

# Resident perceptions of the relative importance of socio-cultural, biodiversity, and commercial values in Australia's Tropical Rivers

Report for the North Australia Water Futures Assessment, March 2012

Natalie Stoeckl<sup>1,2,3</sup>, Barbara Neil<sup>1</sup>, Riccardo Welters<sup>1</sup> and Silva Larson<sup>4</sup>



<sup>1</sup> School of Business, James Cook University

<sup>2</sup> Cairns Institute, James Cook University

<sup>3</sup> TropWater - Centre for Tropical Water and Aquatic Ecosystem Research, James Cook University

<sup>4</sup> CSIRO Ecosystem Sciences, ATSIP Building, James Cook University Drive, Townsville, Australia

## **Disclaimer**

JCU advises that the information contained in this publication comprises general statements based on scientific research. The reader is advised and needs to be aware that such information may be incomplete or unable to be used in any specific situation. No reliance or actions must therefore be made on that information without seeking prior expert professional, scientific and technical advice. To the extent permitted by law, JCU (including its employees and consultants) excludes all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this publication (in part or in whole) and any information or material contained in it.

This report was jointly funded by the Department of Sustainability, Environment, Water, Population and Communities and the National Water Commission. The views and opinions expressed in this publication are those of the authors and do not necessarily reflect those of the Australian Government or the Minister for Sustainability, Environment, Water, Population and Communities. While reasonable efforts have been made to ensure that the contents of this publication are factually correct, the Commonwealth does not accept responsibility for the accuracy or completeness of the contents, and shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of this publication.

## **Copyright**

*This publication is copyright. Apart from any fair dealing for the purpose of private study, research, criticism or review as permitted under the Copyright Act, no part may be reproduced, by any process, without written permission from the publisher. Enquiries should be made to the publisher, James Cook University.*

**Citation:** Stoeckl, N., Neil, B., Welters, R., and Larson, S. (2012). Resident perceptions of the relative importance of socio-cultural, biodiversity, and commercial values in Australia's Tropical Rivers – Report for the North Australia Water Futures Assessment. James Cook University, Townsville.

For further information about this publication:

Natalie Stoeckl,  
School of Business and Cairns Institute  
James Cook University,  
Townsville,  
QLD 4811  
Australia  
Tel: 61 7 4781 4868  
Email: [natalie.stoeckl@jcu.edu.au](mailto:natalie.stoeckl@jcu.edu.au)

## Acknowledgements

The project was jointly funded as part of the Northern Australia Water Futures Assessment (NAWFA). NAWFA is a multidisciplinary program being delivered jointly by the Department of Sustainability, Environment, Water, Population and Communities and the National Water Commission, in close collaboration with the Office of Northern Australia and State and Territory government agencies. This project was developed in collaboration with research partners from TRaCK (Tropical Rivers and Coastal Knowledge [www.track.gov.au](http://www.track.gov.au)) - a research hub which has drawn together more than 70 of Australia's leading social, cultural, environmental and economic researchers.

We gratefully acknowledge and appreciate the contribution to this research made by Mitchell River Catchment Traditional Owners (*The Western Gugu Yalanji; The Mulliridgee; The Bar-barrum, The Kuku Djungan and Gugu Mini*).

A special thank you is also due to:

- The TO's who so graciously introduced us to relevant people and helped us to conduct interviews:
  - Ron Archer – *Kuku Djungan* TO;
  - John Grainer - *Kuku Djungan* TO;
  - Eddie Turpin – *Bar-barrum* TO;
  - Eddie Thomas – *Wokomin* TO;
  - Estelle Waia – *Kuku Djungan* TO;
- Participants in focus group meetings; and
- All those who allowed us to personally interview them.

We also wish to extend our sincere appreciation to the hundreds of anonymous householders who took the time and effort to complete our survey – without such input the project could not have gone ahead.

## TABLE OF CONTENTS

Glossary .....	8
EXECUTIVE SUMMARY.....	9
1 INTRODUCTION.....	17
1.1 A region in which water is both temporally and geographically scarce .....	17
1.2 ‘Solutions’ to water scarcity.....	18
1.2.1 Supply-side approaches.....	19
1.2.2 Demand-side approaches.....	20
1.3 A key knowledge gap: Social and Cultural values.....	22
1.4 The Northern Australia Water Futures Assessment program.....	23
1.5 Overview of project .....	24
1.6 Structure of report.....	25
2 GENERAL OVERVIEW OF NON-MARKET VALUATION METHODS.....	27
2.1 Some preliminaries: WHAT is meant by the word ‘value’?.....	27
2.2 Overview of valuation techniques.....	27
2.3 Which technique is the ‘right’ one?.....	30
2.3.1 Data availability.....	30
2.3.2 Ethical considerations: Economic efficiency and the distribution of income .....	30
2.3.3 Identification of key management questions.....	32
2.4 Take-home messages.....	33
3 RESPONDENTS AND SAMPLING METHODS .....	34
3.1 Determining WHOSE ‘values’ to consider .....	34
3.1.1 Identifying an appropriate region from which to collect data .....	35
3.2 Sampling/data collection procedures.....	37
3.2.1 The large-scale mail-out .....	37
3.2.2 Focus groups and interviews in the Upper Mitchell .....	39
3.3 Sample characteristics and degree to which it is likely to be representative of the population at large .....	40
3.4 Extent to which the sample is able to provide information about different stakeholder groups .....	44
3.5 Take-home messages.....	45
4 WHICH ‘VALUES’ ARE MOST/LEAST IMPORTANT TO WHICH STAKEHOLDER GROUPS?.....	46
4.1 Methodological background .....	46
4.1.1 Determining WHICH ‘values’ to assess.....	46

4.1.2	Determining HOW to assess them .....	50
4.2	Results and analysis .....	51
4.2.1	Importance of 'values' .....	51
4.2.2	Satisfaction with 'values' .....	58
4.2.3	Issues raised as contributors to dissatisfaction .....	61
4.2.4	Identifying policy priorities using information on importance and satisfaction .....	62
4.2.5	The relationship between values (interviewees only) .....	66
4.3	Take-home messages.....	72
5	WILLINGNESS TO TRADE ECONOMIC DEVELOPMENT FOR SOCIAL AND CULTURAL VALUES .....	74
5.1	Methodological background .....	74
5.2	Results and analysis .....	77
5.2.1	A preliminary look at results.....	77
5.2.2	Converting categories to dollar values .....	79
5.2.3	Using dollars (WTP/A) to assess tradeoffs between development and Social/Cultural values.....	82
5.2.4	Factors Influencing WTP/A .....	84
5.3	Take-home messages.....	87
6	HOW MUCH COULD STREAM FLOW OR WATER QUALITY CHANGE BEFORE HAVING A SIGNIFICANT IMPACT ON SOCIAL AND CULTURAL VALUES? .....	89
6.1	Methodological background .....	89
6.2	Results and analysis .....	91
6.2.1	Reactions to changes to stream flow .....	91
6.2.2	Reaction to changes in water quality .....	99
6.2.3	What is worse: reduced stream flow, increases in algae or increased sediment? ....	104
6.3	Take-home messages.....	106
7	SYNTHESIS AND CONCLUDING COMMENTS.....	108
7.1	What is the likely response of stakeholders to consequences of upstream development scenarios and to potential changes in the downstream usages of water?.....	108
7.2	Implications for water planning and management .....	108
8	REFERENCES.....	111

## TABLE OF FIGURES

Figure 1 – The Tropical Rivers region of Australia.....	17
Figure 2 – A range of Valuation Techniques .....	28
Figure 3 – Stylised representation of the different types of estimates (e.g. price, CS, expenditure) that are generated by different valuation techniques .....	28
Figure 4 – Applications, data requirements and limitations of the most popular valuation techniques .....	29
Figure 5 – Median weekly income per person in the poorest and richest catchments of the TR region .....	31
Figure 6 – The distribution of ecosystem benefits across the local, national and international community .....	34
Figure 7 – Mitchell River Catchment .....	35
Figure 8 – Map showing catchments across the TR region using a spectrum of shades/colours.....	36
Figure 9 – Number of years lived in the area for all respondents (including mail-out and interview data) .....	41
Figure 10 – How much longer respondents will live in the area (including mail-out and interview data) .....	42
Figure 11 – Number of respondents in each age category (including mail-out and interview data)...	42
Figure 12 – Income categories of all respondents (including mail-out and interview data) .....	43
Figure 13 – Number of respondents who have completed an education level (including mail-out and interview data).....	43
Figure 14 – Sample survey question to determine the source of household income.....	44
Figure 15 – Primary source of household income for all respondents (including survey and interview data) .....	45
Figure 16 – Ecosystem services of Australia’s TR systems and examples of the activities and benefits they provide.....	47
Figure 17 – Comparison of Total Economic Value (TEV) and Millennium Ecosystem Assessment (MEA) Ecosystem Services frameworks, with some examples relevant to Australia’s Tropical Rivers .....	48
Figure 18 – Sample survey question to determine the relative importance of ‘values’ .....	51
Figure 19 – The relative importance of Social and Cultural values: Mail-out and interview data compared.....	52
Figure 20 – Relative importance of Social and Cultural values – mean responses compared across households dependent upon different industries for income.....	55
Figure 21 – Satisfaction ratings .....	59
Figure 22 – Overlay of importance and satisfaction scores for four broad categories of water values .....	63
Figure 23 – Overlay of importance and satisfaction scores for each Social and Cultural aspect of water .....	63
Figure 24 – Cluster analysis of all aggregated data (n=37) .....	67
Figure 25 – Cluster analysis male data aggregated (n=19).....	69
Figure 26 – Cluster analysis female data aggregated (n=18) .....	69
Figure 27 – Cluster analysis non-Indigenous aggregated data (n=20) .....	71
Figure 28 – Cluster analysis Indigenous aggregated data (n=17).....	71
Figure 29 – Sample willingness to pay survey question .....	76
Figure 30 – Responses to the development scenarios.....	78

Figure 31 – Mean WTP/WTA for protest versus no-protest versions of the questionnaire.....	80
Figure 32 – Willingness to accept incremental damage to Social and Cultural values .....	84
Figure 34 – Sample survey question to determine response to changed stream flow.....	90
Figure 35 – Sample survey question to determine current water quality.....	91
Figure 36 – Sample survey question to determine response to changed water quality.....	91
Figure 37 – Reaction of those living near a perennial river to a variety of different scenarios involving a change in stream flows: distribution of responses.....	92
Figure 38 – Reaction of those living near a perennial river to a variety of different scenarios involving a change in stream flows: mean responses .....	94
Figure 39 – Marginal response to decreasing levels of flow from perennial and seasonal rivers .....	95
Figure 40 – Reaction of those living near a river which is ‘normally’ dry for 3-6 months each year to a variety of different scenarios involving a change in stream flows: distribution of responses .....	97
Figure 41 – Reaction of those living near a river which is ‘normally’ dry for 3-6 months each year to a variety of different scenarios involving a change in stream flows: mean values .....	97
Figure 42 – Reaction of those living near a river which is ‘normally’ dry for >8 months each year to a variety of different scenarios involving a change in stream flows: distribution of responses .....	98
Figure 43 – Reaction of those living near a river which is ‘normally’ dry for >8 months each year to a variety of different scenarios involving a change in stream flows: mean responses.....	99
Figure 44 – Reaction of those living near a river that is currently clear with no algae to a variety of different scenarios involving a change in water quality: distribution of responses .....	100
Figure 45 – Reaction of those living near a river that is currently clear with no algae to a variety of different scenarios involving a change in water quality: mean response .....	101
Figure 46 – Marginal response to changes in turbidity and nutrients for a river which is clear with no algae .....	101
Figure 47 – Reaction of those living near a river that is currently murky for half the dry season to a variety of different scenarios involving a change in water quality: mean response.....	102
Figure 48 – Reaction of those living near a river that is currently murky throughout the dry season to a variety of different scenarios involving a change in water quality: mean response .....	103
Figure 49 – Reaction of those living near a river that is currently clear with some algae to a variety of different scenarios involving a change in water quality: mean response .....	103
Figure 50 – Reaction of those living near a river that is currently clear with lots of algae to a variety of different scenarios involving a change in water quality: mean response .....	104
Figure 51 – Comparison of reactions to decreased stream flow, increased nutrient content and increased turbidity for a river which is currently Perennial and Seasonal and Clear.....	105
Figure 52 – Comparison of reactions to decreased stream flow, increased nutrient content and increased turbidity for a river which is currently Perennial and Seasonal and has some algae.....	105
Figure 53 – Comparison of reactions to decreased stream flow, increased nutrient content and increased turbidity for a river which is currently Perennial and Seasonal and is murky for half of the dry season.....	106
Figure 54 – Cluster analysis Employed aggregated data (n=15) .....	125
Figure 55 – Cluster analysis Passive Income aggregated data (n=21) .....	126
Figure 56 – Reaction of those living near a river that is currently murky for half of the dry season to a variety of different scenarios involving a change in water quality: distribution of responses .....	135
Figure 57 – Reaction of those living near a river that is currently murky throughout the dry season to a variety of different scenarios involving a change in water quality: distribution of responses .....	135

Figure 58 – Reaction of those living near a river that is currently clear with some algae to a variety of different scenarios involving a change in water quality: distribution of responses ..... 136

Figure 59 – Reaction of those living near a river that is currently clear with lots of algae to a variety of different scenarios involving a change in water quality: distribution of responses ..... 136



## TABLE OF TABLES

Table 1 – Characteristics of all respondents (including mail-out and interview data).....	41
Table 2 – Values included in questionnaire .....	49
Table 3 – The relative importance of Social and Cultural values: interviews and mail-out responses compared .....	52
Table 4 – The relative importance of Social and Cultural values: Indigenous and non-Indigenous responses compared (all data) .....	53
Table 5 – The three most important and least important values - Indigenous and non-Indigenous responses compared (all data) .....	54
Table 6 – Demographic, sense of place and economic variables included in the analyses.....	56
Table 7 – Factors influencing levels of importance assigned to water values .....	58
Table 8 – Satisfaction ratings: Indigenous and Non-Indigenous responses compared .....	59
Table 9 – Factors influencing levels of satisfaction assigned to water values .....	60
Table 10 – Issues raised as contributors to dissatisfaction.....	61
Table 11 – Index of Dissatisfaction (IDS) for water values across Northern Australia. Higher values indicate greater importance, dissatisfaction and/or per cent of respondents selecting the value.....	64
Table 12 – Factors influencing index of dissatisfaction associated with different water values .....	65
Table 13 – Values used in cognitive mapping exercise .....	66
Table 14 – Values assigned to categorical responses to WTP/WTA questions.....	79
Table 15 – Descriptive statistics for WTP/WTA question – ‘raw’ data .....	79
Table 16 – Top five amounts nominated as WTP/A for each scenario .....	81
Table 17 – Comments provided about WTP/A survey questions .....	81
Table 18 – WTP/A by household income brackets.....	82
Table 19 – WTP/A as a per cent of income by household income brackets.....	83
Table 20 – Factors influencing WTP/A.....	86
Table 21 – Number of respondents living near rivers with different flow characteristics .....	92
Table 22 – Values assigned to categorical responses measuring (dis)satisfaction with changed stream flow.....	94
Table 23 – Marginal responses to a change in stream-flow .....	95
Table 24 – Number of respondents living near rivers with different levels of turbidity and algae ...	100
Table 25 – Number of respondents living near rivers with different levels of turbidity and algae – and also different existing stream-flow .....	104
Table 26 – The relative importance of Social and Cultural values: Indigenous and non-Indigenous responses compared (mail-out data only) .....	119
Table 27 – The three most important and least important values – Indigenous and non-Indigenous compared (mail-out data only) .....	119
Table 28 – The relative importance of Social and Cultural values: Indigenous and non-Indigenous responses compared (interview data only) .....	120
Table 29 – The three most and least important values – Indigenous and non-Indigenous compared (interview data only) .....	120
Table 30 – Relative importance of Social and Cultural values – mean responses compared across households dependent upon different industries for income .....	121

Table 31 – Satisfaction ratings: responses compared across households dependent upon different industries for income .....	121
Table 32 – Response rate and the formal option to protest (mail out survey only).....	127
Table 33 – Response rate analysis (mail out data only) .....	129
Table 34 – WTP/A as per cent of annual household income – protest and no-protest responses compared (mail out data only) .....	130
Table 35 – WTP/A as per cent of annual household income: mail out response versus interview survey for non-Indigenous residence of the Mitchell river catchment.....	131
Table 36 – Bivariate analysis of WTP/A (per cent of household income) to demographic and environmental characteristics .....	133
Table 37 – Factors influencing WTP/A as a proportion of household income .....	134
Table 38 – Factors influencing WTP/A (straight dollar values) .....	134

## Glossary

CDU	Charles Darwin University
CS	Consumer surplus
CSIRO	Commonwealth Scientific and Industrial Research Organisation
GU	Griffith University
JCU	James Cook University
NAWFA	Northern Australia Water Futures Assessment
NT	Northern Territory
NWC	National Water Commission
NWI	National Water Initiative
QLD	Queensland
TR	Tropical Rivers
TRaCK	Tropical Rivers and Coastal Knowledge
WA	Western Australia
WTA	Willingness to accept
WTP	Willingness to pay

The table below summarises the ‘values’ included in the survey with a single descriptor, which will be used throughout the report.

	<i>Descriptor</i>	<i>‘Value’ used in survey</i>
	Life	Water for human ‘life’: the rivers give water for drinking; they also keep plants and animals alive – and I use these for food
	Biodiversity	Water for other life (biodiversity): the river keeps a variety of plants and animals alive
	Commercial	Water for commercial and economic purposes (eg. irrigating crops, processing minerals, hydroelectricity, tourism)
Water for Social and Cultural purposes	Bequest	I like to know that the river will be there for my children/grandchildren
	Existence	I don’t go to the river, but I like to know it is there
	Fishing	I like to use the river for recreational fishing
	Recreation	I like to meet friends and family at the river, or use the river for swimming, picnics, boating, water skiing and other types of recreation
	Aesthetics	The river gives me peace of mind; I like to look at it; it inspires me
	Teaching	The river allows me to maintain customs, connect with history, remember ancestors; rivers are a good place for teaching / learning

## **EXECUTIVE SUMMARY**

### **Background and overview of project (chapter 1):**

This report describes research that was commissioned by the Northern Australia Water Futures Assessment (NAWFA) Cultural and Social program. The NAWFA Cultural and Social program has funded a number of research projects to help fill some of the critical information gaps about Social and Cultural values associated with Australia's Northern Rivers.

The TRaCK NAWFA Social and Cultural project was comprised of three research activities that were carried out by CSIRO, Charles Darwin University (CDU), James Cook University (JCU) and Griffith University (GU) as part of the Tropical Rivers and Coastal Knowledge (TRaCK) program. The three activities ran in parallel from March 2011 for a period of 12 months, and were:

- Sub-project 1 – Social and cultural values in the planning cycle (CSIRO and CDU);
- Sub-project 2 – Relative values of water for trade-offs (JCU); and
- Sub-project 3 – Developing management models for Indigenous water strategies (GU).

This report relates to Sub-project 2 – Relative values of water for trade-offs.

The overarching aim of this project was to improve our understanding of the Social and Cultural values associated with Australia's Tropical Rivers. Its specific objectives were to improve our understanding of:

1. the relative values of water for different stakeholder groups;
2. the rate at which different stakeholder groups are willing to trade-off economic development for those values;
3. the extent to which stream flow and/or water quality could change before there was a 'significant' impact on Social and Cultural values; and hence
4. the likely response of stakeholders to the consequences of upstream development scenarios and to potential changes in the downstream uses of water.

The project was undertaken within a limited timeframe. Although data collection processes ensured that a reasonable cross-section of views were obtained, these views are not considered to be representative of the views of all residents of Northern Australia. Furthermore, although researchers have been able to conduct a relatively detailed analysis of much of the data and produce useful results, there is scope for further, more sophisticated analysis that may generate further insights. As such, this work should be viewed as generating 'preliminary' findings.

### **Generic methods (chapter 2):**

A hammer is not capable of fixing all building problems. Likewise, no single valuation method can be used in all situations. One needs to consider a variety of different issues, including data availability, ethical and information requirements.

Social and Cultural values are only loosely associated with the market (if at all). As such, many valuation techniques (particularly those which rely on observable market prices) could not be used to assess ALL values of interest. Instead, stated preference techniques were chosen since they alone are able to assess a full range of values (irrespective of whether or not they are associated with the market).

However, researchers were aware of the fact that if they used stated preference techniques to measure preferences at an individual level by asking about Willingness to Pay (WTP), and if they then added those 'preferences' across multiple individuals (each with a different income), they would create what is – in essence – a weighted index of value (where the weights are a function of income). Researchers therefore decided to use both dollar and non-dollar denominated stated preference techniques.

### **Sampling (chapter 3):**

Researchers were cognizant of the fact that the work was commissioned by NAWFA, with the overarching goal of providing information (about Social and Cultural values) to assist water planners. These planners work, almost exclusively, with local residents. So, researchers decided to assess only the 'values' of residents in the tropical river's region – although great care was taken to ensure that information was collected from a broad cross-section of those residents.

A questionnaire was mailed out to more than 1500 residents across Northern Australia. Researchers received 252 usable responses, which were supplemented by interviews that were conducted with 39 residents of the Upper Mitchell River, QLD. The upper part of this catchment was chosen for an intensive case study for three reasons: (1) it is in the formative stages of water policy and planning, so a study such as this was well-timed to provide information that might assist those involved in the planning process; (2) Researchers needed to ensure that data were collected from both Indigenous and non-Indigenous residents, and they had already worked with several Indigenous people in and around the upper reaches of the Mitchell, making it relatively easy to engage with various groups in a short study period of time; and (3) development issues confronting those in the Mitchell Catchment are likely to precede those in other TR catchments (with the exception of regions in and around Darwin), meaning that lessons learned from this case-study could be useful in other regions in later years.

The entire sample included a smaller percentage of Indigenous people, large families, young people and people who did not go to university, than the population from which the sample was drawn. The sample did, however, contain observations from a broad cross-section of most of our targeted 'stakeholder' groups, namely residents who depend upon the agricultural, mining, government and 'other' sectors for income and employment, allowing many important observations to be drawn.

Readers are cautioned not to simply look at aggregate measures (e.g. means), and assume that those measures can be used to draw inferences about the population at large. Instead readers should first check to see if the variable of interest is 'consistent' across stakeholder groups. Where differences exist, readers should look at the information most pertinent to the group(s) of interest, rather than at aggregate measures. If used in this way, the information generated in this report is likely to be very useful.

Readers are, however, urged to exercise extreme caution when seeking to use insights from this study to draw inferences about Indigenous values in other parts of the TR region. This is because of the relatively low number of Indigenous responses received, and the fact that most Indigenous respondents came from one small area of the TR region. But readers should even be cautious about

trying to draw inferences about the values of other Indigenous people within the study area; our Indigenous sample did not include people from ALL traditional owner groups in the Upper Mitchell.

#### **Objective 1 – (chapter 4):**

Researchers sought to assess the relative importance which a wide variety of residents of Northern Australia place upon nine different goods/services associated with Australia's Tropical Rivers, including the values associated with the 'use' (consumptive or otherwise) of rivers for: supporting human life (referred to as *Life*); for supporting *Biodiversity*; for use in *Commercial* ventures; for future generations (termed *Bequest*); for simply 'being there' even if never used (termed *Existence*); for recreational *Fishing*; for other types of *Recreation*; for *Aesthetics*; and for *Teaching*.

Importantly, the list of values comprised six examples of Social and Cultural values, and three examples of other (non-Social/Cultural) values. These other values were included to enable researchers to gauge the importance of Social and Cultural values RELATIVE to other 'values'.

Respondents were presented with a list of those values and asked to indicate (i) how important each was to their overall well-being; and (ii) how satisfied they were with it. When not completely satisfied, they were asked to explain why. The data were analysed using several different approaches, clearly highlighting the following:

- In terms of importance, the top three values identified by respondents were *Biodiversity*, *Life*, and *Bequest*.
- The highest satisfaction ratings were associated with *Biodiversity*, while *Life*, *Bequest* and *Aesthetics* were equally second highest.
- Many of the stated causes of dissatisfaction related to concerns about what might happen in the future (rather than to concerns about what was happening now).
- Most stakeholder groups held similar views about the ranking of values (in terms of 'importance') from highest to lowest, although some socio-demographic, economic, and sense of place factors were found to have a minor influence on importance scores.
- One of the highest policy priorities seems to be that of *Commercial* values. This is not because such values were considered to be important (they were rarely in the 'top three'), but because the satisfaction scores associated with these values were so low. Evidently, the issue here is not one of protecting *Commercial* values, but of addressing problems, and concerns relating to the commercial use of water. Resident concerns included, but were not limited to issues associated with: pollution (past, present, or potential future), pricing, overuse, lack of certainty in supply, allocation and lack of monitoring. Interestingly, there were no systematic or predictable differences in the responses of different stakeholder groups in either the satisfaction scores or the indices of dissatisfaction associated with *Commercial* values; evidently respondents were consistently 'dissatisfied' with this value (although for many different reasons).

A small subset of respondents (interviewees) were also asked to participate in a cognitive mapping exercise – the aim being to determine the extent to which the values assessed in the survey could be viewed as complementary or competitive. *Biodiversity*, *Life* and *Social/Cultural* values were viewed as being largely complementary to each other. In contrast, *Commercial* values were consistently

viewed as quite separate from – and often competitive or detrimental to – these other values (with the important exception of tourism).

### **Objective 2 (chapter 5):**

Respondents were also presented with a series of (hypothetical) development ‘scenarios’. First, they were asked to indicate how much they would be willing to pay (WTP) to prevent development that would impact upon Social and Cultural values. Then they were asked to indicate how much they would be willing to accept (WTA) as compensation if development caused damage to their Social and Cultural values. Finally they were asked how much they would be willing to pay to reduce current development, thus increasing their opportunity to enjoy Social and Cultural values.

Data were analysed using a variety of different methods, highlighting the following:

- 1) A large proportion of respondents were strongly opposed to the development scenarios, evidenced by the fact that
  - Fewer than 33 per cent of respondents indicated that they approved of the development scenarios presented in the first two scenarios – even when the impact on Social and Cultural values was relatively small.
  - A relatively large percentage of respondents refused to consider any trade-off at all (between 30% and 70%, depending upon the format of questionnaire presented).
  - Some respondents noted that they had already spent thousands of dollars fighting development proposals in and around ‘their’ rivers.
  - Of the group that agreed to ‘play’ the trade-off ‘game’, approximately 5 per cent were WTP/A significant sums of money to avoid damage or to ‘repair’ damage to their Social and Cultural values) with maximum values cited in the survey of \$1 million and many values in excess of \$10,000. These maximum values generated highly skewed distributions with mean WTP/A ranging between almost \$6000 per annum per household, to almost \$28,000; median values were much more modest (between \$15 and \$100).
  - More than 50 per cent of respondents indicated that they would be willing to accept a DECLINE in income if it was associated with improved opportunities to enjoy their Social and Cultural values.

This strong sentiment is not altogether surprising given the fact that the previous chapter clearly showed that *Commercial* values were, almost always, rated as being less important than some Social and Cultural values – particularly *Bequest*. Moreover, it is consistent with previous studies in the region (e.g. Straton and Zander, 2010).

This strong sentiment may also at least partially reflect an assumption on the part of respondents that the scenarios would affect more than just Social and Cultural values (i.e. they may be assuming that the development will also impact values such as *Biodiversity* which are viewed by some as essentially inseparable from Social and Cultural values).

- 2) When outliers (i.e. the very high WTP/A dollar votes) were excluded, researchers found that:
- WTP was strongly linked to ability to pay, but that those on low incomes are willing to sacrifice a much higher proportion of their income to protect their rivers than those on high incomes (three to four times higher). This is also consistent with previous findings of Straton and Zander (2010).
  - The importance which people place on *Biodiversity* is, almost always, a positive and statistically significant determinant of their WTP to protect Social and Cultural values (reinforcing earlier observations about the complementarity of these values).
  - People's expressed willingness to accept compensation for 'damage' to Social and Cultural values (which they are unable to prevent from occurring) is significantly higher than their expressed willingness to pay to avoid the damage from occurring in the first place. The potential policy significance of this is discussed in chapter 7 (summarised under issue 3, page vi).

### **Objective 3 (chapter 6):**

Respondents were asked to consider a range of hypothetical scenarios that involved changes to stream flows and water quality in nearby rivers. Specifically, they were asked to indicate (on a five point Likert scale) how these changes would affect their satisfaction with Social and Cultural values. Analysis of the data highlighted the following issues:

- Any change which stops the flow of perennial rivers – even if only for a month or two – is likely to have a significant, negative impact on Social and Cultural values. (The term *significant* indicates that more than 50% of respondents said that such a change would either reduce or greatly reduce their satisfaction.)
- Respondents were generally positive or ambivalent about changes in stream flow which reduced dry periods. In other words, those who live near an intermittent river system stated that they would either have increased or consistent levels of satisfaction with their Social and Cultural values if the dry periods were shortened (or if the river becomes perennial). The important exception to this occurred with respect to perennial but UNPREDICTABLE flows. Perennial flows are viewed positively – as long as the flows are constant, or related to natural, seasonal fluctuations.
- Scenarios that reduce water quality (be it due to increased levels of turbidity or algae) are likely to create a significant negative impact on Social and Cultural values; improvements are likely to generate a significant positive impact.
- Respondents viewed reductions in water quality more negatively than reductions in stream flow, and were consistently more positive about scenarios that involved improvements in water quality than about scenarios that involved increases in stream flow. This may be at least partially due to the fact that respondents are used to living in regions that have extremely variable climates. Changes to stream flows may thus be considered somewhat 'normal'.



## **Concluding remarks and recommendations (Chapter 7):**

**Objective 4** asked researchers to determine:

***What is the likely response of stakeholders to consequences of upstream development scenarios and to potential changes in the downstream usages of water?***

Chapter 4 clearly showed that *Commercial* values are considered to be less important than *Biodiversity*, *Life* and some *Social/Cultural* values, while chapter 5 clearly showed that at least some people are WTP substantial amounts of money to prevent development that impacts upon their *Social/Cultural* values. As such, it seems that developments which impact upon downstream usages of water are likely to be met with quite a negative reaction.

The opposition is likely to be characterised by significant disquiet amongst a possibly vocal minority (those refusing to consider any trade off at all, or WTP very large sums of money to prevent the development from occurring) and a present, but less significant disquiet amongst a larger group of other residents.

Those most willing to accept trade-offs for development include the wealthy and/or people who place highest values on *Commercial* uses of rivers; those who place a high value on *Biodiversity* (a significant proportion of respondents) and/or those who are relatively poor seem to be much less willing to trade their *Social* and *Cultural* values for greater income flows.

### ***Other important comments/insights***

ISSUE 1: Interviewee data indicates that *Biodiversity*, *Life* and *Social/Cultural* values are somewhat complementary to each other, whereas, *Commercial* values are almost always viewed as quite separate from – and often competitive or detrimental to – these other values (with the important exception of tourism). Moreover the larger (mail out) data set showed a strong correlation between WTP to protect *Social/Cultural* values and stated importance of *Biodiversity* values.

Evidently, for many Northern Residents, the existence of biodiversity may be a necessary pre-condition for maintenance of many *Social* and *Cultural* values. Determining whether or not the existence of biodiversity is also a SUFFICIENT condition for the preservation of *Social* and *Cultural* values, stands as a vitally important topic for further, more thorough, research. Why is this so important?

- If the existence of high quality biodiversity values is both a necessary and sufficient condition for the existence of high quality socio-cultural values, then preservation of the former guarantees preservation of the latter. However, if the existence of high quality biodiversity values is a necessary, but not a sufficient condition for the existence of high quality socio-cultural values, then preservation of the former does not guarantee preservation of the latter; other steps may be necessary (e.g. guaranteeing access to areas of high biodiversity value).

- Moreover, if the *Biodiversity* and *Social/Cultural* values that are derived from one ‘area’ are non-rivalrous (meaning that society can benefit from both, simultaneously), then their values should be added together<sup>1</sup> before being traded off against other competing uses of that ‘area’. This is analogous to the situation where a private property owner seeks to determine how much land to devote to cattle and how much to wheat: he/she should firstly estimate the value of ‘cattle’ by considering potential income from both beef and leather, and then compare that (combined) value to the potential income that can be earned from the alternative (wheat). Failure to do so, would be to under-allocate resources (e.g. land, or in this case, possibly aquatic resources) to activities that generate multiple values (e.g. cattle, or in this case, possibly biodiversity and socio-cultural values).

Until we are able to learn more about these important issues<sup>2</sup>, planners may, therefore, wish to adopt a pre-cautionary approach (as advocated by the NWI). That is, they may wish to proceed as if these values are non-rivalrous, perhaps setting aside MORE than the ‘bare minimum’ that is required to maintain biodiversity values, and also ensuring that other steps are taken to facilitate the appreciation of socio-cultural values (e.g. ensuring residents have access to important areas).

ISSUE 2: Respondents were particularly concerned about changes which impact upon water quality, although those who live near perennial rivers were also very concerned about any change that would stop their stream/river flowing for even a short period each year. Moreover, comments made during focus groups and in interviews (as well as comments written on returned, mail-out questionnaires) indicated that (a) many respondents have a holistic view of their environment (incorporating social, cultural, economic and biophysical values); (b) they did not feel as if all local environmental management issues were being dealt with effectively; and that (c) their opposition to development scenarios could be considerably tempered by effective, and well-aligned, social and environmental management systems.

In other words, the size of the ‘trade-off’ between development and *Social/Cultural values* is unlikely to be ‘given’: it varies according to the environmental management systems that are associated with the development.

Some current policies and institutional arrangements separate issues surrounding water quantity (and allocation) from water quality (and environmental management)<sup>3</sup>. However, this research clearly highlights the importance of ensuring that governance systems account for the relationship between the two – and that residents are made aware of the steps that have been taken to ensure this. Evidently, opposition to proposed developments could be at least partially redressed by taking

---

<sup>1</sup> If one wishes to generate an estimate of the market value of a (non-rivalrous) public good, one must conduct a vertical summation of the ‘value’ which each individual derives from it.

<sup>2</sup> There are some very interesting scientific challenges facing researchers who wish to ascertain just HOW to measure highly correlated values such as these in a manner that facilitates “adding”. Standard approaches – such as choice modelling – may not be suitable, and may thus need to be adapted. For example most choice experiments, allow researchers to assess the marginal WTP for changes in one attribute, whilst holding other attributes constant. But if respondents view the attributes as inseparable, then the choice sets that are presented to people may not be viewed as realistic representations of true choices, making it difficult to assess the reliability of estimates so obtained.

<sup>3</sup> E.g. mine water quality management tends to be managed separately from other water management activities.

steps to ensure that the developments do not adversely affect EITHER water quality OR stream flows (taking particular steps to protect perennial flows).

ISSUE 3: Our development 'scenarios' clearly indicated that the amount which respondents expected as compensation for damage, exceeded the amount which they would be willing to pay to prevent a development from going ahead.

This suggests that it is in the interests of policy makers to discuss (and, where feasible, negotiate) development options with affected parties BEFORE development occurs. Compensation after the event could prove much more costly.

The NWI highlights the importance of *community consultation and public participation in water planning*, and this research provides clear evidence of the fact that this type of *consultation* is not just a 'nice' thing to do – it is also financially sensible. Those who attempt to avoid expenditure on appropriate consultative processes may run the risk of having to bear greater costs in subsequent periods when/if aggrieved residents seek 'compensation'<sup>4</sup> for actions have been taken without appropriate consultation and negotiation (and/or if they seek to prevent proposed developments from taking place because they feel they have not had appropriate opportunity to participate in water planning).

ISSUE 4: Finally, it is important to note that the values of residents may differ, perhaps substantially, from the value of non-residents. This may generate conflict – particularly in situations where non-residents are able to influence decisions and planning processes – and raises an important ethical question: Where differences arise, WHOSE values SHOULD be given greatest voice?

If one relies exclusively on dollar-denominated non-market valuation techniques to help address that question, one will – even if unwittingly – give greater voice to the 'rich' than to the 'poor'. And this may, by extension, give greater voice to non-residents than to residents (who are often at considerable socio-economic disadvantage – particularly Indigenous residents). Evidently, it is important for planners to use more than mere dollars when seeking to assess and/or redress the many tradeoffs relating to the uses of Australia's Tropical Rivers.

---

<sup>4</sup> Where appropriate property rights provide for such an entitlement.

# 1 INTRODUCTION

## 1.1 A region in which water is both temporally and geographically scarce

The Tropical Rivers (TR) region comprises 55 river basins that drain into the Timor Sea and Gulf of Carpentaria (the green and orange parts of Figure 1). Covering an area of more than 1.3 million km<sup>2</sup>, it extends across all catchments from the Kimberley to the east side of Cape York, including land along the coast from just south of Broome in Western Australia (WA) through the Northern Territory (NT) and to just south of Innisfail in Queensland (QLD), and inland to south of Fitzroy Crossing, Daly Waters, Mt Isa and Hughenden.

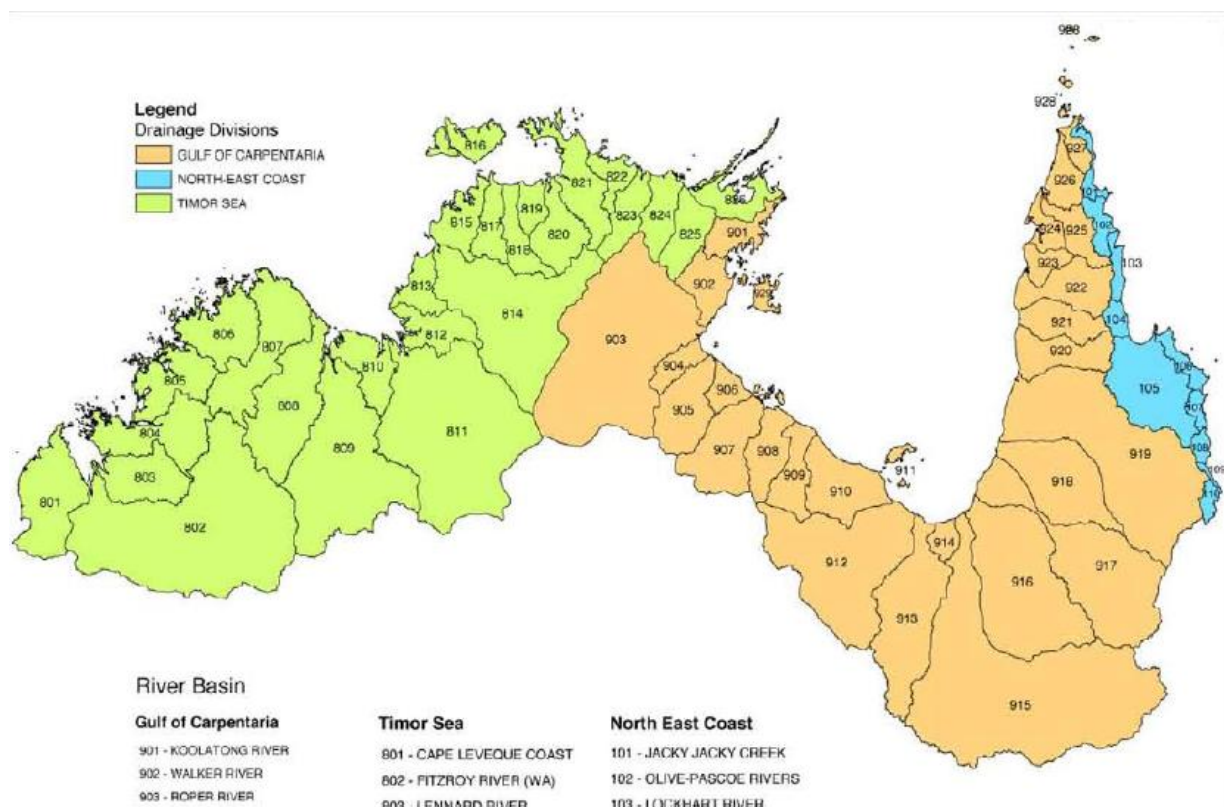


Figure 1 – The Tropical Rivers region of Australia

The region 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). These northern rivers and groundwater systems are estimated to contain roughly 70 per cent of Australia's fresh water resources (Land and Water Australia, 2005), and it is in these regions that the majority (65 per cent) of run-off occurs (Chartres and Williams, 2006, Australian State of the Environment Committee, 2006). In comparison, the southern parts of Australia receive just 6.1 per cent of the country's run-off (Chartres and Williams, 2006).

Figures such as these give one the impression that the north is 'rich' in water resources, yet these highly aggregated statistics mask the fact that very little *perennial* water exists in this area. Australian river systems have the most variable flow regimes in the world (Puckridge et al., 1998, McMahon, 1992), and in the north much of this extreme variability is due to the fact that many

areas receive no rain at all for 6-9 months each year during the winter dry. Few northern rivers flow all year round, and most are but dry, sandy creek beds for long periods each year, flooding – sometimes extensively – during the wet (Kennard et al., 2010). Where perennial streams exist, they are most often fed by groundwater from aquifers such as for the Daly (NT), Gregory (QLD) and Jardine Rivers (QLD) (Commonwealth Scientific and Industrial Research Organisation (CSIRO), 2009).

Evidently, the temporal and geographic scarcity of water (Bennett, 2005, p.1) has influenced European settlers<sup>5</sup> (Jackson et al., 2008): 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, in 2006, the Australian Bureau of Statistics (ABS) census recorded that just 310 000 people (approximately) had their usual residence in the TR region at that time<sup>6</sup> (Carson et al., 2009)<sup>7</sup>.

This scarcity of water, coupled with harsh climatic conditions (high temperatures and humidity through much of the year) has no doubt had a constraining influence on economic development. Nowadays just three sectors (which include: (i) Government Administration and Defence; (ii) Health and (iii) Education) are responsible for more than 25 per cent of employment in Australia's north (Stoeckl and Stanley, 2007).

Many are interested in attempting to diversify that narrow focus – ideally developing industries that capitalize on the region's comparative advantage: namely, its abundant natural resources. Moreover, rising populations, increasing pressure on southern Australian river systems, and the perceived abundance of water resources in Northern Australia is driving strong interest in the potential for greater use of the north's natural resources, particularly for agriculture (Douglas et al., 2011). Yet development of any industry – and in particular agriculture, mining, fishing and tourism – requires the use (consumptive or otherwise) of the region's water resources and associated aquatic ecological processes. Accordingly, all those interested in development must consider issues of access to, quality of, and the implications of use and changes to the region's water resources (Northern Australia Land and Water Taskforce, 2009).

## 1.2 'Solutions' to water scarcity

Current policy makers have clearly recognised that pressures on Australia's water resources mean that it is important to look at both supply-side and demand-side solutions, a brief discussion of which is given below.

---

<sup>5</sup> Importantly, this has not prevented Indigenous owners from occupying lands in the north for thousands of years. Neither has it prevented more recent European migrants from settling in the region. Settlement has been possible at least partially because some perennial surface waters do exist (such as billabongs), and partially because there are many underground aquifers throughout Australia which offer themselves as a viable alternative to surface water and they are often used as such (e.g. for stock, for urban irrigation, and even for human consumption). This is starkly evidenced in the 2001 Community Housing and Infrastructure Needs Survey (CHINS) collected by the Australian Bureau of Statistics (ABS 2001), which found that bore water was the main source of drinking water for 62 per cent of the total population of discrete Indigenous communities.

<sup>6</sup> It is noted that census data may represent a significant undercount, particularly in remote and very remote areas.

<sup>7</sup> Two thirds of those people lived in urban centres and larger localities, with one third alone living in the greater Darwin area (including Palmerston and Litchfield). In 2006, only three centres had more than 10 000 people, 2 centres in the Northern Territory had approximately 5000 people and 24 of the region's river basins had fewer than 500 people; all but four river basins across the top end have less than 1 person per km<sup>2</sup> (Stoeckl et al., 2006).

### 1.2.1 Supply-side approaches

In theory, water scarcity can be at least partially solved by increasing supply – either using more underground resources, or capturing more surface water. But many of the aquifers in Australia's north have been 'fully exploited', particularly those located in the Queensland Gulf area (Department of the Environment and Heritage, 2001). As such, underground resources are simply not able to provide an unlimited supply of water. Moreover, in most cases, use of ground water supplies will impact upon surface water resources<sup>8</sup>.

When insufficient underground resources exist, water scarcity is, on occasion, dealt with by 'capturing' more surface water. Whilst most of the catchments in New South Wales and Victoria have been identified as either overdeveloped or fully-developed, less than 30 per cent of surface waters across most of the TR region are classified as 'developed' (Department of the Environment and Heritage, 2001, pg. 59). With the exception of Lake Argyle, there are few large dams in the TR region. There are several dams supplying water to local towns (e.g. Darwin, Croydon), and mining companies have constructed 'medium'-sized dams that supply water for their operations and to the local town (e.g. near Mt Isa). Likewise many property owners have dams on their property for private use. However, in some instances legislation<sup>9,10</sup> and/or (more often) biophysical factors such as climate and topography<sup>11</sup> prevents or limits the amount of water that can be extracted from rivers.

Most rivers in this region have largely unmodified flow regimes<sup>12</sup> and are comparatively free from the impacts associated with intensive land use (Douglas et al., 2005)<sup>13</sup>, but there are some examples where flow regimes of Tropical Rivers have been modified<sup>14</sup> and this has impacted the ecological, social and cultural environment. For example, the Ord River and Kununurra Diversion Dams have significantly modified the flow regime of the Ord River, leading to the submersion of previously terrestrial habitats (including significant cultural sites) and creating new aquatic ecosystems where none previously existed (Storey et al., 2001, as cited in Straton and Zander, 2009). Stream-flow regulation, such as the release of water from the dam for irrigation demand in the dry season and generation of hydro-electric power, has resulted in a steady flow throughout the year, with smaller and less frequent flood peaks, which now generally occur later in the wet season and for a longer

---

<sup>8</sup> Alexander and Ward (2009) note that much assessment work is still required to better understand surface water – groundwater interaction. As such, the NWC (2011) suggested that unless otherwise established, it should be assumed that all surface and groundwater systems are connected.

<sup>9</sup> For example, the *Wild Rivers Act 2005*, which regulates future development activities within the wild river catchment area, prohibits the development of dams and weirs, levee banks and in-stream mining activities (Alexander and Ward, 2009).

<sup>10</sup> Straton and Zander (2009) citing a National Water Commission (NWC) report (2005) note that the contingent 'rule' for the allocation of groundwater in the NT is that "at least 80 per cent of annual recharge is allocated as water for non-consumptive use, and extraction from consumptive uses will not exceed the threshold level (equivalent to 20 per cent of annual recharge)". Although the '80/20 rule' of the Northern Territory is broadly consistent with the principles of the NWI (refer National Water Commission, 2004), it is not explicitly stated in the Intergovernmental Agreement or the Implementation Plan for the NWI and is only grounded in the Northern Territory Water Allocation Planning and Management Framework not in law (National Water Commission, 2005).

<sup>11</sup> CSIRO (2009)

<sup>12</sup> Nonetheless, there are rivers within the region which have already been substantially modified by agriculture, or urban and industrial development, such as the Ord (WA), Flinders (Qld), Leichhardt (Qld) and Darwin/Finniss River catchments (NT) (Van Dam et al., 2008).

<sup>13</sup> Not only are these natural areas of value by, and of themselves, but because they are in generally good health they also provide many important ecological services upon which a range of human activities depend.

<sup>14</sup> Most notably, the Ord River and the Camballin Irrigation Scheme on the lower reaches of the Fitzroy River.

duration (Trayler et al., 2006). This has had a number of ecological impacts – both to stream flows and aquatic species. Increased agricultural activity, made possible by the consistent presence of water has also led to rising groundwater levels and increased salinity (Straton and Zander, 2009). Furthermore, barriers such as the barrage at Camballin have limited the ability of various aquatic species to migrate and have increased predation of these species because they congregate around the barrier (Morgan et al., 2005). There are also examples in the Northern Territory where water extraction for horticulture or town water supply is approaching the limits of sustainability. In the Katherine region, increased demand for groundwater from the Tindal aquifer has required the development of a water allocation plan to cap and manage extractions (Jackson and Altman, 2009) and similar pressures are evident in the Howard East region adjacent to Darwin (Straton et al., 2011).

Thus, whilst it is clear that one can use supply-side approaches to address issues of water scarcity (either drawing upon surface and groundwater resources in areas where sufficient quantities exist, or – topography permitting – looking at options to capture and store wet-season run-off for use in the dry), it is equally clear that such options are not unambiguously ‘desirable’. Australia’s Tropical Rivers are not only important for the water they can provide to facilitate economic development: their tropical aquatic ecosystems and the rich biodiversity they support are also of biological, social and cultural value (Land and Water Australia, 2005, Douglas et al., 2011).

Determining how best to account for these other important ‘values’ is therefore a key problem facing policy makers when assessing supply-side ‘solutions’ to development pressures.

### **1.2.2 Demand-side approaches**

When water is abundant, there is little need to consider how best to determine who gets how much, but in the presence of scarcity, such issues must be addressed.

In an ideal world, planners and policy makers would seek to maximise social welfare by allocating water resources in a manner that equates the marginal value of competing water uses. This is not just a matter of determining whether water has ‘economic’ value or not; other values must also be considered. Imagine, for example, that it was possible to use water within a river for economic purposes and that this would create an additional \$40,000 per annum in income for a small rural town. On the surface that might seem like a good opportunity. But if, by using the water for that purpose, opportunities to use the river for social and cultural purposes were curtailed, and if those lost opportunities were, collectively, worth more than \$40,000 per annum, then it would not be ‘optimal’ to pursue that development opportunity.

The key point to be made here, therefore, is that policy makers cannot avoid the need to consider a wide variety of ‘values’ – even if they concentrate on demand-side (as opposed to supply-side) approaches.

#### **1.2.2.1 Market-based ‘solutions’ to water scarcity**

Until relatively recently, the main demand-management tools that were used by government were “non-market” mechanisms such as prohibition, regulations, and quantitative allocations. Prices were sometimes used, but in general prices were uneconomically low (such as for urban and irrigation water). But under the Commonwealth of Australian Governments (COAG) water reform agenda

which commenced in the 1990s and was consolidated with the National Water Initiative (NWI) of 2004<sup>15</sup>, markets have become a much more common tool for the allocation of water.

As discussed in Stoeckl et al. (2006), under certain circumstances, markets can be used to ensure that the allocation of the nation's scarce resources is efficient (where 'efficient' means that resources are used to create the greatest benefit for society). There are, however, two broad problems that arise when using a market in this way: the underlying conditions (which are required in order for the market to work efficiently) may not be met<sup>16</sup>; and even if the market operates efficiently, the outcome may not be equitable or fair.

Arguably, one of the more perplexing problems facing those keen to promote the efficient operation of water markets are those associated with externalities. In the TR region, these are likely to arise because one person's consumptive water use (be it of upstream surface waters or connected ground waters) may reduce downstream water flows and/or pollute water downstream. This may reduce the amenity and production value of water in lower reaches of the river<sup>17</sup>, it may erode downstream ecosystem services<sup>18</sup> and/or it may impact upon Indigenous cultural values. Moreover, different types of land use – particularly in areas adjacent to rivers – may either prevent people from gaining access to rivers and/or cause soil degradation and erosion, leading to reduced water quality<sup>19</sup> which thus indirectly impacts ecological, social and cultural values.

---

<sup>15</sup> While the NWI has provided the focus for water policy changes across the Commonwealth, States and Territories, the policy, legal and administrative frameworks remain extremely complex (Stoeckl et al., 2006): indeed, there are over 20 policies and programs impacting on water use for Tropical Rivers across the Commonwealth, States and Territories and 26 pieces of legislation relating to the use of Tropical Rivers (Hegarty et al., 2005).

<sup>16</sup> The underlying conditions that are required for a water market to work efficiently are:

- Investment in water infrastructure and other related goods must be economically efficient and the outputs must be efficiently priced.
- Suppliers and demanders in the water market must have sufficient knowledge and foresight to make decisions which are truly in their own interest.
- Suppliers and demanders must be competitive as demanders and suppliers of water.
- There must be effective and low cost enforcement of property rights, and transaction costs associated with trade must be low.
- There must be no flow-on effects (or 'externalities') from water use or interests in water use beyond those represented in the market.

<sup>17</sup> Whilst common law rights to water are intended to minimise the upstream-downstream conflicts over access to and use of water, their application does not always do so. And more importantly, these rights have often been replaced by water rights under statute law which are the source of conflict. Examples of this include the use of water for irrigation or urban use, the potential for pollutants from mining, manufacturing, agriculture or other activities entering the waterways and – in recent times – proposals for the damming of rivers and the transporting of water to distant urban centres.

<sup>18</sup> Rivers perform an important range of ecosystem services. These include soil formation, nutrient cycling, waste treatment and the provision of habitat for a range of plants and animals. These and many other ecosystem services interact to provide source materials for production and consumption. These functions are vital to human wellbeing, especially in the long run. They are however unlikely to be known to users or are undervalued by them.

<sup>19</sup> For example, agriculture and horticulture, mining, townships, and other land use practices, such as clearing, grazing and wildfires can all impact negatively on water quality. Inappropriate fire regimes late in the dry (Daly Region Community Reference Group, 2004) and clearing of native vegetation can increase land degradation, reduce infiltration and increase run-off (Harris, 2001), particularly when followed by high intensity wet season rainfall, which can lead to erosion and the flow of sediments into aquatic habitats (Straton and Zander, 2009). Faggotter et al. (2011) found that any increase in nutrient loads to the system at the end of the wet season or during the dry season can lead to major changes in the composition and production of aquatic plants and, in some cases, the proliferation of toxic algae or other nuisance aquatic weeds and reduced water clarity (Douglas et al., 2005). Exotic animals, such as cattle, donkeys, pigs and buffalo, can also cause turbidity due to their trampling of wetlands and riverbanks, and this can reduce light for aquatic primary production (Straton and Zander, 2009).



The key point to be made here, therefore, is that even when policy makers choose to use market based approaches and instruments to avoid some problematic water-allocation issues, they will not avoid all. Indeed they are likely to be confronted with many challenging issues – not the least of which is that of determining how best to ensure that the ‘market’ makes allowance for non-market values and externalities.

### **1.2.2.2 Regulatory ‘interventions’ in water-markets**

The issue of market failure is well understood by government and policy makers, and regulations are often used instead of, or in addition to, market based approaches. Regulations that set aside water for ‘environmental flows’, for example, are an attempt to deal with the negative externalities that can arise from overlooking environmental water requirements.

In many jurisdictions, water plans implicitly assume that environmental flows will also meet social and cultural needs<sup>20</sup> which are similarly non-consumptive in nature (Alexander and Ward, 2009). But this issue appears to be inadequately researched and it is not necessarily the case that this approach will ensure ‘optimal’ allocations of water.

To be more specific, economic theory suggests that when allocating a scarce resource across competing uses, the marginal value of that resource in each use should be equated. Simplistically, if water is worth ‘more’ to the miner than the irrigator, then it should be allocated to the miner. But if some of the uses that are being assessed are complementary (perhaps environmental and cultural flows, as is often assumed) then one should add their values before comparing with other (competitive) uses; it is not valid to simply compare the value of ONE of those complementary uses with those of its competitor.

To explain, let us use another, simplistic example: it is possible to use cattle to produce both meat and leather. When determining whether to use land for cattle or for some other, competing use (say grain), private landholders should not ONLY consider meat-values (assuming that leather values are complementary and are thus already ‘taken care of’). Rather, landholders should add both the value of meat and the value of leather together, comparing this combined value against other ‘values’ that could be obtained if using the land for other purposes (e.g. grain). If they fail to do this, too little land will be allocated to cattle (relative to other, competing uses).

To the extent that environmental and Social/Cultural values are also complementary, a similar process may also be appropriate when allocating water across competing uses. In other words, it may not be sufficient to simply determine the amount of water one needs to preserve or protect environmental ‘values’ and assume that this will also take care of Social and Cultural values. Instead, one should firstly add the complementary values (e.g. environmental and Social/Cultural) and then compare that combined value with other competing uses.

## **1.3 A key knowledge gap: Social and Cultural values**

As is apparent from the foregoing discussion, it matters not whether one seeks to address issues of water scarcity from the ‘demand-side’ of the problem, or from the ‘supply side’: policy makers need to ensure that Social and Cultural values are accounted for. This is not simply because an ‘efficient’ allocation of resources requires one to equate marginal values (as discussed above), but because

---

<sup>20</sup> According to the *Water Act 1992* (NT), cultural beneficial uses are defined as aesthetic, recreational and cultural needs, which cover expression by Indigenous and non-Indigenous communities.

people's values, beliefs and practices influence their behaviour, and their likely response to plans or policies. It is, therefore, important to understand values and beliefs if wishing to negotiate competing interests and/or prioritise actions.

Clearly Social and Cultural values are not the ONLY values associated with rivers, but market-based values (such as those associated with production) are rarely overlooked. Moreover, for many decades, Australian policy makers have insisted that ecological values be considered (refer Douglas et al., (2005), Van Dam et al. (2008), Harris (2001), Storey et al. (2001), Faggotter et al. (2011), Blanch et al. (2005)). But it is only recently that policy makers have begun to recognise how important it is to have a solid understanding of community views, values and priorities when developing natural resource policies and management plans. So whilst we have information about several ecological issues of importance to Australia's Tropical Rivers, relatively little is known about the Social and Cultural 'values' of the residents of the region.

Over the last 20 years, both Australian and international researchers have reported on a growing number of methods that, in addition to market and ecological considerations, also incorporate Social and Cultural considerations when assessing minimum environmental flows or potential for economic development of the catchments (for example see Arthington et al., 1998, King et al., 2003, Instream Flow Council, 2004). Several international organisations, such as the World Bank (King et al., 2003) and the International Water Management Institute (Tharme, 2003) now recommend that holistic methods be used for assessment. The objective of these "holistic methods" is to ensure that minimum flows (as well as minimum water quality requirements) do not impact upon "human livelihoods and well-being that depend upon water flows" (see for example the Brisbane Declaration, 2009). However, most of these methods were developed in the context of developing countries (for example, the building blocks method developed in South Africa, King et al., 2000) and thus concentrate mainly on livelihoods, subsistence and hence Social and Cultural (non-market) consumptive values.

In other words, when experts refer to Social and Cultural values of rivers, they are often talking about the consumption of riverine produce or the use of such products in cultural ceremonies (see for example IUCN guidelines, Dyson et al., 2003). But there are clearly many other, non-consumptive Social and Cultural values associated with rivers, about which relatively little is known.

#### **1.4 The Northern Australia Water Futures Assessment program**

The Northern Australia Water Futures Assessment (NAWFA) was established by the Australian Government to inform the development and protection of Northern Australia's water resources, so that development is ecologically, culturally and economically sustainable.

NAWFA is a multidisciplinary program being delivered jointly by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) and the National Water Commission (NWC), in close collaboration with the Office of Northern Australia and state and territory government agencies. Through the *Raising National Water Standards* program under *Water for the Future*, the Australian Government allocated up to \$13 million for projects between 2007-2008 and 2011-2012. The NAWFA has four programs: Water Resources, Ecological, Knowledge Base and Cultural and Social.

It is to the last program – that which focuses on Cultural and Social values – that this project belongs.

The objective of the NAWFA Cultural and Social program is to increase our understanding of the socio-cultural values, beliefs and practices associated with water in Northern Australia and how they may be affected by changes in water availability. It thus seeks to (at least partially) redress the key knowledge gap identified above.

The TRaCK NAWFA Social and Cultural project was comprised of three research activities that were carried out by CSIRO, Charles Darwin University (CDU), James Cook University (JCU) and Griffith University (GU) as part of the Tropical Rivers and Coastal Knowledge (TRaCK) program. These activities focused on social and economic values in water planning and location-specific case studies of the values of particular water use sectors, including Indigenous communities, commercial interests, recreational fishers and conservation groups. They undertook a number of case studies to understand socio-cultural values, beliefs and practices held by various water using groups, including patterns of usage, ecological knowledge, religious significance, economic activities, and governance issues. Attention was also given to tools and mechanisms to articulate and capture Indigenous social and economic aspirations with respect to water. The three activities ran in parallel from March 2011 for a period of 12 months, and were:

- Sub-project 1 – Social and cultural values in the planning cycle (CSIRO and CDU);
- Sub-project 2 – Relative values of water for trade-offs (JCU); and
- Sub-project 3 – Developing management models for Indigenous water strategies (GU).

This report relates to Sub-project 2 – Relative values of water for trade-offs.

## 1.5 Overview of project

The overarching aim of sub-project 2 is to improve our understanding of Social and Cultural values associated with Australia's Tropical Rivers. Importantly, it goes beyond an examination of Social and Cultural consumptive use values to include an entire range of Social and Cultural values<sup>21</sup>. By integrating all types of values and assessing their relative importance against each other, this study goes beyond livelihoods and other consumptive values, considering the entire range of contributions of the rivers to human wellbeing overall.

The specific objectives of this (sub) project are to improve our understanding of:

1. the relative values of water for different stakeholder groups<sup>22</sup>;
2. the rate at which different stakeholder groups are willing to trade-off economic development for those values;
3. the extent to which stream flow and/or water quality could change before there was a 'significant' impact on Social and Cultural values; and hence
4. the likely response of stakeholders to the consequences of upstream development scenarios and to potential changes in the downstream uses of water.

To meet those objectives, researchers:

- Identified the key region of enquiry;

---

<sup>21</sup> A very comprehensive study of Indigenous people's use of water in the north already exists (refer Jackson, 2005).

<sup>22</sup> The stakeholder groups to be included in this project were based on two characteristics: Indigeneity and sector of employment, and these characteristics were pre-defined in the project brief.

- Devised an appropriate survey instrument for measuring (a) relative values and (b) responses of key stakeholder groups to a variety of different development scenarios;
- Used the survey instrument to collect data with a broad-scale mail-out to residents across the TR region and via interview with residents in and around the upper reaches of the Mitchell Catchment;
- Analysed data from the interviews and mail-out survey using both descriptive statistics (e.g. comparing the relative importance of values across different stakeholder groups), and more sophisticated statistical techniques (e.g. testing for the statistical significance of differences, and using multivariate regression to explore the extent to which other variables – such as income, Indigeneity, and location – affect relative values, and/or the willingness of stakeholders to trade economic development for values); and
- Prepared this report to summarise the research activities and key findings (with an intended audience of planners and policy makers).

This research project has thus helped to improve our understanding of:

- the range and relative importance of ‘values’ (associated with water) held by different stakeholder groups;
- the willingness of different stakeholder groups to trade-off those values against different types of economic development; and
- methods that planners can use for eliciting, assessing, and measuring values and trade-offs for different stakeholder groups at an aggregate (planning area) scale.

Moreover, by identifying methods for assessing key Social and Cultural values, this project has also increased the capacity of researchers, agency managers, planners and traditional owners to assess values associated with water in a manner that informs water plans.

## 1.6 Structure of report

Chapter 2 provides some important methodological background, helping to explain what is meant by the word ‘value’ (in this report), and describing how non-market values are commonly assessed by economists.

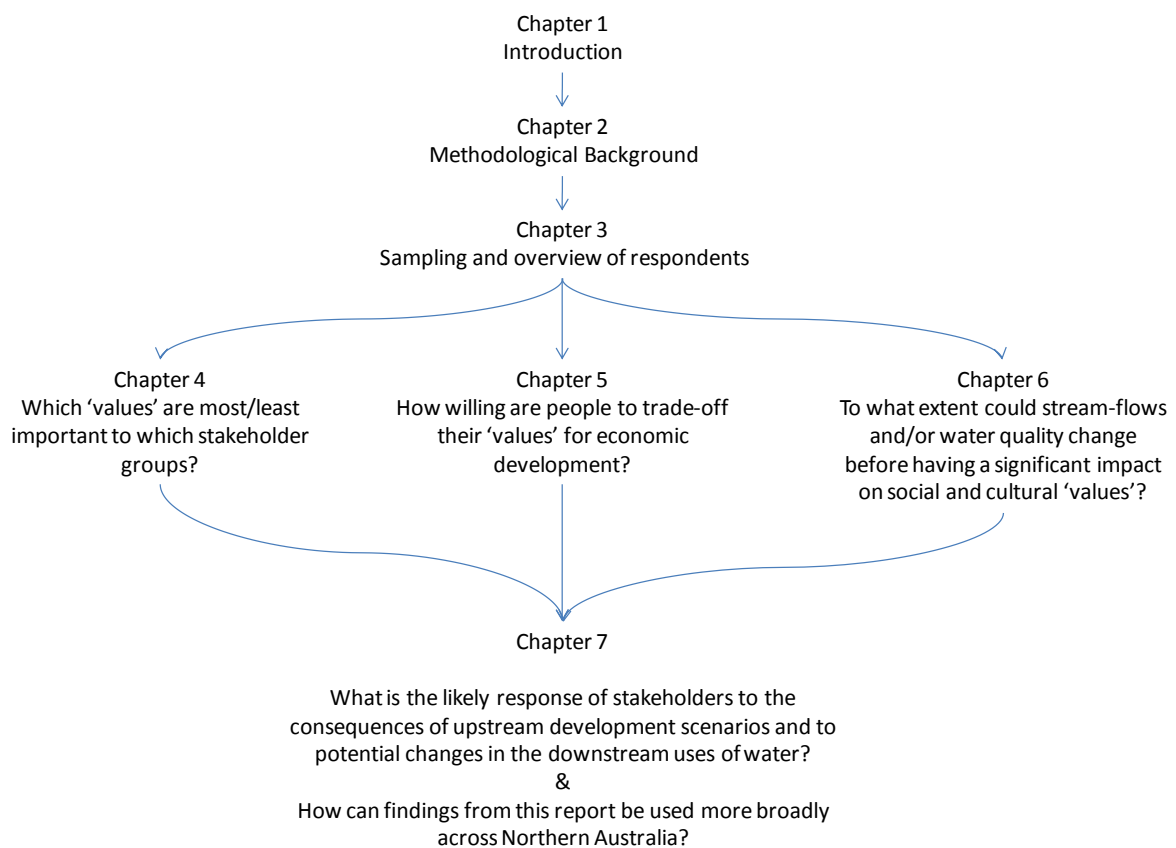
Chapter 3 provides a generic description of the respondents to our survey (those who replied to our mail-out questionnaire, and those who consented to be interviewed), thus giving readers information about the extent to which our sample results are, or are not, representative of a variety of different stakeholders and/or are generalisable to the population at large.

The next three chapters focus on each of our first three project objectives:

- Chapter 4 presents and analyses data collected in the survey that allows us to assess the importance of the Social and Cultural values that are associated with Australia’s Tropical Rivers relative to other ‘values’ for a variety of different stakeholder groups;
- Chapter 5 presents data that allows us to assess the willingness of people to trade-off their Social and Cultural values in exchange for economic development; and

- Chapter 6 presents and analyses data that allows us to determine the extent to which stream flow and/or water quality could change before having a significant impact on Social and Cultural values.

Insights from the preceding chapters are combined in Chapter 7, allowing us to meet the final objective, namely to draw inferences about the likely response of stakeholders to the consequences of upstream development scenarios and to potential changes in the downstream uses of water. This chapter also provides some general advice, and specific ideas about how insights from this research can be used more broadly across Northern Australia.



Appendix K provides some additional discussion points about methods that planners can use for eliciting, assessing and measuring values and trade-offs for different stakeholder groups.

## 2 GENERAL OVERVIEW OF NON-MARKET VALUATION METHODS

### 2.1 Some preliminaries: WHAT is meant by the word ‘value’?

The word ‘value’ means different things to different people.

For example, although many people use the term ‘value’ synonymously with price, economists are more likely to use the word when considering the extent to which a particular good or service contributes to the well-being of an individual or of society. In contrast, social scientists are more likely to use the phrase ‘value system’ when talking about either an individual’s or a society’s set of principles, norms and beliefs (Jackson et al., 2011).

Yet these apparently different interpretations of the meaning of the word ‘value’ are related – albeit in difficult-to-define ways<sup>23</sup>. And, amongst other things, they are bound by two, key ‘themes’:

- Saying that something is ‘valuable’ or ‘of value’ is akin to saying that it is important; and
- Absence of price does not indicate absence of ‘value’.

This second point is particularly important for this study. Many environmental goods and services (e.g. biodiversity) are not traded in the market place, so do not have a price. But many environmental goods and services are vitally important to individuals and to society and may therefore be thought of as being ‘of value’.

As such, a rather loose and broad definition of the word ‘value’ – i.e. something that is important to individuals and/or society – is used in this report. In some situations it may be associated with price, but in many cases it will not.

### 2.2 Overview of valuation techniques

Over the years, economists have developed many different valuation techniques – depicted in Figure 2 – to quantify the benefits (or costs) of environmental goods and services. Indeed, there is now a vast body of literature on different techniques for attempting to derive relevant monetary estimates and interested readers are directed to Getzner *et al.* (2005), Bateman *et al.* (2002), Rietbergen-McCracken & Abaza (2000), Garrod & Willis (1999), and Willis *et al.* (1999) for detailed reviews.

As clearly highlighted by Pagiola’s (2004) summary of some of the popular valuation techniques (refer Figure 4), none of the methodologies (or ‘valuation’ techniques) are flawless: most are surrounded with at least some controversy vis-à-vis the ‘accuracy’ of final estimates; each requires different types of information as an input; and each produces (sometimes subtly) different information as output.

---

<sup>23</sup> The values, norms and beliefs of a society and of the individuals within it, shape individual and social preferences. These values, norms and beliefs also underpin other kinds of human behaviour and influence experiences, which in turn, feed-back – either reinforcing or changing, our ‘values’. So although the different interpretations of the word ‘value’ are related, the relationship between these different interpretations is neither precise, nor predictable.

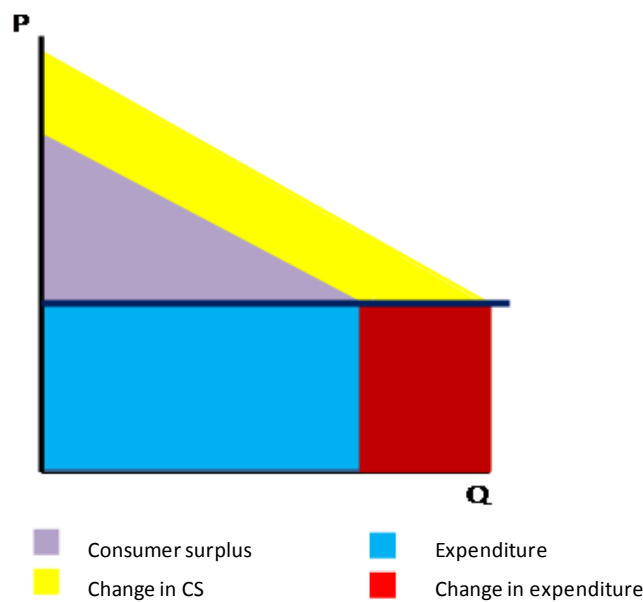
<ol style="list-style-type: none"> <li>1. Valuation techniques that use market prices             <ol style="list-style-type: none"> <li>(a) Changes in the value of Output</li> <li>(b) Loss of Earnings</li> <li>(c) Preventive expenditures (mitigation costs)</li> <li>(d) Replacement cost</li> </ol> </li> <li>2. Revealed preference techniques             <ol style="list-style-type: none"> <li>(a) Property or land value approach</li> <li>(b) Travel cost approach</li> <li>(c) Wage differential approach</li> <li>(d) Acceptance of compensation</li> </ol> </li> <li>3. Stated preference techniques             <ol style="list-style-type: none"> <li>(a) Contingent valuation</li> <li>(b) Choice modelling / Conjoint analysis (contingent rating, contingent ranking and choice experiments)</li> <li>(c) Paired comparison</li> </ol> </li> <li>4. Benefit Transfer</li> </ol>	<table border="0"> <tr> <td style="font-size: 2em; vertical-align: middle;">}</td> <td>Most useful when valuing services that have a market value – e.g. Goods produced, Tourism</td> </tr> <tr> <td style="font-size: 2em; vertical-align: middle;">}</td> <td>Often used to value regulating services (e.g. the amount people pay to prevent beach erosion)</td> </tr> <tr> <td style="font-size: 2em; vertical-align: middle;">}</td> <td>Can be used to value market and <u>some</u> non-market goods and services – e.g. Recreation, Environmental quality</td> </tr> <tr> <td style="font-size: 2em; vertical-align: middle;">}</td> <td>In theory, can be used to value almost anything – depending upon how the questions are structured; doesn't always have to use \$</td> </tr> <tr> <td style="font-size: 2em; vertical-align: middle;">}</td> <td>'Borrowing' estimates from other regions and using them instead</td> </tr> </table>	}	Most useful when valuing services that have a market value – e.g. Goods produced, Tourism	}	Often used to value regulating services (e.g. the amount people pay to prevent beach erosion)	}	Can be used to value market and <u>some</u> non-market goods and services – e.g. Recreation, Environmental quality	}	In theory, can be used to value almost anything – depending upon how the questions are structured; doesn't always have to use \$	}	'Borrowing' estimates from other regions and using them instead
}	Most useful when valuing services that have a market value – e.g. Goods produced, Tourism										
}	Often used to value regulating services (e.g. the amount people pay to prevent beach erosion)										
}	Can be used to value market and <u>some</u> non-market goods and services – e.g. Recreation, Environmental quality										
}	In theory, can be used to value almost anything – depending upon how the questions are structured; doesn't always have to use \$										
}	'Borrowing' estimates from other regions and using them instead										

**Figure 2 – A range of Valuation Techniques**

Adapted from Gregersen et al. (1987), Driml (1994) and Grey (1996)

More specifically, some of the valuation techniques cited above generate estimates of *Prices* – represented by the dark blue line in Figure 3. In contrast, some techniques generate estimates of *Expenditure* – shown as the blue rectangle in Figure 3 – whilst other techniques generate estimates of:

- Consumer surplus - CS (the amount that a consumer would be prepared to pay for a good, over-and-above what is actually paid) – shown as the purple triangle in Figure 3;
- Total Willingness to pay (WTP) = expenditure plus CS (i.e. the blue rectangle plus the purple triangle);
- CHANGES in expenditures – the dark red rectangle in Figure 3; and/or
- CHANGES in CS – the yellow trapezoid in Figure 3.



**Figure 3 – Stylised representation of the different types of estimates (e.g. price, CS, expenditure) that are generated by different valuation techniques**

<i>Methodology</i>	<i>Approach</i>	<i>Applications</i>	<i>Data requirements</i>	<i>Limitations</i>
<b>Revealed preference methods</b>				
Production function (also known as 'change in productivity')	Trace impact of change in ecosystem services on produced goods	Any impact that affects produced goods	Change in service; impact on production; net value of produced goods	Data on change in service and consequent impact on production often lacking
Cost of illness, human capital	Trace impact of change in ecosystem services on morbidity and mortality	Any impact that affects health (e.g. air or water pollution)	Change in service; impact on health (dose-response functions); cost of illness or value of life	Dose-response functions linking environmental conditions to health often lacking; underestimates, as omits preferences for health; value of life cannot be estimated easily
Replacement cost (and variants, such as relocation cost)	Use cost of replacing the lost good or service	Any loss of goods or services	Extent of loss of goods or services, cost of replacing them	Tends to overestimate actual value; should be used with extreme caution
Travel cost (TCM)	Derive demand curve from data on actual travel costs	Recreation	Survey to collect monetary and time costs of travel to destination, distance traveled	Limited to recreational benefits; hard to use when trips are to multiple destinations
Hedonic pricing	Extract effect of environmental factors on price of goods that include those factors	Air quality, scenic beauty, cultural benefits	Prices and characteristics of goods	Requires vast quantities of data; very sensitive to specification
<b>Stated preference methods</b>				
Contingent valuation (CV)	Ask respondents directly their WTP for a specified service	Any service	Survey that presents scenario and elicits WTP for specified service	Many potential sources of bias in responses; guidelines exist for reliable application
Choice modeling	Ask respondents to choose their preferred option from a set of alternatives with particular attributes	Any service	Survey of respondents	Similar to those of CV; analysis of the data generated is complex
<b>Other methods</b>				
Benefits transfer	Use results obtained in one context in a different context	Any for which suitable comparison studies are available	Valuation exercises at another, similar site	Can be very inaccurate, as many factors vary even when contexts seem 'similar'; should be used with extreme caution

Figure 4 – Applications, data requirements and limitations of the most popular valuation techniques

Source: (Pagiola et al., 2004, pg 11)

Consequently, even though most valuation techniques generate estimates of 'value' that are denominated in dollars, this does NOT mean that estimates can be validly compared. To compare price estimates with estimates of changes in WTP, for example, is just as meaningless an exercise as to compare apples and oranges. Researchers thus need to be cognizant of the type of information that is required by managers and policy makers when designing economic valuation projects.



Otherwise, their chosen techniques may not be capable of producing information that is useful in a given decision-making context. They also need to be cognizant of the type of information that is required by each of the valuation techniques.

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

## 2.3 Which technique is the 'right' one?

A hammer is not capable of fixing all building problems. Likewise, no single valuation method can be used in all situations. One needs to consider a variety of different issues, including data availability, ethical and information requirements.

### 2.3.1 Data availability

Although arguably considered to be more 'reliable' than other approaches (primarily because they use objectively verifiable data), valuation techniques that use market prices are not able to provide information about the value of goods or services if they are not exchanged on the market. Revealed preference techniques such as the travel cost approach or hedonic pricing (using property or land values, wage differentials or other) do not require the existence of a market for the good being studied, but they do require a strong association between the market that is being studied (e.g. housing), and the environmental factor of interest (e.g. views of a river). If that association cannot be established, revealed preference techniques cannot be used. In these situations, stated preference (SP) techniques such as choice experiments and contingent valuation studies offer themselves as viable approaches for generating a financial estimate of the 'value' of such goods or services since they do not require the existence of a market and are (in theory at least) able to generate estimates of either the marginal or the total value of anything.

For this project it was evident that researchers needed to work with SP techniques since Social and Cultural values are not closely associated with the market: there is simply no data that allows them to do otherwise. All stated preference techniques are open to criticisms for their hypothetical nature, and choice modelling can be critiqued for its complexity, but if implemented correctly, these approaches can be both robust and relatively cost-effective.

### 2.3.2 Ethical considerations: Economic efficiency and the distribution of income

Most stated preference techniques use measures of willingness to pay (WTP) as an indicator of preferences. Although many people object to the idea of being asked to put a 'price' on what they may view as 'priceless', at an individual level, the concept is not all that unrealistic: *ceteris paribus*, an individual is likely to be WTP more for something that is important to them than for something that is not. As such, the amount which someone is WTP for a particular good or service is likely to at least partially reflect their tastes, preferences or values.

Where the problem arises, is when individual preferences (expressed in terms of WTP) are aggregated to draw inferences about social preferences. This is because WTP is also a reflection of income or wealth. All else constant, a rich person will be ABLE (and thus WILLING) to pay more for the goods and services which they enjoy than the poor<sup>24</sup>. So if one (a) attempts to measure preferences at an individual level by asking about WTP, and then (b) adds those 'preferences' across

---

<sup>24</sup> Not surprisingly, researchers often find that there is a strong relationship between WTP and income (see, for example, Jacobsen and Hanley, 2009).

multiple individuals (each with a different income), one will create what is – in essence – a weighted index of value. And weights will be a function of income. In other words, the preferences of the wealthy will be given more voice than the preferences of the poor<sup>25</sup>.

To state the problem more precisely: Dollar based valuations techniques are frequently used because they are able to identify ‘efficient’ allocations (allocations where the marginal benefit of a good is equal to its marginal cost). But it is not correct to assume that these ‘efficient’ allocations are also ‘optimal’. ‘Efficient’ allocations can only be ‘optimal’ if the current income distribution (which produced these aggregate WTP estimates) is itself, ‘optimal’.

In the TR region, there is a significant gap between rich and poor – as starkly evidenced in Figure 5 below – which shows that median individual incomes in the ‘richest’ parts of the TR are almost 5 times greater than median incomes in the ‘poorest’ catchments. Some may believe that this distribution of income is ‘optimal’, but some may not. As such, one cannot be sure that dollar-based valuation techniques will generate estimates that can be used to identify resource allocations that are both efficient and optimal. For this reason, researchers involved in this project chose to use both monetary and non-monetary (i.e. dollar and non-dollar denominated) SP techniques when assessing Social and Cultural ‘values’ associated with Australia’s Tropical Rivers (with most emphasis being placed upon non-dollar denominated SP techniques).

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

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

Figure 5 – Median weekly income per person in the poorest and richest catchments of the TR region

Source: Larson and Alexandridis, 2009, Table 5, p19

<sup>25</sup> If there is no predictable relationship between incomes and preferences, then (in aggregate) this may not be a problem – differences in final estimates that have been generated from these dollar-based techniques are likely to reflect differences in values. But if there are systematic differences between the values, beliefs, and norms of the ‘rich’ and the ‘poor’ (e.g. if the ‘average’ person on a low income has different preferences to the ‘average’ person on a high income), then dollar-based techniques may generate final estimates of ‘value’ which do a better job of describing differences in income than they do differences in norms or preferences.

### 2.3.3 Identification of key management questions

As discussed in section 2.2, some valuation techniques produce information about the ‘total’ value of a good or service, whilst others produce information about ‘marginal’ values. Which technique is most appropriate depends crucially upon the management question.

To be more specific, valuation techniques which generate a monetary estimate of the ‘total economic value’ of a region, good or service<sup>26</sup> are particularly useful if seeking to:

- describe the current state of affairs – for example, determining that one good or service is of more ‘value’ than another; or if
- address ‘all-or-nothing’ management/policy questions such as: what losses would the region suffer if the entire TR region ceased to exist?

But managers are not always faced with all or nothing choices (river or no river). Rather, they often need to make choices ‘at the margin’, and may, for example, need information that helps answer questions such as:

- What losses would the region suffer if development eroded (rather than erased) some of the region’s values (e.g. if new enterprises affected aesthetic or biodiversity values)?
- What compensation should be sought (monetary or otherwise) if development ‘x’ takes place?

In other words, the managers may not always be interested in the total value of a good or service; they may be more interested in trying to determine how the total value of a good or service might change in response to some external factor or pressure<sup>27</sup>.

Prior to selecting valuation techniques researchers thus considered the specific objectives of this project (outlined in section 1.5, and reproduced in a box below).

#### **Specific objectives of this project**

To improve our understanding of:

1. the relative values of water for different stakeholder groups;
2. the rate at which different stakeholder groups are willing to trade-off economic development for those values;
3. the extent to which stream flow and/or water quality could change before there was a ‘significant’ impact on social and cultural values; and
4. the likely response of stakeholders to the consequences of upstream development scenarios and to potential changes in the downstream uses of water.

The type of data that are required to meet each of those objectives and the associated analytical techniques differ markedly across those objectives. The first objective, in essence, requires one to estimate the ‘total worth’ of a range of Social and Cultural values to different individuals (almost as if one is focusing on the blue rectangle in Figure 3). The second objective requires researchers to estimate the significance of those values compared to opportunities for economic development

<sup>26</sup> Equivalent to the blue rectangle and the purple triangle combined in Figure 3.

<sup>27</sup> In essence, their focus may be on the red and yellow shapes in Figure 3.

(which is almost as if one is attempting to measure the size of the red rectangle plus the yellow trapezoid in Figure 3). The third objective requires researchers to determine whether values are likely to be impacted by a change, and the final requires researchers to synthesise insights from the preceding objectives to draw inferences about the likely 'response' of stakeholders to development that affects their values.

As such, although all objectives require the use of SP techniques (both monetary and non-monetary), the detailed methodological approaches which were chosen (starting from the design of survey questions, through to the analysis of relevant data) are quite different. A description of each is thus held over to each relevant chapter, after providing an overview of the characteristics of respondents to our sample.

## 2.4 Take-home messages

A hammer is not capable of fixing all building problems. Likewise, no single valuation method can be used in all situations. One needs to consider a variety of different issues, including data availability, ethical and information requirements.

Social and Cultural values are only loosely associated with the market (if at all). As such, many valuation techniques (particularly those which rely on observable market prices) cannot be used. Instead, stated preference techniques are required.

In theory, stated preference techniques could be used to generate community-wide dollar-based estimates of the marginal benefit of the Social and Cultural values associated with Australia's Tropical Rivers. These could be compared to marginal costs, thus allowing one to identify 'efficient' allocations. But these (efficient) allocations cannot also be deemed 'optimal' unless the underlying distribution of income is also optimal. Recognising that the significant gap between rich and poor in this part of Northern Australia may be signalling a sub-optimal income distribution, researchers therefore decided to use both dollar and non-dollar denominated SP techniques.

All objectives require the use of SP techniques (both monetary and non-monetary), but the detailed methodological approaches which are required to meet each, specific objective (starting from the design of survey questions, through to the analysis of relevant data) are quite different. A description of each is thus held over to each relevant chapter.

### 3 RESPONDENTS AND SAMPLING METHODS

#### 3.1 Determining WHOSE 'values' to consider

Different people are likely to 'value' the environment in different ways, so the final outcome of any valuation exercise will depend, crucially, upon WHO is included in the study. Some people, for example, are likely to feel that the environment is of value largely because it provides food and shelter; others may place much greater emphasis on recreational, aesthetic or spiritual factors. If one only includes the former group in a study of 'values' one will, necessarily, conclude that the environment is of most value because of the food and shelter it provides. Conversely, if one only includes the latter group in a study of 'values', then one will, also necessarily, conclude that the environment is of most value for recreational, aesthetic and spiritual factors.

Such differences have been observed and documented in a variety of studies and are clearly illustrated in Figure 6. Here, Pagiola et al. (2004) presents a graphical summary of the distribution of the benefits of forest-based ecosystem services in the U.S. according to geographic scale. The international community was found to derive most benefits from biodiversity conservation and recreation; the national community derived most benefits from water services and the extraction of forest products; and local communities derived most benefit from the extraction of forest products. In other words, his study shows that if one had conducted a study of the 'value' of the forest and included:

- only 'local' residents (the light green areas in Figure 6), then one would have concluded that the forest is of value because of its (marketable) 'products'; or
- only members of the international community, then one would have concluded that the forest is of most value because of its conservation and recreation uses (the dark green).

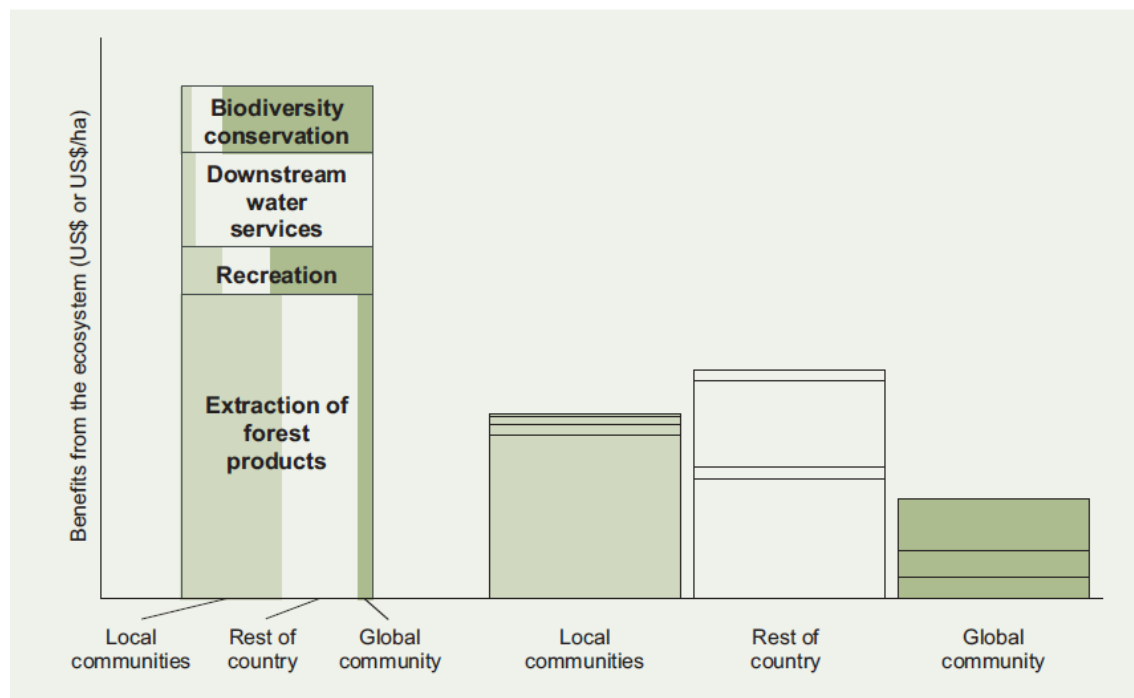


Figure 6 – The distribution of ecosystem benefits across the local, national and international community

Source: (Pagiola et al., 2004, pg 23)

Evidently, one of the most important problems facing researchers involved in a ‘valuation’ study is determining ‘who’ to include in the study.

### 3.1.1 Identifying an appropriate region from which to collect data

In this project, researchers were cognizant of the fact that the work was commissioned by NAWFA, with the overarching goal of providing information (about Social and Cultural values) to assist water planners. These planners work, almost exclusively, with local residents. As such, researchers decided to concentrate exclusively on the ‘values’ of residents in the TR region – although great care was taken to ensure that information was collected from a broad cross-section of those residents<sup>28</sup>.

Initially, researchers had planned to collect data via face-to-face interviews in three catchment areas: the Mitchell in Queensland, the Daly (specifically, Mataranka) in the Northern Territory, and the Ord in Western Australia. However, water planning processes in both the NT and the WA catchments were not at a stage where case-study investigations would have been able to generate timely, pertinent and useful results for relevant government agencies. At the request of state and territory agencies<sup>29</sup>, research plans were thus changed to include:

- a broad scale mail-out of residents across all of Northern Australia, and
- more in-depth investigation (including interviews) in the upper regions of the Mitchell River catchment.

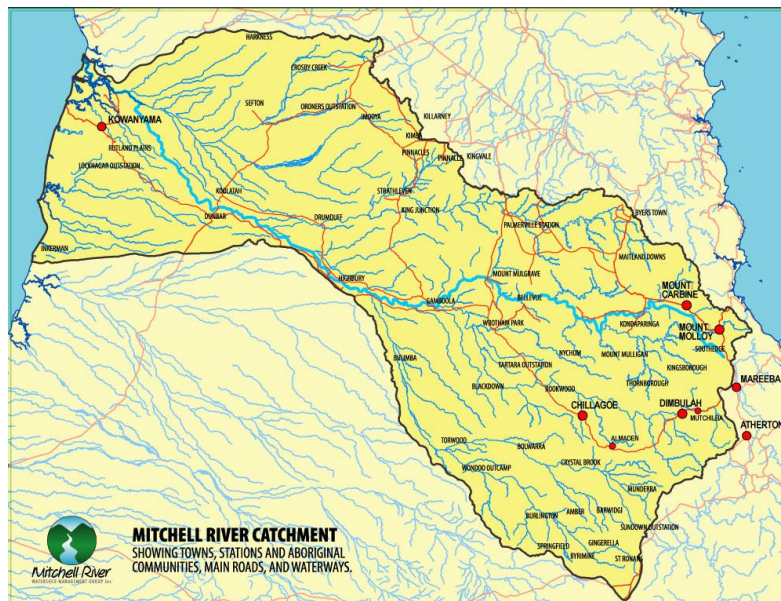


Figure 7 – Mitchell River Catchment

Source: (Mitchell River Watershed Management Group, np)

The Mitchell catchment (Figure 7) covers around 70 000 km<sup>2</sup> and has an average discharge of 11.3 million ML of fresh water each year (Connor et al., 2009). Rainfall varies throughout the catchment, with over 1200 mm in both the upper catchment and on the Gulf of Carpentaria coast, but dropping to 825 mm in the central plains of the area (Connor et al., 2009). Like all Tropical

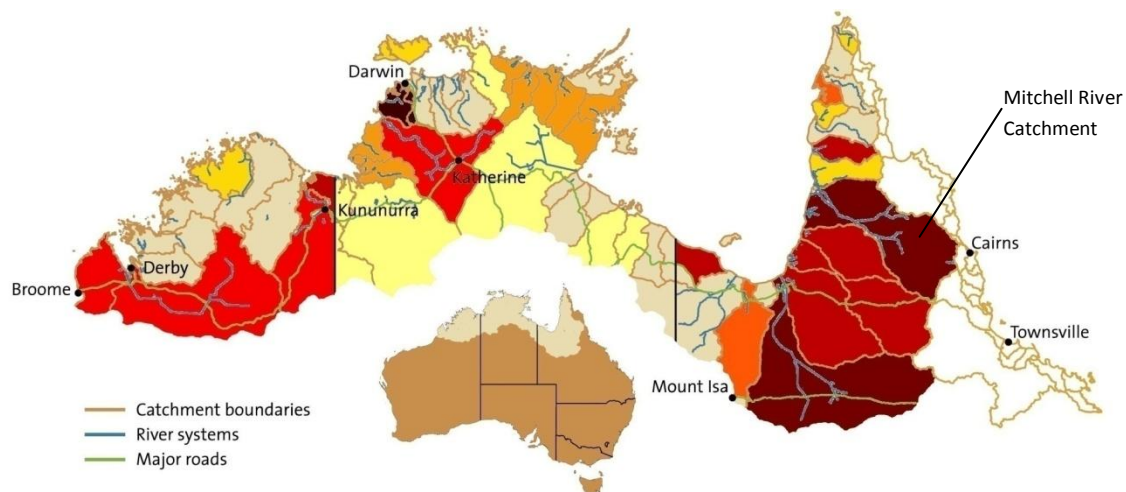
<sup>28</sup> All data collection methods have received human ethics approval from James Cook University.

<sup>29</sup> and with the approval of the steering committee.

Rivers, rainfall is largely monsoonal, with around 80 per cent falling in just 4 months. Stream flows reflect rainfall variability and seasonality. The high rainfall in the upper catchment, together with surrounding aquifers, provide perennial stream flows to this part of the river, while further downstream summer flooding and an absence of flow at other times is typical.

The upper part of this catchment was chosen for an intensive case study area for three reasons.

- 1) It is in the formative stages of water policy and planning, so a study such as this was well-timed to provide information that might assist those involved in the planning process.
- 2) Researchers needed to ensure that data were collected from both Indigenous and non-Indigenous residents. As Indigenous people are much less likely to respond to mail-out questionnaires than non-Indigenous people, researchers decided to employ face-to-face methods to ensure that at least one-half of all participants in the case study were Indigenous. Researchers had already worked with several Indigenous people in and around the upper reaches of the Mitchell, making it relatively easy to engage with various groups in a short study period of time.
- 3) The catchment is not as economically developed as the area in and around Darwin, but is facing more development pressures than other catchments in the TR region. In their efforts to identify catchments that were socio-economically 'similar', Larson and Alexandridis (2009) found that the socio-economic characteristics of the Mitchell River were similar to those of the Flinders. Importantly, they also found that the socio-economic characteristics of the Mitchell are more similar to those of the Darwin/Finiss Catchment, than they are to other much less developed catchments such as those in the more remote parts of the TR region – see Figure 8. As such, development issues confronting those in the Mitchell Catchment are likely to (a) follow those facing residents in and around the Darwin area, and (b) precede those in other TR catchments. Consequently, lessons learned from this case-study may be useful in other regions in later years.



**Figure 8 – Map showing catchments across the TR region using a spectrum of shades/colours.**

Catchments with similar shades/colours are socioeconomically 'similar'. The greater the contrast in shade/colour, the greater the socioeconomic dissimilarities.

## 3.2 Sampling/data collection procedures

### 3.2.1 The large-scale mail-out

#### 3.2.1.1 Background: People and industries of the TR region

On census night 2006, the TR region was home to just over 310,000 people – but the population mix is unusual in comparison with the rest of Australia. For example Carson et al. (2009) note that:

- the median age for the total region was less than that for Australia (33 years compared with 37 years);
- for every 100 females, there were 107 males recorded in the TR region, compared to 97 nationally;
- one quarter of the usual residents in the TR region were Indigenous, compared with just two per cent nationally;
- the TR region experienced growth of about 7 per cent between 1996 and 2001, and Carson et al.'s (2009) population projections indicates that an annual average growth rate of 1.83 per cent to 2026 is likely;
- almost all of the expected future growth (in absolute terms) is likely to be contributed by those aged 40 years and above. Negative growth is predicted in the working age cohorts of 20 to 34 years, and only minor growth in the infant cohort (birth to four years) is expected; and
- 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).

The economic structure of the TR region is also a little unusual in comparison with the rest of Australia. Traditionally, the agricultural and mining sectors have been popularised as the most 'important' regional industries in Australia's north, however it is the government sector which provides most employment in the TR region, accounting for more than 25 per cent of all jobs (if one includes those employed in government, health and education) – see Larson and Alexandridis (2009). Moreover, as highlighted by Stoeckl and Stanley (2007), economies in the TR region – particularly those in remote and very remote parts – are not just 'smaller versions' of larger, Australian economies. The structure of these economies differs, sometimes significantly, from that of Australia as a whole:

- many sectors/divisions which are vitally important to the overall Australian economy are all but non-existent in remote parts of the north – these are: Manufacturing, Electricity, Sewerage, Wholesale, Finance, and Communications;
- many sectors which are relatively unimportant to the overall Australian economy – in terms of aggregate income and/or employment – are vitally important in the north. These sectors include: Agriculture, Mining, Construction, Tourism, Government, and Health; and
- the economic structure of one regional community may differ significantly from that of another, adjoining region.

Evidently, researchers working on this project had to ensure that their study explicitly included the 'values' of (a) Indigenous people (due to the high proportion of the population which are Indigenous); (b) those aged 40 and above (given the expected future growth in this age cohort); and



(c) people associated with the sectors most important to Northern Australia, namely: Agriculture, Mining, Construction, Tourism, Government, Education and Health.

One way to do this, would have been to contact key organisations representing a variety of industries and other groups (e.g. Agforce, the Minerals Council of Australia, various Indigenous Land Councils, the Association of Independent Retirees, etc.), and to work through them. However, one cannot always be sure that organisations such as these adequately represent all those associated with them – particularly if interested in such a large geographic area. An alternative approach – the one used here – is to contact residents directly, seeking background demographic information about them and about the industry (or industries) with which they are most strongly associated. One can then use this information to ensure that the views of a variety of individuals have been included. Details of how that was done are provided in section 3.4.

### 3.2.1.2 *Sampling*

Relevant post codes – which lay either partially or entirely within the TR region – were identified from the ABS Census website<sup>30</sup> and cross referenced against Statistical Local Areas from the same website. There were 36 in total. Data relating to the total population and the number of occupied private dwellings for each post code on the 2006 census night were gathered<sup>31</sup>. In an attempt to ensure a geographically stratified sample, researchers decided to contact approximately 1 in 20 residents from each post code, up to a maximum of 100<sup>32</sup>. A residential data base was purchased from Media M for use in the mail-out survey and the required number of addresses to match that ‘target’ sample were randomly selected from each postcode within it – although many postcodes had fewer than 100 addresses.

In the first instance, 2500 surveys were mailed out to those residents. Following the Dilman (2007) technique, a reminder letter and second survey was sent out three weeks later (allowing for the fact that in remote parts of Australia it can take three-four weeks for mail to be sent out, and to be returned). A third and final reminder, with survey<sup>33</sup>, was sent another three weeks later to those who had not responded to either of the previous two requests.

Of the 2500 addresses targeted for inclusion, 37 per cent proved to be unusable – either because the addresses were incomplete, or the addressee was no longer at that address<sup>34</sup>. As such, researchers estimate that only 1565 surveys reached their intended recipients.

---

30

(<http://www.censusdata.abs.gov.au/ABSNavigation/prenav/LocationList?newgeography=Postal+Area&level1=7&level2=POA0854&mapdisplay=on&collection=Census&period=2006&areacode=7&geography=Postal+Area&method=&productlabel=&producttype=&topic=&navmapdisplayed=true&javascript=true&breadcrumb=L&topholder=297&leftholder=0&currentaction=102&action=102&textversion=false&subaction=2>) [Accessed 13 June 2011]

<sup>31</sup> Noting the caveat mentioned earlier regarding the significant undercount of residents, especially in remote and very remote areas of northern Australia.

<sup>32</sup> Several database suppliers were contacted, but none were able to supply all post codes requested. As such, some post codes were unable to be included, and some were limited to less than 20 records.

<sup>33</sup> In the third mail-out, the survey was shortened in a way which did not compromise the integrity of the data collected, and pre-paid Australia Post envelopes with hand written addresses were used in an attempt to boost the final response rate.

<sup>34</sup> Across the entire survey region, 37 per cent of surveys were ‘returned to sender’, while in WA this rate was 55 per cent, and in the NT it was 50 per cent. This highlights the difficulty in obtaining a reliable database of addresses in the Tropical Rivers region, and in particular, the more remote areas where a high proportion of the population are Indigenous or transient.

## 3.2.2 Focus groups and interviews in the Upper Mitchell

### 3.2.2.1 Background: People and Industries in the Upper Mitchell River

The two most important industries in the Mitchell River catchment – in terms of employment and income – are agriculture (predominantly grazing and some crops such as sugar cane, coffee, stone-fruit and a variety of tropical fruits) and government administration/defence (including health and education), with each sector contributing about 27 per cent of the region’s jobs (Larson and Alexandridis, 2009)<sup>35</sup>.

As for the TR region as a whole, it was clear that researchers working on this project needed to ensure that their interviewees included (a) Indigenous people; (b) those aged 40 and above; and (c) people associated with the sectors most important to the Upper Mitchell, namely: Agriculture, Government, Education and Health.

### 3.2.2.2 The selection of focus group participants and conduct of interviews in the Upper Mitchell River

To help refine the list of ‘values’ to be assessed in this study, focus groups were conducted in the Upper reaches of the Mitchell River - see section 4.1.1.3 for a more detailed discussion of the motivation behind this activity.

Relevant regional organisations (i.e. Indigenous organisations; organisations associated with the agriculture, mining, and/or tourism industries; and government agencies) were selected at random from the *Yellow Pages* website. Listings were first thematically grouped and then representatives from each group were randomly selected to ensure a cross section of stakeholders were included. Referrals were also accepted from participants who could not attend the focus group meeting.

Actual numbers attending the focus groups were smaller than anticipated (11 in total), however the meetings attracted a reasonable cross-section of the community (with participants from all stakeholder groups), and both meetings provided valuable feedback for the development of the survey. A copy of the focus group meeting invitation and agenda are provided in Appendix A.

Face-to-face interviews were conducted in the upper Mitchell River catchment around Mareeba<sup>36</sup>, Dimbulah and Chillagoe during two separate week-long fieldtrips.

---

<sup>35</sup> Ninety-five per cent of land use is directed towards production from unchanged land (predominantly grazing, but the Mareeba Dimbulah Irrigation Scheme also enables the upper catchment to be viable for agriculture, horticulture and small scale cattle fattening projects). Three per cent of the Mitchell catchment has land that is still in its natural condition and almost exclusively under conservation while land under intensive use (including urban, mining, industrial) is minimal at just 0.03 per cent (Mitchell River Watershed Management Group, np, Stoeckl et al., 2011). Notably, there is no ‘natural land’ solely reserved for Indigenous use in the Mitchell (Stoeckl et al., 2011). The predominant crops grown are sugarcane, coffee, stone-fruit and a variety of tropical fruits (Connor et al., 2009). Further agricultural developments in the Mitchell catchment have been discussed for many years, and several projects to supply water to these developments have either already been implemented (e.g. the construction of Lake Tinaroo, and the diversion of water from the Baron river for agricultural developments in the upper Mitchell) or have been deemed unsuitable (e.g. potential of installing a dam at the Pinnacles which could have stored 158 000 ML) (Connor et al., 2009).

<sup>36</sup> Although Mareeba is not, technically, within the geographic boundaries of the Mitchell River, it was included in the study area due to the link with surrounding plans, such as the *Water Resource (Barron) Plan 2002*, and the *Mareeba Dimbulah Water Supply Scheme* (MDWSS). Indeed, around 2/3 of the MDWSS is in the Mitchell River catchment, although it is unclear how much of the Mitchell’s flow is generated from this source (Connor et al., 2009). Given that around \$119 million of agricultural production was achieved by the Mareeba Shire primarily from crops watered by the MDWSS (Connor et al., 2009), it seemed pertinent to also gauge the opinions of these residents.

During the first trip, researchers conducted interviews (using the questionnaire developed for the mail-out survey) with 22 non-Indigenous households associated with a cross-section of industries (mining, tourism, horticulture, grazing, and retail). In the first instance, researchers contacted those participants who had been randomly selected for inclusion in the focus group meetings but were unable to attend. This list was then supplemented by randomly sampling more participants from each of the stakeholder groups derived from the *Yellow Pages*.

During the second trip, researchers conducted interviews with 17 Indigenous households from a variety of language groups (including, Djungan, Gugu Western Yalanji, Wakamin, and Ewanian) using a 'snowball' sampling technique, and employing Indigenous research assistants to help conduct the interviews and to help contact people who might be willing to be interviewed.

During both field trips, respondents were interviewed individually (or as a family group where participants requested); the researcher read the questions from the mail-out survey and recorded the answers provided by the participant. In addition, each participant was asked to complete a cognitive mapping exercise, which is detailed in section 4.2.5.

### **3.3 Sample characteristics and degree to which it is likely to be representative of the population at large**

Of the 1565 questionnaires mailed out across the north, 265 were returned, giving a response rate of approximately 18 per cent (although 13 were returned incomplete and were therefore excluded from the analysis)<sup>37</sup>. 252 had enough information to be included in the analysis. Of those, 177 were received from Queensland; 42 were from Western Australia; and 33 were from the Northern Territory.

The questionnaires were supplemented by 39 surveys completed through the one-on-one interviews in the Upper Mitchell, giving data on 291 households across the TR region.

Of the completed surveys received through the mail, an equal number were received from males and females. The overwhelming majority of respondents were non-Indigenous (96 per cent) – see Table 1, despite the fact that nearly one quarter of the population of the TR region is Indigenous. This supports our earlier notion that Indigenous residents are unlikely to respond to a mail-out survey and justifies our decision to use an interview-based approach with Indigenous research assistants in the Upper Mitchell. Despite the fact that we were able to supplement that data with 17 responses collected during 17 interviews, it is vitally important to note that readers should exercise extreme caution when seeking to use insights from this study to draw inferences about Indigenous values in general.

Also evident from Table 1 is the fact that the vast majority of respondents (85 per cent) were born in Australia and more than a quarter were born in the same region in which they were living when asked to complete the questionnaire. The majority of respondents had lived in the region for more than 15 years (Figure 9) and more than half planned to stay in the area at least until they retired – if

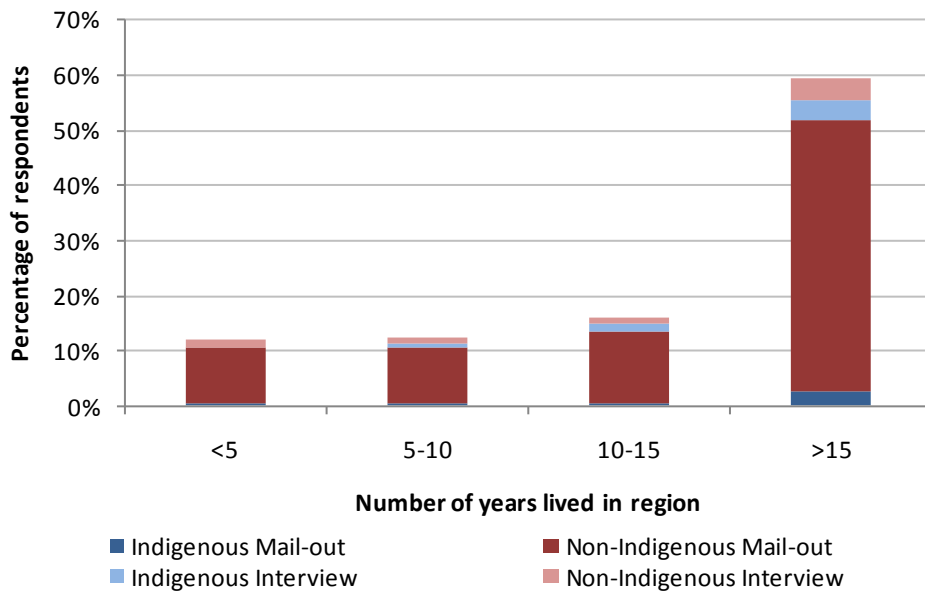
---

<sup>37</sup> Researchers working in this region – e.g. Straton and Zander, 2009; Stoeckl et al, 2011 – have achieved response rates in the order of 20-25%. This relatively low response rate is likely to be at least partially due to the length of the survey (given the breadth of topics to be assessed) and the tight project time-lines.

not, until they died (Figure 10). Evidently, long term residents were more apt to respond to this survey than those who had recently moved to the area.

**Table 1 – Characteristics of all respondents (including mail-out and interview data)**

Characteristic of respondents	Categories	Mail-out		Interview	
		Indigenous	Non-Indigenous	Indigenous	Non-Indigenous
Aboriginal or Torres Strait Islander?	Yes	11	0	17	0
	No	0	240	0	22
Gender	Male	6	119	8	10
	Female	5	121	9	12
State of residence	QLD	6	171	17	22
	NT	2	31	0	0
	WA	3	38	0	0
Mitchell catchment	Yes	1	36	17	20
	No	10	204	0	2
Born in Australia	Yes	11	199	17	18
	No	0	40	0	4
Born in the area	Yes	7	59	5	5
	No	4	181	12	17



**Figure 9 – Number of years lived in the area for all respondents (including mail-out and interview data)**

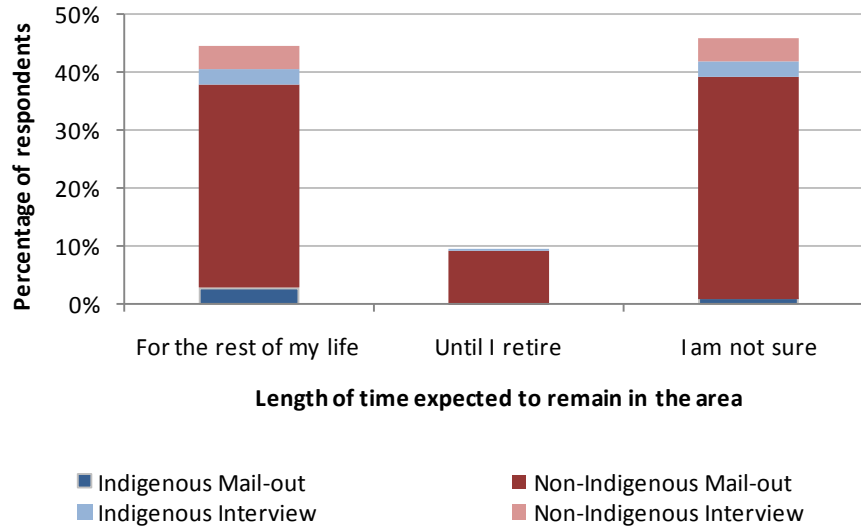


Figure 10 – How much longer respondents will live in the area (including mail-out and interview data)

The average household size for the whole data set (including mail-out and interview) was 2.57, and of those households who stated they had children, the average number was 2.08. In 2006, the average household size across the TR region was 3.2 (Stoeckl et al, 2011), indicating that our sample may under-represent large households (which is consistent with the low response rates amongst Indigenous householders).

In 2006 (on the ABS census night), the median age of all those living in the TR region was 33 years; the median age of respondents to our mail-out and interviews was considerably higher, at 54<sup>38</sup> years. As is evident from Figure 11, our sample has far fewer respondents under the age of 40, than would be expected given the age distribution of the population from which the sample was drawn.

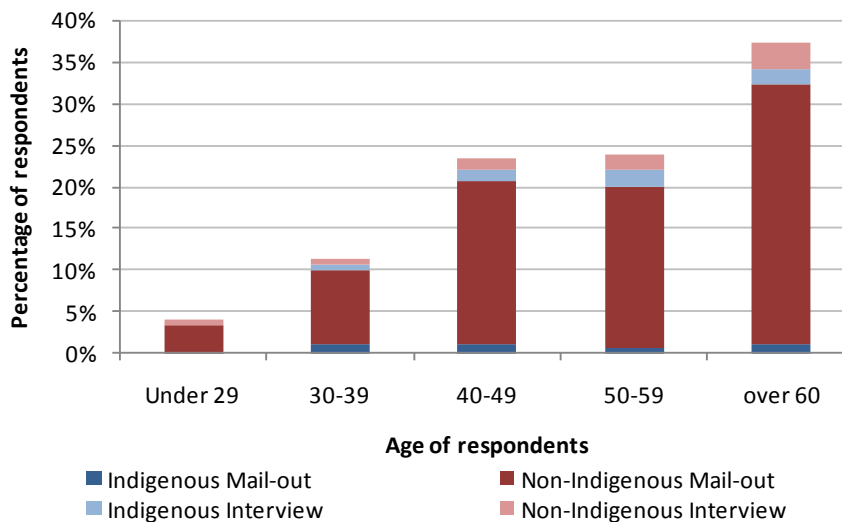


Figure 11 – Number of respondents in each age category (including mail-out and interview data)

Not only was the sample heavily biased in favour of the non-Indigenous and the elderly, but it was also biased in favour of the wealthy: the median weekly household income of respondents was

<sup>38</sup> Using the mid-point of each age category as the respondent’s age

approximately \$500 per person,<sup>39</sup> compared with \$444<sup>40</sup> for the region (Larson and Alexandridis, 2009), and one third of all respondents lived in households with incomes in excess of \$75,000 per annum – see Figure 12.

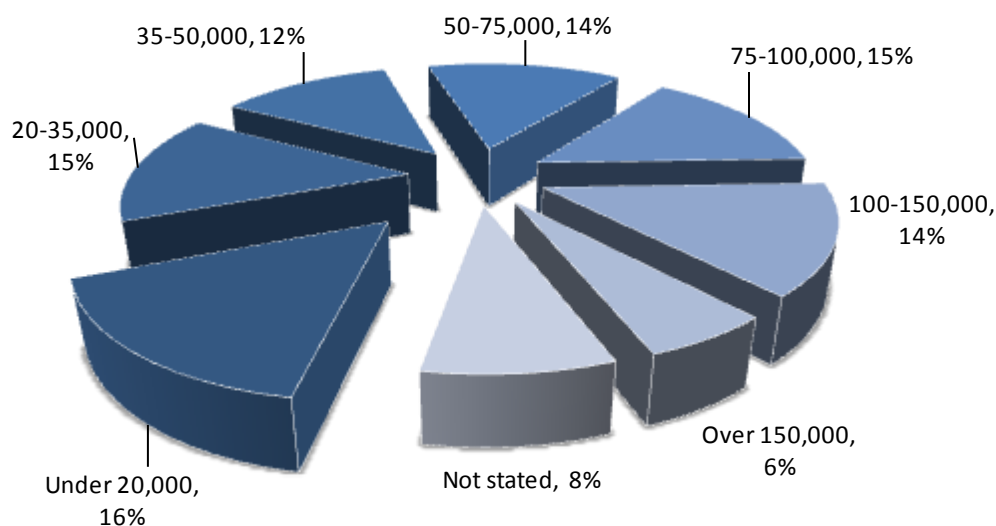


Figure 12 – Income categories of all respondents (including mail-out and interview data)

Moreover, respondents to the mail out survey were also more highly educated, with approximately 24 per cent<sup>41</sup> indicating that they had completed university.

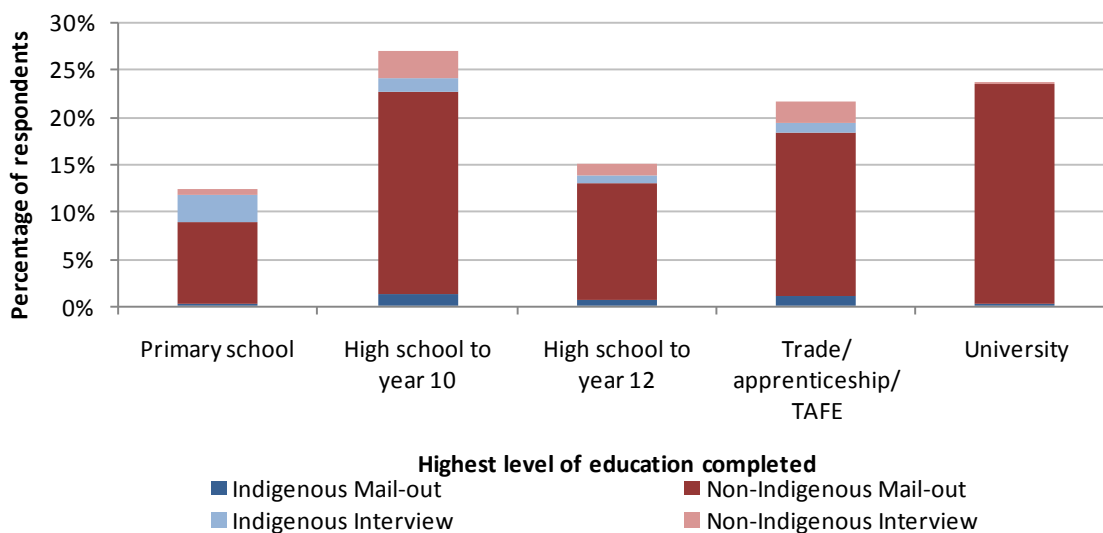


Figure 13 – Number of respondents who have completed an education level (including mail-out and interview data)

That said, these types of results are typical of a mail-out survey, where older, more educated and more affluent people are most likely to respond. This is evidenced by the fact that the characteristics

<sup>39</sup> Calculated using average number of adults per household (those aged over 20 years) – 2.17.

<sup>40</sup> Median weekly household income was \$392 in 2006. This figure was calculated by inflating the 2006 rate by 2.5 per cent per annum to 2011.

<sup>41</sup> Note that this changes when combined with interview data – where 27 per cent of all respondents completed year 10

of respondents to this survey closely resemble those of households who chose to respond to Straton and Zander’s (2009) study in the TR region, and to Stoeckl et al’s (2011) study of the Mitchell and the Daly.

The key point to stress here, therefore, is that the socio-economic characteristics of respondents to this survey do not match the characteristics of the population from which our sample was drawn. As such, it is important to avoid the trap of simply aggregating results and, for example, reporting mean values. Researchers must instead, seek to determine if differences between respondents exist, aggregating only when appropriate.

### 3.4 Extent to which the sample is able to provide information about different stakeholder groups

In order to identify which key stakeholder groups each respondent belongs to, we asked them to indicate their main source of income as outlined below:

15. What is the main source of your household’s income? (If there is more than one source of income, please number the boxes --- giving the number 1 to the most important source of income/job, the number 2 to the next most important, then number 3 etc.)

<p><b>Employed, or running a business in</b></p> <p><input type="checkbox"/> Education</p> <p><input type="checkbox"/> Health</p> <p><input type="checkbox"/> Community services</p> <p><input type="checkbox"/> Agriculture: fruit, nuts, vegetables or other horticulture</p> <p><input type="checkbox"/> Agriculture: livestock (pastoral / open grazing)</p> <p><input type="checkbox"/> Agriculture: livestock (dairy)</p> <p><input type="checkbox"/> Agriculture: fishing</p> <p><input type="checkbox"/> Agriculture: forestry</p> <p><input type="checkbox"/> Mining</p>	<p><input type="checkbox"/> Transport</p> <p><input type="checkbox"/> Construction or other trade (eg electrician, plumber, builder etc)</p> <p><input type="checkbox"/> Manufacturing</p> <p><input type="checkbox"/> Environmental protection / management</p> <p><input type="checkbox"/> Retail or wholesale Trade (eg hairdresser, shop assistant etc)</p> <p><input type="checkbox"/> Accommodation</p> <p><input type="checkbox"/> Real estate or business support services (e.g. lawyer, accountant)</p> <p><input type="checkbox"/> Other (please specify): _____</p>	<p><b>Receiving support from government</b></p> <p><input type="checkbox"/> pension</p> <p><input type="checkbox"/> unemployment benefits</p> <p><input type="checkbox"/> CDEP</p> <p><input type="checkbox"/> Austudy, Abstudy or similar</p> <p><b>OR: Earning income from some other source:</b></p> <p><input type="checkbox"/> income from investment/ private pension (including Superannuation)</p> <p><input type="checkbox"/> support from family/friends</p> <p><input type="checkbox"/> other: (please specify) _____</p>
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

16. Please tick if you, or someone else in your household, OWNS a business

Figure 14 – Sample survey question to determine the source of household income

Across all respondents, approximately 30 per cent indicated that they, or someone in their household, owned their own business. Moreover, 24 per cent of respondents came from household’s whose primary source of income came from education, health, community services, or environmental protection/management (broadly termed the ‘government’ sector in Figure 15). Another significant share of responses (again, 27 per cent) came from those on ‘passive incomes’. Twenty one per cent of respondents were receiving support from the government through unemployment benefits, CDEP or some form of pension, while six per cent received income from investment, private pension or superannuation (Figure 15). This is to be expected, particularly given the relatively high number of aged respondents.

Approximately 9 per cent of respondents came from household’s whose primary source of income was agriculture (there were too few observations to meaningfully differentiate between different types of agriculture); a similar per cent to those dependent upon mining. Approximately 15 per cent of households were primarily dependent upon ‘Industry and transport’ (here, the relatively small number of observations comprising transport, construction and manufacturing were amalgamated).

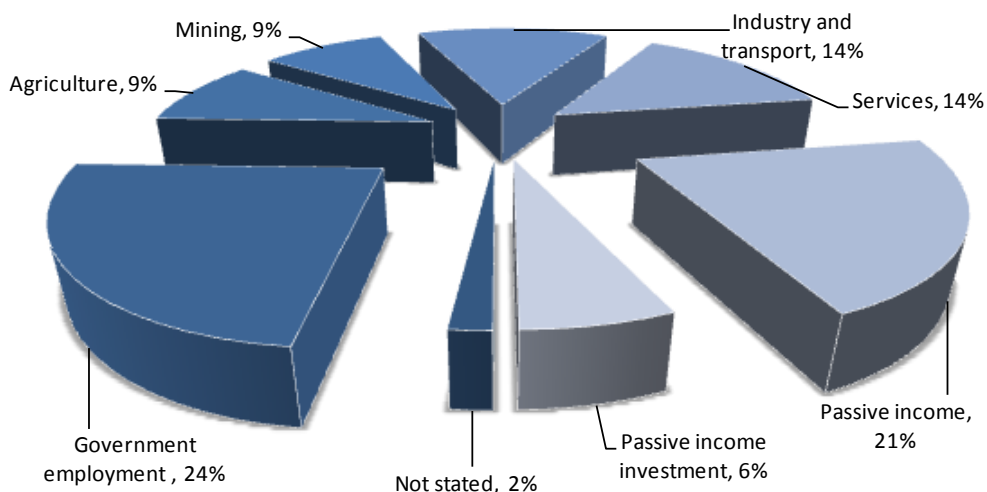


Figure 15 – Primary source of household income for all respondents (including survey and interview data)

With the exception of those dependent upon the mining industry (where there were a larger than expected number of respondents), this distribution is broadly in line with observed employment patterns in the region as evidenced, for example, by Larson and Alexandridis (2009, pg 17) who found that:

*Combined government-provided services (health, education and public services) employed on average 25 per cent of persons over 15 years of age in TR catchments. The second largest employment sector was agriculture and forestry, with an average of 11.5 per cent across catchments, followed by mining, retail and construction, each employing around 4 per cent of persons.*

### 3.5 Take-home messages

The sample does not appear to be representative of the population in general with respect to Indigeneity, household size, age, income, education levels etc.

However, the sample does contain observations from a broad cross-section of most of our targeted 'stakeholder' groups, namely residents who depend upon the Agricultural, Mining, Government, and 'other' sectors (e.g. retail, accommodation, and construction) for income and employment.

Readers are therefore cautioned NOT to simply look at sample means – attempting to draw inferences about the population in general – without first checking to see if the variable of interest is 'consistent' across stakeholder groups. Where differences exist, readers should instead, look at the information most pertinent to the group(s) of interest.

If used in this way, the information may prove to be particularly useful.

Readers are also urged to exercise extreme caution when seeking to use insights from this study to draw inferences about Indigenous values in other parts of the TR region (indeed they should even be cautious about trying to draw inferences about the values of other Indigenous people within the study area).



## 4 WHICH 'VALUES' ARE MOST/LEAST IMPORTANT TO WHICH STAKEHOLDER GROUPS?

As discussed in section 1, one of the key objectives of this study was to learn more about the relative importance of different Social and Cultural values associated with Australia's Tropical Rivers, to different stakeholder groups. In the first instance, this required researchers to determine WHICH values to assess. They then needed to determine HOW to assess them, before making comparisons across stakeholder groups. Details are provided in the following sub-sections.

### 4.1 Methodological background

#### 4.1.1 Determining WHICH 'values' to assess

##### 4.1.1.1 Frameworks for thinking about 'values' associated with the environment

Shortly after the turn of the century a group of (mainly biophysical) scientists working on a project entitled the Millennium Ecosystem Assessment (MEA) sought to highlight the fact that the environment is 'of value' for a variety of reasons – not simply because it can be used to 'produce' food and shelter for humans.

Specifically, the MEA noted that humans are the recipients of a variety of different ecosystem services (ES) – categorised as *provisioning, regulating, cultural and supportive services* – which contribute to a variety of different constituents of human and social wellbeing, such as *security, health, social relations, food and freedom of choice and action* (Millennium Ecosystem Assessment (MEA), 2005). And in their study of Australia's Tropical Rivers, Straton and Zander (2009) provided specific examples of the types of ecosystem services provided by Australia's Tropical Rivers – see Figure 16.

Yet the idea that value extends beyond price is not new to this century; neither is it new to social scientists. The economists Dupuit in 1861, and later Marshall in 1881, noted that market price is not synonymous with value (introducing the concept of *consumer surplus*), and economists have long been called upon (for good or for evil) to generate monetary estimates of the value of the environment – i.e. they are frequently asked to conduct *valuation* exercises (discussed in more detail in section 2). In an attempt to make this valuation task easier, economists sometimes work with what is called the Total Economic Value (TEV) framework which identifies different categories of value such as: 'direct use value'; 'indirect use value', 'option values', 'bequest' and 'existence' value (after Weisbrod in the 1960s and Kurtilla in 1967).

On the surface, the MEA and TEV frameworks appear quite different, but both frameworks include similar concepts and thus have much in common. Figure 17 attempts to highlight some of those similarities, indicating similar concepts that are named and sometimes categorised differently. For example, in the MEA food from aquatic resources would be classified as a 'provisioning service' (provisioning services are marked with a dark blue arrow in Figure 17); whilst in the TEV framework food from aquatic resources would be included in 'fisheries' and thus classified as a 'direct use value'. Similarly the MEA's 'regulating' values (light blue diamond in Figure 17) are most often considered as 'indirect use' values in the TEV framework; while MEA's 'cultural' values correspond to a range of use and non-use values of the TEV.

Further, both frameworks are similar in that they highlight the fact that:

- a) the environment has value far above and beyond that which is reflected in the marketplace;
- b) there is a multitude of different ways in which people relate to, interact with and benefit from the environment – i.e. there is a multitude of different ‘values’; and
- c) the Social and Cultural values associated with environmental assets are themselves, complex.

Ecosystem services	Examples of goods, activities and benefits provided
<i>Provisioning</i>	
Food	Production of fish, other aquatic and terrestrial species, fruits, and grains for recreational and subsistence hunting and gathering
Fresh water	Storage and retention of water for domestic, ecological, aquaculture, mining, fishing, and agricultural use
Fibre and fuel	Production of logs, fuelwood, and fodder for building, cooking, and warmth
Ornamental resources	Production of ornaments
Biochemical	Production of biochemicals and medicines
Genetic materials	Production of genetic material
<i>Regulating</i>	
Climate regulation	Source of and sink for greenhouse gases; influence local and regional temperature, precipitation, and other climatic processes
Water regulation (hydrological flows)	Groundwater recharge/discharge; hydrological regime is key driver of ecosystem processes and food-web structure
Water purification and waste treatment	Retention, recovery, and removal of excess nutrients and other pollutants
Erosion regulation	Retention of soils and sediments
Natural hazard regulation	Flood control, storm protection
Biological control	Control of pests and diseases
<i>Cultural</i>	
Spiritual and inspirational	Source of inspiration for well-being and art; spiritual benefit; specific and unique Indigenous spiritual and cultural values
Recreational	Opportunities for recreational activities and tourism
Heritage and sense of place	Cultural heritage and identity; responsibility for caring for country
Aesthetic	Many people find beauty or aesthetic value in aspects of wetland ecosystems
Educational	Opportunities for formal and informal education and training
<i>Supporting</i>	
Soil formation	Sediment retention and accumulation of organic matter
Habitat provision	Provision of habitat for wildlife feeding, shelter, and reproduction
Nutrient cycling	Storage, recycling, processing, and acquisition of nutrients

Figure 16 – Ecosystem services of Australia’s TR systems and examples of the activities and benefits they provide

Source: Stanton and Zander (2009, p 50)

# The Total Economic Value (TEV) of Tropical Rivers

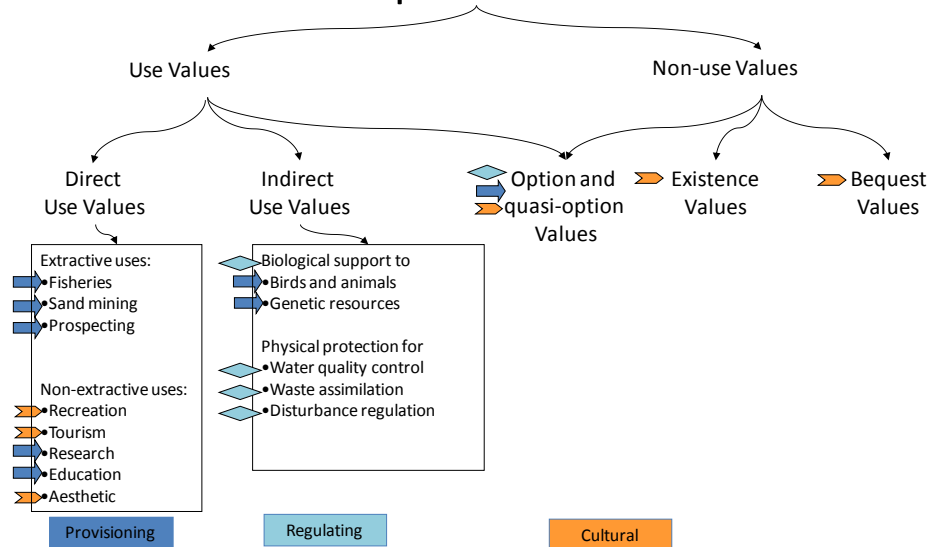


Figure 17 – Comparison of Total Economic Value (TEV) and Millennium Ecosystem Assessment (MEA) Ecosystem Services frameworks, with some examples relevant to Australia’s Tropical Rivers

## 4.1.1.2 Previous relevant research in the TR region

When seeking to determine which Social and Cultural values to measure in this project, researchers considered both of the frameworks discussed above, alongside information that had been collected by Storey et al. (2001), Toussaint et al. (2001), the Department of Agriculture, Fisheries and Forestry (2003), Jackson (2005), Mabire (2005), Van Dam and Bartolo (2005), Stoeckl et al. (2006), Woodward et al. (2008) and Sraton and Zander (2009) in their previous studies of Social and Cultural values in the TR region. Together these frameworks and research projects indicated that the Social and Cultural values most relevant to TR region were:

- Spiritual, cultural and inspirational values;
- Recreational values – including, but not limited to those associated with recreational fishing, swimming, and camping;
- Heritage and sense of place values;
- Aesthetic values;
- The direct – and indirect – use-values associated with rivers that accrue to the large number of Indigenous people for cultural purposes, for fishing, for recreation, for health and for a multitude of other reasons; and
- Environmental, aesthetic, bequest, and option values that exist even when the rivers are not being ‘used’ – or used up.

With these concepts in mind, researchers thus set out to develop a more definitive list of values to be assessed. A discussion of how that was done is provided in section 4.1.1.3 below.

### 4.1.1.3 Refining the list of ‘values’

To help refine the list of ‘values’ to be assessed in this study, focus groups were conducted in the Upper reaches of the Mitchell River<sup>42</sup>. Rather than presenting participants with the list of ‘values’ constructed from the literature (discussed in section 4.1.1.1, above) and then asking them to validate the list, those in the focus group were given a ‘blank’ piece of paper, and asked to construct their own list of ‘things’ (associated with rivers) which they thought were important (Stark and Torrance, 2006). These lists were found to correlate well with the concepts identified from the literature search, with no additional ‘values’ noted by respondents. The lists were, however, extensive, with multiple examples.

Recognising that respondents to a mail-out survey were unlikely to be willing to assess excessively long lists of ‘values’, researchers then set out to find ways of shortening the list that would be presented to residents within the mail-out survey. The general aim was to combine similar values/items into groups that could be presented collectively (e.g. swimming and snorkelling). The MEA and TEV frameworks discussed above, provided researchers with some ideas about how values might be grouped, but researchers were also interested in hearing the thoughts of the focus group participants. So participants were NOT presented with an existing framework (i.e. MEA or TEV); rather they were asked to develop their own set of ‘groupings’. Interestingly, these ‘groupings’ correlated well with those of the TEV framework. The final list of ‘values’ identified for inclusion in the survey (together with descriptions presented to respondents) was:

Table 2 – Values included in questionnaire

	<b>Descriptor</b>	<b>‘Value’ used in survey</b>
	Life	Water for human ‘life’: the rivers give water for drinking; they also keep plants and animals alive – and I use these for food
	Biodiversity	Water for other life (biodiversity): the river keeps a variety of plants and animals alive
	Commercial	Water for commercial and economic purposes (eg. irrigating crops, processing minerals, hydroelectricity, tourism)
Water for Social and Cultural purposes	Bequest	I like to know that the river will be there for my children/grandchildren
	Existence	I don’t go to the river, but I like to know it is there
	Fishing	I like to use the river for recreational fishing
	Recreation	I like to meet friends and family at the river, or use the river for swimming, picnics, boating, water skiing and other types of recreation
	Aesthetics	The river gives me peace of mind; I like to look at it; it inspires me
	Teaching	The river allows me to maintain customs, connect with history, remember ancestors; rivers are a good place for teaching / learning

<sup>42</sup> These focus groups were also used to trial other survey questions.

Importantly, readers will note that the list comprises six examples of Social and Cultural values, and three examples of other (non-Social/Cultural) values.

This was done because researchers are cognizant of the fact that dollar-denominated valuation techniques (like those discussed in chapter 2) are popular primarily because they are able to generate estimates of non-market 'value' which can be compared to other 'values' (all using a common currency).

In other words, dollar-denominated estimates allow one to determine whether non-market values (such as the Social and Cultural values associate with TR) are more or less important than other values that may be more closely associated with the market (e.g. using water to irrigate crops – or 'Commercial' values).

These other values were therefore included to enable researchers to gauge the importance of Social and Cultural values RELATIVE to other 'values'.

#### **4.1.2 Determining HOW to assess them**

To meet objective 1, researchers needed to be able to describe the current state of affairs – to determine which 'values' identified in section 4.1.1<sup>43</sup> were more/less important to which groups of people<sup>44</sup>. This meant they had to work with techniques that could assess the 'total' (as opposed to marginal) importance of each of these different 'values'. As discussed in section 2.2, there are numerous techniques for attempting to assess the relative importance of 'values' such as these, but stated preference techniques are required, since few Social and Cultural values are even loosely associated with the market. Moreover, it was noted that dollar-based techniques could be used to generate monetary estimates of those 'values', but that dollar-based estimates are essentially weighted voting systems (with the wealthy being given more votes than the poor). The gap between rich and poor in the TR region is significant, and there is no evidence to either confirm or deny that such a gap is 'optimal'. As such, researchers were reticent to use dollar-denominated techniques.

Survey respondents were therefore asked about the importance of each of the values identified in section 4.1.1. Specifically, using a non dollar-denominated technique developed by Larson (2011), respondents were asked to do three things:

1. Tell us how 'important' each of those values are (on a scale of 0 to 100);
2. Tell us how 'satisfied' they are with each of those values (on a scale of 0 to 100); and
3. If not 100 per cent satisfied, to tell us WHY (e.g. explaining their concerns).

A copy of the relevant survey question is provided on the following page:

---

<sup>43</sup> i.e. those associated with water for *Life*; with *Biodiversity*; with *Commercial* uses and/or with various *Social and Cultural* purposes.

<sup>44</sup> i.e. Indigenous/non-Indigenous residents; and those whose primary source of income derives from different sectors of employment (mining, agriculture, government etc.).

**B. QUESTIONS ABOUT WHAT YOU THINK IS IMPORTANT ABOUT WATER IN YOUR LOCAL RIVERS**

In the table below, we have constructed a list of things which different people sometimes think are important about water. In this section, we'd like to learn about what you think is most / least important about Australia's Tropical Rivers, and how satisfied you are with the current state of affairs in the river(s) near you.

17. We would like you to read through the list in the table below and do four things:

1. Tell us which things you think are important about your local rivers and water holes	2. Tell us <u>how important</u> this is to you	3. Tell us <u>how satisfied</u> you are with your local opportunities to do the things you think are important	4. If you are not completely satisfied with something, please tell us briefly why.
Look at the list below. If something is missing, which you think is important, please write it down at the end of the list	Give a score between 0 (not important) and 100 (extremely important). You may give some of the things the same number of points if you wish – several things might be equally important to you.	Give a score between 0 (not satisfied at all) to 100 (most satisfied). More than one thing can receive the same satisfaction rating.	For example, you might tell us that water for human life is very important and you give it a score of 100. But you only give it a satisfaction score of 75. This might be because you are drinking bore water and the quality is not good.
Water for human life: the rivers give water for drinking; they also keep plants and animals alive – and I use these for food			
Water for other life (biodiversity): the river keeps a variety of plants and animals alive.			
Water for commercial and economic purposes (e.g. irrigating crops, processing minerals, hydroelectricity, tourism)			
Water for social & cultural purposes:			
I like to know that the river will be there for my children / grandchildren			
Even if I never go to the river, I like to know it is there			
I like to use the river for recreational fishing			
I like to meet friends and family at the river, or use the river for swimming, picnics, boating, skiing and other types of recreation.			
The river gives me peace of mind; I like to look at it; it inspires me			
The rivers allow me to maintain customs, connect with history, remember ancestors; rivers are a good place for teaching/ learning			

18. Thinking only about the social and cultural ('feel good') values listed in the table above (in the green section), could you give an overall rating for how satisfied you are with all of these things combined? (Give a score between 0 and 100) \_\_\_\_\_

Figure 18 – Sample survey question to determine the relative importance of ‘values’

By asking respondents to do this for all listed values, researchers were able to collect enough data to assess the importance of Social and Cultural values relative to other values.

In addition, participants were asked to give an overall rating for how satisfied they were with all of the Social and Cultural values combined, as well as a score for how satisfied they were with their life as a whole. This was to enable researchers to put the ‘values’ of water into perspective – specifically comparing overall life satisfaction scores with scores associated with the rivers.

Finally, those who were interviewed (in and around the Upper Mitchell) were also asked to participate in a cognitive mapping exercise – designed to determine the extent to which respondents considered the ‘values’ presented in the earlier part of the questionnaire, complemented, or competed with each other. This technique was developed by Delisle et al. (2009), and is a modified version of the concept mapping technique (Trochim, 1989) and the pile-sorting technique (Rosenberg and Kim, 1975). This technique employs ‘cards’ which depict each of the Social and Cultural values and ‘other’ values together with a relevant visual picture. Participants are asked to sort each card into groups of values that ‘go well together’. Any comments made by participants to explain their rationale behind the sorting and rating are also recorded, to enable a deeper understanding of the cognitive structures shaping the views of these residents on the values of their local rivers. Further detail on the techniques and statistical analysis is provided in section 4.2.5.

## 4.2 Results and analysis

### 4.2.1 Importance of ‘values’

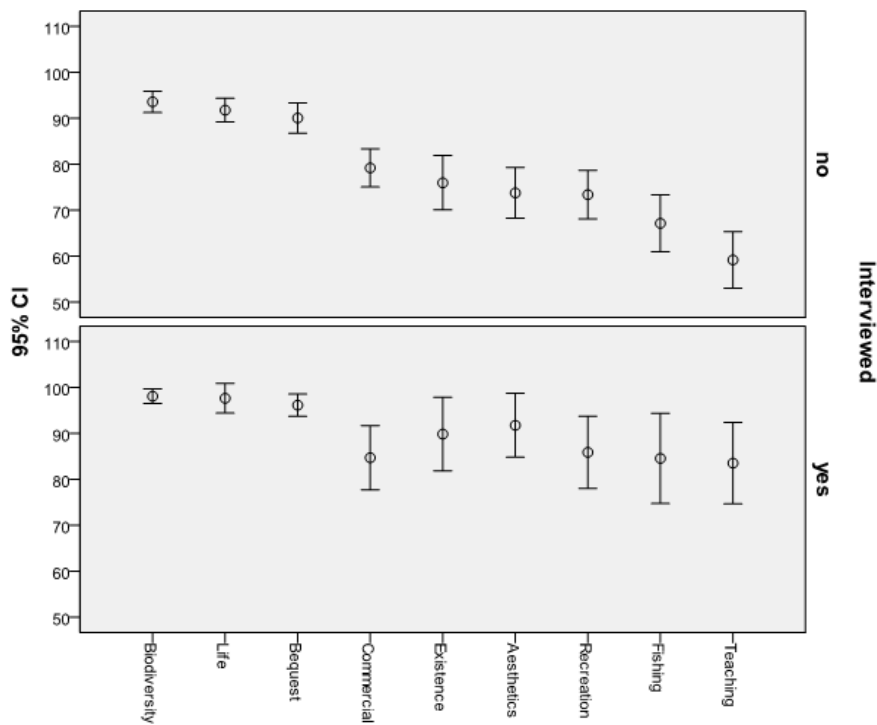
Respondents allocated the highest ‘importance scores’ to *Biodiversity, Life* and *Bequest* values. *Teaching, Existence, Fishing* and *Recreation* values were given the lowest scores.

Interviewees gave statistically significant higher ‘importance’ scores to each of the values than did mail-out respondents, (although there was consistency in the relative scores between the two samples). Given this indication of the presence of interview bias, data pertaining to the mail-out and to the interview components of this survey are presented separately in Table 3.

**Table 3 – The relative importance of Social and Cultural values: interviews and mail-out responses compared**

How important are rivers for...	Interviewed, n=39			Mail-out, n=237		
	Mean	Median	SD	Mean	Median	SD
... Biodiversity?	97*	100	7.58	91	100	20.86
... Life?	97**	100	9.72	90	100	20.51
... Commercial purposes?	85*	100	19.04	73	80	30.23
.... Social and Cultural values:						
Bequest?	93	100	17.64	86	100	27.19
Aesthetics?	88**	100	26.30	71	90	65.28
Recreation?	83**	100	25.93	67	80	38.06
Fishing?	82***	100	30.24	59	80	73.68
Existence?	81***	100	34.95	54	80	45.67
Teaching?	78***	100	32.96	48	50	41.34

significantly higher than mail-out sample at \*p<0.1; \*\*p<0.01; \*\*\*p<0.001  
n=276



**Figure 19 – The relative importance of Social and Cultural values: Mail-out and interview data compared**

For interviews, the confidence intervals associated with the ‘importance’ scores overlapped with each other (see Figure 19). This is likely to be a consequence of the relatively small sample. But for mail-out respondents, the confidence intervals associated with the top three values did NOT overlap those of other values. Evidently, these three values are considered to be more important than the others for mail-out respondents.

#### 4.2.1.1 Differences in the importance of values across Indigenous and non-Indigenous respondents

Researchers used a range of statistical tests to determine if responses to questions about the importance of key values were statistically different between Indigenous and non-Indigenous respondents<sup>45</sup>. Summaries of perceptions about the relative importance of key values are presented in Table 4. Most notable is the fact that in all but one case, Indigenous respondents gave higher importance scores to key values than did non-Indigenous respondents, and these differences were almost always statistically significant<sup>46</sup>. The important exception here is water for *Commercial* purposes: Indigenous respondents gave this a lower score than did non-Indigenous respondents (although the difference between the two was not statistically significant).

**Table 4 – The relative importance of Social and Cultural values: Indigenous and non-Indigenous responses compared (all data)**

How important is water for...	Non-Indigenous			Indigenous		
	Mean	Median	Valid N	Mean	Median	Valid N
... Life?	93	100	242	99**	100	27
... Biodiversity?	94	100	240	99*	100	27
... Commercial purposes?	79	90	235	73	75	27
... Bequest?	92	100	233	96*	100	27
... Existence?	79	100	179	88	100	22
... Fishing?	69	80	212	96*	100	26
... Recreation?	76	90	218	93*	100	26
... Aesthetics?	79	95	224	97*	100	26
... Teaching?	61	60	193	99*	100	26

\*Indigenous response significantly higher than non-Indigenous at p<0.1;

\*\*Indigenous response significantly higher than non-Indigenous at p<0.01;

The top three ‘values’ for non-Indigenous respondents mimic those of the entire data set: *Biodiversity*, *Life*, and *Bequest* values. Indigenous respondents concurred with the ranking of the top two values, but felt that the values associated with *Teaching* were even more important than *Bequest* values - Table 5. Both groups felt that *Recreational* uses of the river were relatively unimportant and Indigenous respondents felt that *Commercial* values were the LEAST important of all.

<sup>45</sup> When doing so, researchers firstly combined all data (including mail-out and interview), and then looked at the two data sets separately. Results were consistent across all analysis. As such, only information relating to the entire data set is presented here. Results for the data sub-sets (mail-out and interview only) are presented in Appendix B.

<sup>46</sup> Using non-parametric tests.



Table 5 – The three most important and least important values - Indigenous and non-Indigenous responses compared (all data)

	Non-Indigenous respondents		Indigenous Respondents	
Top three	Biodiversity	94	Biodiversity	99
'values'	Life	93	Life	99
(mean)	Bequest	92	Teaching	99
Bottom three	Recreation	76	Recreation	93
'values'	Fishing	69	Existence	88
(mean)	Teaching	61	Commercial purposes	73

#### 4.2.1.2 Differences in the importance of values across respondents reliant upon different industries for income

Researchers also used a range of tests<sup>47</sup> to look for statistically significant differences in responses to questions about the importance of key values across people whose households depended upon different industries/sectors for income. These are shown in Figure 20 (raw data is provided in Appendix C) – where four circles have been drawn around groups of values where the differences in responses across stakeholder groups were found to be statistically significant. These are discussed below.

- *Commercial values:*
  - Households which were primarily dependent upon the Agricultural or Industry/Transport sector for income placed a higher value on water for Commercial purposes, than did those dependent upon other sectors. However, it is important to note that respondents from the Agriculture and Industry/Transport sectors still rated *Biodiversity* and *Life* values higher than *Commercial* values, which tied in third place alongside *Bequest* values.
- *Bequest values*
  - On average, households which were primarily dependent upon the Mining industry for income rated Bequest values as being less important than did those dependent upon other sectors but the top three 'values' of people associated with the Mining sector were still – in order – *Biodiversity*, *Life* and then *Bequest* values.
- *Teaching and learning:*
  - On average, households which were primarily dependent upon Passive Income from the Government valued *Teaching* as being more important than those dependent upon other sectors.
- *Aesthetic values*
  - On average, households which were primarily dependent upon a Passive Income from the Government rated *Aesthetic* values as being less important than did those dependent upon the Agriculture, Mining, or Government sectors.

<sup>47</sup> Specifically: Anova's and post-hoc comparisons of means

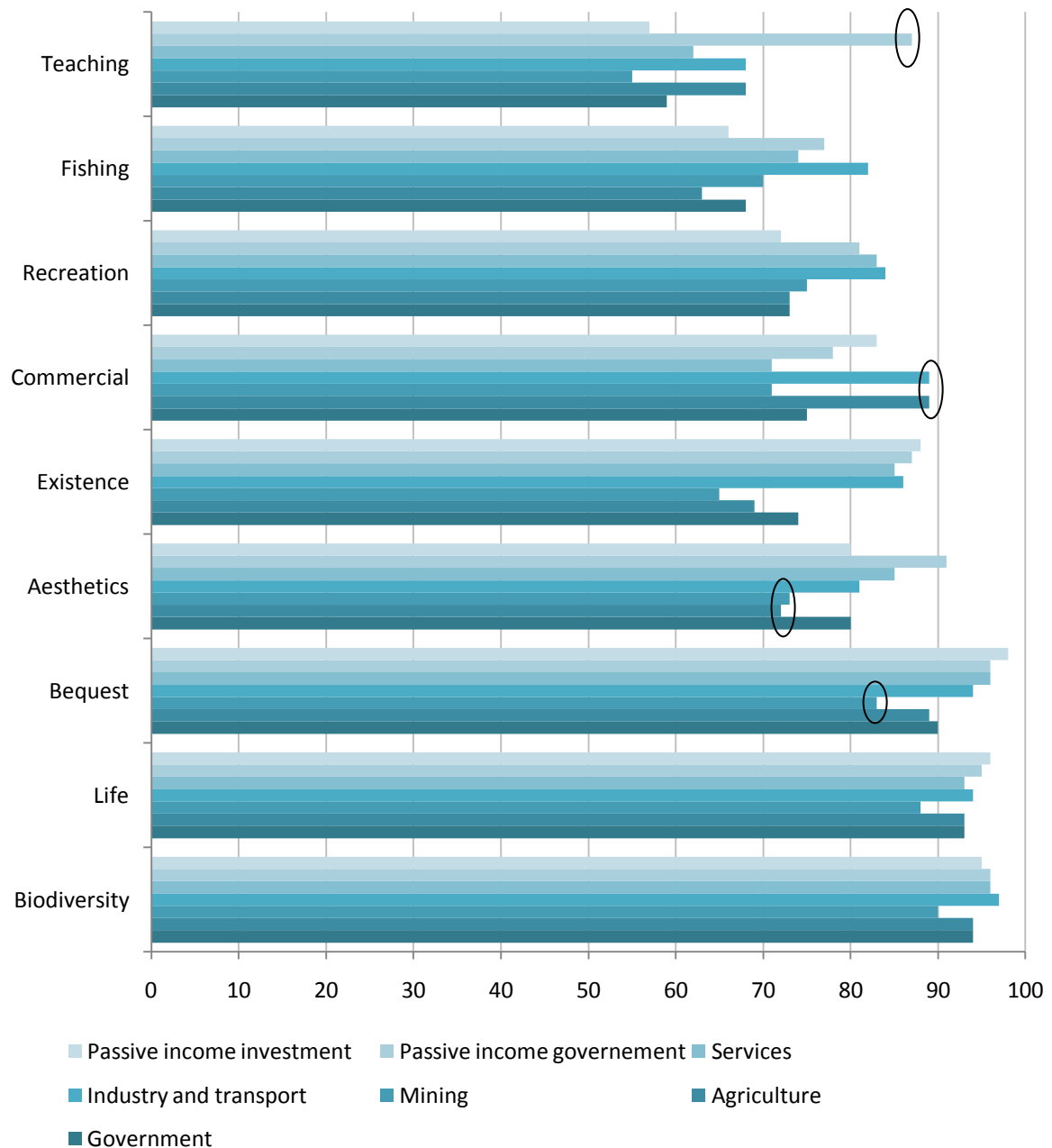


Figure 20 – Relative importance of Social and Cultural values – mean responses compared across households dependent upon different industries for income

#### 4.2.1.3 Other determinants of the importance of values

A key problem with the foregoing analyses is that it neglects to account for the fact that there are many other factors influencing ‘importance’; and that these factors may be inter-related in complex ways. In an effort to control for this, researchers used stepwise ordinary least squares (OLS) regression, to determine if other characteristics are associated with importance scores. The characteristics that were included in the analysis are listed in Table 6; Table 7 shows those which were found to be significantly correlated with ‘values’.

Table 6 – Demographic, sense of place and economic variables included in the analyses

Variable	Details
Male	Dummy variable: 1 if male, 0 otherwise
HasChildren	Dummy variable: 1 if has children, 0 otherwise
Age	Midpoint of age category
HigherEducation	Dummy variable: 1 if has higher education, 0 otherwise
Indigenous	Dummy variable: 1 if Indigenous, 0 otherwise
SizeOfHousehold	Number of people living in household
ResidentofNT	Dummy variable: 1 if resident of NT, 0 otherwise
ResidentofWA	Dummy variable: 1 if resident of WA, 0 otherwise
BornOverseas	Dummy variable: 1 if Born Overseas, 0 otherwise
BornInRegion	Dummy variable: 1 if born in region, 0 otherwise
YearsLivedInRegion	Number of years lived in region
UnsureIfWillStayInRegion	Dummy variable: 1 if unsure, 0 otherwise
OwnerOfPrivateBusiness	Dummy variable: 1 if business owner, 0 otherwise
Government	Dummy variable: 1 if Government provides income, 0 otherwise
Agricultural	Dummy variable: 1 if Agriculture provides income, 0 otherwise
Mining	Dummy variable: 1 if Mining provides income, 0 otherwise
Industry	Dummy variable: 1 if Industry provides income, 0 otherwise
Services	Dummy variable: 1 if Services provides income, 0 otherwise
PassiveInvIncome	Dummy variable: 1 if Investment provides income, 0 otherwise
Income	Midpoint of income category

First, it is important to note that this more sophisticated analysis allows for a more accurate interpretation of earlier results.

For example, the earlier (simpler) comparisons of scores across Indigenous and non-Indigenous people highlighted the fact that Indigenous people were more likely to allocate higher scores to *Life*, *Biodiversity*, and *Bequest* values (see Table 4). But this more sophisticated multivariate analysis shows that when controlling for other factors, it is NOT Indigeneity per se that is driving those differences, it is other factors (also correlated with Indigeneity) that seem to matter most.

Specifically, respondents who had children were more likely to place a higher value on *Life*, and *Bequest* values. Likewise, younger people, and those who were interviewed were more likely to allocate higher values to *Biodiversity*. When one controls for these factors, the ‘Indigeneity’ effect is no longer evident<sup>48</sup>. Similar comments pertain to the earlier simplistic analysis of importance across respondents who depended upon different sectors for income: our first analysis found that those dependent upon the Agricultural or Industry/Transport sectors were likely to allocate higher importance scores to *Commercial* values than other respondents. This more sophisticated analysis indicates that it is not an association with those sectors *per se* that drives results. Rather it seems that people involved in those two sectors are more likely to own their own business than those involved in other sectors; and that it is private business ownership that inflates respondent perceptions about the importance of using river water for *Commercial* purposes.

---

<sup>48</sup> It is just that Indigenous respondents were more likely to have children than their non-Indigenous respondents, and were also, on average, younger, and more likely to be interviewed, which led to the earlier (incorrect) attribution.

As such, this multivariate analysis allows us to replace earlier observations with the following:

- Importance scores are relatively consistent across stakeholder groups (most clearly evidenced by the low predictive power of the models).
- Interview bias is evident for *Biodiversity* and *Existence* values – all else constant, mail-out respondents were likely to attach lower importance scores to these key values than interviewees<sup>49</sup>.
- Socio-Demographic variables affect values.
  - Indigenous residents are likely to attach a higher level of importance to *Fishing*, *Recreation*, *Aesthetic* and *Teaching* values than their non-Indigenous counterparts.
  - People with children are likely to attach a higher level of importance to *Life*, and *Bequest* values than people without children.
  - Younger people were more likely to allocate high values to *Biodiversity* than the elderly.
  - Persons born in Australia were likely to attach a higher level of importance to *Aesthetic* values than persons born overseas.
- Economic factors affect values.
  - Those who own their own business are more likely to place a higher level of importance to *Commercial* and *Fishing* values than those who do not own their own business.
  - Those dependent upon the Mining sector for income were likely to place a lower level of importance on *Commercial* values than those receiving a Passive Income from the Government.
  - Those dependent upon the Services sector for income were likely to attribute higher importance scores to *Bequest* values than those receiving a Passive Income from the Government.
- Values differ across regions.
  - Residents of WA are likely to attach lower importance scores to *Commercial* and *Existence* values than residents of QLD.
  - Residents of NT are likely to attach lower importance scores to *Life* and *Teaching* values than residents of QLD.

---

<sup>49</sup> Perhaps interviewees were attempting to ‘please’ researchers by inflating importance scores.

Table 7 – Factors influencing levels of importance assigned to water values

How important are rivers for...	Most important determinants of importance (stepwise multivariate tests):	Predictive capacity of model (adjusted R <sup>2</sup> )
... Life?	↑ Has Children ↓ Resident of NT	0.135
... Biodiversity?	↑ Interviewed ↓ Age	0.037
... Commercial purposes?	↑ Owns Business ↓ Resident of WA ↓ Dependent upon mining sector for income	0.057
... Bequest?	↑ Has Children ↑ Dependent upon services sector for income	0.106
... Existence?	↑ Interviewed ↓ People living in WA	0.067
.... Fishing?	↑ Indigenous ↑ Owns Business	0.096
... Recreation?	↑ Indigenous	0.033
.... Aesthetics?	↑ Indigenous ↓ Born Overseas	0.057
.... Teaching?	↑ Indigenous ↓ Resident of NT	0.154

#### 4.2.2 Satisfaction with 'values'

Respondents were also asked about their current satisfaction levels, with life overall and with the various aspects of water (Figure 21). Out of the broad categories of water values, satisfaction was highest with *Biodiversity*, followed by water for *Life* and overall *Social and Cultural* values<sup>50</sup>. The lowest satisfaction scores were associated with water for *Commercial* purposes. In terms of individual Social and Cultural values tested, equal highest satisfaction scores were reported for *Bequest* and *Aesthetic* values; while *Fishing* and *Teaching* values received lower scores. Satisfaction with life overall was rather high, compared to Australian averages (see, for example, Australian Unity, 2008) and was higher than satisfaction with the current state of water values.

Indigenous people reported higher satisfaction with all aspects of water than did non-Indigenous respondents (Table 8), but only the scores relating to *Recreation*, *Fishing*, *Aesthetics* and *Teaching* were statistically different between the two stakeholder groups.

<sup>50</sup> Calculated using the mean of sub-categories of Social and Cultural values.

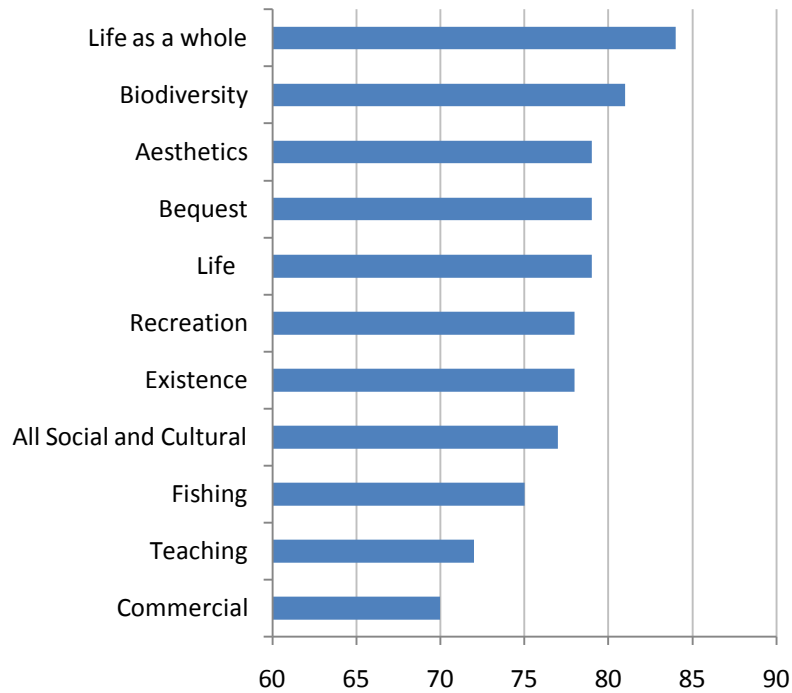


Figure 21 – Satisfaction ratings

Table 8 – Satisfaction ratings: Indigenous and Non-Indigenous responses compared

How satisfied are you with	Non-Indigenous	Indigenous
... Life as a whole	84	87
How satisfied are you with rivers for ...		
Life	78	84
Biodiversity	80	83
Commercial purposes	71	67
Bequest	78	85
Existence	77	84
Fishing	73	92**
Recreation	76	93**
Aesthetics	77	92**
Teaching	69	90**

\*\* Indigenous response significantly higher than non-Indigenous at  $p < 0.01$

Satisfaction levels were compared across respondents who came from households which were dependent upon different industries for income. In only one case was a statistically significant difference found: those receiving a Passive Income from private investments reported significantly higher satisfaction with *Aesthetic* values than all other stakeholder groups (refer Table 31 in Appendix C).

As was done for Importance scores, researchers also conducted a more sophisticated analysis of satisfaction scores, seeking to determine which – if any – of the variables listed in Table 6 were associated with high/low levels of reported satisfaction.

**Table 9 – Factors influencing levels of satisfaction assigned to water values**

How satisfied are you with	Significant determinants of satisfaction (stepwise multivariate tests):	Predictive capacity of model (adjusted R <sup>2</sup> )
Life in General?	↓ Resident of NT ↓ Unsure if will stay in region until retirement ↑ University Education ↑ Indigenous	0.082
<b>How satisfied are you with rivers for ...</b>		
... Life?	↑ Resident of WA ↓ Passive Income from private investment	0.054
... Biodiversity?	↓ Age	0.035
... Commercial purposes?		0
... Bequest?		0
... Existence?	↑ Owns Business	0.022
.... Fishing?	↑ Indigenous ↑ Owns Business	0.055
... Recreation?	↑ Interviewed ↓ Male	0.054
.... Aesthetics?	↓ Income ↓ Age	0.047
.... Teaching?	↑ Indigenous ↑ Age	0.096

As such, this multivariate analysis allows us to replace earlier observations with the following:

- 1) Like importance scores, satisfaction scores are relatively consistent across stakeholder groups (most clearly evidenced by the low predictive power of the models).
- 2) Socio-demographic variables affected satisfaction ratings.
  - Indigenous residents were likely to assign higher satisfaction ratings for *Life in general*, *Fishing*, and *Teaching* values than their non-Indigenous counterparts.
  - People with a university education were likely to assign higher satisfaction scores to *Life in general*.
  - People who were unsure about whether they would stay in the region until (at least) retirement were more likely to assign lower satisfaction scores to *Life in general*.
  - Younger people were likely to assign a higher satisfaction score to *Biodiversity* and *Recreation*; and to attach a lower score to *Aesthetics*.
  - Males were likely to assign a lower satisfaction score to *Recreation* values.
- 3) Economic factors affect satisfaction ratings.
  - Those who own their own business were more likely to assign higher satisfaction scores to *Existence* and *Fishing* values than those who do not own their own business.

- Those dependent upon Passive Incomes from Private Investment were likely to assign lower levels of satisfaction on *Life* and higher levels of satisfaction on *Aesthetic* values.
- Those dependent upon the Services sector for income were likely to assign higher satisfaction scores to *Bequest* values than those receiving a Passive Income from the Government.
- Those who were earning a higher income were likely to assign lower satisfaction scores for *Aesthetic* values.

4) Satisfaction levels differ across regions.

- Residents of WA were likely to assign higher satisfaction scores to *Life* and *Bequest* values than residents of QLD.
- Residents of NT were likely to attach higher satisfaction scores to *Life in general* than residents of QLD.

### 4.2.3 Issues raised as contributors to dissatisfaction

Participants were afforded the opportunity to provide reasons why they were dissatisfied with any of the values listed. Generally, comments pertained to *Commercial* purposes, *Life*, *Fishing*, *Recreation*, *Teaching* and *Existence* values, and most often participants expressed concerns or fears about what might happen to those 'values' in the future (e.g. the potential for pollution, or higher prices to impact things that are important to them), rather than about what was actually happening now. Common concerns related to water quality, water use and storage, access (physical and regulatory), and the presence of crocodiles.

Table 10 – Issues raised as contributors to dissatisfaction

<i>Commercial</i> purposes	Pollution (from mines) Use / over-use (tourism, irrigation, commercial, domestic) – requires better monitoring The cost of water and uncertainty about future access Capture and storage (need for dams) and improved recycling
<i>Life</i> values	Quality (chemicals) Boundaries and regulations / Government restrictions Use / over-use (too many bores / cattle watering points, exports to Perth, tourists) Capture and storage (store rain water) Improve environment – need more shade trees Concern for the future – water is not looked after
<i>Fishing</i> values	Access / permits Overfished and overcrowded by fishers
<i>Recreation</i> values	Presence of crocodiles Inaccessible Lack of Land care rangers and attention by Council
<i>Teaching</i> values	Access
<i>Existence</i> values	Presence of crocodiles (NB: this comment most likely explaining why some people do not use the rivers for recreational purposes but instead simply enjoy them for their 'existence' value)



#### 4.2.4 Identifying policy priorities using information on importance and satisfaction

Simply being able to state that people think a value is important or that they are satisfied with a value does not necessarily help policy makers determine priorities for funding, analysis, or negotiation. Some values, for example, may be considered to be vitally important – but if residents are generally satisfied with their ability to enjoy that value, then the efforts of policy makers may be better focused on other issues (*if it aint broke: don't fix it*). Similarly, some residents may be particularly dissatisfied with an issue: but if that issue is relatively unimportant to those residents, then the efforts of policy makers may also be better focused on different issues (*important issues should be given higher priority*). In short, policy makers need to consider BOTH the importance of a particular value, and people's relative satisfaction with it.

##### 4.2.4.1 Using Importance Performance Analysis techniques

The marketing literature<sup>51</sup>, often works with what is known as Importance Performance Analysis (IPA) – using data that is similar, although not identical to the Importance-Satisfaction data presented here. When conducting these studies, researchers ask customers to allocate both an importance and a performance score to various services provided by a business. When customers allocate a higher score to the importance of a particular service than they do to the performance of the business with respect to that service, then this is interpreted as indicating that the business needs to focus more attention on that service. If the opposite holds true (i.e. importance is less than satisfaction), then this is interpreted as indicating that the business may be focussing too much attention on that service.

The analysis undertaken here uses the same approach, although it compares importance with satisfaction (rather than importance and 'performance'). Figure 22 shows both importance and satisfaction scores for each of the four broad categories of values considered here, namely: *Biodiversity, Life, Commercial uses* and (all) *Social and Cultural values combined*<sup>52</sup>. In all cases, respondents allocated a higher score to 'importance' than they did to 'satisfaction', and these differences were statistically significant for all categories of 'value'<sup>53</sup>. This finding indicates a discrepancy between reported importance and satisfaction and thus suggests that restoration of some aspects of these values might be warranted.

Figure 23 presents similar information – focusing entirely on the subset of values under the broader category of 'Social and Cultural' values. Interestingly, in this diagram there are several values where importance has been allocated a lower (or equivalent) score than satisfaction<sup>54</sup> – most notably *Teaching*. This is, no doubt, at least partially (if not entirely) due to the fact that just 38 respondents were Indigenous – so these aggregate results are masking important underlying differences.

---

<sup>51</sup> See, for example: Annin and Hisham, 2008, Chu and Choi, 2000, Dolinsky and Caputo, 1991, Duke and Persia, 1996, Edward and George, 2008, May, Graf et al., 1992, Hammitt et al., 1996, Kinley et al., 2002, Martilla and James, 1977, Mengak et al., 1986, Oh, 2001, O'Neil and Palmer, 2004, Tonge and Moore, 2007, Wade and Eagles, 2003, Yeo, 2003.

<sup>52</sup> Respondents were not asked to provide an importance score for all social and cultural values combined therefore this was calculated as the mean of all sub categories of Social and Cultural values combined. For consistency, the same calculation was performed for satisfaction scores.

<sup>53</sup> Here, paired samples tests were used.

<sup>54</sup> Although differences between scores allocated to all of these importance/satisfaction pairs were not statistically significant using paired samples tests.

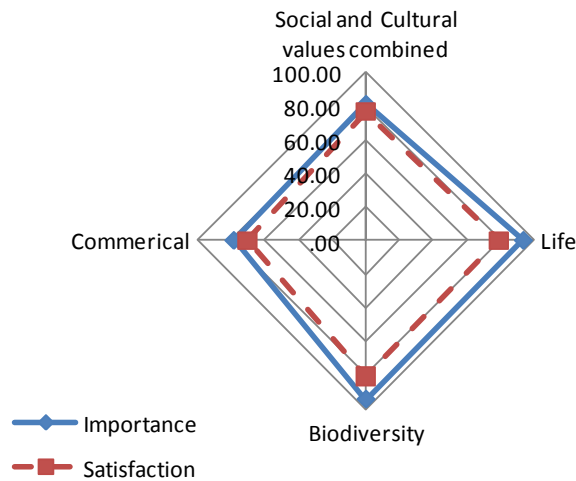


Figure 22 – Overlay of importance and satisfaction scores for four broad categories of water values

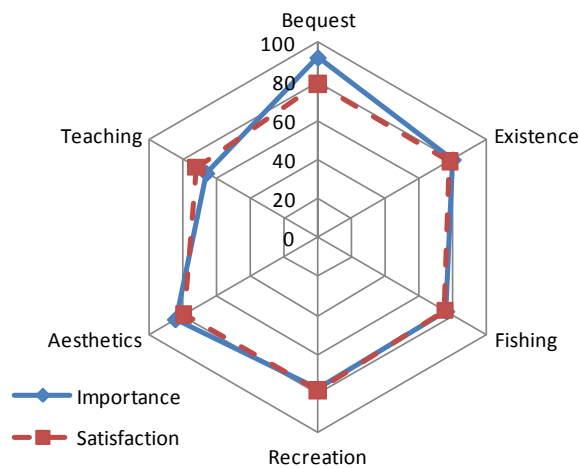


Figure 23 – Overlay of importance and satisfaction scores for each Social and Cultural aspect of water

The important exception to this is *Bequest* values. Here, respondents allocated a higher score to importance than they did to satisfaction, an insight that accords with previous observations about the fact that many of the expressed concerns and statements of dissatisfaction related to what might happen in the future, rather than what was actually happening now.

In summary, to the extent that this information can be interpreted using insights from IPA, our results indicate that the values which policy makers need to focus most attention on include those associated with *Life*, *Biodiversity*, *Commercial* purposes and *Bequest* values. Respondents consistently rate these as being very important (as noted in the previous section), but the satisfaction ratings associated with these values are consistently lower than the importance ratings.

#### 4.2.4.2 Using the index of dissatisfaction (IDS)

To further explore the relationship between current levels of satisfaction and the perceived importance of each water value, scores for importance and satisfaction, as assigned by each respondent, were combined using a modified Index of Dissatisfaction (IDS) approach developed by Larson (2010, 2011). The IDS approach allows one to communicate both the perceived needs of

residents and their perceived satisfaction with those needs, using a single score. As such, the IDS method allows one to identify and focus on ‘problem areas’: namely those which are important and which also ‘need fixing’.

To calculate the IDS, one needs to firstly convert satisfaction ratings into *dissatisfaction* scores:

$$\text{Dissatisfaction score} = 100 - \text{satisfaction score}$$

One can then calculate the IDS associated with each value by multiplying the mean *dissatisfaction* score by the mean *importance* score and also by the percentage of respondents who allocated an importance score to that particular value (out of a total of 276 people who completed the importance/satisfaction question).

$$\text{IDS} = \overline{\text{importance score}} \times \overline{\text{dissatisfaction score}} \times \text{per cent of respondents indicating value is important}$$

The results are presented in Table 11, ranked from highest to lowest. Interestingly, *Commercial* values now appear at the top of the priority list. This is not because it is deemed most important (as previously highlighted, three other values were consistently nominated as being more important than *Commercial* purposes). Rather it is because of the high levels of dissatisfaction about issues associated with the commercial use of water. The last column of the table, provides specific examples of those expressed issues about which respondents are dissatisfied (see also more detailed discussion in section 4.2.3) – clearly, some people are dissatisfied because of an inability to access enough water for commercial use, others are dissatisfied because they feel that too much water is being used and/or because of concerns about pollution.

**Table 11 – Index of Dissatisfaction (IDS) for water values across Northern Australia. Higher values indicate greater importance, dissatisfaction and/or per cent of respondents selecting the value**

Rivers for...	Mean Importance	Mean Satisfaction	per cent of respondents indicating value is important	IDS	Reasons for dissatisfaction (concerns)
... Commercial purposes?	78	70	95	22	pollution; overuse; lack of monitoring of water use
... Life?	93	79	98	19	overuse by agriculture, tourism; water exports; future
... Biodiversity?	95	81	97	18	-
... Bequest?	92	79	95	18	-
... Fishing?	72	75	87	16	overfishing; lack of access
... Recreation?	78	78	89	15	crocodiles; better attention from council
... Teaching?	66	72	80	15	uncertainty with access; insufficient acknowledgment of rights
... Aesthetics?	81	79	91	15	-
... Existence?	80	78	73	13	crocodiles

### 4.2.4.3 Factors Influencing IDS

Researchers also sought to determine which – if any – of the variables listed in Table 6 were associated with high/low indices of dissatisfaction<sup>55</sup>.

Table 12 – Factors influencing index of dissatisfaction associated with different water values

How important are rivers for...	Significant determinants (stepwise multivariate tests):	Predictive capacity of model (adjusted R <sup>2</sup> )
... Life?	↑Passive Income from Investments ↓Resident of WA	.058
... Biodiversity?	↑Age	.025
... Commercial purposes?		0
... Bequest?	↑Has children	.026
... Existence?	↓Resident of WA ↓Owns Business ↑Male	.056
.... Fishing?		0
... Recreation?		0
.... Aesthetics?		0
.... Teaching?	↑Age	.019

As such, this multivariate analysis allows us to replace earlier observations with the following:

- 1) Again, the IDS scores are relatively consistent across stakeholder groups, with a low predictive power for each of the models.
- 2) Socio-demographic variables affect dissatisfaction ratings.
  - Older residents had higher indices of dissatisfaction associated with *Biodiversity* and *Teaching* values than did younger residents.
  - Those residents who have children had higher indices of dissatisfaction associated with *Bequest* values than those who did not have children.
  - Males had higher indices of dissatisfaction associated with *Existence* values than did females.
- 3) Economic factors affect dissatisfaction ratings.
  - Those who own their own business had lower indices of dissatisfaction associated with *Existence* values than those who do not own their own business.
  - Those dependent upon the Passive Incomes from Private Investment had higher indices of dissatisfaction associated with *Life*.
- 4) Dissatisfaction indices differ across regions.
  - Residents of WA had lower indices of dissatisfaction associated with *Life* and *Existence* values than residents of QLD.

<sup>55</sup>It is also possible to calculate an IDS for each 'value', for each respondent (rather than an IDS for each value, averaged across all respondents) and this was done to facilitate the multivariate analysis. Here, missing importance values were replaced by zero, and then individual IDS's were calculated by simply multiplying the importance score by the dissatisfaction score.

#### 4.2.5 The relationship between values (interviewees only)

Researchers produced a set of cards that had pictures and words depicting different types of ‘values’ associated with those assessed in the earlier part of the questionnaire (see Appendix D). There was not, however, a direct one-to-one correspondence between the ‘cards’ and earlier questions. This is because the earlier part of the questionnaire focused primarily on different Social and Cultural values (with six sub-categories), and grouped other values very broadly (e.g. all commercial activities together). For this exercise, respondents were presented with many more ‘values’, allowing for a more detailed analysis of relationships. These are listed on the left hand side of the table below (the right hand side shows the broad category of ‘value’, used in the earlier questionnaire that is associated with each)<sup>56</sup>:

Table 13 – Values used in cognitive mapping exercise

‘Value’ appearing on card	Broad category of ‘Value’ used in earlier questionnaire
Human life (drinking and food)	<i>Life Values</i>
Plant life	<i>Biodiversity Values</i>
Animal life	
Hydroelectricity	
Tourism	<i>Commercial Values</i>
Irrigation	
Cattle (grazing)	
Processing minerals	
Peace of mind, aesthetics, inspiration	<i>Social and Cultural Values</i>
Recreational fishing	
Future generations	
Culture (tradition, connect with history, remember ancestors), Teaching and Learning	
For their own sake (even if I never use them)	

Participants were then asked to sort the cards into groups that “go well together”. The following was given as an (unrelated) example to explain what researchers wanted them to do:

*Let’s look at these three cards: A tree with a bird sitting in it; a tree with a person sitting under it; and a pile of wood. If I were asked to sort the cards into piles that ‘go well together’, I would probably put the first two together (reasoning that the bird and the person could both use the tree), but put the other card separately. This is only my opinion, and you might have another opinion.*

*Today we are interested in hearing YOUR opinion about some of the values associated with Tropical Rivers. And we would like you to play a similar ‘game’ with this larger group of cards, showing us which values you think ‘go well together’ ... Please remember, there is no ‘right or wrong’ way to group these cards.*

During the course of this exercise, comments were made by participants to explain their rationale behind the sorting, and these were recorded to be used in conjunction with statistical techniques

<sup>56</sup> Unfortunately, the *Recreation* card was misplaced during the first fieldtrip (covering all non-Indigenous participants). It was therefore deliberately omitted from all subsequent interviews to maintain consistency.

described below to gain a deep understanding of the cognitive structures shaping the views of these residents on the values of their local rivers.

In the first instance, the multi-dimensional scaling method (MDS) described by Kruskal and Wish (1978) was used. To do this, researchers constructed 39 separate matrices (one for each respondent). Each of the 'values' presented on the cards represented both a column heading and a row heading, giving a symmetric matrix. Binary entries indicated whether or not the respondent placed the two values in a group together (entry = 1), or whether the values were separated (entry = 0). The matrices were subsequently added, producing a single 'similarity' matrix, which was analysed using non-metric MDS. Results are presented in Figure 24 below<sup>57</sup>.

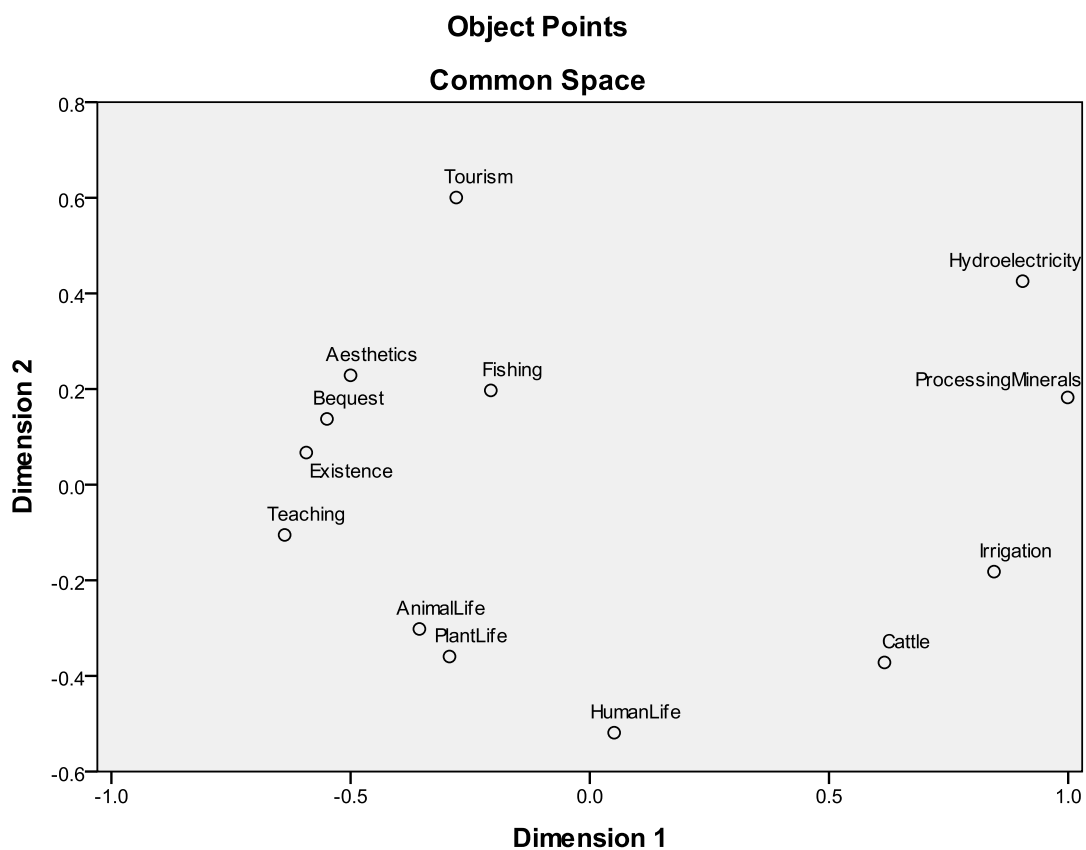


Figure 24 – Cluster analysis of all aggregated data (n=37)

When interpreting results from this type of analysis it is informative to look at the graph in two different ways.

First – look across the horizontal (dimension 1). The items on the far right hand side all relate to commercial uses of water (for cattle, irrigation, hydroelectricity and the processing of minerals), whilst the items on the left generally relate to Social and Cultural values. With the exception of

<sup>57</sup> Kruskal's stress is slightly higher than ideal (0.117), but Tucker's coefficient of congruence indicates there is a good fit between the original proximity measures and derived distances (0.993).

Tourism, there is, therefore, a clear break on the horizontal dimension: between commercial and non-commercial values.

Now look down the vertical (dimension 2). On the right hand side of the chart, all the commercial values are quite separate from each other. But on the left hand side of the chart, there is evidence of some 'grouping'. Tourism is on its own<sup>58</sup>, but most of the Social/Cultural values group together, as do the biodiversity values (animal and plant life).

Each participant's matrix was also aggregated with other participants of the same gender to produce two similarity matrices (one for males, one for females), which were analysed separately using non-metric MDS. Figure 25 below shows the results of all males aggregated, while Figure 26 shows the results of all females aggregated<sup>59</sup>.

Again there is a clear separation on the horizontal dimension, between commercial and non-commercial values, although this is more pronounced with males, particularly with respect to the separation between *Commercial* values and *Social and Cultural* values on the horizontal dimension. Females appear to separate *Fishing* from the other Social and Cultural values and it could either be grouped with *Biodiversity*, or on its own. Again there is a much tighter clustering of the Social and Cultural values on the vertical dimension than the commercial values for both males and females.

---

<sup>58</sup> Several respondents saw Tourism as the way of the future, particularly for Indigenous residents (it was often Indigenous participants making these observations), and that meant it often clustered with Teaching, Bequest, and Aesthetic values.

"Tourism, culture and future generations – this is the future"

"Tourism and future generations – this is the future"

"Tourism and culture – this is what I want for the future – using areas for teaching and learning / tourism for cultural purposes"

"Culture, beauty, tourism and future generations – learning and teaching for the future"

<sup>59</sup> In each case, Kruskal's stress is reasonable (although slightly higher than ideal) at 0.123 for males and 0.152 for females. Nonetheless, Tucker's coefficient of congruence indicates there is a good fit between the original proximity measures and derived distances for both males and females (0.992 and 0.988 respectively).

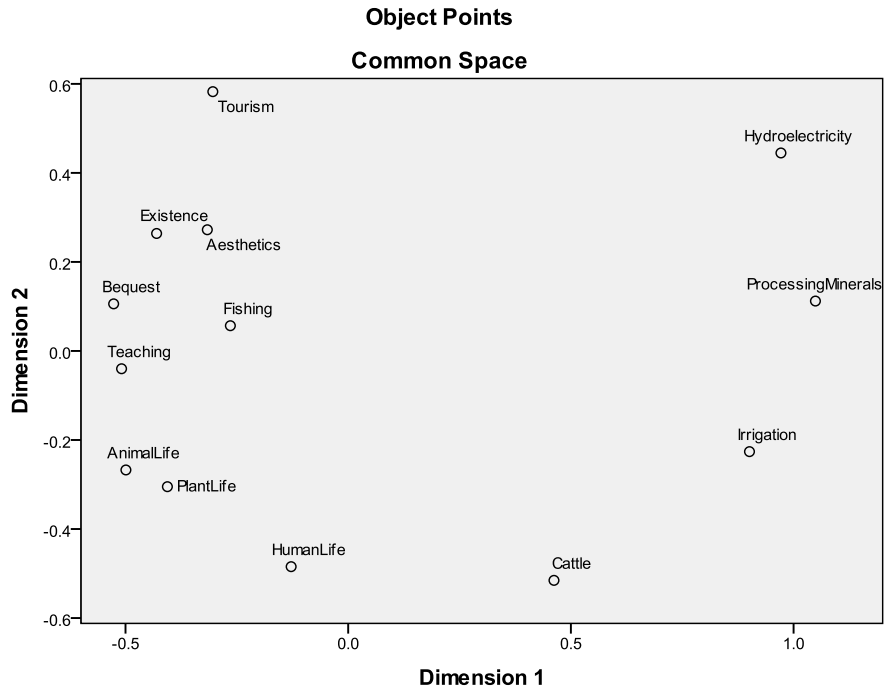


Figure 25 – Cluster analysis male data aggregated (n=19)

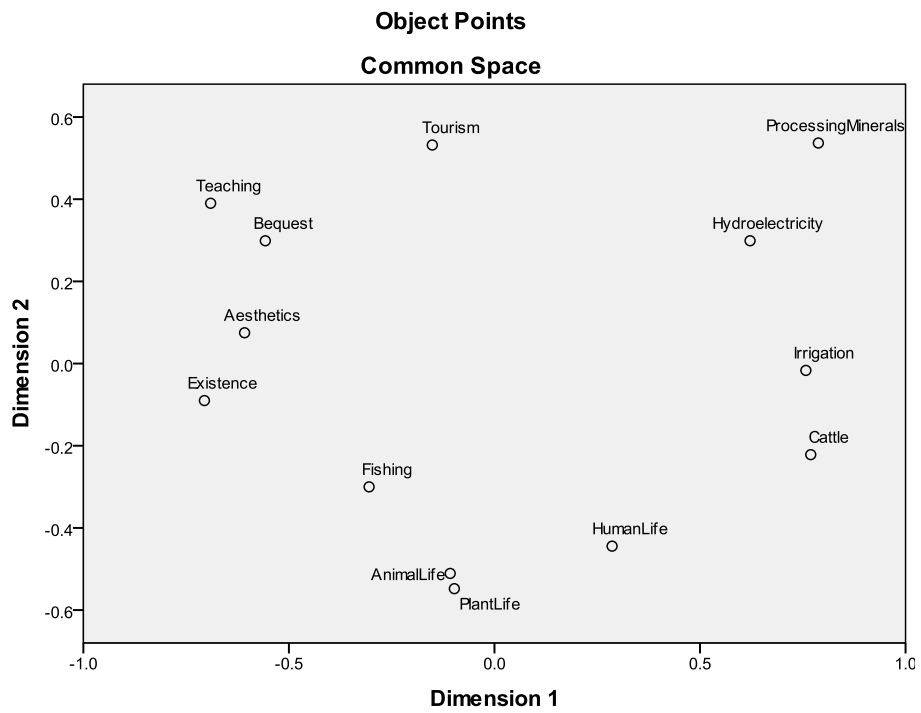


Figure 26 – Cluster analysis female data aggregated (n=18)



Next, each participant's matrix was aggregated with other participants by Indigeneity. Figure 27 below shows the results of the MDS analysis for all non-Indigenous participants aggregated, while Figure 28 shows the results of all Indigenous participants aggregated<sup>60</sup>.

These maps also show a clear separation between commercial and non-commercial values on the horizontal dimension. For non-Indigenous data, *Tourism* appears to be more closely aligned with *Teaching*, whereas for the Indigenous data, *Tourism* was more closely aligned with other cultural values: *Teaching* lay between Social/Cultural and *Biodiversity* values.

While the qualitative statements do not provide any insight into these major differences, there are a number of comments provided by Indigenous participants supporting the strong separation between commercial and non-commercial values:

*"irrigation, hydroelectricity, processing minerals and cattle – these can harm the cultural connection to the river system, causing an imbalance to the river system"*

*"processing minerals, irrigation, hydroelectricity and cattle – these are not natural and would impact on the quality and quantity of water available"*

There is also tighter clustering of the Social and Cultural values on the vertical dimension compared to the commercial values, with the exception of fishing in the Indigenous data. This could be due to the inability to separate recreational fishing from food for survival (human life): several Indigenous participants indicated that they did not think it made sense to separate 'recreational fishing' from 'food for survival', while some also saw 'recreational fishing' as a commercial enterprise which was the domain of non-Indigenous, non-local people.

---

<sup>60</sup> The results of Kruskal's stress was good (0.105) for non-Indigenous data and Tucker's coefficient of congruence confirms there is a good fit between the original proximity measures and derived distances (0.995). For Indigenous data, Kruskal's stress was slightly higher than ideal (at 0.14), however Tucker's coefficient of congruence indicates there is a good fit between the original proximity measures and derived distances for this data (0.99).

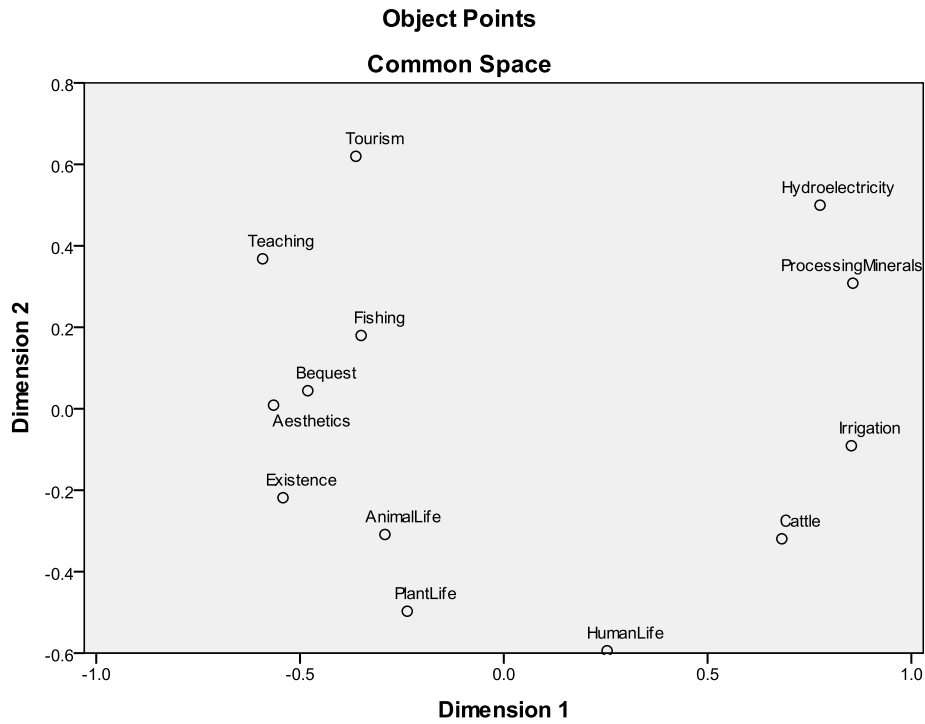


Figure 27 – Cluster analysis non-Indigenous aggregated data (n=20)

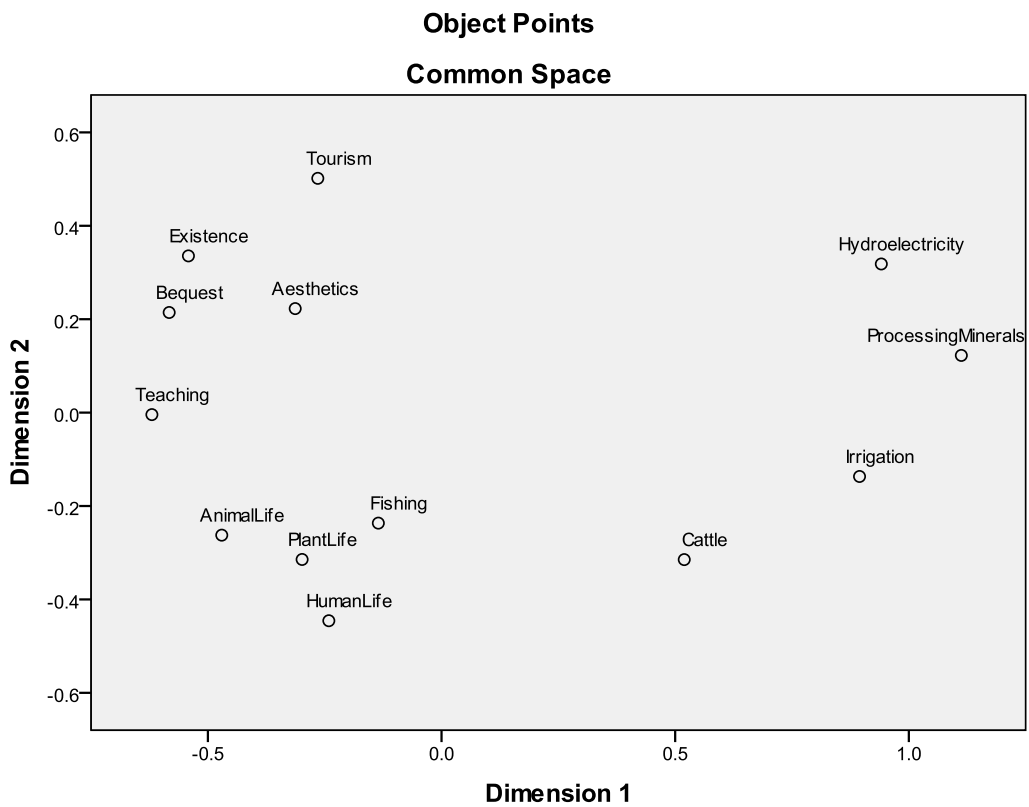


Figure 28 – Cluster analysis Indigenous aggregated data (n=17)

Each participant's matrix was then aggregated with other participants by income source (employed versus passive income – be it from the government or from private investments). These results are presented in Appendix E and show similar results as previous 'maps'. The main point being that there is a clear separability of commercial and social values but the stronger relationship between other values remains.

Evidently, most interviewees (regardless of gender, Indigeneity, or sector of employment) are of the opinion that at least some Social and Cultural values 'go well' with (or complement) *Biodiversity* values<sup>61</sup>. But it seems that the 'split' between commercial and other values is not invariant. At the end of each cognitive mapping exercise, participants were asked to provide insights into the causal relationships between each group (i.e. they were asked to indicate whether one group had a positive or negative relationship with another group). They consistently indicated that commercial activities were likely to have a negative impact on Social and Cultural values<sup>62</sup>, but that the extent of the impact was strongly affected by management/policy. Often participants suggested that impacts could be positive if managed successfully, by, for example, carefully monitoring water quality in and around new agricultural and/or mining developments (and stringently enforcing regulations where necessary).

### 4.3 Take-home messages

This chapter focused on the first objective: namely to improve our understanding of Social and Cultural values for different stakeholder groups.

To facilitate that, all respondents were asked to provide information about the importance of and satisfaction with, 8 'values' associated with Australia's Tropical Rivers. These values included, but were not limited to, Social and Cultural values, thus enabling one to assess the importance of Social and Cultural values RELATIVE to other values. The analysis clearly highlighted several issues:

- 1) In terms of importance, the 'top three' values identified by respondents were *Biodiversity*, *Life*, and *Bequest*.
- 2) The highest satisfaction ratings were associated with *Biodiversity*, while *Life*, *Bequest* and *Aesthetics* were equally second highest.
- 3) Many stated 'causes' of dissatisfaction related to concerns about what might happen in the future (rather than to concerns about what was happening now).
- 4) The ranking of the importance of these values (from highest to lowest) – and the associated satisfaction ratings – were relatively invariant across different stakeholder groups; although some socio-demographic, economic, and sense of place factors were found to have a minor influence on importance scores.
- 5) Insights from IPA analysis indicate that policy makers may need to focus most attention on the values associated with *Life*, *Biodiversity*, *Commercial* purposes and *Bequest* values.

---

<sup>61</sup> There is also some statistical support for that from the broader mail-out sample: researchers calculated a correlation between all importance scores for the 'values' assessed in the questionnaire. All were positive, and statistically significant, and the strongest relationship occurred between *Biodiversity* and *Bequest* (0.598).

<sup>62</sup> It should be noted that no quantitative analysis was carried out with this information.

Respondents consistently rated these as being very important, but the satisfaction ratings associated with these values were consistently lower than the importance ratings.

- 6) Insights from the Index of Dissatisfaction (IDS) analysis suggest that the highest policy priority may be *Commercial* purposes. This is not because such values were considered to be important (multiple other values are consistently rated as being more important than *Commercial* values across a broad range of stakeholders), but because the satisfaction scores associated with these values were so low. Evidently, the issue here is not necessarily one of protecting *Commercial* values, but of fixing problems associated with them. Resident concerns include, but are not limited to issues associated with: pollution, overuse, and lack of monitoring.

A subset of respondents (i.e. the interviewees) were also asked to participate in a cognitive mapping exercise – the aim being to determine the extent to which the values assessed in the survey could be viewed as complementary or competitive.

- 7) With the exception of Tourism, *Commercial* values were consistently viewed as quite separate from – and often commented as being detrimental to – these other values .
- 8) The vital qualifying statement often voiced however, was that if (commercial) values were managed properly, then they need not be detrimental, and may in fact be beneficial, to other values.
- 9) *Biodiversity, Life* and *Social/Cultural* values were viewed as being largely complementary to each other – and perhaps even inseparable, as highlighted by the following comment from one of the mail-out respondents:

*“To ask how a river changing its flow regime ... would affect your level of satisfaction is ridiculous and especially separating out biodiversity and life values – they are all interconnected values and any change on one value will affect the others.”* Burketown, QLD.

This view was strongly reinforced by an Indigenous Interviewee<sup>63</sup>:

***You cannot separate these values:***

***Water = Country = Culture = People***

---

<sup>63</sup> Which also lends strong support to the findings of Nikolakis et al. (2010) who found that Indigenous people did not separate land and water values.

## 5 WILLINGNESS TO TRADE ECONOMIC DEVELOPMENT FOR SOCIAL AND CULTURAL VALUES

### 5.1 Methodological background

Objective (2) – which seeks to learn more about the extent to which different stakeholders were willing to trade-off Social and Cultural values in exchange for economic development – focuses on the impacts of change. Simplistically, it is as if one is acknowledging that economic development may affect stream flows or water quality, thus reducing the Social and Cultural ‘values’ and thus causing the demand curve (for Social and Cultural values) to shift inwards. In this case, the objective is not just to determine whether the demand curve shifts and if values are impacted (which is essentially the focus of the next chapter), but to see if respondents could be compensated for the associated losses – i.e. to determine the monetary ‘value’ of those impacts / losses.

As noted previously, stated preference techniques are required because the values being impacted by the change (i.e. the Social and Cultural values) are not associated with the market, and there are no existing sources of data that can be used to draw inferences about those impacts. This ‘basket’ of techniques includes methods such as Contingent Valuation and Choice Modelling.

Although the number of researchers using choice experiments is rapidly increasing, the contingent valuation method (CVM) has, historically, been one of the most popular of the different SP approaches. It has been used in thousands of research studies – at least partially because of its simplicity and the economy of the data required (Navrud, 1992, Hanley and Spash, 1993, Bateman et al., 2002, Blore, 1996, Hanley and Knight, 1992) – and it is the CVM technique that was used in this study.

Questionnaire design is critical to the CVM. Researchers must design questions which allow them to elicit an individual’s willingness to pay (WTP) to avoid a loss, or willingness to accept (WTA) compensation for a loss. These are considered to be an expression of consumer preference (Ovaskainen and Kniivila, 2005). The valuation questions can be created in several ways, the most common being: the open-ended (OE); dichotomous choice (DC); and payment card (PC) approaches. Many researchers – e.g. Smith et al. (1986), Johnson et al. (1990), Kealy and Turner (1993) and Ready et al. (1995) – have found that the different question formats generate different WTP estimates.

In the OE approach, participants are simply asked how much they are willing to pay for a particular good or service (or ‘scenario’). This format has been criticised as being likely to provide unreliable estimates because people are not used to being asked to put dollar values on environmental goods or services (Reaves et al., 1999, Arrow et al., 1993). Rather, consumers are more used to facing choice situations (to buy, or not to buy). As such, some researchers have argued that the OE format is likely to misrepresent the consumers’ preferences (Halvorsen and Soelensminde, 1998, Arrow et al., 1993).

In the DC format, respondents are presented with a given amount of money and asked if they are willing to pay that amount for an environmental improvement or to accept or reject a project (Hakansson, 2008, Reaves et al., 1999). The DC question format can induce anchoring effects (Halvorsen and Soelensminde, 1998, Arrow et al., 1993) and starting point bias (Cameron and

Quiggin, 1994, Holmes and Kramer, 1995, Mitchell and Carson, 1989, Herriges and Shogren, 1996, McFadden, 1994), and empirical investigations need large samples to generate robust models (Cameron and Huppert, 1989) which can be statistically complicated (Cooper and Loomis, 1992, Johansson et al., 1989, Hanemann, 1989). But the format has been endorsed by the National Oceanic and Atmospheric Administration (NOAA) Panel (Arrow et al., 1993) and found to be superior to the OE approach (McCollum and Boyle, 2005). That said, there is evidence to suggest that the DC approach can, in some instances, over-estimate WTP variance (Boyle et al., 1996, Hanley et al., 1998), and also mean and median WTP estimates (Boyle et al., 1996, Walsh et al., 1989, Kristrom, 1997, Brown et al., 1996, Sellar et al., 1985, Welsh and Poe, 1998) – perhaps at least partially because of ‘yah-saying’ tendencies on the part of respondents.

The payment card (PC) question format gets around the problem of ‘yah-saying’ by providing respondents with an ordered range of threshold values starting at \$0. Participants are asked to circle the highest amount they are willing to pay (Campbell and Luckert, 2002, Loomis and Ekstrand, 1997), and their true valuation point is assumed to lie ‘somewhere in the interval between the circled value and the next option’ (Hakansson, 2008, pg 176). The PC approach avoids the starting point bias that can occur in traditional bidding applications (Mitchell and Carson, 1984, Mitchell and Carson, 1989) and allows participants to consider a range of possible WTP bids that represent the participants maximum WTP (Cameron and Huppert, 1991, Thunberg, 1988). As such it ‘conserves [respondent] effort because even a fairly detailed set of thresholds can be quickly scanned and there is no need for prompting by an interviewer’ (Cameron and Huppert, 1989, p. 231). Perhaps at least partially because of this, the PC approach avoids the high rate of non-response often observed in empirical DC studies. Reaves et al. (1999), for example, found that the rate of protest responses for the payment-card format was significantly lower than in a dichotomous choice format.

For these reasons, the PC approach was adopted in this study. However, researchers are cognisant of its problems:

- The range of values provided in the question (Cameron and Huppert, 1989, Campbell and Luckert, 2002, Rowe et al., 1996), anchoring effects (Arrow et al., 1993) and the interval size displayed on the card can influence responses (Cameron and Huppert, 1989). As such the range of dollar values used in CV studies should be tested before use. Here researchers used the range of dollar values that others (notably Straton and Zander, 2009) have applied successfully in similar research in the TR region – between \$0 and \$200.
- Results are sensitive to the treatment of protest votes (Reaves et al., 1999, p. 376). To deal with this issue, researchers developed two different versions of the survey: one with a ‘protest vote’ option, and one without (further details are provided below).

Three different scenarios were presented to respondents. First, they were asked to indicate how much they would be willing to pay (WTP) to prevent development that would impact upon Social and Cultural values. Then they were asked to indicate how much they would be willing to accept (WTA) as compensation if development caused damage to their Social and Cultural values. Finally they were asked how much they would be willing to pay to reduce current development, thus increasing their opportunity to enjoy Social and Cultural values. All respondents were asked to

assess the above three scenarios for three different levels of ‘impact’ on their Social and Cultural values:

- a 25 per cent decrease / increase in opportunities to enjoy rivers for Social and Cultural purposes;
- a 50 per cent decrease / increase in opportunities to enjoy rivers for Social and Cultural purposes; and
- a 100 per cent decrease / increase in opportunities to enjoy rivers for Social and Cultural purposes.

An excerpt from the survey that is relevant to the first scenario (and which did NOT provide a formal ‘protest’ option) is provided below:

Imagine there was going to be a new development UPSTREAM from where you live. The development would not make you or your family richer, and would not provide you or your family with more work. But it would reduce your opportunity to enjoy the ‘feel good’ things (social and cultural values) associated with your local rivers and water holes (e.g. there would be fewer opportunities to go fishing, to picnic or to see the river). Suppose that you could STOP the development from going ahead by making a financial payment. Payments would need to be made each and every year to ensure the development never occurred – you could ask for the money to be deducted from your wages, or pay it as a fee once a year. In total, how much would your entire household (i.e. you and all other members of your household) be willing to pay each year to prevent the development in each of the following situations?

	I agree with the development: so I would pay nothing	I do not agree with the development, I would pay:					
		Less than \$25	\$25	\$50	\$100	\$200	More than \$200
If the development reduced your ‘feel good’ opportunities by about ¼ (e.g. you could only enjoy the river 3 times a year instead of 4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
If the development reduced your ‘feel good’ opportunities by about ½ (e.g. you could only enjoy the river 2 times a year instead of 4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
If the development stopped your ‘feel good’ opportunities altogether (e.g. you could never go to enjoy the river)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

If you ticked ‘less than \$25’ or ‘more than \$200’, please tell us how much you are willing to pay \$ \_\_\_\_\_

Figure 29 – Sample willingness to pay survey question

The other version of the survey, contained exactly the same scenario description, but the table below the scenario included an extra column (at the far right) that facilitated a formal ‘protest’ vote. It was officially labelled as:

*Nothing: I do not agree with the development but I think it is wrong to ask people to pay to stop it*

The other two scenarios that were presented to respondents (with and without formal protest options) were as follows:

1. Imagine there was going to be a new development UPSTREAM from where you live. The development would increase your household’s income but it would also reduce your opportunity to enjoy the ‘feel good’ things (Social and Cultural values) associated with your local rivers and water holes (e.g. there would be fewer opportunities to go fishing, to picnic or to see the river). In total, how much extra (after tax) income would your entire household (i.e. you and all other members of your household) need to receive each year to compensate for the loss of opportunities in each of the following situations?
2. Imagine there was an opportunity to reduce economic activity UPSTREAM from where you live. This would increase your opportunity to enjoy the ‘feel good’ things (Social and Cultural values) associated with your local rivers and water holes (e.g. there would be more opportunities to go fishing, to picnic or to see the river) but it would also decrease your household’s income each and every year. How much of a reduction in annual (after tax) household income would you be

willing to accept to ensure that you really did have more opportunities to enjoy the ‘feel good’ things in each of the following situations?

## 5.2 Results and analysis

### 5.2.1 A preliminary look at results

In the first instance, researchers looked at the entire data set, and then also divided data according to whether respondents had been given the option to formally protest or not. The distribution of responses to each scenario question is presented in Figure 30.

Here, several observations can be made:

- Fewer than 33 per cent of respondents indicated that they approved of the first two development scenarios presented – even when the impact on Social and Cultural values was relatively small. When given an option to formally protest, the proportion of respondents approving each development scenario was much less (generally about half that of the group that were not given a protest option). More will be said about this important point later.
- More than 50 per cent of respondents indicated that they would be willing to accept a DECLINE in income (associated with a reduction in economic activity), if it was associated with improved opportunities to enjoy their Social and Cultural values.
- The greater the impact of development change on Social and Cultural values, the more respondents would be WTP to avoid it (or WTA as compensation) – and these differences are statistically significant.

Those comments aside, what is perhaps most evident is the marked difference between the distribution of responses for the charts in the top row, and those in the bottom row. As expected, providing respondents with the option to ‘protest’ (rather than being forced to answer, or skip the question altogether) has a marked impact upon results. Researchers therefore conducted a series of statistical tests to determine whether those who received a questionnaire that had a formal ‘protest’ option were more or less likely to:

- a) complete the entire questionnaire (and return it);
- b) complete the relevant questions; and/or
- c) answer the question differently than those who were sent a questionnaire without a protest option.

Detailed results are presented and discussed in Appendix F, the main findings being that:

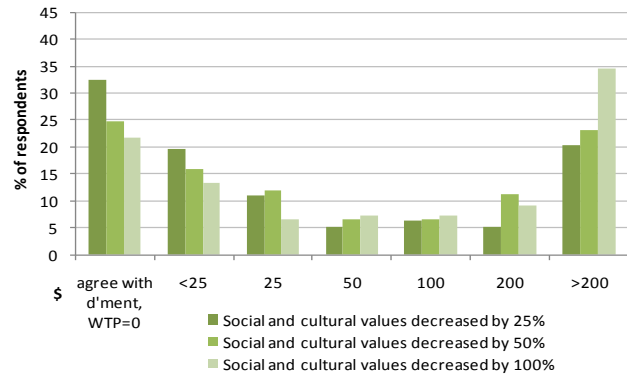
- a) the protest/no protest option did not affect overall questionnaire response rates;
- b) those who were NOT given a formal protest option were much more likely to skip the WTP/WTA questions than others; and
- c) ignoring the protest votes, there was no statistically significant difference in the distribution of responses across dollar categories between the protest / no protest questionnaires.

Evidently, giving people a protest option reduced the total number of dollar responses. But it did not alter the ‘pattern’ of responses amongst those who chose to answer the scenario question. From this point onwards, we have, therefore, grouped results from both sets of questionnaires together – although we exclude interview data (since analysis suggests that interview bias is a significant factor here – see Appendix G).

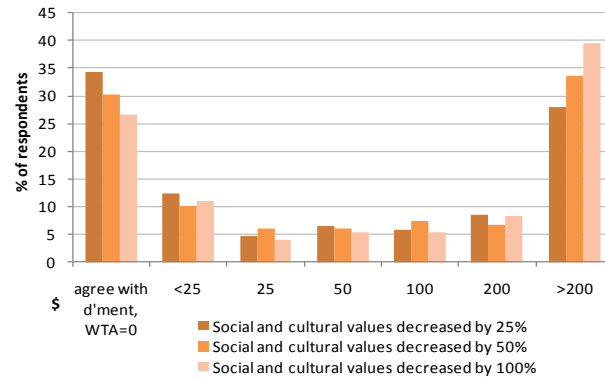


All responses combined (with protest votes treated as missing values)

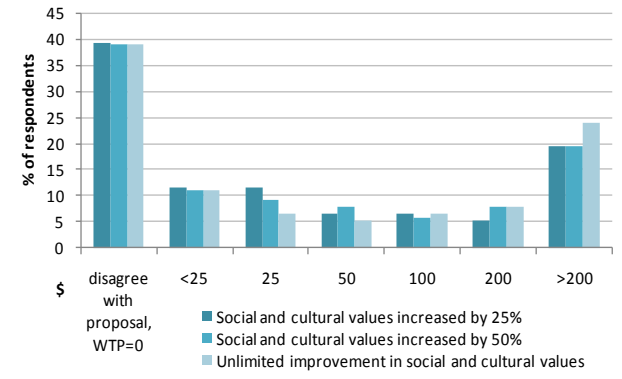
Willingness to pay to avoid a development which would reduce Social and Cultural values but would not provide any extra income



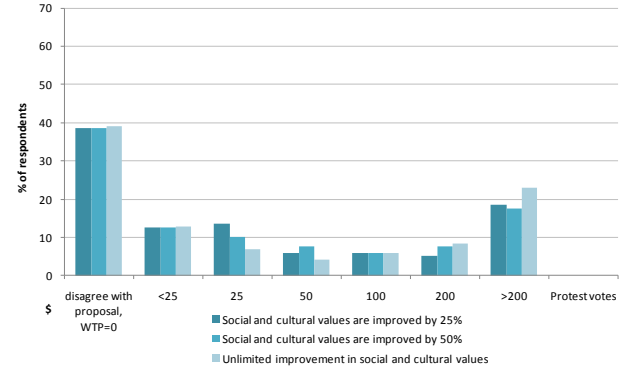
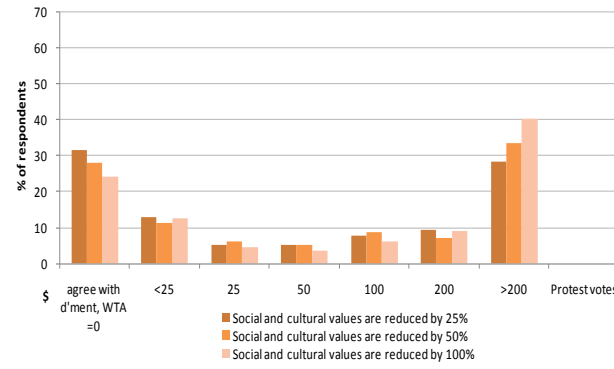
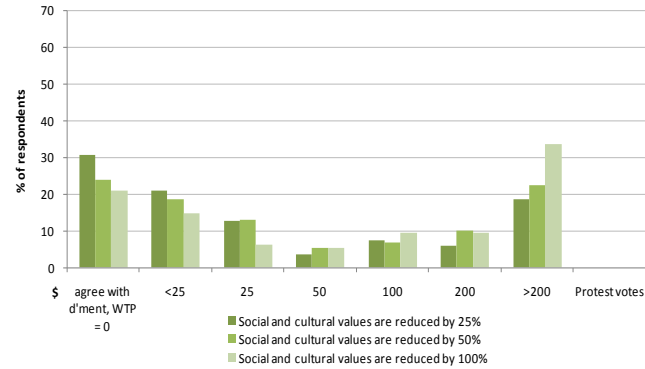
Willingness to accept compensation from development which reduces Social and Cultural values



Willingness to pay to reduce development, thus providing more opportunity to enjoy Social and Cultural values



Does not include protest vote



Includes protest vote

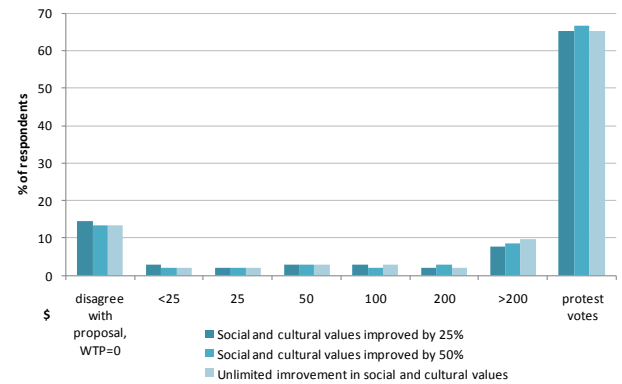
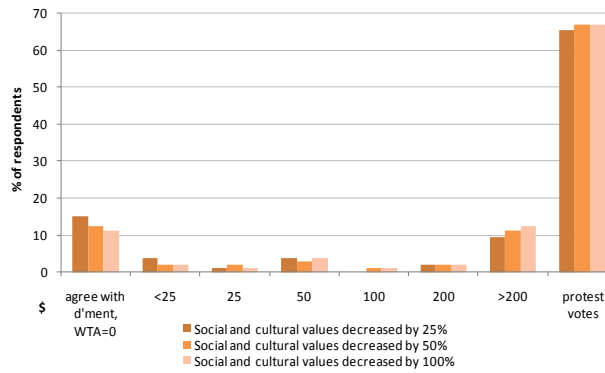
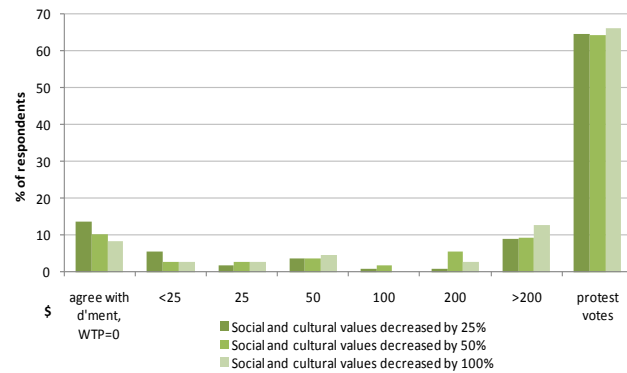


Figure 30 – Responses to the development scenarios

## 5.2.2 Converting categories to dollar values

In order to conduct a more sophisticated analysis of results, researchers converted the categorical responses into dollar values, as detailed below:

**Table 14 – Values assigned to categorical responses to WTP/WTA questions**

Category	Value assigned
1 = I do (or do not) agree with this idea and would not be prepared to pay to prevent it (or to accept compensation if it went ahead)	0
2 = less than \$25	\$12.50, unless respondent recorded specific amount
3 = \$25	\$ 25
4 = \$50	\$50
5 = \$100	\$100
6 = \$200	\$200
7 = more than \$200	\$201, unless respondent recorded specific amount
8 = Nothing: I think it is wrong	Omitted from analysis

Table 15 presents some descriptive statistics, highlighting the fact that mean values are significantly higher than median values. This is largely because of the very high maximum values recorded.

**Table 15 – Descriptive statistics for WTP/WTA question – ‘raw’ data**

	Mean	Median	Valid N	Standard Deviation	Maximum
<b>Scenario 1 (WTP)</b>					
- 25 per cent reduction	5911	15	173	76 020	1 000 000
- 50 per cent reduction	6071	25	169	76 912	1 000 000
- 100 per cent reduction	6256	100	165	77 836	1 000 000
<b>Scenario 2 (WTA)</b>					
- 25 per cent reduction	26 281	25	154	159 531	1 000 000
- 50 per cent reduction	27 216	50	149	162 121	1 000 000
- 100 per cent reduction	27 723	100	147	163 181	1 000 000
<b>Scenario 3 (WTP)</b>					
- 25 per cent increase	6802	20	155	80 323	1 000 000
- 50 per cent increase	6851	23	154	80 583	1 000 000
- 100 per cent increase	6866	23	154	80 582	1 000 000

Moreover, there is evidence to suggest that those who were not given a formal protest option may have ‘protested’ by providing unrealistic responses to the OPEN ENDED PART of the WTP/WTA questions. This is most evident in Figure 31 which shows mean responses to the WTP/WTA scenarios across the two different types of questionnaires (see also the discussion in Appendix F). Evidently, it is only valid to combine responses to the two different types of questionnaires, if one controls for the excessive ‘outlier’ problem created by the desire of respondents to protest.

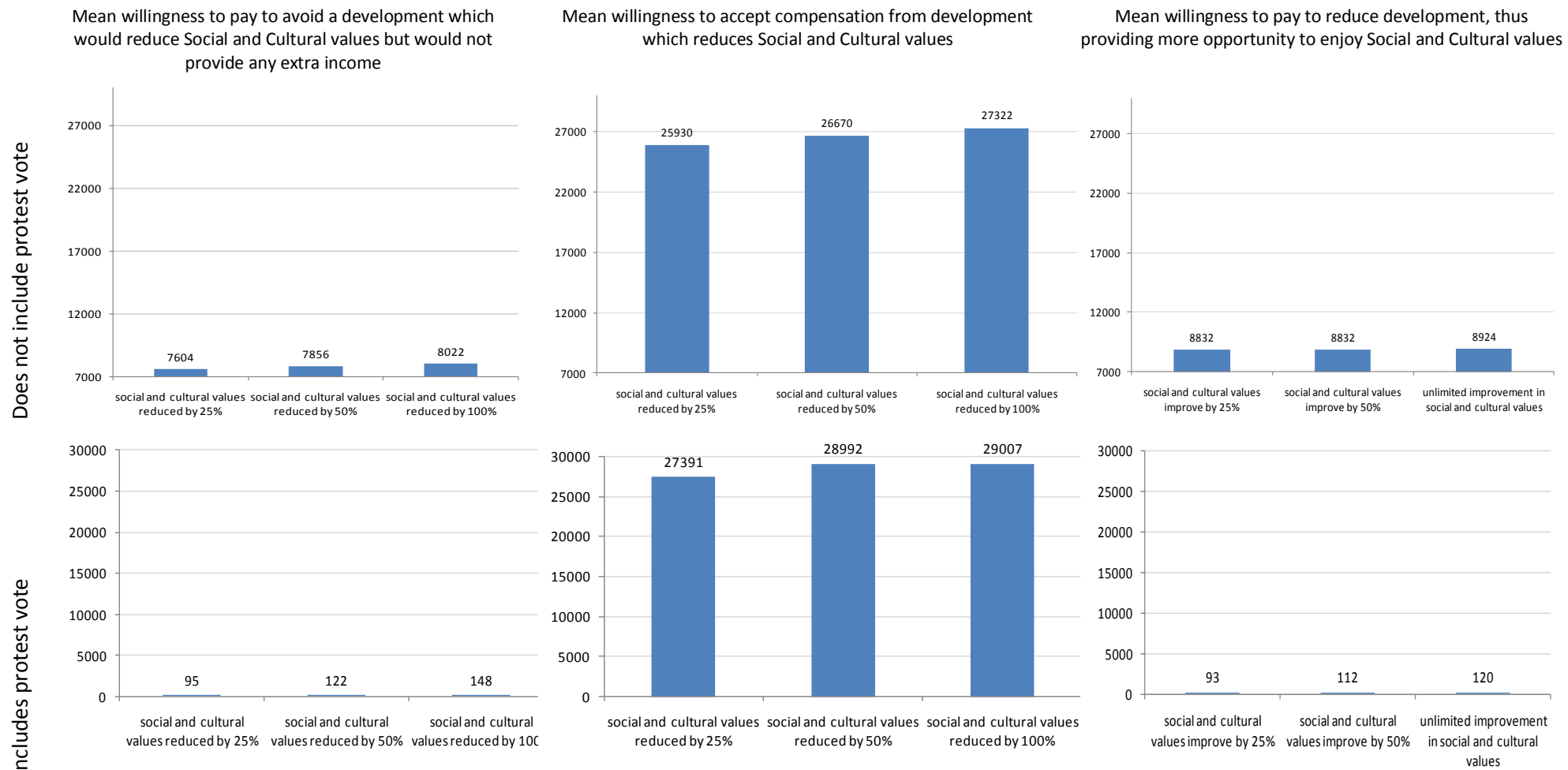


Figure 31 – Mean WTP/WTA for protest versus no-protest versions of the questionnaire

Researchers therefore used SPSS’s inbuilt procedure to identify ‘outliers’ (specifically, the five largest values across the 291 questionnaires). In all cases, these exceeded \$750 (see Table 16).

**Table 16 – Top five amounts nominated as WTP/A for each scenario**

Scenario 1 (WTP)		Scenario 2 (WTA)		Scenario 3 (WTP)	
amount	frequency	amount	frequency	amount	frequency
1 000 000	1	1 000 000	4	1 000 000	1
5 000	1	20 000	1	25 000	1
1 300	1	10 000	2	10 000	1
1 000	5	5 000	2	5 000	1
750	1	2 500	1	1 000	4

These ‘outliers’ (i.e. questionnaires with a WTP/A vote that exceeded \$750) were excluded from the subsequent multivariate analysis.

Before presenting these results, however, it is important to note that excluding the outliers facilitates further analysis of the data (which allows researchers to look for ‘patterns’ across the remaining group of respondents). But it hides the fact that there is a small group of people who are vehemently opposed to ANY type of development that affects their Social and Cultural values – as starkly evidenced by the very high maximum values given above, and by the numerous comments along the following lines:

**Table 17 – Comments provided about WTP/A survey questions**

Type of comment	Number of times this type of comment was made
Criticism of philosophical approach to research – e.g. of desire to measure social, cultural or environmental values using dollars	4
Flat out refusal to accept any type of compensation; would move away if damage done	11
Can’t answer without more info about type of development	2

It is also exemplified by specific comments like those below:

*“I could not accept any compensation as this implies that my acceptance of the situation can be bought. If the development affected me that much I would move away.”* Jabiru, NT

*“I am sure that my household would not compromise its values to increase its income through a development that we did not agree with. We only have one go at protecting our waterways. We already destroyed waterways and land with plants/weeds we know do nothing for our environment. Our main priority should be*

*to keep our waterways flowing, free from weeds and commercial extractions.”*  
Biboorha, Qld

*“If it made me a millionaire I would still rather have the river.”* Dimbulah, Qld  
(interview)

*“Priceless. How can money ever cover the beauty of nature? I can’t see the correlation between income / dollars and ecology! ...”* Darwin, NT

### 5.2.3 Using dollars (WTP/A) to assess tradeoffs between development and Social/Cultural values

As discussed in section 2.3.2, one of the problems with using dollar-denominated valuation techniques, is that they do not solely capture tastes and preferences: WTP is, necessarily, a function of ability to pay.

To test for this, researchers divided their data set into three groups representing respondents living in households with low, middle, and high incomes. As starkly evidenced in Table 18 mean responses to each WTP/WTA scenario are strongly dependent upon income, and these differences are statistically significant.

Table 18 – WTP/A by household income brackets

Change in ‘feel good’ factors	Household income			All respondents combined
	< \$20,000	\$20,000 – \$100,000	> \$100,000 (reference)	
Scenario 1 (WTP)				
- 25% reduction	\$19.44 <sup>+++</sup>	\$76.68 <sup>+</sup>	\$116.09	\$77.64
- 50% reduction	\$29.17 <sup>+++</sup>	\$94.11 <sup>+</sup>	\$139.40	\$95.33
- 100% reduction	\$40.28 <sup>+++</sup>	\$131.09 <sup>+</sup>	\$185.16	\$130.52
Scenario 2 (WTA)				
- 25% reduction	\$55.67	\$61.05 <sup>+</sup>	\$99.31	\$70.12
- 50% reduction	\$55.67 <sup>+</sup>	\$79.92 <sup>+</sup>	\$116.62	\$85.15
- 100% reduction	\$61.92 <sup>++</sup>	\$94.35 <sup>++</sup>	\$146.98	\$102.27
Scenario 3 (WTP)				
- 25% increase	\$17.63 <sup>++</sup>	\$72.21	\$69.10	\$62.58
- 50% increase	\$20.26 <sup>++</sup>	\$67.57	\$90.14	\$87.34
- 100% increase	\$25.53 <sup>++</sup>	\$79.31	\$105.31	\$77.02

<sup>+++</sup> Statistically significantly lower than reference category at 1 per cent, <sup>++</sup> at 5 per cent, <sup>+</sup> at 10 per cent;

In contrast, Table 19 presents WTP/WTA responses as a percent of household income. Here it is evident that low income earners are willing to sacrifice a much larger percentage of their income to maintain their Social and Cultural values than are those on high incomes.

This is a particularly important finding for policy makers who are working in regions where there are a large number of ‘poor’ people: poorer residents are WTP less to protect their values because they are ABLE to pay less – but the strength of their opposition to development that erodes Social and Cultural values (captured here, by measuring WTP as a percent of income) may be more intense than that of wealthier residents.

Table 19 – WTP/A as a per cent of income by household income brackets

Change in ‘feel good’ factors	Household income			All Respondents combined
	< \$20,000	\$20,000 – \$100,000	> \$100,000 (reference)	
<b>Scenario 1 (WTP)</b>				
- 25% reduction	0.19**	0.14	0.08	0.13
- 50% reduction	0.29**	0.17*	0.10	0.17
- 100% reduction	0.40**	0.22**	0.13	0.23
<b>Scenario 2 (WTA)</b>				
- 25% reduction	0.56***	0.13*	0.07	0.19
- 50% reduction	0.56***	0.17*	0.08	0.22
- 100% reduction	0.62***	0.19*	0.10	0.24
<b>Scenario 3 (WTP)</b>				
- 25% increase	0.18**	0.12**	0.05	0.11
- 50% increase	0.20**	0.12*	0.06	0.12
- 100% increase	0.26**	0.13*	0.08	0.14

\*\*\* Statistically significantly higher than reference category at 1per cent, \*\* at 5per cent, \* at 10per cent.

Before moving on to the next section, we also note three other interesting findings.

- 1) Willingness to accept compensation for deterioration is higher than willingness to pay to prevent it from occurring – compare scenario 1 to scenario 2 (for all respondents combined, and for the lower income groups). Respondents would expect more money as compensation in the event of damage that occurs without them being given a ‘say’ about whether or not a development goes ahead (as per scenario 2), then they would be willing to pay to prevent a development from occurring. This suggests that it is in the interests of policy makers to discuss (and, where feasible, negotiate) development options with affected parties BEFORE development occurs. Compensation<sup>64</sup> after the event could prove much more costly.
- 2) Willingness to pay to prevent deterioration is higher than willingness to pay to realise improvement – compare scenario 1 to scenario 3. This may be at least partially due to the fact that many respondents lived near rivers that are in relative good condition. As such, asking about WTP to ‘improve’ the river is not particularly meaningful. If it is in good condition already, why pay to make it better?

<sup>64</sup> Where property rights dictate such an entitlement.

- 3) Willingness to pay and willingness to accept is decreasing incrementally – see Figure 32<sup>65</sup>. That is, WTP/A for initial damage/improvement is higher than WTP/A for successive damage/improvement. It is the first/initial change that has the greatest impact.

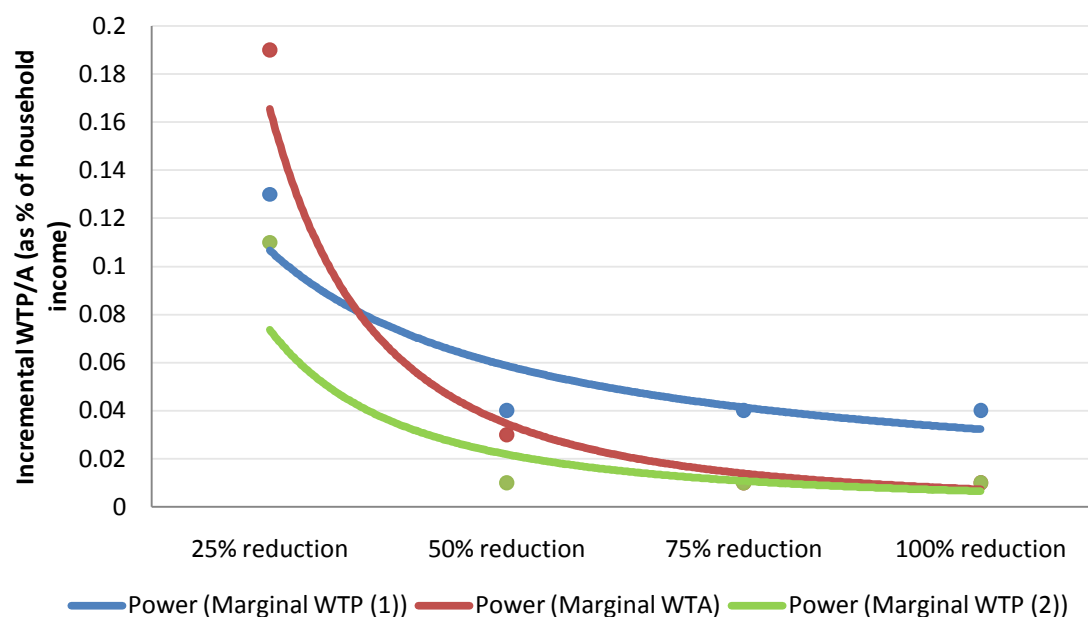


Figure 32 – Willingness to accept incremental damage to Social and Cultural values

#### 5.2.4 Factors Influencing WTP/A

Researchers sought to determine which – if any – of the variables listed in Table 6 were associated with high/low WTP/WTA. In the first instance researchers conducted a bivariate analysis to reveal links between WTP/A and separate demographic and environmental characteristics to obtain some sense of what characteristics impact on WTP/A (see Appendix H). Researchers then conducted a multivariate analysis to determine which of the demographic and environmental characteristics that had been identified in the preliminary bivariate analysis were the most important determinants of differences in WTP/A.

The key difference between this analysis and that of the preceding chapter however, is that here, two extra variables, intended to capture the relative importance of *Commercial* and *Biodiversity* ‘values’ were also included. The underlying hypothesis being that if people feel as if some values were more important than others, then they may be WTP more to protect them.

As discussed in chapter 4, respondents were asked to indicate how important they thought rivers were for four very broad categories of values, namely: *Biodiversity*, *Commercial* purposes, *Life*, and *Social and Cultural* values (although, this latter category was broken up into six sub-categories). But clearly some respondents were more likely to assign high importance scores to all values than others (the ‘yah-sayers’). So raw scores cannot necessarily be relied upon to reflect underlying ‘values’ or preferences – rather, it is the importance which an individual assigns to a particular value relative to

<sup>65</sup> We do not have separate information for the third and fourth increment, but only the sum of both increments. For convenience we split the sum halfway for both increments. The lines are trend lines that best fit the data (dot points).

the importance he/she assigns to other values that captures preferences. As such, researchers used measures of ‘relative’ importance in the analysis (e.g. the relative importance of *Biodiversity* was measured by dividing the importance score assigned to *Biodiversity* by the sum of importance allocated to all four (broad) categories of values<sup>66</sup>).

As is evident from the discussion in section 5.2.3, there are two ways one can present responses to the WTP/A questions, one can use:

- WTP/A expressed in dollar terms as the independent variable and include household income as a dependent variable in the regression; or
- WTP/A as a percentage (or proportion) of household income as the independent variable.

Both approaches allow one to consider the impact which income has upon expressed WTP/A. When using the latter approach, however, it is also possible to include income as an independent variable, thus testing to see if WTP as a per cent of income is relatively constant across all respondents, or if it too, varies across different income categories<sup>67</sup>.

Appendix I provides full details of the analysis, with results summarised in Table 20, allowing the following observations.

1) Relatively few variables are strongly associated with WTP/A. There are, however, a few important exceptions:

- Income is, almost always, a statistically significant determinant of WTP
  - Wealthy people are WTP more than poor people in absolute dollar terms, but
  - Wealthy people are WTP less than poor people as a per cent of their income.
- The importance which people place on *Biodiversity* is, almost always, a positive, and statistically significant determinant of their WTP to protect Social and Cultural values.
- In contrast, those who place a relatively high value on the *Commercial* uses of rivers are generally WTP less to protect Social and Cultural values than others.

2) Other variables which deserve comment include:

- Gender: Most studies include only gender, and find that women are WTP more for environmental goods and services than men. Here, we are analysing WTP for Social and Cultural values, while controlling for values associated with *Biodiversity*. This analysis thus indicates that if a male and a female both consider *Biodiversity* to be equally important, then the male is likely to be WTP more to also protect *Social and Cultural* values than the female.
- Education: This is an important predictor of WTP/A when it is measured in absolute dollars, but is not an important predictor when looking at WTP as a per cent of income. This is, no

---

<sup>66</sup> When determining an overall importance score for social and cultural values, we used the highest importance score assigned to one of the six sub-categories.

<sup>67</sup> More formally, the two different approaches can be represented mathematically as

$$\begin{aligned}
 1) \quad & WTP = a + bX + cY, \text{ with } \partial WTP / \partial Y = c \\
 2) \quad & WTP/Y = d + eX + cY, \text{ with } \frac{\partial WTP}{\partial X} = (d + eX) + 2cY
 \end{aligned}$$

Where: Y represents income, and X represents ‘other’ determinants of WTP



doubt, due to the fact that education and income are highly correlated, and because the marginal effect on WTP of increases in income is not constant (see footnote 67). When WTP as a per cent of income is used as the regressand, this non-constant effect is accounted for, but not when using WTP by itself (in that case education is forced into ‘capturing’ some of the diminishing marginal impact of income – hence the counter-intuitive negative relationship).

Finally, we observe that the fit (i.e. predictive power) of the regressions (for both approaches):

- increases with the severity of the intervention (i.e. a 25 per cent, 50 per cent, or 100 per cent change in Social and Cultural values). This does not come as a surprise. Though marginal WTP/A is decreasing, it is not negative;
- is considerably lower for the final scenario, which may reflect respondents’ ‘tiredness’ with the WTP/A assignment in the questionnaire or complexity of that specific scenario.

**Table 20 – Factors influencing WTP/A**

<b>Scenario, and subsequent impact on Social and Cultural values</b>	<b>Significant determinants of WTP/A when measured as a percent of income<sup>68</sup></b>	<b>Significant determinants of WTP/A when measured a simple \$ value:</b>
<b>Scenario 1 (WTP)</b>		
- 25per cent reduction	↓ Education ↑ Importance placed on Biodiversity	↑ Income ↑ Importance placed on Biodiversity ↓ Importance placed on Commercial Values
- 50per cent reduction	↓ Education ↓ Income ↑ Importance placed on Biodiversity	↑ Income ↑ Importance placed on Biodiversity
- 100per cent reduction	↑ Males ↓ Education ↓ Income ↑ Importance placed on Biodiversity	↑ Income ↑ Males ↑ Importance placed on Biodiversity
<b>Scenario 2 (WTA)</b>		
- 25per cent reduction	↓ Income ↑ Importance placed on Biodiversity	↑ Importance placed on Biodiversity ↓ Importance placed on Commercial Values
- 50per cent reduction	↓ Income ↑ Importance placed on Biodiversity	↑ Importance placed on Biodiversity ↓ Importance placed on Commercial Values ↑ Males ↑ Live near perennial river
- 100per cent reduction	↓ Income ↑ Importance placed on Biodiversity	↑ Importance placed on Biodiversity ↓ Importance placed on Commercial Values ↑ Income ↑ Males ↑ Live near perennial river
<b>Scenario 3 (WTP)</b>		
- 25per cent reduction	↓ Income	
- 50per cent reduction	↓ Income ↓ Education ↑ Importance placed on Biodiversity	↑ Income
- 100per cent reduction	↓ Income ↓ Education ↑ Importance placed on Biodiversity	↑ Importance placed on Biodiversity ↑ Income

<sup>68</sup> When using WTP/A as a percentage of household income, it is important to note that the dependent variable in the multivariate analysis is not a continuous variable, nor is it a binary variable. Rather, it is bounded between zero and 100. As such, use of ordinary least squares regression is inappropriate, so researchers used generalised linear modelling techniques – see Papke and Wooldridge (1996). A simple logit transformation would not have been appropriate, as it would have discarded all respondents who reported zero WTP/A, which in our case is not an extreme outcome of the distribution function, but a deliberate choice option.

### 5.3 Take-home messages

This chapter focused on the project's second objective: namely to investigate the extent to which people are willing to trade their Social and Cultural values for economic development (and vice versa).

It used the contingent valuation method, presenting respondents with a series of (hypothetical) development 'scenarios'. First, they were asked to indicate how much they would be willing to pay (WTP) to prevent development that would impact upon Social and Cultural values. Then they were asked to indicate how much they would be willing to accept (WTA) as compensation if development caused damage to their Social and Cultural values. Finally they were asked how much they would be willing to pay to reduce current development, thus increasing their opportunity to enjoy Social and Cultural values.

- 1) A large proportion of respondents were strongly opposed to the development scenarios, evidenced by the fact that:
  - fewer than 33 per cent of respondents indicated that they approved of the first two development scenarios presented – even when the impact on Social and Cultural values was relatively small;
  - more than 50 per cent of respondents indicated that they would be willing to accept a DECLINE in income (associated with a reduction in economic activity), if it was associated with improved opportunities to enjoy their Social and Cultural values;
  - a relatively large percentage of respondents refused to consider any trade-off at all<sup>69</sup>, and/or noted that they have already spent thousands of dollars fighting development proposals in and around 'their' rivers; and
  - of the group that agreed to 'play the trade-off game', people were WTP significant sums of money to avoid damage to or to 'repair' damage to their Social and Cultural values with maximum values cited in the survey of \$1 million and many values in excess of \$10,000 (Table 16). These maximum values generated highly skewed distributions with mean WTP/A ranging between almost \$6000 per annum per household, to almost \$28,000; median values were much more modest (between \$15 and \$100).

This strongly negative reaction to the development scenarios is not altogether surprising given the analysis of section 4.2.1.3 which highlighted the relative unimportance of *Commercial* values (compared to *Biodiversity* and *Bequest* values). Evidently, planners should expect - and be prepared for - this type of reaction in many of the north's Tropical Rivers.

- 2) When outliers were excluded, researchers found that:
  - WTP was strongly linked to ability to pay, but the 'poor' are willing to sacrifice a much higher proportion of their income to protect their rivers than the rich.
  - The importance which people place on *Biodiversity* is, almost always, a positive and statistically significant determinant of their WTP to protect Social and Cultural values. This clearly reinforces earlier observations from the cognitive mapping exercises done by interviewees about the complementarity of these two values.

---

<sup>69</sup> When given the opportunity to protest, 66 per cent of respondents chose to do so. When not given this option, 5-11 per cent (WTP/WTA respectively) nominated an amount greater than \$750.

- In contrast, those who place a relatively high value on the *Commercial* uses of rivers are WTP less to protect Social and Cultural values than are others.

It seems that those most willing to accept trade-offs include the wealthy, and those who place highest values on *Commercial* uses of rivers; those who place a high value on *Biodiversity* (a very large per cent of population) and/or those who are relatively poor seem to be much less willing to trade their Social and Cultural values for greater income flows.

## 6 HOW MUCH COULD STREAM FLOW OR WATER QUALITY CHANGE BEFORE HAVING A SIGNIFICANT IMPACT ON SOCIAL AND CULTURAL VALUES?

### 6.1 Methodological background

As noted in section 1, one of the key aims of this project was to determine the extent to which stream flow and/or water quality could change before having a 'significant' impact on Social and Cultural values.

In an ideal situation, researchers would investigate such a problem by collecting data relating to Social and Cultural values before and after a change occurs, measuring how that change impacted values. But a proper analysis using an approach such as that, would require a vast quantity of data (collected over, at minimum, several decades, and multiple regions) – due to the need to control for a multiplicity of confounding factors, not the least of which is related to the extreme variability of stream flows evident during 'normal' situations in this part of the world. Such data were not available in this instance. Consequently, researchers used insights from the non-market valuation literature to develop a series of questions testing the likely reaction of respondents to a series of (hypothetical) scenarios in which stream-flows and water quality changed. Whilst not ideal, this type of data is better than the alternative of no data at all.

Survey design is crucial when using ANY stated preference approach (not just the CVM used for objective 2). When asking people about how they would respond to a particular change, for example, it is important to first establish what the current system looks like - someone who lives next to a perennial river is likely to respond quite differently to a scenario that suggests the river stops flowing for 1-2 months per year, than someone who lives next to a river that is currently dry for most of the year (the first person will view the change as making their river drier, the second will view it as making their river wetter). Moreover, the more complex the scenario, the more cognitively difficult it becomes for respondents to understand the changes suggested and to provide clear answers.

After trialling a few 'scenarios' in the focus groups, researchers decided to have two separate sections of the questionnaire devoted to this problem: the first seeking to assess the likely impact of changes in stream flow; the second focusing on the impact of changes in water quality.

The part of the survey that sought to determine the extent to which stream flows could change before having a 'significant' impact on Social and Cultural values, started by asking respondents to tell researchers about the river they lived near, using three commonly observed 'types of rivers' characterised by Kennard et al. (2010):

- the river flows all year round, but with much more water in it during the wet than during the dry (hereon referred to as 'perennial and seasonal');
- the river stops flowing for 3-6 months each year, with regular big flows (or floods) in the wet season (hereon referred to as 'dry for 3-6 months'); and
- the river stops flowing for more than 8 months each year, with infrequent floods (hereon referred to as 'dry for more than 8 months').

After having established the CURRENT state of each respondent’s river, they were then asked to indicate (on a 5 point Likert scale) how their Social and Cultural values might be affected by a change in stream flows from that state, to another. Five changes were presented in addition to the current state (giving 6 conditions in total); an example of one of the relevant survey questions (pertinent to those living near a perennial river) is given below:

<input type="checkbox"/> The river I live near flows all year round, but there is much more water in it during the wet than during the dry									
<i>Now imagine that there were changes to 'your' river. For each type of change (described below), please tell us how those changes would affect your overall satisfaction with the social and cultural values listed in question 18 (ignoring how this would affect 'commercial', 'biodiversity' or 'life' values)</i>									
	☺ I would be much more satisfied		It would not really affect me			☹ I would be much less satisfied		I'm not sure	
The river flows all year round, but with about the same amount of water in it all year	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The river stopped flowing for 1 - 2 months each year, with regular big flows (or floods) in the wet season	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The river stopped flowing for 3 - 6 months each year, with regular big flows (or floods) in the wet season	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The river stopped flowing for more than 8 months each year, with infrequent floods coming at any time of the year	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The water levels in the river go up and down markedly without warning during the dry season	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NOW GO TO QUESTION 21 ON PAGE 7									

Figure 33 – Sample survey question to determine response to changed stream flow

The first group of scenarios were deemed to represent a continuum of changes to stream flow (from perennial through to dry for long periods of time). The last two change scenarios (‘perennial and constant’ and ‘perennial and fluctuating’) were included to represent possible situations that could arise if a dam were constructed, and if this meant that flow could be regulated in either a constant or unpredictable fashion (although this was not explicitly stated in the questionnaire to avoid biased responses).

Before continuing it is worth noting that the objective to which this question relates, seeks to determine *how much stream flows can change before having a significant impact on Social and Cultural values*. However there is no unambiguously ‘correct’ way of determining what does, or does not, constitute a ‘significant’ impact. In this instance, researchers decided to declare an impact as ‘significant’ if more than 50 per cent of respondents indicated that they would be dissatisfied (the two right hand boxes, excluding the ‘I’m not sure’ category). More detailed data is presented, should readers decide that an alternative interpretation of responses more adequately captures the meaning of ‘significant’.

It was a little more challenging to construct relevant questions for the water quality part of the survey. This is because, unlike stream flows, which most people are able to comment on if they are able to see a river, there are many water quality issues which cannot be identified without conducting (sometimes quite complex) tests. As such, many people are not able to determine the quality of the water in their local rivers by simply looking at them. This makes it exceedingly difficult to construct a survey that is capable of measuring the impact of hypothetical changes in water quality on Social and Cultural values.

After consulting several water quality experts in Northern Australia, researchers decided to focus on just two indicators of water quality, namely turbidity and algal content. These were selected because they are visually obvious and thus easily identifiable by respondents. Simply put, excess sediment can reduce the clarity of water, which impacts on aquatic plant growth. This, in turn, can lead to de-oxygenation, while algal blooms could be the cause of excess nutrients and eutrophication (Harris, 2001, as cited in Straton and Zander, 2009, Douglas et al., 2005). There are numerous other water

quality problems (e.g. the presence of chemicals) which affect water quality however it is rarely (if ever) possible for a layman to detect these problems by simply ‘looking’ at their river. As such, they were not assessed in this survey. Moreover, some problems are visually evident (e.g. ‘fish kills’), but may not have a unique causal factor (e.g. fish kills may occur for a range of reasons including some which are unrelated to water quality, such as a sudden drop in temperature). Consequently, these types of problems were also excluded from the survey.

As previously, when asking people about how they would respond to changes in water quality, it was important to firstly establish the characteristics of the existing system. Respondents were thus asked to begin this section of the survey by completing the following question:

21. This question is about the quality of water in the river and waterhole(s) near you. Below are a series of statement that describe different rivers. Please select the one which best describes the river near you.
- The river and/or water holes I live near are generally clear throughout the dry season, with little or no algae, and just the ‘right amount’ of water plants
  - The river and/or water holes I live near are often murky for half of the dry season, but there is no algae, and just the ‘right amount’ of water plants
  - The river and/or water holes I live near are murky for most of the dry season, but there is no algae, and just the ‘right amount’ of water plants
  - The river and/or water holes I live near are clear during the dry season, but there is some algae on the river bed or banks, and just the ‘right amount’ of water plants
  - The river and/or water holes I live near are clear during the dry season, but algae is present throughout the dry season and water plants choke the river and water holes

Figure 34 – Sample survey question to determine current water quality

Having answered that question, respondents were then asked to tell us about the way in which ‘changes’ to water quality of their river would impact upon their Social and Cultural values. An example of one of the relevant survey questions is given below:

<input type="checkbox"/>	The river and/or water holes I live near are generally clear throughout the dry season, with little or no algae, and just the ‘right amount’ of water plants									
<p><i>Now imagine that there were changes to ‘your’ river. For each type of change (described below), please tell us how those changes would affect your overall satisfaction with the social and cultural values listed in question 18 (ignoring how this would affect ‘commercial’, ‘biodiversity’ or ‘life’ values)</i></p>										
	The river became murky for half of the dry season	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	The river became murky throughout the dry season	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Some algae started to form on the river beds or banks during the dry season	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Algae became present throughout the dry season and water plants choked the river and water holes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NOW GO TO QUESTION 22 ON PAGE 9										

Figure 35 – Sample survey question to determine response to changed water quality

Here too, ‘significant’ impacts were deemed to be those where more than 50 per cent of respondents indicated that they would be dissatisfied (by ticking either of the two right hand boxes, excluding the ‘I’m not sure’ category).

## 6.2 Results and analysis

### 6.2.1 Reactions to changes to stream flow

As is apparent from Table 21 (below), the majority of respondents lived near rivers that were perennial and seasonal (n=205). Forty six respondents lived near rivers that were dry for 3-6 months each year, and 28 lived in areas where the river is dry for more than 8 months each year.

Table 21 – Number of respondents living near rivers with different flow characteristics

	Mail-out respondents			Interviewees		
	Non-Indigenous	Indigenous	Total	Non-Indigenous	Indigenous	Total
Perennial and Seasonal	164	9	173	19	13	32
Dry 3-6 months	41	0	41	1	4	5
Dry >8 months	28	0	28	0	0	0

Since it only makes sense to consider responses to questions about the way in which people are likely to react to changed stream flow in the context of their current flows, data were divided, and results are presented separately.

**6.2.1.1 Responses to changed stream flow when current state is perennial and seasonal**

In the first instance, researchers simply counted the number of times an individual ticked a particular ‘box’ when asked about changed stream flow (i.e. the number saying they would be much less satisfied, the number saying they would be somewhat less satisfied, etc).

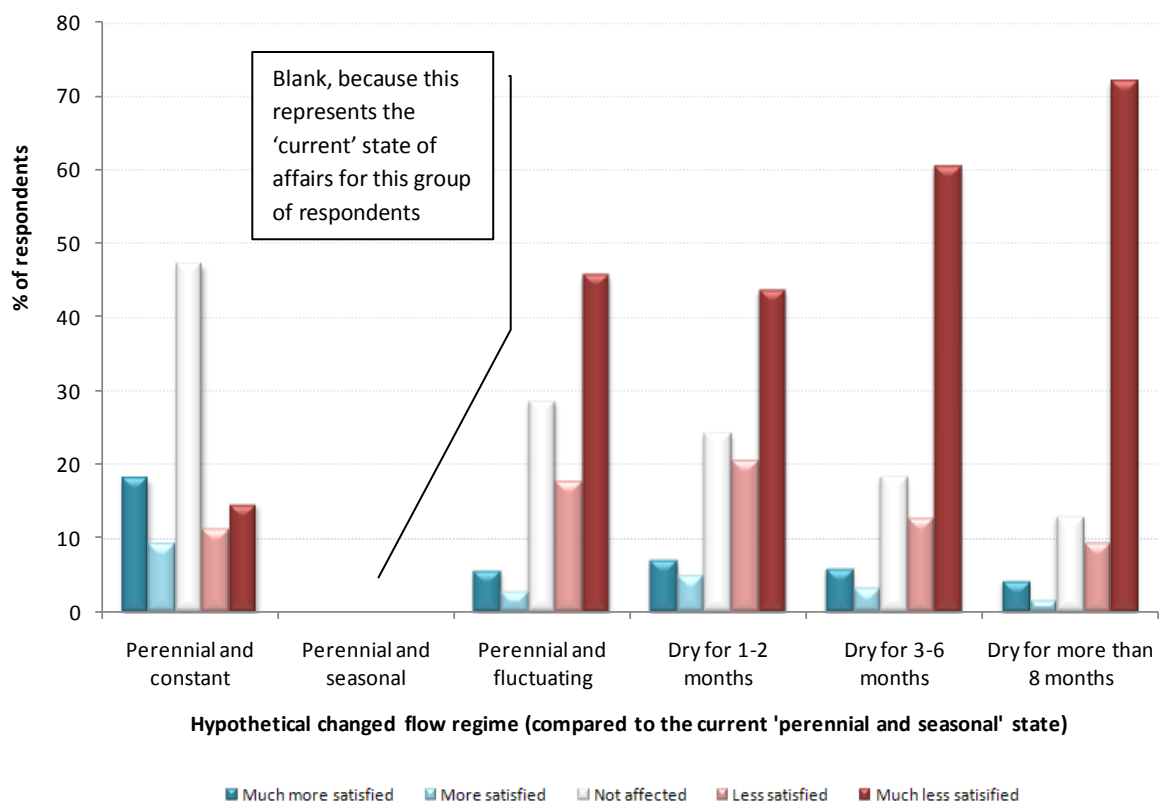


Figure 36 – Reaction of those living near a perennial river to a variety of different scenarios involving a change in stream flows: distribution of responses

As can be seen in Figure 36 (which shows responses to all change scenarios, presented next to each other) there was a consistently strong negative response to any change that saw the river stop flowing, even if only for a short period of time each year. Indeed, more than 50 per cent of respondents indicated that they would be dissatisfied (the two right hand boxes, excluding the 'I'm not sure' category), indicating that this is a scenario which is likely to generate a 'significant' (negative) impact on Social and Cultural values.

There was also a strongly negative response to the river becoming perennial with marked, unpredictable changes in flow (perennial and fluctuating). Here too, more than 50 per cent of respondents indicated that they would be dissatisfied, indicating that this is another scenario which could generate a 'significant' (and negative) impact on Social and Cultural values.

While some respondents indicated they would be less satisfied if their perennial and seasonal river lost its 'seasonality' and maintained a constant flow year round, others said they would be more satisfied, and most indicated that they would not be affected at all. In any case, this type of change would not generate a 'significant' impact (either positive or negative) on Social and Cultural values.

Interestingly 80 per cent of respondents living near the Ord River stated that they would be most dissatisfied if the river stopped flowing, even for 1-2 months each year. This is despite the fact that the flow regime of the Ord River was significantly modified as a result of construction of the Ord River Dam and Kununurra Diversion Dams in 1963. Prior to regulation by the Kununurra Diversion Dam and more significantly, the Ord River Dam, the lower Ord River typified a tropical river - experiencing large seasonal variations in flow. In the wet season, very high flow was generated by monsoonal depressions and storms, while in the dry season, little or no flow reduced the river to a series of disconnected pools (Department of Water, 2006, as cited in Black, Bloss & Lunau, 2011). Since completion of the Ord River Dam (1974-75) average wet season flows have reduced by 67 per cent and average dry season flows have increased by 439 per cent (Trayler et al., 2006). Evidently, respondents to this survey would not like to see a reversion to the 'old days'. That said, it is vitally important to note that this observation may not be representative of the population at large – as discussed in section 3.1, the sample is clearly biased in favour of particular 'types' of respondents. Moreover, there are clearly other, quite strong yet opposing views, as evidenced by a comment from a person living in Wyndham, WA:

*"I would like the rivers to be unchanged from their natural flow patterns, there is far too much human intervention affecting the river's ecology. We in Wyndham (Kimberley) can see detrimental effects, caused by human interference upon our rivers, increasing each year. The population increase has a huge impact on the amount of produce that must be grown to support it. Land is cleared and water is used on an ever increasing scale. Population increase must be stopped."* Wyndham, WA

#### 6.2.1.1.1 Are increasing periods of 'no flow' associated with increasing levels of dissatisfaction?

It is not strictly statistically correct to convert Likert scale data into numbers and to then calculate means, but doing so facilitates an easy visual comparison of responses. This was done by assigning each 'category' a number (as set out below) and then calculating mean responses to each scenario.



Table 22 – Values assigned to categorical responses measuring (dis)satisfaction with changed stream flow

Category	Value assigned
'much more dissatisfied'	-2
'more dissatisfied'	-1
'not affected'	0
'more satisfied'	1
'much more satisfied'	2

Figure 37 shows the mean reaction of respondents to a change in stream flows from the current state of 'perennial and seasonal' to one that is drier, or one that has an altered flow (e.g. perennial and constant, or perennial and fluctuating). This clearly shows that the drier the scenario, the more negative respondent's reactions will be – an observation that accords with *a priori* expectations.

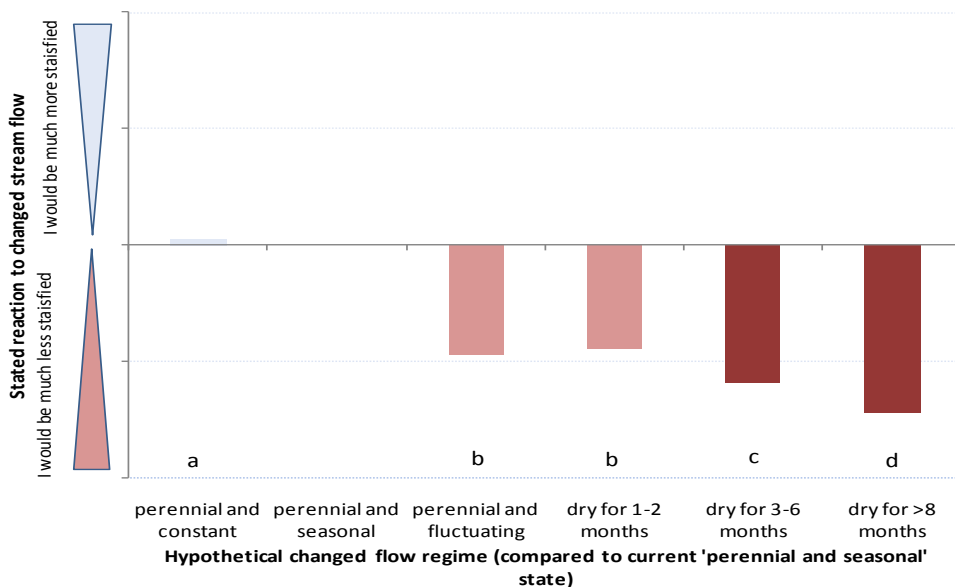


Figure 37 – Reaction of those living near a perennial river to a variety of different scenarios involving a change in stream flows: mean responses

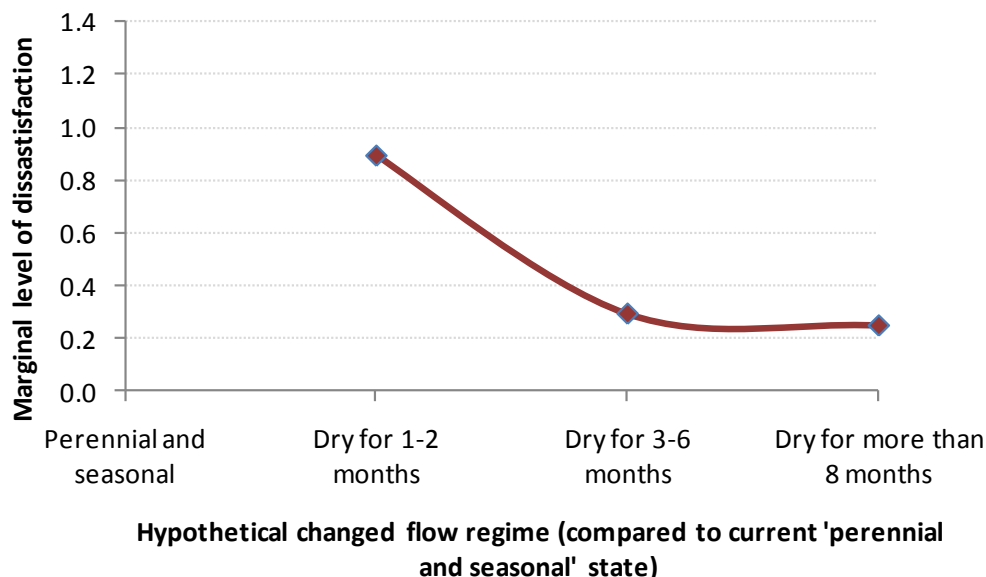
To ensure analytical rigour, the Wilcoxon signed rank test was used to check for statistically significant differences in the distribution of responses across categories (as opposed to simply comparing means). Letters have been added to each 'bar' on Figure 37 to show the results of those tests. If two categories share the same letter, responses are statistically similar. For example, the scenarios 'perennial and fluctuating' and 'dry for 1-2 months' both have the letter *b* above them. This indicates that respondent reactions to these scenarios were statistically similar (both making respondents equally dissatisfied). But the other 3 scenarios (perennial and constant, dry for 3-6 months and dry for more than 8 months) do NOT share that letter. Visually, the graph tells us that the drier the river becomes, the more dissatisfied respondents become. The formal tests tell us that these increasing levels of disquiet with reduced stream flow are statistically significant.

An oft observed phenomenon is that people are most (dis)satisfied when there is an initial change to the state of something, with successive changes causing less, additional (dis)satisfaction<sup>70</sup>. To see if that is so, researchers assigned the current state (a river with perennial and seasonal flows) the satisfaction level '0' (neither satisfied nor dissatisfied). They then compared this value (zero) with the mean levels of (dis)satisfaction which respondents recorded when asked how they would feel if the river dried up for 1-2 months a year. As shown in Table 23, below, this reduced satisfaction from the current state (assumed 0) to -0.9. When asked about how they would feel if the river dried up for even longer – in this case 3-6 months – dissatisfaction rose from -0.9 to -1.2.

**Table 23 – Marginal responses to a change in stream-flow**

Category	Mean response from survey	Change in 'satisfaction'
Current state – perennial and seasonal	Assumed 0	
Dry for 1-2 months per annum	-0.9	-0.9
Dry for 3-6 months per annum	-1.2	-0.3
Dry for more than 8 months per annum	-1.4	-0.2

It is these changes in satisfaction (termed marginal changes by economists) that are shown in Figure 38. Evidently, residents are most affected by an initial change in the state of the river (from having perennial flows to drying up for 1-2 months each year). Further reductions in stream flow are disliked – but the negative response is not as marked as that initial change. This can be seen in the table, but it is much more visually apparent in the chart.



**Figure 38 – Marginal response to decreasing levels of flow from perennial and seasonal rivers**

<sup>70</sup> The idea of diminishing marginal (dis)utility.

#### 6.2.1.1.2 Differences in the reaction to changed stream flow scenarios across different stakeholder groups

Statistical tests were used to determine if there were differences in the reactions of people to changed stream flows, depending upon whether or not their responses were collected in the mail-out survey, or during an interview<sup>71</sup>. In all but one case<sup>72</sup>, the differences were not statistically significant. We also tested for statistically significant differences in reaction to changed stream-flow regimes across Indigenous and non-Indigenous respondents - finding no evidence of such<sup>73</sup>, although it is interesting to note that during interviews, several Indigenous respondents indicated that changed stream flows would not necessarily make things 'better' or 'worse', just different – e.g. always having water was nice, but if the river dried into a series of water holes, then this could be useful in that having the wildlife congregate in those areas made it easier to hunt or fish.

We also tested for differences in reaction to changed stream flow regimes across households which are dependent upon different industry/sectors for income. Those associated with the Mining, Industry and Services sectors indicated the highest levels of dissatisfaction, while those receiving a Passive Income from Government had the lowest levels of dissatisfaction – although there were few statistically significant differences in responses<sup>74</sup>.

#### 6.2.1.2 Responses to changed stream flow when current state is dry 3-6 months each year

A similar set of tests were run for respondents who indicated that their closest river was dry for 3-6 months each year. Figure 39 plots the frequency of responses to each of the changes from this river condition (excluding those who selected 'I don't know'). In line with the reaction of those who live near rivers which are currently perennial, more than 50 per cent of these respondents also indicated that they would be dissatisfied if the river became drier, or if the river started flowing all year round with marked, and unpredictable fluctuations in stream flow. Evidently, such changes would also be viewed by these residents as having a 'significant' (negative) impact on their Social and Cultural values. In contrast, the majority of respondents were unaffected by the river becoming dry for less time each year, and up to 48 per cent indicated that they would be more satisfied if the river become perennial and constant or perennial and seasonal.

As previously, the categorical data was converted to numbers (using the values presented in Table 22) and mean responses to each scenario are shown in Figure 40. Again, the Wilcoxon matched-pair signed rank test was used to determine if differences in the distribution of responses were statistically significant. As previously, values which are 'similar' share the same letters. Evidently, respondents were generally happy with the idea of having more water available, as long as river levels did not fluctuate unpredictably – that caused increased levels of dissatisfaction. The most marked reaction is to the river becoming drier - another 'significant' impact.

---

<sup>71</sup> Specifically: the Mann-Whitney-U test.

<sup>72</sup> The difference in reactions between mail-out respondents and interviewees to the river becoming dry for 3-6 months was significant at 0.01. For this scenario, those respondents who were interviewed were more strongly opposed to this occurring than those who responded to the mail-out.

<sup>73</sup> Here too, the Mann-Whitney-U test was used.

<sup>74</sup> Indeed they only existed between the lowest and highest groups – i.e. those on Passive Incomes from Government, and those dependent upon Mining, Industry, Services, or Government.

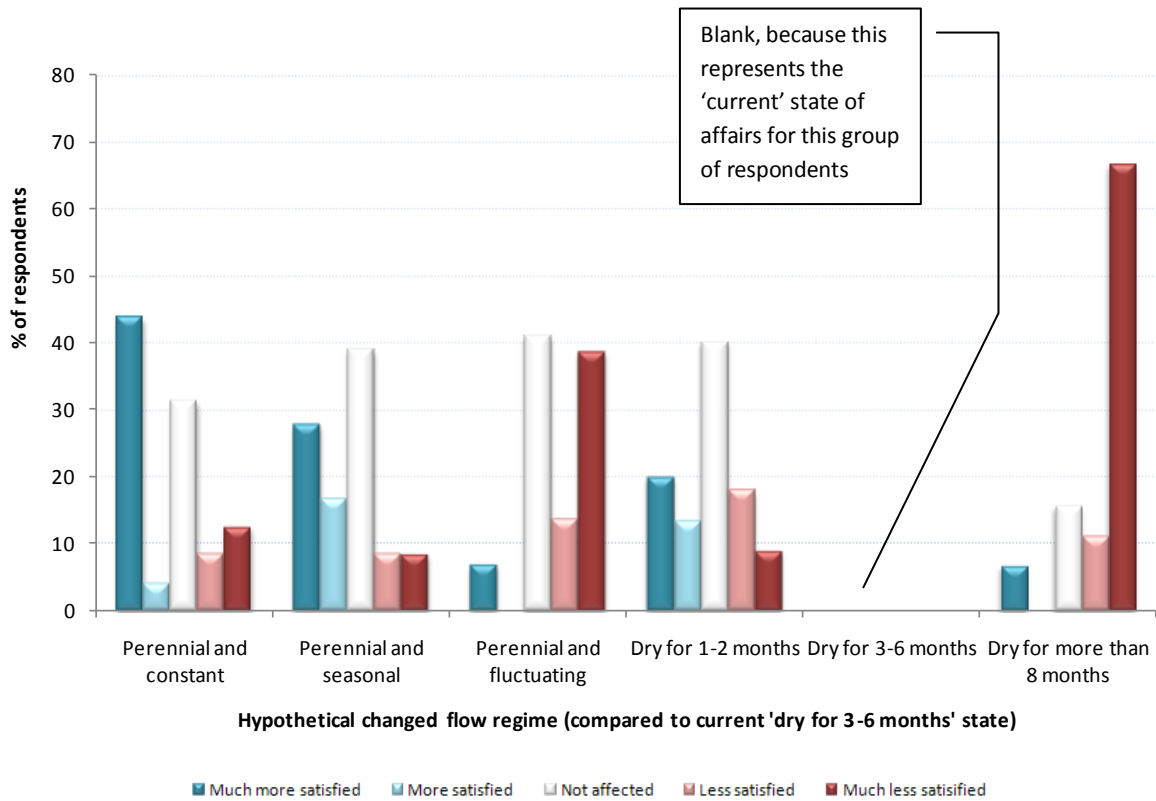


Figure 39 – Reaction of those living near a river which is ‘normally’ dry for 3-6 months each year to a variety of different scenarios involving a change in stream flows: distribution of responses

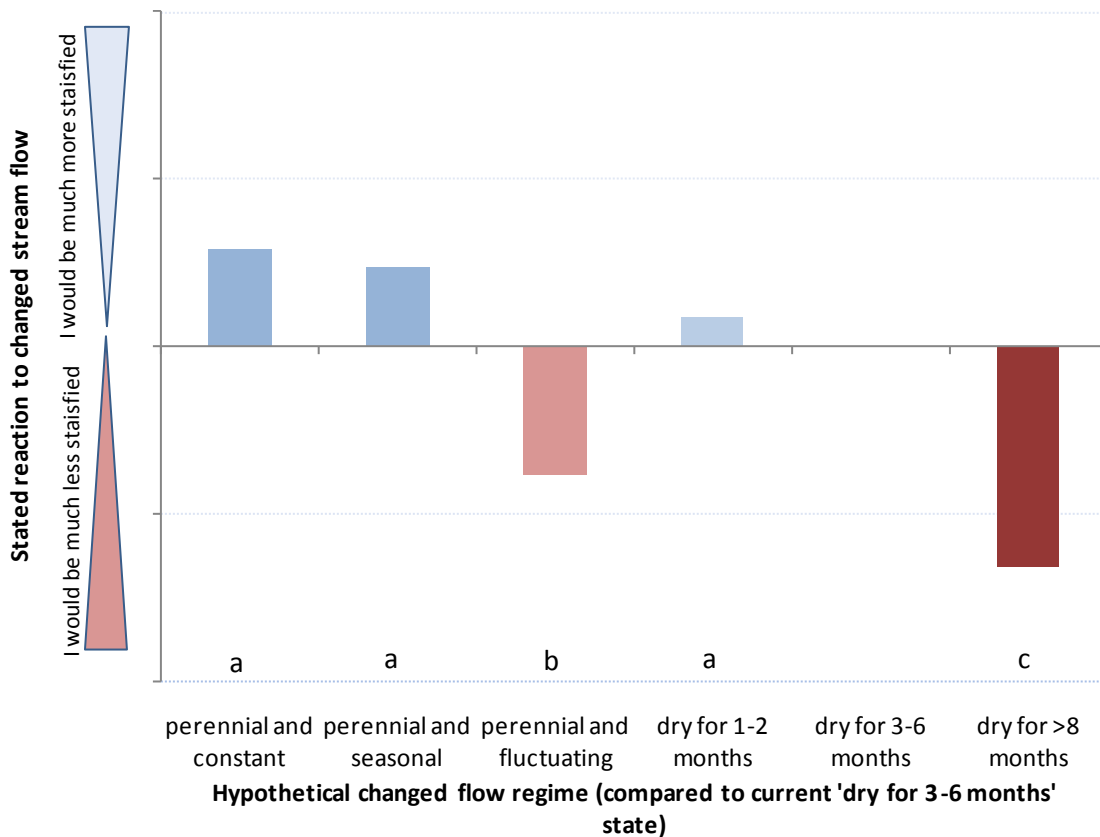


Figure 40 – Reaction of those living near a river which is ‘normally’ dry for 3-6 months each year to a variety of different scenarios involving a change in stream flows: mean values

Also as previously, tests were conducted for interview bias, and again there was no statistical difference in responses between those who were interviewed and those who responded to the mail-out survey. Likewise, the differences in responses between Indigenous and non-Indigenous residents were not statistically significant; although there was, again, evidence to suggest that respondents whose household incomes were primarily dependent upon Passive Incomes were likely to be less dissatisfied with reduced stream flows than those associated with Mining and Services.

### 6.2.1.3 Responses to changed stream flow when current state is dry for more than 8 months each year

Finally, researchers looked at responses of respondents who indicated that their closest river was dry for more than 8 months each year – just 28 respondents. Figure 41 plots the frequency of responses to each of the changes from this river condition (excluding those who selected ‘I don’t know’). Figure 42 plots mean responses. Evidently, most respondents said that they would be unaffected by changed stream flows, although there appears to be a stronger positive reaction to the idea of the river becoming perennial than to other scenarios, under the proviso – again – that flows were either constant or seasonal, and did not fluctuate unpredictably.

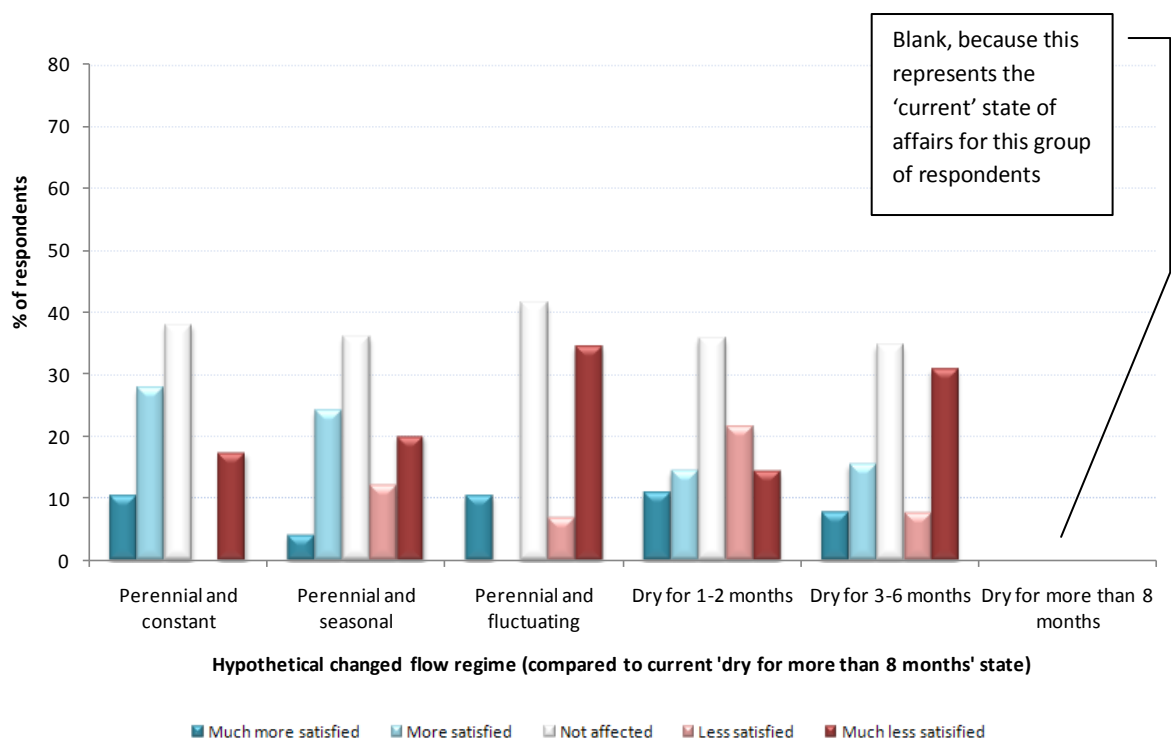


Figure 41 – Reaction of those living near a river which is ‘normally’ dry for >8 months each year to a variety of different scenarios involving a change in stream flows: distribution of responses

Importantly, Figure 42 shows that the mean response of residents living near a river that is dry for more than 8 months is one of general dissatisfaction with any changes to the natural state of their river. While there is a marginally positive response to the river becoming perennial and constant, this is not statistically different to the negative response to the river becoming perennial and seasonal or dry for 1-2 months. This is, no doubt, at least partially due to the relatively small number of respondents who lived next to these types of rivers (just 28), but it may also be indicative of the fact that feelings about changed stream flows to rivers such as these are quite mixed.

For example, a respondent in Hughenden, QLD stated:

*“All rivers should be dammed i.e. flow controlled to conserve water. Don’t let it run away!”*

Whilst another respondent expressed concern over the causes of ANY change:

*“How happy would I personally be in an intermittence system if it suddenly becomes perennial? Not very happy at all as this would mean something in the system has suffered a catastrophic change affecting the environment and thus my capacity to enjoy this resource.”*

Burketown, QLD

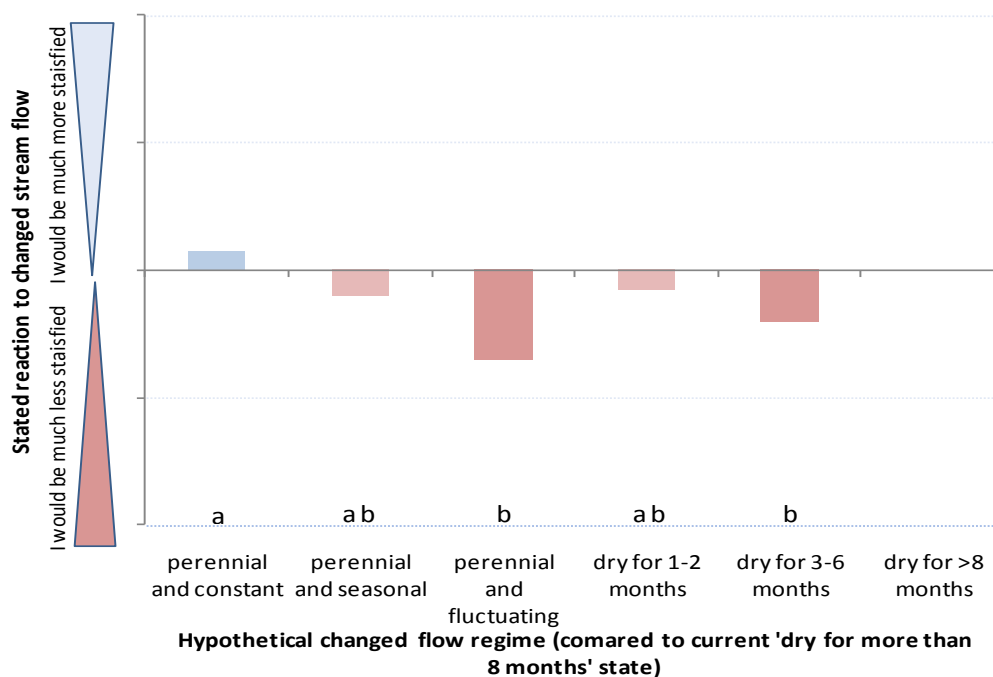


Figure 42 – Reaction of those living near a river which is ‘normally’ dry for >8 months each year to a variety of different scenarios involving a change in stream flows: mean responses

All respondents who were living near a river that was dry for more than 8 months each year were non-Indigenous and collected from the mail-out survey therefore it was not possible to test for statistical differences between Indigeneity or for interview bias. Researchers did, however, perform statistical tests for differences in responses across households dependent upon different sectors for income. Here, too, there were no statistically significant differences – most likely attributable to the fact that the number of respondents in this category was small.

### 6.2.2 Reaction to changes in water quality

Table 24 (below), shows that the majority of respondents lived near rivers that were clear (during the dry season) with no algae (n=137), while very few respondents indicated that their river was clear with lots of algae (n=21).

Table 24 – Number of respondents living near rivers with different levels of turbidity and algae

	Mail-out respondents			Interviewees		
	Non-Indigenous	Indigenous	Total	Non-Indigenous	Indigenous	Total
Clear, no algae	112	7	119	15	3	18
Murky 1/2 dry	43	2	45	1	0	1
Murky throughout dry	36	0	36	3	1	4
Clear, some algae	38	0	38	3	11	14
Clear, lots of algae	20	0	20	0	1	1

As noted earlier, it only makes sense to consider responses to questions about the way in which people are likely to react to changes in water quality in the context of current conditions. So, response data were divided, and results are presented in separate sub-sections. The scenarios selected do not represent one continuum of states of clarity, so will be assessed as changes in the level of turbidity (murkiness) and changes in the level of nutrients (algae and plant content).

6.2.2.1 Responses to changed water quality when current state is clear with no algae

In the first instance, researchers simply counted the number of times an individual ticked a particular ‘box’ when asked about changed water quality (i.e. the number saying they would be much less satisfied, the number saying they would be somewhat less satisfied, etc). As can be seen in Figure 43, there was a very strong negative response to any change in turbidity or algae – more than 70 per cent of respondents in most cases. Evidently, any of these changes would have a ‘significant’ impact on the Social and Cultural values of these residents.

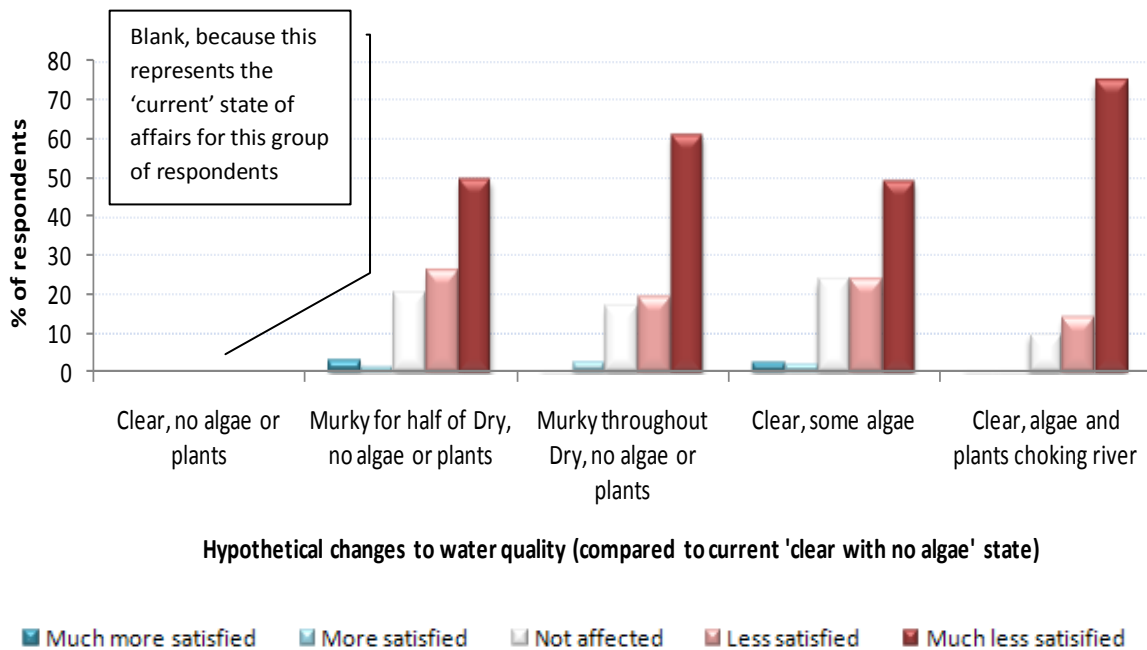


Figure 43 – Reaction of those living near a river that is currently clear with no algae to a variety of different scenarios involving a change in water quality: distribution of responses

Here again, responses to these questions were converted from categorical to scale data using the values presented in Table 22. Figure 44 shows the results of this, where each bar summarises the response to that change. The reaction of respondents to a relatively minor change in water quality was statistically similar – irrespective of whether that change was caused by sediment or algae.

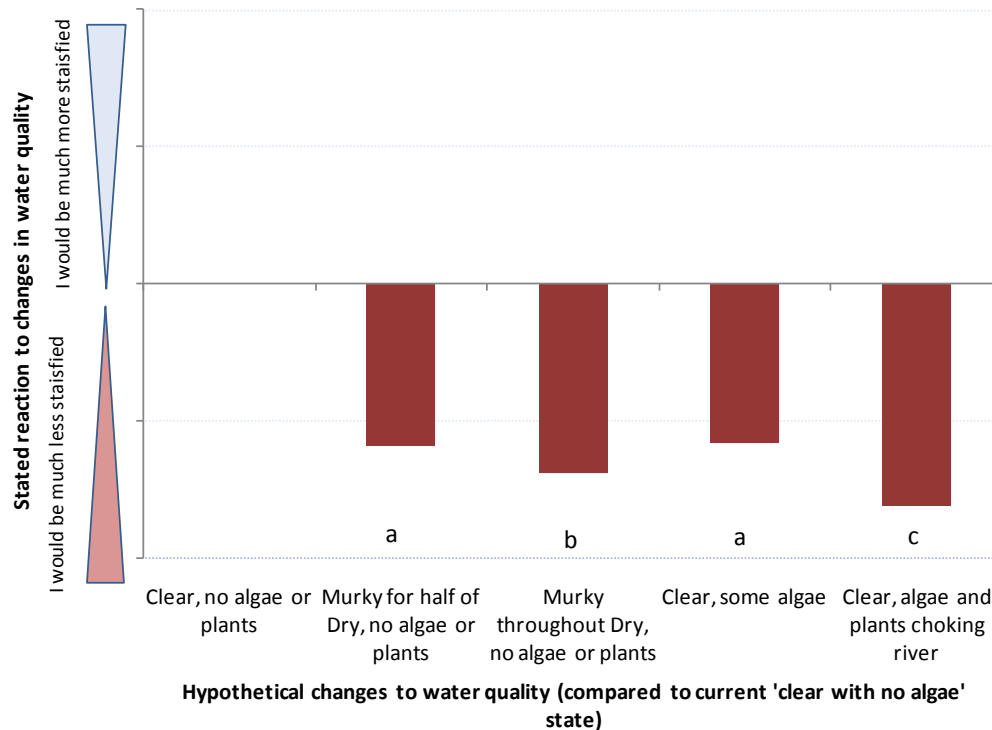


Figure 44 – Reaction of those living near a river that is currently clear with no algae to a variety of different scenarios involving a change in water quality: mean response

As might have been expected *a priori*, greater levels of deterioration in water quality (i.e. murky for longer periods of time, or higher levels of algae) are associated with greater levels of dissatisfaction and these differences were statistically significant. Moreover, as economic theory predicts, the marginal level of disutility is greatest following an initial shock to the system (i.e. moving from clear to murky for half of the dry season, or from clear with no algae, to clear with some algae) (refer Figure 45) and diminishes as the level of turbidity or algae is increased.

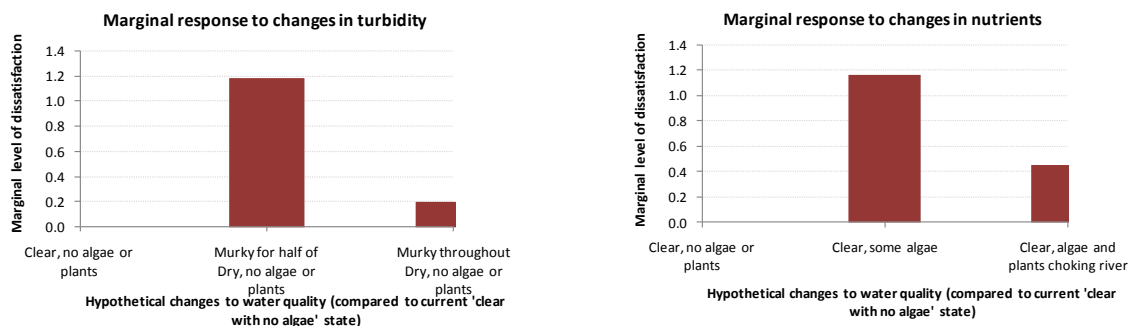


Figure 45 – Marginal response to changes in turbidity and nutrients for a river which is clear with no algae

Interestingly, respondents had a stronger negative reaction to the idea of having 'lots of algae with water plants choking the river' than they did to the idea of having a river that was murky all year round. These differences were also statistically significant.



### 6.2.2.2 Responses to changed water quality when current state is murky for half of the dry

Figure 55 in Appendix J plots the frequency of responses to each of the changes from this river condition (excluding those who selected “I don’t know”); mean responses are given below (Figure 46). The reaction to changes in increased turbidity or increased levels of algae was also strongly negative (more than 65 per cent of respondents indicating they would be dissatisfied). Here too, it seems as if a decline in water quality would have a ‘significant’ and negative impact on Social and Cultural values. Further, as one would expect, respondents would be more satisfied if their river became clear; and this reaction was strong, with almost 70 per cent of respondents reacting positively to that scenario. Evidently, improvements in water quality could have a ‘significant’ and positive impact on Social and Cultural values.

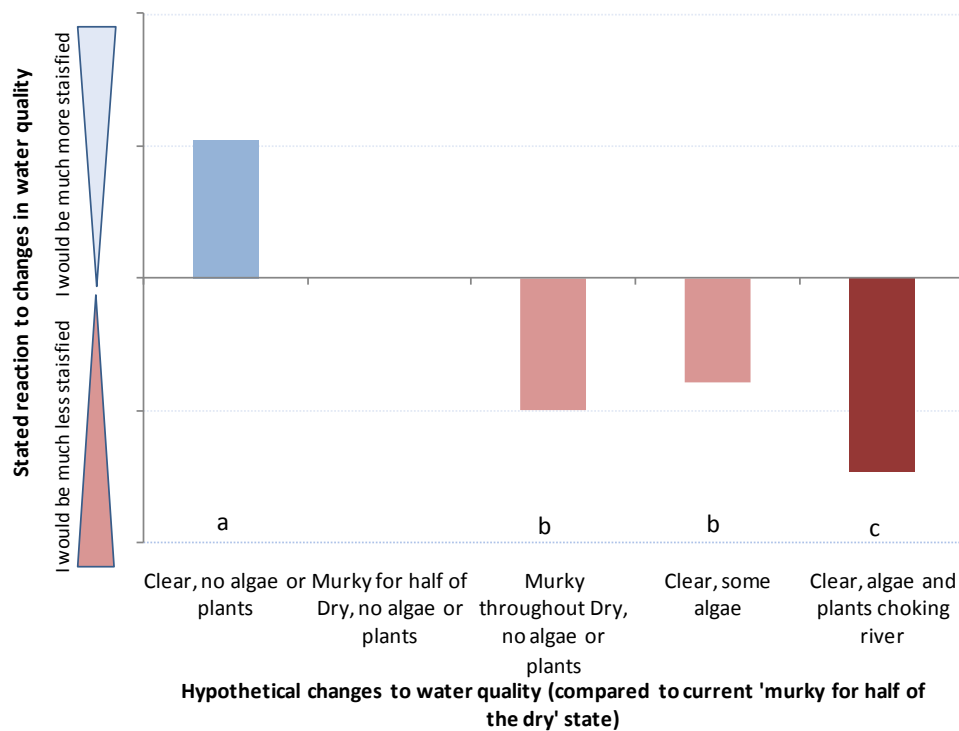


Figure 46 – Reaction of those living near a river that is currently murky for half the dry season to a variety of different scenarios involving a change in water quality: mean response

Marginal responses were as expected.

### 6.2.2.3 Responses to changed water quality when current state is murky throughout the dry

Figure 56 in Appendix J plots the frequency of responses to each of the changes from this river condition (excluding those who selected “I don’t know”) with mean responses presented in Figure 47 below (all of which are statistically different from each other). Here, more than 50 per cent of respondents were dissatisfied by changes to the levels of algae present, again confirming that this change could have a ‘significant’, negative impact on Social and Cultural values (although the negative reaction was not as prominent as previously, with some respondents suggesting that some algae would increase their level of satisfaction with their Social and Cultural values).

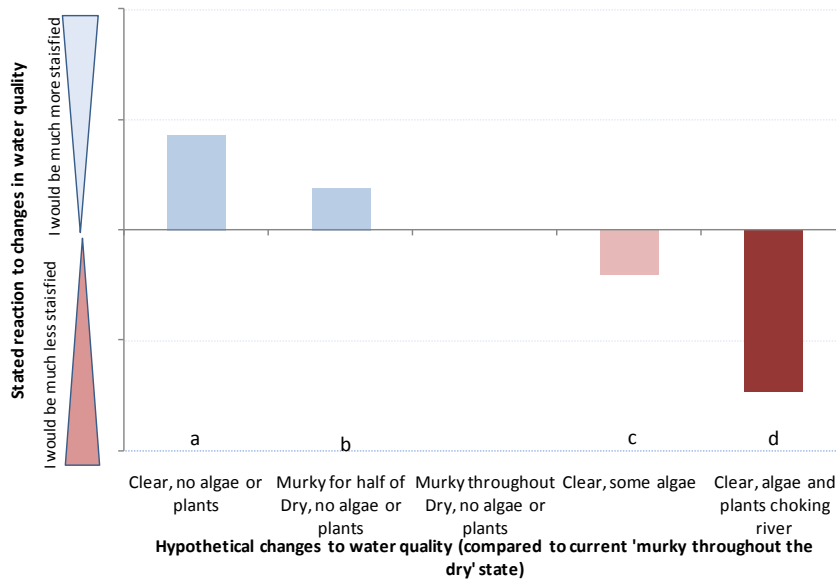


Figure 47 – Reaction of those living near a river that is currently murky throughout the dry season to a variety of different scenarios involving a change in water quality: mean response

As previously, more than 50 per cent of respondents reacted positively to large reductions in turbidity (a ‘significant’ positive impact), and a slightly smaller percentage of respondents reacted positively to smaller reductions in turbidity.

#### 6.2.2.4 Responses to changed water quality when current state is clear with some algae

Figure 57 in Appendix J plots the frequency of responses to each of the changes from this river condition; mean responses are given below (all of which were statistically different from each other). Evidently, respondents would be dissatisfied by increased levels of algae and more satisfied if the river became clear. However increasing levels of turbidity generated increasing levels of dissatisfaction. All of these reactions were ‘significant’ (in that more than 50 per cent of respondents reacted similarly). This is supported in Figure 48 below which depicts the mean response to these changes.

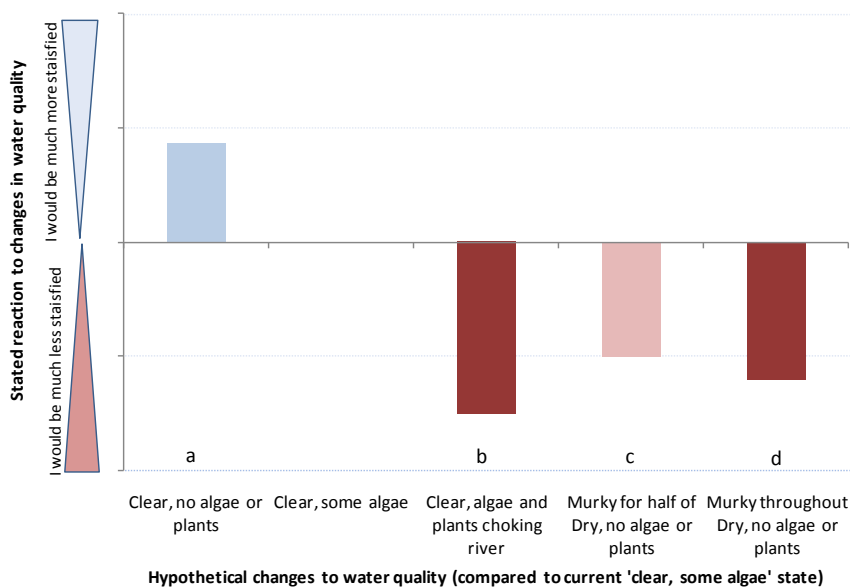


Figure 48 – Reaction of those living near a river that is currently clear with some algae to a variety of different scenarios involving a change in water quality: mean response

### 6.2.2.5 Responses to changed water quality when current state is clear with lots of algae

Figure 58 in Appendix J plots the frequency of responses to each of the changes from this river condition (excluding those who selected “I don’t know”). More than 50 per cent of respondents indicated that they would be dissatisfied by increased levels of turbidity (however this was less pronounced than for other river types), and would be satisfied by increasing levels of clarity – both ‘significant’ impacts. Figure 49 below suggests there is no statistical difference between the mean responses to changes in the level of turbidity however the mean level of satisfaction increases as clarity improves.

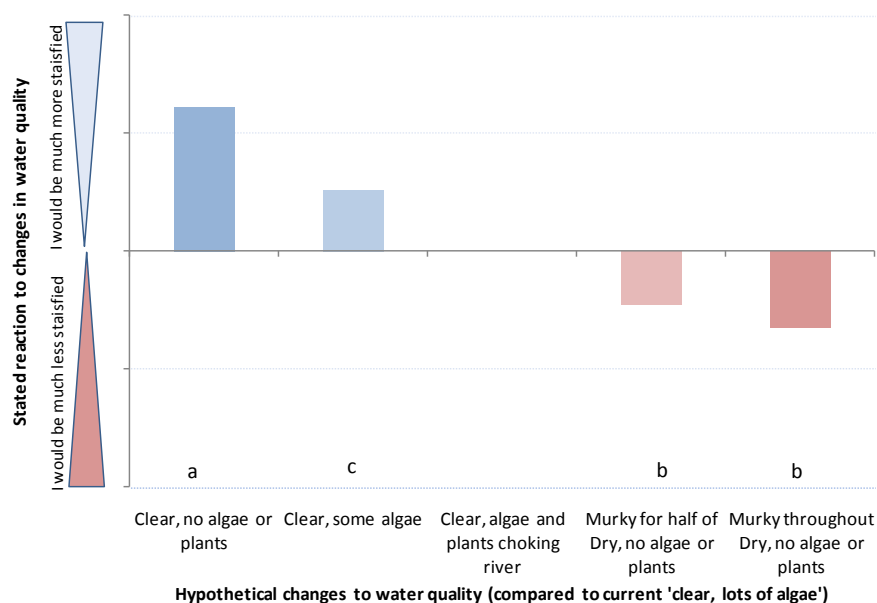


Figure 49 – Reaction of those living near a river that is currently clear with lots of algae to a variety of different scenarios involving a change in water quality: mean response

### 6.2.3 What is worse: reduced stream flow, increases in algae or increased sediment?

To facilitate a valid comparison of stated reactions to changes in stream flow and changes in water quality, questionnaires were divided into groups according to the existing river system (i.e. current stream flow, and current water quality) – see Table 25.

Table 25 – Number of respondents living near rivers with different levels of turbidity and algae – and also different existing stream-flow

	Perennial and seasonal	Dry for 3-6months per year	Dry for more than 8 months per year
Clear	134	18	12
Clear with a little algae	44	15	8
Clear with lots of algae	22	8	5
Murky for half the dry	38	15	10
Murky for all of the dry	31	11	10

In the first instance, researcher selected only those respondents who lived near rivers that were (a) Perennial and seasonal; and (b) Clear (during the dry) with no algae (n=134). They then looked at mean responses to changes in the state of that river – see Figure 50 below.

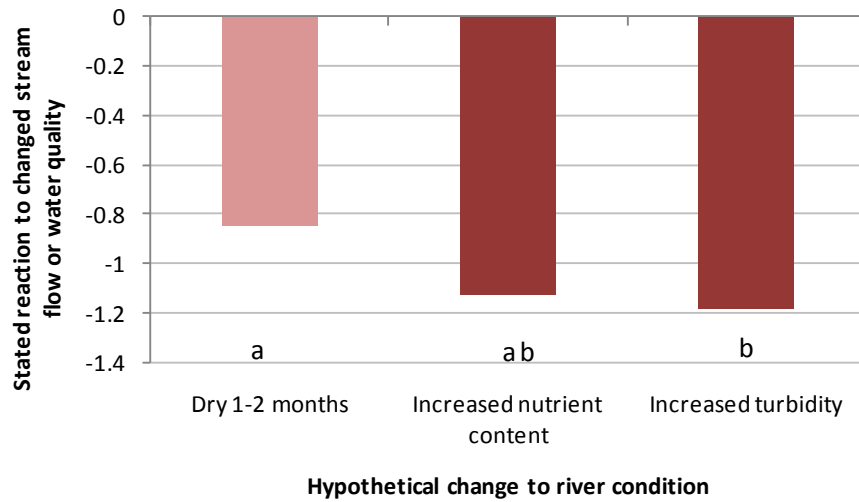


Figure 50 – Comparison of reactions to decreased stream flow, increased nutrient content and increased turbidity for a river which is currently Perennial and Seasonal and Clear

As previously, values which are ‘similar’ share the same letters. It is evident that those residents who live near this type of river are more strongly opposed to hypothetical changes which adversely affect turbidity than to changes which represent drying conditions. The difference between stated responses to increased nutrient content and increased turbidity was not statistically significant; neither was the difference between stated responses to increases in algae and the river becoming drier. As discussed in sections 6.2.1.1 and 6.2.2.1, each of these changes will have a significant impact on the Social and Cultural values of the residents.

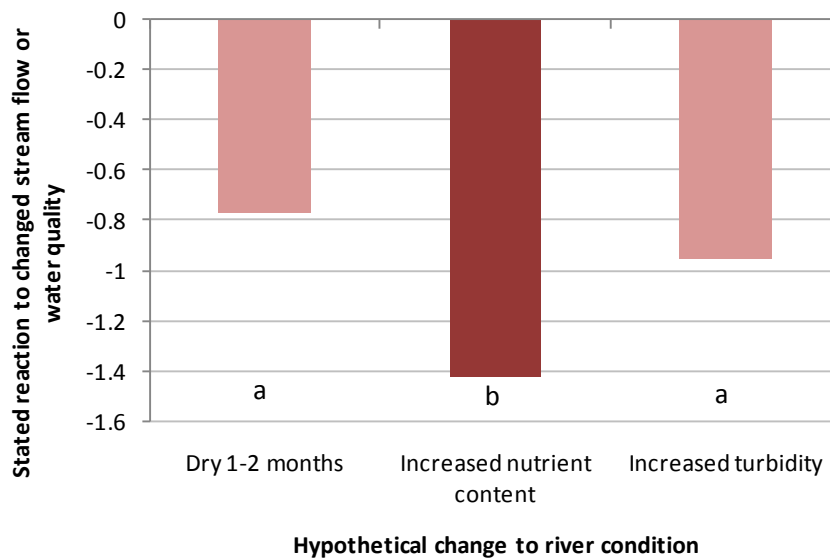


Figure 51 – Comparison of reactions to decreased stream flow, increased nutrient content and increased turbidity for a river which is currently Perennial and Seasonal and has some algae

Figure 51 above shows the mean responses of residents who currently live near a river which is (a) Perennial and Seasonal and (b) has some algae to becoming dry for 1-2 months (n=44), and to increases in nutrient content and turbidity. In this case, residents are again more strongly opposed to changes in water quality however the reaction to increased nutrient content is greatest. The difference in responses to changes in stream flow and increased turbidity are not statistically significant.

The results for residents who currently live near a river which is Perennial and Seasonal and is murky for half of the dry season (n=38) is similar to that of residents living near a perennial and clear river (Figure 52) – but none of the differences were statistically significant.

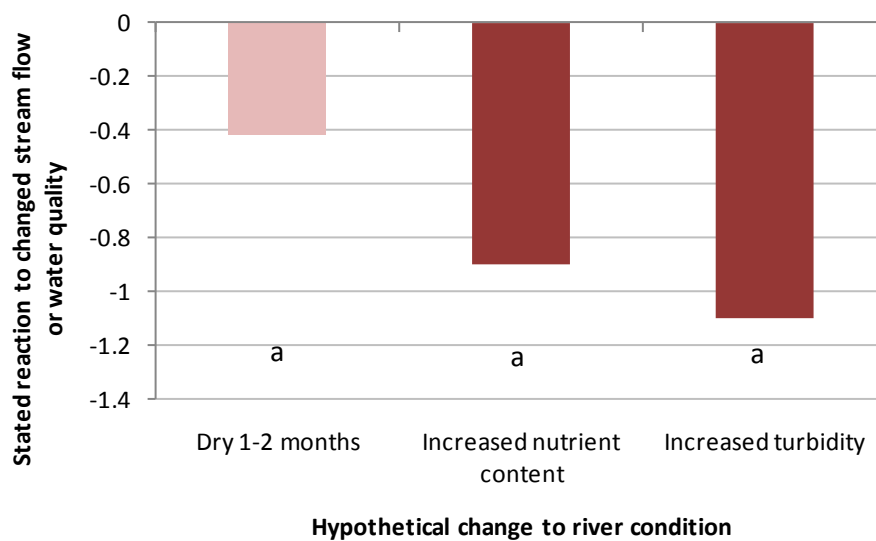


Figure 52 – Comparison of reactions to decreased stream flow, increased nutrient content and increased turbidity for a river which is currently Perennial and Seasonal and is murky for half of the dry season

### 6.3 Take-home messages

This chapter focused on the project’s third objective: namely seeking to improve our understanding of the extent to which stream flows and/or water quality could change before there was a significant impact on Social and Cultural values.

Specifically, respondents were asked to consider a range of hypothetical scenarios that involved changes to stream flows and water quality in rivers near them, telling us (on a five point Likert scale) how that would affect their satisfaction with Social and Cultural values.

#### Reactions to changes in stream flows

- 1) Respondents who currently live near rivers that flow all year round expressed extremely negative sentiments about any change that causes flows to cease – even if for only 1-2 months each year. Evidently, any change which stops flows that are currently perennial (be that because of naturally occurring springs, or because of existing ‘modifications’) will have a significant, negative impact on Social and Cultural values.

- 2) These views appear to be relatively consistent across a range of different respondents<sup>75</sup>, although those on passive incomes were less likely to express strongly negative feelings about their rivers becoming drier than those dependent upon employment for their income.
- 3) Respondents were almost always positive (or ambivalent) about changes in stream flow which reduce dry periods. In other words, those who live near an intermittent river system (dry for 3-6 months) stated that they would have increased levels of satisfaction with their Social and Cultural values if their river was to become perennial, although this was generally not a significant improvement. The important exception to this occurs with respect to perennial but UNPREDICTABLE flows. Evidently, some respondents would like to live near a perennial river – as long as flows are constant, or related to natural, seasonal fluctuations.

#### **Reactions to changes in water quality**

- 4) Reductions in water quality invariably had a significant negative impact on Social and Cultural values.
- 5) Improvements in water quality had a significant positive impact on Social and Cultural values.

#### **Comparison of reactions to changes in stream flow and/or water quality**

- 6) Reactions to scenarios that affected water quality were almost always ‘stronger’ (i.e. more respondents are strongly opposed or in favour) than reactions to scenarios that affected stream flow<sup>76</sup>.

---

<sup>75</sup> Based on bivariate tests only.

<sup>76</sup> For example,

- Residents who lived near a Perennial river were consistently more sensitive to changes in water quality than to changes in stream flow – regardless of whether their river was currently clear, murky or had some algae. And these differences were statistically significant.
- Those living near a river which was clear or murky for half of the dry were more sensitive to increased turbidity, while those living near a river which had some algae were more sensitive to increased levels of algae.

## 7 SYNTHESIS AND CONCLUDING COMMENTS

The final objective of this project required researchers to compile and interpret information from the first three objectives, to draw inferences about the likely response of stakeholders to developments that may alter stream-flows, water quality and thus uses of water downstream.

### 7.1 What is the likely response of stakeholders to consequences of upstream development scenarios and to potential changes in the downstream usages of water?

Chapter 4 clearly showed that *Commercial* Values are considered to be less important than *Biodiversity*, *Life* and some *Social/Cultural* values, and chapter 5 clearly showed that at least some people are WTP substantive amounts of money to prevent development that impacts upon their *Social/Cultural* values. As such, it seems that developments which impact upon downstream usages of water are likely to be viewed quite negatively by residents of Northern Australia.

The opposition is likely to be characterised by significant disquiet amongst a possibly vocal minority (those refusing to consider any trade off at all, or WTP very large sums of money to prevent the development from occurring) and a present, but less significant disquiet amongst a large group of other residents.

Those most willing to accept trade-offs for development include the wealthy and/or people who place highest values on *Commercial* uses of rivers; those who place a high value on *Biodiversity* (a significant proportion of respondents) and/or those who are relatively poor seem to be much less willing to trade their *Social* and *Cultural* values for greater income flows.

### 7.2 Implications for water planning and management

ISSUE 1: Interviewee data indicates that *Biodiversity*, *Life* and *Social/Cultural* values are somewhat complementary to each other, whereas, *Commercial* values are almost always viewed as quite separate from – and often competitive or detrimental to – these other values (with the important exception of tourism). Moreover the larger (mail out) data set showed strong correlation between WTP to protect *Social/Cultural* values and stated importance of *Biodiversity* values.

Evidently, for many Northern Residents, the existence of biodiversity may be a necessary pre-condition for maintenance of many *Social* and *Cultural* values. Determining whether or not the existence of biodiversity is also a SUFFICIENT condition for the preservation of *Social* and *Cultural* values, stands as a vitally important topic for further, more thorough, research. Why is this so important? If the existence of high quality biodiversity values is both a necessary and sufficient condition for the existence of high quality socio-cultural values, then preservation of the former guarantees preservation of the latter. However, if the existence of high quality biodiversity values is a necessary, but not a sufficient condition for the existence of high quality socio-cultural values, then preservation of the former does not guarantee preservation of the later; other steps may be necessary (e.g. guaranteeing access to areas of high biodiversity value).

Moreover, if the *Biodiversity* and *Social/Cultural* values that are derived from one 'area' are non-rivalrous (meaning that society can benefit from both, simultaneously), then their values should be added together<sup>77</sup> before being traded off against other competing uses of that 'area'. This is analogous to the situation where a private property owner seeks to determine how much land to devote to cattle and how much to wheat: he/she should firstly estimate the value of 'cattle' by considering potential income from both beef and leather, and then compare that (combined) value to the potential income that can be earned from the alternative (wheat). Failure to do so, would be to under-allocate resources (e.g. land, or in this case, possibly aquatic resources) to activities that generate multiple values (e.g. cattle, or in this case, possibly biodiversity and socio-cultural values).

Until we are able to learn more about these important issues<sup>78</sup>, planners may, therefore, wish to adopt a pre-cautionary approach (as advocated by the NWI). That is, they may wish to proceed as if these values are non-rivalrous, perhaps setting aside MORE than the 'bare minimum' that is required to maintain biodiversity values, and also ensuring that other steps are taken to facilitate the appreciation of socio-cultural values (e.g. ensuring residents have access to important areas).

#### ISSUE 2:

Respondents were particularly concerned about changes which impact upon water quality – although those who lived near perennial rivers were also very concerned about any change that would stop their stream/river flowing for even a short period each year. Moreover, comments made during focus groups and in interviews (as well as comments written on returned, mail-out questionnaires) indicated that many respondents have a holistic view of their environment (incorporating social, cultural, economic and biophysical values) and that their opposition to the development scenarios could be considerably tempered by effective, and well-aligned, social and environmental management systems.

Many current policies and institutional arrangements separate issues surrounding water quantity (and allocation) from water quality (and environmental management). But this research seems to indicate that it may be important to try to better align associated governance systems to account for the relationship between the two and/or to demonstrate to the public that this is being done. Evidently, opposition to proposed developments could be at least partially redressed by taking steps to ensure that the developments do not adversely affect EITHER water quality OR stream flows (taking particular steps to protect perennial flows).

In other words, the size of the 'trade-off' between development and Social/Cultural values is not 'given': it varies according to the way in which the impacts of development are managed. As such, greater attention from whole of government to any of the impacts of developments (with, for

---

<sup>77</sup> If one wishes to generate an estimate of the market value of a (non-rivalrous) public good, one must conduct a vertical summation of the 'value' which each individual derives from it.

<sup>78</sup> There are some very interesting scientific challenges facing researchers who wish to ascertain just HOW to measure highly correlated values such as these in a manner that facilitates "adding". Standard approaches – such as choice modelling – may not be suitable, and may thus need to be adapted. For example most choice experiments, allow researchers to assess the marginal WTP for changes in one attribute, whilst holding other attributes constant. But if respondents view the attributes as inseparable, then the choice sets that are presented to people may not be viewed as realistic representations of true choices, making it difficult to assess the reliability of estimates so obtained.



example, integrated catchment management plans) may serve to reduce trade-offs (and thus increase the value of development) compared to situations in which there is a singular focus on water allocation planning (Douglas et al, 2010).

### ISSUE 3:

Our development 'scenarios' clearly indicated that the amount which respondents expected as compensation for damage, exceeded the amount which they would be willing to pay to prevent a development from going ahead.

This suggests that it is in the interests of policy makers to discuss (and, where feasible, negotiate) development options with affected parties BEFORE development occurs. Compensation<sup>79</sup> after the event could prove much more costly.

The NWI highlights the importance of *community consultation and public participation*, and this research provides clear evidence of the fact that *participation and engagement* is financially sensible as well as an important part of transparent water management. Those who attempt to save money by avoiding the costs associated with setting up appropriate consultative processes, run the risk of having to pay out even more in subsequent periods when/if aggrieved residents seek 'compensation' for actions taken without consultation.

ISSUE 4: Finally, it is important to note that the values of residents may differ, perhaps substantially, from the value of non-residents. This may generate conflict – particularly in situations where non-residents are able to influence decisions and planning processes – and raises an important ethical question: Where differences arise, WHOSE values SHOULD be given greatest voice?

If one relies exclusively on dollar-denominated non-market valuation techniques to help address that question, one will – even if unwittingly – give greater voice to the 'rich' than to the 'poor'. And this may, by extension, give greater voice to non-residents than to residents (who are often at considerable socio-economic disadvantage – particularly Indigenous residents). Evidently, it is important for planners to use more than mere dollars when seeking to assess and/or redress the many tradeoffs relating to the uses of Australia's Tropical Rivers.

---

<sup>79</sup> Where property rights provide for such an entitlement.

## 8 REFERENCES

- ALEXANDER, K. & WARD, J. 2009. The current status of water governance in Northern Australia: water management in the Northern Territory, Queensland and Western Australia. *Northern Australia Land and Water Science Review: full report*.
- ANININ, S. & HISHAM, N. 2008. Applying importance-performance analysis to information systems: An exploratory case study. *Journal of Information Technology, and Organisations*, 3, 95-103.
- ARROW, K., SOLOW, R., PORTNEY, P. R., LEAMER, E. E., RADNER, R. & SCHUMAN, H. 1993. Report of the NOAA panel on contingent valuation. *Federal Register*, 58(10), 4601-4614.
- ARTHINGTON, A. H., BRIZGA, S. O. & KENNARD, M. J. 1998. Comparative Evaluation of Environmental Flow Assessment Techniques: Best Practice Framework. *LWRRDS Occasional Paper 25/98*. Canberra: Land and Water Resources Research and Development Corporation.
- AUSTRALIAN BUREAU OF STATISTICS. 2001. *Community Housing and Infrastructure Needs Survey (CHINS) Cat.4710.0* [Online]. Available: <http://www.abs.gov.au/AUSSTATS/abs@nsf/DetailsPage/4710.02001?OpenDocument> [Accessed 12 April 2006].
- AUSTRALIAN STATE OF THE ENVIRONMENT COMMITTEE. 2006. Australia State of the Environment 2006: Independent report to the Australian Government Minister for the Environment and Heritage. Canberra: Department of the Environment and Heritage.
- AUSTRALIAN UNITY 2008. What makes us happy? Survey Report 18.2. Melbourne: Australian Unity and Deakin University.
- BATEMAN, I., CARSON, R. J., DAY, B., HANEMANN, M., HANLEYS, N., HETT, T., JONES-LEE, M., LOOMES, G., MOURATO, S., OZDEMIROGLU, E., PEARCE, D., SUGDEN, R. & SWANSON, J. 2002. *Economic Valuation with Stated Preference Technique: A Manual*, Cheltenham, Edward Elgar.
- BENNETT, J. 2005. *The evolution of markets for water: Theory and Practice in Australia*, UK, Edward Elgar.
- BLANCH, S., REA, N. & SCOTT, G. 2005. Aquatic conservation value of the Daly River catchment. WWF Australia, Sydney.
- BLORE, I. 1996. How useful to decision makers is contingent valuation of the environment? *Public Administration and Development*, 16, 215-232.
- BOYLE, K. J., JOHNSON, F., MCCOLLUM, D., DESVOUSGES, W. H., DUNFORD, R. W. & HUDSON, S. P. 1996. Valuing Public Goods: Discrete Versus Continuous Contingent Valuation Responses. *Land Economics*, 72(3), 381-396.
- BRISBANE DECLARATION. 2009. *The Brisbane Declaration of Environmental Flows: Environmental Flows are Essential for Freshwater Ecosystem Health and Human Well-Being; An international declaration signed on 14 November 2009* [Online]. Available: <http://waterplanning.org.au/news/the-brisbane-declaration-on-environmental-flows> [Accessed 16/02/2012].
- BROWN, T. C., CHAMP, P. A., BISHOP, R. C. & MCCOLLUM, D. 1996. Which Response Format Reveals the Truth about Donations to a Public Good? *Land Economics*, 72 (May), 152-66.
- CAMERON, T. A. & HUPPERT, D. D. 1989. OLS Versus ML Estimation of Non-Market Resource Values With Payment Card Interval Data. *Journal of Environmental Economic Management*, 17, 230-246.
- CAMERON, T. A. & HUPPERT, D. D. 1991. Referendum Contingent Valuation Estimates: Sensitivity to the Assignment of Offered Values. *Journal of American Statistics Association*, 86, 910-918.
- CAMERON, T. A. & QUIGGIN, J. 1994. Estimation Using Contingent Valuation Data from a 'Dichotomous Choice with Follow-Up' Questionnaire. *Journal of Environmental Economic Management*, 27, 218-234.
- CAMPBELL, B. M. & LUCKERT, M. K. 2002. *Uncovering the hidden harvest: valuation methods for woodland and forest resources*, US, Earthscan Publications.

- CARSON, D., TAYLOR, A. & CAMPBELL, S. 2009. Demographic Trends and Likely Futures for Australia's Tropical Rivers. Darwin: School for Social and Policy Research, Charles Darwin University.
- CHARTRES, C. & WILLIAMS, J. 2006. Can Australia overcome its water scarcity problems? *Journal of Developments in Sustainable Agriculture*, 1, 17-24.
- CHU, R. & CHOI, T. 2000. An importance-performance analysis of hotel selection factors in the Hong Kong hotel industry: a comparison of business and leisure travellers. *Tourism Management*, 21.
- COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION (CSIRO). 2009. Water in the Timor Sea Drainage Division. A report to the Australian Government from the CSIRO Northern Australia Sustainable Yields Project. . Australia. : CSIRO Water for a Healthy Country Flagship.
- CONNOR, S., SOKOLICH, B., HOOGWERF, T., MACKENZIE, J. & BUTLER, J. 2009. Mitchell river catchment: Regional perspective. Available: [http://www.nalwt.gov.au/files/Chapter\\_26-Mitchell\\_River\\_catchment\\_regional\\_perspective.pdf](http://www.nalwt.gov.au/files/Chapter_26-Mitchell_River_catchment_regional_perspective.pdf).
- COOPER, J. & LOOMIS, J. 1992. Sensitivity of Willingness-to-Pay Estimates to Bid Design in Dichotomous Choice Contingent Valuation Models. *Land Economics*, 68(2), 211-224.
- DALY REGION COMMUNITY REFERENCE GROUP. 2004. Executive Summary of the Draft Report of the Daly Region Community Reference Group. Darwin: Daly Region Community Reference Group, Northern Territory Government.
- DELISLE, A., STOECKL, N. & MARSH, H. 2009. Perceived costs and benefits of Indigenous hunting of dugongs and marine turtles: Mabuiag Island as a case study. *Australia New Zealand Society for Ecological Economics Conference*. Darwin.
- DEPARTMENT OF AGRICULTURE FISHERIES AND FORESTRY. 2003. *The National Recreational and Indigenous Fishing Survey* [Online]. Available: [http://www.daff.gov.au/data/assets/pdf\\_file/0011/23501/final\\_recsurvey\\_report.pdf](http://www.daff.gov.au/data/assets/pdf_file/0011/23501/final_recsurvey_report.pdf) [Accessed 13 July 2011].
- DEPARTMENT OF THE ENVIRONMENT AND HERITAGE. 2001. Australia State of the Environment Report. Canberra: CSIRO Publishing.
- DEPARTMENT OF WATER. 2006. Ord River Water Management Plan. *Water Resource Allocation Planning Series Report No WRAP 15*. Department of Water, Government of Western Australia.
- DILLMAN, D. A. 2007. *Mail and Internet Surveys: the Tailored Design Method.*, San Francisco, John Wiley & Sons, Inc.
- DOLINSKY, A. & CAPUTO, R. 1991. Adding a competitive dimension to Importance-Performance Analysis: An application to traditional health care systems. *Health Marketing Quarterly*, 8, 61-77.
- DOUGLAS, M., BUNN, S. E. & DAVIES, P. M. 2005. River and wetland food webs in Australia's wet-dry tropics: general principles and implications for management. *Marine and Freshwater Research*, 56, 329-342.
- DOUGLAS, M., JACKSON, S., SETTERFIELD, S., PUSEY, B. J., DAVIES, P. M., KENNARD, M. J., BURROWS, D. & BUNN, S. E. (eds.) 2011. *Northern futures: threats and opportunities for freshwater systems*, Darwin: Charles Darwin University Press.
- DRIML, S. 1994. *Protection for Profit*, Townsville, Great Barrier Reef Marine Park Authority.
- DUKE, C. & PERSIA, M. 1996. Performance-Importance Analysis of escorted tour evaluations. *Journal of Travel and Tourism Marketing*, 5, 207-223.
- DYSON, M., BERGKAM, G. & SCANLON, J. (eds.) 2003. *Flow. The Essentials of Environmental Flows*, Switzerland and Cambridge, UK: IUCN.
- EDWARD, M. & GEORGE, B. 2008. Destination attractiveness of Kerala as an international tourist destination: An importance-performance analysis. *Meeting of Tourism in India - Challenges Ahead*

- FAGGOTTER, S., BURFORD, M., ROBSON, B. J. & WEBSTER, I. T. 2011. Nutrients and Primary Production in the Flinders River. Charles Darwin University, Darwin.
- GARROD, G. & WILLIS, K. 1999. *Economic Valuation of the Environment*, Cheltenham, UK, Edward Elgar.
- GETZNER, M., SPASH, C. & STAGL, S. 2005. *Alternatives for Environmental Valuation*, New York, Routledge.
- GRAF, L., HEMMASI, M. & NIELSON, W. 1992. Importance satisfaction analysis: A diagnostic tool for organisational change. *Leadership and Organisation Development Journal*, 13(6), 8-12.
- GREGERSEN, H. M., BROOKS, K. N., DIXON, J. A. & HAMILTON, L. S. 1987. Guidelines for economic appraisal of watershed management projects. *Food and Agriculture Organisation of the United Nations Conservation Guide 16*. Rome.
- GREY, F. 1996. Estimating values for Australia's native forests. *Environmental Economics Research Paper No.4*. Canberra: Department of the Environment, Sport and Territories.
- HAKANSSON, C. 2008. A new valuation question: analysis of and insights from interval open-ended data in contingent valuation. *Environmental Resource Economics*, 39, 175-188.
- HALVORSEN, B. & SOELENMINDE, K. 1998. Differences between Willingness-to-Pay Estimates from Open-Ended and Discrete-Choice Contingent Valuation Methods: The Effects of Heteroscedasticity. *Land Economics*, 74(2), 262-282.
- HAMMITT, W., BIXLER, R. & NOE, E. 1996. Going beyond the importance-performance analysis to analyse the observance-influence of park impacts. *Journal of Park and Recreation Administration*, 14(1), 45-62.
- HANEMANN, M. 1989. Welfare Evaluations in Contingent Valuation Experiments with Discrete Response Data: Reply. *American Journal of Agricultural Economics*, 71(4), 1057-61.
- HANLEY, N. & KNIGHT, J. 1992. Valuing the environment: recent UK experience and an application to greenbelt land. *Journal of Environmental Planning and Management*, 35, 145-160.
- HANLEY, N., MACMILLAN, D., WRIGHT, R. E., BULLOCK, C., SIMPSON, I., PARSISSON, D. & CRABTREE, B. 1998. Contingent Valuation Versus Choice Experiments: Estimating the Benefits of Environmentally Sensitive Areas in Scotland. *Journal of Agricultural Economics*, 49(1), 1-15.
- HANLEY, N. & SPASH, C. 1993. *Cost-benefit analysis and the environment*, Cheltenham, Edward Elgar.
- HARRIS, G. P. 2001. Biogeochemistry of nitrogen and phosphorus in Australian catchments, rivers and estuaries: effects of land use and flow regulation and comparisons with global patterns. *Marine and Freshwater Research*, 52, 139-149.
- HEGARTY, P., KELLETT, B. & BRISTOW, K. 2005. A Guide to Northern Australia's Institutional Water Frameworks. CSIRO Land and Water, Townsville
- HERRIGES, J. A. & SHOGREN, J. F. 1996. Starting Point Bias in Dichotomous Choice Valuation with Follow-up Questioning. *Journal of Environmental Economics and Management*, 30, 112-131.
- HOLMES, T. P. & KRAMER, R. A. 1995. An Independent Sample Test of Yea-Saying and Starting Point Bias in Dichotomous-Choice Contingent Valuation. *Journal of Environmental Economic Management*, 29, 121-132.
- INSTREAM FLOW COUNCIL 2004. *Instream Flows for Riverine Resource Stewardship, Revised Edition*, Cheyenne, WY.
- JACKSON, S. 2005. Indigenous values and water resource management: a case study from the Northern Territory. *Australasian Journal of Environmental Management*, 12, 136-146.
- JACKSON, S. & ALTMAN, J. 2009. Indigenous rights and water policy: perspectives from tropical Northern Australia. *Australian Indigenous Law Review* 13 (1), 27-48.
- JACKSON, S., STOECKL, N. & LARSON, S. (eds.) 2011. *The social, cultural and economic significance of tropical aquatic ecosystems: a diversity of values*, Darwin: Charles Darwin University Press.
- JACKSON, S. U. E., STOECKL, N., STRATON, A. & STANLEY, O. 2008. The Changing Value of Australian Tropical Rivers. *Geographical Research*, 46, 275-290.
- JOHANSSON, P. O., KRISTROM, B. & MALER, K. G. 1989. A Note on Welfare Evaluations with Discrete Response Data. *American Journal of Agricultural Economics*, 71, 1054-1056.

- KEALY, M. J. & TURNER, R. W. 1993. A test of the equality of closed-ended and open-ended contingent valuations. *American Journal of Agricultural Economics*, 75, 321-331.
- KENNARD, M. J., PUSEY, B. J., OLDEN, J. D., MACKAY, S. J., STEIN, J. L. & MARSH, N. 2010. Classification of natural flow regimes in Australia to support environmental flow management. *Freshwater Biology*, 55, 171-193.
- KING, J., BROWN, C. & SABET, H. 2003. A Scenario-based Holistic Approach to Environmental Flow Assessments for Rivers. *River Research and Applications*, 19, 619-639.
- KING, J. M., THARME, R. E. & DE VILLERS, M. S. 2000. Environmental flow assessments for rivers: manual for the Building Block Methodology. *Water Resources Commission Report TT 131/100*. Pretoria, South Africa.
- KINLEY, T., YOUN-KYUNG, K. & FORNER, J. 2002. Tourist-destination shopping center: an importance-performance analysis of attributes. *Journal of Shopping Center Research*, 9 (1), 51-72.
- KRISTROM, B. 1997. Spike models in contingent valuation models. *American Journal of Agricultural Economics*, 79, 1013-1023.
- LAND AND WATER AUSTRALIA 2005. The Tropical Rivers Program Canberra: Land and Water Australia.
- LARSON, S. 2010. Regional wellbeing in tropical Queensland, Australia: developing a dissatisfaction index to inform government policy. *Environment and Planning A*, 42, 2972-2989.
- LARSON, S. 2011. *From Individual Wellbeing to Regional Priorities: Concepts and Measures to Assist Policy Makers*, Newcastle upon Tyne, UK, Cambridge Scholars Publishing.
- LARSON, S. & ALEXANDRIDIS, K. 2009. Socio-economic profiling of tropical rivers. Townsville: CSIRO Sustainable Ecosystems
- LOOMIS, J. & EKSTRAND, E. 1997. Economic Benefits of Critical Habitat for the Mexican Spotted Owl: A Scope Test Using a Multiple-Bounded Contingent Valuation Survey. *Journal of Agricultural and Resource Economics*, 22 (2), 356-366.
- MABIRE, C. 2005. Economic importance of the wetlands in the Mary and the Daly River catchments in Northern Australia. University of Wageningen, Wageningen
- MARTILLA, J. & JAMES, J. 1977. Importance-performance Analysis. *Journal of Marketing*, 41 (1), 77-79.
- MCCOLLUM, D. & BOYLE, K. J. 2005. The effect of respondent experience / knowledge in the elicitation of contingent values: an investigation of convergent validity, procedural invariance and reliability. *Environmental Resource Economics*, 30(1), 23-33.
- MCFADDEN, D. L. 1994. Contingent Valuation and Social Choice. *American Journal of Agricultural Economics*, 76, 689-708.
- MCCMAHON, T. A. 1992. World hydrology: does Australia fit? *Hydrology and Water Resources Symposium*. National Conference Publication 83/2, The Institution of Engineers.
- MENGAK, K., DOTTAIO, F. & O'LEARY, J. 1986. Use of Importance-Performance Analysis to evaluate a visitor center. *Journal of Interpretation*, 11, 1-13.
- MILLENNIUM ECOSYSTEM ASSESSMENT (MEA) 2005. *Ecosystems and Human Well-being: A Framework for Assessment*, Washington, DC, Island Press.
- MITCHELL, R. & CARSON, R. 1984. A Contingent Valuation Estimate of National Fresh Water Benefits: A Technical Report to the US Environmental Protection Agency. Washington, DC: Resources for the Future.
- MITCHELL, R. & CARSON, R. 1989. *Using Surveys to Value Public Goods*, Baltimore, John Hopkins University for Resources for the Future.
- MITCHELL RIVER WATERSHED MANAGEMENT GROUP. np. *About the catchment* [Online]. Available: [http://www.mitchell-river.com.au/about\\_the\\_catchment.html](http://www.mitchell-river.com.au/about_the_catchment.html) [Accessed 28 April 2011].
- MORGAN, D., THORBURN, D., FENTON, J., WALLACE-SMITH, H. & GOODSON, S. 2005. Influence of the Camballin Barrage on fish communities in the Fitzroy River, Western Australia. Perth: Murdoch University, Kimberley Land Council, Western Australia Government Department of Environment, Land and Water Australia.

- NATIONAL WATER COMMISSION 2005. National Competition Policy Assessment of Water Reform Progress. Canberra.: National Water Commission.
- NATIONAL WATER COMMISSION 2011. The National Water Initiative - Securing Australia's Water Future 2011 Assessment. Canberra: National Water Commission,.
- NAVRUD, S. 1992. *Pricing the European Environment*, New York, Oxford University Press.
- NGIS AUSTRALIA. 2004. *Australia's Tropical Rivers – Data Audit* [Online]. Canberra: Land and Water Australia. Available: <http://lwa.gov.au/files/products/river-landscapes/pr040674/pr040674.pdf> [Accessed 27 June 2011]
- NIKOLAKIS, W., GRAFTON, R. Q. & TO, H. 2010. Stakeholder Values and Attitudes towards Water Markets across Northern Australia. Charles Darwin University, Darwin.
- NORTHERN AUSTRALIA LAND AND WATER TASKFORCE 2009. Sustainable development in Northern Australia. Canberra: Northern Australia Land and Water Taskforce.
- O'NEILL, M. & PALMER, A. 2004. Importance-performance analysis: A useful tool for directing continuous quality improvement in higher education *Quality Assurance in Education*, 12 (1), 39-52.
- OH, H. 2001. Revisiting importance-performance analysis. *Tourism Management*, 22, 617-627.
- OVASKAINEN, V. & KNIIVILA, M. 2005. Consumer versus citizen preferences in contingent valuation: evidence on the role of question framing. *Australian Journal of Agricultural Resource Economics*, 49, 379-394.
- PAGIOLA, S., VON RITTER, K. & BISHOP, J. 2004. *How Much is an Ecosystem Worth: Assessing the Economic Value of Conservation.*, Washington, DC, The International Bank for Reconstruction and Development / THE WORLD BANK.
- PAPKE, L. & WOOLDRIDGE, J. 1996. Econometric Methods for Fractional Response Variables with an Application to 401(k) Plan Participation Rates. *Journal of Applied Econometrics*, 11(6), 619-632.
- PUCKRIDGE, J. T., SHELDON, F., WALKER, K. F. & BOULTON, A. J. 1998. Flow variability and the ecology of large rivers. *Regulated Rivers: Research and Management*, 9, 55-72.
- READY, R. C., WHITEHEAD, J. & BLOMQUIST, G. 1995. Contingent valuation when respondents are ambivalent. *Journal of Environmental Economic Management*, 29, 181-196.
- REAVES, D. W., KRAMER, R. A. & HOLMES, T. P. 1999. Does Question Format Matter? Valuing an Endangered Species. *Environmental Resource Economics*, 14, 365-383.
- RIETBERGEN-MCCRACKEN, J. & ABAZA, H. 2000. *Environmental Valuation: A Worldwide Compendium of Case Studies*, London, Earthscan.
- ROSENBERG, S. & KIM, M. P. 1975. The method of sorting as a data gathering procedure in multivariate research. *Multivariate Behavioral Research*, 10, 489-502.
- ROWE, R. D., SCHULZE, W. D. & BREFFLE, W. S. 1996. A Test for Payment Card Biases. *Journal of Environmental Economics and Management*, 31, 178-185.
- SELLER, C., STOLL, J. R. & CHAVAS, J. P. 1985. Valuation of Empirical Measures of Welfare Change: A comparison of non-market techniques. *Land Economics*, 61 (May), 156-75.
- STARK, S. & TORRANCE, H. 2006. Case Study. In: SOMEKH, B. & LEWIN, C. (eds.) *Research methods in the Social Sciences*. London, UK: Sage Publications Ltd.
- STOECKL, N., ESPARON, M., STANLEY, O., FARR, M., DELISLE, A. & ALTAI, Z. 2011. Socio-economic activity and water use in Australia's Tropical Rivers: A case study in the Mitchell and Daly River. Charles Darwin University, Darwin.
- STOECKL, N. & STANLEY, O. 2007. Key Industries in Australia's Tropical Savanna. *Australasian Journal of Regional Studies*, 13, 255-286.
- STOECKL, N., STANLEY, O., JACKSON, S., STRATON, A. & BROWN, V. 2006. An Assessment of the Social and Economic Values of Australia's Tropical Rivers Program. Land and Water Australia, CSIRO and James Cook University.
- STOREY, A. W., DAVIES, P. M. & FROEND, R. H. 2001. Draft Report: Fitzroy River System: Environmental Values, . Prepared for the Waters and Rivers Commission, Australia.

- STRATON, A., JACKSON, S., MARINONI, O., W., P. & WOODWARD, E. 2011. Exploring and evaluating scenarios for a river catchment in Northern Australia: using combined scenario development, multi-criteria analysis and a deliberative process as a tool for water planning. *Water Resource Management*, 25 (1), 141-149.
- STRATON, A. & ZANDER, K. 2009. The Value of Australia's Tropical River Ecosystem Services. Charles Darwin University, Darwin.
- THARME, R. E. 2003. A Global Perspective on Environmental Flow Assessment: Emerging Trends in the Development and Application of Environmental Flow Methodologies for Rivers. . *River Research and Applications*, 19(5-6), 397-441.
- THUNBERG, E. M. 1988. *Willingness to Pay for Property and Non-Property Flood Hazard Reduction Benefits: An Experiment Using the Contingent Value Survey Method*. Ph.D. thesis, Virginia Tech.
- TONGE, J. & MOORE, S. 2007. Importance-satisfaction analysis for marine-park hinterlands: A Western Australian case study. *Tourism Management*, 28, 768-776.
- TOUSSAINT, S., SULLIVAN, P., YU, S. & MULARTY JNR., M. 2001. Fitzroy Valley Indigenous Cultural Values Study: a preliminary assessment. Water and Rivers Commission, Perth
- TRAYLER, K., MALSEE, B. & BARAIMBRIDGE, M. 2006. Environmental values, flow related issues and objectives for the lower Ord River. Department of Water, Western Australia.
- TROCHIM, W. 1989. An introduction to concept mapping for program planning and evaluation. *Evaluation and Program Planning*, 12, 1-16.
- VAN DAM, R. & BARTOLO, R. 2005. Australia's tropical rivers: an integrated data assessment and analysis. *RipRap-River and Riparian Lands Management Newsletter*.
- VAN DAM, R., BARTOLO, R. & BAYLISS, P. 2008. Ecological risk assessment for Australia's northern tropical rivers. Sub-project 2 of Australia's tropical rivers - an integrated data assessment and analysis (DET18). Darwin: Environmental Research Institute of the Supervising Scientist, National Centre for Tropical Wetland Research.
- WADE, D. & EAGLES, P. 2003. The use of importance-performance analysis and market segmentation for tourism management in parks and protected areas: An application to Tanzania's National Parks *Journal of Ecotourism*, 2 (3), 196-212.
- WALSH, R. G., JOHNSON, D. M. & MCKEAN, J. R. 1989. Issues in non-market valuation and policy application: A retrospective glance. *Western Journal of Agricultural Economics*, 14, 178-188.
- WELSH, M. & POE, G. L. 1998. Elicitation Effects in Contingent Valuation: Comparisons to a Multiple Bounded Choice Approach. *Journal of Environmental Economics and Management*, 36, 170-185.
- WILLIS, K., BUTTON, K. & NIJKAMP, P. 1999. *Environmental Valuation*, Northampton, Edward Elgar.
- WOODWARD, E., JACKSON, S. & STRATON, A. 2008. Water Resources of the Howard River Region, Northern Territory: A Report on the Social and Cultural Values of a Stakeholder Assessment of Water Use Scenarios. CSIRO Sustainable Ecosystems: Darwin.
- YEO, A. 2003. Examining a Singapore bank's competitive superiority using importance-performance analysis. *Journal of American Academy of Business*, 3 (1), 155-161.

## Appendix A – Focus group meeting invitation and agenda



### Relative values of water for trade-offs.

You are invited to take part in a research project about the values of water different groups of people have (for example, residents, businesses, agriculturalists, horticulturalists, mines etc) and how they might respond to changes in water quality and/or quantity in their catchment area.

The project is being conducted by researchers at James Cook University and CSIRO and is funded by the North Australia Water Futures Assessment (NAWFA) under the Social and Cultural program. The aim of NAWFA's Cultural and Social program is to understand the socio-cultural values, beliefs and practices associated with water and how they may be affected by changes in water availability.

This project will aim to provide policy makers with a better understanding of the things people 'value' most about their rivers, and about their willingness to trade those 'values' for things like more jobs or higher incomes. The study is being conducted by Natalie Stoeckl, Barbara Neil and Riccardo Welters and will contribute to a broader range of projects aimed at increasing the understanding of the social and economic characteristics of the Tropical Rivers region.

If you agree to be involved in the study, you are invited to participate in this community workshop to discuss how important water is to you and what you use it for, as well as how things might change if something happened to change either the quality or quantity of water in the Mitchell River. We would also like to use this workshop to trial some questions to be used later on (in interviews and possibly also in a mail-out questionnaire) to help us understand how important water is for other people in this catchment and for people living in other parts of Northern Australia.

During the workshop we would like to discuss:

- if different people use and/or 'value' water for different things (such as fishing, swimming, farming or simply 'watching')
- how important it is (to different people) to be able to do those things
- how satisfied you are with the current situation
- how these things could change in response to a variety of different development scenarios

The workshop should only take approximately 2 hours of your time, and will be conducted at the Mareeba Leagues Club. Tea, coffee and light refreshments will be supplied.

Taking part in this study is completely voluntary and you can stop taking part in the study at any time without explanation or prejudice.

Your responses and contact details will be strictly confidential. The data from the study will be used in research publications and you will not be identified in any way in these publications. The data collect in this research may be used by other researchers in future research projects.

If you have any questions about the study, please contact Natalie Stoeckl or Barbara Neil.

#### Principal Investigator:

**Natalie Stoeckl, (JCU)**

☎: 4781 4868

✉: [Natalie.stoeckl@jcu.edu.au](mailto:Natalie.stoeckl@jcu.edu.au)

#### Researchers:

**Barbara Neil (JCU)**

☎: 4781 5014

✉: [Barbara.neil1@jcu.edu.au](mailto:Barbara.neil1@jcu.edu.au)

**Riccardo Welters (JCU)**

☎: 4781 4325

✉: [riccardo.welters@jcu.edu.au](mailto:riccardo.welters@jcu.edu.au)

*If you have any concerns regarding the ethical conduct of the study, please contact:  
Sophie Thompson, Human Ethics and Grants Administrator, Research Office  
James Cook University, Townsville, Qld, 4811  
Phone: (07) 4781 6575 ([Sophie.Thompson@jcu.edu.au](mailto:Sophie.Thompson@jcu.edu.au))*



## MAREEBA FOCUS GROUP - AGENDA

- 8.50am Tea and Coffee
- 9.00am Welcome and introductions, including Traditional Welcome to Country
- 9.10am Brief introduction/ explanation of our research
- 9.20am Activity 1 – Creating a list of things which people think are important about their rivers (group activity)
- 9.40am Activity 2 – Deciding which of those things are most important to you, and telling us how ‘satisfied’ you are with your ability to enjoy (or take advantage of) those things. (individual activity)
- 9.50am Activity 3 – Telling us how your ‘satisfaction’ might change if there were changes in rainfall which altered stream flows and water quality (individual activity)
- 10.10am Activity 4 – Telling us how your ‘satisfaction’ might change if a hypothetical development took place that altered stream flows, but which also provided jobs and income (individual activity)
- 10.30am Activity 5 – Telling us about which types of things which you like about rivers ‘go together’ and which do not. (group activity)
- 10.50am Wrap up and discussion
- 11.00am Morning tea

*Thank you for your participation ☺*

## Appendix B – Differences between Indigenous and non-Indigenous responses to questions about the relative importance of key values (mail-out, and interview data considered separately)

### **Mail-out data only**

Summaries of perceptions are presented in Table 26. Even here – with only 10 Indigenous respondents to the mail-out – it is clear that Indigenous respondents are likely to allocate higher importance scores to key values than are non-Indigenous respondents, and in many cases, those differences are statistically significant (non-parametric tests were used because of the very small sample of Indigenous respondents). As previously, it is clear that values associated with *Life* and *Biodiversity*, consistently out-rank other values – see Table 27 – and that water for *Commercial* purposes is the least important value for Indigenous respondents.

**Table 26 – The relative importance of Social and Cultural values: Indigenous and non-Indigenous responses compared (mail-out data only)**

How important are rivers for...	Non-Indigenous			Indigenous		
	Mean	Median	Valid N	Mean	Median	Valid N
... Life?	92	100	220	98***	100	10
... Biodiversity?	94	100	218	99***	100	10
... Commercial purposes?	78	90	213	63	65	10
... Bequest?	92	100	212	97	100	10
... Existence?	78	100	161	76	100	5
... Fishing?	73	80	191	96***	100	9
... Recreation?	75	90	197	97***	100	9
... Aesthetics?	83	95	203	92	100	9
... Teaching?	60	60	174	97***	100	9

**Table 27 – The three most important and least important values – Indigenous and non-Indigenous compared (mail-out data only)**

	Non-Indigenous respondents		Indigenous Respondents	
Top three 'values'	Biodiversity	94	Biodiversity	99
	Life	92	Life	98
	Bequest	92	Bequest	97
Bottom three 'values'			Teaching	
	Recreation	75	Recreation	
	Fishing	73	Aesthetics	92
	Teaching	60	Existence	76
		Commercial purposes	63	

**Interviewee data only**

Summaries of perceptions are presented in Table 28. As expected (given the previous analyses), Indigenous respondents allocated higher importance scores to key values than non-Indigenous respondents. As previously, it is clear that values associated with *Life* and *Biodiversity*, consistently out-rank other values – see Table 29 – and that water for *Commercial* purposes is the least important value for Indigenous respondents.

**Table 28 – The relative importance of Social and Cultural values: Indigenous and non-Indigenous responses compared (interview data only)**

How important are the rivers for...	Non-Indigenous			Indigenous		
	Mean	Median	Valid N	Mean	Median	Valid N
... Life?	95	100	22	100*	100	17
... Biodiversity?	95	100	22	99	100	17
... Commercial purposes?	90	100	22	79	90	17
... Bequest?	95	100	21	96	100	17
... Existence	88	100	18	92	100	17
... Fishing?	75	95	21	96***	100	17
... Recreation?	81	90	21	91**	100	17
... Aesthetics?	83	100	21	99***	100	17
... Teaching?	71	80	19	99***	100	17

**Table 29 – The three most and least important values – Indigenous and non-Indigenous compared (interview data only)**

	Non-Indigenous respondents		Indigenous Respondents	
Top three 'values'	Life	95	Life	100
	Biodiversity	95	Biodiversity	99
	Bequest	95	Aesthetics	99
Bottom three 'values'			Teaching	99
	Recreation	81	Existence	92
	Fishing	75	Recreation	91
	Teaching	71	Commercial purposes	79

## Appendix C – Comparing the relative importance and satisfaction of Social and Cultural values across respondents whose households depend upon different industries for income

**Table 30 – Relative importance of Social and Cultural values – mean responses compared across households dependent upon different industries for income**

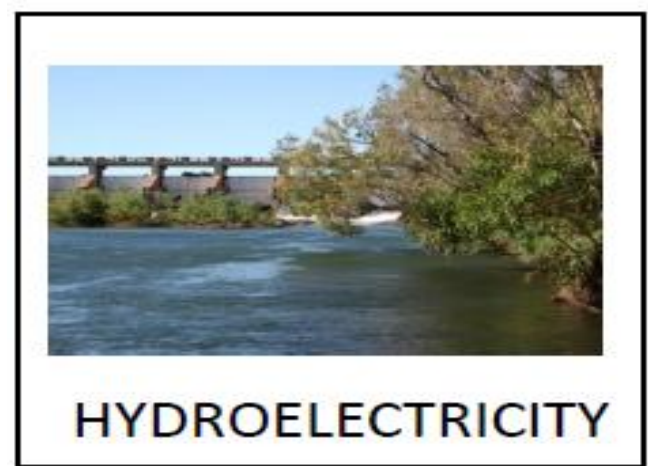
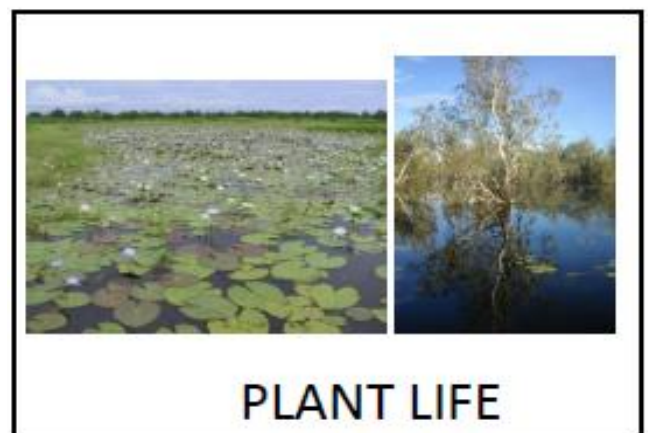
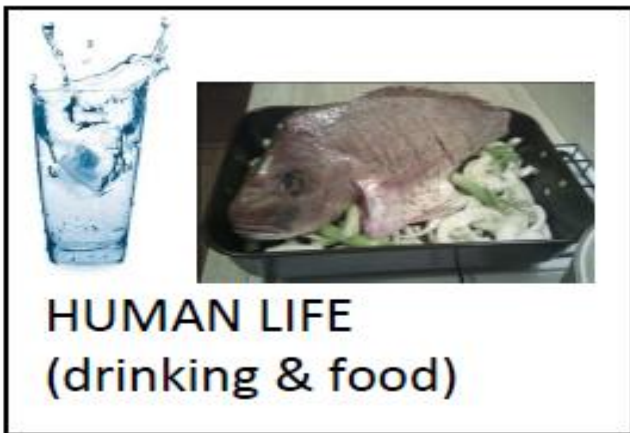
How important are rivers for...	Government	Agriculture	Mining	Industry and transport	Services	Passive income government	Passive income investment
... Life?	93	93	88	94	93	95	96
... Biodiversity?	94	94	90	97	96	96	95
... Commercial purposes?	75	89	71	89	71	78	83
... Bequest?	90	89	83	94	96	96	98
... Existence?	74	69	65	86	85	87	88
... Fishing?	68	63	70	82	74	77	66
... Recreation?	73	73	75	84	83	81	72
... Aesthetics?	80	72	73	81	85	91	80
... Teaching?	59	68	55	68	62	87	57

**Table 31 – Satisfaction ratings: responses compared across households dependent upon different industries for income**

How satisfied are you with ...	Government	Agriculture	Mining	Industry and Transport	Services	Passive Income Government	Passive Income Investment
Life as a whole	82	83	82	84	83	86	88
How satisfied are you with rivers for ...							
Life	79	83	77	79	81	80	66
Biodiversity	79	89	80	80	81	82	77
Commercial purposes	68	73	70	70	72	71	71
Bequest	77	83	78	75	81	81	78
Existence	71	86	76	79	79	80	83
Fishing	71	79	79	78	71	78	75
Recreation	73	78	82	80	80	84	75
Aesthetics	76	82	77	75	81	89	78
Teaching	64	91	76	65	73	80	73

## Appendix D – Cognitive mapping exercise cards

The following are examples of the cards used in the cognitive mapping exercise.





**CATTLE (grazing)**



**PROCESSING MINERALS**



**PEACE OF MIND,  
AESTHETICS,  
INSPIRATION**



**RECREATIONAL FISHING**



**SOCIALISING AND OTHER  
TYPES OF RECREATION**



**FUTURE  
GENERATIONS**



FOR THEIR OWN SAKE  
(even if I never use them)



CULTURE (tradition,  
connect with history, remember  
ancestors), TEACHING / LEARNING

## Appendix E – MDS output for those who are on passive incomes compared to those who are employed.

Figure 53 below shows the results of the MDS for all employed participants aggregated, while Figure 54 shows the results of all participants receiving a passive income aggregated<sup>80</sup>. It had been anticipated that passive income mapping and Indigenous mapping would be similar, given that the majority of Indigenous participants' primary source of income is passive. However, comparing Figure 28 and Figure 54, shows that while the split between commercial and non-commercial values on the horizontal dimension is similar, the ordering of other values varies on the vertical dimension, particularly recreational fishing (which is much higher for passive income data).

The employed participant's mapping shows a much tighter cluster of Social and Cultural values, while 'human life' and 'recreational fishing' are much lower on the vertical dimension than for those receiving a passive income.

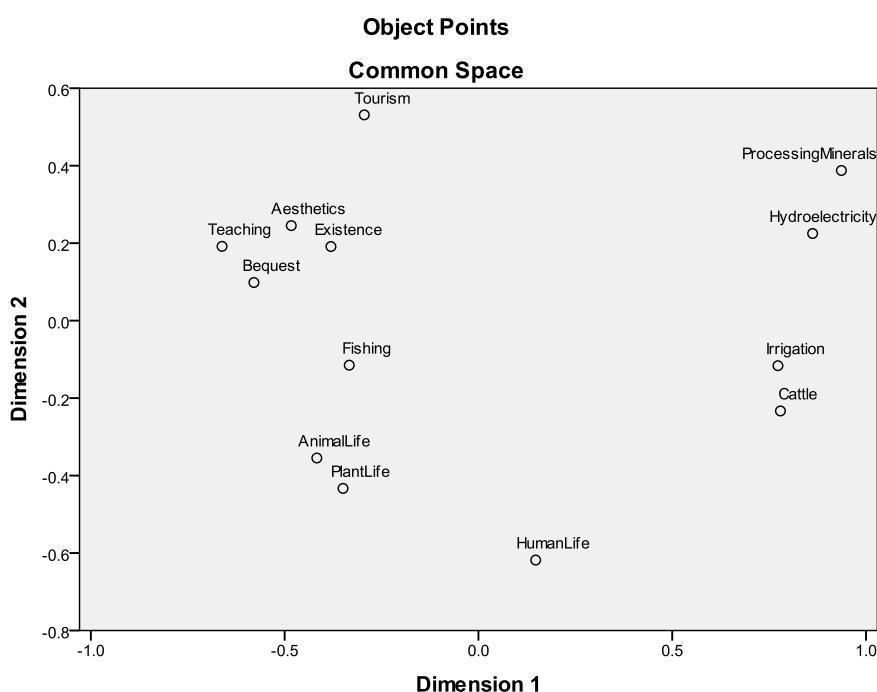


Figure 53 – Cluster analysis Employed aggregated data (n=15)

<sup>80</sup> In both cases, Kruskal's stress was reasonable (albeit slightly higher than ideal – 0.132 for employed data and 0.176 for passive income data) however Tucker's coefficient of congruence indicates there is a good fit between the original proximity measures and derived distances for both data sets (0.991 for employed data and 0.984 for passive income data).



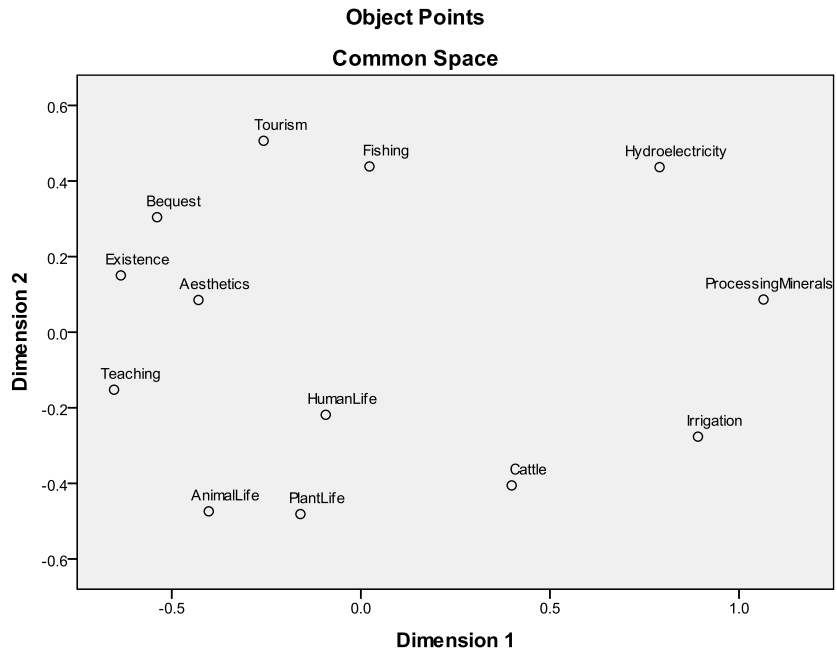


Figure 54 – Cluster analysis Passive Income aggregated data (n=21)

## Appendix F – How much did inclusion of the ‘protest’ option affect responses to the WTP/WTA question

The inclusion of the option to protest against the notion of using payment transfers to accommodate changes in Social and Cultural values of local rivers and waterholes as a result of changes in economic activity may lead to behavioural change of the respondents.

We discuss two types of behavioural change: change in response behaviour and change in WTP/A reporting behaviour.

### F.1 Overall response rate

Here we focus on the mail-out questionnaires only as interviewees were not provided with a formal ‘protest’ option; rather, they were given the opportunity to voice their objections in person. First we check whether the availability of a formal protest option in the questions relating to WTP/A affects the respondent’s decision to fill out (and return) the questionnaire altogether.

Targeted respondents were divided equally to receive a questionnaire which included a formal protest option or a questionnaire without a formal protest option. Table 32 shows the response rates. We note that 47.6 per cent of returned questionnaires included the protest option. Formal testing shows that 47.6 per cent is not statistically different from 50 per cent at a 10 per cent confidence level. As such there is no evidence to suggest that the availability of the protest option has lead respondents to change their decision to return the questionnaire.

Table 32 – Response rate and the formal option to protest (mail out survey only)

	Formal option to protest	No formal option to protest
Response rate	47.6	52.5

#### F.1.1 Decisions to respond to WTP/WTA questions

Not changing the return decision of the questionnaire as a result of the option to protest does not necessarily mean that respondents did not change their answering behaviour to the questions that were directly related to the protest option. Table 33 summarises the results for possible behavioural change in regards to the questions in which the protest vote is used. Again we focus on the mail out questionnaires only, while differentiating between respondents who faced a questionnaire without the protest option and those who did have that option.

The following indicators are reported:

- the Non Response Rate (NRR) – respondents who leave the relevant question(s) unanswered;
- the Effective Non Response Rate (ENRR) – respondents who leave the relevant question(s) unanswered or provide an unrealistic answer (i.e. outliers); and
- the Effective Response Rate (ERR) – respondents who answer the relevant question(s) in a way that we – researchers – can interpret their reported results (i.e. exclude protest votes).

Comparing the NRRs for both groups, we find that the NRR is nearly double for the respondents who could not choose to protest, suggesting that skipping the relevant question(s) was – in absence of a formal possibility to protest – their way of protesting. Further evidence of skipping the relevant question(s) as a means to protest is that the NRR increases for each sub scenario within all three scenarios. That is, once the sub-scenario gets progressively more extreme, the NRR increases for respondents without a formal protest option, while much less so for respondents who had a formal protest option.

#### **F.1.2 Distribution of responses across the other ‘categories’ that were presented as options**

Non-parametric tests of the distribution of responses across the other ‘options’ that were presented to respondents (i.e. pay/accept nothing, pay/accept < \$25; pay/accept \$25 etc) indicated that there were no statistically significant differences between those who were presented with a formal protest option and those who were not.

#### **F.2 Response behavioural change: response to the relevant question(s)**

As discussed in section 5.2.2 there was evidence to suggest that those who were not given a formal protest option, may have ‘protested’ by providing unrealistic responses to the open ended part of the WTP/WTA questions – termed ‘outliers’.

If we add the outliers to the non response, we obtain the effective non response rate (ENRR). The difference between the ENRR and the NRR is the share of outliers. Table 33 shows that this share is higher for those who did not have a formal protest option. Therefore, providing an unrealistic answer to the relevant question(s) might also be a way to protest.

Consequently, it seems that providing a formal protest option reduces non response and improves the accuracy of the provided answers. However, it comes at a cost: a lower effective response rate as the third ratio in Table 33 shows. Once you provide respondents with a formal protest option, they make use of it. And that share is much larger than can possibly be explained by those, who in the absence of a formal protest option, leave the relevant questions blank or provide an unrealistic answer.

Subsequently, it seems that providing the formal protest option can only be justified – from a researcher’s perspective – if it improves answer accuracy, as it will decrease response rates.

Table 33 – Response rate analysis (mail out data only)

	Protest option			No protest option		
	NRR	ENRR	ERR	NRR	ENRR	ERR
Scenario 1						
25 % reduction	0.085	0.093	0.322	0.169	0.208	0.792
50 % reduction	0.093	0.102	0.322	0.185	0.223	0.777
100 % reduction	0.093	0.102	0.305	0.200	0.246	0.754
Scenario 2						
25 % reduction	0.110	0.136	0.288	0.223	0.300	0.700
50 % reduction	0.119	0.153	0.263	0.246	0.354	0.646
100 % reduction	0.119	0.153	0.263	0.262	0.377	0.627
Scenario 3						
25 % increase	0.136	0.136	0.305	0.231	0.292	0.708
50 % increase	0.127	0.127	0.297	0.238	0.300	0.700
100 % increase	0.136	0.136	0.305	0.246	0.308	0.692

To shed some light into answer accuracy we now turn to the impact of the inclusion of the protest option in the questionnaire on the WTP/A of respondents for the three scenarios. We know there are four potential reasons that may explain differences in the answers we obtained from questionnaires that contain the protest option compared to questionnaires that did not contain the protest option:

- selection bias resulting from the respondent’s decision not to return the questionnaire as a result of the inclusion (or exclusion) of the protest vote option;
- selection bias resulting from the respondent’s decision to skip the relevant question(s) as a result of the inclusion (or exclusion) of the protest vote option;
- selection bias resulting from the respondent’s decision to tick the protest vote box while they would have answered the question if the protest option had not been available; or
- inaccurate answering as a result of the inclusion (or exclusion) of the protest vote option.

The preceding analysis shows that the first reason can only play a marginal role, while the fourth reason can be controlled for. As Table 33 shows the second and third reasons cannot be ruled out, but do they apply? Table 34 intends to answer this question. It shows the sums of WTP/A expressed as percentages of total household income, split into the availability of a formal protest option and – in the bottom part – the likelihood that WTP/A found among respondents who had a formal protest vote option is different from that of those who did not have that option.

This probability is not higher than 90 per cent for any sub-scenarios, therefore we reject the hypothesis that the mean WTP/A is different for those who had no formal option to protest than for those who did, provided one controls for unrealistic answering. Analysis (results not shown here) in which one tightens the outlier assumption, demonstrates that one must accept the above hypothesis – at least for WTP; not for WTA.

Table 34 – WTP/A as per cent of annual household income – protest and no-protest responses compared (mail out data only)

Questions in questionnaire	Scenario 1	Scenario 2	Scenario 3
Sample group	(WTP)	(WTA)	(WTP)
<b>Protest option included:</b>			
25 % decrease / increase	0.14	0.20	0.15
50 % decrease / increase	0.18	0.21	0.16
100 % decrease / increase	0.23	0.22	0.17
<b>Protest option not included:</b>			
25 % decrease / increase	0.13	0.19	0.10
50 % decrease / increase	0.17	0.22	0.10
100 % decrease / increase	0.23	0.25	0.12
<b>Total:</b>			
25 % decrease / increase	0.13	0.19	0.11
50 % decrease / increase	0.17	0.22	0.12
100 % decrease / increase	0.23	0.24	0.14
<b>Probability Value<sub>Protest</sub> ≠ Value<sub>No protest</sub>:</b>			
25 % decrease / increase	10 %	10 %	79 %
50 % decrease / increase	19 %	5 %	86 %
100 % decrease / increase	6 %	26 %	59 %

## Appendix G – Statistical tests for differences between mail-out and interview responses to WTP/WTA scenarios

We decided to exclude the interview data from our analysis, because we suspect that WTP/A data collected from mail out surveys and interview surveys are non-comparable. To verify this, we conducted a similar analysis to the one presented in Table 34. However, we split the sample not on the protest option but on the type of survey (mail out versus interview). Since the interviews were collected in the Mitchell River catchment only and we know that WTP/A differs significantly between Mitchell River catchment residence and residence elsewhere, we focus on Mitchell River catchment residence only. Further we also concentrate on the non-Indigenous part of our response. That is, we also expect Indigenous people to provide different WTP/A figures than non-Indigenous people.

Table 35 contains the results of our analysis. The results are as expected: WTP is higher in a face-to-face (with the interviewer) situation, whilst WTA is lower. The probabilities that WTP/A values are not equal are fairly high, which – given the low sample sizes – induces us to not merge data from the mail out survey and the interview survey in this section of the report.

**Table 35 – WTP/A as per cent of annual household income: mail out response versus interview survey for non-Indigenous residence of the Mitchell river catchment**

Questions in questionnaire	Scenario 1	Scenario 2	Scenario 3
Sample group	(WTP)	(WTA)	(WTP)
<b>Mail out survey:</b>			
25 % decrease / increase	0.13	0.34	0.19
50 % decrease / increase	0.17	0.36	0.19
100 % decrease / increase	0.20	0.35	0.20
<b>Interview survey:</b>			
25 % decrease / increase	0.23	0.15	0.32
50 % decrease / increase	0.26	0.15	0.36
100 % decrease / increase	0.28	0.21	0.44
<b>Probability Value<sub>Mail out</sub> ≠ Value<sub>Interview</sub>:</b>			
25 % decrease / increase	76 %	56 %	74 %
50 % decrease / increase	66 %	61 %	84 %
100 % decrease / increase	63 %	41 %	94 %

## Appendix H – Bivariate analysis of WTP/WTA responses

Table 36 presents a breakdown of the WTP/A values to various demographical and environmental characteristics in a bivariate setting. First, we note that the general principles that held for the total sample, also hold for nearly all demographic subsamples: (1) WTP to prevent damage is lower than WTA compensation for damage incurred, (2) WTP to prevent deterioration is higher than WTP to realise improvement, and (3) WTP and WTA is decreasing incrementally.

We find that women and older respondents report higher WTP/A figures than men and younger respondents respectively, though these gender and age differences are not statistically significant. However, those with less formal schooling are WTP statistically significantly more to prevent damage to the ‘feel good’ factors associated with the local rivers and waterholes (scenario 1). We should be somewhat careful with that result, as lower household income is a statistically significant predictor of higher willingness to pay and educational attainment and income levels may be correlated – the subsequent multivariate analysis will reveal which of these two factors is dominant (if one is at all). The availability to indicate that you cannot afford to make a payment to avoid the resultant impacts on their Social and Cultural ‘values’ does not change the general finding that low income earners are WTP/A more than higher income earners.

We also included information about the water flow of the river to which the respondents refer. The decreasing marginal WTA/P seems to suggest that respondents are opposing initial damage more than subsequent damage. Does that mean that they are more opposed to development in a perennial river than in a non-perennial river? Comparing the WTP/A figures in Table 36 suggest the answer is in the affirmative, although the low sample size prevents us from drawing definite conclusions – the multivariate specification may provide more information.

Finally, there is some weak statistical support for the thesis that respondents residing in the Mitchell River catchment are WTP a larger sum for improvements to their ‘feel good’ factors than respondents residing elsewhere in Queensland, in the Northern Territory or in Western Australia.

Table 36 – Bivariate analysis of WTP/A (per cent of household income) to demographic and environmental characteristics

Change to feel good factors	Scenario 1 (WTP)			Scenario 2 (WTA)			Scenario 3 (WTP)		
	25 % reduction	50 % reduction	100 % Reduction	25 % reduction	50 % reduction	100 % reduction	25 % increase	50 % increase	100 % increase
Demographics									
Gender:									
Male	0.12	0.16	0.23	0.16	0.20	0.21	0.09	0.09	0.10
Female	0.14	0.18	0.22	0.23	0.24	0.28	0.13	0.15	0.17
Age:									
< 50 years of age	0.12	0.17	0.23	0.15	0.19	0.23	0.09	0.09	0.10
> 50 years of age	0.15	0.17	0.22	0.23	0.24	0.26	0.13	0.14	0.17
Indigeneity:									
Indigenous <sup>81</sup>	0.19	0.19	0.19	0.21	0.21	0.21	0.19	0.19	0.19
Non-Indigenous	0.13	0.17	0.23	0.19	0.22	0.24	0.11	0.11	0.13
Education:									
Secondary school at most	0.17*	0.23**	0.29*	0.25	0.26	0.29	0.14	0.15	0.17
Further education	0.10	0.11	0.16	0.13	0.16	0.19	0.09	0.09	0.10
Household income:									
< \$20,000	0.19*	0.29*	0.40*	0.56***	0.56**	0.62***	0.18**	0.20*	0.26*
\$20,000 – \$100,000	0.14	0.17	0.22*	0.13	0.17	0.19	0.12*	0.12	0.13
> \$100,000 (reference)	0.08	0.10	0.13	0.07	0.08	0.10	0.05	0.06	0.08
Perennial river:									
Yes	0.15	0.19	0.24	0.24	0.25	0.28	0.11	0.12	0.14
No	0.10	0.12	0.19	0.07	0.12	0.15	0.10	0.10	0.12
Residence:									
Mitchell catchment	0.13	0.17	0.20	0.34	0.36	0.35	0.19*	0.19	0.20
Elsewhere (WA, NT or QLD)	0.13	0.17	0.23	0.17	0.19	0.23	0.10	0.10	0.13

\*\*\* Statistically significantly different from reference category at 1 per cent, \*\* at 5 per cent, \* at 10 per cent

<sup>81</sup> Only 4 responses were received for WTP scenarios and 3 for WTA



## Appendix I - Multivariate analysis of WTP/WTA responses

Table 37 – Factors influencing WTP/A as a proportion of household income

Change to feel good factors		Most important determinants of WTP/A (generalised linear modelling):	Log pseudolikelihood
Scenario 1	25% reduction	↓ with further education ↑ Rivers important for Biodiversity	-0.96
	50% reduction	↓ with further education ↓ as household income increases ↑ Rivers important for Biodiversity	-1.18
	100% reduction	↓ Females ↓ with further education ↓ as household income increases ↑ Rivers important for Biodiversity ↓ Rivers important for Commercial purposes	-1.51
Scenario 2	25% reduction	↓ as household income increases ↑ Rivers important for Biodiversity	-1.06
	50% reduction	↓ as household income increases ↑ Rivers important for Biodiversity	-1.19
	100% reduction	↓ as household income increases ↑ Rivers important for Biodiversity ↓ Rivers important for Commercial purposes	-1.32
Scenario 3	25% reduction	↓ as household income increases	-0.85
	50% reduction	↓ with further education ↓ as household income increases ↑ Rivers important for Biodiversity	-0.85
	100% reduction	↓ with further education ↓ as household income increases ↑ Rivers important for Biodiversity	-0.96

Table 38 – Factors influencing WTP/A (straight dollar values)

Change to feel good factors		Most important determinants of WTP/A (generalised linear modelling):	Adjusted R <sup>2</sup>
Scenario 1	25% reduction	↓ for households with lower income ↑ Rivers important for Biodiversity	0.02
	50% reduction	↑ as household income increases ↑ Rivers important for Biodiversity	0.09
	100% reduction	↓ Females ↓ for households with lower income ↑ Rivers important for Biodiversity ↓ Rivers important for Commercial purposes	0.13
Scenario 2	25% reduction	↑ River is perennial ↑ Rivers important for Biodiversity ↓ Rivers important for Commercial purposes	0.11
	50% reduction	↓ Females ↑ River is perennial ↑ Rivers important for Biodiversity ↓ Rivers important for Commercial purposes	0.13
	100% reduction	↓ Females ↓ for households with lower income ↑ Rivers important for Biodiversity ↓ Rivers important for Commercial purposes	0.16
Scenario 3	25% reduction	No significant determinants	
	50% reduction	↓ for households with lower income	-0.05
	100% reduction	↓ for households with lower income ↑ Rivers important for Biodiversity	-0.03

## Appendix J – Changes to water quality frequency plots

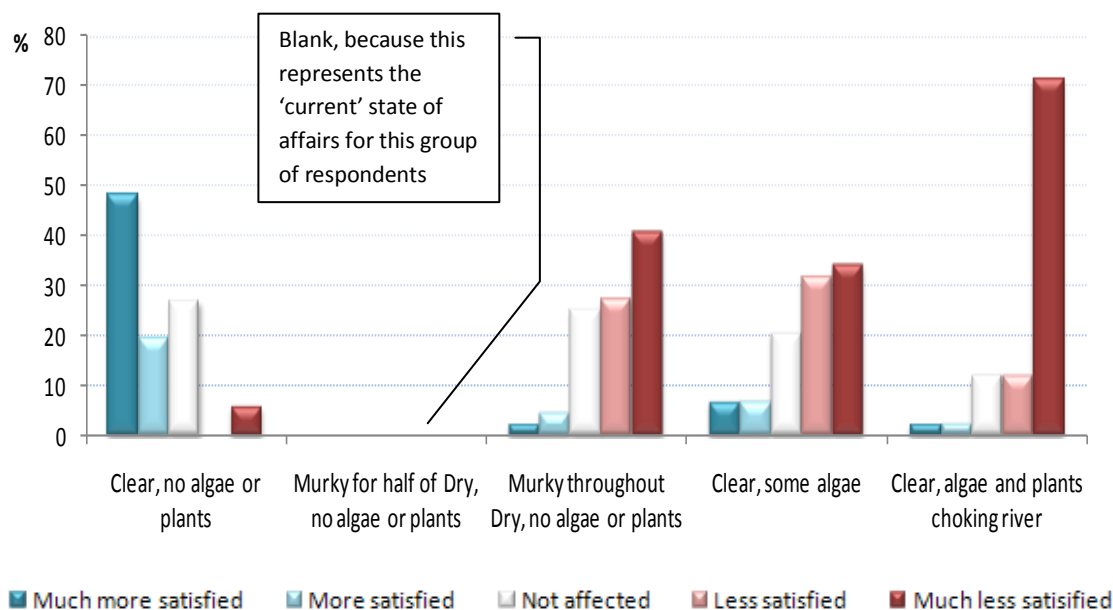


Figure 55 – Reaction of those living near a river that is currently murky for half of the dry season to a variety of different scenarios involving a change in water quality: distribution of responses

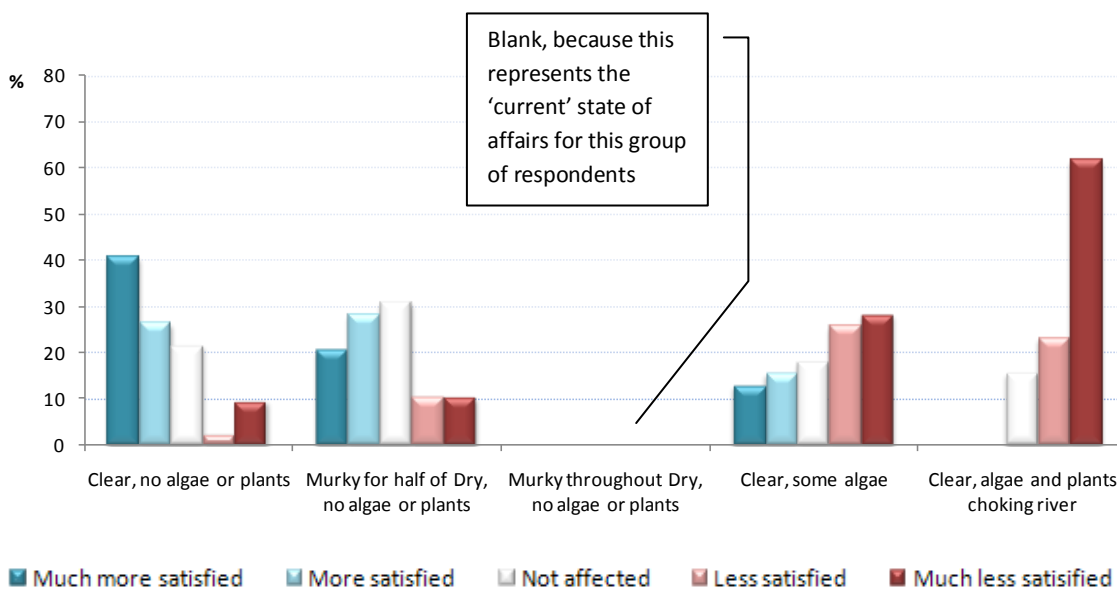


Figure 56 – Reaction of those living near a river that is currently murky throughout the dry season to a variety of different scenarios involving a change in water quality: distribution of responses

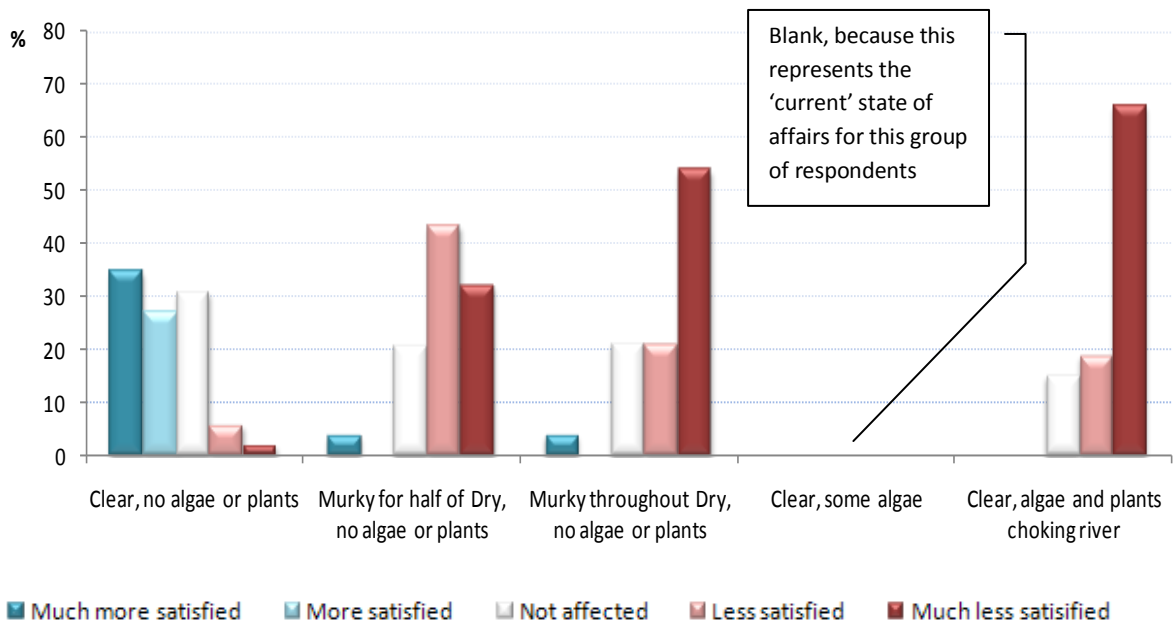


Figure 57 – Reaction of those living near a river that is currently clear with some algae to a variety of different scenarios involving a change in water quality: distribution of responses

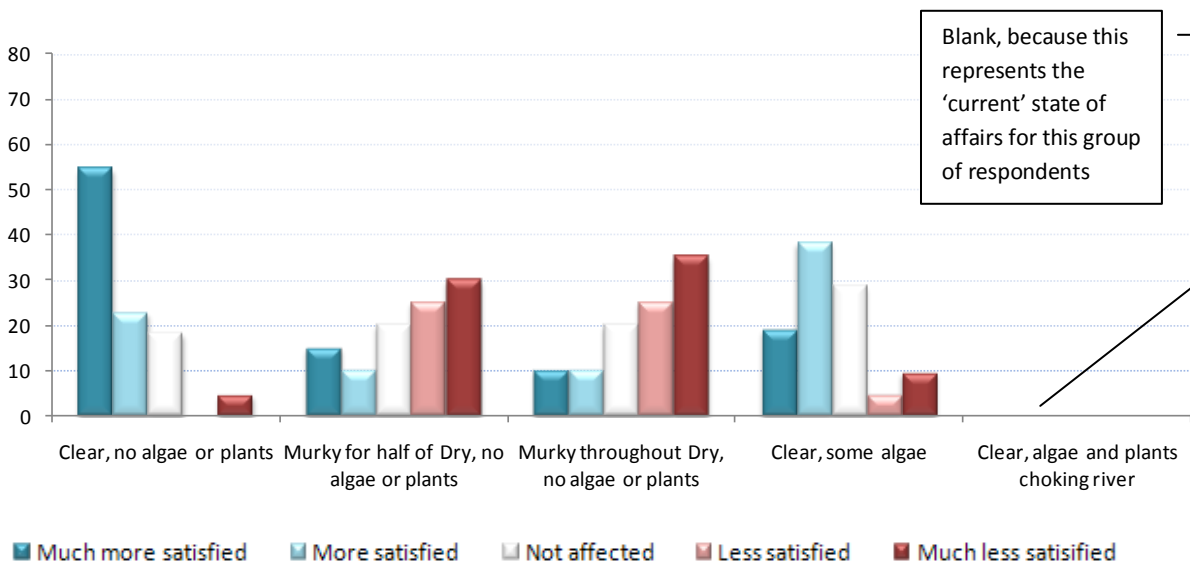


Figure 58 – Reaction of those living near a river that is currently clear with lots of algae to a variety of different scenarios involving a change in water quality: distribution of responses

## Appendix K – Methods that planners can use for eliciting, assessing and measuring values and trade-offs of different stakeholder groups (at an aggregate, planning area, scale)

### K.1 Capturing the views of a broad range of people

Consultations are not just an academic exercise: stakeholder engagement is a fundamental principle for water planning which is articulated in the NWI<sup>82</sup>. Moreover, although it takes time, effort, and money to properly consult prior to invoking a change, consultation may ultimately save time and money if it can reduce tensions, and increase the chance of making determinations that are acceptable to many.

When deciding who to 'consult', one should make every effort to include a broad range of stakeholder groups, for example, Indigenous and non-Indigenous residents, and those whose primary source of income is derived from agriculture, mining, government agencies and 'other' sectors (such as retail, accommodation and construction).

A historical trend in Australian planning and natural resource management is to conduct consultations with land owners only (Indigenous and non-Indigenous), consequently excluding town-people (Indigenous and non-Indigenous). Ensuring that residents in various sectors of employment (i.e. services, transport, mining, government, pensioners etc.) are included in the consultation plans would be one way of addressing this shortcoming.

Given that around ¼ of residents in the TR region are Indigenous, every effort should be made to engage with these residents and gather a representative proportion of opinions. Much better outcomes are likely to be obtained if planners work with Indigenous research assistants (or cultural brokers) to find appropriate ways to engage with Indigenous residents and Traditional Owners.

Depending upon the region, and the personalities involved, it may be necessary to have separate meetings with different stakeholder groups.

Focus group discussions are a useful means of gathering information, but they are not the only way. Moreover, some people may be unable to attend meetings, or focus group discussions or they may be too shy to speak out in public. Planners are therefore encouraged to also consider the use of interviews and mail-out questionnaires (although, as discussed above, mail-out questionnaires are not appropriate in Indigenous communities). When deciding WHO to send questionnaires to (or WHO to ask to participate in an interview), planners should select residents RANDOMLY, to ensure they collect data from a broad cross-section of residents – not just those who 'know someone' who would like to do an interview. Techniques like those discussed in section 3.2 can be used to determine if the sample really is representative of a broad cross-section of residents.

---

<sup>82</sup> Indeed, the NWC (2011) contends that water reform will probably always be contentious, but to deliver innovative solutions and better coordination, local knowledge and community consultation that genuinely engages with people is required. Failure to communicate the case for reform effectively, or to demonstrate its benefits, results in anxiety in affected communities and undermines political and social commitment to change (Alexander and Ward, 2009).

## K.2 Identifying the ‘values’ for assessment

Our research clearly shows that location matters: people in different parts of the country felt that different things were important, and these differences were statistically significant.

As such, it is clear that one needs to compile a list of ‘values’ that are relevant to the affected population. Whilst it is possible to consult the literature to get a general idea about the types of ‘values’ that *may* be important, the final list needs to be constructed in consultation with residents.

Moreover, whilst it is possible to go into a meeting with some background ideas about what MIGHT be included in the final list, it is probably better to start any such meeting with a ‘blank sheet of paper’ (so to speak). This ensures that participants have the opportunity to raise ideas which may not have been previously thought of, rather than simply saying yes or no to items that are presented to them (which can also serve to irritate participants, and make them feel as if the final list is not really ‘theirs’).

One effective means of running these types of meetings is to ask people to work in small groups (of about 4-5 people), coming up with a list of things which they think are important (perhaps writing them on a large sheet of paper). Those lists can then be ‘shared’ with other tables and/or shown side by side at the front of the room. The aim of this ‘sharing’ is to use those separate lists to construct one ‘common’ list, that is of a reasonable length (ideally not more than 10-15 ‘values’). Often, it is possible to ‘group’ items together: table 1, may use one set of words to describe a ‘value’, and table 2 may use another, but when put side by side, it becomes apparent that both tables had been talking about the same thing.

Another way of trying to compile a reasonably ‘short’ list of values is to conduct cognitive mapping exercises, to find out which values ‘go well together’, and which values do not.

## K.3 Understanding the relationship between values

Cognitive mapping exercises proved to be a particularly effective means of gaining a better understanding of the resident’s views on the complex inter-relationships between different values.

Once a comprehensive list of values has been compiled (using techniques like those described above) researchers should produce some cards that contain written and visual descriptions of the values to be assessed. People are probably able to cope quite well with up to 20 or so values. An example of those used in this study can be found in Appendix D.

Appropriate methods for collecting, analysing and interpreting these cards are outlined in section 4.2.5. The main point here, is that planners can use cognitive mapping type exercises, to identify sensible ‘groups’ of ‘values’ that can then be assessed separately, using techniques like those described in the earlier sections of chapter 4.

## K.4 Using ‘development’ scenarios to assess trade-offs

Before developing the scenarios used in the questionnaire, researchers trialled a more detailed and ‘realistic’ scenario in focus group discussions. Participants had difficulty providing responses to the scenarios – primarily because they felt the scenarios were not realistic enough – there simply wasn’t enough detail for them to make a considered decision. Recognising that it was not going to be

possible to devise highly detailed, and realistic scenarios for each and every river catchment across the TR region, researchers involved in this project decided to go the other way: making their scenarios more 'abstract', so that they could be used across a large and diverse region.

But planners are generally only concerned with one area. If they are trying to assess the potential reactions to a KNOWN development proposal, they should, therefore, consider the idea of using established planning tools and processes (such as environmental impact statements, which assess the likely environmental impact of the development on stream flows and water quality) to develop detailed and realistic scenarios that respondents may find easier to assess.

Once realistic scenarios are developed, they should be carefully described – noting the way in which the development is likely to impact a BROAD RANGE OF 'VALUES' (ideally, those identified using focus group discussions or similar in the step above). Moreover, it is clear that these scenarios should carefully describe how stream flows and water quality are likely to be affected; paying particular attention to the environmental management processes that will be put in place.

Once that is done, a broad cross-section of residents could be asked to comment – perhaps just asking them to indicate whether or not they 'approve' of the development (rather than asking about WTP to prevent the development from going ahead, since that type of question is likely to inflame residents when dealing with a very real and 'known' proposal).