dry season	14.46	7.05		
Non-Indigenous Households			**2.47**	**8.38**
Wet season	3.47	2.47		
Dry season	8.38	7.50		

5.2.5 The matrix E: Direct use of Indigenous and Non-Indigenous employees

The matrix E provides information about the number of employees (in this case, Indigenous and Non-Indigenous) per dollar of income earned by each sector. To calculate coefficients for this vector, researchers thus needed information on (a) the number of Indigenous and Non-Indigenous employees per sector; and (b) the output per sector, within each catchment.

Employment and GVA data was not available at the catchment level, so in the first instance, researchers used state-wide data to generate an estimate of the average number of employees per dollar earned within each sector for each state (specifically, they divided the total number of employees within each sector by each sector's GVA[37] - see Table 18 and Table 19).

[37] When undertaking a similar task for water-use coefficients, researchers were only able to obtain information on water use per sector during 2001. For consistency, it was therefore, decided to use income data for 2001 also. In this instance however, researchers were able to obtain information on employment per sector for 2006. So for consistency, they choose to use 2006 output data – although as in the water use case, they were again required to use state-wide GVA data.

Table 18 – 2006-07 GVA, Employment and Employment per $M GVA for QLD

Industry	GVA ($M, 2006) (1)	Employment ('000 persons) (2)	Employees per $M GVA (2) / (1)
Agriculture	6,234	76.6	12.29
Mining	36,079	221.8	6.15
Electricity	3,725	20.3	5.45
Construction	16,413	225.9	13.76
Retail	19,705	324.9	16.49
Accommodation	6,271	150.2	23.95
Transport	13,373	121.4	9.08
Finance	35,704	288.9	8.09
Government	35,381	561.5	15.87
Culture	5,611	129.1	23.01
Total	178,496	2120.6	11.88

Source: Australian Bureau of Statistics (2009)

Table 19 – 2006-07 GVA, Employment and Employment per $M GVA for NT

Industry	GVA ($M, 2006) (1)	Employment ('000 persons) (2)	Employees per $M GVA (2) / (1)
Agriculture	283	3.1	10.95
Mining	4,143	5.3	1.28
Electricity	292	1.6	5.48
Construction	1,021	7.5	7.35
Retail	721	12.8	17.75
Accommodation	367	8.7	23.71
Transport	770	5.6	7.27
Finance	1,805	12.6	6.98
Government	2,785	40.6	14.58
Culture	367	7.6	20.71
Total	**12,554**	**105.4**	**8.40**

Source: Australian Bureau of Statistics (2009)

Table 20 – 2006-07 Persons Employed per $M GVA – by sector, catchment and Indigenous Status

Sector	Daly River Catchment		Mitchell River Catchment	
	Indigenous	Non-Indigenous	Indigenous	Non-Indigenous
Agriculture	0.81	10.14	0.66	11.63
Mining	0.10	1.18	0.31	5.84
Electricity	0.00	5.48	0.00	5.45
Construction	0.73	6.62	0.35	13.41
Retail	2.03	15.72	0.25	16.24
Accommodation	2.61	21.10	0.86	23.09
Transport	0.63	6.64	0.45	8.63
Finance	0.95	6.03	0.29	7.80
Government	3.67	10.91	6.40	9.47
Culture	4.45	16.26	0.85	22.16
Total	1.50	6.90	1.66	10.22

These estimates were then converted into estimates of the number of Indigenous and Non-Indigenous employees per dollar of output using the data supplied by the ABS (Table 8) to apportion the total number of employees per $M of GVA (shown in Table 18 and Table 19) across household types (Table 20).

For example, the number of Indigenous employees used per dollar of GVA in the Agricultural sector in the Daly was calculated as:

$$\frac{\text{No of Indigenous employees working in the Agricultural sector (34)}}{\text{Total no of employees working in the Agricultural sector } (34+427)} \times \text{Employees per \$ GVA in the NT } (10.95) = 0.81$$

It is these figures, which comprise the coefficients of the matrix of (direct) employment requirements.

6 Results

6.1 Estimating multipliers

6.1.1 Type I and Type II income multipliers

The models described in the preceding section were used to assess the impact of a one-dollar increase in income (or final demand) in each of the 10 different sectors identified within the model. Mathematically, this is equivalent to 'simulating' a one-unit change in the vector $\Delta\begin{pmatrix} f \\ g \end{pmatrix}$ for each individual sector, and then using Equation 6 to estimate $\Delta\begin{pmatrix} x \\ y \end{pmatrix}$.

Figure 25 shows the aggregated regional effects that occur across all industry sectors (type I multipliers) and across all industry AND all households (type II multipliers) in both the Daly and the Mitchell.

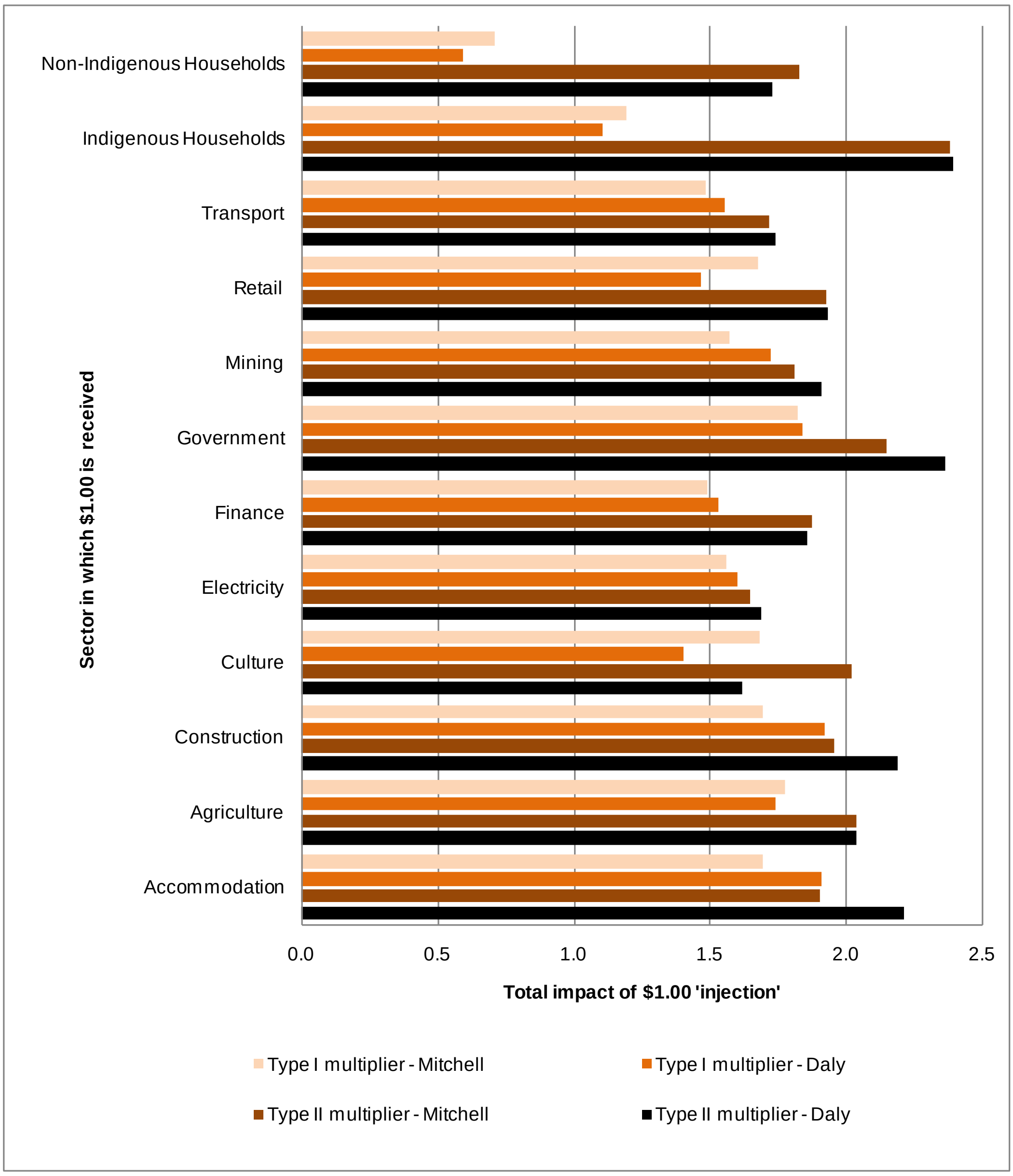


Figure 25 – Mitchell River and Daly River Multipliers Compared

To be more specific, the figure shows the (estimated) total regional impact of a $1.00 'stimulus' within each individual sector – assuming, of course, that all of the assumptions underlying the IO model (e.g. constant prices, constant technology, unlimited access to resources) hold true. Our estimates indicate, for example, that if the Daly River Accommodation sector were to receive an extra dollar of income, then the TOTAL change in regional income, after allowing for the endogenous 'flow on' spending effects in other businesses would be approximately $1.91 (the type I multiplier). If one allows for the endogenous 'flow on' spending effects from both businesses and households, then the total regional effects are closer to 2.2 (the type II multiplier). In the Mitchell River, the multipliers associated with the accommodation sector are somewhat smaller, at (approximately) 1.9 and 1.7, respectively, for the Type I and Type II estimates.

In addition to making specific observations, it is also possible to draw some more general conclusions here. Most obvious, perhaps, is the fact the multipliers are quite small – type I multipliers are generally between 1 and 1.5, with type two multipliers less than 0.5 units higher (the most important exception occurring when the $1.00 stimulus occurs in the Indigenous household sector). That these multipliers are small is expected given the relatively small size of the economies to which they apply.

Detailed results – showing the way in which the aggregate 'impacts' depicted in Figure 25 are distributed across each individual sector are presented in Table 21 (Mitchell River) and Table 22 (Daly River). These tables provide one with a much richer picture – clearly highlighting which sectors gain most/least from these changes.

As regards the Mitchell River, if one reads down the first column of Table 21, one can see that:

- A one-dollar increase in final demand within the Accommodation sector will generate a net increase in regional income of $1.90. Most of that money stays within the Accommodation sector ($1.01), although it must be understood that a full $1,00 of that $1.01 'stimulus' to the Accommodation sector is due to the initial 'injection' of funds. Only one extra cent accrues to the Accommodation sector via the multiplier process depicted in Figure 11 (i.e. the 'flow-on' impacts are just 1 cent in this case). It is the Finance sector, the Wholesale sector and Non-Indigenous households which benefit most from 'flow-on' effects: each receiving approximately 20 cents. Indigenous Households receive just one cent in flow-on effects; approximately one-half of one per cent of the total regional stimulus, and just one per cent of the total flow-on effects.

- The story is similar in other industries. As illustrated in columns 2, 3 and 4 which, respectively, show the impact of a one-dollar stimulus in the Agricultural, Construction, and Cultural sectors: the total, regional multiplier is close to 2; but just 0.01 accrues to Indigenous households in the form of increased incomes.

- The largest indirect increase in Indigenous incomes occurs if one stimulates the Government sector, but even there, the increase is just 5 cents.

Similar results obtain in the Daly River Catchment although (1) the size of the multipliers are generally a bit higher, and (2) Indigenous households generally receive between 2 and 5 cents of flow-on effects (rather than the 1-2 cents observed in the Mitchell).

Table 21 - MITCHELL RIVER - Total change in output/incomes following a one-unit change in final demand within a single sector

SECTOR IN WHICH IMPACT IS FELT	**SECTOR IN WHICH INITIAL ONE-UNIT ($1) CHANGE OCCURS**											
	Accommodation	Agriculture	Construction	Cultural + Personal	Electricity	Finance + Communications + Property + Business	Government + Education + Health	Mining + Manufacturing	Wholesale + Retail	Transport	Indigenous Households	Non-Indigenous Households
Accommodation	1.01	0.02	0.03	0.04	0.01	0.03	0.03	0.03	0.04	0.02	0.05	0.03
Agriculture	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.10	0.05	1.12	0.07	0.19	0.04	0.09	0.06	0.06	0.03	0.05	0.05
Culture	0.01	0.01	0.03	1.04	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
Electricity	0.12	0.06	0.06	0.08	1.07	0.05	0.07	0.05	0.07	0.04	0.10	0.07
Finance	0.18	0.14	0.16	0.16	0.10	1.16	0.23	0.14	0.18	0.14	0.28	0.19
Government	0.01	0.03	0.02	0.03	0.02	0.02	1.04	0.03	0.03	0.02	0.03	0.02
Mining	0.01	0.00	0.01	0.00	0.00	0.00	0.01	1.08	0.01	0.01	0.00	0.00
Retail	0.20	0.25	0.22	0.22	0.08	0.15	0.31	0.14	1.21	0.18	0.62	0.28
Transport	0.05	0.09	0.05	0.04	0.07	0.04	0.04	0.04	0.07	1.04	0.06	0.06
Indigenous Households	0.01	0.01	0.01	0.01	0.00	0.03	0.05	0.01	0.01	0.01	1.01	0.01
Non-Indigenous Households	0.20	0.25	0.25	0.32	0.08	0.35	0.27	0.23	0.24	0.22	0.18	1.11
TOTAL IMPACT	**1.9**	**2.03**	**1.96**	**2.01**	**1.63**	**1.88**	**2.15**	**1.82**	**1.93**	**1.73**	**2.39**	**1.83**

Table 22 - DALY RIVER - Total change in output/incomes following a one-unit change in final demand within a single sector

SECTOR IN WHICH IMPACT IS FELT	SECTOR IN WHICH INITIAL ONE-UNIT ($1) CHANGE OCCURS											
	Accommodation	Agriculture	Construction	Cultural + Personal	Electricity	Finance + Communications + Property + Business	Government + Education + Health	Mining + Manufacturing	Wholesale + Retail	Transport	Indigenous Households	Non-Indigenous Households
Accommodation	1.01	0.02	0.03	0.01	0.01	0.01	0.04	0.01	0.02	0.01	0.04	0.03
Agriculture	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.11	0.05	1.22	0.05	0.21	0.03	0.10	0.08	0.02	0.07	0.03	0.03
Culture	0.05	0.01	0.00	1.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01
Electricity	0.19	0.05	0.08	0.09	1.07	0.07	0.08	0.08	0.05	0.05	0.09	0.05
Finance	0.21	0.14	0.21	0.13	0.11	1.23	0.23	0.15	0.16	0.11	0.28	0.18
Government	0.02	0.03	0.04	0.02	0.03	0.04	1.04	0.01	0.02	0.02	0.03	0.02
Mining	0.01	0.00	0.02	0.00	0.00	0.00	0.00	1.05	0.00	0.00	0.00	0.00
Retail	0.27	0.23	0.22	0.07	0.08	0.11	0.26	0.18	1.15	0.26	0.58	0.22
Transport	0.04	0.09	0.10	0.04	0.07	0.03	0.08	0.15	0.03	1.03	0.05	0.05
Indigenous Households	0.03	0.02	0.02	0.03	0.01	0.04	0.05	0.02	0.04	0.02	1.03	0.01
Non-Indigenous Households	0.28	0.27	0.24	0.19	0.08	0.28	0.47	0.17	0.42	0.17	0.26	1.12
TOTAL IMPACT	**2.22**	**2.03**	**2.18**	**1.63**	**1.67**	**1.85**	**2.36**	**1.9**	**1.91**	**1.74**	**2.4**	**1.72**

In other words, it matters not whether a 'stimulus' (i.e. extra income) is delivered to private business (for example, in the form of more custom), or to private households (for example, in the form of a tax refund). The same general observation holds true: the sectors which gain the most from such a stimulus include Retail, Finance and Non-Indigenous Householders. Very little money ever flows from Non-Indigenous householders and/or businesses to Indigenous households.

In contrast, when Indigenous incomes are increased exogenously (by, for example, an increase in Centrelink payments), Non-Indigenous people capture more of the multiplier effects than do Indigenous people. The second last column of each table shows that a $1 exogenous increase in Indigenous incomes results in Indigenous people in the Mitchell and the Daly gaining a flow-on benefit of 1 cent and 3 cents, respectively, whereas Non-Indigenous people gain an increase in income of 18 and 26 cents, in those same catchments. Moreover, a one-unit change in final demand within the Indigenous households sector generates net increases of regional income of $2.39 and $2.40 respectively. This increase is the highest observed in our model compared with a one-unit change in any other sector of the regional economy. This is due to a difference in spending patterns: Indigenous households spend a higher proportion of their money locally than do either Non-Indigenous households or businesses and government organizations.

Evidently, in these two catchments, the Indigenous and Non-Indigenous economic systems are divided. And the divide is starkly asymmetric.

6.1.2 **Indigenous and Non-Indigenous Employment multipliers**

Just as one can use the models to assess the way in which the expansion of a particular sector will affect regional incomes, so too can one use the models to assess the way in which the expansion of different sectors is likely to affect employment. The models were thus used to look at the way in which a one-million dollar increase in the income (or, more precisely, final demand) of each of the 10 different sectors identified within the model would affect employment for both Indigenous and Non-Indigenous Households. Mathematically, this is equivalent to 'simulating' a one-million dollar change[38] in the vector $\Delta\begin{pmatrix} f \\ g \end{pmatrix}$ for each individual sector, and then using Equation 8 to estimate $\Delta E = e'\Delta\begin{pmatrix} x \\ y \end{pmatrix}$.

Figure 26 shows the aggregated regional effects that occur in the Daly, and can be interpreted as follows (assuming that there are no structural changes to the economy and/or changes in prices that might alter the relationships specified in the Input-Output tables) :

- If there were a $1million increase in the demand for goods and services provided by the accommodation sector (caused, perhaps, by growth in the tourism sector), then this would generate at approximately 30 new jobs.

- In contrast, a $1m increase in the final demand for goods and services provided by the mining and manufacturing sector would generate, in aggregate, closer to 7 jobs.

Figure 27 shows similar information for the Mitchell; here too there are significant differences between employment multipliers for different industry sectors. Evidently, those only interested in expanding regional ***income*** might, therefore, hold quite different views about which sectors that could or should be supported, compared to those interested in expanding regional ***employment***.

[38] A one million dollar change was used in place of a $1 change since numbers would otherwise be too small to measure.

Also evident in both charts, is the sharp contrast between the size of the employment multipliers associated with Indigenous and Non-Indigenous persons. It matters not which sector is expanded: job growth in the Indigenous sector is always significantly less than in the Non-Indigenous sector. That said, Indigenous employment multipliers in the Daly are generally higher than in the Mitchell, an entirely expected result given that the data used to populate the model (detailed in section 5.2.5) showed higher Indigenous involvement in the labour market in the Daly River Catchment than in the Mitchell. Indeed in the Mitchell River Catchment, it seems that Indigenous job growth is only associated with growth of the Government sector (although even here, the Indigenous employment multiplier is significantly less than the Non-Indigenous employment multiplier). These figures thus serve to confirm earlier observations regarding the disparate effects of economic development on these two groups given the current socio-economic structure (assumed constant in IO analysis).

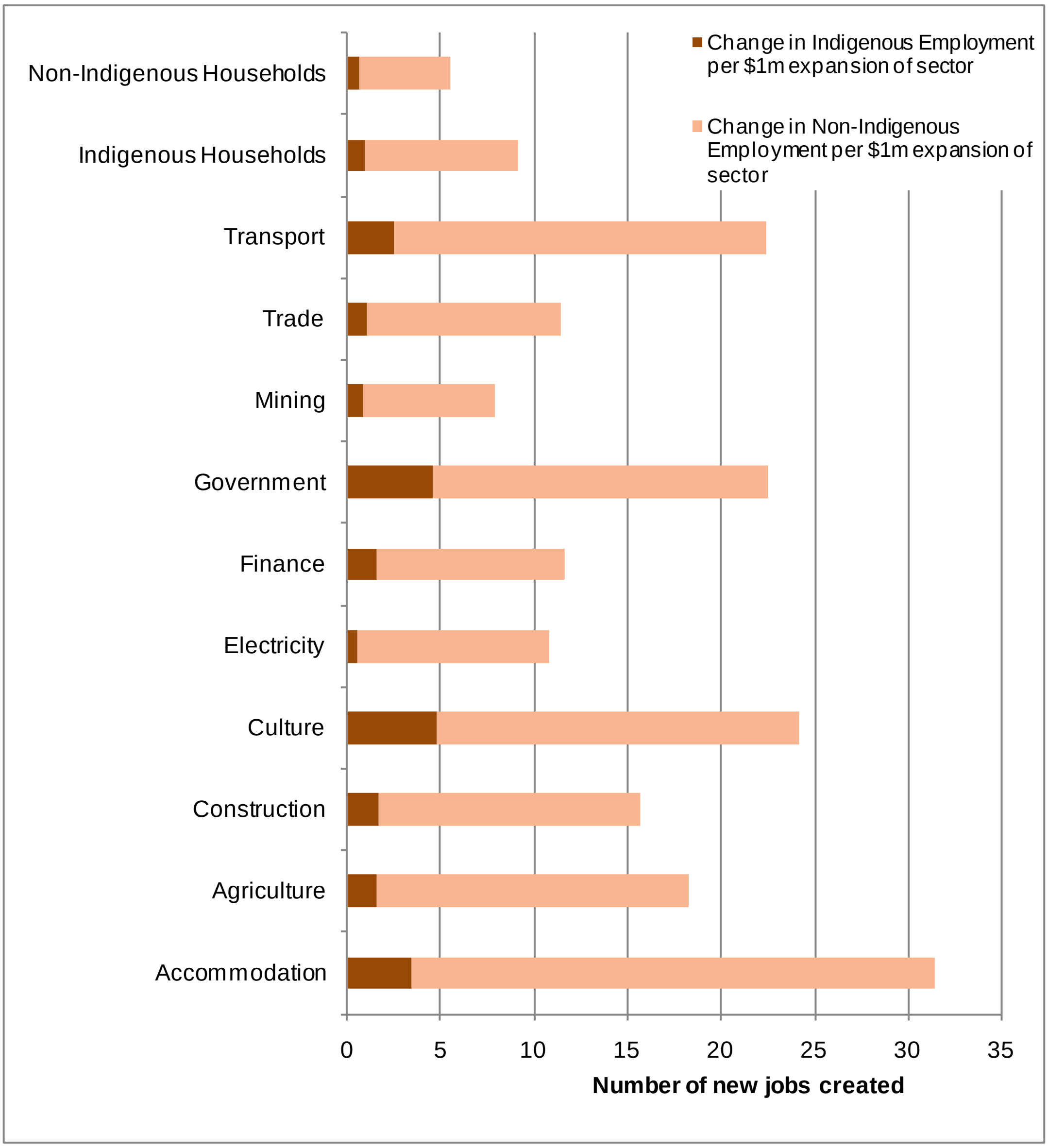


Figure 26 – Indigenous and Non-Indigenous employment 'multipliers' by sector – Daly River

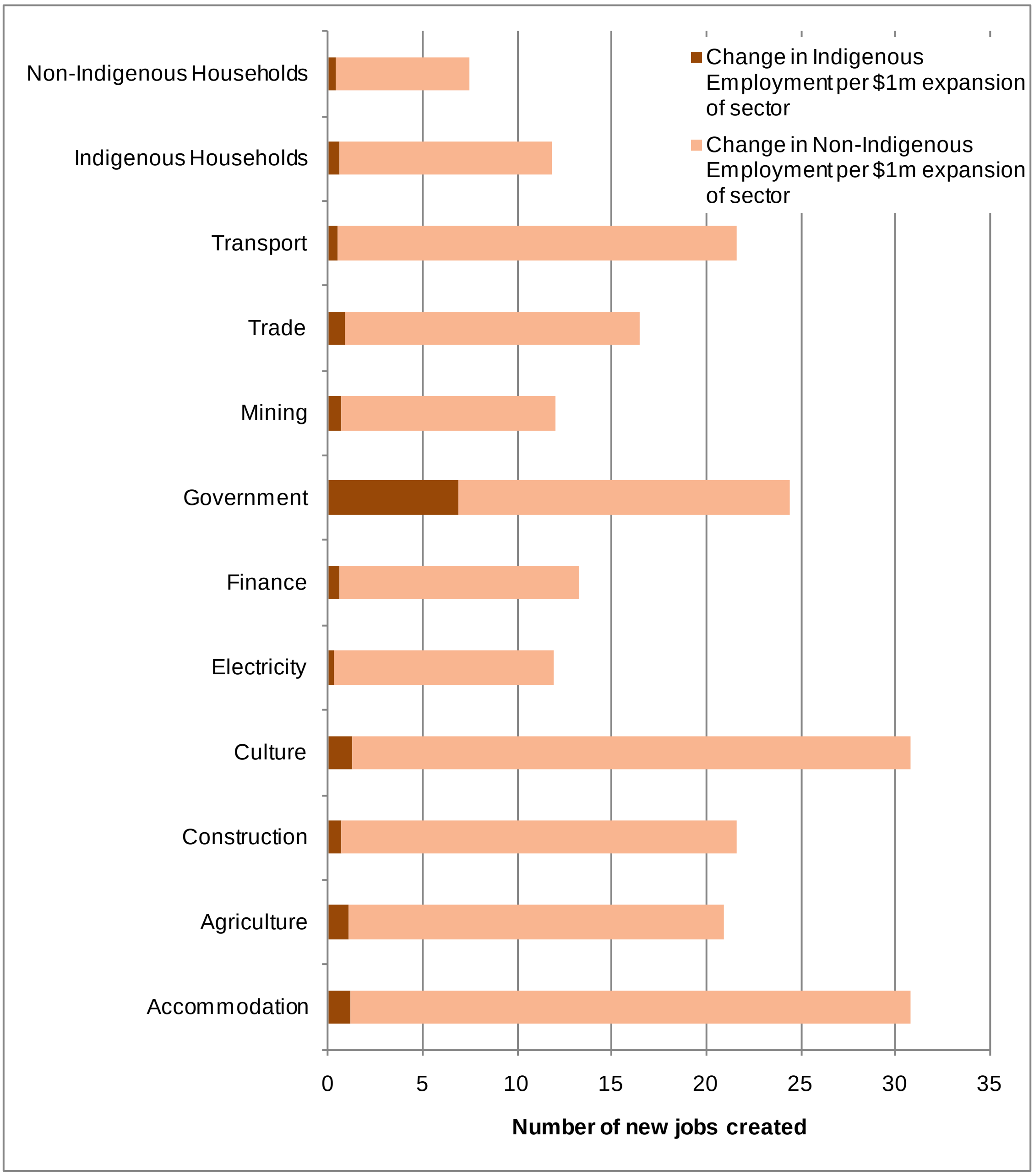


Figure 27 – Indigenous and Non-Indigenous employment 'multipliers' by sector – Mitchell River

6.1.3 **Water multipliers**

Researchers also used the models to assess the way in which the expansion of a particular sector would affect water demand – using, as discussed earlier, both 'upper bound' and 'lower bound' estimates of water use coefficients. Here, the models were used to look at the way in which a one-million dollar increase in the income (or, more precisely, an increase in final demand) in each of the 10 different sectors identified within the model would affect water demand assuming both a low-water and high-water use coefficients. Mathematically, this is equivalent to 'simulating' a one-million dollar change in the vector $\Delta\begin{pmatrix} f \\ g \end{pmatrix}$ for each individual sector, and then using Equation 7 to estimate $\Delta W = w'\Delta\begin{pmatrix} x \\ y \end{pmatrix}$. Figure 28 and Figure 29, respectively, show the aggregated regional effects that occur in the Daly and the Mitchell.

Most evident from these charts, is the fact that the aggregate water multipliers associated with the Agricultural sector dwarf all other multipliers – although considerable care must be taken when interpreting data relating to the Mining and Manufacturing sector: as noted by the NALW taskforce (2009, p 23) "mining and resource projects are generally excluded from water resource accounting, exact water use estimates for this industry are not readily available". As such, the estimates presented here may understate – perhaps grossly – actual figures for the mining sector.

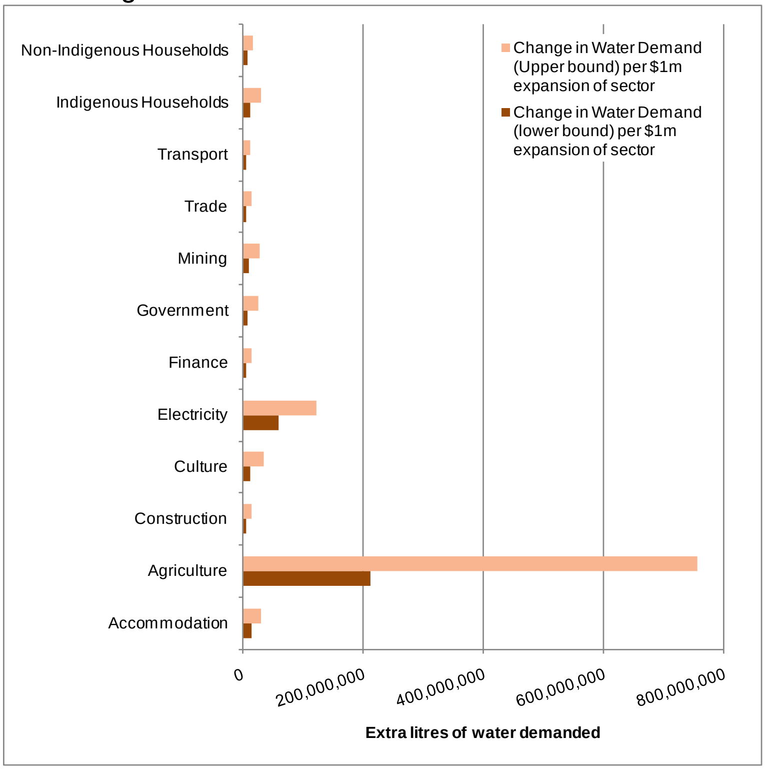


Figure 28 – Water 'multipliers' by sector – Daly River

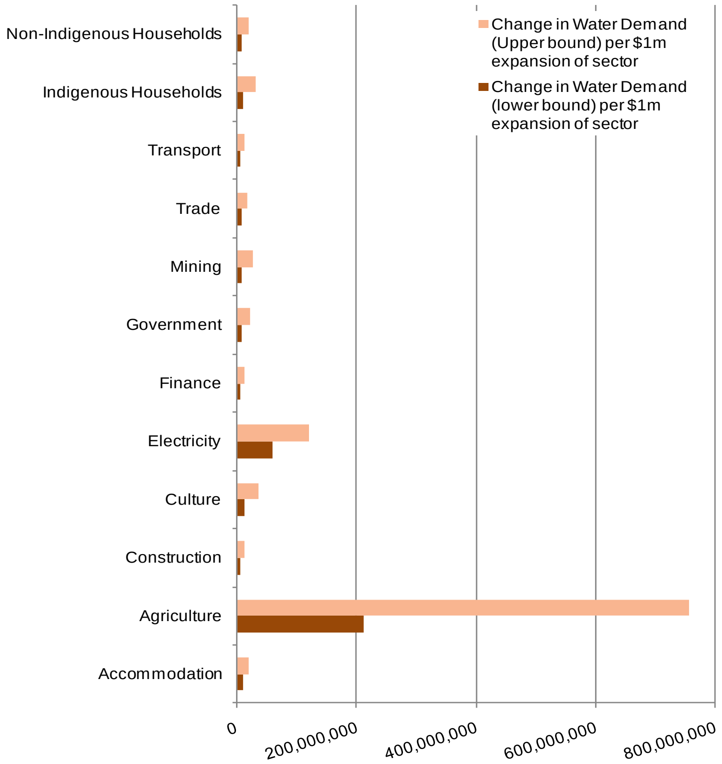


Figure 29 – Water 'multipliers' by sector – Mitchell River

Also clearly evident from these figures is the difference between multipliers estimated using upper and lower-bound water use coefficients. To the extent that water is at least partially substitutable with other resources (e.g. it is possible to reduce water use and still grow certain types of plants by, for example, mulching, or applying water at critical phases of a plant's growth cycle), then these figures clearly illustrate the potential importance of water-saving technologies. This is particularly so in the agricultural sector, where the water-use multipliers differ by orders of magnitude.

Moreover, despite the fact that there are some locational differences in the income and employment multipliers associated with any given sector (e.g. Indigenous employment multipliers are generally higher in the Daly then in the Mitchell), differences in the water multipliers are negligible. Evidently, it is the differences in water use coefficients, NOT differences in socio-economic structure which serve to explain most variation in these water multiplier estimates.

6.2 Simulating the effects of different types of growth

The WIO models were used to model some of the economic impacts and also the consumptive water-use impacts of different types of growth. Details of the way in which these growth-scenarios were developed and analyzed are presented in the following sub-sections.

6.2.1 **Establishing a baseline**

As discussed in section 4.2, IO models are not able to capture a range of real world 'complications' and feed-backs (such as changes in prices that occur in response to changes in demand, technology, etc). One therefore needs to be careful when interpreting the results of simulations since absolute numbers will be misleading (they are likely to over-estimate the final, aggregate impact of changes). Furthermore, it is difficult to determine the significance of reported changes without having some baseline with which to compare them: losing three jobs from a base of 1000 does not seem like much, but to lose three jobs from a base of 10 is significant.

Rather than reporting modeling results as a series of final estimates/numbers (which gives the impression that the modeling exercise is more precise than is actually the case), researchers therefore decided to report results in relative terms – e.g. showing the way in which development of type A, is likely to change employment as compared to the way in which development of type B is likely to change employment.

The first step of the modeling exercise thus required researchers to establish starting-point (or base year) values for key variables, as detailed below. In all cases, this was assumed to be 2006, since that is the year during which most of the data that populate these models were collected.

6.2.1.1 Estimating employment by sector by catchment, 2006

The ABS census data that were purchased to populate the vector V (see section 5.2.3, Table 8) were also used as the starting point estimates of employment in each sector for each catchment, and each household type (i.e. Indigenous and Non-Indigenous).

6.2.1.2 Estimating household Income by household type by catchment, 2006

Researchers used data collected from the household survey, to estimate Indigenous and Non-Indigenous household Incomes. In each catchment, aggregate household income was calculated as: average per-person income x estimated resident population[39] - see Table 23 .

[39] The ABS income data purchased to populate the vector V only provided information about the income which householders earn from industry, and may, therefore, have omitted income from other sources. Hence the decision to use survey data in this instance.

Table 23 – Estimated Household Income by catchment and Indigenous status (A$ per annum)

	Indigenous Households	Non-Indigenous Households	Total income from all households
Daly River Catchment	32,645,393	194,990,433	227,635,826
Mitchell River Catchment	13,813,131	100,451,204	114,264,335

6.2.1.3 Estimating industry output per sector by catchment, 2006

In the Mitchell River, data from Table 18 (which provides estimated GVA and employment for QLD) were used to estimate GVA per employee in each sector for QLD as a whole. These ratios were then multiplied by the number of employees in the Mitchell, to generate an estimate of GVA for each sector in the Mitchell[40] (see Table 24).

Table 24 – Estimating industry GVA for the Mitchell River

Industry	**Queensland GVA per employee (calculated by dividing column 1 of** Table 18 **by column 2)**	**Mitchell River Employment (persons, 2006)**	**Implied Mitchell River GVA ($M, 2006-07)**
Agriculture	81,384	974	79
Mining	162,665	258	42
Electricity	183,498	26	5
Construction	72,656	239	17
Retail	60,649	396	24
Accommodation	41,751	222	9
Transport	110,157	122	13
Finance	123,586	169	21
Government	63,012	975	61
Culture	43,462	163	7
Total	84,172	3544	280

There are no publically available data on GVA for the same geographic area as that covered here, during 2006. As noted earlier, the (Queensland) Office of the Government Statistician (OGS) released a set of regional IO tables that were derived from data collected in 1996/97 (OGS, 2004). And these tables provide estimates of sectoral output. However the boundaries of the Statistical Divisions for which the Queensland regional tables were built do not match the biophysical boundaries of our focal region: the Mitchell River catchment spans part of both the North West and the Far North Statistical Divisions. As such, it is not possible to validate the estimates presented in Table 24 by comparing them to other figures.

Similar procedures were used to estimate the GVA per sector in the Daly (Table 25). Here too, it was not possible to find estimates of GVA that are directly comparable to these, because the regional boundaries used by agencies responsible for the collection of economic data do not coincide with those of biophysical river catchments. However, it was possible to find estimates of GVA per sector for the entire Katherine Region – a region that stretches across the entire NT below Darwin and above Alice Springs. The last column of Table 25 presents the NT government's estimates of gross regional product (GRP) by sector for that region. That the estimates generated in this report are, in all cases, smaller than those of the entire Katherine region is expected: the Daly River Catchment is a subset of the Katherine Region. As such, these estimates seem 'plausible'.

[40] This approach requires one to assume that worker productivity is the same in each sector in the Mitchell River Catchment as it is in QLD.

Table 25 – Estimating industry GVA for the Daly River

Industry	Northern Territory GVA per employee (calculated by dividing column 1 of Table 19 by column 2)	Daly River Employment (persons, 2006)	Implied Daly River GVA ($M, 2006-07)	NT Government estimates of the GRP of Katherine Region[41]
Agriculture	91,290	461	42	73
Mining	781,698	125	98	292
Electricity	182,500	17	3	22
Construction	136,133	253	34	57
Retail	56,328	603	34	39
Accommodation	42,184	254	11	23
Transport	137,500	174	24	25
Finance	143,254	323	46	56
Government	68,596	2207	151	253
Culture	48,289	214	10	21
Total	119,108	**4631**	**454**	**861**

6.2.1.4 Estimating total water consumption per sector by catchment, 2006

The upper and lower-bound water use coefficients estimated in section 5.2.4 were multiplied by estimates of GVA during 2006 to generate upper and lower-bound estimates of the total amount of water consumed by each sector within each catchment. For householders, upper and lower bound estimates of total annual water use were generated by multiplying daily dry-season (upper-bound) and daily wet-season (lower-bound) estimates of per-person water use (see Table 16) by 365 and by estimates of the total population (Table 1) for each household type (i.e. Indigenous and Non-Indigenous). These estimates are presented in Table 26.

In 2006/07 an estimated 1,085 ML of water was used from the Tindall Aquifer for 'public water supply'; an additional 12,456 GL was used for Agriculture (including Horticulture), with 1,195 GL used for Industry, and 1,128GL used for Rural Stock and Domestic purposes[42]. At close to 16GL in total, this is higher than the lower bound estimates of water use (9.7GL) and just under one-half of the upper bound estimates of water use (34.2GL) for the entire Daly Catchment during 2006. As such, it seems that the actual quantity of water used in this catchment during 2006 is likely to be between the upper and lower bound estimates presented here. These measures are not precise, but in this context it seems that they are, at least 'plausible'. As such, researchers chose to use the mid-point of each range for each sector as the baseline estimate: giving an overall estimate of annual water use in the Daly and the Mitchell during 2006 as approximately 22GL and 36GL, respectively.

[41] Katherine Economic Development Committee and Department of Regional Development, Primary Industry, Fisheries and Resources (2008)
[42] Department of Natural Resources, Environment, The Arts and Sport, 2009, p.13

Table 26 – Estimated total water consumption by sector and by catchment (ML, 2006)

	Daly River Catchment		Mitchell River Catchment	
Sector	Lower bound	Upper bound	Lower bound	Upper bound
Agriculture	7,794,223	27,966,140	15,145	25,619
Mining	381,239	1,518,556	14,680,611	52,674,915
Electricity	168,394	344,933	1,158	2,239
Construction	2,296	4,441	44,783	152,651
Retail	54,282	120,261	258,951	530,429
Accommodation	17,507	29,616	12,350	17,996
Transport	45,110	83,766	106,316	561,417
Finance	27,361	39,867	163,742	652,220
Government	261,983	1,383,447	38,382	85,036
Culture	65,325	222,671	25,339	47,053
Indigenous Households	205,046	441,090	101,544	168,132
Non-Indigenous Households	684,566	2,077,216	359,257	868,197
Total	9,707,332	34,232,004	15,807,578	55,785,904

6.2.2 **Specifying the growth scenarios**

6.2.2.1 The demographic scenario

This scenario assumes that it is ONLY household income/expenditure that changes, and that these changes are a direct function of population changes – as predicted by Carson et al., (2009). A summary of their key observations with respect to the way in which population has changed over the last ten years is reproduced in Table 27. These changes were used to determine the implied annual growth rate, and the associated change in population between 2006 and 2007. The predicted changes in population were multiplied by expenditure figures (section 5.2.2.5) to estimate the associated changes in expenditure:

- average expenditure per Indigenous person * Δ Indigenous population;

  and
- average expenditure per Non-Indigenous person * Δ Non-Indigenous population.

These projected changes in expenditure (i.e. an annual contraction of household expenditure equal to approximately $1 milion in the Daly River and $0.5 million in the Mitchell) were differentiated by sector and used to define elements of the vector $\Delta\begin{pmatrix} f \\ g \end{pmatrix}$ - the change in final demand likely to occur as a result of changes in household expenditure associated with population (assuming all else constant). Equation 6 was then used to calculate the total change in regional output that could occur in response to that change in final demand.

Table 27 – Estimating the change in household expenditure that is likely to occur in conjunction with changes in population – by catchment

	Daly River Catchment	Mitchell River Catchment
Estimated Resident Population 2006		
Indigenous	3111	1250
Non-Indigenous	5094	4131
Not stated	957	275
Total	9162	5656
Population change 1996 – 2006		
Indigenous	24.7%	-25.6%
Non-Indigenous	-17.7%	-2.8%
Total change (% changes of each sub-group weighted by population)	-3.0%	-7.0%
Implied annual growth rate[43] 1996 – 2006		
Indigenous	2.23%	-2.91%
Non-Indigenous	-1.93%	-0.28%
Total (% growth rate of each sub-group, weighted by population)	-0.30%	-0.72%
Implied annual change in population 2006 – 2007		
Indigenous	69	-36
Non-Indigenous	-98	-12
Total	-29	-48
Implied annual change in household expenditure ($ '000)		
Indigenous household expenditure	$623	-$294
Non-Indigenous household expenditure	-$1438	-$124
Total	-$815	-$418

6.2.2.2 1.5 per cent growth across all industries

The 2009-10 budget[44] forecasted economic growth of approximately 1.5 per cent over the 2010-11 financial year. This particular scenario replicates that, assuming that each sector within each of the focal catchments grows by 1.5 per cent each year. Consequently, for this scenario the elements of the vector describing the initial change in final demand were calculated as:

- $\Delta\begin{pmatrix} f \\ g \end{pmatrix}$ = 0.015 x estimated 2006 GVA for each sector[45]

6.2.2.3 5 per cent growth in Agriculture

As highlighted in the discussion of section 2.2, Agriculture is an important industry in Northern Australia, as well as in our focal catchments. In 2006, the sector was responsible for more than 27 per cent of all employment in the Mitchell River and our estimates of

[43] Calculated as: $(pop2006/pop1996)^{0.1} - 1$
[44] (Commonwealth of Australia, 2009)
[45] Estimated in the last column of Table 24 and Table 25

regional GVA indicate that Agriculture contributed more than 25 per cent of all GVA in this area. Using GVA as a measure, Agriculture can thus be viewed as the single most important sector to the Mitchell. Although the sector is relatively less important in the Daly River – which is almost entirely dominated by the Government sector – the Northern Land and Water Taskforce (2009) clearly singles out Agriculture as a sector which is of vital importance to the future economic growth of the region, as highlighted by the following excerpts from the report:

> *Irrigated Agriculture*
>
> *The potential for growth in groundwater irrigable land in Northern Australia is estimated at between 100 and 200 per cent, or around 20 000 – 40 000 hectares.*
>
> *…The Daly, Wiso and Georgina groundwater provinces in the Northern Territory and North western Queensland were assessed in the Science Review as having high prospectivity and together might be expected to sustain around half of the estimated total area of groundwater-irrigable land across the North — that is, around 20 000 – 30 000 hectares. <u>The Science Review also indicated that the Wiso and Georgina groundwater provinces are large, underlying multiple surface catchment boundaries. They extend from near Mataranka, south east of Katherine, well south and east across the Barkly Tablelands almost to Mt Isa, and south well beyond the Northern boundary of the Tanami desert. Even the smaller Daly province, which is critical to perennial river flows in the Daly catchment, extends across the Timor Sea and Gulf of Carpentaria drainage divisions.</u> The extensive area of these groundwater resources and their critically important interconnection with surface water flows need to be thoroughly assessed prior to any major extractions commencing.*
>
> *The Northern beef cattle industry*
>
> *The Northern beef cattle industry involves around 60 per cent of the land area across Northern Australia (90 per cent if Indigenous pastoral land is included) and accounts for around 5 per cent of jobs. It is a major part of the North's contemporary history, economy, culture, and social and physical landscape. The pastoral industry has been and will continue to be critically important to the future of the North. Currently the North carries about 30 per cent of the nation's cattle and produces 80 per cent of Australia's live cattle exports, worth about $300–400 million a year. Positive opportunities exist to expand production from the Northern beef industry, including among Indigenous-owned properties, through changing enterprise structure and increasing intensification. <u>Leading producers in the Northern Territory, Queensland and Northern Western Australia advised the Taskforce there is scope to more than double production from Australia's Northern beef cattle herd, and possibly lift output as much as fourfold in value in some areas</u>.*

It therefore seemed sensible to ensure that at least one scenario focused on Agriculture – and in this case, we assumed 5 per cent growth per annum. Starting from a baseline (2006) estimate of GVA ≈ $79 million in the Mitchell, 5 per cent annual growth would effectively 'double' and then quadruple the size of the industry within approximately 15 and 30 years respectively. A 5 per cent growth rate thus seems to fit, broadly, within the Taskforce's projections. Thus, for this 'agricultural' scenario the elements of the vector describing the initial change in final demand were calculated as:

- $\Delta\begin{pmatrix} f \\ g \end{pmatrix}$ = 0.05 x estimated 2006 GVA for Agriculture[46]

6.2.2.4 5 per cent growth in Mining

The socio-economic profiles presented in section 2.2 indicate that mining does not currently account for a substantial proportion of employment in either of the focal catchments – although its overall contribution to GVA is larger. However, as shown in Figure 30, resources have been identified as being 'available' in the upper reaches of the Mitchell, and in some parts of the Daly. That, coupled with the fact that the world is currently in the grips of a commodities boom, highlights the importance of having at least one scenario focus on the mining sector.

[46] From the last column of Table 24 and Table 25

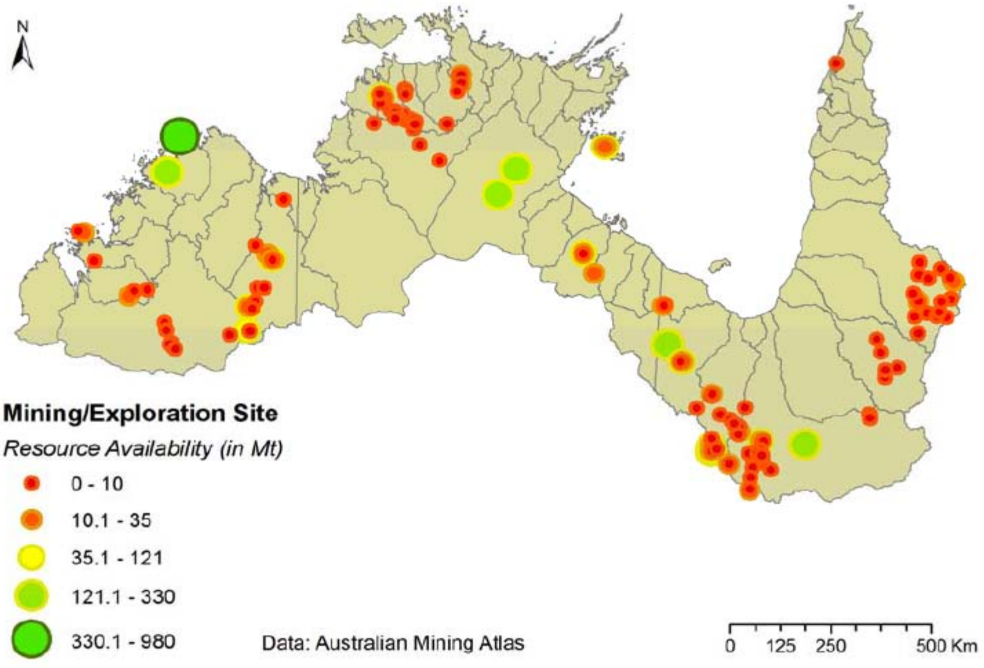


Figure 30 - Mining/Exploration Sites in the TR region
Source: Figure 14 from Larson and Alexandridis (2009, p 30)

To maintain consistency with the previous scenario, this scenario assumes that the mining sector grows at five per cent per annum. Hence, the elements of the vector describing the initial change in final demand were calculated as:

- $\Delta\begin{pmatrix} f \\ g \end{pmatrix}$ = 0.05 x estimated 2006 GVA for Mining[47]

6.2.2.5 5 per cent growth in Tourism

Carson et al., (2009) noted that there had been little to no change in either domestic or international tourism numbers in the TRaCK region in the ten years prior to 2006. They therefore concluded that the prospects for significant growth in that industry in the near future are small. Indeed, the one consistent trend apparent in the data considered by Carson et al., (2009) was the increased urbanisation of tourism, with smaller numbers venturing beyond regional centres each year. Nevertheless, as noted by the Northern Land and Water (NLAW) Taskforce (2009, p 16), "tourism offers development opportunities in conjunction with other major industry sectors in Northern Australia, such as commercial and recreational fishing, beef cattle, Indigenous culture and conservation. There is also potential for growth in core tourism markets, such as scenic and experiential tours". Consequently, it seemed appropriate to have at least one scenario focusing on Tourism.

The key problem here, of course, is that there is no single sector in the IO model that is directly attributable to tourism – it is an industry that relies upon several related sectors including Accommodation, Transport and Retail. Moreover, there is very little data about the 'impact' of tourism at a fine geographic scale; most tourism data is collected for relatively large regions (e.g. for statistical divisions, or at a state-wide level). Consequently, it is difficult to tell what the 'baseline' tourism expenditure is, from which to determine the change in final demand associated with an x per cent growth in that sector. However, the ABS regularly produces Tourism Satellite Accounts (ABS, 2010) – accounts which identify the tourism share of industry GVA, and it was possible to use this information to draw inferences

[47] From the last column of Table 24 and Table 25

about the likely contribution of tourism to the GVA of individual sectors in the focal catchments. Specifically, data from the ABS's 2005-06 Tourism Satellite Accounts were aggregated, to calculate the 'share' of GVA attributable to tourism in each of ten sectors used within the WIO models for Australia as a whole. In the absence of more accurate regional data, researchers assumed that these 'shares' roughly apply in the focal catchments, and then multiplied the Australia-wide 'shares' by estimates of GVA within each catchment to generate an estimate of the current GVA attributable to tourism in the Mitchell and the Daly (Table 28).

Table 28 – Tourism Share of Industry Gross Value Added for Australia, 2005-06, and associated estimates of the GVA attributable to Tourism in each focal catchment

Industry	Share of GVA for Australia (%)	Implied GVA attributable to tourism in the Daly River Catchment ($, 2006)	Implied GVA attributable to tourism in the Mitchell River Catchment ($, 2006)
Accommodation	35.6	3,814,438	3,299,665
Agriculture	–		
Construction	–		
Culture	4.6	475,362	325,881
Electricity	–		
Finance	1.5	694,065	313,291
Government	1.4	2,119,481	860,108
Mining	–		
Retail	8.2	2,785,200	1,969,408
Transport	12.6	3,014,550	1,693,326
Total		$12,903,096	$8,461,679
Tourism GVA as a % of Catchment GVA		2.34%	3.02%

In line with previous scenarios, researchers assumed 5 per cent growth in tourism. Consequently, for this scenario the elements of the vector describing the initial change in final demand were calculated as:

- $\Delta\begin{pmatrix} f \\ g \end{pmatrix}$ = 0.05 x estimated 2006 GVA attributable to tourism for each sector

6.2.3 **Simulation outputs**

For each scenario, the final change in regional output and household income $\Delta\begin{pmatrix} x \\ y \end{pmatrix}$ that is likely to occur in response to the projected change in final demand was calculated using Equation 6. Equation 7 was used to estimate the associated change in consumptive water demand (using both lower-bound and upper-bound estimates of direct water use, as discussed in section 5.2.4), and Equation 8 was used to estimate associated changes in Indigenous and Non-Indigenous employment. These changes were then compared with the starting-point values associated with each key variable (specific in section 6.2.1) to determine the percentage change in each key variable from 2006. The percentage changes were then extrapolated forward over a twenty-year time horizon, to explore the potential longer-term impacts of these different types of growth.

Figure 31 shows the projected changes in Consumptive Water demand (lower and upper), Indigenous employment and household income, Non-Indigenous employment and household income, and total industry income that would occur under the 'demographic' scenario: i.e. no growth in industry, and an annual decline in population of 7 per cent. Over a twenty year period, the fall in household expenditures associated with that decline in population, is likely to see regional incomes and employment fall by up to 5 per cent. Figure 32 presents similar information for the Daly River. Interestingly, the annual aggregate per cent decline in population in the Daly (3 per cent) is less than that of the Mitchell (7 per cent), but the overall decline in incomes and employment is higher. This is because, a larger share of the Daly River population decline is with Non-Indigenous householders (indeed, Indigenous populations are rising). But losses in expenditure from the Non-Indigenous householders more than make up for the gains from Indigenous householders (with incomes and expenditures assumed to rise in line with population), thus contributing to an overall decline in regional incomes.

The key point to be made here therefore, is that the size of the Daly River and Mitchell River 'economies' may decline, over time, without there being some external stimulus to the business sector.

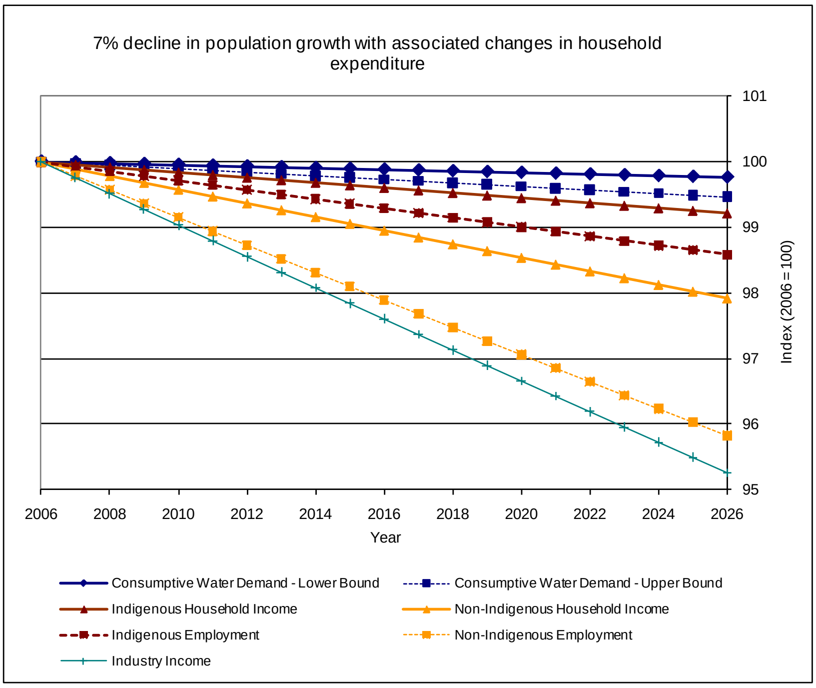


Figure 31 – Demographic Scenario – Mitchell River

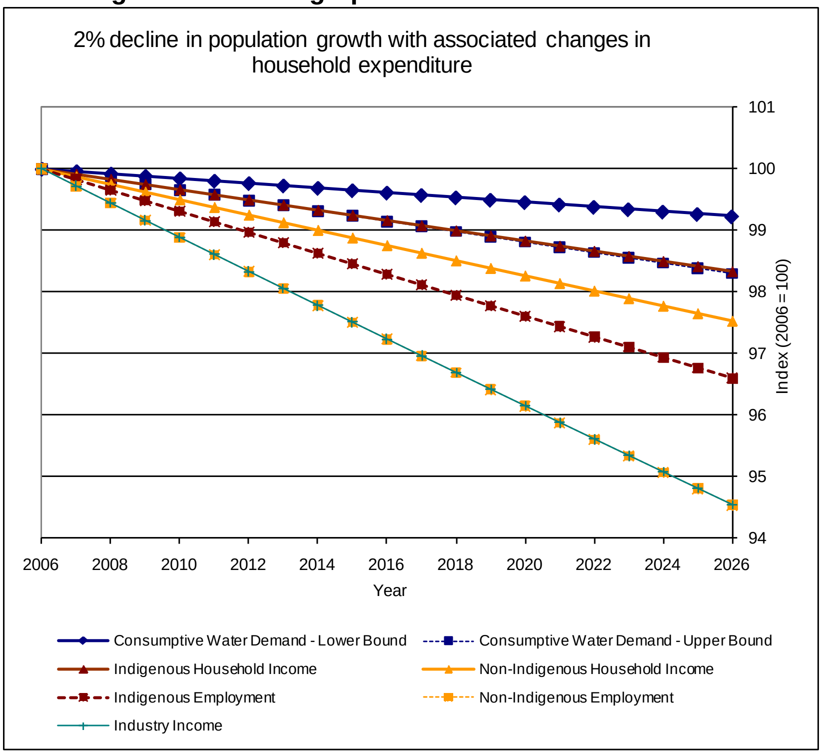


Figure 32 – Demographic Scenario – Daly River

The potential impact of four different types of external stimuli (described as the four different growth 'scenarios', above) are shown in Figure 33 (Mitchell River) and Figure 34 (for the Daly). From these charts, several observations can be made:

1. The 'balanced' growth scenario (of 1.5 per cent per annum across all industries) significantly out-performs all other scenarios for employment and income in the Daly and is one of the top generators of income and employment in the Mitchell (alongside the 5 per cent growth in Agriculture scenario). Within 20 years, this scenario increases Industry Income and Non-Indigenous Employment to levels that are close to 1.6 times greater than in 2006. Indigenous employment outcomes are more modest – rising to between 1.4 and1.5 times the 2006 levels. This balanced growth scenario is also associated with moderate increases in consumptive water demand – rising to between 1.2 and 1.7 times 2006 levels depending upon whether one uses lower or upper bound estimates.
2. In the Mitchell River, growth in the Agricultural sector generates substantial increases in business/industry incomes and in Non-Indigenous employment. Here too, outcomes for Indigenous people are much more modest. If growth in Agriculture is achieved using water-efficient techniques ('mimicked' here, with the lower-bound water use coefficients), then in 2026, consumptive water demand may be just 1.6 times greater than 2006 levels; but consumptive water demand could be more than double 2006 levels in less than a decade if higher water-use coefficients prevail.

3. Income and employment outcomes associated with the Agricultural scenario are more modest in the Daly than in the Mitchell, but pressures on consumptive water demand are similar, and outcomes for Indigenous people (incomes and employment) are very modest – rising by less than 10 per cent, in total, over a 20 year period.

4. The tourism scenario seems to deliver the smallest 'returns' – to income and employment for both Indigenous and Non-Indigenous households, in both catchments. This is a consequence of the fact that tourism currently makes a relatively small contribution to these economies (just 3 and 2.3 per cent of the Mitchell and Daly River's GVAs, respectively). Consequently, a 5 per cent growth rate in tourism represents a very small increase in economic activity (5 per cent of 3 per cent is not much at all!).

5. The mining scenario seems to deliver marginally better income and employment outcomes to both Indigenous and Non-Indigenous households than does the tourism scenario, but the returns are still quite small. In contrast, the associated increase in industry output/incomes is relatively good, and they even out-perform those of the agricultural scenario in the Daly River. The predicted increases in consumptive water demand are similar for the mining and tourism scenarios. However, as noted by the NALW taskforce (2009, p 23) "mining and resource projects are generally excluded from water resource accounting, exact water use estimates for this industry are not readily available". It is, therefore possible that these simulations under-estimate (perhaps substantially) the amount of consumptive water demand associated with the mining scenario.

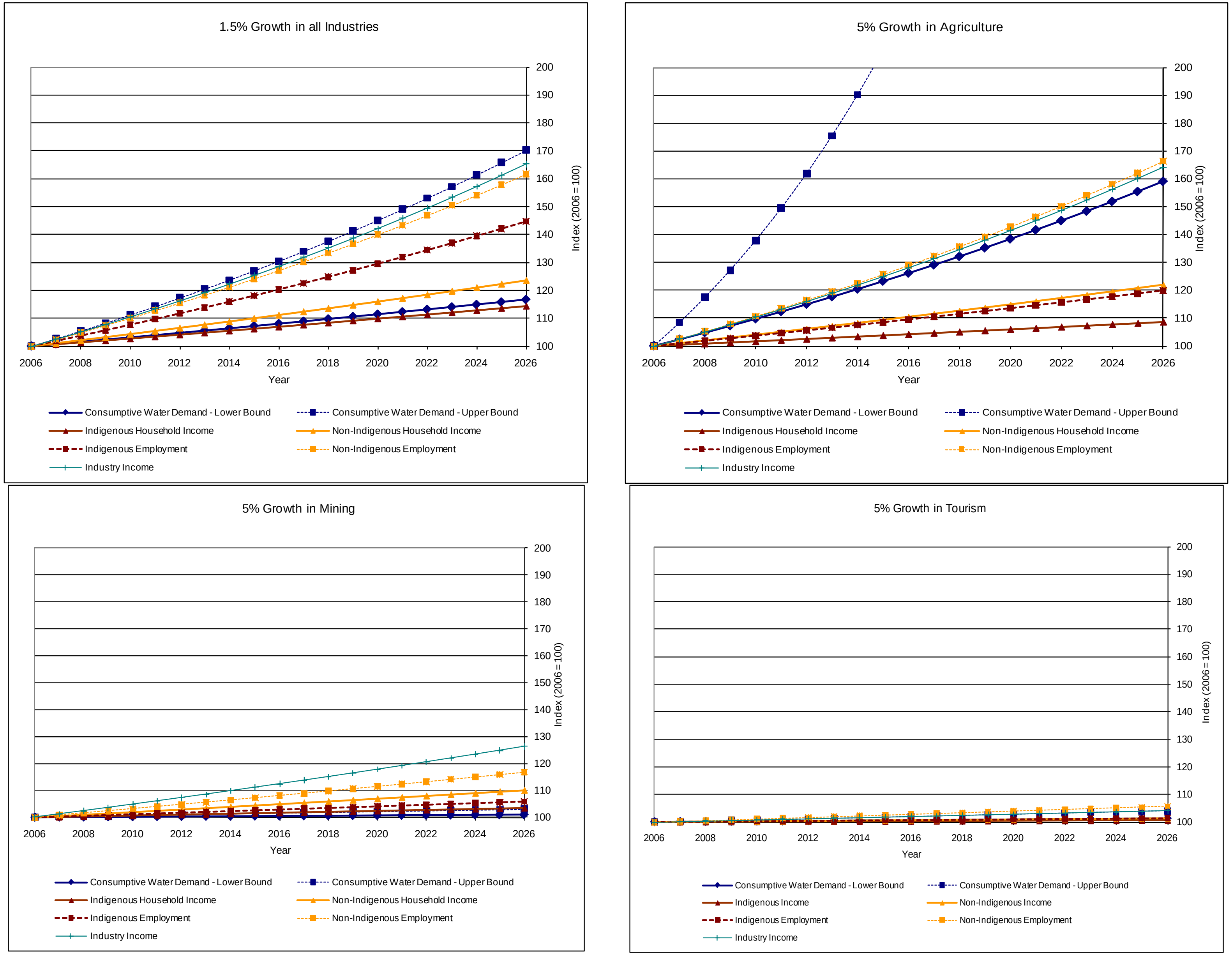


Figure 33 – Growth scenarios in the Mitchell River

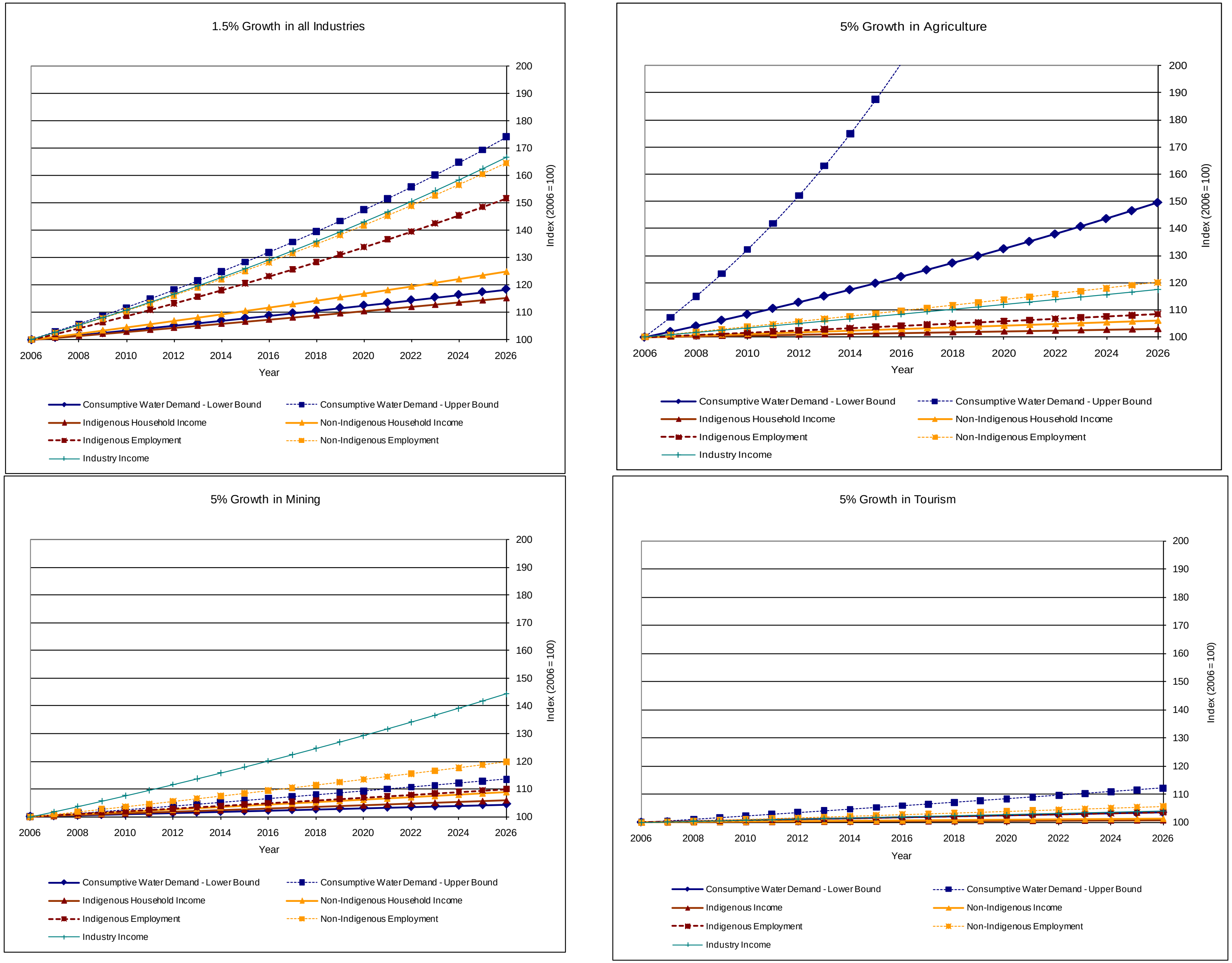


Figure 34 – Growth scenarios in the Daly River

7 Discussion

The results of this research are important to anyone involved in, or interested in, northern economic development. They provide an indication of the downstream benefits from the stimulation of any industry, though not, of course the costs of such stimulation.

As discussed in section 2.2.4, Larson and Alexandridis (2009) used several different types of cluster analysis across several different groups of variables to identify catchments within the TR region which are socio-economically 'similar' and which might also, therefore face similar development issues to those focused upon in this report. When clustering across all variables, they found that the following catchments shared 'similar' socio-economic characteristics:

The Mitchell and the Flinders; and

The Daly, the Fitzroy, the Ord and Cape Leveque Coast

Interestingly, if clustering across economic variables only, both the Mitchell and the Daly River catchments clustered together, alongside the catchments noted above, and also several others. As such, all of the following catchments could be considered economically 'similar':

Adelaide, Buckingham, Daly, Darwin/Blackmore, Embley, Finniss/Elizabeth/Howard, Leichardt, Mitchell, Nicholson, Prince Regent, Keep

Consequently, it *may* be valid to generalize some of the broad observations (if not the detailed numbers) made in this report across more catchments (and more people) than just the Daly and the Mitchell.

These broad observations, and their implications for policy, are discussed below.

There is an asymmetric divide between Indigenous and Non-Indigenous Economic systems

The 'multiplier' analysis in sections 6.1.1 and 6.1.2, found that a one-dollar increase in final demand for the goods and services provided by almost any business sector will generate a net increase in regional income of between $1.60 and $2.40, depending upon the sector.

Whilst most of that money stays within the initial sector that is stimulated (i.e. the $1.00), there are flow-on effects in other sectors. In most cases, it is the Finance sector, the Retail sector and Non-Indigenous households which benefit most from 'flow-on' effects: each receiving approximately 20 cents. Indigenous Households generally receive just a few cents in flow-on effects; approximately one-half of one per cent of the total regional stimulus, and just one per cent of the total flow-on effects. Moreover, when Indigenous incomes are increased exogenously (by, for example, an increase in Centrelink payments), Non-Indigenous people capture more of the flow-on effects than do Indigenous people. The stimuli affect the labour market in a similar manner: increases in Indigenous employment are significantly less than for Non-Indigenous employment, irrespective of the sector in which the expansion occurs.

The key message here, therefore, seems to be that it matters not to the 'average' Indigenous household which (Non-Indigenous) type of growth occurs: very little money, and very few jobs ever trickle down to them. For the most part, money that is injected into regional businesses (most of which are owned, or staffed by Non-Indigenous people) seems to flow outside the region, to other business, or to Non-Indigenous households.

Researchers started the project with the conceptual model shown in Figure 2, where all households and businesses were treated as if they were essentially homogenous. However, this analysis suggests that such an approach is grossly misleading. One needs to treat the Indigenous and Non-Indigenous economic systems separately. Their economic systems are disconnected, and the disconnect is asymmetrical: monies received by persons in the Non-Indigenous system circulate within that system, whereas monies received by Indigenous households flow almost directly into the hands of the owners of local retail outlets and/or houses, and thence into the Non-Indigenous system – as depicted in the left hand side of Figure 35.

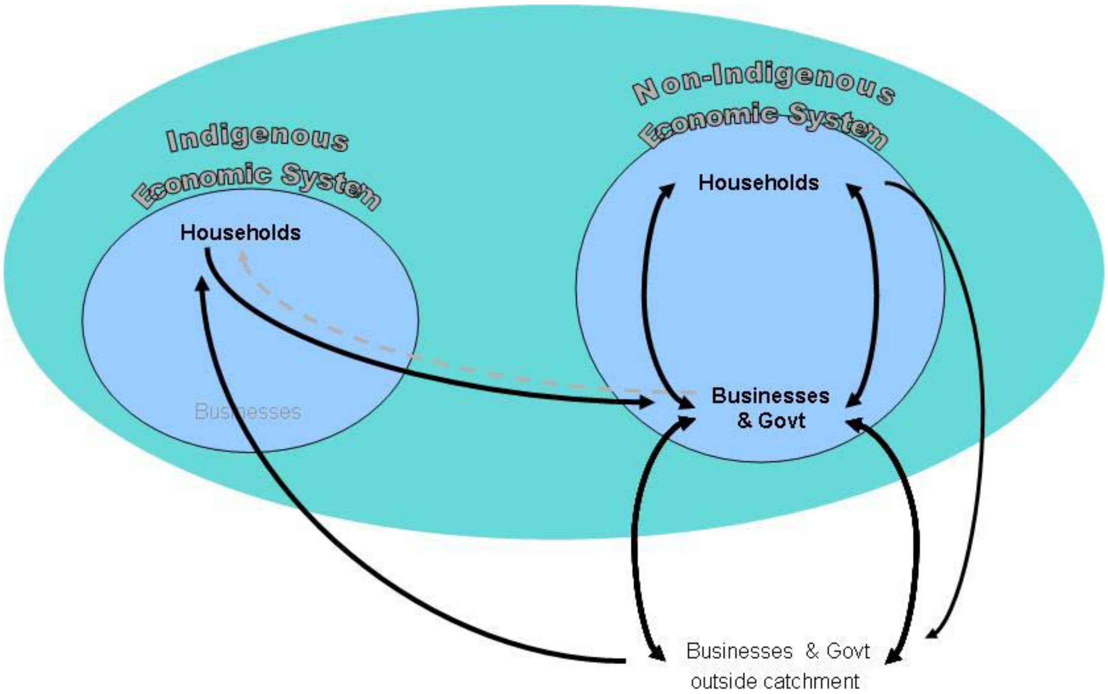


Figure 35 – The great asymmetric divide

The 'disconnect' so apparent in our simulated results is occurring because few local businesses are owned or operated by Indigenous people, and few Indigenous people are formally employed by these organisations. Even where employment levels are relatively high (as in, for example, the Government sector) the very low rates of pay received by Indigenous employees mean that relatively little stimulus received by the Non-Indigenous sector flows through to these people.

Put simply, there is no structural avenue by which monies are able to flow from the Non-Indigenous to the Indigenous sectors in regions such as these. As a result, connections between these sectors are affected by external organisations as when, for example, the federal government collects taxation revenues from Non-Indigenous households and businesses, and then redistributes them to Indigenous householders. This asymmetric disconnect is thus likely to continue until, or unless there is structural change.

Our analysis therefore suggests that development strategies which only serve to increase the *quantity* of goods and services that are produced within the region (without changing the *way* in which these goods are produced) will serve mainly to benefit Non-Indigenous householders. Simply replicating that which is already occurring – albeit on a grander scale – is akin to photocopying failed plans. Those seeking to significantly improve the incomes of Indigenous people living in Northern Australia may thus need to try and alter the way in which goods and services are produced. In other words, there needs to be structural change (see Figure 36): more (well-paid) Indigenous participation in the workforce, more Indigenous management, and more Indigenous ownership of productive assets so that the money flowing in to the region finds its way to Non-Indigenous households – without needing to go through an external conduit.

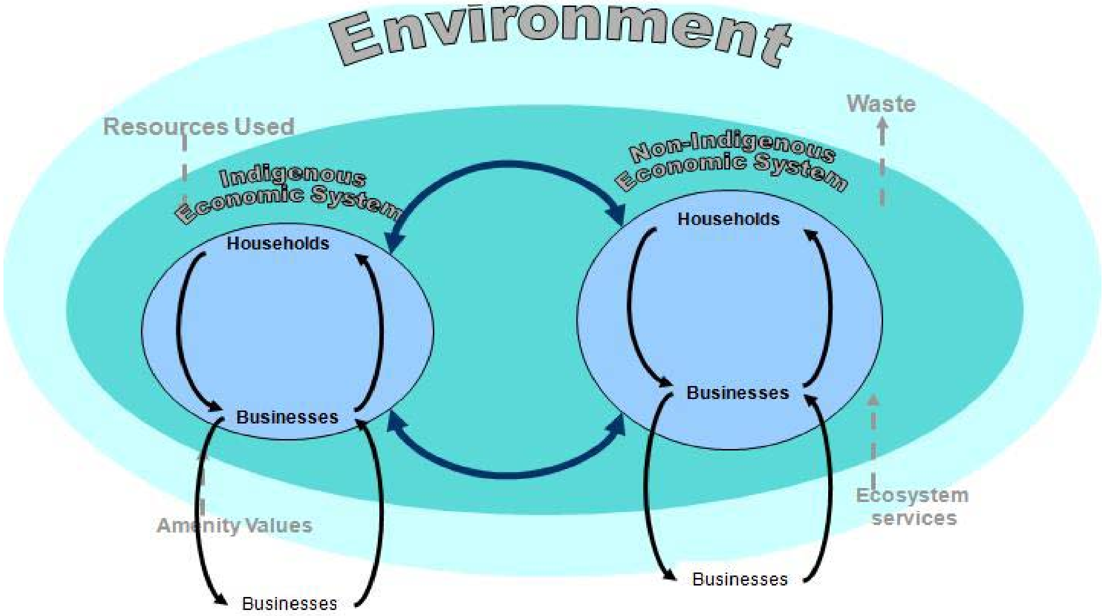


Figure 36 – A re-structured system

It will, undoubtedly, be difficult to affect such structural changes – they will not occur without significant investments of time and money, and without alterations in social attitudes (both Indigenous and Non-Indigenous). Nevertheless, since the observed disconnect is asymmetric, our analysis suggests that such a change could, potentially, improve the lives and livelihoods of both Indigenous and Non-Indigenous householders, alike. It may be a long term game, but it is not zero-sum.

Some industries can generate significant increases in (business) income, without creating local employment.

Although there is relatively little variation in Type I and Type II income multipliers across sectors (ranging from 1.6 to 2.4), there are significant differences in employment multipliers. For example, a $1 million expansion of the Accommodation sector creates, in aggregate, more than four times as many new jobs within the Daly River catchment than an equivalent expansion of the Mining sector.

The key point to be made here, therefore, is that when assessing the potential impact of different types of development, it is important to consider a range of different factors. Those who are primarily interested in expanding regional ***income*** might hold quite different views about which sectors could or should be supported, than those who are primarily interested in expanding regional ***employment***.

Also evident is the sharp contrast between the size of the employment multipliers associated with Indigenous and Non-Indigenous persons. It matters not which sector is expanded: job growth in the Indigenous sector is always significantly less than in the Non-Indigenous sector. That said, Indigenous employment multipliers in the Daly are generally higher than in the Mitchell, an entirely expected result given that the data used to populate the model (detailed in section 5.2.5) showed higher Indigenous involvement in the labour market in the Daly River Catchment than in the Mitchell. Indeed in the Mitchell River Catchment, it seems that Indigenous job growth is only associated with growth of the Government sector (although even here, the Indigenous employment multiplier is significantly less than the Non-Indigenous employment multiplier). These figures thus serve to confirm earlier observations regarding the disparate effects of economic development on these two groups given the current socio-economic structure (assumed constant in IO analysis).

Those concerned with reducing consumptive water demand should focus on the Agricultural sector (and possibly also the mining sector).

The analysis of section 6 clearly highlights the fact that there are significant differences between water-multipliers that have been estimated using upper and lower-bound water use coefficients. To the extent that water is at least partially substitutable with other resources (e.g. it is possible to reduce water use and still grow certain types of plants by, for example, mulching, or applying water at critical phases of a plant's growth cycle), these results clearly illustrate the potential importance of water-saving technologies, particularly in the agricultural sector.

That the agricultural sector is particularly important is highlighted by our analysis which identifies significant differences in water multipliers across different industries. Water multipliers in the Agricultural sector were orders of magnitude larger than those in other sectors - although considerable care must be taken when interpreting data relating to the Mining and Manufacturing sector: as noted by the NALW taskforce (2009, p 23) "mining and resource projects are generally excluded from water resource accounting, exact water use estimates for this industry are not readily available".

That point aside, both Agriculture and mining are capable of generating significant income flows. But, unlike growth in the government, health or educational sectors, growth in the agricultural sector, and possibly also in the mining sector (there is a significant information gap here) is associated with significant growth in consumptive water demand. Like the situation where there are differences between income and employment 'outcomes', development strategists may thus also wish to explicitly identify cases where there may be a trade-off between growth and conservation outcomes, so that transparent choices (and potential compensations) can be made.

8 Concluding comments

Some types of development are likely to benefit Indigenous people, some (most?) are likely to benefit private business; some may be good at creating employment, and some may place considerable strain on regional resources (be it water or otherwise). Those interested in promoting sustainable regional development need to explicitly acknowledge the fact that not all types of development have similar impacts. They need to acknowledge the differences, and make conscious decisions about what it is they wish to 'develop'. Do they want to maximise the growth of income, or of employment? Are they primarily interested in promoting the expansion of regional income or of national income? Or are they more interested in promoting Indigenous Economic Development, or in conserving the region's water resources?

In short, strategists need to explicitly acknowledge both the monetary and non-monetary impacts of different development options – not all of which will be negative. They need to look for ways of trying to exploit synergies and minimise tradeoffs. Where tradeoffs exist, they may need to devise innovative methods of redressing imbalances which particular types of development may create, ensuring that such methods allow for the structural idiosyncrasies of these small northern economies (i.e. the asymmetric divide discussed above).

Appendix 1 – Household expenditure and water use survey

JAMES COOK UNIVERSITY AUSTRALIA

Socio-economic activity and Water use in the Tropical Rivers Region
Resident survey

TRaCK Tropical Rivers and Coastal Knowledge

HOUSEHOLD OCCUPANT INFORMATION

1. What is the name of the town or community that you live in? ______________________________
If you do not live in a town, please tell us the name of the town or community that is closest to you

2. How many people 'normally' live in your house (including yourself)? _______________
Please fill in number. If the number of people changes from week to week, then please give us an 'average' number

3. How many of those people are Aboriginal or Torres Strait Islanders? _______________
Please fill in number

4. How many of those people are *Please fill in number*
________ Under 20 years old? ________ Between 35 and 65 years old?
________ Between 20 and 34 years old? ________ More than 65 years old?

WATER USAGE INSIDE THE HOME

5. Where does most of the water that is used <u>inside</u> your house come from? *Please tick appropriate box*
☐ From a dam ☐ From a river or stream
☐ From rainwater/tanks ☐ From an underground bore or well
☐ From the local government (e.g. mains water) ☐ Other_______________________

6. Do you know how much water your household uses each year?
☐ No *(Please go to question 7)* ☐ Yes
If yes, approximately_________ ML per year *Please fill in the amount*
Does this amount also include water that is used OUTSIDE your house (e.g. the garden)?
☐ No *(Please go to question 15)* ☐ Yes *(Please go to question 18)*

The following questions will allow us to estimate your 'normal' internal household water usage

7. What type of washing machine do you have? *Please tick appropriate box. If you do not have a washing machine, but use a Laundromat instead, then please tell us about the type of washing machine at the Laundromat*
☐ We do not have a washing machine – and wash our clothes by hand. *(Please go to question 9)*
☐ Twin Tub ☐ Front Loader ☐ Top Loader

8. How many times per week does your household use a washing machine? *Please tick appropriate box. If you do your washing at a Laundromat, please tell us how many times you use a washing machine at the Laundromat*
☐ We rarely use a washing machine (or do not have one)
☐ Once a week ☐ 4 times a week ☐ 7 times a week (approx once a day)
☐ Twice a week ☐ 5 times a week ☐ 14 times a week (approx twice a day)
☐ 3 times a week ☐ 6 times a week ☐ More than 3 times a day

9. Do you have a dishwasher? *Please tick appropriate box* ☐ No *(Please go to question 10)* ☐ Yes
If yes, how many times per week do you use your dishwasher? *Please tick appropriate box*
☐ We rarely use the dishwasher
☐ Once a week ☐ 4 times a week ☐ 7 times a week (approx once a day)
☐ Twice a week ☐ 5 times a week ☐ 14 times a week (approx twice a day)
☐ 3 times a week ☐ 6 times a week ☐ More than 3 times a day

1

10. Is there a shower (one or more) in the house? ***Please tick appropriate box***

☐ No ***(Please go to question 11)*** ☐ Yes.

If yes, how often do people in your household 'normally' use the shower? ***Please tick appropriate box***

☐ We rarely use the shower
☐ Each person showers once a week
☐ Each person showers twice a week
☐ Each person showers 3 times a week
☐ Each person showers 4 times a week
☐ Each person showers 5 times a week
☐ Each person showers 6 times a week
☐ Each person showers 7 times a week (once a day)
☐ Each person showers 14 times or more a week (more than twice a day)

How long does each person 'normally' spend in the shower? ***Please tick appropriate box***

☐ Less than 5 minutes ☐ 5 – 10 minutes ☐ 10-15 minutes
☐ 15 – 20 minutes ☐ 25 – 30 minutes ☐ More than 30 minutes

Do you have a water saver showerhead? ***Please tick appropriate box*** ☐ No ☐ Yes

11. Do you have a bathtub in your house? ***Please tick appropriate box*** ☐ No ***(Please go to question 12)*** ☐ Yes

If yes, how many times per week do you fill your bathtub? ***Please tick appropriate box***

☐ We rarely use the bathtub
☐ Once a week ☐ 4 times a week ☐ 7 times a week (approx once a day)
☐ Twice a week ☐ 5 times a week ☐ 14 times a week (approx twice a day)
☐ 3 times a week ☐ 6 times a week ☐ More than 3 times a day

12. Do you have a dual flush toilet(s)? ***Please tick appropriate box*** ☐ No ☐ Yes

13. Do you have a leaking toilet in your household? ***Please tick appropriate box*** ☐ No ☐ Yes

14. Do you have any leaking taps? ***Please tick appropriate box*** ☐ No ☐ Yes

If yes, how many leaking taps do you have? ***Please fill in the number***__________

WATER USAGE OUTSIDE THE HOME -- FOR DOMESTIC PURPOSES

15. Where does most of the water that is used outside your house for domestic purposes come from? (please ignore water used for 'business' – e.g. for stock and/or irrigating crops) ***Please tick appropriate box***

☐ From a dam ☐ From a river or stream
☐ From rainwater/tanks ☐ From an underground bore or well
☐ Recycled (e.g. grey water) ☐ From the local government (e.g. mains water)
☐ Other______________

16. Do you know how much water your household uses for OUTSIDE domestic purposes each year?

☐ No ***(Please go to question 17)*** ☐ Yes

If yes, approximately ______ML per year ***Please fill in the amount and go to question 18***

The following question will allow us to estimate your 'normal' external household water usage

17. Approximately how many hours per week do you use water to … (***Please fill a separate number for the wet and the dry season***)

	In the wet season	In the dry season
Hose the driveway or wash the car	____hours per week	____hours per week
Water the garden *(please leave blank if you do not have a garden or if you live in an apartment)*	____hours per week	____hours per week
Fill a swimming pool *(please leave blank if you do not have a swimming pool or if you live in an apartment)*	____hours per week	____hours per week
Other ***(Please specify)***	____hours per week	____hours per week

HOUSEHOLD SAVINGS, TAX, INTEREST AND LOAN PAYMENTS

Money that is spent locally gets passed around to others in the community. Money that is taxed (taken away by the government), saved (in pillow cases or elsewhere), or that is paid as interest to banks outside the local region does not get passed around within the community. This money is taken out of the system. The following questions allow us to estimate how much of your household income gets taken out of the system.

18. Approximately how much of your total household income is

Saved?____________________ ***Example: If you save about 10 dollars from every 100 dollars that you earn, then write "10%" (or one-tenth); if you never save any money then write "0".***

Taxed?____________________ ***Example: If approximately 50% of all your household income is paid in tax, then write "50%" (or one-half).***

19. Does anyone in the household have a credit card? ***Please tick appropriate box.***

☐ No ***Please to question 20*** ☐ Yes

If yes, do the credit cards 'belong' to banks or other businesses that have a 'local' branch? ***Please tick appropriate box***

☐ No ☐ Yes *If the bank or business is located – or has a branch office - within your postcode, then please tick 'local. If you live in a large town/centre with several postcodes, then tick 'local' if that bank or financial institution has a branch in that larger town.*

What is the rate of interest charged on the credit card(s)______ % *If there is more than one credit card, please just give us the 'average' interest rate. If you always pay off your credit card before being charged interest, then please write '0'.*

20. Does anyone in your household have a home loan or mortgage? ***Please tick appropriate box.***

☐ No ***Please to question 21*** ☐ Yes

If yes, was the money borrowed from a bank (or other financial institution) that has a 'local' branch? ***Please tick appropriate box***

☐ No ☐ Yes *If the bank is located – or has a branch office - within your postcode, then please tick 'local. If you live in a large town/centre with several postcodes, then tick 'local' if that bank or financial institution has a branch in that larger town.*

What was the total amount borrowed (when the loan was first taken out)? $_________ *If there is more than one mortgage, please add the amounts together*

What is the term of the loan (How many years were you given to repay it, counting from the start of the loan)?______years. *If there is more than one mortgage, please tell us the LONGEST term.*

What is the rate of interest you are being charged on that loan?______ % *If there is more than one mortgage, please just give us the 'average' interest rate.*

21. Does anyone in your household have any other loan? ***Please tick appropriate box.***

☐ No ***Please to question 22*** ☐ Yes

If yes, was the money borrowed from a bank (or other financial institution) that has a 'local' branch? ***Please tick appropriate box***

☐ No ☐ Yes *If the bank is located – or has a branch office - within your postcode, then please tick 'local. If you live in a large town/centre with several postcodes, then tick 'local' if that bank or financial institution has a branch in that larger town.*

What was the total amount borrowed (when the loan(s) were first taken out)? $_________ *If there is more than one loan, please add the amounts together*

What is the term of the loan (how many years were you given to repay it, counting from the start of the loan)?______years *If there is more than one loan, please tell us the LONGEST term*

What is the rate of interest you are being charged on that loan?______ % *If there is more than one mortgage, please just give us the 'average' interest rate*

HOUSEHOLD EXPENDITURE

Sometimes people do their shopping locally and at other times they purchase goods and services from outside their local area. For the next question, we would like to find out about where your household buys different types of goods and services.

22. For each item below, please tell us (approximately) how much of the money that your household spends goes to 'local' businesses and people *(If you purchase goods or services from a business that is located – or has a branch office - within your postcode, then consider this a 'local' purchase. If you live in a large town/centre with several postcodes, then think of 'local' as being part of that larger town).* **PLEASE only tell us about DOMESTIC (Household) expenditure; e.g. if you live on a property, then please ignore business-related expenses such as fencing, stock, etc.**

	Approximately how much of the money you spend on these goods and services, is spent with 'local' businesses? ***Please tick appropriate box***							
	We buy **ALL** of these things from **'local'** businesses	We buy more than 75% of these things from 'local' businesses		We buy about half of these things from 'local' businesses		We buy less than 25% of these things from 'local' businesses	We **NEVER** buy any of these things from **'local'** businesses	**Where else do you buy these things? e.g. Darwin, Melbourne** *(please specify)*
Food and alcohol consumed at cafés, restaurants and bars	☐	☐	☐	☐	☐	☐	☐	
Food and Alcohol that is consumed at home	☐	☐	☐	☐	☐	☐	☐	
Tobacco products	☐	☐	☐	☐	☐	☐	☐	
Clothing and footwear	☐	☐	☐	☐	☐	☐	☐	
Household furnishings (including whitegoods)	☐	☐	☐	☐	☐	☐	☐	
Personal care (e.g. hairdresser)	☐	☐	☐	☐	☐	☐	☐	
School Fees	☐	☐	☐	☐	☐	☐	☐	
Hardware or equipment for hobbies (e.g. camping gear, pet supplies)	☐	☐	☐	☐	☐	☐	☐	
Hiring tradespeople to maintain cars, home, etc	☐	☐	☐	☐	☐	☐	☐	
Recreation (e.g. movies, gym fees)	☐	☐	☐	☐	☐	☐	☐	
Fuel (petrol, diesel)	☐	☐	☐	☐	☐	☐	☐	
Transport (e.g. airplane and bus tickets)	☐	☐	☐	☐	☐	☐	☐	
Insurance (e.g. car, house, boat, health)	☐	☐	☐	☐	☐	☐	☐	
Medical goods/services and pharmaceuticals	☐	☐	☐	☐	☐	☐	☐	
Communication (e.g. telephone, internet)	☐	☐	☐	☐	☐	☐	☐	
Cars and Vehicles	☐	☐	☐	☐	☐	☐	☐	
Gas & Electricity	☐	☐	☐	☐	☐	☐	☐	
Other *(please specify)* …………………..	☐	☐	☐	☐	☐	☐	☐	

23. Please tell us approximately how much all the people in your household (added together) spend on each of the following goods and services each WEEK. ***Please tick appropriate box.*** *If your spending is high in some weeks e.g. $400 and low in other weeks e.g. nothing, please give an 'average' – e.g. $200* **PLEASE only tell us about DOMESTIC (Household) expenditure; e.g. if you live on a property, then please ignore business expenses such as fencing, stock, etc.**

	Approximate dollars PER WEEK									
	$0	$1 - 20	$20-50	$50-100	$100-150	$150-200	$200-300	$300 - 400	$400 - 500	Other *(specify)*
Rent	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Mortgage repayments	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Credit card repayments	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Other loan repayments	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Food and alcohol consumed at cafés, restaurants and bars	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Food and Alcohol that is consumed at home	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Tobacco products	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Clothing and footwear	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Recreation (e.g. movies, gym fees)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Fuel (petrol, diesel)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Communication (e.g. telephone, internet)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Other *(please specify)………………*	☐	☐	☐	☐	☐	☐	☐	☐	☐	$

24. Please tell us approximately how much all the people in your household (added together) spend on each of the following goods and services each YEAR. ***Please tick appropriate box.*** *If you only purchase some things once every few years then please give us an average amount (e.g. If you buy a car once every ten years, then tell us one-tenth of the value of your car. If you buy a freezer once every two years, then tell us one-half the cost of the freezer).*

	Approximate dollars PER YEAR									
	$0	$1 - 50	$50-100	$100-250	$250 – 500	$500-$1000	$1000-$2000	$2000-$4000	$4000-$8000	Other *(specify)*
Gas & Electricity	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Water and Rates	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Insurance (e.g. car, house, boat, medical)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Hiring tradespeople to maintain cars, home, etc	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Medical goods/services and pharmaceuticals	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Hardware or equipment for hobbies (e.g. camping gear, pet supplies)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
School Fees	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Personal care (e.g. hairdresser)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Cars and Vehicles	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Household furnishings (including whitegoods)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Transport (e.g. airplane and bus tickets)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Other Travel / Holiday expenses (e.g. hotels)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Other *(please specify)……………*	☐	☐	☐	☐	☐	☐	☐	☐	☐	$

General Household Information

Finally, we would like to know a little bit more about your household. This information will be kept strictly confidential and is used to ensure that we have collected information from a wide variety of households.

25. What is the highest level of education that anyone in your household has achieved?
Please tick appropriate box

☐ Primary ☐ High school ☐ University
☐ Trade ☐ Other *(please specify)* ________________

26. How many of the people who 'normally' live in this house (including yourself) are; ***Please fill a number beside each category. For example, if two people in the house are employed, write the number "2" next to the word Employed.***

_____Retired _____Unemployed _____Student
_____Employed _____On CDEP *(Commonwealth Development Employment Program)*

27. How many of the people who 'normally' live in this house, and who are working (on CDEP or otherwise), work in the following industries? ***Please fill a number beside each category. For example, if two people in the house are employed in the local shop, write the number "2" next to the words "Retail & Wholesale".***

_____Accommodation, Cafes & Restaurants
_____Agriculture, Forestry & Fishing
_____Communication Services
_____Construction and trade services
_____Cultural & Recreational Services
_____Finance & Insurance
_____Educational Services
_____Electricity, Gas & Water Suppliers
_____Government administration & Defence
_____Health & Community Services
_____Manufacturers
_____Mining, Quarries & Related Services
_____Personal & Other Services
_____Property and business services
_____Retail & Wholesale shops/stores
_____Transport, Travel & Storage

28. What is the total, combined, annual (taxable) income of ALL the people who 'normally' live in your house? ***Please tick appropriate box***

☐ <$20,000 AUS Dollars
☐ $20,000-$40,000 AUS Dollars
☐ $40,000-$60,000 AUS Dollars
☐ $60,000-$80,000 AUS Dollars
☐ $80,000-$100,000 AUS Dollars
☐ $100,000-$120,000 AUS Dollars
☐ $120,000-$140,000 AUS Dollars
☐ $140,000-$160,000 AUS Dollars
☐ > $160,000 AUS Dollars

YOUR FEEDBACK IS APPRECIATED

Appendix 2 – Indigenous households' interview

Socio-economic activity and Water use
in the Tropical Rivers Region
Daly River household interview

HOUSEHOLD INFORMATION

1. How many people 'normally' live in your house (including yourself)? _______________

Please fill in number. If the number of people changes from week to week, then please give us an 'average' number

2. How many people slept at your house last night (including yourself)?_______________

3. How many of the people who 'normally' live in your house are Aboriginal or Torres Strait Islanders? _______________ ***Please fill in number***

4. How many of those people are ***Please fill in number***

________ Under 20 years old? ________ Between 35 and 65 years old?

________ Between 20 and 34 years old? ________ More than 65 years old?

5. What is the highest level of education that anyone in your household has achieved?
Please tick appropriate box

☐ Primary school ☐ High school ☐ University
☐ Trade ☐ Other ***(please specify)*** ______________________

6. How many of the people who 'normally' live in this house (including yourself) are; ***Please fill a number beside each category. For example, if two people in the house are employed, write the number "2" next to the word Employed.***

_____Retired _____Unemployed _____Student _____Pension
_____Employed _____On CDEP *(Commonwealth Development Employment Program)*

7. What types of work do the people in your household do? (i.e. where do you work, and what do you do?)

Person 1: ____

Person 2: ____

Person 3: ____

Person 4: ____

Person 5: ____

Person 6: ____

Person 7: ____

1

WATER INSIDE THE HOME

8. Where does most of the water that is used <u>inside</u> your house come from? ***Please tick appropriate box***

☐ From a dam ☐ From a river or stream
☐ From rainwater/tanks ☐ From an underground bore or well
☐ From the local government (e.g. mains water) ☐ Other________________________

9. Do you know how much water your house uses each year?
☐ No ☐ Yes

If yes, how much per year (approximately)__________ ____________***Please fill in the amount***

Does this amount also include water that is used OUTSIDE your house (e.g. the garden)?
☐ No ***(Please go to question 17)*** ☐ Yes ***(Please go to question 20)***

The following questions will allow us to work out how much water you normally use each year

10. Does your house have a dual flush toilet? ***Please tick appropriate box*** ☐ No ☐ Yes

11. Does your house have a leaking toilet? ***Please tick appropriate box*** ☐ No ☐ Yes

12. Are there any leaking taps in your house? ***Please tick appropriate box*** ☐ No ☐ Yes

If yes, how many leaking taps are there? ***Please fill in the number***__________

---

13. Is there a shower in your house? ***Please tick appropriate box***

☐ No ☐ Yes.

If yes, how often do people in your house 'normally' use the shower? ***Please tick appropriate box***
☐ We rarely use the shower
OR……….Each person showers …..

☐ once a week ☐ 5 times a week
☐ twice a week ☐ 6 times a week
☐ 3 times a week ☐ 7 times a week (once a day)
☐ 4 times a week ☐ 14 times or more a week (more than twice a day)

How long does each person 'normally' spend in the shower? ***Please tick appropriate box***
☐ Less than 5 minutes ☐ 5 – 10 minutes ☐ 10-15 minutes
☐ 15 – 20 minutes ☐ 25 – 30 minutes ☐ More than 30 minutes

Do you have a water saver showerhead? ***Please tick appropriate box*** ☐ No ☐ Yes

---

14. Do you have a bathtub in your house? ***Please tick appropriate box***
☐ No ☐ Yes

If yes, how many times per week do you fill your bathtub? ***Please tick appropriate box***
☐ We rarely use the bathtub
☐ Once a week ☐ 4 times a week ☐ 7 times a week (approx once a day)
☐ Twice a week ☐ 5 times a week ☐ 14 times a week (approx twice a day)
☐ 3 times a week ☐ 6 times a week ☐ More than 3 times a day

15. Do you have a washing machine in your house?

☐ No – we wash our clothes by hand ☐ No – we wash our clothes at a laundromat

☐ Yes

If yes, what type of washing machine do you have? ***Please tick appropriate box. If you do not have a washing machine, but use a Laundromat instead, then please tell us about the type of washing machine at the Laundromat***

☐ Twin Tub ☐ Front Loader ☐ Top Loader

How many load of washing does your household do each week? ***Please tick appropriate box. If you do your washing at a Laundromat, please tell us how many times you use a washing machine at the Laundromat***

☐ We rarely use the washing machine

☐ One a week ☐ 4 a week ☐ 7 a week (approx one a day)

☐ 2 a week ☐ 5 a week ☐ 14 a week (approx two a day)

☐ 3 a week ☐ 6 a week ☐ More than 3 a day

16. Do you have a dishwasher? ***Please tick appropriate box***

☐ No ☐ Yes

If yes, how many times per week do you use your dishwasher? ***Please tick appropriate box***

☐ We rarely use the dishwasher

☐ Once a week ☐ 4 times a week ☐ 7 times a week (approx once a day)

☐ Twice a week ☐ 5 times a week ☐ 14 times a week (approx twice a day)

☐ 3 times a week ☐ 6 times a week ☐ More than 3 times a day

WATER USAGE OUTSIDE THE HOME -- FOR DOMESTIC PURPOSES

17. Where does most of the water that is used outside your house for domestic purposes come from? (please ignore water used for 'business' – e.g. for stock and/or irrigating crops) ***Please tick appropriate box***

☐ From a dam ☐ From a river or stream

☐ From rainwater/tanks ☐ From an underground bore or well

☐ Recycled (e.g. grey water) ☐ From the local government (e.g. mains water)

☐ Other____________

18. Do you know how much water your household uses for OUTSIDE domestic purposes each year?

☐ No ***(Please go to question 19)*** ☐ Yes

If yes, approximately ______ML per year ***Please fill in the amount and go to question 20***

19. Approximately how many hours per week do you use water to … (***Please fill a separate number for the wet and the dry season***)

	In the wet season	In the dry season
Hose the driveway or wash the car	____hours per week	____hours per week
Water the garden *(please leave blank if you do not have a garden or if you live in an apartment)*	____hours per week	____hours per week
Fill a swimming pool *(please leave blank if you do not have a swimming pool or if you live in an apartment)*	____hours per week	____hours per week
Other ***(Please specify)***	____hours per week	____hours per week

Household Expenditure

Sometimes people do their shopping locally and at other times they purchase goods and services from outside their local area. For the next question, we would like to find out about where people who live in your house buy different types of goods and services.

20. For each item below, please tell us (approximately) how much of the money that your household spends goes to 'local' businesses and people *(in your community)*

	Approximately how much of the money you spend on these goods and services, is spent with 'local' businesses? ***Please tick appropriate box***							
	We buy **ALL** of these things locally	We buy more than 75% of these things locally		We buy about half of these things locally		We buy less than 25% of these things locally	We **NEVER** buy any of these things locally	**Where else do you buy these things? e.g. Darwin, Melbourne** *(please specify)*
Fast food	☐	☐	☐	☐	☐	☐	☐	
Groceries	☐	☐	☐	☐	☐	☐	☐	
Tobacco products	☐	☐	☐	☐	☐	☐	☐	
Alcohol	☐	☐	☐	☐	☐	☐	☐	
Clothing and footwear	☐	☐	☐	☐	☐	☐	☐	
Household furnishings (including whitegoods)	☐	☐	☐	☐	☐	☐	☐	
Personal care (e.g. hairdresser)	☐	☐	☐	☐	☐	☐	☐	
School Fees	☐	☐	☐	☐	☐	☐	☐	
Hardware or equipment for hobbies (e.g. camping gear, pet supplies)	☐	☐	☐	☐	☐	☐	☐	
Hiring tradespeople to maintain cars, home, etc	☐	☐	☐	☐	☐	☐	☐	
Recreation (e.g. movies, gym fees)	☐	☐	☐	☐	☐	☐	☐	
Fuel (petrol, diesel)	☐	☐	☐	☐	☐	☐	☐	
Transport (e.g. airplane and bus tickets)	☐	☐	☐	☐	☐	☐	☐	
Insurance (e.g. car, house, boat, health)	☐	☐	☐	☐	☐	☐	☐	
Medical goods/services and pharmaceuticals	☐	☐	☐	☐	☐	☐	☐	
Communication (e.g. telephone, internet)	☐	☐	☐	☐	☐	☐	☐	
Cars and Vehicles	☐	☐	☐	☐	☐	☐	☐	
Gas & Electricity	☐	☐	☐	☐	☐	☐	☐	
Other *(please specify)* …………………	☐	☐	☐	☐	☐	☐	☐	

21. Please tell us how many people you share expenses with (how many of you 'chuck in' to buy food and things together)? ________________________

22. Please tell us approximately how much all of the people you share expenses with (added together) spend on each of the following goods and services each Fortnight. ***Please tick appropriate box.*** *If your spending is high in some weeks e.g. $400 and low in other weeks e.g. nothing, please give an 'average' – e.g. $200*

	Approximate dollars PER FORTNIGHT									
	$0	$1 - 20	$20-50	$50-100	$100-150	$150-200	$200-300	$300 - 400	$400 - 500	Other *(specify)*
Rent (or Levy)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Mortgage repayments	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Credit card repayments	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Other loan repayments	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Food consumed at fast food places	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Groceries	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Tobacco products	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Alcohol	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Clothing and footwear	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Recreation (e.g. movies, gym fees)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Fuel (petrol, diesel)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Communication (e.g. telephone, internet)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Gas & Electricity	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Other *(please specify)*……………….	☐	☐	☐	☐	☐	☐	☐	☐	☐	$

23. Please tell us approximately how much all the people you share expenses with (added together) spend on each of the following goods and services each YEAR. ***Please tick appropriate box.*** *If you only purchase some things once every few years then please give us an average amount (e.g. If you buy a car once every ten years, then tell us one-tenth of the value of your car. If you buy a freezer once every two years, then tell us one-half the cost of the freezer).*

	Approximate dollars PER YEAR									
	$0	$1 - 50	$50-100	$100-250	$250 – 500	$500-$1000	$1000-$2000	$2000-$4000	$4000-$8000	Other *(specify)*
Insurance (e.g. car, house, boat, medical)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Hiring tradespeople to maintain cars, home, etc	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Medical goods/services and pharmaceuticals	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Hardware or equipment for hobbies (e.g. camping gear, pet supplies)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
School Fees	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Personal care (e.g. hairdresser)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Cars and Vehicles	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Household furnishings (including whitegoods)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Transport (e.g. airplane and bus tickets)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Other Travel / Holiday expenses (e.g. hotels)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Other - e.g. money for family *(please specify)*…………….	☐	☐	☐	☐	☐	☐	☐	☐	☐	$

HOUSEHOLD SAVINGS, TAX, INTEREST AND LOAN PAYMENTS

Money that is spent locally gets passed around to others in the community. Money that is taxed (taken away by the government), saved (in pillow cases or elsewhere), or that is paid as interest to banks outside the local region does not get passed around within the community. This money is taken out of the system. The following questions allow us to estimate how much of your household income gets taken out of the system.

24. Approximately how much of your total household income is

Saved?__________________ ***Example: If you save about 10 dollars from every 100 dollars that you earn, then write "10%" (or one-tenth); if you never save any money then write "0".***

Taxed?__________________ ***Example: If approximately 50% of all your household income is paid in tax, then write "50%" (or one-half).***

25. Does anyone in the house have a credit card? ***Please tick appropriate box.***

☐ No ☐ Yes

If yes, what is the rate of interest charged on the credit card(s)______ % *If there is more than one credit card, please just give us the 'average' interest rate. If you always pay off your credit card before being charged interest, then please write '0'.*

26. Does anyone in your house have a home loan or mortgage? ***Please tick appropriate box.***

☐ No ☐ Yes

If yes, what was the total amount borrowed (when the loan was first taken out)? $_________ *If there is more than one mortgage, please add the amounts together*

What is the term of the loan (How many years were you given to repay it, counting from the start of the loan)?_______years. *If there is more than one mortgage, please tell us the LONGEST term.*

What is the rate of interest you are being charged on that loan?______ % *If there is more than one mortgage, please just give us the 'average' interest rate.*

27. Does anyone in your house have any other loan? ***Please tick appropriate box.***

☐ No ☐ Yes

If yes, was the money borrowed from a 'local' person? ***Please tick appropriate box***

☐ No ☐ Yes

What was the total amount borrowed (when the loan(s) were first taken out)? $_________ *If there is more than one loan, please add the amounts together*

What is the term of the loan (how many years were you given to repay it, counting from the start of the loan)?_______years *If there is more than one loan, please tell us the LONGEST term*

What is the rate of interest you are being charged on that loan?______ % *If there is more than one mortgage, please just give us the 'average' interest rate*

GENERAL HOUSEHOLD INFORMATION

28. What is the total, combined, annual income of ALL the people who 'normally' live in your house?
Please tick appropriate box

☐ <$20,000 AUS Dollars
☐ $20,000-$40,000 AUS Dollars
☐ $40,000-$60,000 AUS Dollars
☐ $60,000-$80,000 AUS Dollars
☐ $80,000-$100,000 AUS Dollars
☐ $100,000-$120,000 AUS Dollars
☐ $120,000-$140,000 AUS Dollars
☐ $140,000-$160,000 AUS Dollars
☐ > $160,000 AUS Dollars

THANK YOU!

Appendix 3 – Introductory letter sent to households

Socio-economic activity and Water use
in the Tropical Rivers Region
Resident survey

Date

Mail merge address
Mail merge address
Mail merge address

Researchers at James Cook University (myself included) are involved in a project (funded by TRaCK) which is investigating the financial links between business, government and households in northern Australia. The project is also investigating some of the links between people and the environment in this area (although in the first instance, we are only looking at water use).

Once we have a better understanding of financial links and water use, we should be able to answer question such as

- What would generate the largest increase in regional employment – more tourism or more horticulture?
- What would have the largest impact on regional incomes – an expansion of health services or of agriculture?
- What would cause the largest increase in the demand for water – an increase in tourism or an increase in agriculture?
- How much water might be needed, if northern populations keep growing at current levels?

On the back of this letter, we have provided you with a little more information about the project. We give some background information and describe what we need to learn (i.e. the type of information we need) if we want to build a model that will allow us to answer important questions like these.

The key point of this letter is to alert you to the fact that we will soon be sending you a questionnaire which we hope you will agree to complete – and send back to us. The questionnaire should not take more than 10 or 15 minutes to complete. It will ask about the types of things your household spends money on, about WHERE the people in your house spend their money, and about your water uses / requirements. All information which we collect will be kept **strictly confidential**. No information will be attributed to any single person or household, and results will only be released in aggregate form (e.g. approximately 25% of those surveyed purchased their clothes from Sydney). Responses to the survey will be stored separately from the names and addresses of households, so that no link can be made between them.

Should you have any queries about the study or if you are interested in seeing the results of our survey please do not hesitate to contact me. On behalf of the JCU research team, I thank you – in advance – for your help.

Yours sincerely,

Associate Professor Natalie Stoeckl
School of Business
James Cook University
Townsville, QLD 4814
Tel: 07 4781 4868, Fax: 07 4781 4019
Email: Natalie.Stoeckl@jcu.edu.au

Should you have any complaints or enquiries relating to the ethical conduct of this research please contact: Tina Langford, Ethics Officer, James Cook University, Telephone: 07 4781 4342, Fax: 07 4781 5521 or email: tina.langford@jcu.edu.au

Appendix 4 – Reminder letter

JAMES COOK UNIVERSITY AUSTRALIA

Socio-economic activity and Water use in the Tropical Rivers Region
Resident survey

TRaCK Tropical Rivers and Coastal Knowledge

27.05.09

About 4 weeks ago, I sent you a questionnaire that asked you to tell us about the way in which your household uses water and about where you buy different types of goods and services. To the best of our knowledge, it has not yet been returned.

The information received from people who have already responded has provided some interesting insights. For example, it seems that people living in remote communities (such as Pine Creek) need to spend more (per person) per week on food, than other people. And about a third of the people who have responded depend on bores, dams, creeks and rainwater tanks for the water used within their house. We think that this type of information is going to be very useful to local, state, and federal leaders - and many others.

We are writing again because of the importance that your questionnaire has for helping to get accurate results. We have sent questionnaires to many people living in (and around) the Daly River and Mitchell River catchments, but it is only by hearing from nearly everyone in the sample that we can be sure that our results are truly representative.

A few people have written to say that they should not have received the questionnaire because they no longer live in (or near) the Daly River or Mitchell River catchments. If this applies to you, then please let us know on the cover of the questionnaire and return it in the enclosed reply paid envelope so that we can delete your name from the mailing list.

A comment on our survey procedures. A questionnaire identification number is printed on the front of the questionnaire so that we can check your name off the mailing list when it is returned. The list of names is then destroyed so that individual names cannot be connected to our results in any way. As we have noted earlier, no information will be ever be attributed to any single person or household, and results will only be released in aggregate form (e.g. approximately 25% of those surveyed purchased their clothes from Sydney). Protecting the confidentiality of people's answers is very important to us, to James Cook University, and to TRaCK.

We hope that you will fill out and return the questionnaire soon, but if for any reason you prefer not to answer it, please let us know by returning a note or blank questionnaire in the enclosed reply-paid envelope.

Sincerely,

Associate Professor Natalie Stoeckl
School of Business
James Cook University
Townsville, QLD 4814
Tel: 07 4781 4868, Fax: 07 4781 4019
Email: Natalie.Stoeckl@jcu.edu.au

P.S. If you have already completed and returned the questionnaire, then please accept our sincere thanks.

Should you have any complaints or enquiries relating to the ethical conduct of this research please contact: Tina Langford, Ethics Officer, James Cook University, Telephone: 07 4781 4342, Fax: 07 4781 5521 or email: tina.langford@jcu.edu.au

Appendix 5 – Factsheet

Socio-Economic Activity and Water Use in the Tropical Rivers Region

Significance of water

The importance of water can not be overstated. It maintains life, is of strong cultural and religious significance, and is also used to produce things in 'industry' (e.g. to grow vegetables, to process minerals).

When people look at or swim in waterholes, they 'use' water, but do not 'consume' it; the water stays there for other people to look at or swim in. That type of water-use is called 'non-consumptive'.

'non-consumptive use'

In contrast, when people drink water, they consume it – and there is less available for others.

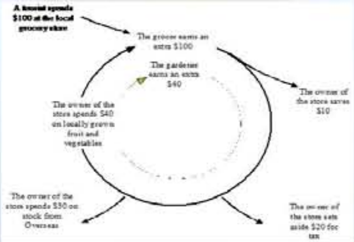
'consumptive use'

As populations rise, there will be increasing pressure on our scarce water resources – for both consumptive and non-consumptive use. And even if populations do not increase, there may still be more demand for water if people start to use/consume more. It is important therefore, to learn more about the value of water – about who is using it and for what.

What is the project about?

Some TRaCK researchers are investigating 'non-consumptive' uses of water. But this project is looking at 'consumptive' uses only. It is trying to work out which people, and which industries 'use' how much water for which reasons – e.g. for drinking, for gardening, for stock, for fruit trees, or in a mine. And it is doing this so that we can learn more about which types of development/growth are likely to place more or less pressure on the regions resources.

To do this, it will build a Water-Use Input-Output Model for three river catchments: the Mitchell (Qld); the Fitzroy (WA); and the Daly (NT). A 'standard' input output model shows how businesses and households are connected, financially, by their payments and purchases. And it allows us to understand how changes in one part of the economy (say an increase in tourist expenditure at the local store) can affect other parts of the economy. For example, when a tourist spends $100 at the local store, the owner of the store earns more money. He/she can save some money, will probably have to pay some taxes, and may also use it to do things like buy stock from the local gardener. So the gardener ends up earning money – indirectly – from the tourist too.



A 'water-use input-output model' allows us to trace through all those financial links – but it also keeps track of how much water is used by different people in a region. So it can tell us how much (consumptive) water is likely to be needed by both the store keeper AND the gardener when the tourist comes to town!

How will this model be used and who will use it?

The model will be used to compare the way in different types of development are likely to affect regional employment, incomes and demand for 'consumptive' water. It will allow us to answer the following types of questions

- What would have the largest impact on regional incomes – an expansion of health services or agriculture?
- What would cause the biggest increase in employment – an increase in retail trade or educational services?
- What would cause the largest increase in the demand for water – an increase in tourism or agriculture?

Activities and Time frame

From late 2008 to early 2009, researchers will be doing some background research – designing the model, filling it with data that is already available, etc.

In the first half of 2009, we will start collecting data about the expenditure and water-use patterns of people who live in the Daly, the Mitchell and the Fitzroy. Some of this data will be collected in a postal survey, but we also hope to visit many Indigenous Communities to collect data in person – providing, of course, that we are welcome.

We will use this data to build the model (which we hope will be finished by late September 2009). After that, we can start using the model, to explore the likely effects of different types of development.

TRaCK Tropical Rivers and Coastal Knowledge

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

JCU JAMES COOK UNIVERSITY

Team Contacts
For more information on this project contact:
Dr Natalie Stoeckl
James Cook University, Townsville
Natalie.Stoeckl@jcu.edu.au
07 4781 4868

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