

STAKEHOLDER BELIEFS ABOUT CLIMATE
CHANGE IN THE GREAT BARRIER
REEF CATCHMENT

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Climate Change Action Plan

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EXECUTIVE SUMMARY

This research had three core objectives which were to (i) define the potential impacts of GBR climate change on social systems in the GBR; (ii) define associated risks for natural resource management in the GBR; and (iii) present stakeholder preferences for working collaboratively with Government to address issues associated with climate change.

A total of 44 semi-structured interviews were undertaken with participants from specific stakeholder groups and sectors within the GBR catchment. They include Local Government and Government agencies involved in coastal development and planning; the commercial fishing industry; the recreational fishing sector ; Traditional Owners; regional NRM organisations and the tourism industry .

The interview consisted of three phases which included (i) identifying participants understanding of climate change; (ii) identifying participants beliefs about how their industry or sector would respond to climate change scenarios, which included marine ecosystem scenarios for 2040 and 2080 and a storm surge and sea level rise scenario of four metres; and (iii) identifying methods for communicating climate change issues to stakeholders. Although statements and questions were used to introduce the three phases of the interview the interview itself was unstructured.

A thematic analysis of interviews identified three clusters of issues associated with participants' beliefs about climate change. The three issues clusters included (i) acknowledging climate change; (ii) knowledge of climate change; and (iii) impacts and responses to climate change.

Acknowledging Climate Change

While all participants acknowledged climate change was occurring, there were several factors which determined the extent to which they acknowledged climate change as a significant issue requiring some preparedness and response.

The most important issue in this context was the attributions participants made about climate change and specifically whether they attributed climate change to natural processes or human activities. The attribution that was made underpinned whether participants were motivated to undertake actions in preparedness for climate change. For instance, those who indicated a belief that climate change was a natural process were less likely to undertake preparatory actions or change their current behaviour as such actions would often be seen as being outside the natural adaptive process. On the other hand, those who believed climate change was attributable to human actions and activities were generally more likely to take preparatory actions, as it was human actions in the first instance that had given rise to climate change.

Participants' recognition of climate change, beliefs about attribution and the magnitude of climate change was also influenced by their beliefs about the certainty of scientific evidence, their experience of previous impact predictions, the level of trust they had in science and the organisations and institutions managing or responding to climate change and their previous experience of climate change.

Knowledge of Climate Change

Although there were exceptions, much of the knowledge about marine ecosystems and climate change amongst Government agencies and regional NRM organisations was based on 'scientific data' and the knowledge of 'experts', and tended to be more abstract, general and applicable to the macro rather than micro scale. On the other hand, commercial fishers, Traditional Owners and to a

lesser extent recreation fishers and tourism operators, often had very detailed local knowledge and belief systems about marine ecosystems and climate change processes. For those who relied on scientific knowledge, climate change was often seen as a future scenario and issues were raised in relation to gaps in scientific knowledge and the need for a coordinated approach to scientific research. Those who relied on experiential knowledge on the other hand, tended to attribute many of the changes they were experiencing in marine ecosystems to climate change and as such often indicated that climate change was occurring now and was not a future scenario.

The interviews also indicated that many participants held cognitive models of climate change which were essentially linear impact trees¹, where primary climate change process would lead to multiple and cumulative flow on impacts. The primary climate change processes identified by participants included changes in rainfall, an increase in land and sea temperatures and an increase in the variability and intensity of climatic events. Through a series of interdependent flow on impacts these primary events led to specific ecological, social and economic impacts.

Impacts and Response to Climate Change

Beliefs about the effects of climate change focussed on impacts to the both the marine ecosystem and social and economic systems. A common theme discussed in relation to all impacts was the adaptive capacity of ecosystems and social and economic systems. Although dependent upon beliefs about the rapidity of change, many participants believed the marine ecosystem would be able to adapt to the impacts of climate change. Beliefs about adaptive capacity directly influenced the level of concern participants had about climate change and the extent to which they believed action was needed to address climate change issues.

Participants believed rising sea temperatures raised the possibility of a diverse range of potential flow on ecological impacts, including impacts to biodiversity, the inundation of coastal mangroves and other fish habitat areas; impacts on turtle reproduction and breeding through increases in sand temperatures; and changes in the abundance, diversity and distribution of many marine species.

As might be expected given the media attention, coral bleaching was a commonly reported impact of climate change. While the many participants believed the cause of coral bleaching was a rise in sea surface temperatures, many also believed coral bleaching to be caused by excessive freshwater runoff, reduced salinity and the interaction of clearer water with increased sea temperatures. Many participants also questioned whether coral bleaching was attributable to climate change processes or whether it was episodic and occurred in response to natural variations in sea surface temperatures. Furthermore, many participants also believed that corals were sufficiently resilient that they would, after a short period of time, return to their normal state.

While participants discussed the potential social and economic impacts of climate change at a community or industry level, few participants discussed the impacts of climate change at an individual level. In other words, the impacts of climate change tended to be objectified and discussed in terms of what might happen to others, rather than to themselves as individuals. The displacement of potential impacts as something that will occur to others, rather than themselves may have been a coping mechanism or a way of resisting behaviour change.

While many participants believed that action could be undertaken to prepare for climate change, there were several participants who indicated a level of helplessness in relation to climate change

¹ *In the context of a cognitive model, a linear impact tree represents a sequence of causal events, which may be biophysical, social or economic which are believed to be caused by a climate change event such as a rise in sea surface temperatures.*

events and impacts. The level of helplessness that some participants experienced in relation to climate change was directly related to the level of perceived control they believed they had over these events and their capacity to comprehend and understand climate change processes.

Commercial and Recreational Fishing

Many fishers indicated little preparedness in responding to the impacts of climate change. Some fishers indicated they had been preoccupied with other changes to their industry, including fisheries management plans and the representative areas program, which had limited their capacity to address issues associated with climate change. On the other hand, some fishers believed they would adapt to the impacts of climate change as through recent changes to their industry, they had become more resilient and developed greater capacity to adapt to future changes.

Tourism

Participants from the tourism sector expressed concern about the impacts of climate change and indicated a willingness to prepare for potential climate change impacts. Of concern for many participants was the negative image impacts from climate change to the GBR (eg. coral bleaching) would create amongst potential visitors. In relation to reef tourism, some believed that the reef experience may become more staged with tour operators 'farming' individual sites to ensure a quality visitor experience. Other potential impacts and changes associated with the tourism sector included operators relocating to sites with less visual impact and in the more extreme, a possible shift from reef based tourism to water or ocean based water sports or other similar non-reef based activities.

Traditional Owners

An area of concern for Traditional Owners was the impacts climate change would have on the availability of plant and animals life for traditional hunting and gathering. Other concerns focussed on the impact climate change may have on their totems and the displacement of people from coastal and island communities through increases in sea levels.

Regional NRM Organisations

While there was acknowledgement of climate change, for many regional NRM organisations the imperative to address climate change issues and the delivery of specific management actions associated with climate change was often limited. Many current NRM plans did not recognise climate change as a driver for management actions, nor was it common for management actions to be included in response to climate change. This was partly due to many NRM plans being developed at a time when climate change was not considered a significant issue for many in the community. Furthermore regional NRM organisations have a three year investment cycle for the delivery of their NRM plans and as an organisation do not necessarily have the longer term funding security to address climate change issues. Although there were issues with the capacity of regional NRM organisations to address climate change issues, one organisation saw its key role as developing organisational and institutional frameworks in which to address climate change and its impacts in the region.

Coastal Development and Planning

While there was recognition that climate change impacts had implications for coastal development and planning, political and institutional constraints were identified as the key impediments to changes in existing coastal development and planning policies which would address climate change issues. Pressures for increased development of the coastal zone and the capital investment

being made in these coastal developments were such that it was difficult at a political level to resist these development demands. In many instances agencies found themselves being only able to provide advice or guidelines for new developments or building structures to protect existing developments.

Implications for Climate Change Communications and Management

In relation to the management of climate change and communicating with stakeholders in the GBR catchment, there are a number of critical issues that need to be addressed, which include:

1. As a component of a climate change action plan, a community involvement framework for climate change needs to be developed by the GBRMPA. While one objective of the framework would be to focus on outcomes associated with communication and interaction amongst community, stakeholders and the GBRMPA, a second key objective would be to address key procedural issues associated with developing trust and credibility.
2. The community involvement framework should include specific communications strategies, which address climate change issues for different stakeholder groups within the GBR catchment. As each stakeholder group and sector differs in its acknowledgement and beliefs about climate change, a single communications strategy for all stakeholders would be unable to adequately address the diversity of issues across each of the stakeholder groups.
3. Underpinning communication and the management of climate change is the need for community and industry partnerships to be developed. The tourism industry and several regional NRM organisations have already initiated partnership with the GBRMPA to address climate change issues and these arrangements need to be developed for other stakeholder groups. However, community and industry partnerships should be only one form of communications within an overarching community involvement framework, which would also utilise other engagement strategies to ensure broader involvement of industry and community.
4. A community involvement framework needs to consider how scientific information about climate change is presented and used. There are three issues that need to be addressed:

Firstly it is difficult for many stakeholders to comprehend climate change processes and the impacts of climate change and there is a need to examine alternate ways of presenting often complex technical and scientific information about climate change to stakeholders. This research indicates that the cognitive models participants' have of climate change were essentially linear impact trees, where a single climate change process, would lead to multiple and cumulative flow on impacts. If this is the way climate change is cognitively structured and comprehended, then the presentation of scientific information using a similar framework may also be more understandable and acceptable to stakeholders.

Secondly, the presentation of scientific information about climate change may conflict with some stakeholder's existing beliefs which are based on experiential knowledge. The presentation of scientific information needs to be integrated with stakeholder experiential knowledge which of course requires a better understanding of how climate change is conceptualised and the experiential basis of this knowledge. Furthermore the greater the integration of experiential and scientific information about climate change, the greater the acceptance of climate change issues amongst stakeholders.

Thirdly, while the presentation of scientific information about climate change may be presented in the context of scientific uncertainty, it needs to be recognised that this uncertainty

may lead to the rejection of scientific evidence about climate change amongst stakeholders. This is a difficult issue as scientific uncertainty does exist in the context of climate change research, however where there is greater certainty this should be emphasised to stakeholders.

1. INTRODUCTION

In recognising the potential threat climate change poses to the Great Barrier Reef, the Great Barrier Reef Marine Park Authority (GBRMPA) in partnership with the Australian Greenhouse Office, has established a Climate Change Response Program to better understand the impacts and consequences of climate change on coastal and marine ecosystems and dependent social and economic system in the GBR catchment.

The core objectives of the Climate Change Response Program are to:

- Sustain Great Barrier Reef ecosystems;
- Sustain industries and communities that depend on the Great Barrier Reef; and
- Foster supportive policy and networks.

To address each of these objectives, the GBRMPA is developing an action plan to assist in adaptation to and mitigation of potential ecological, social and economic impacts that are predicted consequences of current climate change models. In developing the action plan the GBRMPA has commissioned this research project to better understand stakeholder's beliefs and attitudes about climate change and its impacts and the anticipated responses of different industries and sectors to the projections of the Intergovernmental Panel on Climate Change (IPCC).

This research is based on interviews with participants from different stakeholder groups whose activities will most likely be affected by climate change. Participants were also selected by the GBRMPA to ensure a reasonable cross-section of viewpoints that represented the multiple uses of the Great Barrier Reef Marine Park. Interviews were undertaken with participants from State Government agencies, Local Government, regional NRM organisations, the commercial fishing industry, the recreational fishing sector, GBR tourism operators and Traditional Owners.

2. PROJECT OBJECTIVES

This project will be used to support the development and implementation of the GBRMPA Climate Change Action Plan for the GBR. More specifically this project will assist the GBRMPA to understand and address the underlying social dimensions of climate change in the GBR catchment.

The three core objectives of this project were to:

1. Define the potential impacts of GBR climate change on social systems in the GBR;
2. Define associated risks for natural resource management in the GBR; and
3. Present stakeholder preferences for working collaboratively with Government to address issues associated with climate change.

3. PROJECT METHODOLOGY

A total of 44 semi-structured interviews were undertaken with participants from specific stakeholder groups. An initial contact list for participants was provided by the GBRMPA, although several participants were also identified through the interview process itself. The project team contacted individuals and arranged for a face-to-face interview, which was held at the stakeholders home or place of business. Due to difficulties in contacting some participants a small number of interviews were undertaken by telephone. The intent of the interviews was to gain an understanding of how participants understood climate change and how they believed their industry or sector would respond to the impacts of climate change. All participants were informed that the information they provided would be confidential.

3.1 Interview Structure

Prior to the interview, participants were provided with a letter outlining the scope and intent of the interview. The initial phase of the interview was designed to elicit stakeholders understanding of climate change, without any intervention or prompting on behalf of the interviewer. The latter phases of the interview were more explicit and used specific questions that were designed to identify the participants response to coral reef ecosystem and coastal zone impact scenarios, based upon IPCC predictions. The final stage of the interview sought to identify the most effective communication methods that could be employed by the GBRMPA to provide climate change information to stakeholder groups and the general public.

3.2 Interview Schedule

An interview schedule was designed to provide guidance and structure to the interview process. The interview consisted of three phases which included:

1. Identifying participants understanding of climate change;
2. Identifying participants responses to climate change scenarios; and
3. Identifying methods for communicating climate change issues to stakeholders.

Phase 1: Participant understanding of climate change

The interviewer commenced the interview by stating, "As you are aware, we are trying to understand what people know about climate change and how they believe their industry [or sector] will respond to any future climate changes."

- Could I start by asking what you think the climate might be like in this region in say 35 years time...say about 2040?
- Do you think changes in climate might result in any changes to the marine and coastal environment by this time? What might those changes be?
- As the climate changes, and the marine and coastal environment changes, how do you think your industry [or sector] may respond? What will be different for your industry [or sector] by 2040?

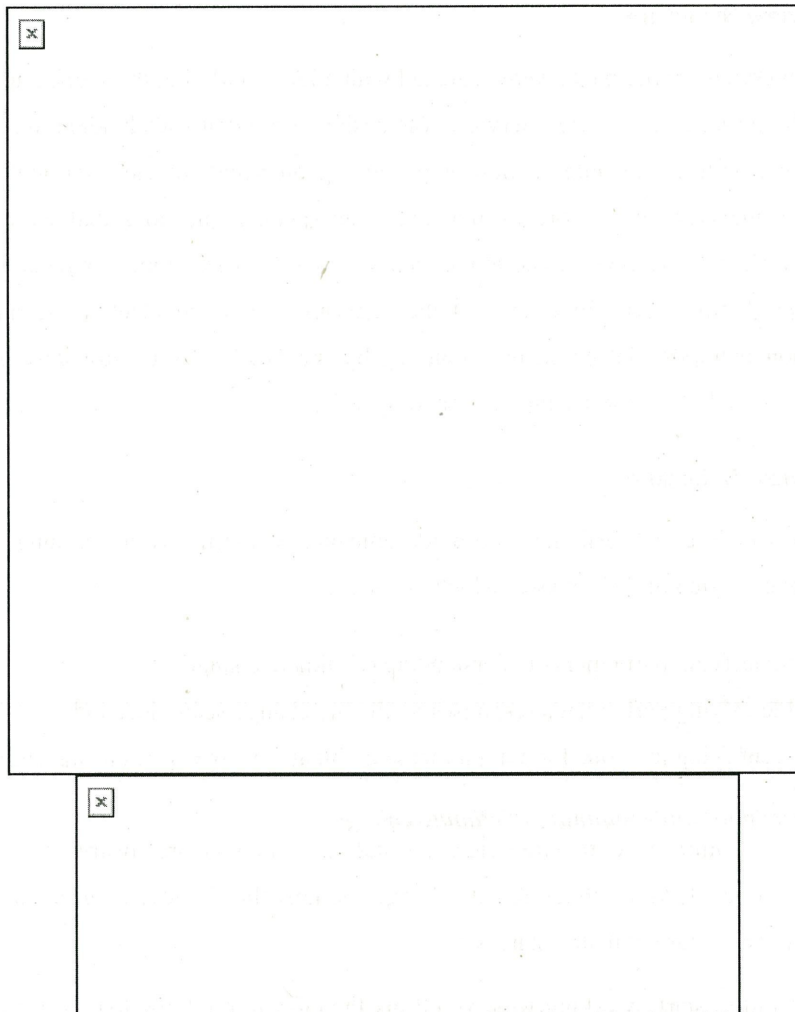
Phase 2: Ecosystem and Climate Change Scenarios

The interviewer commenced this phase of the interview by stating, “What I want to do now is show you what experts on climate change believe the marine and coastal environment may be like in the future.”

2040 Climate Change Scenario: The description of the 2040 climate change scenario included:

- a 1°C rise in sea surface temperature;
- a slight reduction in bleaching sensitive Acropora corals;
- a substantial reduction in butterflyfish, slight reduction in damselfish, parrot fish and coral trout, and a large increase in rabbitfish.

The following graphics illustrated the scenario:



- As the climate changes, and the marine and coastal environment changes, how do you think your industry [or sector] may respond to these changes?
- What will be different for your industry [or sector] in 2040?

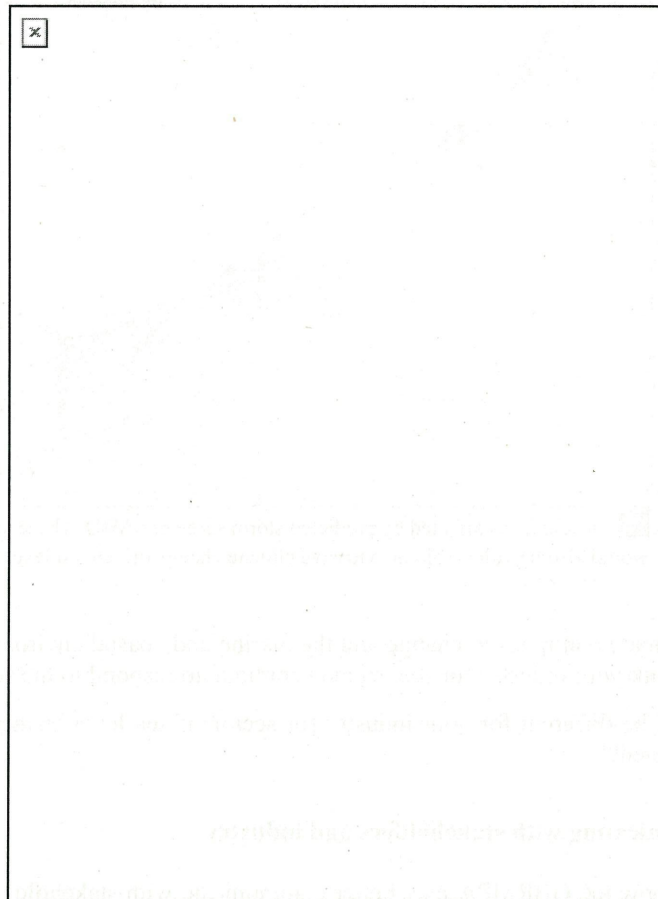
The 2080 climate change scenario which included a substantial reduction in greenhouse gas emissions, included:

- A 2°C rise in sea surface temperature;
- A substantive loss of sensitive corals and a small loss of more resilient corals;
- A complete loss of butterflyfish and parrotfish, further deductions in damselfish and coral trout, and an increase in rabbitfish .

The 2080 climate change scenario with a limited reduction in greenhouse gas emissions, included:

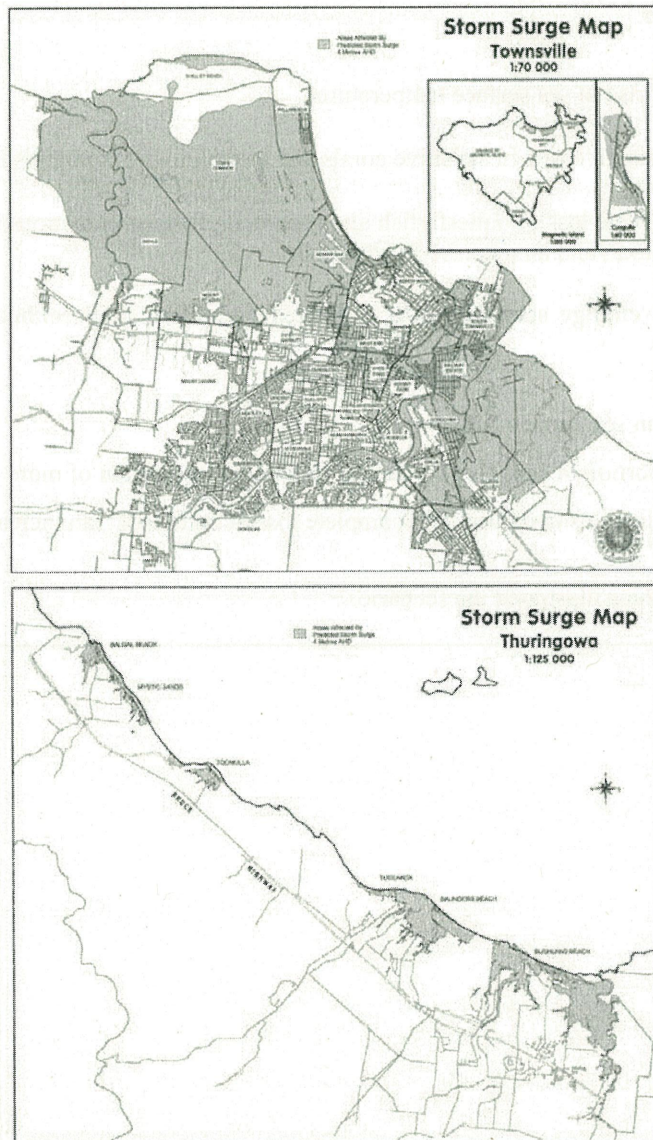
- a 3°C rise in sea surface temperature;
- Large proportion of sensitive corals and increasing proportion of more resilient corals lost
- Further reductions in damselfish, complete loss of coral trout; an increase in rabbitfish.

The following graphics illustrated the scenario:



- As the climate changes, and the marine and coastal environment changes, how do you think your industry [or sector] may respond to these changes?
- What will be different for your industry [or sector] in 2080?

Storm Surge and Sea Level Rise Scenarios



■ Current areas affected by predicted storm surge 4m AHD. These areas would also be vulnerable to extensive climate change driven sea level rise.

- As the climate continues to change and the marine and coastal environment changes, how do you think your industry [or sector] may continue to respond to the sea level rise?
- What will be different for your industry [or sector] if sea level changes to the coast line are permanent?

Phase 3: Communicating with stakeholders and industry

In understanding how the GBRMPA may better communicate with stakeholders and industry, the interviewer asked, "How do you believe the GBRMPA can better work with people in your industry or sector in communicating issues about climate change and its impacts?"

3.3 Interview Summary

As shown in Table 1, participants were drawn from three geographic areas (North, Central and Southern Queensland) in order to ensure the inclusion of stakeholders from across the different GBR regions. Appendix A also shows the type of individuals selected from within each stakeholder group.

Table 1. Interview summary by stakeholder group and geographic location.

Stakeholder group	Northern	Central	South	Total Interviews
Local Government and coastal development	4	6	3	13
Commercial fishing industry	3	2	2	7
Recreational fishing sector	2	2	3	7
Traditional Owners	2	3	2	7
Regional NRM organisations	2	1	2	5
Tourism industry	2	0	3	5
Total	15	14	15	44

Source: EBC (2006)

The average time for each interview was approximately 40 minutes and varied between 15 minutes and 90 minutes. Most commonly interviews were undertaken with a single individual or with a couple. Occasionally, interviews included other representatives from the stakeholder group. All interviews were later transcribed and the transcription used as the basis for analysis.

3.4 Qualitative Analysis

The interviews were digitally recorded and transcribed. The transcripts were used as the basis for thematic analysis using Atlas.Ti qualitative analysis software.

The qualitative method used in this research uses a 'grounded' approach, where frameworks and themes are developed after data and information have been collected. This is essentially an inductive approach, as opposed to a more deductive approach where theory and conceptual frameworks are selected, imposed and subsequently tested, rather than developed during the research process.

Qualitative research methods are often criticised for their inability to generalise from selected interviews to broader populations. However, it is not the intent of this research to make an assessment of the generalisability of the research findings to the broader population. This would require the use of a different methodology (e.g., survey research) and is usually undertaken after the qualitative research has been completed. The intent of this research is to identify the core issues and processes which may underpin stakeholder responses to climate change and not to provide frequency or percentage counts which may illustrate the generalisability of these issues.

Many of the findings and issues that are raised in this research reflect the subjective judgements, knowledge, values and beliefs of participants. It is important to recognise and understand these

belief systems, particularly in relation to how they determine attitudes towards climate change and how they influence decisions and behaviours. It is not the objective of this research to critically evaluate the beliefs of participants in terms of their 'correctness', or whether they accord with existing scientific evidence or some objective assessment of environmental condition. What is important is to understand the beliefs that are reported in their own right, independently of any objective yardstick that might be used as a measure of 'correctness'.

Table 1: Interview schedule by participant group and topic

Participant Group	Topic	Number of Interviews
Local Government	Local Government	4
	Community	4
	Business	4
	Education	4
Non-Local Government	Local Government	4
	Community	4
	Business	4
	Education	4
Total	Local Government	8
	Community	8
	Business	8
	Education	8

The average duration of each interview was approximately 45 minutes and varied between 15 minutes and 90 minutes. Most community interviews were conducted with a single individual or with a couple. Occasionally, interviews included other representatives from the individual group. All interviews were audio taped and the transcripts used as the basis for analysis.

3.4 Qualitative Analysis

The interviews were digitally recorded and transcribed. The transcripts were used as the basis for thematic analysis using ATLAS.ti qualitative analysis software.

The qualitative method used in this research was a grounded approach where interview topics and questions were developed after data had been collected. This is essentially an inductive approach, as opposed to a deductive approach where theory and conceptual frameworks are defined, refined and subsequently tested when they are developed during the research process.

Qualitative research methods are often contrasted to their ability to generate firm statistical evidence to predict population behaviour. However, it is not the intent of this research to make an assessment of the generalisability of the research findings to the broader population. This would be done by the use of a different methodology (e.g. survey research) and is usually restricted to the qualitative research that has been conducted. The intent of this research is to identify the beliefs and attitudes which may influence individual responses to climate change and not to provide evidence on population trends which may influence the generalisability of these results.

Beliefs about climate change and issues that are central to the research project are explored through a series of interviews and details of responses are a requirement to explore and understand these

4. A CONCEPTUAL FRAMEWORK

One of the first tasks undertaken in the analysis was the development of a conceptual framework through which the issues and information in the interviews could be discussed and reported. The process of developing the conceptual framework was grounded in a review of the interview transcripts and had to be sufficiently generic that it would be generally applicable to all interviews.

An interpretive approach is used in the analysis of interviews, which is based on the assumption that human understanding and action is based on the interpretation of information and events by the people experiencing them (Rabinow & Sullivan, 1979). The information that people have about events is organised as a schema (Neisser, 1980), which is an internal working model or cognitive representation through which an individual organises and describes the information they have about the world. Any individual's cognitive schema is in a constant state of change and adapts as new information about the world and the events they are experiencing are assimilated and/or accommodated into the existing schema (Piaget, 1973). The schema holds what is commonly referred to as a person's 'knowledge' or beliefs about a concept or issue and it is the schema itself which determines how individuals respond and behave in situations. The importance of cognitive schemas is emphasised by Niemeyer, Petts, Hobson and McGregor (2004), who state in the context of climate change, that "facts do not determine behaviour so much as perceptions about those facts" (p.2)

As indicated previously, it is not the objective of this research to critically evaluate the knowledge or beliefs of participants in terms of their 'correctness', or whether they accord with existing scientific evidence or some objective assessment of environmental condition. What is important is to understand the beliefs that are reported in their own right, independently of any objective yardstick that might be used as a measure of 'correctness', as it is the beliefs themselves and the organising schema in which they are embedded that are the best predictors of human attitudes and behaviour.

Some care is also required in distinguishing on the one hand the use of schemas as guiding an individual's behavioural response to climate change and on the other hand, the use of schemas to explain behavioural response to climate change. For example a commercial fisher may possess a relatively complex schema about climate change processes, the content of which guides their behaviour and response to climate change. The same individual may also use that schema to explain the resilience or vulnerability of their industry to climate change. In the former case the schema is directing their behaviour while in the latter it is being used as a basis from which they can report their attitudes and beliefs about climate change.

A thematic analysis of interviews with participants identified three clusters of issues associated with participants' beliefs about climate change. The three issues clusters included:

1. Acknowledging climate change;
2. Knowledge of climate change; and
3. Impacts and responses to climate change

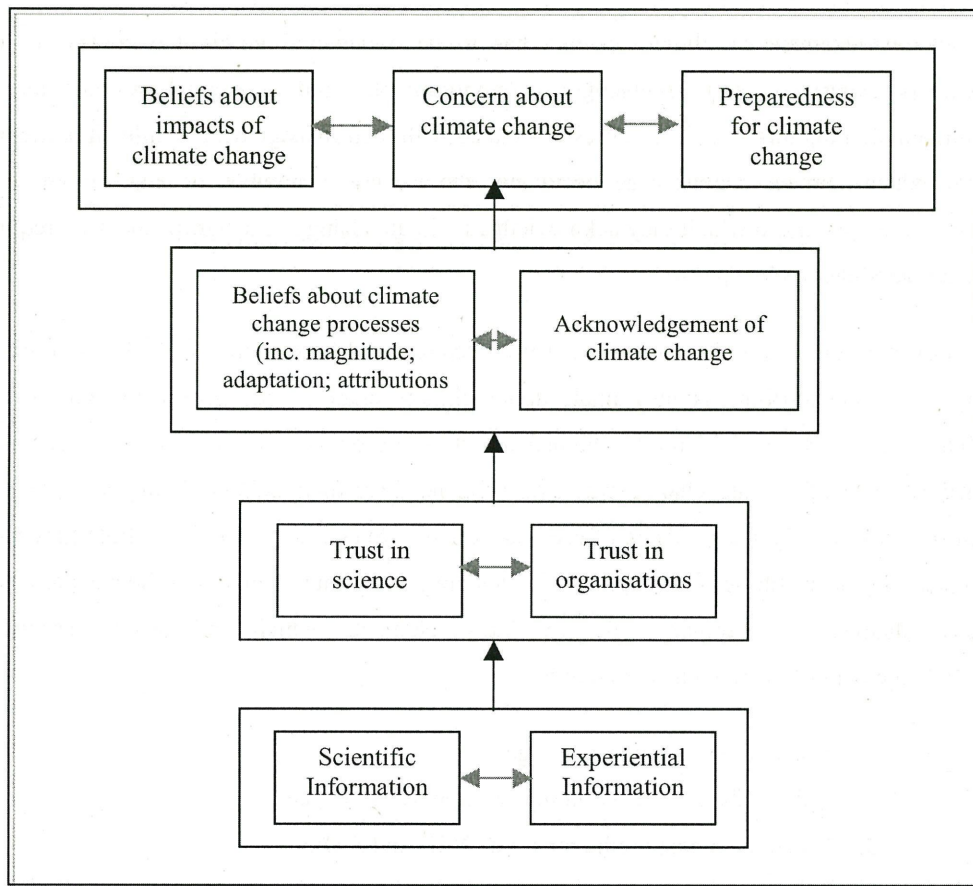
The three clusters of issues are not independent and there is some cumulative and causal (reciprocal and unidirectional) associations between each of the three issues clusters. For instance, someone who does not recognise or acknowledge climate change will often also possess a relatively simple cognitive schema (Crockett, 1965) about the climate change process and in turn will have difficulty identifying any consequences or impacts of climate change. In contrast, those who recognise or acknowledge climate change, will often possess a relatively complex cognitive schema to describe climate change processes and the consequences or impacts of climate change.

It is certainly possible to leave any discussion of climate change at a descriptive level by simply identifying and discussing the content of the three clusters of issues. However, through the analysis of qualitative interviews it is possible to at least begin to draw out a more predictive framework for understanding climate change.

For instance and as shown in Figure 1, the extent to which individuals are prepared for climate change; the concern they express about climate change; or the beliefs they have about the impacts of climate change, is determined by several key interrelated concepts including their acknowledgement of climate change and their beliefs about climate change processes. Acknowledgement and beliefs about climate change, including beliefs about the magnitude and attributions for climate change, are dependent upon experiential and scientific sources of information. However and as shown in Figure 1 the relative importance of these information sources is mediated by several key factors including the trust individuals have in science and the organisations presenting scientific information.

The framework as presented in Figure 1 is only intended to illustrate how qualitative research as undertaken in the current project can be used to develop explanatory and predictive frameworks to better understand human response to climate change. Of course further development of such a framework would need additional quantitative based survey research with a larger range of stakeholders and participants.

Figure 1. An illustrative framework of human response to climate change



5. ACKNOWLEDGING CLIMATE CHANGE

The acknowledgement of climate change has to be understood within the context of each individuals experience and knowledge of environmental and ecological systems and the institutional and organisational structures associated with their management. While all participants acknowledged climate change was occurring, there were a number of key factors which determined the extent to which they acknowledged climate change as a significant issue requiring some preparedness and response.

The most important issues in terms of their preparedness and future actions in relation to climate change were the attributions they made about climate change and specifically whether they attributed climate change to natural or human activities or processes. The attribution processes and the significance of climate change was also influenced by their beliefs about the certainty of scientific evidence, their experience of previous impact predictions, the level of trust they had in organisations and institutions managing or responding to climate change and their experience of climate change. In summary, the five key elements which influenced participants' acknowledgement of climate change included:

1. Attributions of climate change
2. Beliefs about the uncertainty of scientific evidence,
3. Previous impact predictions (i.e., Y2K and SARS),
4. Trust in organisations and institutions, and
5. Experiential knowledge

5.1 Attribution of Climate Change

In any discussion of climate change a key issue which consistently emerged was the extent to which changes in climate were attributable to natural processes or whether climate change was caused by human actions and activities. The attributions made in relation to climate change were exceedingly important and underpinned whether participants were motivated to undertake actions in preparedness for climate change or whether they would respond in changing their current patterns of behaviour. For instance, those who indicated a belief that climate change was a natural process were less likely to undertake preparatory actions or change their current behaviour as such actions were seen as being outside of the natural adaptive process. On the other hand, those who believed climate change was attributable to human actions and activities were generally more likely to take preparatory actions and responses, as it was human actions in the first instance that had given rise to climate change.

The attribution of climate change to human induced and natural processes is shown in the following quotation, where in this instance a recreational fisher indicates some indecision as to the relative weight that should be attached to both attributions.

“There’s two schools of thought. There’s the human impact, carbon dioxide of course, which I don’t think anyone denies but it makes sense. The debate is the extent that it is having an influence. I kind of seem to think it’s the major contributor and others think it isn’t so. I’m not qualified to make a judgment on whose right and who’s wrong. We’ve had ice ages and we’ve now got deserts where there used to be forest, so I mean this is a cyclical thing...there are a number of significant influences that affect climate change...CO₂ is one of the manmade influences which is having an effect. I don’t know to what extent.”

5.1.1 Climate Change and Natural Processes

When participants attributed climate change to natural processes it was very common for them to refer to cyclic processes and that the changes we were currently experiencing or about to experience in the future had occurred often in the past. The following quotations from recreational fishers illustrate the belief that climate change processes were part of a natural cycle. It should be noted that in both these quotations no attribution for climate change is being made to any human activity.

“...all areas go through cycles and I believe the cycle that we are currently in at the moment is just one of those cycles. There is, what I would classify as small cycles, and then there are larger cycles and then there are the big picture cycles, like your ice age to your polar caps melting and climate change and things like that.”

“Over long periods of time...when you have 10 to 12 years, a 50 year cycle and then you have a 100 year cycle. Within 100 years the reef could be totally gone from where it is now and we could be 100 miles further out or it could be gone totally...and then it will come back when the conditions are right for it. Which is what it has done over a period of time.”

Traditional Owners also emphasised the cyclic nature of natural processes, including climate change itself, and emphasised that while there may be significant impacts, their traditional stories told of times when sea levels were much higher than today with many sacred and significant places now located undersea.

“It is not the first time that we’ve had a rise in sea level. I mean the Aboriginal stories tell us that the sea rose much higher than it is today and then they were much lower than they are today and then they rose much higher and then they receded again. So we know it’s a process and I see it might happen again because of the stories of these people.”

“...when you look at the history and some of the places up around the canyon...they reckon that was all ocean a long time ago. There’s rock art there about 18,000 years old. That probably happened back in the ice ages you know, when the sea was up there.”

“...climate change, its an ongoing thing. It evolves. It goes round and round and round... and the climate change of course ... that’s inevitable because it just keeps recycling...”

5.1.2 Human Induced Climate Change

While many participants described climate change as being part of a natural and often cyclic process, there were still other participants who believed human activity, including the burning of fossil fuels and creation of greenhouse gases, contributed significantly to climate change. The following three quotations all illustrate that climate change has been induced by human activity. However, and in clear contrast to those who attributed climate change to natural processes, is the belief as shown in all three quotations, that human actions and changes in Government policy are able to address climate change issues.

“I have a lot of worries about a Government that supports so much greenhouse gas...and basically we've got a very economically driven policy at the moment with respect to things like coal and the phase out of coal and everything.”

“Ultimately I think we have the ability to work with our neighbours. Some of them, the developing countries that are so refined on fossil fuels and things like that and are huge contributors in terms of climate change.”

“I think we're on the verge of a climate crisis at the moment...its here now and shame on the Queensland Government for shovelling all the coal out of the ground as quick as they can, because I think we've got global warming big time, it's out of control and it's going to be like a train smash.”

5.2 Scientific Uncertainty

Perhaps the most common issue associated with the acknowledgement of climate change was the belief that since there was uncertainty within the scientific community and amongst experts about climate change; as a lay person they could only be expected to express an equal level of uncertainty about climate change.

“My understanding of the science is that the scientists don't really know what is going to happen with fish numbers and with fisheries as a result of climate change. They don't know that...so how should I know.”

“...very much subject to conjecture because the scientists themselves have such broad ranging opinions that even they can't agree.”

“Obviously impacts on reefs will probably have an impact on fish numbers. But my understanding of the science is that the scientists don't really know what is going to happen with fish numbers and with fisheries as a result of climate change. They don't know that. I have read that in documents on this topic.”

5.3 Previous Impact Predictions

Several participants also indicated that there had been warnings and predictions about the impacts of other catastrophic events in the past, such as the Y2K bug and SARS. The predicted impacts from these events had not occurred and they questioned why climate change impacts would be any different. This phenomena is similar to the 'crying wolf syndrome' (Breznitz, 1984) reported in

the hazard perception literature, in which repeated false alarms may reduce the credibility of warning information and increase the vulnerability of populations to hazard events.

“...what went on with the Y2K...we're going to have this big thing about computers, and I think that particular process created a lot of the scepticism in people that said we are going to have this big impact and we didn't have it. Planes didn't fall out of the sky; water didn't stop flowing and whatever.”

“I was a virgin. I didn't know much about it. I was like everyone...sceptical and cynical. I had been through the Y2K nonsense and I had been through the 9/11 nonsense and all the other stuff. I have a lot of responsibility to a lot of people's futures and I was quite sceptical...here we go again, another lot of crap...people trying to make a job for themselves' is what I thought.”

The uncertainty amongst experts and the failure of past predictions, reflected amongst some participants a lack of trust in science (Johnson and Slovic, 1995; Ladle, Jepson & Whittaker, 2005), which as also identified by Fenton (2003; 2006) is becoming an increasingly common theme within rural and resource dependent communities. A large survey of community attitudes towards risk undertaken in the United Kingdom in 2003, showed that in relation to climate change, 71% of the population trusted scientists working for universities or environmental groups as compared to only 42% trusting scientists who worked for Government (MORI, 2003).

5.4 Trust in Organisations and Institutions

In addition to a lack of trust in the science, there was also amongst some participants, a lack of trust expressed in the organisations that were advancing climate change as an issue (see also Adger, 2003). Amongst some commercial fishers and to a lesser extent recreational fishers, there was some cynicism about climate change impacts and a belief amongst many, that the GBRMPA was raising this issue as another mechanism through which fishing effort on the reef could be reduced. The following quotations illustrate this specific belief and the general lack of trust many commercial and recreation fishers have in the GBRMPA.

“I wouldn't tell GBRMPA anything, because anything we say they use against us. All they'll want to do is close more areas and they can get rooted...we know damn well there are hidden agendas for more closures.”

“A lot of us are sceptical. It's just going to keep going. You know they are just going to keep closing more and more and you know that would be fair too if climate change was happening...either close more or cut our tonnages back. You know, that's a real fear.”

“I think we have a major problem with the GBRMPA. For a start we need to rebuild the bridge between the industry and [the GBRMPA]. They certainly would be very sceptical of anything that GBRMPA could come up with at this stage because of being misled over the last five or six years.”

The following quotation also illustrates not only the lack of trust in the GBRMPA, but a lack of trust in the way that the GBRMPA uses science and scientific information.

"A lot of these scientists have come up with stuff that will I guess to keep themselves employed and the bigger the group of scientists the bigger the problem they come up with..... GBRMPA say they've got scientists and I'm not rubbishing scientists,... that show A, and yet an independent scientist does the same research in the same area for the same reason and comes up with B, so who do you believe? Why does GBRMPA say theirs is right and go ahead with their plans when an independent scientist comes up with a dispute and he is ignore? The latest comments by GBRMPA that reef fish have increased by 70% in the green zone, right; in two years they've got scientists that can say that the green zones have improved the number of reef fish....within two years of them being closed. That's not true. I'm sorry, but that's the sort of thing that we deal with all the time. They are only pulling those figures out of a hat to make themselves sound good...."

While some participants reported a lack of trust in the science and resource management organisations, others including many from the tourism industry, regional NRM organisations and Government expressed a quite contrary view and had considerable trust in the science being undertaken and the scientific community and management agencies.

"I think we could work well with DPI Fisheries and GBRMPA and those sort of guys to try and keep at least on the planning level, some sort of environmental consideration for all this..."

"We've commissioned a major report on climate change on the Barrier Reef with the WWF to assess the economic impacts, potential impacts from climate change...."

5.5 Experiential Knowledge

While some participants didn't acknowledge climate change or didn't attribute climate change to the changes they were experiencing in the marine environment, there were others who not only acknowledged climate change as occurring, but also attributed the changes they were experiencing to climate change processes. To some extent those who had experiential knowledge² of changes in the ecology of the marine environment, tended to be more likely to report the immediacy of climate change impacts and that impacts were occurring now.

"We've noticed sea levels here change, its much higher now in the low tide than it used to be. We've noticed different species turning up there that were never caught here before...we're getting things like Fingermarks...never, never caught here until the last 4 years. Never even seen one here, until the last 4 years and now the recreational fishermen are catching...them in their nets, they've never been here before ever. So that's to do with water temperature....climate change."

In contrast amongst, those with limited experiential knowledge of ecosystem change and who based their knowledge on independent scientific evidence, there was a tendency to view climate change as something that would happen as a scenario in the future. For example, the first quotation from someone with limited experiential knowledge indicates that climate change may

² *Experiential knowledge is defined as knowledge gained through "affective and cognitive transactions with the biophysical and built environments" (Pruneau, Gravel, Borque & Langis, 2003, p. 443) or the process of direct interaction with environment through which meaning is discovered (Bell, 1995)*

result in changes in fish populations in the future. This is in contrast to the previous quotation from a participant with considerable experiential knowledge who is indicating they are currently experiencing changes in fisheries populations.

“I think you are going to see a fairly rapid increase in other fish, with the ones that are not so prominent now increasing and others, the prominent ones now will virtually drop into the background. That is the way I see what could happen in the future.”

“How we deal with existing developments, with existing development commitments...it’s going to be an interesting exercise into the future.”

It may well be that those with greater experiential, local and day-to-day knowledge of the ecology of marine ecosystems are simply able to detect some of the more subtle changes than those without this knowledge.

6. KNOWLEDGE OF CLIMATE CHANGE

If we are to understand how individuals prepare for and respond to climate change, it becomes critically important to understand how climate change is conceptualised and understood. In other words and in broad terms, what is the content of people's cognitive constructions or schema representing climate change and how does this influence preparedness and response? Of course such an approach invokes a constructivist as opposed to a realist analysis (Taylor-Gooby & Zinn, 2006), which emphasises that individuals prepare and respond not to the 'real' or objective climate change processes, but to their own construction of climate change, which is influenced by a wide range of individual and socio-cultural factors. For instance, research on the use of affective and cognitive heuristics (Kahneman & Tversky, 1974; Slovic, Finucane, Peters & MacGregor, 2004;) social learning theory (Eiser, 2005) and explicit mental models of change events, all indicate that the construction or representation of risk is important in understanding both preparedness and response.

6.1 Experiential and Scientific Knowledge

Although there are exceptions, much of the knowledge about marine ecosystems and climate change amongst Government agencies and regional NRM organisations was based on 'scientific data' and the knowledge of 'experts', which "had been given to us" by others and tended to be more abstract, general and applicable to the macro rather than micro scale. As illustrated in the following four quotations each participant makes reference to 'data', 'scientific data' and 'research' as a basis for their knowledge about climate change.

"...and are our estimates for storm tide increases appropriate at this stage. Because a lot of that has been just historical data. I don't know whether anyone has sat down and had a new look at all the recent data that has come out?"

"We're now starting to get better and better data about inundations and where areas would be flooded and those sort of things."

"My opinion of reading vast amounts of scientific data and other pieces of information is that people are game to avoid this at their peril."

"My understanding from the research that I have been exposed to...there is going to be potentially anywhere between one to two degrees increase in heat for this area...with that will come reworking four major areas: temperature, rainfall... a continuation of the drying trend. More El Nino events from La Nina in the upcoming years.....and more potential category 5 tropical cyclones. And sea level rise over time. There is certainly some interesting work around coral bleaching events. And when we start talking about our severe weather events the run offs and erosion issues that are potentially caused by the on land issues of that drying trend over time and torrential downpour and flooding and the impact of that kind of materials being taken offshore. It is certainly a concern that you'd be looking at within that period...those are areas certainly affecting climate change within 30-35 years that I think will be factual."

Many in these organisations indicated a paralysis of action because of the lack of 'data' or scientific knowledge on which to plan and develop effective strategies for climate change. In addition, and as climate change had become a topical area of scientific inquiry, several participants also expressed the view that there was no cohesion to the scientific research being undertaken.

"The GBRMPA should bring a bit more cohesion to the research that is going on...it's all over the shop at the moment, there's every man and his dog that's getting involved in it...it's quite topical."

Across the different interview participants, there was considerable variation in the level of experiential and 'scientific' knowledge individuals had about the marine ecosystem and climate change. At one extreme commercial fishers, Traditional Owners and to a lesser extent recreation fishers and tourism operators, often had very detailed local knowledge and belief systems about how the ecology of the local area functioned. For example, the following quotation from a commercial fisher explains how even small river flows (freshes) are required to maintain the coastal fishery.

"...what happens is you have small freshes that are captured in the major dams. All the small freshes have got sediments in them and they push out the mouth of the river. Lets say it happens three times a year at the mouth of the river...that sediment out there stirs up, you know what I'm saying? When you have a dam that stops that flow, that frequency of flow so you only have one major flow event, it interrupts the whole cycle. It's the frequency of flow that's more important than what the volume is...it doesn't matter how small, its the small flow events that keeps the solidity levels in the river systems and the estuarine section."

While scientific knowledge provided important information about managing and responding to climate change, the type of experiential local knowledge held about the marine environment has obvious implications in relation to how people respond to climate change. The following quotation indicates how one commercial fisher conceptualised the causal relationship between droughts on the land and reduced catch rates.

"...if it is drought on the land we always say we have a drought at sea too...the water seems to be warmer. The boys always say the temperature is a lot warmer and it needs good rain to oxygenate the water... in long dry hot periods the fish go down deeper and your catch rate goes right down."

While commercial and recreational fishers provide numerous examples which illustrated their beliefs about how ecological processes influenced their fishery, there were also numerous examples of how ecological process had changed across time. While there was on the one hand often considerable consensus that significant change had occurred in the marine ecosystem, there

was in contrast often little consensus in the beliefs about the causal attributions for these changes and whether these changes could be attributed specifically to climate change processes³.

While some participants attributed ecosystem changes they had experienced to climate change processes; several participants also considered these changes to be 'natural' processes or attributed the changes to other human actions such as over-fishing, pollutants, sediment runoff and the use of agricultural fertilisers. As one Traditional Owner stated...

"I've always blamed the aerial sprays, the fertiliser in the land...the seepage from waterways here and it takes it to the reef...especially in the warmer climate."

Some participants described a more complex belief system which illustrated the causal relationship between the changes they were observing and the processes of climate change. In effect these participants had developed their own 'cognitive model' of the impacts of climate change which described for them the interrelationship between climate change process and ecological systems. As shown in the following quotation from a recreational fisher; climate change produces less rain, which produces less runoff, which leads to fewer sediments, which in turns leads to an increase in water clarity and an improvement in the spear fishing environment.

"...less rain...we're spear fishing under the lighthouse now at the mouth of the river where that waters never been clean ever because of sediments and that that came out...now you can actually spear fish there."

As indicated in the previous section, the schemas individuals develop for climate change processes are based on and drawn from multiple sources of information, including experiential knowledge and 'expert' information. However, as several Local Government and regional NRM organisations indicated, there is a significant lack of scientific information about climate change, particularly at the local level; with many people simply being uninformed by science or attempting to fill the gaps they have in their knowledge through their own experience and beliefs about climate change.

"So we know a great deal about what the parameters are that will change, but we don't know obviously precisely how that will impact on the ecology of the reef and surrounding areas."

"The problem is that a lot of that modelling just hasn't been done yet. People are going into it very uninformed, because they don't really know the implications for them...local councils working a three year cycle...why should it be something that they invest in."

³ *This attribution is different to the attribution discussed in Chapter 5. In Chapter 5 the discussion focussed on the attributions for climate change, while here the focus is on the attributions made in relation to changes experienced in ecological and environmental processes.*

6.2 Temporal Comparisons and Climate Change

The first phase of the interview schedule asked participants to describe their predictions of climate change impacts by 2040. In doing so, many participants referred to their past or present experiences of climate change and climate change impacts. In several cases their past experiences were cited as evidence for future climate change impacts. The widespread reference to past environmental events as evidence for climate change is clearly related to experiential knowledge and the attribution of climate change processes as discussed in previous sections.

In referring to past and current experiences of climate change, many of the participants were indicating that climate change was not a scenario for the future but was already occurring.

“We were saying that if climate change was in the future, the past decade or so were the hottest years ever recorded. So what we have got to say is that climate change is with us; global warming is with us now. It may have a while to go by all accounts; it may have a long process to go through, but to think that it’s something in the future, I think that’s wrong, I think it’s with us now.”

“What we do know is that there are changes happening now and they are certainly expected to continue into the future.”

“I look back...we witnessed it last year where northern beach suburbs that have been there for quite some time and have never experienced problems previously. They got tidal surges and storm surges two or three times over the wet season. There’s been a lot of erosion on the beach areas and those sort of settled areas close to the beach I think are probably at risk now and into the future.”

“But we notice a big difference in how the winds are and all like that to what it was twenty years ago.”

“...we’re fishing and he said to me see where that water is over there....I’ve fished here for 60 years and that water’s never been there”

6.3 Climate Change Process and Events

As also alluded to previously, participants did not conceptualise climate change as a series of independent events, but in many instances described climate change as a series of interdependent and causally connected events occurring within the environment. Table 2 identifies the core climate change processes were identified by participants⁴. The first four events identified in Table 2 could be considered as primary events in so far as they are directly related to climate change. On the other hand, the latter three events are secondary in so far as they are dependent upon the primary climate change events.

⁴ *It should be noted that as this is not a survey of stakeholders or interest groups, it is not possible to identify the frequency or commonality of occurrence for these beliefs.*

Table 2. Climate change processes identified by participants

Climate change event	Illustrative quotation
1. Change in rainfall	<p>“We’ll have greater precipitation in North Queensland.”</p> <p>“It may well be that the rainfall will hug the coast a lot more and not go very far inland off the coast.”</p> <p>“...winter rains instead of summer rains”</p>
2. Increase in land temperatures	<p>“From my understanding it’s going to be hotter.”</p> <p>“The clear indication is that it will be hotter in most areas.”</p> <p>“Predictions would suggest that we will be getting drier and hotter.”</p>
3. Increase in sea temperatures	<p>“The sea temperature will be higher than it currently is.”</p> <p>“I anticipate that the sea temperatures will rise.”</p> <p>“Sea temperature rise of...a couple of degrees.”</p>
4. Increase in the variability and intensity of climatic events	<p>“...there will be an increased pattern of variability, with more frequent, possibly stronger events... cyclones and so on.”</p> <p>“An increase in storm events which are going to cause damage to reefs, particularly the shallower reefs...”</p>
5. Rise in sea levels	<p>“...with global warming there is probably going to be increases in sea level.”</p> <p>“The sea level is going to rise a little so we’re going to have a lot of trouble with local beaches and erosion.”</p> <p>“We’ll be looking at planning in the future for sea level rise”</p>
6. Changes in runoff and sediment flows	<p>“Increased amounts of rainfall...will drag sediments onto the reef areas”</p> <p>“Rising sea levels...would cause more sediment to be taken back in the waterway and that has a choking effect on everything in the food chain.”</p> <p>“With a major event here...we will still get a massive sediment and nutrient export”</p>
7. Changes in salinity	<p>“...and sea level rise over time which is a bit of a concern in relation to the salinity.”</p> <p>“With the rising of the sea level the actual salt concentration etc would change.”</p> <p>“Too much salinity out at sea which we have found it detrimental to our fishing.”</p>

Many participants described the interdependence between climate change events and processes. For example, with increased rainfall there would be more runoff which in turn would reduce the salinity of the inshore marine ecosystem. Similarly, and as shown in the quotation below, with a rise in sea levels, there would be an increase in erosion, leading to increased sedimentation and runoff which again would impact on the marine ecosystem.

“Well if there is a higher water temperature, that’s going to strip coral, it will probably increase coral bleaching, if there are increased amounts of rainfall in the north there will be a lot more run off going onto reefs. That will reduce the salinity, which will probably increase coral bleaching also, and will drag sediments and so on onto the reef areas. That is going to have an effect of shaping particularly the inshore reefs and there are impacts all the way through the food chain with that.”

The following quotation also illustrates a cognitive model of climate change events and impacts, which is counter to the one illustrated above; where reduced rainfall rather than an increase in rainfall leads to greater sediment runoff and increased impacts on coral reef systems.

“...there are obviously secondary impacts that could occur there too if there are more arid inland areas with more sediment being washed out into the sea that could have further impacts on the reef.

What was important for many participants was the magnitude or scale of the climate change processes. While it was acknowledged by many participants that these processes would occur, there was significant variation across participants in their beliefs about the scale or magnitude of climate change. On the one hand, the following quotation illustrates a belief that the impacts of increases in sea temperature will be negligible.

“I can’t imagine a one degree change in the average sea temperature can be that critical. Really...the water out here in winter goes down to about 19 degrees most winters...summer it can be 30 degrees. An enormous differential that the animals and plants already tolerate.”

In contrast, for some participants, the impacts of climate change elicit a near panic response as is evident in the following quotation.

“...it is a profound affect...what people are saying by 2040...forget it...we are going to be in deep trouble by then... It’s at a runaway point very soon. Its almost scary what will happen. Rain forests are affected, sea levels are affected, coral is affected, our fishing grounds, our farming, our climate, ourselves, our health and of course as that starts to run away so will law and order be effected.”

7. UNDERSTANDING IMPACTS AND RESPONSES TO CLIMATE CHANGE

Beliefs about the effects of climate change focussed on impacts to the marine ecosystem and to the social and economic systems. Effects to the marine ecosystem were essentially the secondary or higher order ecological impacts of climate change (as discussed in Section 6), which in turn often impacted on dependent social and economic systems. It was clear, as has been discussed elsewhere, that amongst those participants who acknowledged climate change, each participant possessed a cognitive model or schema which identified the climate change process and the causal attributions describing initial and flow on impacts through ecological and dependent socio-economic systems.

While there was some commonality across participants in the content of individual's cognitive models of the impacts of climate change, there were also significant differences in the breadth and depth of knowledge about the potential impacts of climate change. The state of an individual's cognitive representation of climate change impacts was in some cases not too dissimilar to the "hodgepodge" state of scientific knowledge about climate change as expressed by one regional NRM body.

7.1 Adaptive Capacity

The belief that the marine ecosystem would be resilient to climate change or able to adapt to the effects of climate change was also a common theme identified by many participants. For most participants the adaptive mechanism used by marine ecosystems was based on a change in the spatial distribution or geographic location of marine species. Corals for instance would simply adapt and move into deeper waters which were cooler. Corals and fish alike would change their geographic distribution and begin to grow or frequent areas further south in cooler waters.

"I would have thought...warmer temperatures...say up past New Guinea for example. You have a look at what their wildlife that is there. Well you would say that it will eventually come here. There might be an upset and an imbalance there for some time but it will eventually balance itself into an environment of its own, a sustainable environment under those temperatures. That's the way I see it."

"They might now go down to northern New South Wales for example. Assuming that the water increases or the climate increases ...well that's a real possibility as well."

Adaptation through spatial relocation is also evident in the following quotation about the impacts of climate change on coastal mangrove environments. In this case the participant believes mangroves would no longer grow in areas where the water was higher and would simply begin to grow in other areas which had more suitable water levels.

"I'm thinking of mangroves and that sort of coastal environment. I think it will adapt...I won't say quickly in geographic terms, but geological terms I mean. I imagine it won't have a huge detrimental effect. I think the

mangroves will just regress as the water rises and grow very quickly back in places perhaps they don't at the moment. It's probably not a huge environmental problem I don't think."

As one fisher indicated, fish themselves appeared to have a level of intelligence which would clearly enable them to adapt to any changes or increases in sea surface temperatures.

"What I see...personally...is fish will adapt. The mackerel are down low where the water temperate is quite cooler and when the water heats up they get right up to the surface. If coral bleaching occurs and the water temperatures occur, they'll just go deeper. They'll survive and I know what its like to catch fish. They're survival is pretty good. They're pretty smart. I know they've got very little brain but they are a bit smarter than you think... don't worry."

While the belief that the marine ecosystem had the resilience and capacity to adapt to change was a commonly held belief, some participants as shown in the following quotation, also expressed the contrary view that coral reef ecosystems did not have the adaptive capacity to respond to the rapidity of the climate change process.

"I don't believe the reef is going to be able to adapt quickly enough to climate change, I mean there will be some adaptation but it's not going to be enough to maintain it as a tourist icon or bio diverse paradise as it is at the moment."

In terms of addressing the ecological impacts of climate change, from the broader perspective of natural resource management several regional NRM organisations also indicated that while they may not have the resources to address the direct impacts of climate change, they could nevertheless improve the resilience of marine and natural ecosystems by addressing other stressors such as improving water quality through better land use practices.

"...if we can get world peace we're okay. Get rid of all the carbon that is being burned in war we'd probably be okay, but the reality is we can do very little about that. What we can do is recognise that there are some vectors that will impact on that, presumably if you place any animal under stress then other things have more impact. That's generally what ecosystem analysis says about most animals, so presumably if that's the case for our marine environment the best we can do is work on reducing the other stressors on their systems which is around sediments, nutrients and poisons. To do anything about sea surface temperature when we're in a global system...there's virtually nothing we can do."

While there was certainly considerable discussion about the adaptive capacity of coral reefs and marine ecosystems, for some participants there was a belief that human systems would also adapt to climate change. The first three quotations illustrates the adaptive capacity of commercial and recreational fishers, while the last quotation focuses specifically on the adaptive capacity of the tourism industry.

"Fishermen are very adaptable. Once they find out something's happening they change."

“I don’t think it makes any difference to us...what we see, we see. What we catch, we catch. We just keep going there.”

“It would then be about going further...to deeper reefs and working areas that are less affected, because I believe that the closer inshore reefs are the ones going to be most affected anyway.”

“I think industry itself is going to have to reinvent what it wants to do, admittedly the coral reef is going to be screwed over through global warming worldwide, it’s not just going to happen here on the Barrier reef, but the loss of coral in this region means that we will have to start looking at things like iconic species and working more with big fish and those kind of things. So it’ll be a matter of, I think we might find that fish feeding becomes more important so that we can actually attract things into sites so that the tourists can see them. But the tourism that we see right now won’t exist in 20 years time.”

The extent to which ecological and social systems would adapt to climate change was also based on beliefs about the rapidity of climate change. If the climate change process was a gradual and slow process, then there was a belief that this would give time to respond and adapt to the changes, while a more rapid process of climate change would limit adaptive response.

“I mean there’s a predicted rising water level in the oceans as well. I guess its going to be just a small change...or it could be fairly major...I guess it depends on how rapidly things start warming up.”

“...how rapidly is sea level was rising? Would it be something that was very slow in which case you would have time to say; alright, well all the people along here are all going to have to move? Where are we going to put a housing estate? Where are we going to put these people? If it was a very fast process then I guess we would have to consider a wider area and think about where to put them.”

Most importantly, and as shown in Figure 1, beliefs about the adaptive capacity of marine ecosystems and dependent social and economic systems directly influenced the level of concern participants had about the impacts of climate change and the extent to which they believed action was needed to address climate change. The first quotation below is from a commercial fisher, while the second quotation is from a Traditional Owner.

“I can’t see that there’s anything we can do to prevent this. It’s a matter of how we adapt to it.”

“I think we will adapt very easily. We don’t complain a lot about stuff. We just watch things that happen then we go along with it because that is how we work for thousands of years anyway. We just adapt.”

7.2 Ecological Impacts

A common ecological theme amongst many participants was that warmer sea temperatures that would be the initial climate change process that would give rise to an increase in the incidence of coral bleaching and other associated impacts on the marine ecosystem.

“...my understanding of it is that it's going to get hotter and of course getting hotter means it's going to have an impact on both land and water, and so obviously from a point of view of the marine park, it's impact that it has on waters and the heating of waters and then issues around coral bleaching and other impacts on our reefs”

Participants indicated the impact of rising temperatures also raised the possibility of a diverse range of potential flow on ecological impacts, including impacts to biodiversity, the inundation of coastal mangroves and other fish habitat areas; impacts on turtle reproduction and breeding through increases in sand temperatures; and changes in the abundance, diversity and distribution of many marine species.

“...we have a number of mangrove species for example, they are at the northern most or the southern most limits and that is going to have real implications from climate change, because ultimately when species are at their northern or southern most limits there is nowhere else for them to go...”

“...the temperatures of turtle eggs, the different temperatures in the sand and I suppose even just these things; they are being affected by the water temperature and how much they produce and their lifespan and the food cycle”

7.2.1 Coral Bleaching

As might be expected given the media attention, coral bleaching was a commonly reported impact of climate change. Three issues were raised in relation to the ecosystem impacts of coral bleaching.

Firstly, while the majority of participants believed the cause of coral bleaching was a rise in sea surface temperatures, there were also a number of other events which were believed to cause coral bleaching. As shown in the following quotations, which again illustrates participants' cognitive models of ecological processes, this included excessive freshwater runoff, reduced salinity and the interaction of clear water with increased sea temperatures.

“..if there is a higher water temperatures that's going to strip coral, it will probably increase coral bleaching.”

“...bleaching can also be caused by excessive freshwater run off”

“...that will reduce the salinity, which will probably increase coral bleaching.”

“...the absolutely clear waters and the intensity of the sun caused the coral bleaching. A combination of the temperature and the intensity of the sun causes the plant cells in the coral to produce so much oxygen that is toxic to the coral.”

Secondly, several participants questioned whether coral bleaching should be attributable to the general process of climate change or whether it was episodic and occurred in response to natural variations and changes in sea temperature.

“My understanding is that there have been coral bleaching events in the Great Barrier Reef in recent years. I think there were some that occurred in about 1997 and 1998 and some that occurred in 2002. But they can't necessarily be put down to any one particular event. And reefs do recover.”

Thirdly, while the process of coral bleaching was recognised, many participants also believed that corals were sufficiently resilient that they would return after a short time period. Furthermore and as shown in the last quotation there was a belief amongst some that the GBRMPA through the representative areas program had made the GBR more resilient to changes.

“...the coral regrowth is quite astonishing. We killed off half the bay's coral reefs in 1991 when a monster flood came down...just obliterated it. You go out there today and you would not know that there was such an event 15 years ago. The coral has actually bounced back within 15 years.”

“...but what I'm saying is 1 degree...my own anecdotal observation is now being reinforced by people who have said coral might be a bit more resilient than we actually gave it credit for...because they've realised that it can live in temperatures lower than they thought and higher.”

“...that's why we've been so insistent about the representative areas programme and all those things which will contribute I suppose to make the reef more resilient.”

As discussed later in this section, for the tourism industry it was not only the ecological impacts of coral bleaching that were important, but the adverse publicity associated with coral bleaching and the impacts of this adverse publicity on the tourism industry as a whole.

“They might say they think it's going to be one degree but that one degree is still not going to account for what we are going to lose because of coral bleaching. I think coral bleaching is going to make a massive difference. Not only are you going to get the difference from the fact that the coral is gone...as the events occur we are going to attract an enormous amount of adverse publicity and that adverse publicity is going to affect tourism businesses as well.”

7.3 Social and Economic Impacts

The social and economic impacts identified by participants include beliefs about the potential impacts of climate change to industry, communities and people's way of life. While participants discussed the potential social and economic impacts of climate change at a community or industry level, few participants discussed the impacts of climate change at an individual level. In other words, the impacts of climate change tended to be objectified and generally discussed in terms as what might happen to others, rather than to themselves as individuals. The displacement of potential impacts as something that will occur to others, rather than themselves may be a coping mechanism or a way of resisting change (Lazarus & Folkman, 1988; Lowe, 2006). For others, as

shown in the following quotation, it may simply be that because of their age they have little interest in the impacts of climate change in the future.

“Me? Well I’m 55, I’ve only got 10 years to go, so I don’t care...I’ve got everything I want.”

“...now fortunately I’m a pretty old fart so I’m not going to be here to see it”

Given that participants were drawn from a number of different stakeholder groups and industry sectors, beliefs about the social and economic impacts of climate change are described in relation to each group or sector.

7.3.1 Commercial and Recreational Fishing

Several fishers indicated that there was little preparedness amongst the commercial fishing industry and recreational fishing sector to respond to the impacts of climate change as they had been preoccupied with other changes occurring in their industry or sector, including the trawl and reef line plan and the representative areas program. As shown in the following quotation, it could be argued that many in the commercial and recreational fisheries sectors, as a consequence of recent changes, have limited resources and adaptive capacity to respond to climate change issues.

“I have to say is not top priority on our radar. There are far more important threats to our industry, our leisure and our recreation than climate change.”

“I think there are far more immediate issues facing the fishery that we’re involved with than climate change. Climate change is a longer term issue that we’re all aware of, but not sure what to do about it...act of God thing. Whereas there are a number of other issues impacting on the fishery that we can influence and have an involvement in and so that’s where most of our time and energy is spent.”

In contrast, several commercial and recreational fishers believed they would adapt to the impacts of climate change as through the recent changes to their industry and sector, they had become more resilient and had developed greater capacity to adapt and respond to future changes.

“I think just the resilient nature of the industry that I represent would take it in their stride but it is something that I think we are going to have to work towards.”

While there was some indication that the live fish industry may have to change its methods for the storage of live fish given temperature increases; that there may be an increase in costs associated with cooling and refrigeration; and that the use of equipment to measure sea temperature may be more common, the most frequent response amongst both commercial and recreational fishers was that they would adapt and change their fishing patterns and methods to whatever the prevailing conditions were at the time. As such there was no indication from participants that the commercial and recreational fishing sectors were in anyway preparing for the impacts of climate change.

“It means that when you’re net fishing, let’s say for shark, you’ve got to retrieve your net back into the boat every hour, because they die in the net and then they go green in the gut because it’s so hot. I’ve fished up north in the summer...you’ve got to keep running your net, you’ve got to keep pulling them out and chilling them down and you use more ice. Your ice box has got to be more efficient, the costs go on because of it. You’ve got to work much harder. You’ve got time limits from when you’ve caught something to when you actually ice it and that’s the biggest killer...so your product doesn’t spoil.”

7.3.2 Tourism

In contrast to fishers, who indicated they were more likely to respond and adapt to change as it occurred, participants from the tourism sector expressed far more concern about the impacts of climate change and indicated a willingness to prepare for any potential climate change impacts.

Of particular concern for many participants from the tourism sector, was the image that the impacts of climate change to the GBR would create amongst potential visitors. For the tourism industry coral bleaching may not only have a direct impact on the marine tourism experience, but the national and international publicity associated coral bleaching and the image of the GBR as being ‘damaged’ by climate change could create a negative image of the GBR and effectively reduce visitor numbers. In this sense the tourism industry was seen as being potential vulnerable to negative messages about coral reef bleaching and the impacts of climate change.

On a somewhat related issue, there was also an emphasis on managing the impacts of climate change and the experience of climate change impacts by visitors, by ensuring that the product which presented the visitor experience of the GBR did not create expectations that were too high. Clearly any mismatch between the expectation of the reef experience and the actual experience itself could also have a significant negative impact on the reef experience by visitors (see for example Fenton, Young & Johnson, 1998).

In relation to reef tourism, several participants indicated the reef experience may become more staged, similar to the ‘staged authenticity’ of tourism experiences as described by MacCannell (1973), with tour operators ‘farming’ individual sites to ensure a quality experience amongst reef visitors. The farming of reef sites would generally include the employment of specialists to manage sites, which would include the maintenance and transplantation of the ‘best’ corals and fish feeding being used to attract the larger and more iconic species of fish.

“...a lot more farming of individual sites to keep their tourism patches looking good.... doing their onsite gardening of the best corals... coral transplantation. Fish feeding is going to become an activity to attract tourists, so you can show them fish.”

Other potential impacts and changes associated with the tourism sector included operators relocating to sites with less visual impact and in the more extreme, a possible shift from reef based tourism to water or ocean based water sports or other similar non-reef based activities. Increases in

sea levels were also seen as having a potential impact on tourism infrastructure, particularly in the major coastal ports such as Port Douglas, Cairns and the Whitsunday Islands.

The potential increase in the frequency and intensity of cyclones, as a result of climate change, was also seen as having a potential impact on the tourism industry. Quite apart from the direct impacts of cyclones on coral reefs and tourism infrastructure, participants indicated two possible issues associated with an increase in the intensity and duration of cyclones. Firstly, there was a possibility as with coral bleaching, that an increase in cyclonic activity may create a significant amount of negative publicity in the international tourism market, resulting in a decline in international visitors. Secondly, climate change may extend the cyclone season by commencing earlier or finishing later, which in itself may reduce the effective tourism season for international visitors.

7.3.3 Traditional Owners

One of the key areas of concern for Traditional Owners was the impacts increases in sea temperatures and potential changes in seasonal patterns would have on the availability of plant and animals life for traditional hunting and gathering.

In addition and of concern to several participants from coastal Traditional Owner groups, was the impact climate change may have on their totems (Fourmile, 1996), which are used to identify Traditional Owner groups and may be represented in any number of marine animals and plants. As totems are an important part of Traditional Owner cultural identity and are especially significant in song and dance, any loss of totem animals or plants would have significant impacts on the cultural identity of Traditional Owners including their lore and kinship relationships.

“...we have sea creatures or animals that we know as our totem so we'd rather preserve and look after those animals so that we know that we are connected to the area...lore and our kinship and relationship with other groups within our tribes and neighbouring tribes. If we do lose some of these animals and coral species it would be a big blow for our cultural heritage and our stories.”

Several Traditional Owners believed climate change would have a significant impact on their communities, resulting in the displacement of people from these communities through increases in sea levels. Examples were given of islands in the Torres Strait which were currently being affected by rising sea levels and there was concern about the impacts of moving people in these communities from their home islands and country to other island communities.

While several Traditional Owners identified potential impacts from climate change on themselves and their culture, others accepted that change was inevitable and essentially part of the natural order of their country which had occurred in the past.

“I think we will adapt very easily. We don’t complain a lot about stuff. We just watch things that happen then we go along with it because that is how we’ve worked for thousands of years. We just adapt. When one fish dies off and becomes obsolete we eat the other. And they are all food...and the algae may bring other things around...other food into the area.”

7.3.4 Regional NRM Organisations

Regional natural resource management (NRM) organisations have a responsibility for NRM in the coastal catchments adjacent to the GBR. These organisations not only address coastal and marine issues, but also a wide range of other critical NRM issues in each catchment. In Queensland regional NRM organisations have been operational for the past five years and each organisation has developed in the last 2-3 years a regional NRM plan, which describes the NRM targets and associated management actions they intend to implement to address the critical NRM issues they have identified.

Included in the interviews were several participants from regional NRM organisations and while there was recognition and acknowledgement of climate change, the imperative to address climate change issues and the delivery of specific management actions associated with them was limited. NRM plans developed by regional NRM bodies will often include an array of several hundred management actions. However, many of the current NRM plans did not appear to recognise climate change as a driver for their management actions, nor was it common for management actions to be included in response climate change. The following two quotations illustrate the relatively limited response of some regional NRM organisations to climate change.

“Within the plan itself...we do have one management action that primarily is focused on climate change...and it is to do some scenarios with Local Government...with the coastal councils for emerging issues.”

“...we just started to delve into what the organisation does about that.”

The lack of urgency in recognising and addressing climate change issues amongst regional NRM organisations appeared to be attributable to two core issues.

Firstly, these organisations in developing their NRM plans and investment strategies were required to develop plans and strategies which were community based and which represented the NRM issues of concern to stakeholders and communities in each region (Joint State and Commonwealth Steering Committee, 2002). Several years ago, when these plans and strategies were being developed, climate change was not considered a significant issue for many in the community. As a consequence, climate change issues were only found on the periphery of many NRM plans and it was rare that specific management actions were developed in response to climate change issues. The following quotation illustrates this issue and provides some credence to those who question the credibility of community based NRM (Bradshaw, 2003).

“...ultimately we are responding to what our community put forward for this NRM Plan. The fact that the community didn't raise it [climate change] as a larger problem says to us that the community is largely unaware of the issues.”

Secondly, regional NRM organisations are locked into a three year investment cycle for the delivery of their NRM plan and as an organisation do not necessarily have security beyond 2008. The dilemma is that while these organisations are responsible at a regional level for the management of natural resources, the short term institutional constraints on their funding and operation makes it exceedingly difficult for them to address longer term issues associated with climate change. As one participant indicated, the best that many regional NRM organisations can do is to improve the resilience of ecological systems in the short term, so that they are better able to absorb and potentially recover from climate change impacts in the future.

While climate change issues may have not been extensively addressed in many current regional NRM plans, it was seen by one regional NRM organisation as a critical issue in the review of the NRM plan.

“...in a sense climate becomes an asset in the NRM plans, so part of the vision is that we see climate as one of our critical regional assets which means that we start setting targets for resource conditions, we start setting targets for management action to achieve those trend issues, and the maintaining the existing climate. This sort of reconstruction of the plan around the climate asset is a pretty big job for the next two years...for reviewing our plan as well.”

In contrast to several other regional NRM organisations who believed they were limited in what they could achieve in responding to climate change, one regional NRM organisation saw one of its key roles as developing a organisational and institutional framework in which to address climate change and its impacts in the region. As shown in the following quotation, for this regional NRM organisation this was achieved through facilitating the formation of an alliance amongst several key organisations in the region.

“The purpose of the alliance is basically to start to work pretty dramatically towards a carbon neutral environment. The alliance has got some pretty strong players in it, in that it's got a couple of Local Governments; its got the Wet Tropics Management Authority which sees this as a significant issue. We'd like to see GBRMPA come to the table and they have been heavily involved so I'm presuming they will actually be part of the alliance.”

7.3.5 Coastal Development and Planning

Several participants were from State agencies and Local Government who were responsible for coastal development and planning. For many participants involved in and responsible for coastal development and planning, it was seen as the responsibility of Local Government to address coastal development issues which may be affected by climate change processes.

“...we are indicating on maps where the erosion prone areas are but at the current stage Local Government is taking the lead in terms of mapping of their respective Local Government areas in terms of storm tide inundation. They are mainly taking the lead and then it's up to councils when they assess the applications to have due regard to those maps that they have produced to ensure that they don't develop in those areas.”

“the whole development of these areas is something which is controlled by Local Government, so we'll have to take these things into account when we are looking at our planning strategy.”

While there was some recognition of the impacts of climate change for coastal development and planning, political and institutional constraints were identified as the key impediments to changes in existing coastal development and planning which would address climate change issues.

Most importantly, these participants identified institutional constraints and barriers as often inhibiting their response to climate change. For example, several participants indicated that there clearly should be no development allowed in flood prone or storm surge areas of the coast. However, pressures for increased development of the coastal zone and the significant capital investment being made in these coastal developments were such that it was difficult at a political level to resist these development demands. In many instances agencies found themselves being only able to provide advice or guidelines for new developments or building structures to protect existing developments.

“I would be surprised if there's anything we can do about it...they are spending millions of dollars getting the absolute beachfront house and 90% of the population's dream is to do that. So the politicians are not going to stop them putting that sort of investment right on the front in the most prone areas. And when it comes to it they'll have enough political clout to get the politicians to see it their way. So I think the coast line in the urban areas will be strongly defended by lots of rock walls, which means the beaches will disappear and we will lose a lot of the values of the coastline.”

Several participants believed they were only just obtaining the controls over coastal development that were needed for the State to limit its liability in relation to storm surge or flood and as such there would be a continued emphasis on the development of engineering solutions, including the building of groynes and sea walls. However, as one participant indicated, the size of the sea walls required to prevent storm surges would most likely “start blocking people's views...which will become an extremely political issue to manage.”

While participants recognised there were significant institutional and political issues associated with addressing the impacts of rising sea levels on coastal development within existing urban development areas, some participants found that they achieved greater success in relation to development control by focussing on new developments in non urban areas.

“I think the coast line in the urban areas will be strongly defended by lots of rock walls. Which means the beaches will disappear and we will lose a lot of the values of the coastline. So reality is...our fight is more in the non

urban areas and that's where we are trying desperately to keep development out. Where there is no development we have a sporting chance to keep it out. And I have got some confidence there."

7.4 Response to Climate Change

As indicated in the previous discussions, there are numerous factors that influence how individuals will respond to and prepare for climate change, including their knowledge of climate change processes, their trust in science and institutions and their belief in the adaptive capacity of ecological and social systems.

While this research project does not include a representative sample of stakeholders from different GBR industries and sectors, the information drawn from the participants involved in the interview process indicates that there is limited current preparedness for climate change amongst commercial and recreational fishers and Traditional Owners. Amongst State agencies, Local Government and regional NRM organisations the early stages of acknowledgement and preparedness are emerging however these organisations are often constrained by institutional, political barriers and resource constraints. The tourism industry currently appears to be most active in addressing climate change issues in terms of commissioning additional research and developing institutional arrangements, particularly with the GBRMPA to address climate change issues.

While many participants believed that action could be undertaken to prepare for climate change, there were several participants who indicated a level of helplessness in relation to climate change events and impacts.

"You're going to lose it anyway. You know? How are you supposed to stop it? It's a concern but what the hell are you going to do? I mean there's a global concern, you know, what can anyone do?"

"To do anything about sea surface temperature when we're in a global system, there's virtually nothing we can do."

"We'll just adjust and move with it. There is nothing else we can do."

As shown in the following quotations, the level of helplessness (see Seligman, 1975) that some participants experienced in relation to climate change was directly related to the level of perceived control they believed they had over these events.

"I think we've got global warming big time, its out of control and its going to be like a train smash. Does that answer your question?"

"It's an event that's beyond our control"

"I think that has got to be the biggest message to go out there, that we can control the future in regards to greenhouse gas emissions, to global warming, I think that is the message that we've got to put out, that's what I feel about it."

8. COMMUNICATING CLIMATE CHANGE

In the final phase of the interview participants were asked, "How do you believe the GBRMPA can better work with people in your industry or sector in communicating issues about climate change and its impacts?" Overall the stakeholder groups indicated a willingness to collaborate with the GBRMPA in achieving better communication about climate change. The suggested mechanisms ranged from relatively passive education based options to full stakeholder integration into the GBRMPA's climate change planning and management processes.

8.1 Commercial and Recreational Fishing

Many of the participants from the commercial fishing sector expressed concern and scepticism in relation to GBRMPA communication and engagement processes. Participants' comments were characterised by a lack of trust in the GBRMPA to the extent that some viewed the IPCC climate change scenarios with suspicion and as a covert strategy by the GBRMPA to further restrict commercial fishing. The responses also indicated considerable support for fishing party objectives and major revisions of the GBRMPA. The following quotation is representative of the degree of animosity that was expressed by several participants. On a positive note the recently introduced regional GBRMPA offices were viewed in a positive light by several respondents who were otherwise sceptical of the authority.

"I wouldn't tell GBRMPA anything because anything we say they use against us..... Talk to me about GBRMPA. See that coral I've got in there. I made sure I got that out of GBRMPA area. That's how much I hate them."

Recreational fishers also expressed some scepticism of GBRMPA's previous communication and engagement processes particularly in relation to the Representative Areas Program (RAP). They were, however, generally more positive than commercial fishers about future collaboration on education and public awareness programs. As the following quotation illustrates the recreational fishing associations would welcome GBRMPA support for sector generated education materials and programs.

"The perfect relationship is to work in partnership; they know our position in regards to these sorts of things. Everyone doesn't have the same view. But part of our portfolio is education. We want to take the message to as many people as we can. If they can't do it, if they want to give us the resources to do it, if they want to give us the money to pay for the venues, have a guest speaker come down, we'll organise it. Get some expert to come in and talk about it and say, 'hey, have a look at this'...scare the shit out of you."

8.2 Tourism

Tourism operators requested clear guidance on the 'facts' relating to climate change and the anticipated impacts. Participants from the tourism industry indicated a willingness to actively elevate climate change to a federal political issue, by highlighting its importance to the tourism

industry and ultimately to the Queensland economy. In addition, tourism operators requested clear communications from the GBRMPA on actions that could be taken to mitigate climate change impacts. For example, one participant suggested that the GBRMPA could provide flexible tourism permits that could be varied to take account of specific climate change impacts at tourism sites, while another requested information on the design of tourism infrastructure to take account of climate change impacts.

“We need to get very proactive in getting the information out there. We need to make sure the industry understands what the worst case and best case scenarios are and the likelihood of it being either one of those or being somewhere in the middle. The more people I talk to on this kind of issue, it shows me that there is an enormous amount of misinformation and lack of knowledge.”

“We are going to make a political issue of this at the next federal election because people are just pretending this doesn’t exist. We have to get this in the public eye. I’ve got to tell you, it’s horrifying. I don’t see it as being the death as we know it of our world, but it’s going to make significant changes.”

“I think GBRMPA has a responsibility to make sure the operators understand what the likelihood is, our moorings are going to have to be redesigned....”

8.3 Traditional Owners

Traditional owners identified the need for meaningful involvement with the GBRMPA in communicating and addressing climate change issues and emphasised that in the past their involvement had often been tokenistic as shown in the following quotation.

“...maybe utilising community rangers in these communities where they can be the eyes and ears for the authorities, for the GBRMPA. But in a meaningful way and not just tokenistic as has happened in the past, where people such as myself have been marine park inspectors. That’s where it just stopped and there wasn’t any more engagement by certain Government organisations.”

An additional issue raised by Traditional Owners was that rather than the Traditional Owners being ‘educated’ by the GBRMPA and other State agencies, it was also the case that Traditional Owners, given their traditional knowledge, were often in a better position to educate others about changes occurring within their environment.

“...they [Traditional Owners] are very much up on what is happening, even if they express it in different ways. They are very much up on what is happening insofar as the natural environment is concerned and they are very attuned to changes in it. When changes occur...what happened to that species? Why isn’t it there anymore? What has affected it? What is going on? All those sorts of things. That is very much watched by indigenous people, they keep a very sharp eye on that sort of thing....We can’t educate the rest of society because the rest of society wants to educate us.”

8.4 Regional NRM Organisations

Regional NRM organisations highlighted a willingness to support GBRMPA in climate change communication programs and the management of climate change. However, many of the responses from regional NRM organisations identified the need for the GBRMPA to assist in changing Government policy relating to climate change.

“... one of the things that stuck in people’s throats a little bit about the reef water quality protection plan is that it’s well recognised that climate change is going to have a much bigger impact than water quality on the reef and that federal and state Governments seem to sweep that under the carpet because it is too hard. And they are not going to take on climate change because it is going to mean things like the mining industry and other income generating sources for them would have to be curtailed I suppose in terms of the relationship with us and GBRMPA we would really like to see GBRMPA putting some pressure on Government to address climate change and do something about it and present the same sort of information to them about what the risks are. And we would be in there with bells on supporting them....”

In addition several regional NRM organisations indicated that the GBRMPA could assist in coordinating climate change research more effectively and ensuing better dissemination of the research to the broader community.

“...all the different bits of research into climate change and climate variability...is a hodgepodge. The Australian government is one Government and it has the responsibility to bring that together more. It’s all very well to have different researchers doing different things, but there is definitely a need for a higher level of coordination of the research on climate change and climate variability.”

8.5 Coastal Development and Planning

As with the regional NRM organisations there was consensus support for collaboration with GBRMPA on the communication of climate change impact and risk information. Local Government participants cited the current assessment procedures as one opportunity to work more closely with GBRMPA in identifying coastal development issues in at risk areas. Local councillors highlighted their need for expert advice from GBRMPA and other agencies to persuade dissenting council members of the need to plan and manage for climate change risks. The following quotation represents a valuable summary of the communication suggestions from Local Governments and the manner in which key messages should be delivered

“Frequently. Simply. Communicate well. If you talk to any person in marketing they’ll say you’ve normally got three core facts you are trying to deliver, do them well, keep it simple, and keep repeating those issues. That is the way that you can get people to gain knowledge and remember something. Keep your message simple for local government and community. Don’t have guys discussing at a high technical level about impacts. Quite simple everyday language....”

9. SOCIAL SCIENCE RESEARCH AND CLIMATE CHANGE

As identified in previous chapters, there is a complex array of interrelated beliefs about climate change which are embedded in both experiential and 'scientific' knowledge about climate change. In addition, behaviours related to preparedness, response and adaptation are ultimately dependent upon the schema or representation individuals have of climate change and the cognitive models they possess which describe the climate change process.

The research presented in this report, utilises only one social science methodology and partly because of the nature of the methodology that has been used, has adopted an interpretive approach to the interviews based on the qualitative analysis of information from the interview process. The approach used in this report is useful as a starting point in understanding what the key social science issues might be and what the implications are for the development of management strategies to address climate change.

Given the range of stakeholders included in this research from different industries and sectors, the geographic distribution of stakeholders and the breadth of the interview process itself, this research is reasonably superficial and is essentially only able to identify what some of the key issues are. The research is primarily a scoping process to identify key issues based on interviews with key informants and is not able to provide a very detailed analysis of any one specific issue.

There are two approaches to future social science research in relation to climate change in the GBR catchment.

One approach is to examine the generalisability of the issues identified in this report, with the objective of beginning to understand the causal relationships amongst key components of the framework as presented in Figure 1. This approach would require quantitative survey research across communities, industries and stakeholder groups. For example and at a descriptive level, it would be able to describe the level of trust people have in the science of climate change; the type of experiential knowledge people have about climate change; and the level of acknowledgement of climate change. At a predictive level this type of research would also be able to begin to identify what the core factors were in determining preparedness or concern about climate change or what does or does not motivate people to respond to climate change.

A second approach is to examine, using appropriate social science research methods, in greater depth the issues identified in this report. For example, using structured interviews what is the structure of individuals' cognitive models of climate change and climate change processes; what are the knowledge gaps in these cognitive models; what are the attributions made for climate change; how is 'science' based knowledge and 'experiential' knowledge integrated; and how do climate change processes determine beliefs about impacts and beliefs about what actions should be taken to address these impacts.

10. CLIMATE CHANGE COMMUNICATIONS AND MANAGEMENT

It is clearly the case that the management of climate change does not imply management of the climate but the management of social and economic systems in preparing for climate change and in responding to climate change. Any action plan that is developed will be about assisting community, stakeholders and industry to prepare for or mitigate the ecological, social and economic impacts of climate change.

In relation to communications with stakeholders in the GBR catchment by Government and the GBRMPA there are a number of critical issues that need to be addressed. They include:

1. As a component of a climate change action plan, a community involvement framework for climate change needs to be developed by the GBRMPA. While one objective of the framework would be to focus on outcomes associated with communication and interaction amongst community, stakeholders and the GBRMPA, a second key objective would be to address key procedural issues associated with developing trust and credibility. One approach to addressing these procedural issues would be to actively involve stakeholders in the development of the community involvement framework for climate change
2. The community involvement framework should include specific communications strategies which address climate change issues for different stakeholder groups within the GBR catchment. As is evident in the current research, each stakeholder group and sector has different beliefs about climate change and different levels of acknowledgement in relation to climate change issues. A single communications strategy for all stakeholder groups and industry sectors would be unable to adequately address the diversity of issues across each of the stakeholder groups.
3. Underpinning communication about climate change and the management for climate change is the need for community and industry partnerships to be developed within the context of a broader community involvement framework. The tourism industry and several regional NRM organisations have already initiated partnership with the GBRMPA to address climate change issues and these arrangements need to be developed further and for other stakeholder groups. However, community and industry partnerships should only be seen as one form of communications within an overarching community involvement framework for climate change. Partnership arrangements are relatively formal and often only include 'representatives' of industry and stakeholder groups. An overarching community involvement framework for climate change would utilise other engagement strategies and modes of communication to ensure broader involvement of industry and community.

4. Any community involvement framework or communications strategy needs to consider how scientific or 'expert' information about climate change is presented. There are three key issues in relation to the presentation of this information.

Firstly, and as shown in the current research, many participants in this study had difficulty comprehending climate change processes and the impacts of climate change. There is therefore a need to examine alternate ways of presenting often-complex technical and scientific information about climate change to stakeholders. For instance, this research indicates that the cognitive models participants' had of climate change were essentially linear impact trees, where a single climate change process, such as a rise in sea temperatures would lead to multiple and cumulative flow on impacts (Abel, Ross, Herbert, Manning, Walker & Wheeler, 1998). If this is the way climate change is cognitively structured and comprehended, then the presentation of scientific information using a similar framework may also be more understandable and acceptable to stakeholders.

Secondly, the presentation of scientific information about climate change may challenge or conflict with some stakeholder's existing beliefs about climate change which are based on experiential knowledge. As such the presentation of scientific information about climate change needs to recognise and be integrated with stakeholder experiential knowledge. Of course this requires a better understanding of how climate change is conceptualised and the experiential basis of this knowledge. However the greater the integration between experiential and scientific information; where scientific findings are recognised in their experience of climate change, the greater the acceptance of climate change issues.

Thirdly, while the presentation of scientific information about climate change may be presented in the context of scientific uncertainty, it needs to be recognised that this uncertainty may lead to the rejection of scientific evidence about climate change amongst stakeholders. This is a difficult issue as scientific uncertainty does exist in the context of climate change research, however where there is greater certainty this should be emphasised to stakeholders.

Appendix A Study Participants

Local Government and Coastal Development (13)

- State Government planning/environment officer (9)
- Local Government planning/environment officer (3)
- Local Government councillor (1)

Commercial Fishing Industry (7)

- Office holder in a commercial fishing organisation (1)
- Commercial net/line fishers (5)
- Aquarium fish collector (1)

Recreational fishing sector (7)

- Recreational fisher (2)
- Office holder in a recreational fishing organisation (4)
- Skindiver (1)

Traditional Owners (7)

- Member of a Land Council (3)
- Traditional Owner (4)

Regional NRM organisations (5)

- CEO of a regional NRM organisation (3)
- Coastal and marine coordinators (2)

Tourism Industry (5)

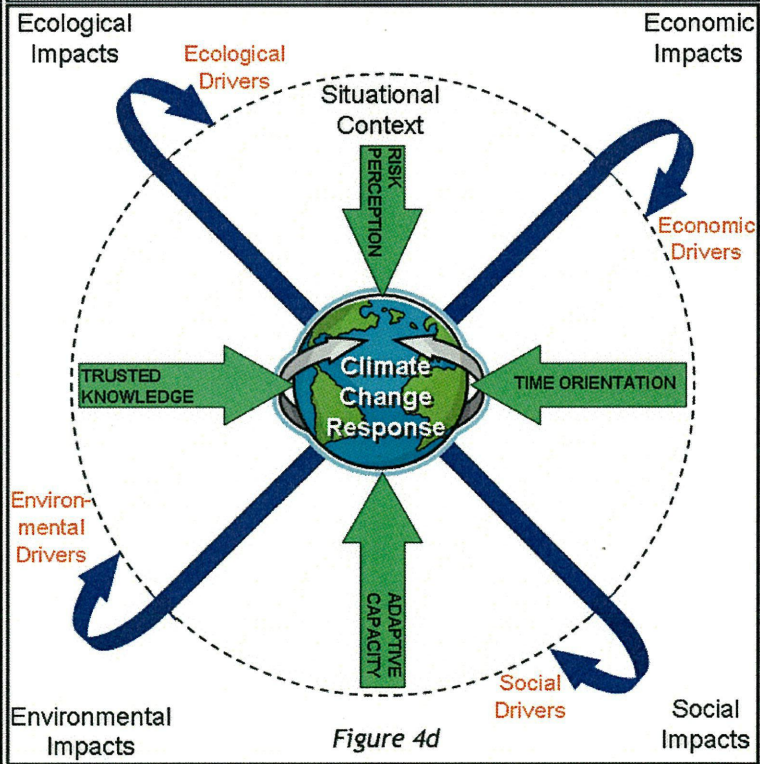
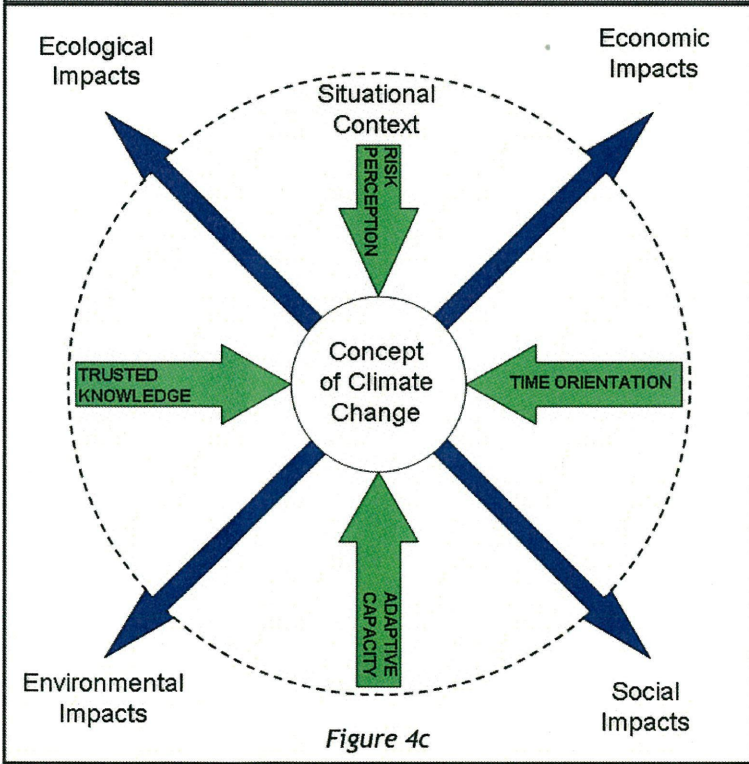
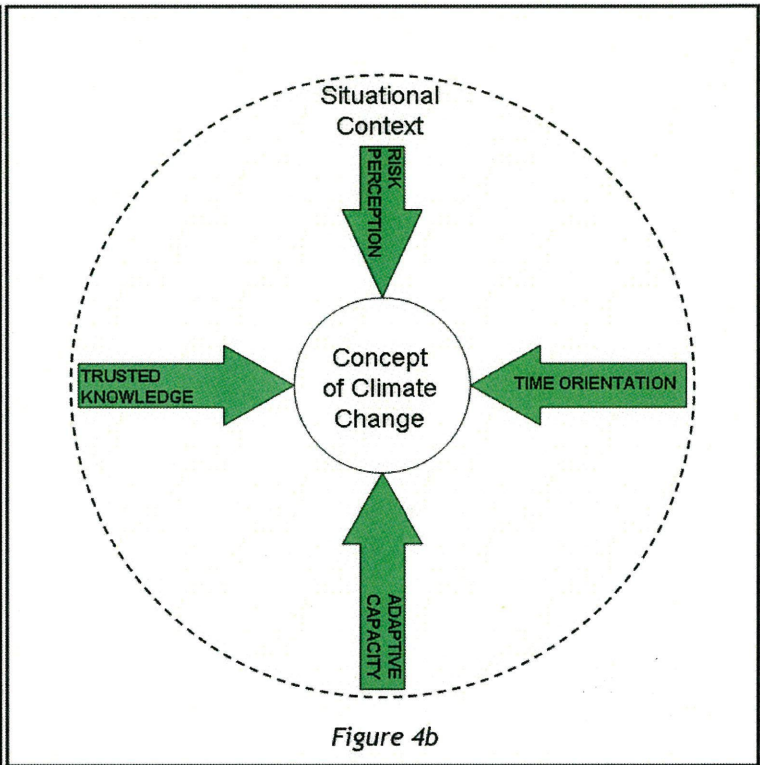
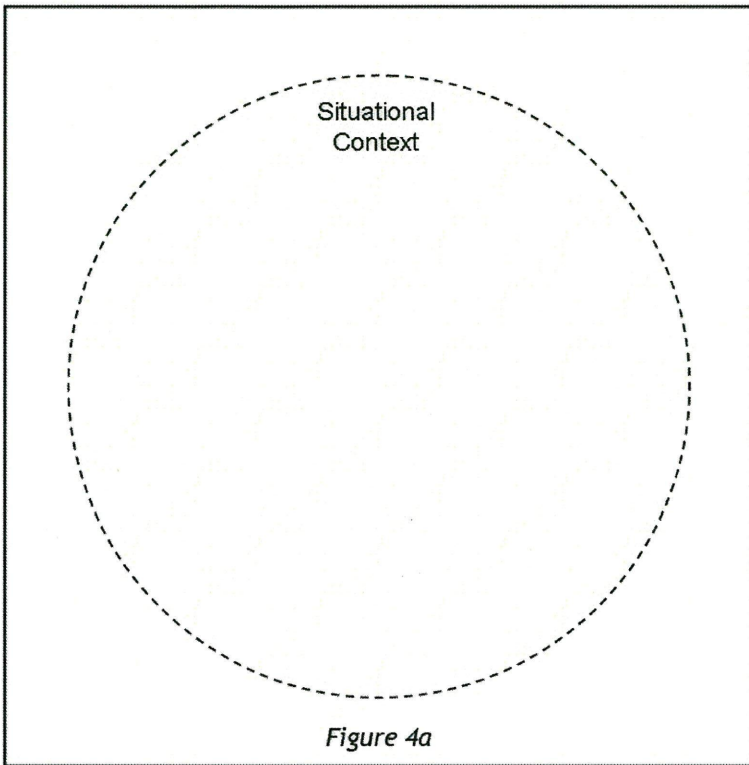
- Office holder in an organisation supporting the tourism industry (3)
- Marine tourism operator (2)

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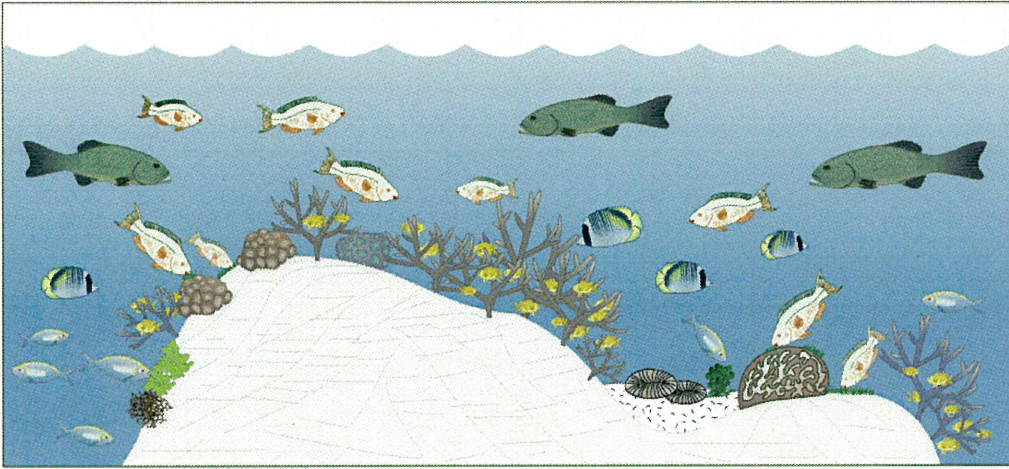
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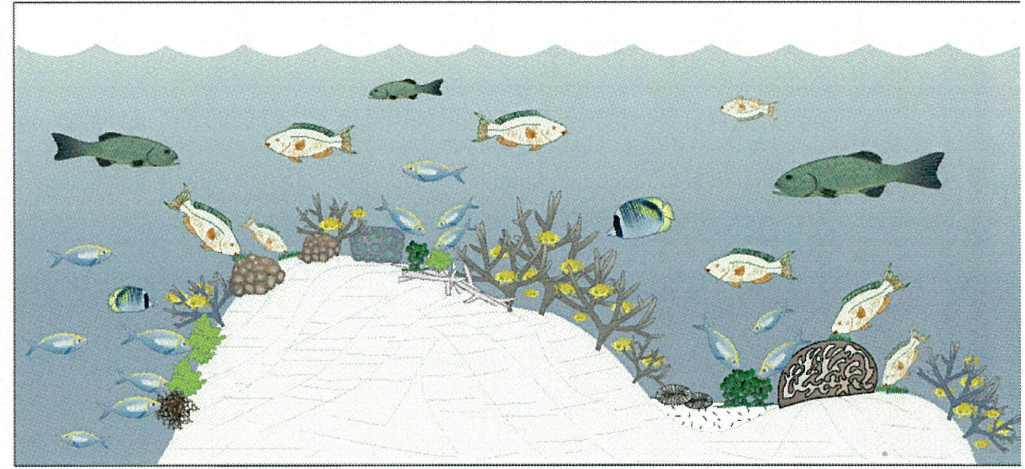
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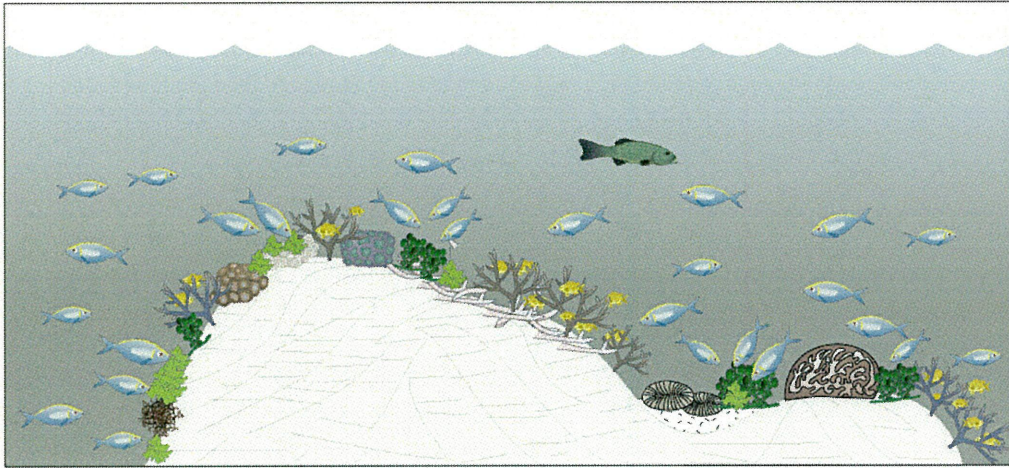
Current scenario



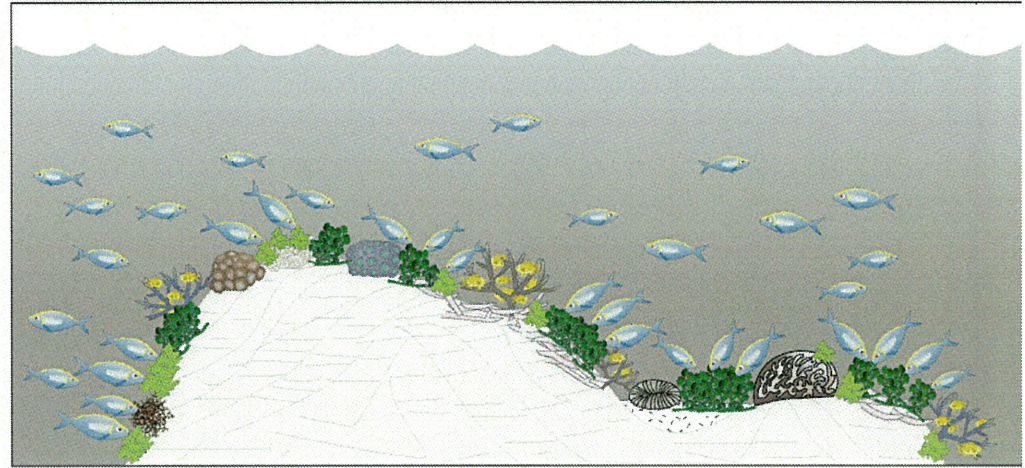
Future scenario - 2040













Future scenario -2080, substantial greenhouse gas reductions)



Future scenario - 2080, limited greenhouse gas reductions



	Bleaching sensitive corals		Damselfish
	Bleaching resistant corals		Rabbitfish
	Algae		Parrotfish
	Turf algae		Butterflyfish
	Bleached coral rubble		Coral trout

Sea Level Rise
Coastal Flooding
Storm Surge
Coastal Erosion

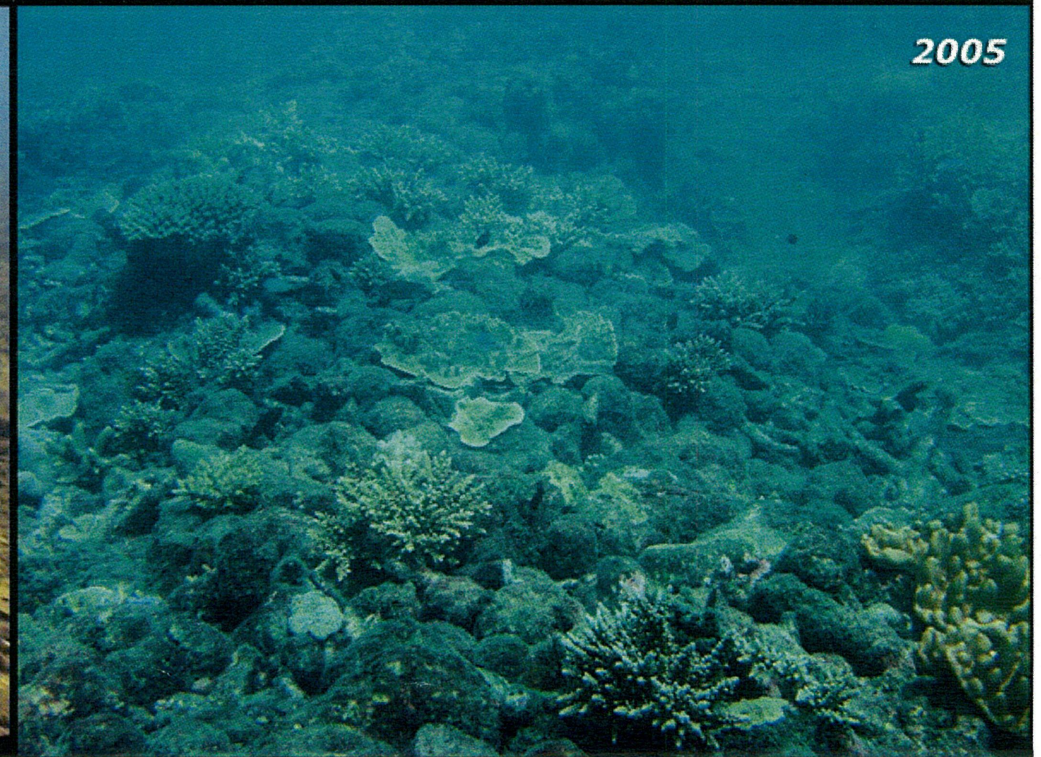
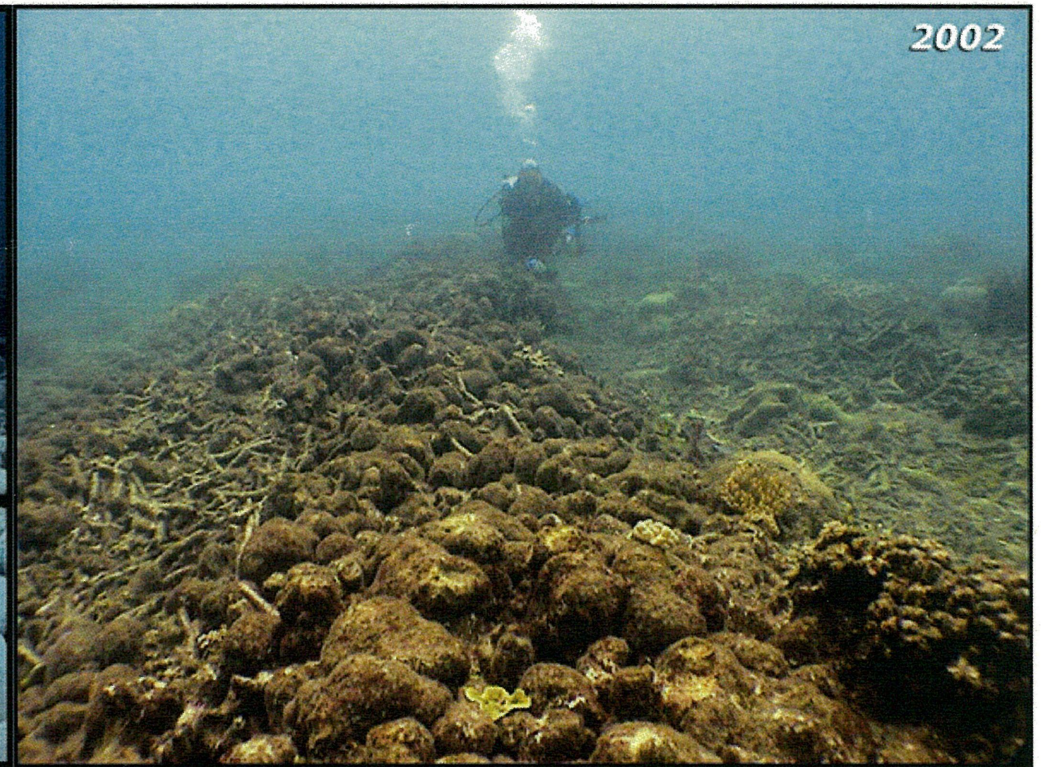
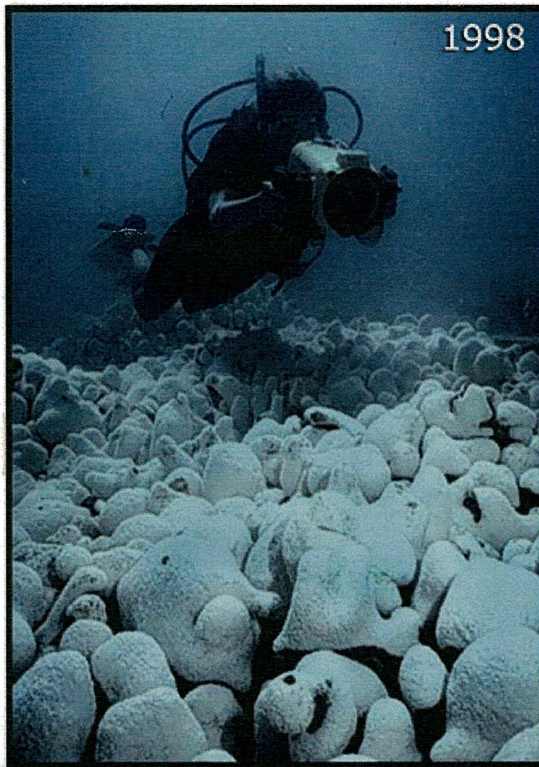
Coral Cover
Fish Abundance
Coral Reef Health
Coral Bleaching
Sea Level Rise
Ocean Acidity

Coral Cover
Fish Abundance
Coral Reef Health
Coral Bleaching
Sea Level Rise
Ocean Acidity

Coral Bleaching

Ecosystem recovery time series. Images taken at the same site 1998, 2002, 2004, 2005.

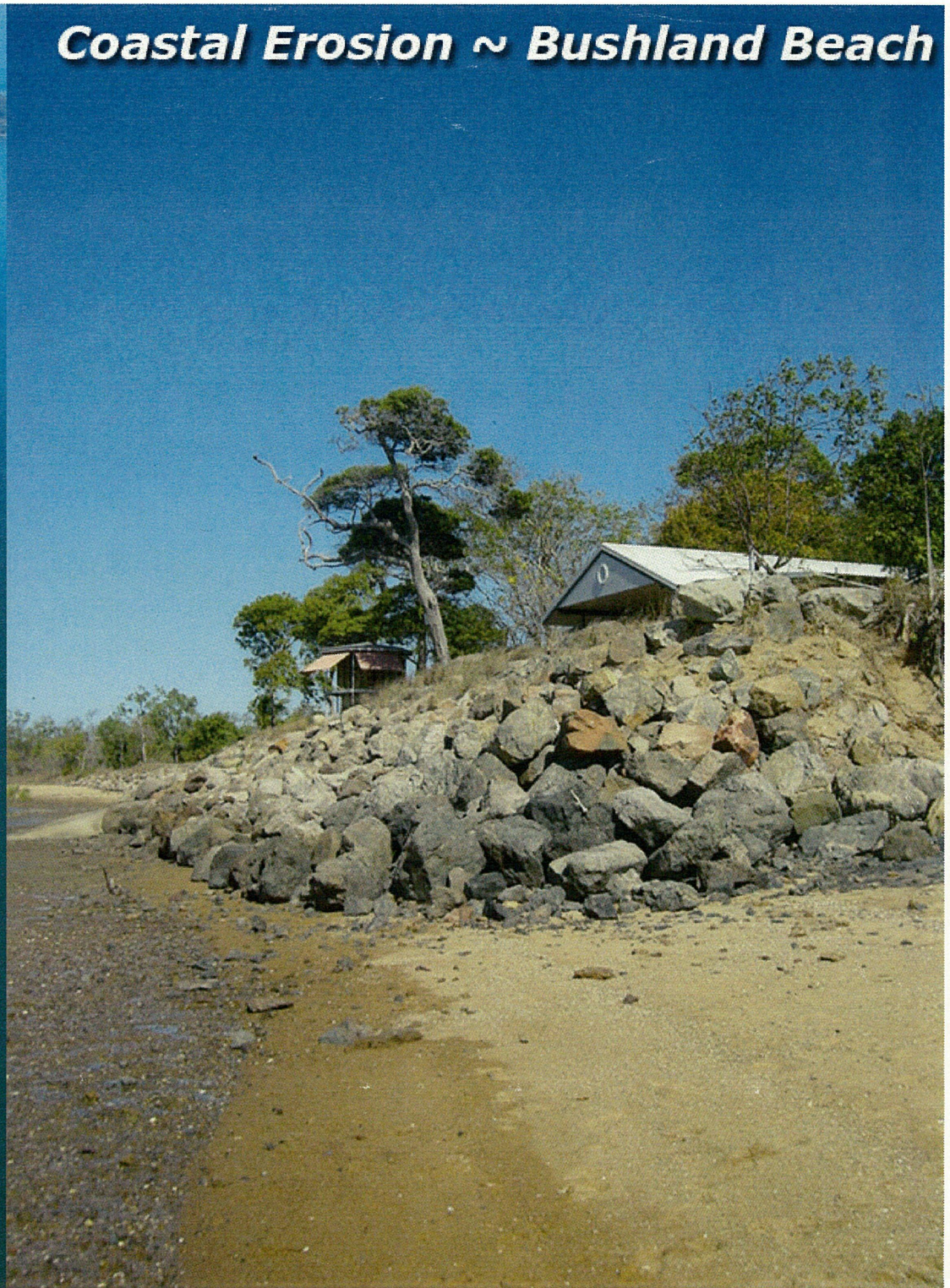
Pelorus Island,
Inshore Fringing Reef,
Great Barrier Reef,
Queensland, Australia.



Storm Defences ~ The Strand



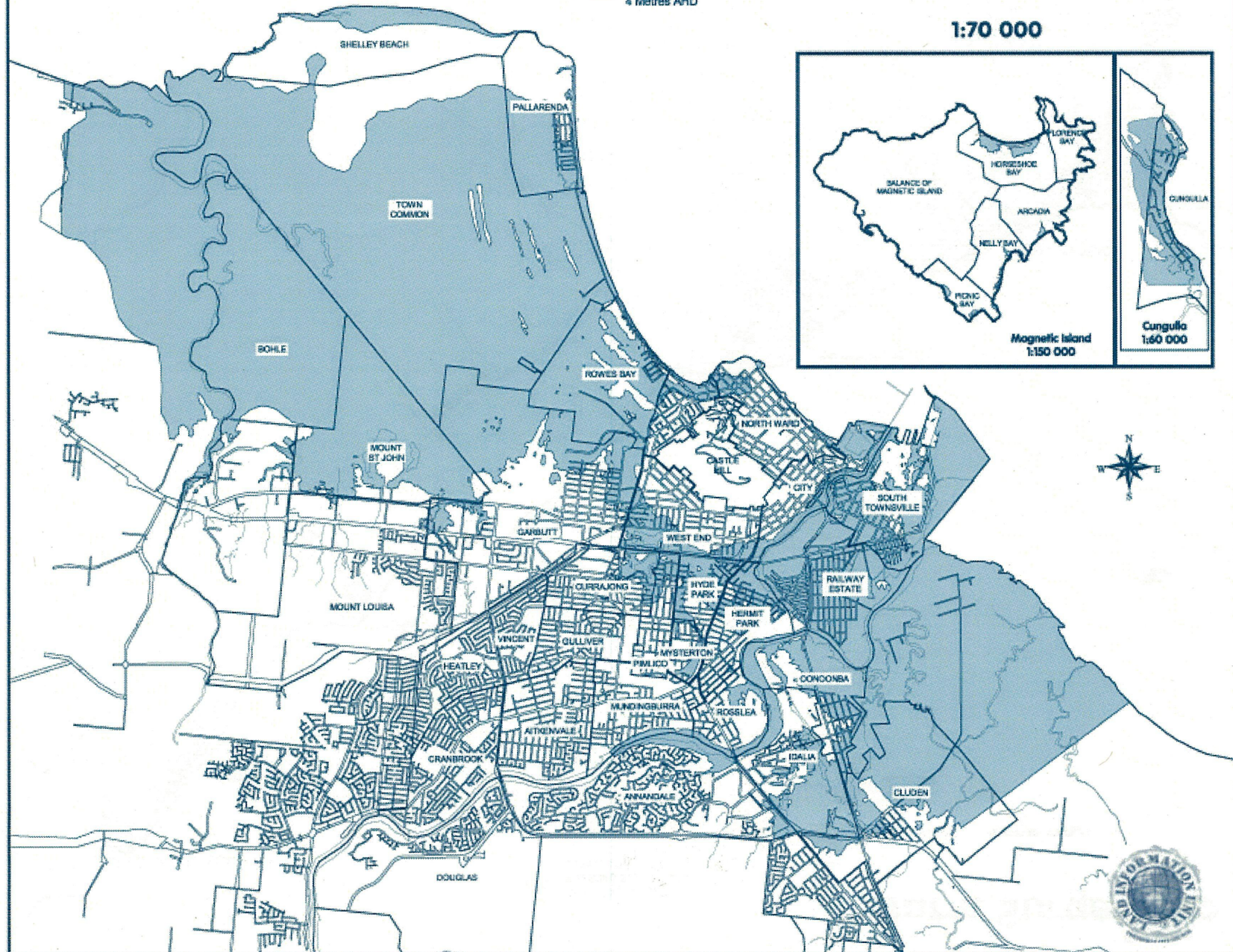
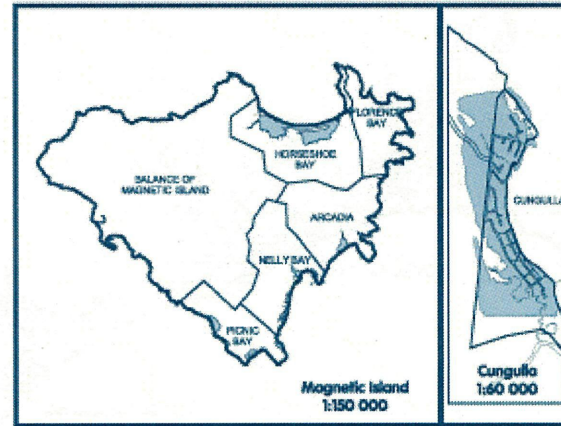
Coastal Erosion ~ Bushland Beach



Storm Surge Map

■ Areas Affected By
Predicted Storm Surge
4 Metres AHD

1:70 000



Storm Surge Map

Areas Affected By
Predicted Storm Surge
4 Metres AHD

1:125 000

