Coastal Vulnerability and Climate Change in Australia:

Public risk perceptions and adaptation to climate change in non-metropolitan coastal communities

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ABSTRACT

The degree to which society is potentially vulnerable to the impacts of climate change can be expressed through an assessment of either the biophysical (external) or social (internal) elements at risk. In Australia, the focus to date has been on the biophysical elements, or the level of physical exposure and sensitivity to potential climate change impacts. A greater understanding of the social elements of vulnerability is needed, including society's adaptive capacity. In short, whilst individuals and communities may not be able to control how the climate changes around them, they can influence how they adapt in the face of those changes. One social element, fundamental to adaptive capacity, relates to how individuals perceive the risks of climate change, which can either compel people to, or constrain them from, addressing risk.

Public risk perception is playing an increasingly important role in shaping environmental policy and management response systems and, as highlighted by several Australian and international research priorities, this is particularly relevant at the local level where individual adaptation is context specific. This study has examined public risk perceptions of property owners from two Australian non-metropolitan coastal Local Government areas which contributes to current theoretical understandings of risk, and demonstrates the use of particular methodological approaches in exploring such perceptions, in order to provide clarity to policy-makers on the factors motivating individuals to address and ignore risk.

This study has explored the role that public perceptions of climate change risk have in influencing an individual's willingness to support policy initiatives and consequently adapt to climate change. Utilising representative samples in Rockingham, Western Australia, and Yorke Peninsula, South Australia, data obtained from a mixed-method mail-out survey indicates that the majority of property owners are concerned about climate change, and almost one half believe it is occurring now. An optimism bias was identified, however, whereby many perceived their personal risk as less than that of others in the same community, and they believed strongly in their own capability to adapt. This is despite the fact that many respondents consider climate change impacts as occurring now or likely to occur in the next 25 years, and the fact that they expect such impacts to cause disruption to their lives. Notably, these results were particularly significant for males, those with low education levels, and those over 60 years of age.

This thesis has implications for behavioural change, and hence, proactive adaptation and vulnerability reduction strategies. Indeed, underestimations of personal risk and high levels of self-efficacy may in fact lead to large proportions of the population believing themselves to be exempt from future climate change risks, which is highly undesirable in a changing climate. This study concludes that a deeper understanding of public risk perceptions might help decision-makers to better inform the public of risk and policy-makers of the way the public perceive risk. Here, adaptation response strategies are able to be framed more appropriately in local contexts, and in a way that is deemed acceptable to the public.

DECLARATION

I, Christopher David Button, certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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ABBREVIATIONS AND ACRONYMS

ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
AHD	Australian Height Datum
ANZLIC	Australian New Zealand Land Information Council
AR4	Fourth Assessment Report
COAG	Council of Australian Governments
CRCSI	Cooperative Research Centre for Spatial Information
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCC	Department of Climate Change (Federal)
DCCEE	Department of Climate Change and Energy Efficiency (Federal)
DEC	Department of Environment and Conservation (Western Australia)
DEH	Department for Environment and Heritage (South Australia)
DEM	Digital Elevation Model
EIA	Environmental Impact Assessment
ESP	Ecosystem Services Product
GCM	Global Circulation Models
ICZM	Integrated Coastal Zone Management
IOCI	Indian Ocean Climate Initiative
IPCC	Intergovernmental Panel on Climate Change
LAPP	Local Adaptation Pathways Program
LGA	Local Government Association
MLS	Mutual Liability Scheme
NCVA	National Coastal Vulnerability Assessment
NEDF	National Elevation Data Framework
NEXIS	National Exposure Information System
NRC	National Research Council
NRM	Natural Resource Management
NSTF	National Sea change Taskforce
NYNRM	Northern and Yorke Natural Resource Management Board
PAR	Participatory Action Research

PAR model	Pressure and Release model
PIRSA	Primary Industries and Resources South Australia
RAC	Resource Assessment Commission
SA	South Australia
SARF	Social Amplification of Risk Framework
TAFE	Training and Further Education
TAR	Third Assessment Report
TDM	Tailored Design Method
UK	United Kingdom
UNCED	United Nations Convention on Environment and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
WA	Western Australia

Chapter 1 – Introduction

The degree to which humans are vulnerable to the impacts of climate change at the coast worldwide is a product of numerous and varied interacting social, political, economic and environmental forces. This thesis will argue that future climate change vulnerability and adaptation research work should consider to a greater extent the generic indicators of social vulnerability in coastal case studies to strengthen shifts towards more strategic coastal planning and management. Case studies will assist in determining the extent to which findings from such indicators can be generalised in particular contexts (Gurran *et al.*, 2008; Wall and Marzall, 2006).

As a research project, this thesis utilises case studies to examine perceived vulnerability to climate change in two different coastal settlement contexts in Australia. This will demonstrate how a better understanding of the human dimensions of climate change can help to inform policy (Hulme, 2008; Moser, 2010b). Specifically, this thesis considers public perceptions of climate change risks including, but not limited to, sea-level rise and storm surge flooding, along with the capability and willingness of individuals to adapt to climatic changes (as outlined by Thom, 2007). This thesis will simultaneously consider attitudes towards unique development pressures that arise as a result of the 'sea change' phenomenon.

This introductory chapter will begin by outlining the aim, objectives, and rationale of the research project. Next, it will emphasize the key issues surrounding climate change and the vulnerability of human settlements. It will highlight the importance of the coast to human populations, with respect to climate change, including coastal delineation and its value, as well as coastal pressures including population growth, governance and management. It will then provide a more detailed analysis of the varied and contested theoretical concepts of vulnerability and adaptation to climate change, differentiating between two fundamental approaches to vulnerability assessment, the biophysical and the social assessment, as well as the integration between the two approaches. The chapter will conclude with a brief discussion on the research gaps and questions, and highlight the need for a greater understanding of the human dimensions of climate change adaptation through a focus on the social assessment of vulnerability.

1.1 Purpose of the study

1.1.1 Aim

The primary aim of this research is to enhance coastal vulnerability assessments in Australia by including public perceptions of risk, adaptive capacity and adaptation to climate change and development pressures. In doing so, this thesis will contribute to knowledge such that it will assist in the facilitation of local adaptation to climate change, as well as shifts towards more strategic coastal planning and management.

1.1.2 Objectives

The objectives of this study, based on the literature to be discussed within this chapter (and derived from the two research gaps described in a later section), are to:

1. Identify the relationship between perceived risks and perceived adaptive capacities of property owners within non-metropolitan coastal settlements in order to better understand their predisposition towards actions for reducing vulnerability to climate change;
2. Identify social factors influencing individual adaptation in order to determine potential ways to increase the adaptive capacity of coastal property owners; and
3. Identify motivating factors for risk reduction in order to help society prepare and be willing to support adaptation to climate change and development pressures.

1.1.3 Rationale

Vulnerability assessments are valuable for identifying current and potential future climate change impacts, and can be divided into biophysical vulnerability and social vulnerability assessments (Füssel, 2007b; Tapsell *et al.*, 2010; Zahran *et al.*, 2008). In Australia, there have been a number of biophysical vulnerability assessments, most notable being the Federal Government's recent 'first pass' National Coastal Vulnerability Assessment (NCVA) (DCC, 2009). Only a very few social vulnerability assessments have been wholly undertaken, with the majority of multidisciplinary projects having only a limited scope for social vulnerability analyses and generally forming a smaller component of a much larger biophysical assessment (Glover, 2007).

Traditionally, there was a disproportionate amount of research examining climate mitigation than climate change adaptation, although the latter has been receiving increasing research attention in

recent years (Füssel, 2007a) (for example, through the establishment in Australia of the National Climate Change Adaptation Research Facility - NCCARF). It is paramount that climate change risks be addressed through a combination of both mitigation and adaptation measures, since mitigation prevents further future impacts, and adaptation reduces the effects of current impacts and lessens the extent of negative impacts. Particularly in the coastal zone, as discussed by Lazarow *et al.* (2006, p. xv), "not enough emphasis has been placed on some of the political, economic and social drivers of change", which are consequently placing increased pressure on coastal resources. Indeed, as Giddens (2009, p. 178) asserts "[p]roper and detailed vulnerability assessments should be the first line of defence in adaptation, since practical action is hardly feasible if the extent and location of risks are not known". This thesis, consequently, seeks to address some of these research gaps.

Current vulnerability assessments tend to focus on biophysical elements at risk (Finucane, 2009; Stehlik and Costello, 2008) and only incorporate narrow assessments of society's capacity to adapt. A greater emphasis is needed in reference to the social aspects of adaptation to climate change. As Thom (2007) explains, the fundamental question confronting those at the coast relates to society's capability to adapt to changes as a result of climate change. For instance, research should investigate the positive impacts on coastal management issues and outcomes that well-informed communities and bureaucracies can achieve, since it is unclear whether or not coastal communities realise the potential for adaptation (IPCC, 2007a; Lazarow *et al.*, 2006). Indeed, biophysical studies are critical components in vulnerability assessments and have proved extremely valuable, however, important elements of social vulnerability have generally been overlooked (Stehlik and Costello, 2008). For effective decision-making, whilst it is crucial for studies in the natural and climate sciences to further understand the biophysical risks of climate change, it is also crucial to better understand "the human drivers for initiating, promoting, or hindering political change" (Renn, 2011, p. 154). This political change is likely to be more effectively facilitated, therefore, through an awareness and acknowledgement of societal perceptions of climate change.

An assessment of social vulnerability can be made through an examination of, but not limited to, adaptive capacity since it is a key factor in determining the potential for adaptation (Wall and Marzall, 2006). Adaptive capacity is partially dependent on social, human, institutional, technological, natural, and economic resources, and successful adaptation options are limited by these factors (IPCC, 2007d). The social components and barriers to adaptation include factors

such as human cognition, perceptions, values, and socio-institutional networks. Specifically, this study proposes an examination of one particular factor, perceptions of climate change risk, vulnerability, and adaptation at the community level. This study will not, however, develop indices of subjective vulnerability from the results, but rather explore how they may help to inform policy. Indeed, public perceptions of climate change risks will strongly influence levels of support for, or opposition to, related public policies (Leiserowitz, 2005). As such, successful uptake of government policies to reduce climate change vulnerability at the coast may be fundamentally influenced by risk perceptions.

Many of the current large-scale Australian vulnerability studies examine in detail the biophysical elements of risk, for example, such as:

- The Australia-wide 'first pass' NCVA (DCC, 2009; DCCEE, 2011).
- The mapping of Australian low-lying urban areas through sea-level rise visualisation tools (Geoscience Geoscience Australia, 2011).
- The South-East Queensland case study conducted under the CSIRO Climate Adaptation Flagship program (Wang *et al.*, 2010).
- The inundation modelling in the Victorian 'Future Coasts' program (McInnes *et al.*, 2009a; McInnes *et al.*, 2009b), and Sydney Coastal Councils Group (2011).

It is imperative, however, to examine in more detail the social elements of risk for Australia's vulnerability assessments to be a more holistic tool for policy and decision-makers. For that reason, as recommended by the IPCC (2007d), a vulnerability assessment that includes an analyses of the adaptive capacity of a system (to assess social vulnerability) will complement the analyses of biophysical risks and vulnerability (Dolan and Walker, 2004). In addition, the National Climate Change Adaptation Framework (COAG, 2006) identified the need for building tools to assist in sectoral and regional vulnerability assessment. This study, consequently, will support these recommendations through an examination of local level (individual) adaptive capacity and willingness to adapt to climate change, based on public perceptions of climate change risks. Examining public risk perceptions within the context of a vulnerability assessment, as such, will assist in identifying the social vulnerabilities within society not recognised elsewhere (Nursey-Bray *et al.*, 2012).

This study will differ from the current biophysical vulnerability assessments that use geomorphological and other geographical variables, such as elevation and proximity to coast. It

will collect primary data from coastal property owners, and explore their perceptions of a number of climate change risks and adaptation issues at a local level. This is predicated on the knowledge that "public perceptions and interpretations of 'dangerous' climate change are "based on psychological, social, moral, institutional and cultural processes" (Dessai *et al.*, 2004, p. 14), as well as the scientific and technical descriptions of danger (Leiserowitz, 2005). Future events, as described by Bandura (1986, p. 19), such as projected climate change impacts and subsequent adaptation options, therefore, cannot be determinants of behaviour, but the cognitive representations of such events "can have a strong causal impact on present action". Since these cognitive representations are mediated by factors such as personal experience, affect and emotion, imagery, trust, values and worldviews (Slovic, 2000b), risk perceptions are significant elements of the socio-political context within which policy-makers operate (Leiserowitz, 2005).

Coastal property owners are the focus of this research since they are in a unique predicament in the context of climate change. They are vulnerable to both the physical impacts of climatic changes, as well as the consequences of the implementation of mitigation and adaptation policy. For instance, not only will property owners be exposed to storm surges, sea-level rise inundation and erosion, as well as be responsible for initiating personal adaptation responses (Gurran *et al.*, 2008), but due to the likely introduction of more stringent policy in the near future, property owners are susceptible to a range of flow-on effects. For example, planning restrictions regarding the minimum height of new development in low-lying areas raises issues of liability for councils and developers (Harvey and Clarke, 2007; Harvey *et al.*, 2011). Furthermore, the costs to individuals arising from climate change impacts will increase since governments will likely be required to make allowances for emergency relief within existing budget constraints, and since insurers are likely to pass on their increased exposure through tighter conditions and higher premiums (McDonald, 2007). A better understanding of public perceptions of climate change risk, within such a non-metropolitan coastal context, will help in the facilitation of local adaptation to climate change through an evidence-based policy-making approach (Banks, 2009).

The two case studies for this research are located in the City of Rockingham, in Western Australia; and the District Council of Yorke Peninsula, in South Australia. They represent two different settlement areas along the Australian coast; the non-metropolitan and peri-metropolitan, and they are both spatially distant from one another, yet climatically similar, coastal 'sea change' regions. The various characteristics of the case study sites will allow for a comparison based on the 'hazards-of place' model of vulnerability (developed by Cutter *et al.*, 2003). From this

comparison, due to the particular demographic and lifestyle differences present between the two regions (to be discussed in Chapter 1.3.6 and Chapter 2.2.1), it is hypothesised that there will be substantial variations in the aggregate responses of property owners in terms of perceived risk. The null hypothesis is that there will be no statistically significant differences in the responses of property owners based on the case study sites (place) and residency (type of property).

This study also intends to assist in the development of sectoral and regional vulnerability assessments for researchers and decision-makers, and knowledge regarding social trends and impacts of climate change, consistent with the Australian National Climate Change Adaptation Framework (COAG, 2006). The 'potential areas for action' outlined by the Council of Australian Governments (COAG) National Climate Change Adaptation Framework, with reference to regional climate change and vulnerability information (COAG, 2006), specify that an analysis of social trends and data to assess how social factors are likely to influence vulnerability will be required. Indeed, people respond differently to hazards both perceived and not perceived; people differ in their views of uncertainty since neither they, nor their views, are homogenous, and; people do not necessarily react uniformly under uncertainty either.

To analyse the local level social vulnerability, the complexity of the interrelationships between the biophysical and social components of risk requires a comprehensive, multi-disciplined and multi-method approach. Therefore, using primary and secondary quantitative and qualitative data, the vulnerability and adaptive capacity of two non-metropolitan coastal communities will be examined.

1.2 Climate change

The unprecedented rapid global warming that has occurred over the past century as a result of increasing anthropogenic greenhouse gas emissions, which has forced the climate to change, has altered and will continue to alter Earth's socio-ecological systems. The Intergovernmental Panel on Climate Change (IPCC) has concluded that "warming of the climate system is unequivocal" (IPCC, 2007b, p. 5). Perhaps importantly, it is the rate at which global warming is occurring which has the most significant implications for human society and the natural environment. The global surface temperature has increased on average by around 0.05°C per century since the end of the last glacial period, roughly 20,000 years ago, however, in the last 50 years the observed rate of temperature increase has been 1.3°C per century (Pittock, 2009).

Timeframes available for both natural and humans systems to appropriately adapt, therefore, have been greatly reduced.

There is a growing body of evidence that the atmosphere is following the higher ranges of average global temperature increase estimates, as discussed by the IPCC (2007b). Furthermore, with the oceans accruing the bulk of the energy imbalance (IPCC, 2007b), global warming is also likely to be associated with an intensification of the hydrologic cycle (Huntington, 2006; Sheffield and Wood, 2007). This warming-induced intensification is brought about by increases in evaporation and precipitation, as a function of temperature, which would result in more frequent and intense extreme events, such as tropical storms, floods, and droughts (IPCC, 2007a).

The extremes of natural climate variability have always had an impact on socio-ecological systems. In the past, however, natural climate variability and much slower rates of climatic change allowed species to adapt and evolve so that conditions are favourable to them more often than not (Pittock, 2009). In the case of extreme events, located beyond or at the fringes of favourable conditions, critical thresholds may be crossed and species may no longer function as they did during 'normal' conditions. In the case of global climate change, with extreme events becoming more pronounced through an intensification of the hydrologic cycle, the likelihood of crossing critical thresholds, both biophysical and social, as well as experiencing unfavourable conditions increases substantially (Meze-Hausken, 2008; Pittock, 2009). The consequences for humans and human settlements, therefore, already highly sensitive to extreme conditions, are manifest significantly under scenarios of future climate change.

Climate change impacts will vary both temporally and spatially, and precise impacts are still unclear despite the best efforts to predict and model possible change. Of particular relevance to this research project are semi-arid, or Mediterranean-type, climatic systems whereby strong warming and drying trends have been experienced since the 1970s (Bardsley and Edwards-Jones, 2007). Since it is expected that these regions will continue to experience such trends as a result of climate change more so than other climate types, this could result in dramatic alterations in productivity levels (Bardsley and Sweeney, 2010; Bengtsson *et al.*, 2006; Dunkeloh and Jacobeit, 2003; IPCC, 2007a). These changes have been projected to affect evapotranspiration rates, cloud characteristics, and soil moisture, along with vegetation pattern and growth rates, storm intensity, the timing and magnitude of floods and droughts, runoff regimes and groundwater recharge rates (Ragab and Prudhomme, 2002). The flow on effects of these alterations under

high emissions scenarios are forecasted to result in a substantial polarisation of impacts including marked increases in food prices, and regional variation in crop production (Parry *et al.*, 2004). These issues are particularly relevant for regional non-metropolitan economies experiencing such conditions.

Climate change is widely recognised as one of the most pressing 'wicked' problems facing humanity (Lorenzoni *et al.*, 2006). These problems are not explicitly 'wicked' in a moral sense, but are 'wicked' because they are characterised by uncertainty; they are hard to define, or ill-defined; they are seldom the responsibility of any one body; they vary in the extent to which multiple, partisan participants contribute to solutions; and they lack clear understandings of the means, consequences or cumulative impacts of collective actions (Carley and Christie, 2000; Head, 2008; Rittel and Webber, 1973). Uncertainty from both the science of climate change and from the future behaviour of humans (Pittock, 2009), consequently means that "very little can be said with confidence about vulnerability to long-term climate change" (Downing and Patwardhan, 2004, p. 71). Since the many challenges of uncertainty are growing as key concerns for humanity, as such, communities and stakeholders expect greater involvement in the decision-making processes invoked, in part, by increasingly democratic governance systems (Brody, 2003; Brody *et al.*, 2003; Burby, 2003).

Of great concern for humanity is that climate change is moving societies into positions whereby comfortable, or at least accustomed, climatic conditions become less common, and extreme events become more common (Pittock, 2009). Whilst it is generally accepted that occurrences of extreme weather events and prolonged adverse weather conditions, such as storm surges and drought, require government assistance and external support, in a changing climate it is important not to create dependency relationships or inadvertently provide incentives to continue poor risk management practices (Kretzmann and McKnight, 1993; McKnight, 1995; Stehlik and Costello, 2008). Adaptation, therefore, has become a strong component of vulnerability analysis (McFadden, 2007). Indeed, one of the best ways to adapt to a future of climate uncertainty is through reducing vulnerability to hazards and extreme events and improving current responses to such events (Burton, 1997; Smit and Wandel, 2006).

In this respect, since these types of individual hazards are usually local and regional phenomena, adaptation is more relevant at the community level, and as van Aalst *et al.* (2008, p. 170) explain, adaptation to climate change means:

> *…being able to maintain (and preferably improve) the current living standards in the face of expected changes in climate trends and the intensity and frequency of severe events that may affect people's livelihoods.*

Formal hazard and risk studies, including those concerning climate change, are typically formed by examining a combination of factors that considers the potential exposure of people to particular hazards or stress, based on the potential outcomes and probability (Cutter, 1996; Wisner *et al.*, 2004). In these instances, experts have often asked and answered such questions involving risk almost independently of the views of the general public (Oppenheimer and Todorov, 2006). In order to understand broader climate change risks, it is inadequate to have knowledge solely regarding the types of hazards or stresses. Rather, there must also be an understanding of the different levels of vulnerability inherent to different groups and individuals in society (Adger *et al.*, 2009). If there is to be a shift towards more strategic planning, therefore, consistent with the notion that that "environmental policies that target human behavior should incorporate insights about behavioral change and decision-making", a much more holistic assessment of climate change vulnerability and adaptation requires an examination of people and place since any solution developed without the public is unlikely to be imposed successfully (Oppenheimer and Todorov, 2006, p. 1).

1.2.1 Sea-level rise

The rapid and unprecedented rates of global warming have already increased sea levels, and are projected to continue to increase them well into the future. Whilst the sea level has fluctuated significantly during glacial/interglacial cycles, it has remained relatively stable over the past several millennia (Church *et al.*, 2008). Paleo data has indicated that the sea level was around 4 to 6 metres (or possibly even greater) above current levels approximately 125,000 years ago during the last interglacial period (Overpeck *et al.*, 2006). As the planet transitioned into a glacial period approximately 20,000 year ago, the sea level dropped by over 120 metres. Since then the sea level has risen at an average rate of approximately 10 millimetres per year, with peak rates of up to 40 millimetres per year, up until around 7,000 years ago when it rose much more slowly (Lambeck, 2002). However, sea level has been rising at increasing rates in the 19th and 20th

centuries, as indicated by geological and tide-gauge data, with recent satellite-altimeter and tide-gauge data revealing a 3.0 millimetre per year rise (Church *et al.*, 2008).

Throughout the 20th century, the total sea-level rise was estimated to be 17±5 millimetres (Pittock, 2009). This rise is in part due to the thermal expansion of the oceans as they absorb more heat trapped in the Earth's atmosphere. As a result of the inertia of the oceans, this will mean a lag-time between atmospheric warming and a consequential future rise in sea level (IPCC, 2007a). The rise is also due to increases in the net volume of water in the oceans due to the melting of ice sheets, ice caps and land-based glaciers, as well as *relative* sea level rises due to land subsidence as a result of natural isostatic movement and human interference with sub-surface fluids, or groundwater (IPCC, 2007b).

Working Group One (WG1) of the IPCC's Fourth Assessment Report (AR4) (IPCC, 2007c), depending on particular emissions scenarios, project future sea-level rise to be in the range of 18 to 59 centimetres by the year 2100 (detailed as the vertical bars in Figure 1.1). However, the AR4 estimates only incorporated thermal expansion as well as water added to the oceans from land-based ice, and did not take into account rapid and dynamic ice flow changes that would occur, for example, if the Greenland icesheet collapsed completely. Vermeer and Rahmstorf (2009), on the other hand, utilise a method of projection based on temperature observations (the red line in Figure 1.1) and the IPCC's temperature projections to calculate a range of sea-level rise projections of between 75 centimetres and 1.9 metres. Of great concern for human societies are the risks to settlements in low-lying coastal areas, and the potential loss of coastal land due to erosion and inundation as a result of sea-level rise and storm surges.

Figure 1.1: Projections of sea-level rise from 1990 to 2100 based on IPCC temperature projections

NOTE:
This figure is included on page 11 of the print copy of the thesis held in the University of Adelaide Library.

Source: Vermeer and Rahmstorf (2009, p. 21530)

It is difficult to attribute a precise proportion of coastal change solely due to sea-level rise due to the complex and non-linear morphological nature of coastal systems (Dronkers, 2005; Pittock, 2009). In addition, there are more localised factors of change, such as variability in storminess or the construction of sea walls, for instance (Dronkers, 2005; Pittock, 2009). Furthermore, projecting the future amount of sea-level rise and rate of rise at local and regional scales, as well as on various temporal scales will prove challenging due to these localised variability factors, future emissions pathways and degree of global warming. It is the more localised, relative sea level changes and their subsequent impacts, however, that are of direct interest to coastal managers (Harvey, 2006).

1.3 The coastal zone

This section will summarise the predominant coastal zone management issues on a global scale first, with each issue then becoming more focussed on particular issues relevant to Australia. Each subsection is predicated on the realisation that:

- The coast is a difficult entity to define.
- Coastal resources are important to human livelihoods and development.

- Resources are provided by a diverse range of habitats and species.
- Humans have historically settled and are continuing to settle at the coast.
- Managing increasing settlement and resource use is complex, irrespective of future climate change risk.
- Climate change risk is likely to exacerbate existing pressures.

1.3.1 Coastal delineation

What precisely constitutes the 'coast' varies considerably, and for policy actions to have meaning in a practical sense there must be some delineation of the 'coast' or 'coastal zone' (Harvey and Caton, 2003). In its most basic form, the coast can be defined as where the land meets the sea, however, applying this simple definition neglects many other socio-ecological systems that are influenced far from that direct land/sea interface. In reality, therefore, the coastal zone is much more complex, and as McFadden and Green (2007, p. 121) describe, it is "an area of [a] collision of interests as well as the collision of processes". Such a definition demonstrates the uniqueness of this interaction between social, terrestrial and aquatic systems and the equally unique management challenges it presents.

If the coastal zone is defined too broadly then there are areas and ecosystems that could be included which have very little to do with practical coastal management and, as such, merely complicate matters (Harvey and Caton, 2003). Alternatively, if the coastal zone is defined too narrowly it may exclude some areas and ecosystems that are strongly linked in coastal dynamical processes and suffer as a result (Harvey and Caton, 2003). Kay and Alder (2005) describe how a definition of the coast can be either scientific in nature or policy oriented. From a science perspective, as Ketchum (1972) explains, coastal areas can be thought of as where there is a connection between the land and ocean in the sense that terrestrial processes and land uses directly affect ocean processes and uses, and vice versa. In this respect, Kay and Adler (2005) define coastal areas as:

1. Containing both land and ocean components;
2. Having both land and ocean boundaries determined by the degree of influence each component has on the other; and
3. Having a varying width, depth and height.

The landward and seaward limits of the coastal area are largely dependent on the purpose of creating the definition in the first place (Harvey and Caton, 2003), coined a 'need-driven' approach. Defined from a policy oriented perspective, Kay and Alder (2005) describe four ways in which the limits of a coastal area may be defined:

1. Whereby distances landward and seaward are fixed (typically used for jurisdictional purposes);
2. Whereby distances are variable depending on physical features (for example, the edge of continental shelfs), biological features (for example, limits of specific vegetation types), and administrative boundaries (for example, town limits);
3. According to how it will be used (typically utilised if addressing a direct management issue); and
4. Hybridly (utilising one of the above different 'types' of definition for each component).

In summary, the uniqueness of the coast is highlighted by the interaction between terrestrial and marine environments, and consequently, any working definition should reflect this uniqueness. Additionally, since it was also previously outlined that the realisation that people's perceptions of risks play a significant factor in determining the extent to which people react to those risks, any working definition of the coast and/or coastal zone should also encompass this realisation. Therefore, for use within this thesis, it is appropriate to acknowledge and examine the 'total coastal system', and therefore the coast is defined as *where the interrelationships lie between the natural, as well as human and social elements of the land-sea interface*. Any delineation of what constitutes the coast by the participants of the mail-out survey questionnaire in this research (to be discussed in Chapter 2), as well as what coastal vulnerability issues are discussed, is consequently encompassed within this working definition.

1.3.2 Coastal population

In terms of human populations and their proximity to the coast, it is not surprising that populations are as large as they are considering "past, present and future dependence on coastal waterways for food, commerce, travel, and recreation" (Tyson *et al.*, 2004, p. A455). With definitions of the coast varying within and between nations, coastal population estimates range from approximately one third to one half of the world's population (Kay and Alder, 2005). Current trends reveal massive growth in coastal megacities as a result of migration from rural to urban areas (Hugo *et al.*, 2009), and projections of the future global coastal population are predicted to approach six billion by the year 2025 (Kennish, 2002).

Australia, despite its continental expanse, has been described as an 'island' country when considering population distribution (Chen and McAneney, 2006). Around 86% of Australia's population live in the coastal zone (Harvey *et al.*, 2008), with an estimated 6% of Australian properties situated within 3.0 kilometres of the shoreline and below 5.0 metres above sea level, as well as an estimated 50% of the population within 7.0 kilometres of the shoreline (Chen and McAneney, 2006). Most recently, a report commissioned by the Australian Federal Government found that between 157,000 and 247,600 individual buildings are potentially at risk of coastal inundation from a 1.1 metre sea-level rise, which have a combined value of up to AU$63 Billion (DCC, 2009).

On a broader scale, the Australian Bureau of Statistics (ABS, 2006c) has estimated that 77% of Australians live in towns and cities of over 1,000 people located within 50 kilometres of the coast. This proportion is principally concentrated in large and isolated urban centres spread throughout the country, with roughly two thirds of the total population residing in the state capital cities, all of which are coastal (ABS, 2006c). This type of city dominance over the country in terms of population conglomerations is referred to as 'metropolitan primacy' (Burnley and Murphy, 2004). Metropolitan primacy in Australia, according to Burnley and Murphy (2004), developed due to four primary reasons:

1. European settlement coincided with the industrial revolution which favoured cities as centres of industrial activity;
2. Climatic characteristics in much of Australia, such as low and variable rainfall and soil fertility, do not support European-like population densities in land;
3. Raw materials from rural areas, such as food and minerals, were exported with little, if any, local processing which limited industrial growth; and
4. The expansion of the railways meant the bypassing of small rural towns for swift transportation and production in coastal capitals.

1.3.3 Coastal development

Growing human populations are concentrated in the coastal zone (IPCC, 2007a; Small and Nicholls, 2003), and by the middle of the 21st century, an estimated 11-15 million people are predicted to migrate into Australia's coastal zone (Davis and Weller, 1993). Human development in the form of housing and associated infrastructure is associated with this increase in population, as well as the growth in human dependency on coastal resources, is placing increased stress on coastal ecosystems and the services they provide (UNEP, 2012). Within the context of this

coastal development and resource use, it is not surprising that “conditions have worsened for sewage, nutrients, marine litter, and physical alteration and destruction of habitats” (UNEP, 2012, p. 1). For instance, human activities associated with point and non-point sources of pollution have resulted in billions of litres of wastewater being discharged into the ocean and coastal waterways (Tyson *et al.*, 2004).

Development within the coastal zone is a strongly contentious issue worldwide, made difficult by changing coastal conditions and processes. Disputes over interpretations of ‘coastal’ definitions amongst planners, policy-makers, developers and stakeholders, among others, are regularly debated regarding the appropriateness of proposed developments (Harvey and Caton, 2003). Coastal resources on a global scale are continuing to come under increasing pressure from humanity (French, 2004; von Bodungen and Turner, 2001), however, there is also a growing awareness of the importance and value of these resources to a greater range of stakeholders.

Resource pressures regarding coastal development have seen environmental conflicts become key features of coastal decision-making. As Rockloff and Lockie discuss (2004, p. 82), conflict within the coastal zone is strongly “a symptom of the interconnectedness of environmental processes and issues”. The conflicts that arise for development, used here in the broadest sense, generally stem from the various decision options, that is, to protect development, abandon development, or restrict development. In addition to this, it must also be noted that each Australian state, and the Northern Territory, deals with coastal development issues differently due to their legislative requirements, depending on the types of development, as well as the level of environmental impact and type of environmental impact assessment (EIA) necessary (Harvey, 1998).

Both nationally and internationally, coastal development pressures are growing (Gurran *et al.*, 2006; Huppatz, 2005). In terms of real estate, Schneider and Chen (1980) provided one of the first cost estimates for coastal properties within the possible range of future sea-level rise scenarios. Their high estimate, inflated to 1990 dollars, was around US$474 Billion for United States coastal property for a sea-level rise of 25 feet (approximately 7.6 metres). More recently, for example, estimates of funds invested in real estate and infrastructure along the barriers and mainland beaches of the east coast of the United States alone amount to US$3 Trillion (Evans, 2004).

In terms of development-related impacts on the coast, the approach of planners and managers of the past was typically to protect human settlements through the construction of hard barriers and shields (French, 2004). These adaptation options, however, have generally proven inadequate in the long-term due to variations in local geomorphic characteristics and changes in such characteristics over time. The need for long-term solutions to coastal management problems, coupled with a greater knowledge of dynamic coast processes, among other things, has given rise to the concept of 'integrated management' (McFadden, 2007).

1.3.4 Managing the coast

Harvey and Caton (2003) detail the growing international push for improved coastal management, which gained prominence following the Rio 'Earth Summit' in 1992 as a result of a realisation of the importance of the coast for human survival (UNCED, 1992). In reference to Australian coastal management, Thom and Harvey (2000) discuss four key factors that have played a significant role in perpetuating reform (Figure 1.2), including:

1. Global environmental change;
2. Adoption of the principles of sustainable development;
3. Application of strategic planning principles as a result of pressure for a more holistic or integrated approach to resource management; and
4. Greater community awareness of management issues and greater community participation in decision-making.

Figure 1.2: Factors for late 20th century reform of Australian coastal management



Source: Thom and Harvey (2000)

Integrated coastal zone management (ICZM) is a more holistic and strategic approach to coastal planning and environmental management. 'Integration', with reference to all facets of environmental management, has emerged as the ideal concept internationally for management involving the goals of sustainable development (Sorenson, 1997). As discussed by McFadden (2007, p. 202), a change to more strategic thinking "reflects a paradigm shift 'from defensive actions against hazards, to management of the risk'" itself. The emergence of ICZM as the ideal framework, therefore, was ultimately a realisation that coastal resources could no longer be managed in isolation, but instead needed to be managed from a perspective which viewed the biophysical, economic and social environment as one total system (Harvey and Caton, 2003; Kay and Alder, 2005; McFadden, 2007).

More recently, as Harvey *et al.* (2011) discuss, the eminence of the IPCC Fourth Assessment Report (AR4) (IPCC, 2007a; b) raised considerable public awareness of the need to consider climate change in coastal management. In Australia, particularly following the AR4, three key national initiatives have been implemented to address climate change issues within coastal management:

1. The most recent Australian national inquiry into coastal management was established in the context of climate change (HORSCCCWEA, 2009);
2. The Federal Government's 'first pass' National Coastal Vulnerability Assessment (NCVA) (DCC, 2009); and
3. The establishment of an advisory Coasts and Climate Change Council to provide advice to the Federal Government on preparing coastal communities for the challenges of a changing climate (Coasts and Climate Change Council, 2011).

1.3.5 Issues for coastal biodiversity

Stemming from the impacts that human population and development pressures can have on landscape processes, are the subsequent impacts on ecosystem biodiversity and ecosystem services. Changes in biodiversity are directly caused by exploitation, pollution (including invasive species) and habitat destruction (Worm *et al.*, 2006). Higher levels of biodiversity have been found to contribute to increased productivity levels and to provide ecosystem stability (Folke, 2006). With a growing global populus living within the coastal zone, further losses to already damaged ecosystems will have substantial negative consequences (Palmer *et al.*, 2005; Worm *et al.*, 2006).

Indeed, the coast is not only important to those who reside at it. The importance of the coast can be gauged in terms of the numbers of people whose livelihoods depend on its resources. Coastal resources are valuable in terms of their direct use value, such as the goods and services they provide; their indirect use values, such as the ecological functions that indirectly support economic activity; and their non-use values, such as their aesthetic existence and bequest value (World Bank, 2005). Coastal resources, in many instances around the world, can be the primary means by which nations are able to grow their economy and are paramount in ensuring citizen well-being (Orams, 2002). For instance, Martinez *et al.* (2007) estimated the total value of ecosystem services product (ESP) at the coast globally, as being roughly US$2 Trillion. In Australia, this total ESP value was estimated at being roughly US$300 Billion annually (Costanza *et al.*, 1997; Martínez *et al.*, 2007).

Throughout the world, for example, the contribution that fish production alone makes to the global economy is extremely substantial, with aquaculture and capture fisheries contributing approximately US$148 Billion in 2004 (World Bank, 2005). Within Australia, the gross value of fisheries production was AU$2.19 Billion during 2007-2008, and included in this figure is the export value of products, which was worth AU$1.3 Billion (ABARE, 2009). The significance of the coastal and marine tourism industry on the global economy, similarly, is particularly substantial, however, since it is such a difficult industry to define tightly, there is no estimate of its value (Orams, 2002).

Due to the 'value' of the coast, degradation of coastal ecosystems can have substantial negative impacts on societies, both local and global. For instance, a combination of dilapidating coral reefs, mangroves and seagrasses, as well as rapid coastal population growth and development can reduce fisheries catch effort due to over-fishing, and increased pollution loads may cause algal blooms and productivity losses (World Bank, 2005). Over the last century, the direct impacts on the coast due to human utilisation of coastal resources are much more substantial than impacts that can be attributed to climate change (Lotze *et al.*, 2006; Scavia *et al.*, 2002). Indeed, one of the key challenges in considering climate change at the coast is in determining whether "observed changes have resulted from alteration in external factors… exceeding an internal threshold… or short-term disturbance within natural climate variability…" (IPCC, 2007a, p. 318).

Issues regarding the integrity of natural coastal ecosystems are also common with reference to human populations and development at the coast (French, 1997; Hanson and Lindh, 1993). From an historical perspective, for example, such as the commercialisation of coastal resort towns in Europe throughout the 19th century, development and population growth at the coast has revealed conflicts between relatively static human constructs and dynamically changing biophysical environments (McFadden, 2007). For instance, the social constructions of the coast presupposed it as a benign and tameable environment due to its hidden geomorphological and high-energy characteristics (McFadden, 2007). In many instances, vast amounts of land and habitat had been cleared for development which consequently destabilised dune systems and dispersed or destroyed native fauna (Hanson and Lindh, 1993). With the addition of constructed hard coastline defences for 'stabilisation' and protection, it further destabilised beach and sand movement through changes in wave characteristics, thus exacerbating initial problems (Hansom, 2001; Hanson and Lindh, 1993).

It is due to the dynamic nature of the coast and the fragility of many of the marine and terrestrial ecosystems present within the coastal zone, that development pressures can potentially have a substantial impact on the natural environment (Worm *et al.*, 2006). In addition to the potential impacts on natural ecosystems, development can also be hazardous to humans. For instance, if human settlements are situated in areas prone to erosion, flooding and storm damage, which are capable of causing considerable financial and emotional damage, as well as potential loss of life, they present increasingly potent management challenges. As population numbers increase at the coast, such as the case of 'sea change', and the likelihood of future extreme weather events increase under climate change conditions, these management challenges are further exacerbated (Gurran *et al.*, 2008; Thom, 2007).

1.3.6 The 'sea change' phenomenon

In Australia, the rise in lifestyle migration to the coast (the *sea change* phenomenon) has resulted in an overwhelming influx of people to coastal amenity locations away from state capital cities, and has raised significant social, economic and environmental issues (Connell and McManus, 2011; Gurran *et al.*, 2005b; Salt, 2003). Overall, the growth rates of regional coastal Local Governments are equal to or higher in proportion and numbers than in metropolitan areas (ABS, 2007c; Gurran, 2008). Population numbers, however, do not always reveal the internal characteristics of a particular population or its change over time (Harvey *et al.*, 2008). There may be changes within a population that are structural and compositional, which stem from the underlying demographic, economic and social characteristics of a population (McKenzie, 2006).

Non-metropolitan lifestyle migration, or amenity migration as it is also known, often does not follow traditional economic theories of migration, since the move is intended to improve lifestyle and personal or cultural factors, rather than financial standing (Berwick, 2007; Rudzitis, 1999; Saint Onge *et al.*, 2007). This major demographic phenomenon, more commonly known as 'sea change' in Australia (Salt, 2003), is not endemic to Australia but is a driving force behind much of the non-metropolitan coastal urbanisation in many other countries including the United States, the United Kingdom, and throughout Europe (Gurran *et al.*, 2006).

Gurran and Blakely (2007) discuss the two major schools of thought that have dominated debates about coastal amenity migration in Australia. First, that coastal development is an extension of metropolitan expansion, where the coastal and rural hinterlands provide space for the overflow of burgeoning urban populations and second home tourism (O'Connor, 2004). Second, that coastal

amenity migration is a significant and enduring population movement which threatens the coast's ecological integrity, and therefore warrants a comprehensive national policy response (ALP, 2006). Research into amenity migration from other Western societies, however, supports the position that Australia's sea change is more than a new commuting phenomenon or desire for a weekend beach house (Gurran, 2008). The second view aligns with the expectation that coastal growth patterns in Western societies, in general, will continue due to an ageing population, technological developments in telecommunications and transportation, and a "growing cultural orientation towards leisure and lifestyle" (Gurran, 2008, p. 393).

The movement of large numbers of people from metropolitan to non-metropolitan Australia since the 1970s has mirrored similar 'population turnaround' situations in many Western industrialised nations (Murphy, 2002). Although growth in non-metropolitan areas has oscillated over many years, the drivers of the phenomenon continue to provide the foundation for demographic, social and economic change (Burnley and Murphy, 2004). Some of the origins of the sea change phenomenon are described in considerable detail by Burnley and Murphy (2004, p. 12), who focus on the central argument that growth in sea change localities, that is, contemporary economic and population growth in coastal non-metropolitan areas, can be significantly attributed to "shifts in metropolitan economies and cultures since the 1960s". Furthermore, Burnley and Murphy (2004) argue that wealth accretion in cities as a result of economic globalisation during the past thirty years is a key factor in the demand for resources, specifically material and amenity, in non-metropolitan areas.

Sea change regions can be firstly divided into two main types, those that are relatively close to metropolitan areas and those that are in more remote areas (Burnley and Murphy, 2004, p. 3). The former areas are referred to as 'peri-metropolitan regions', and the latter are referred to as 'high amenity growth regions'. Gurran *et al.* (2005a), however, divide the typologies of sea change areas into five broad 'ideal types' of regions (Table 1.1). The settlements are described as:

- Coastal commuter locations.
- Coastal getaways.
- Coastal cities.
- Coastal lifestyle destinations.
- Coastal hamlets.

The ways in which the 'sea change' phenomenon impacts upon the variety of coastal settlements in Australia can be examined through an understanding of the settlements themselves (Gurran *et al.*, 2006). It must be noted that these typologies have been made to distinguish the locational, settlement and population variations in order to better understand the characteristics of sea change communities (Gurran *et al.*, 2007; Gurran *et al.*, 2008).

Table 1.1: Broad 'Typology' of 'Sea Change' Communities

'Sea Change' Settlement 'Type'	**Description**
Coastal Commuters	Peri-metropolitan suburbanised coastal communities typically located on the coastal outer fringes of state capital cities bordering the hinterlands
Coastal Getaways	Small to medium sized coastal settlements or groups of settlements (populations between 15,000 and 100,000) typically in local government areas within a 3-hour driving distance of state capital cities
Coastal Cities	Large coastal conurbations (populations above 100,000) typically stretching along the coastline located at some distance away from state capital cities
Coastal Lifestyle Destinations	Small to medium sized coastal settlements or groups of settlements typically located in local government areas situated beyond a 3-hour driving distance from state capital cities
Coastal Hamlets	Small and very small sized coastal settlements or groups of settlements (populations less than 15,000) typically located in local government areas beyond a 3-hour driving distance from state capital cities

Sources: Adapted from Gurran et al. (2005a, pp. 3-6) and Gurran et al. (2006, p. 3)

The two settlement types studied in this research include 'coastal commuter' locations and 'coastal hamlets' due to their key contrast, where the former is the peri-metropolitan region of Rockingham in Western Australia, and the latter is the high amenity growth region of Yorke Peninsula in South Australia.

Growth in peri-metropolitan regions is typically associated with low-density outwards expansion into non-urban hinterland from growing metropolitan areas, due to 'spillover' (Low Choy, 2006; Low Choy *et al.*, 2008). Factors such as the high cost of housing stock within metropolitan centres, as well as cheaper housing stock in peri-metropolitan regions have contributed to this shift, along with the tendency of more affluent 'sea changers' to 'down-size' their house and shift to such coastal areas for the high capital gains that selling one's metropolitan property can achieve (Gurran *et al.*, 2005a).

High amenity growth regions, on the other hand, are characterised in part by their distance from metropolitan areas, as well as their high proportions of housing stock intended for seasonal or occasional use by the owners (holiday homes) (Saint Onge *et al.*, 2007). As disposable income and leisure time generally increases, along with improved transport and road access, coastal properties within a three to four hour drive from cities have become more affordable, and draw a high proportion of their migrants from capital cities (Gray and Lawrence, 2001; Kelly and Hosking, 2008).

Coastal population growth in non- and peri-metropolitan locations around Australia tends to follow the linear characteristics of the coastline, for reasons of aesthetics and access, whereby a greater number of people can be closer in proximity to the beach, ports and foreshore areas in view of the ocean (Batisse, 1990). These linear characteristics have generally facilitated the sprawling trend of settlements and tourism along the coast (Trumbic, 2004). Linear growth is also associated with high vehicle dependency rates, and concentrates residential, recreational and tourism activities spread along the low-lying 'zone' of coastline that is potentially most vulnerable to erosion, sea-level rise and storm surge events (Gurran *et al.*, 2005b). Indeed, climate change poses a threat to all Australian communities, coastal or otherwise, however, it is of strategic importance that specific vulnerabilities be identified in order to prioritise actions. Consequently, Table 1.2 details the potential climate change impacts and implications for sea change communities (Gurran *et al.*, 2008), which can also relate to other coastal settlements in general.

Table 1.2: Potential climate change effects and impacts for sea change communities

Potential Climate Change Effects	Impacts for sea change communities
Sea level rise Coastal erosion	• Loss of beaches • Migration of sand dunes • Loss of / threat to private property • Infrastructure threat / damage • Impact on lifestyle / amenity values • Biodiversity loss • Tourism values (especially iconic beaches)
Frequent storm events More intense storm events / cyclones Increased rainfall Decreased rain fall	• Public safety and evacuation capacity • Capacity of emergency services – volunteers, infrastructure (hospitals, shelters, supplies) • Damage to infrastructure (energy, water, road, buildings, telecommunications, coastal ports, jetties) • Water shortages (during drought) & contamination (storm events, inundation, flooding, ground water salination / disturbance) • Agricultural industry impacts – sudden weather events (eg. cyclone) + long term events (eg. drought) • Tourism impacts (damage to tourism infrastructure, visitor perception of risk) • Damage to marine ecosystems from storm / agricultural runoff
Warming sea temperatures, ocean acidification	• Damage to coral reefs • Threats to marine habitat and species, coastal ecosystems (mangroves, saltmarshes, sea grass) • Damage to estuaries – biodiversity, tourism and economic values • Threat to fisheries & recreational fishing • Threats to port functions
Increased temperatures Increased humidity	• Public health, especially frail aged community • Disease vectors (insects) • Food spoilage • Capacity of health services • Economic impacts of disease • Peak energy demand increases

Sources: Adapted from Gurran et al. (2008, p. 20)

Sea change communities have particular social vulnerabilities to climate change (Gurran *et al.*, 2008) due to several of the inherent qualities that make them desirable coastal destinations in the first place. Pressures arise in sea change regions not only because of the high levels of biophysical vulnerability associated with low-lying coastal settlement, but are due to demographic and lifestyle features, such as high rates of resident turnover, ageing, and lower income levels (Gurran *et al.*, 2008), as well as tension amongst existing residents and 'sea changers' over a mismatch between values, needs and expectations (Ford, 2001). Table 1.3 below, also presented by Gurran *et al.* (2008), outlines several of the key characteristics which constitute social vulnerability and the subsequent risk that each of these characteristics imposes on the individual/group in more detail. Each community, however, is inherently different, which results in a variety of differences in relative vulnerabilities, risk perceptions and implications of climate change for individuals and communities (IPCC, 2007a).

Table 1.3: Social vulnerability and climate change risk

Social characteristic	Risk
Low income	• May be inadequately insured • Limited capacity to afford adaptation actions to improve safety and thermal comfort of dwelling • Higher impact of pricing mechanisms, less capacity to 'purchase green alternatives'
Rental tenure	• Limited capacity to undertake adaptation actions to improve safety and thermal comfort of dwelling • At greater risk of permanent displacement following a disaster
New arrivals / high population 'turnover'	• Unfamiliar with disaster protocol / evacuation procedures • Less time / capacity to adapt dwelling to disaster risk • Less connected to social support networks
Caravan park residents	• Dwelling type unable to withstand major storm events • Dwellings often located in exposed positions, or on floodplains • Low income caravan park residents at risk of permanent displacement as higher income evacuees require temporary emergency housing
Older population profile	• Aged people more vulnerable to health and safety impacts of disease outbreaks, heatwaves, and storm events • May be unable to comply with disaster protocol

Source: Adapted from Gurran et al. (2008)

Indeed, as climatic and demographic research reveals, communities are changing and the climate is changing. As such, policies need to reflect changing conditions and societal norms, to take into account perceived issues, whilst at the same time push the boundaries of these norms to reflect the broad goals of climate change mitigation and adaptation. By better understanding the social profile in sea change communities, with reference to their perceptions of climate change impacts as well as capacity and willingness to adapt, as this thesis will do, policy may be tailored to better suit the capacity of communities.

1.3.7 Coastal tourism

Coastal tourism is a prized and valuable aspect of a country's overall economy, providing international appeal and visitation, as well as a critical opportunity for local and regional development (Trumbic, 2004). Both within and between countries, there is a substantial degree of competitiveness to attract tourists and secure the benefits of its flow-on effects (Coccossis, 2004).

Tourism in general often simultaneously exerts a considerable degree of pressure on environmental and cultural resources and, due to the nature of tourist inflows, affects the social and economic characteristics of the destination in a multitude of ways (Coccossis and Mexa,

2004). Frequently, management responses to the problems associated with tourism are reactive and remedial, and typically the underlying causes of these problems, which stem from the growth patterns, remain a secondary priority to further growth (Coccossis and Mexa, 2004).

The majority of coastal and marine tourism and use globally, as described by Orams (2002), has two primary patterns: firstly, it is typically concentrated in areas close to human populations, namely cities and other urbanised areas – whereby the majority of usage is the result of 'day-tripping', and; secondly, it tends to be more strongly associated with near-shore environments since "humans are terrestrial-based animals" (Orams, 2002, p. 21), the near-shore ecosystems tend to be more productive with high natural amenities, and the cost-efficiency of travel for both tourists and tourism operators is maintained.

Since tourism is predicted to rapidly increase in the future (Brown and Bellamy, 2007), it is important to recognise the dilemma this pattern of growth causes. As Orams (2002, pp. 21-22) states:

> *Greater levels of human use occur close to shore and close to cities, and it is these environments that are the most critical to the health and long-term survival of the oceans and all that live within them (Earle, 1995)[sic]… therefore, [it occurs] in those ecosystems that are the most vulnerable to disturbance.*

Of great interest to Australian coastal managers is the expected increase in tourism in the future, which is forecasted to be country's largest export earner, with estimates of an increase in revenue of 50% by the year 2020 (Berwick, 2007). It will be coastal councils that "bear the brunt of the impact of this [tourism] growth" (Berwick, 2007, p. 85). Visitors and seasonal holiday-makers to coastal locations generate revenue for local economies, but they do not contribute to rates or directly contribute to the cost of the public infrastructure they use whilst visiting, and nor is there a mechanism to capture tourism expenditure as a contribution to public infrastructure (Berwick, 2007). Consequently, the bulk of the costs of maintaining and expanding infrastructure equivalent to the needs of the expanding tourism industry will inevitably fall on local rate payers (Berwick, 2007; Shepherd, 2005b).

The effects of coastal tourism are similar to that of coastal population and settlement growth in that it has a wide array of linkages to a range of other economic sectors and activities. Tourism pressures are often seasonal and the degree to which local services can cope with increased

amounts of resource use and waste generation during these seasonal periods is not typically sufficient. The burden on the community is usually the result of exceeding the local 'carrying capacity' of its local services (Coccossis, 2004). Indeed, Gurran *et al.* (2007) found with coastal tourism growth, similar to coastal population growth, that despite the perception that it is good for local economies, the overall positive economic outcomes, particularly in high amenity growth regions, is poor. Since this increased demand typically occurs during a relatively short seasonal period, which is particularly the case for amenity regions, it is often uneconomic for communities to invest in and provide services that cater for greater volumes of people all year round (Saint Onge *et al.*, 2007; Trumbic, 2004).

It is at the local-scale where the impacts of climate change and pressures of tourism and population growth will surface to impact the most on individuals (Berwick, 2007). It is also at this individual level where impacts will need to be most appropriately adapted to, in order to minimise harm. Consequently, it has been argued that greater coordination and cooperation is needed within and between all levels of government and regional Natural Resource Management (NRM) organisations (Berwick, 2007; Gurran *et al.*, 2006). This coordination is required to emphasise the social, cultural and economic factors that influence how large-scale problems, such as climate change, may be resolved at a local scale (Shepherd, 2005b). The vulnerability of coastal settlements (the local level vulnerability), therefore, will be dependent upon the social, cultural and economic characteristics of settlements, and consequently, the individual capacity for adaptation will also be dependent on such characteristics (Grothmann and Patt, 2005; NSTF, 2006a; Smit and Wandel, 2006).

1.3.8 Coastal governance in Australia

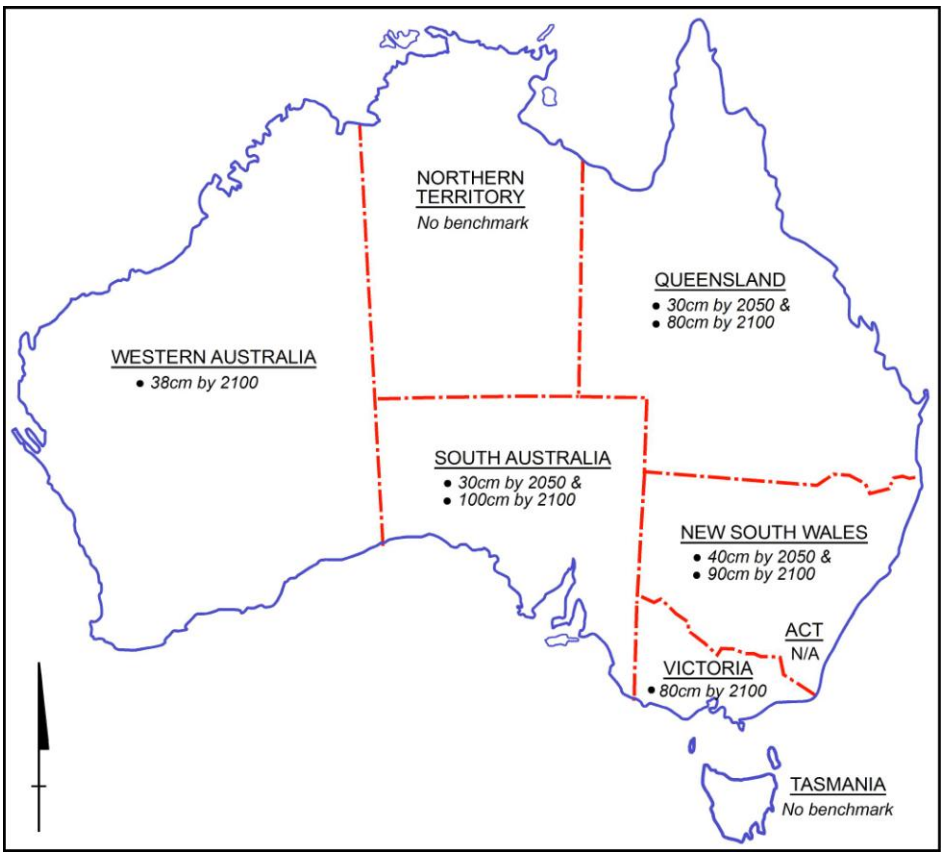
Governance of the coast can generally be described as the range of "laws, policies, plans and legal precedents that can either prescribe how the coast is used or constrain its use" (Middle, 2004, p. 3). Of particular concern for Australian coastal management are jurisdictional responsibilities, which are dispersed by the country's three tier governmental system – the Federal, State, and Local Governments. These three levels of government are responsible for coordinating numerous cross-institutional arrangements over multiple regulatory jurisdictions, of which frequent duplication, confusion and conflict of regulations occurs (Rockloff and Lockie, 2004).

The formal governance arrangements for the Australian coast generally falls under the jurisdiction of the respective Local and State Governments, with some exceptions, as in the case of Federal affairs such as with international sea ports, airports, military zones and world heritage sites (Harvey *et al.*, 2011). As Harvey and Clarke (2007) discuss, however, the various and separate responsibilities of each tier of government generally results in fragmentation of planning policy on issues such as climate change, coastal vulnerability, and adaptation.

In reference to sea-level rise,

Figure 1.3 illustrates the State Governments' sea-level rise benchmarks, as outlined in their respective policies (the ACT and Northern Territory do not have benchmarks), which demonstrate the differences and inconsistencies between the State Government authorities. It must be noted that governance is not necessarily confined to these domains but, in fact, can operate across public, private and voluntary sectors (Gurran *et al.*, 2007).

Figure 1.3: Australian State Government sea-level rise benchmarks



Source: Author, map produced courtesy of Christine Crothers

Despite its minor statutory responsibility in coastal governance, the Federal Government plays an important role in facilitating cooperation between the states, as well as through its endorsement of ICZM and funding provisions (Gurran *et al.*, 2007). Statutory responsibility is, in fact, vested in the State Governments, however, it is Local Governments who are empowered through respective state legislation to exercise particular planning and management controls within their councils (Thom and Harvey, 2000). The consequence of such complexity is that many coastal environments may be simultaneously subjected to: a coastal management plan, estuary management plan, floodplain management plan, and catchment management plan; various statutory and non-statutory environmental planning and land use instruments being administered independently by any of the three tiers, and; sector specific planning instruments that may create conflicting goals within and between institutions (Smith and Doherty, 2006).

Day-to-day management of the coast, however, such as regular maintenance and up-keeping duties of a range of coastal facilities and infrastructure, is more frequently the responsibility of Local Government authorities (Harvey and Clarke, 2007). In conjunction with many existing stresses, therefore, any additional pressure climate change impacts will impose on these management activities at local levels will significantly test the capabilities of respective local authorities, as well as the political wills of State and Local Governments (Gurran *et al.*, 2007; Thom and Harvey, 2000). As such, the costs of coastal management have fallen, and will continue to fall, disproportionately on Local Government authorities, industries, communities and workers (Nursey-Bray, 2009).

McFadden and Green (2007, p. 120) suggest that because of the complexity of changing coastal dynamics, understanding and managing vulnerability at the coast is important at the day-to-day scale. Consequently, vulnerability problems can be linked to this day-to-day management and behaviours at more local scales, since present actions at this level will create legacies that may constrain options in the future (Moser and Tribbia, 2007a; b). Indeed, as Thom and Harvey (2000, p. 287) state, as “we consider the future of coastal land and sea management in the next millennium, our inheritance from past and present public administrative structures and practices cannot be overlooked”. As such, it is vitally important that the triggers which brought about coastal management reform in Australia, described earlier, be sustained to support not only coastal population growth but also healthy coastal environments (Thom and Harvey, 2000). The following discussion will primarily focus of the issues present at a Local Government level in

Australia, albeit still briefly outlining many on the major coastal governance issues at higher jurisdictional levels.

In the context of Local Government authorities, governance is more typically concerned with plans and policies. Since the Resource Assessment Commission's (RAC) Coastal Zone Inquiry in 1993 revealed the strong need for a "concerted national effort" (RAC 1993, p. 362) towards managing coastal zone resources, all three tiers of government have been actively involved in enhancing their capacity to do so with updated legislation and policies, as well as strategic planning and development procedures being put in place (Middle, 2004).

Many governance issues within the coastal zone, in fact, extend over wider catchment areas and landscapes (Rockloff and Lockie, 2004). This is due, in part, to the range of interlocking and overlapping natural systems, as well as the many and varied interests of stakeholders and institutional arrangements (that is, a 'collision' of interests and processes). Governance tension consequently arises from accountability over resource degradation and responsibility over solutions and remediation works, as well as between resource users over rights and access arrangements (Rockloff and Lockie, 2004; Scholz and Stiftel, 2005). The sea change phenomenon in Australia, as described earlier, provides an example of where governance arrangements involving intricate, cross-jurisdictional planning and management processes have led to collective action problems of great complexity (Berwick, 2007; Scholz and Stiftel, 2005). In the case of sea change, the existence of many individual planning instruments specific to certain issues or sectors creates conflicting goals within and between institutions. As such, much of the documented difficulty has cited the need for greater translation of federal and state policy into local implementation and objectives (Harvey and Caton, 2003).

Due to an increase in more 'sustainable' long-term management plans, partly as a result of ICZM, coastal strategies that include soft protection measures, beach replenishment, mandatory minimum construction height above sea level and managed retreat, for example, have become conventional (Capobianco and Stive, 2000; Hashim, 2010). The initiation of many new and updated policies and management programs with ICZM principles has also been welcomed by governments at all three tiers in recent years. Despite such efforts, however, there is still a strong body of criticism aimed at coastal policy-making abilities (Middle, 2004), and there is a strong consensus that more still needs to be done (Lazarow *et al.*, 2006). This raises issues regarding the amount of adequate funding as well as the amount of trained staff and planners, which is

particularly more pronounced at the local level where 'on-the-ground' management occurs (Nursey-Bray, 2009).

Despite the appropriateness of many management plans in terms of their long-term sustainability, there can often still be a substantial degree of public opposition towards them. This opposition does not necessarily stem from an overall resistance to 'change', *per se*, but rather a resistance to a loss of comfort, income, and status, that a disturbance to the *status quo* may bring about (Dent and Goldberg, 1999). The perception that the changes may bring about harm or discomfort, or that supposed benefits may be minimal can be a substantial barrier to successfully implementing change. Labelling such issues as 'resistance to change' may, in fact, be impeding efforts (Dent and Goldberg, 1999). In light of recent studies indicating that future climate change may in fact be worse than originally projected (Sokolov *et al.*, 2009), the inadequacies of many policies and management plans, as well as the opposition towards many appropriate ones may have long-term detrimental impacts on socio-ecological systems.

Management of the coast at the Local Government level is typically hindered by budget limitations, as well as a lack of expertise (Shepherd, 2005b). In addition, those experiencing 'sea change' impacts may also have a reduced capacity to respond to climate change as a result of endemic social disadvantage (Harvey *et al.*, 2008). In most instances, the coast may not be as sustainably managed as it needs to be in order to maintain the natural resource base and amenity that makes it a desirable locality in the first place (Shepherd, 2005a). As it stands, many councils were ill prepared for the unprecedented levels of growth that occurred during the 'population turnaround' in the 1970s, 1980s and 1990s, and have subsequently struggled to adequately address the social, economic and environmental impacts that rapid and substantial local changes can have (Shepherd, 2005a).

Local Governments are responsible for reducing the risks and vulnerabilities of climate change, as well as ensuring the resilience of their communities to climate change impacts (Gurran *et al.*, 2008). In order to successfully accomplish this, Gurran *et al.* (2008) discuss that an initial vulnerability assessment is required, which specifically incorporates existing information about potential risks, the capacity of existing systems to adapt, and the potential to introduce new adaptation strategies. Gurran *et al.* (2008, p. 16) go on to explain that "many actions are beyond the legislative and financial capacity of local government and require a partnership with State or in some cases national government". Accordingly, Local Government relies heavily on external

funding sources. However, current grants programs are *ad hoc* in nature and are generally only for a single year or do not extend beyond the length of a project to ensure sustainability (Shepherd, 2005a).

The pressures associated with an influx of people in non-metropolitan coastal locations due to the sea change phenomenon makes policy and service demands on Local Government and the communities a particularly pressing and complex issue (Gurran *et al.*, 2006). In response to the pressures being faced by Local Governments, planners, and managers in coastal Australia, the National Sea Change Taskforce (NSTF) was established in 2004 with a key focus on the sustainability of coastal communities and the environment. The NSTF's primary role is to represent the needs of coastal councils and communities experiencing sea change and to provide support and guidance in managing associated impacts. A commitment to a coordinated national approach is required by all three levels of government to collaboratively manage sea change growth, with sustainability being the core goal (Gurran *et al.*, 2006).

Currently, there is a lack of coordination and integration between Local Government and between coastal zone managers which has and will continue to lead to a heightening of detrimental impacts on coastal environments (Gurran *et al.*, 2006; Middle, 2004; Shepherd, 2005a). As development on the coast increases, so too does the pressure on existing land uses and subsequently the biodiversity within those coastal areas (Shepherd, 2005b). As described by Shepherd (2005b, p. 7) since "councils themselves may not have well coordinated internal processes to address environmental issues", these issues and action priorities may need to be more clearly defined so that they can be addressed suitably. In the context of climate change, the achievement of such a goal may be aided through the assessment of vulnerability.

1.3.9 Coastal vulnerability

Both the absolute population and density of people residing in vulnerable low-lying coastal areas is increasing globally (Hanson *et al.*, 2011; IPCC, 2007a; McGranahan *et al.*, 2007; Nicholls *et al.*, 2011), which means greater numbers of people are being exposed to coastal climate change risks. Of particular relevance, also, is the flow-on effect on the population dependent on coastal resources derived from industries disturbed by climate change. For instance, the delays in trade through the potential disruption to sea ports and supply-chain networks as a result of more frequent and intense storms will cause significant disturbances in the distribution of trade goods throughout society (Nursey-Bray and Miller, 2012). Since observations already indicate existing

severe problems in numerous coastal regions around the world, under plausible future climate change scenarios many of these problems will be further exacerbated (Zhang *et al.*, 2004).

In Australia, due to the patterns of coastal population described earlier, climate change and associated coastal risks are expected to have a significant impact on the large majority of the population. In addition to livelihoods at risk, there are also many large-scale investments that are at risk, including public and private infrastructure, as highlighted by the recent 'first pass' National Coastal Vulnerability Assessment (NCVA) (DCC, 2009; DCCEE, 2011). Specifically, the resultant flooding, inundation and erosion due to sea-level rise and storm surges will have a considerable impact on a vast number of Australian communities situated at the coast (DCC, 2009; DCCEE, 2011).

According to Working Group Two (WG2) of the IPCC's Fourth Assessment Report (AR4) (2007a), there are six key policy-relevant messages that have emerged relating to the Australian coast:

1. Consequences of hazards relating to climate change and sea level are being experienced at the coast now;
2. Over the coming decades, the coast will be exposed to increasing risks due to climate change and sea-level rise;
3. Human-induced pressures are exacerbating the coastal impacts of climate change;
4. Constraints on adaptive capacity will greatly influence human vulnerability more than other factors;
5. The costs of inaction will far outweigh the costs of adaptation action; and
6. Human development patterns and trends often conflict with unavoidable sea-level rise and long-term coastal planning.

In addition to the concentration of the bulk of Australia's population in the metropolitan coastal centres, the remote location of many coastal communities outside of Australia's large metropolitan areas results in reduced availability of fewer resources (both physical and human resources). Many common planning and provisional issues that hinder authorities within metropolitan areas are consequently exacerbated by a combination of community remoteness and access to resources. Since coastal populations are projected to continue to grow, as much of the demographic evidence suggests will happen, there will need to be serious attention paid to planning, policy development and post-policy partnerships, as well as the operationalisation of plans and policies (Lazarow *et al.*, 2006).

1.4 Theoretical concepts of vulnerability and adaptation

The analysis of climate change vulnerability and adaptation is generally dominated by the idea of risk which attributes vulnerability to physical assets (Adger, 1996; Wisner *et al.*, 2004), for instance, the amount of land area lost or property inundated as a result of flooding. In this sense, an assessment of vulnerability is a fundamental component of any attempt to identify the magnitude of threats posed by climate change (IPCC, 2007a). The potential impacts of these threats are variable depending upon the ability of the system under threat to withstand impacts and/or recover – that is, to be resilient (Moser, 2010b). This avenue of theory, concerned with risk and vulnerability to environmental change, typically takes land or economic assets, and utilises topographical or climatic factors to determine the risk to such assets (Adger, 1996). Such an approach has been employed by the IPCC (2001a; 2007a).

The focus for climate vulnerability research has largely been directed at biophysical processes underlying risk, such as the impacts of changed climatic conditions on natural processes, human settlements, and populations (Finucane, 2009). While these types of biophysical studies are critical, a growing body of research, however, is needed to focus on the human dimensions of vulnerability and adaptation, which provides insights into how communities respond to changes, either perceived or actual (Finucane, 2010b; Hulme, 2008; Moser, 2010c). Indeed, the non-physical processes that take place within society are those that strongly influence how people cope with hazardous events (Adger *et al.*, 2005). Therefore, there is a need to focus on a far broader set of issues including "social, socio-economic, demographic, institutional, legal, technological, ethical, organizational, ecological, and cultural aspects of societal functioning, management, and policy-making" (Moser, 2010b, p. 467). The goal of this thesis is to contribute to this broadening interdisciplinarity.

The following subsections introduce the individual concepts of vulnerability and adaptation, their broad definitions and linkages, and their use throughout a range of disciplines. In addition, they discuss the concept of 'resilience' and its relevance to climate change vulnerability and adaptation studies, as well as the way in which the concepts can at times be used interchangeably and how they can also be "polar opposites" (Gallopin, 2006, p. 293). The subsections further discuss the two prime theoretical approaches in assessing vulnerability,

through either a biophysical or social perspective, with a focus on climate change and coastal management issues.

1.4.1 Vulnerability

The 'vulnerability' concept and its precise definition and components are generally contested, and is a term used in a variety of disciplines. Definitions of vulnerability not only vary considerably between the different disciplines that employ the term, but they can also differ within the disciplines depending on the precise elements being studied. As in the case of vulnerability to climate change, the definition will vary the more it is concentrated on being used in either the biophysical or social assessment of vulnerability. In terms of coastal vulnerability there seems to be a general consensus about, and concern for, climate change and its potential impact on coastal areas, despite a specific definition (Allen, 2003).

The 'value' or 'usefulness' of a definition of vulnerability is consequently "the degree to which it gives new and useful insights into the nature of the problem at hand and the choices of action to be adopted" (McFadden and Green, 2007, p. 122). The relationship created by the interactions between vulnerability and the preferred course of action, therefore, should be considered reflexive, whereby "vulnerability implies a course of action; [and] the course of action implies a definition of vulnerability" (McFadden and Green, 2007, p. 121).

In response to the 'plethora' of definitions surrounding vulnerability, Moser (2010b) insists that future scholars need to be clear and upfront about the assumed meanings within their understanding of the key terms, to assist others in seeing the relevance and connection to related work. The working definition of vulnerability for this research project, therefore, similar to suggestions by Moser (2010b), integrates a variety of approaches, but particularly incorporates that discussed by Wisner *et al.* (2004, p. 11), who define vulnerability as:

> *…the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard (an extreme natural event or process).*

The definition from Wisner *et al.* (2004) details vulnerability in an anthropocentrically oriented fashion and distinguishes it as an inherent condition of the system which, similar to Kelly and Adger (2000) and Adger (2006), fundamentally determines how a system responds to a hazard. In the context of climate change, vulnerability is predominately described as one of two forms, being either:

1. The potential damage caused in response to an impact or hazard (McFadden *et al.*, 2007); or
2. A state that exists in a system prior to an impact or hazard event (Adger, 2006).

Füssel (2007b) describes these two 'classical' conceptualisations as either the 'risk-hazard' or 'political economy' approach, respectively. These two approaches to vulnerability principally correspond to the 'geocentric' and 'anthropocentric' study of criticality in physical attributes and ecological dimensions, identified by Kasperson *et al.* (1995). The former description of vulnerability by McFadden *et al.* (2007), however, is typically used in the biophysical assessment of vulnerability, and the latter by Adger (2006) is typically used in the social assessment of vulnerability (Allen, 2003). These individual descriptions of biophysical and social vulnerability assessment, along with a 'hybrid' of the two perspectives (Cutter *et al.*, 2009), will be further discussed in later subsections.

Kelly and Adger (2000) discuss how analyses of approaches to vulnerability fall into three broad categories with respect to where vulnerability is situated within a study. These categorisations depend on whether vulnerability is either conceptualised as the 'end point', the 'focal point', or the 'starting point' of the assessment. These notions will be discussed in much greater detail in Chapter 3. The relevancy of these categories rests in the underlying interests of the study including, for instance, the level of uncertainty, relevance to policy, and disciplinary focus (Kelly and Adger, 2000). For use within this thesis, vulnerability, as per the working definition discussed above, is conceptualised as the 'starting point' of an analysis since vulnerability is conceptualised as an inherent state of the system.

Vulnerability, in reference to many climate change impacts studies, has thus far typically concentrated on the direct physical, chemical or biological effects of change, including the specific knowledge of hazards and their potential impact on humans (Kelly and Adger, 2000; Stehlik and Costello, 2008), which normally position vulnerability as the 'end point' of an analysis. Such current vulnerability assessments lack a more broad policy-relevant focus, which could be

achieved through an analysis of coping mechanisms. Therefore, it will be argued, a more holistic assessment of vulnerability is also required, in order to detail the manner in which society is likely to respond to climate change through personal adaptation.

1.4.2 Adaptation

As Kelly and Adger (2000, p. 348) explain, "vulnerability is intrinsically linked to the process of adaptation… [since] adaptation is facilitated by reducing vulnerability". Therefore, any attempt to reduce vulnerability inevitably leads to the process of adaptation, and consequently the strengthening of adaptive capacity (Kelly and Adger, 2000). An approach that encompasses adaptation, therefore, is necessary since the precise nature of potential impacts cannot be defined, and therefore neither can a potential form of adaptation (Kelly and Adger, 2000).

In the context of climate change, adaptation is often viewed as an alternative or complimentary response strategy to mitigation (Wall and Marzall, 2006), and can be described as autonomous, reactive, proactive, concurrent, anticipatory, spontaneous or planned, as well as being short-term and tactical, or long-term and strategic (Smit *et al.*, 2000). Smit *et al.* (2000) explain that as the topic of adaptation receives increasing amounts of research attention, analysts have realised the importance of distinguishing types, characterising attributes, and specifying applications of adaptation. Adaptation, for example, can refer to natural or socio-economic systems and can take technological, economic, legal or institutional forms; it can be targeted at specific climatic variables or risks; or it can be in response to, or in anticipation of, such a variable or risk, or be independent or designed (Pelling and High, 2005b).

The difference between mitigation and adaptation is that mitigation is concerned with the prevention of impacts through emissions reductions and carbon sequestration which has been highly publicised, for instance, in discussions regarding the Kyoto Protocol. Mitigation surfaced as a progression from the realisation of anthropogenic climate change and subsequent impact assessments of the 1980s, which focussed on how best, and at what cost, humanity could limit global climate change impacts (Smit *et al.*, 2000). One of the primary reasons why mitigation has been substantially focussed on is its ability to be beneficial on all climate-sensitive socio-ecological systems (Füssel, 2007a). Interest in adaptation studies grew as a result of mitigation work and the imperative to include a perspective from which the potentially affected social and ecological systems were to respond to the unavoidable aspects of climate change, such that it could be considered by economists in cost-benefit analyses (Grothmann and Patt, 2005).

Kelly and Adger (2000) assert that vulnerability and adaptation studies need to be more concerned with recommendations and conclusions that are policy-orientated in terms of long-term climate change and immediate needs consistent with a precautionary approach. Indeed, research has shown that "there are rarely simple cause-effect relationships between climate change risks and the capacity to adapt" (IPCC, 2007a, p. 731), in part, because vulnerability is often context specific and the way in which adaptive capacity translates into adaptation rarely occurs instantaneously, if at all (Adger and Barnett, 2009; Brooks *et al.*, 2005). Instead, however, these relationships are much more complex and need to be examined as such. This thesis, therefore, whilst it does not attempt to identify causal relationships of vulnerability, it attempts to further knowledge on the human and social elements of vulnerability that may be reduced through adaptation.

1.4.3 Resilience

Resilience, for use within this thesis, primarily focuses on social resilience, or adaptive capacity, and is quite often regarded as the opposite of 'vulnerability' (Giddens, 2009). In this sense, as Giddens (2009) explains: vulnerability creates risk, whereas resilience creates opportunity. Folke *et al.* (2010, p. 22), define resilience as the "capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function… and therefore identity". The concept of resilience, however, is historically linked to the field of ecology. Holling (1973, p. 17) asserts that the resilience of systems is defined as "a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist". The concept originated in studies relating to ecosystem management and, as such, there has been a long-standing focus on theoretical and mathematical models.

The more dominant and traditional ecological views saw the environment as stable and infinitely resilient, a concept which Holling (1973) argued did not suffice due to the transient behaviour of systems that are not near equilibrium (Folke, 2006; Holling, 1973). Rather, Holling (1973) proposed that there were in fact multiple 'basins of attraction' which potentially allow for a system to experience qualitative shifts in dynamics under the influence of changing environmental conditions, both sudden and long-term. From this perspective it is argued, in relation to society, that resilience provides the capacity to cope with both surprises and large scale changes, which is what will allow social institutions to not only cope with change in the face of climate change uncertainty, but allow for innovation and social learning (Adger, 2000).

Folke *et al.* (2010) describe that both adaptability and transformability are prerequisites for resilience in social-ecological systems, due to the interdependencies between humans and nature. In this instance, adaptability refers to the system's ability to adjust to allow for development within its current domain of stability, and transformability refers to the capacity to create new domains and landscapes of stability, as well as cross thresholds to move away from undesirable and into more desirable domains (Folke *et al.*, 2010; Lebel *et al.*, 2006). As such, with respect to climate change, it is reasonable to conceive that any change which fundamentally causes natural ecosystems to self-organise towards a radically different 'basin of attraction', may seriously compromise human well-being (Folke *et al.*, 2010; Rockström *et al.*, 2009; Steffen *et al.*, 2007). Indeed, social change is essential for resilience, therefore, to prevent such an undesired critical transition (Folke *et al.*, 2010).

In recent years, the human dimensions of resilience have received greater attention through the understanding that resilience not only describes the autonomous capacity of systems to absorb change, but also offers opportunities for renewal, reorganisation and development (Adger, 2000; Folke, 2006). It is within this line of enquiry whereby the resilience concept seeks to shift the focus from solely controlling change or disturbance, to supporting the broader capacity to cope with change or disturbance and the opportunities such change creates (Berkes *et al.*, 2003; Folke, 2006; Smit and Wandel, 2006). It is in this way that resilience is linked with, and provides continuous development through, adaptive capacity (Smit and Wandel, 2006). A greater and more in-depth discussion of resilience is provided in Chapter 3.

1.4.4 Biophysical vulnerability analysis

Biophysical vulnerability analyses stem from the idea that vulnerability is primarily a system's potential to be harmed in response to exposure to an impact or hazard (Cutter, 1996). However, the role of human systems in alleviating this potential harm is often downplayed or neglected (Adger *et al.*, 2004). Much of the debate surrounding vulnerability has thus far focussed on risk and exogenous threats (Kasperson, 2001), consequently, much of the vulnerability theory complements literature in the fields of disaster and risk management, as well as natural hazards.

The concept of disaster is important from a biophysical vulnerability standpoint, and the notion of a 'disaster' used here follows that initially expressed by Fritz (1961, p. 655), whereby it causes disruption to, or the prevention of "essential functions of the society". Susman *et al.* (1983, p. 264) further this definition whereby they assert that a disaster occurs at "the interface between an

extreme physical event and a vulnerable human population". Similarly, Wisner *et al.* (2004), discuss the nature of risk and vulnerability by stating that disasters are the result of the interactions between both vulnerability and hazard. From this societal standpoint, therefore, a disaster cannot occur if there is (theoretically) nothing vulnerable, and vice versa. The biophysical vulnerability of a socio-ecological system, as such, can be summarised as "a function of frequency and severity (or probability of occurrence) of a given type of hazard" (Brooks, 2003, p. 4).

Consequently, Wisner *et al.* (2004, p. 49) argue that the biophysical risk of disaster is therefore a combination of the "hazard and the number of people, characterised by their varying degrees of vulnerability to that specific hazard, who occupy the space and time of exposure to the hazard". In this respect, biophysical vulnerability assessments consider three primary elements: disaster/risk, vulnerability, and hazard/stress, whereby the vulnerability is the potential harm a disaster could inflict on a system in response to a hazard. A key method used in measuring the vulnerability or potential harm, as such, is to compile and normalise certain indicators that represent the structural characteristics of the exposed system (Schneiderbauer and Ehrlich, 2006).

The impacts incorporated into biophysical vulnerability analyses are often measured by palpable indicators including monetary or production costs, human mortality, proximity to hazard, magnitude, frequency or probability, duration and spatial extent, as well as ecosystem damage (Cutter, 1996; Jones and Boer, 2003). Such indicators often represent the outcomes of a consequence due to a particular hazard or event, and demonstrate the sequence between 'first-order' biophysical impacts and their subsequent human or biological flow-on affects (Adger *et al.*, 2004; Brooks, 2003). Wisner *et al.* (2004) similarly discuss that much of the literature on disasters is associated with natural 'trigger' events, for example, severe coastal storms impacting upon vulnerable people leading to destruction of life, livelihood and property, and that disasters are "departures from 'normal' social functioning" (Wisner *et al.*, 2004, p. 10). The challenges of applying metrics to vulnerability analyses will be discussed in greater detail in Chapter 3.

Biophysical vulnerability analysis is distinguished by its focus on the 'external' perspective of exposure to risks, shock, agents, or stress, as opposed to the 'internal' perspective which relates to coping mechanisms, or lack thereof (Bohle, 2001; Chambers, 2006; Schneiderbauer and Ehrlich, 2006). A prime example of an assessment of biophysical vulnerability is the 'first pass' National Coastal Vulnerability Assessment (NCVA) commissioned by the Australian Federal

Government (DCC, 2009), to be discussed in greater detail in Chapter 3, which considered the total number of coastal properties exposed to an upper and lower estimate of sea-level rise. The 'internal' perspective of vulnerability, on the other hand, is often independent of a hazard and will be discussed at length in the subsection below as it pertains to social vulnerability analyses. On the contrary, since much of the 'external' dimension relating to biophysical vulnerability is hazard-dependent, it is therefore usually only relevant to the physical parameters of a specific hazard, or at most, a few hazards (Schneiderbauer and Ehrlich, 2006).

Although rigorous in many respects, biophysical vulnerability analyses can be limited by their focus on perturbations and stressors which often provides an inadequate understanding of the impacts and responses of the total system or its components (Mileti, 1999; Turner *et al.*, 2003). With respect to studies that incorporate human and social elements as part of the total system, they are often limited through use of census data and typically represent demographical trends of the regions and areas in question.

1.4.5 Social vulnerability analysis

Social vulnerability analyses stem from the idea that vulnerability is present within a system prior to any stress (Adger, 2006). A system is considered more or less vulnerable depending on the severity of the stress, and the degree of adaptive capacity (Gallopin, 2006;; Sharples, 2006; Smit *et al.*, 2000). Vulnerability, therefore, exists within a system prior to any stress because adaptive capacity is considered inherent to the system, and for this reason, it is not necessary for a stress to occur for adaptive capacity to be examined. A system's vulnerability depends on both the severity of the stress and how the socio-ecological system is organised with respect to its own resources and in respect to other systems. It is important to note, here, that whilst adaptive capacity is a key factor in this respect, it is crucial not to overlook the prominence of other elements of social vulnerability, such as exposure and sensitivity to risk (discussed in Chapter 3.1.1). Specifically, Adger (2000, p. 348) defines social vulnerability as "the exposure of groups of people or individuals to stress as a result of the impacts of environmental change".

The task of 'measuring' social vulnerability is typically through indicators and indices (Cutter *et al.*, 2003). These indicators, such as gender, age, race, income and education, have revealed a strong positive correlation between low socio-economic status and high vulnerability (Blaikie *et al.*, 1994; Kuhlicke *et al.*, 2011). Whilst such generic indicators of vulnerability are also indicators of social inequality, their fundamental advantage lies with respect to policy, whereby they may

draw attention to issues of social vulnerability to natural hazards, and place them on the public agenda (Benson, 2004). In addition, these indicators are also considered transferable to different contexts, making cross-regional and cross-country comparisons possible (Kuhlicke *et al.*, 2011). Challenges arise, however, when utilising this approach narrowly since it "may give rise to stereotyped and unenlightened views of people's vulnerability" (Kuhlicke *et al.*, 2011, p. 792). For instance, as Buckle *et al.* (2000), Brown and Damery (2002), and Handmer (2003) assert, it is not any one single indicator that determines the vulnerability of a person or group of people, rather it is a combination of different variables within the societal context in which the hazard occurs that matters. Indeed, there are also many aspects within society that influence levels of vulnerability which are difficult to measure, albeit possibly unmeasurable altogether, including traditional knowledge, traditions, cultural norms and mores (Kuhlicke, 2010; Kuhlicke *et al.*, 2011).

As discussed previously, Kelly and Adger (2000) argue that since the precise nature and magnitude of a hazard cannot be predicted, therefore the likely adaptive pathway cannot be prescribed either. Nonetheless, it is still necessary to examine the sensitivities and limitations that influence the likely adaptive pathways. Wisner *et al.* (2004) argue for caution, consequently, since there is a risk with these types of studies which emphasise people's weaknesses and limitations, which may display people as being passive and incapable of change. Described as resilience and adaptive capacity, people typically do, however, possess the qualities and characteristics necessary to respond positively to hazards and stress (Pine, 2008), which includes the capacity for self-protection and social learning (Reed *et al.*, 2010).

Wisner *et al.* (2004) place a greater emphasis on the different ways in which social systems operate that inherently make people vulnerable to hazards in the first place. In this way, through an examination of underlying causes of a disaster, there can be a hierarchical framework of factors that contribute to the unfavourable pre-conditions, or weakening of the system, for when an 'impact' does occur (Wisner *et al.*, 2004). In an attempt to understand risk in terms of the vulnerability relevant to specific hazards, Wisner *et al.* (2004) discuss two related models of disaster, the Pressure and Release model (PAR model) and the 'Access model'. Both of these models will be discussed in greater detail in Chapter 3.

Wall and Marzall (2006) propose a 'bottom-up' framework for adaptive capacity which directly relates to resource levels since, they suggest adaptive capacity is fundamentally dependant on access to resources. In this respect, Wall and Marzall (2006, p. 378) suggest that resource

availability provides an essential platform on which to further investigate the process of adaptation or, specifically, "the collective action required to handle climate change impacts". Resources, in reference to studies on adaptive capacity, are represented as human, social, institutional, natural and economic (Wall and Marzall, 2006). As discussed previously, however, with respect to the variables of vulnerability, the measurement of adaptive capacity resource variables proves to also be problematic.

The abovementioned resource variables differ in their metric due to their quantitative and qualitative nature. Wall and Marzall (2006) propose that assessments of the variables be converted into scores based on a Likert scale of 0 – 10. The use of a Likert scale also allows results to be displayed graphically for convenience and effectiveness in presentations to community members, policy-makers and other stakeholders. In the context of 'bridging the gap' between the science and the actions required by policy-makers, social vulnerability studies can be implemented as useful in understanding and potentially focusing climate change policy towards increasing adaptive capacity, thereby promoting long-term sustainability.

Kelly and Adger (2000) similarly construct their analysis of social vulnerability from a viewpoint of human use of resources to which people are 'entitled', which extends beyond materialistic income and well-being factors. Following work by Watts and Bohle (1993), Bohle *et al.* (1994), Cutter (1996) and Hewitt (1997), the use of 'entitlements' as a concept in determining levels of vulnerability is not new. Kelly and Adger (2000) endeavoured to define how the different socio-economic and political characteristics, processes and trends influence vulnerability in order to improve future scenarios through developing better policy practices. From this viewpoint, it is important to acknowledge, as Kelly and Adger (2000) have done, that such a societal perspective inherently brings to the fore many issues relating to values and perceptions.

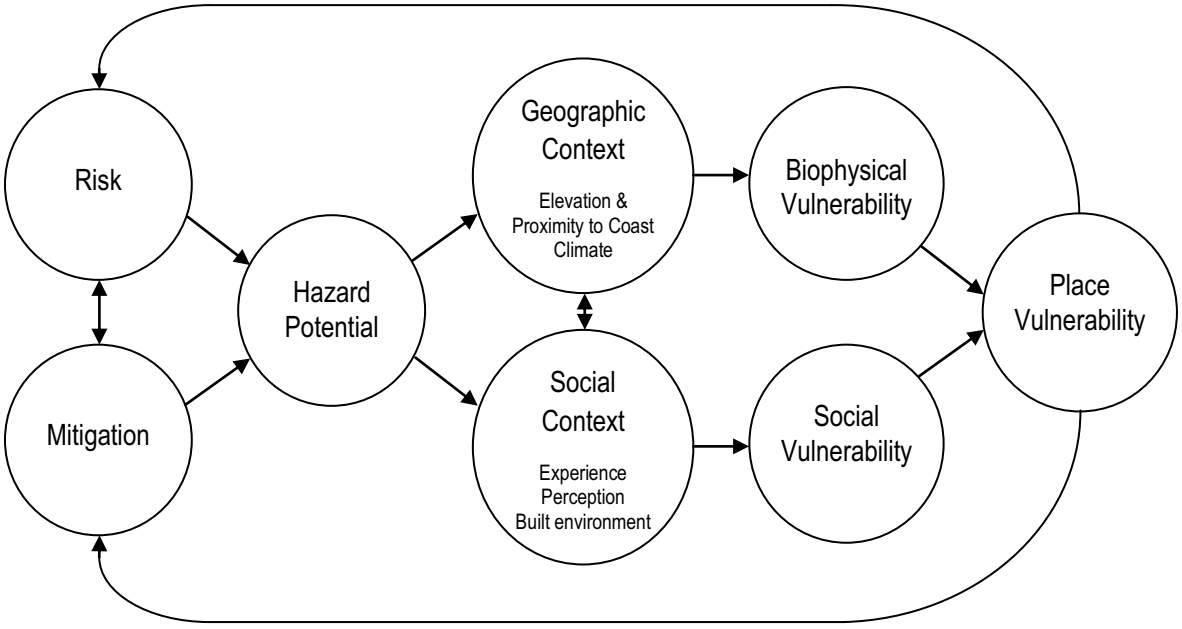
1.5.5.1 An integrative approach to vulnerability

Traditional studies of social vulnerability focussed on risks associated with a hazard or stress, and specifically the social, economic and political processes that render people vulnerable, as well as what types of hazard or stress compound a greater level of vulnerability in people (Adger *et al.*, 2004; Wisner *et al.*, 2004). In this respect, although social vulnerability is not a function of hazard, it is often hazard specific (Adger *et al.*, 2004; Brooks *et al.*, 2005), and as Cutter *et al.* (2003) discuss, the potential loss from a hazard, therefore, is also confined in space and time. Consequently, there are generic factors of vulnerability that are likely to determine the

vulnerability of individuals and communities for a wide range of hazards in particular contexts, such as households at risk in low-lying coastal areas with respect to sea-level rise flooding, inundation, and storm surges (Adger *et al.*, 2004; Brooks *et al.*, 2005).

Furthermore, recent additions to the literature (Adger *et al.*, 2004; Armitage, 2005; Grothmann and Patt, 2005; Moser, 2010b; Moser and Ekstrom, 2010; Vincent, 2007; Wall and Marzall, 2006) have emphasised 'adaptive capacity' as a means of coping and responding more proactively to hazards, rather than purely concentrating on vulnerabilities that limit groups and individuals. Here, there is an integration of potential exposures and societal resilience that is context specific, which Cutter (1996) and Cutter *et al.* (2003) have described as the 'hazards-of-place' model of vulnerability, outlined in
Figure 1.4. When considering 'inherent' vulnerability in terms of this model, it is important to acknowledge the integration of human factors that both create exposure to hazards and produce the adaptive capacity to cope with such exposures.

Figure 1.4: The hazards-of-place model of vulnerability



Source: Author, adapted from Cutter et al. (2003, p. 244)

Figure 1.4 shows how the 'hazard potential' is the result of the interaction between the risks (as the potential for hazard) and any mitigation (as measures to reduce risk and/or any impacts), which is then filtered through the particular geographical and social context, as well as enhanced

or attenuated between them (Kumpulainen, 2006). The elements of both the biophysical and social vulnerability are then combined to produce an overall place vulnerability (Cutter *et al.*, 2003). Whilst not specified in
Figure 1.4, the elements of vulnerability, including exposure and sensitivity to risk (discussed in Chapter 3.1.1), are present within the model and interact to varying degrees within the cells to produce the overall 'place vulnerability'.

Through a consideration of the overall 'place vulnerability', it is evident that the aim and objectives of this research project (Chapter 1.1) allow for the 'hazards-of-place' model to be utilised as a conceptual guide. Indeed, as will be established throughout the following chapters, there are many 'known' components within the 'hazards-of-place' model, with respect to the two coastal case study areas of this research, including risk, and to some degree hazard potential, geographic context, and biophysical vulnerability. What remains to be established, therefore, are the components of social context, through an exploration of perceptions of risk, which, once analysed in the geographic context of the case studies, will constitute the social assessment of vulnerability.

1.5 Research gaps and questions

As suggested by Working Group Two (WG2) of the IPCC Fourth Assessment Report (IPCC, 2007a), a high priority should be given to increasing the capacity of regions, *inter alia*, to adapt to climate change with respect to broader goals of sustainable development. This research will therefore consider two non-metropolitan coastal communities, and consequently explore perceptions of risk and notions of adaptation (adaptive capacity) (Grothmann and Patt, 2005; Lorenzoni *et al.*, 2000; Nicholls, 1999). Additionally, WG2 (IPCC, 2007a, p. 737) also suggested that an integrated regional and sectoral assessments of impacts, adaptations and risks to climate change are desirable. As such, this research will therefore utilise the 'hazards-of-place' model as a conceptual guide to approach issues of social vulnerability and, hence, due to the use of case studies, place vulnerability (Cutter *et al.*, 2003). This study will therefore directly seek to fill two primary research gaps derived from the above:

1. Identify the relationships between perceived societal risks, preparedness and willingness to adapt to climate change through an examination of the human dimensions of climate change; and

2. Contribute to regional and place-based vulnerability assessments through the identification of perceived vulnerabilities and potential avenues for adaptation.

This research will utilise much of the biophysical and demographic information readily available within an Australian coastal context, particularly the geomorphological and population material, and add to the existing body of knowledge by exploring public perceptions of risk within specific social contexts. In doing so, it will be able to complement the biophysical studies currently being undertaken in Australia, such as that of the 'first pass' National Coastal Vulnerability Assessment, for example (DCC, 2009; DCCEE, 2011). Indeed, by providing a social element to vulnerability assessment, it will be able to "combine multiple perspectives in determining priorities, increases the number of action options, and facilitates successful adaptation to the changing climate" (Finucane, 2009, p. 7).

The broad application of this study, therefore, is to assist coastal policy and management to deliver more proactive and long-term, future orientated strategies with respect to climate change adaptation in non-metropolitan communities, where multiple resource constraints are prevalent (Shepherd, 2005b). As with most research, there is an inherent expectation that its results will help to bring about 'better' decisions in order to provide positive social outcomes. Indeed this expectation is assumed here, however, and as Sarewitz and Pielke Jr. (2007) assert, the idea of 'better' decisions may depend upon who stands to benefit from the potential 'improvement' in decision-making, since there may be some who are adversely affected. Nonetheless, while the research is intended to provide 'useable' knowledge for those attempting to make 'better' decisions, the overall goal is still to improve our fundamental understanding of phenomena (Sarewitz and Pielke Jr., 2007), that is, through the exploration of public perceptions of coastal climate change risk.

The literature introduced thus far in this thesis demonstrates that a necessary step forward for vulnerability assessment, particularly in Australia, is an enhancement of the social elements of vulnerability (constituting, but not limited to, adaptation and adaptive capacity) to be combined with the biophysical elements. This can be expressed through the key research question: *How willing and capable are coastal property owners to adapt to climate change risks and associated vulnerabilities?* The following sub-questions, therefore, are posed:

- *What are the perceived vulnerabilities of residents in coastal settlements in terms of climate change?*

- *What are the perceived societal opportunities, limitations and barriers of climate change adaptation?*
- *What constitutes adaptation, how does it occur and what are the implications for government planning and policy-makers?*
- *Can planners and policy-makers utilise knowledge of perceived vulnerabilities to better prepare society for change?*

1.6 Thesis structure

The remainder of this thesis will consist of the following format and structure:

- Chapter 2 will describe the methodology and research techniques applied to obtain and analyse the research data used for this study.
- Chapter 3 will discuss the principles and theory of vulnerability assessment and the concepts involved in adaptation to climate change, along with a review of similar case study research, as well as an outline of current studies and projects along the Australian coast, and in the respective states where the case studies are located.
- Chapter 4 will give a full description of the literature relating to public perceptions of risk in the context of decision-making under uncertainty, with specific reference to climate change and its 'uniqueness'.
- Chapters 5, 6 and 7 will detail the results of the two case study sites, divided into the themes of demographics, risk and vulnerability, and adaptation, respectively.
- Chapter 8 will provide a discussion of major findings, as well as a conclusion on the implications of the study and recommendations of future research.

1.7 Summary

This chapter outlined the primary aim of this thesis, that is: to enhance coastal vulnerability assessments in Australia by including public perceptions of risk, adaptive capacity and adaptation to climate change. The preliminary issues discussed thus far, including the complex nature of coastal management, particularly in light of the sea change phenomenon, as well as a brief introduction to the concepts and practice of vulnerability assessment and adaptation to climate change, have indicated a need for a greater understanding of the human dimensions of climate change. Such an understanding can be gained through the use of case studies that are regional and place-based. Additionally, these discussions have also indicated that there is a simultaneous

need for an incorporation of social vulnerability analyses to both complement existing biophysical studies and strengthen shifts towards more strategic coastal planning and management.

Chapter 2 – Methodology

This chapter provides an overview of the research project's methodology. First, it explains and justifies the specific techniques and procedure employed regarding the primary research instrument – a structured, self-administered mixed-methods mail-out survey questionnaire to be distributed throughout portions of two coastal case studies. Next, this chapter discusses the research project's theoretical and methodological framework in order to review, critique and justify the techniques and procedure that are utilised. To finish, this chapter concludes with a consideration the limitations and barriers of the research, as well as a brief discussion on each of these concerns, their influence on the research, and how they have been addressed methodologically.

2.1 Introduction

McFadden and Green (2007) explain the complexity of the coast as the collision of three primary systems: the socio-economic system; the geomorphological system, and; the ecosystem. Vulnerability analyses of these systems can be done individually, although such an approach may not do justice to the complexities and interconnectedness of coastal systems. Due to the growing recognition of the importance of integrated management approaches, there has arisen a more widespread use of inter- and trans-disciplinary research and multidimensional approaches to coastal vulnerability assessment. Both discussions and the practical application of integrated approaches, however, have seldom considered all three systems together (McFadden and Green, 2007). As McFadden and Green (2007) suggest, there are important questions involving all three systems that have not been adequately addressed.

As outlined in the previous chapter, the aim of this study is to contribute to knowledge such that it will assist in the facilitation of local adaptation to climate change, as well as shifts towards more strategic coastal planning and management. Moser and Tibbia (2007b), in their analysis of Californian coastal management, recommend that the assistance needs to be provided to Local Governments when it comes to managing coastal climate change issues. Indeed, as Moser and Tibbia (2007a, p. 3) point out, since "coastal managers have their hands full with dealing with current and ongoing problems", issues relating to long-term planning for climate change highlight

an existing disconnect between science and practice. Subsequently, assistance in communities needs to be relevant to user needs, appropriate for the decision context, reliable and trustworthy, compatible with user values and interests, timely, and communicated appropriately (Sarewitz and Pielke Jr., 2007).

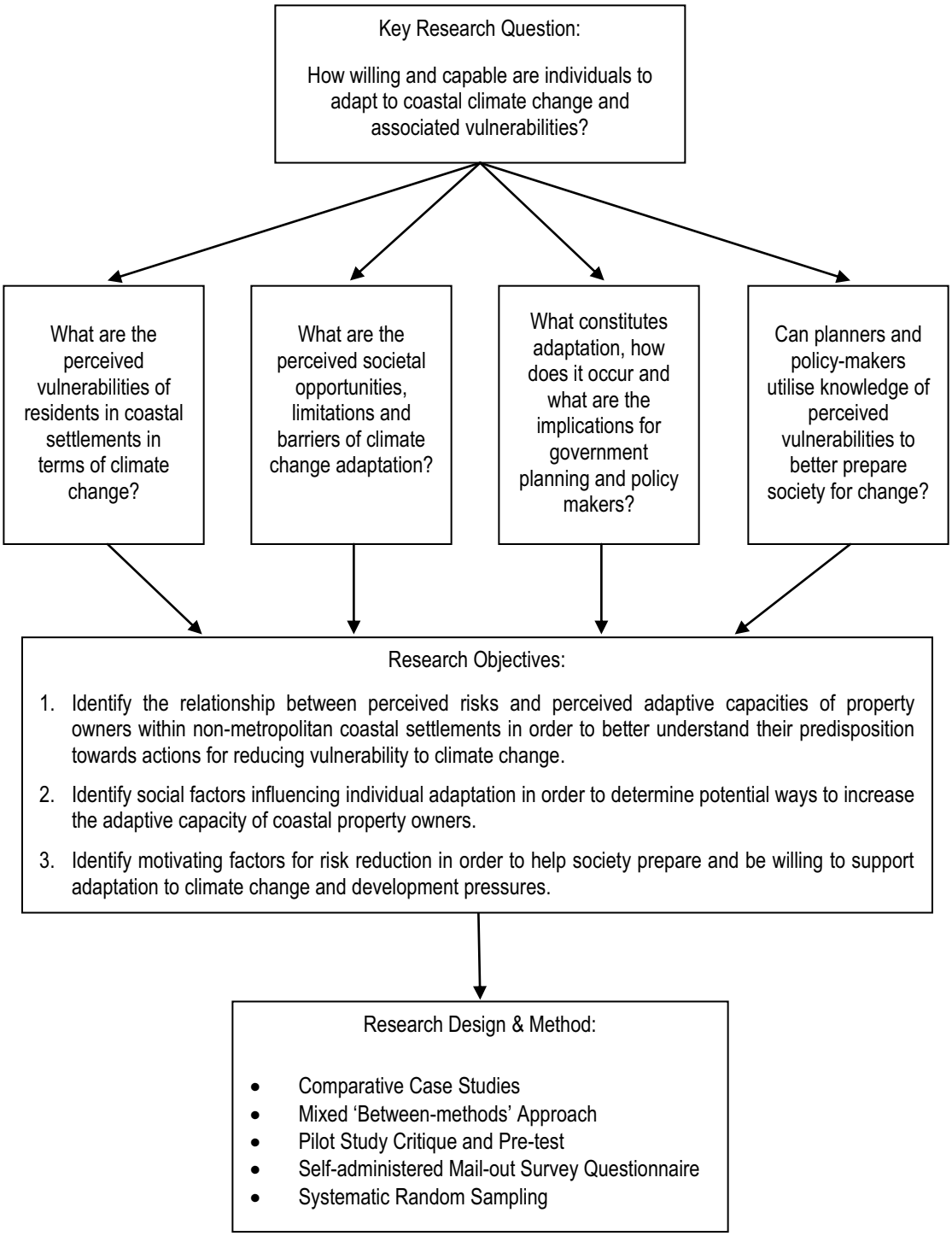
In order to achieve the above aim, this research has focussed on exploring the perceptions of individuals with respect to coastal climate change impacts – that is, the differences between various coastal risks, as well as the differences among those perceiving the risk. This focus includes their perceived vulnerability to coastal climate change impacts and expected level of disruption, as well as their willingness, and community's potential willingness, to adapt. It is hypothesised that this will lead to a better understanding of the opportunities and limitations to adaptation, based on the perceived strengths and weaknesses of particular coastal communities. The willingness of individuals and communities to adapt is an important issue of concern for policy-makers, planners and managers, since it will add to our understanding of the potential societal acceptance of particular adaptation strategies (Gurran *et al.*, 2008). This study will explore human attitudes and perceptions towards climate change and development related impacts and adaptation options, as well as behaviour and preparedness as a result of such impacts, potential impacts and potential adaptation.

Following on from the above, the following research design and method has been chosen:

- ⇒ comparative case studies
- ⇒ mixed 'between-methods' approach
- ⇒ pilot study critique and pre-test
- ⇒ self-administered mail-out survey questionnaire
- ⇒ systematic random sampling

Figure 2.1 illustrates the key research question and sub-questions, as well as the research design and method that will be utilised to fulfil the objectives described in Chapter 1:

Figure 2.1: Flow chart of research methodology and structure



Aspects of coastal vulnerability that have been widely researched primarily include links between ecosystems and human populations, such as the goods and services provided by environmental

systems, or engineering facets in response to a recovery to a prior state or 'equilibrium' after a disaster, as in the case of cyclone and storm surge damage (McFadden, 2007). There are numerous issues present which currently receive only minor research attention, including the issues surrounding human perceptions of changing environmental conditions and vulnerabilities, the processes that inhibit and promote the adaptive capacity of individuals or governing bodies, as well as the 'total' integration of the socio-economic system, geomorphological system and ecosystem (IPCC, 2007a). As yet, there has been only limited discussion on the application of vulnerability in the context of such a 'total coastal system' (McFadden and Green, 2007).

2.2 Research methodology

The research questions were formulated following an inquiry into the nature of vulnerability and adaptation from a community perspective with the incorporation of a demographic 'sea change' element (Gurran *et al.*, 2008). Of particular relevance to this research project is the recommendation of Moser (2010a) to bolster research attention towards case-specific enquiries into how the public perceives the issue of adaptation and also how to communicate the need for adaptation to climate change itself. Upon closer examination of the literature (discussed in Chapter 3 and Chapter 4), the discourse on vulnerability highlighted that varying perceptions of risk result in mixed attitudes towards change which consequently influences why and how people adapt to change, such that these perceptions fundamentally compel or constrain action to address risk (Bell *et al.*, 2001; Leiserowitz, 2005; Slovic, 2000b).

2.2.1 Case studies

As per the IPCC's (2007a) recommendations, this project utilises case studies whereby there is a regional focus that considers people and their interactions and connectedness with place, similar to that described by Vidal de la Blache (1845-1918). This is beneficial to understanding climate change adaptation, because, as Peet (1998, p. 15) denotes, the "scientific study of places – scientific in terms of a series of carefully designed regional studies… result in meaningful generalisations".

The philosophies of the natural and social sciences differ theoretically under the existential notion that natural science is concerned with explanation whereas social science seeks human understanding (Peet, 1998). This research project, however, intends to consider both within the context of the total coastal system, which results in a combination of the natural and social

sciences. Therefore, an understanding of humans and their explanation (perception) of the natural world is sought to inform policy on a broader spatial scale to eliminate or alleviate a problem (Miller and Salkind, 2002).

Geographical research to identify and differentiate the vulnerabilities and adaptive capacities at a local and regional level is therefore justified in the use of case studies, as per the concepts identified in the 'hazards-of-place' model (Cutter *et al.*, 2003), particularly if it can result in 'meaningful generalisations' that can be applied to other regions (Peet, 1998). As such, this research focuses on two different sea change communities located within spatially distant, yet climatically similar, coastal regions of Australia: the City of Rockingham, in Western Australia; and the District Council of Yorke Peninsula, in South Australia.

The lifestyle and demographic differences between these two sea change regions allows for a comparison in two ways: first, proportions of permanent and non-permanent (holiday homeowner) residents between the two communities varies, noted in the ABS 2006 census based on occupied (permanent residence) and unoccupied (holiday home) private dwellings on census night (Chapter 5.1) (ABS, 2007a; b); second, there are differences in the demographic characteristics between the two sea change communities highlighted the 2006 census data (Chapter 5.1), based on the typology of sea change communities discussed Chapter 1 (Gurran *et al.*, 2007; Gurran *et al.*, 2008).

The physical characteristics of the case study locations provide a foundation for similarities in risk, whereby they are both located in low-lying coastal areas potentially vulnerable to sea-level rise and storm surge flooding, primarily. In addition, the case study sites are both located in temperate 'Mediterranean' climatic regions (Bardsley and Edwards-Jones, 2007). In this way, therefore, this research can focus on the specific coastal climate change risks including sea-level rise and storm surge flooding primarily, such that perceptions of the same 'types' of physical risk can be explored.

The case study sites represent two types of the uniquely diverse settlement areas along the Australian coast; the non-metropolitan and peri-metropolitan. As such, the analysis of biophysical vulnerability is coupled with a threat from human population and development pressure at the coast (the 'sea change' phenomenon). They are different case study sites because of the way property is utilised within them, that is, as either a permanent residence or as a second (holiday)

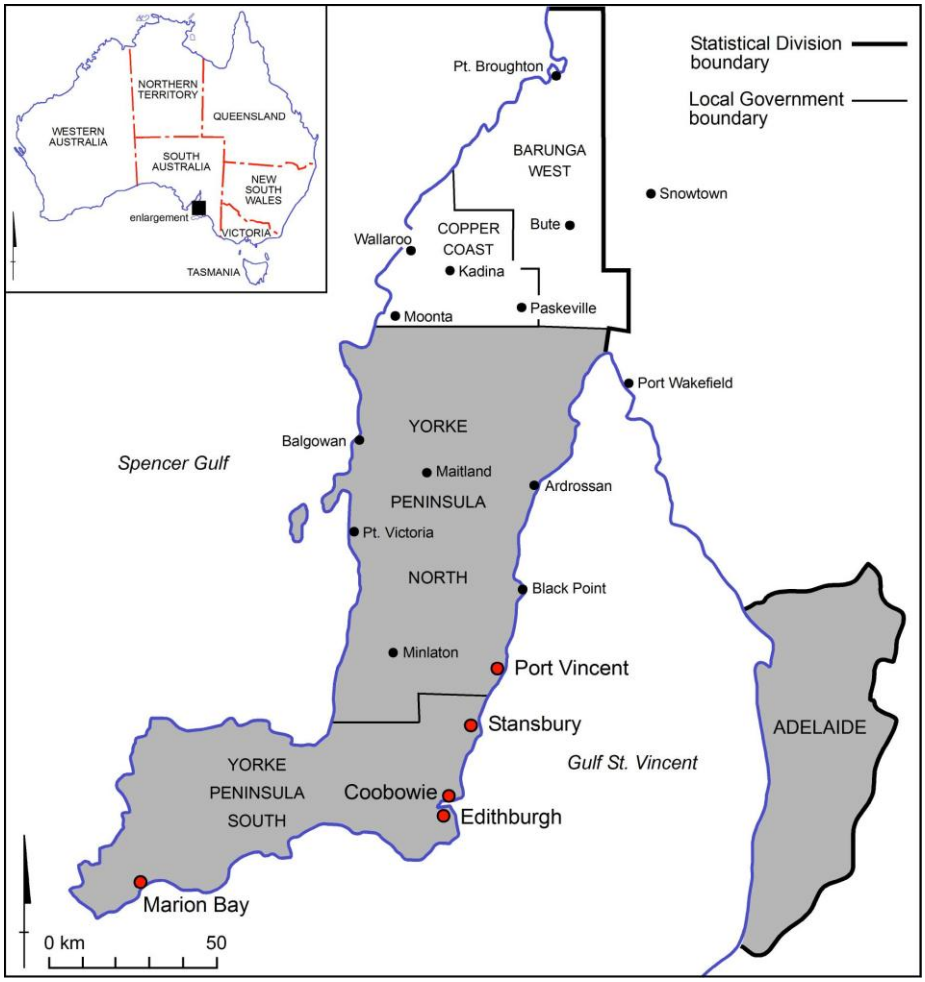
home. It is expected, therefore, that there should be substantial differences between the property owners' perceptions of risk within the two case study sites based on the type of property potentially at risk, as well as the lifestyle and demographic differences aforementioned. These case study sites have an equally diverse range of local coastal issues that fall under the broad theme of climate change and coastal development (Gurran *et al.*, 2008). The preference for biophysical vulnerability assessments, along with fewer studies on adaptation and adaptive capacity as a component of social vulnerability, represent the gap in knowledge to be filled (Dolan and Walker, 2004).

It is necessary to examine issues of vulnerability and adaptation through the use of case studies in order to enhance integrated regional assessments of adaptation to climate change, as recommended by Working Group Two (WG2) of the IPCC (2007a). Along the Australian coastline, many of the existing human settlement areas potentially vulnerable to climate change impacts contain property and associated infrastructure that constitute a significant investment on behalf of numerous stakeholders. Just as there is a need to manage these investments in the face of natural disaster risks, this needs to be extended to incorporate the risks posed by climatic changes projected in the future. In order to provide the research with a strong statistical foundation, such that data collected can be confidently extrapolated to make the 'meaningful generalisations' about the attitudes of the homeowners in those particular areas, each study location required a random sample of homeowners and the distribution of surveys to the selected participants. The following sub-sections discuss the individual case study locations and their rationale for use within this research project.

2.2.1.1 Yorke Peninsula, SA

Yorke Peninsula is a rural region located approximately two hours drive from the South Australian state capital of Adelaide, with its furthermost settlements located approximately four and one half hours drive from Adelaide. A map of the region, highlighting the five settlements sampled (in red), is shown in Figure 2.2.

Figure 2.2: Yorke Peninsula and selected case study settlements



Source: Author, map produced courtesy of Christine Crothers

The townships are located on the south eastern and southern side of the Peninsula, and include the townships of Port Vincent, Stansbury, Coobowie, Edithburgh and Marion Bay (Figure 2.2). Yorke Peninsula contains low-lying non-metropolitan 'coastal hamlet' townships, as highlighted by the National Sea Change Taskforce (Gurran *et al.*, 2005a). These townships fall within the Local Government authority of the District Council of Yorke Peninsula. The townships are assessed as being low-lying coastal settlements of less than 5.0 metres above sea level Australian Height Datum (AHD), which have a moderate to high number of new developments and are generally identified as further growth areas, as well as generally having some history of known flooding (Harmer and Guy, 2007). Other townships were excluded due to their location inland and height above sea-level, which markedly reduces their potential risk to coastal climate change impacts.

Overall, the resident population of the District Council of Yorke Peninsula region was estimated at 11,795 (ABS, 2012) with approximately one quarter of the population residing in townships of

between 200 and 1,000 persons (ABS, 2006c). According to population growth figures, between 2001 to 2011 the District Council of Yorke Peninsula experienced a 2.4% change, or 0.24% per annum over the last 10 years (ABS, 2012). In addition, between 2010 to 2011 it was ranked 35th out of the 70 South Australian councils in terms of fastest growth, and 34th in terms of the largest growth (ABS, 2012).

Yorke Peninsula is scattered with over thirty very small, small and medium sized coastal townships, with 36% of the region's population residing in very small settlements of less than 200 persons or outside of these areas (Figure 2.3). These townships experience very large influxes of tourists seasonally (Planning SA, 2007), particularly from intrastate tourism (South Australian Tourism Commission, 2007). Population figures within the region do not reflect the demands placed on the townships by tourist activity, such as accommodation and other services, highlighted, for example, by a substantially greater number of development approvals compared to people moving to the region to take up permanent residence (Planning SA, 2007). This demand is also highlighted by the amount of residential holiday homes and units in the region, as well as the number of unoccupied and occupied dwellings during off-peak periods (Planning SA, 2007). Census data from 2006 indicated occupied dwellings on census night constitute 55% of properties within the District Council of Yorke Peninsula (ABS, 2006a).

Figure 2.3: Yorke Peninsula Region: settlement sizes

NOTE:
This figure is included on page 55 of the print copy of the thesis held in the University of Adelaide Library.

Source: Adapted from Planning SA (2007, p. 7)

The study area and the five individual townships represent fairly homogenous non-metropolitan, low-lying 'coastal hamlets' (small to very small sized towns, over 3 hours drive from the state capital). They are homogenous in the sense that they have similar demographic profiles, as well as substantial proportions of holiday homes for domestic tourism, including 'day trips' and weekend 'escapes' (Gurran *et al.*, 2005a). Land use throughout the region beyond town limits is predominately agricultural comprising of broad acre crop farming (Planning SA, 2007). 'Coastal hamlets' tend to have a much higher median age compared to Australia overall, are ageing at a much faster rate, have lower median household incomes compared to Australia overall, with a high proportion of property owners being absentee landlords, who own holiday homes or are weekend residents (Gurran *et al.*, 2005a). Such 'coastal hamlets', as highlighted by the National Sea Change Taskforce, are under increasing pressure from human development (Gurran *et al.*, 2006).

Based on the rates database list provided by the District Council of Yorke Peninsula, there was a total of 1,937 properties in the five townships (as of June 2009). Table 2.1 provides a breakdown of the townships. A more specific demographic breakdown is provided in Chapter 5, when considering results.

Table 2.1: Properties within Yorke Peninsula case study townships

Yorke Peninsula – *n* Properties within case study townships	
Port Vincent	580
Stansbury	466
Coobowie	230
Edithburgh	395
Marion Bay	266
TOTAL	1,937

Source: Author, compiled from council rates database list

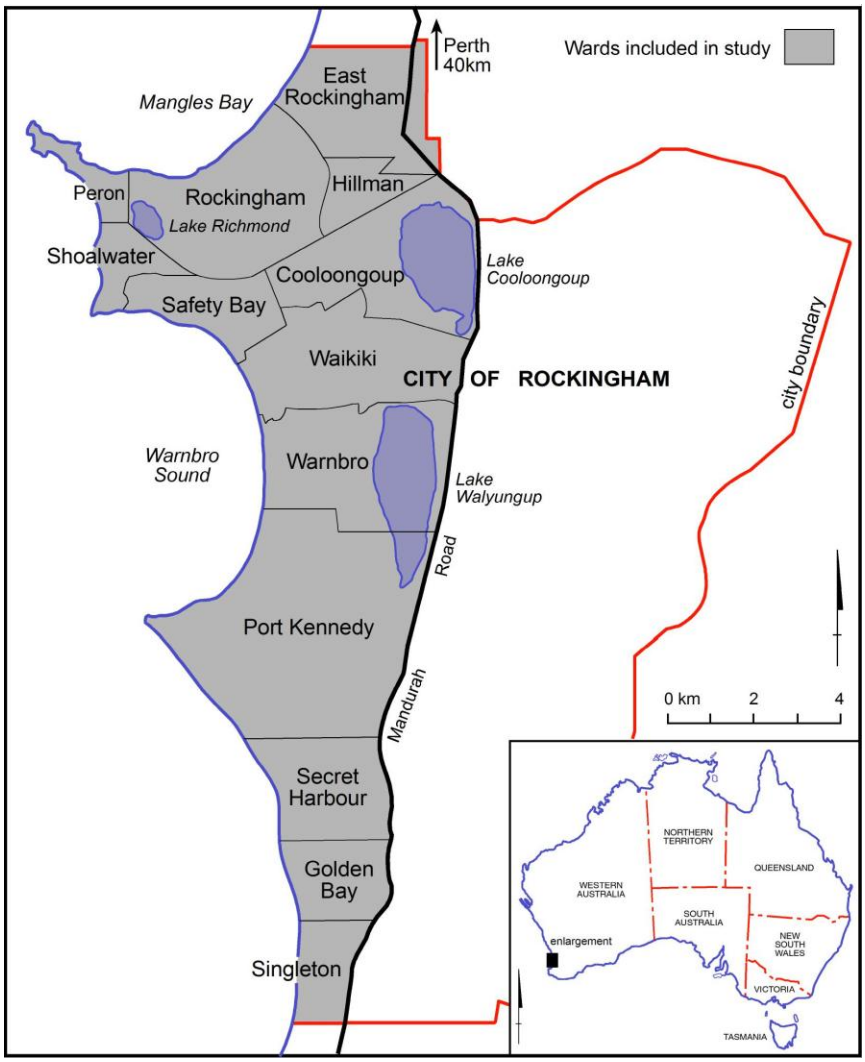
2.2.1.2 Rockingham, WA

The City of Rockingham marks the southern-most border of the Perth metropolitan region, located approximately 40 kilometres south of the state capital of Perth. The resident population within the City of Rockingham is estimated to be 108,022 (ABS, 2012). The city has experienced a significant growth rate in recent times since it is both a desirable coastal location and is within commuting distances to the city of Perth for work or family commitments. According to population growth figures, between 2001 to 2011 the City of Rockingham experienced a 45.9% change, or 4.6% per annum over the last 10 years (ABS, 2012). In addition, between 2010 to 2011 it was

ranked 8th out of the 139 West Australian councils in terms of fastest growth, and 3rd in terms of the largest growth (ABS, 2012). The City of Rockingham is divided into four 'Wards': one ward is considered predominately rural, and as a result is excluded from the sample; whilst the other three wards contain the bulk of residential properties.

Figure 2.4 displays the 12 suburbs included within this study, located within the city's three coastal wards. They include Cooloongup, East Rockingham, Golden Bay, Hillman, Port Kennedy, Rockingham (including Peron), Safety Bay, Secret Harbour, Shoalwater, Singleton, Waikiki, and Warnbro. The coastal suburbs of the City of Rockingham represent the suburbs included in the sampling frame.

Figure 2.4: Rockingham and selected case study wards



Source: Author, map produced courtesy of Christine Crothers

Rockingham has a particularly diverse range of land use patterns in terms of residential, commercial, industrial and military zones as well as areas that are relatively undeveloped and retain natural vegetation and dune systems. Rockingham is a low-lying peri-metropolitan 'coastal commuter' community, as defined by the National Sea Change Taskforce (Gurran *et al.*, 2005a). Census data from 2006 indicated occupied dwellings on census night constitute 89% of properties in Rockingham (ABS, 2006a).

The study of the City of Rockingham, being a peri-urban 'sea change' area, provides a substantial demographic contrast between the rural 'sea change' and more homogenous communities of Yorke Peninsula, and enable further comparison between the residents of changing non-metropolitan and peri-metropolitan areas. 'Coastal commuter' locations Australia wide tend to have much higher growth rates than the national average, primarily due to the 'spillover effect' from increasingly unaffordable metropolitan areas, as well as a lower median age than Australia overall (Gurran *et al.*, 2005a).

Each suburb within the City of Rockingham is more heterogeneous in terms of its demographic profile than that of Yorke Peninsula and therefore requires the use of all of the suburbs within the three coastal wards coastal to obtain an adequate sample. A more specific demographic breakdown will occur in Chapter 5, when considering results. Based on the property lists provided by the City of Rockingham (as of July 2009), there are 34,103 properties within the 12 suburbs. Table 2.2 provides a breakdown of the suburbs.

Table 2.2: Properties within Rockingham case study suburbs

Rockingham – *n* Properties within case study suburbs	
Rockingham & East Rockingham (including Peron)	6,913
Golden Bay	880
Secret Harbour	3,056
Cooloongup	2,756
Hillman	774
Port Kennedy	4,570
Safety Bay	3,413
Shoalwater	2,001
Singleton	1,100
Waikiki	4,426
Warnbro	4,214
TOTAL	34,103

Source: Author, compiled from council rates database list

2.2.2 The questionnaire

The project intended to provide 'meaningful generalisations' of the perceptions of property owners, and it was, therefore, necessary to utilise representative samples in order for that extrapolation to be valid. Since both case study sites are 'sea change' communities the most reliable way to obtain current lists of property owners within changing communities was through the most up to date rate payer databases, which could be obtained from the respective Local Governments (outlined in Table 2.1 and Table 2.2). These lists provided details of the owners' names, property address, as well as residential address, allowing the survey questionnaires and envelopes to be personalised.

Questionnaires were distributed to homeowners in the case study regions and, if they were willing to participate, completed in their own time. Questions were designed to be descriptive, attitudinal and behavioural, with a style-mixture of both closed (quantitative) and open-ended (qualitative). Within such a mixed-method approach, it is sometimes difficult to define which philosophical tradition the particular research is bound by, since individual methods have their own individual philosophies (Greene *et al.*, 2005). This research consequently uses several methodological paradigms, inherent to coastal vulnerability studies (McFadden and Green, 2007), since the 'total coastal system' constitutes a wide range of process dimensions: the socio-economic system, the geomorphological system, and the ecosystem.

As Greene *et al.* (2005) discuss, in practice a mixed-method approach has several key dimensions of importance which influence research design. In the context of this research, concerned with perceptions of risk towards climate change and its associated impacts within a representative sample of property owners, the quantitative methodology dominates over the qualitative. There are however, numerous qualitative techniques used to provide direction in developing the questionnaire.

The questionnaire began its formation through the simultaneous process of literature review, informal telephone, email and personal conversations with experts and established researchers, as well as deliberation with supervisors and fellow postgraduate researchers. These initial engagements formulated the early forms of a much greater iterative and cyclical progression of the generation of ideas, understanding and reflection – a simplified and impromptu hermeneutic circle (see Figure 2.8 in the following section for a more detailed discussion).

It was determined within this process that a structured mixed-methods mail-out survey was appropriate since it was primarily the property owners who would ultimately become those potentially vulnerable to coastal climate change impacts and be responsible for initiating an adaptation response (Gurran *et al.*, 2008). The next requirement within this progression of ideas was in pre-testing and critiquing the draft questionnaire so as to confirm its validity as a core research technique, which will be discussed in the following subsection.

The structured questionnaire contained a total of 49 questions within 7 pages (a total of 73 variables); 36 closed and 13 open-ended questions, with a final sheet enclosed for any additional comments (Appendix 3). The questionnaire is divided into four sections representing the key themes:

1. Climate change;
2. Sea-level rise and storm surges;
3. The 'sea change' phenomenon; and
4. Respondent details.

Closed questions consisted of a mixture of binary 'yes, no'; ternary 'yes, no, unsure'; Likert scaling both horizontally and vertically on the page; and ranking of lists, in order to provide the respondent with a variety of formats. Open-ended questions were generally included to allow the respondent the opportunity to explain their closed question choices via space provided below it. For an example of each question type, refer to Figure 2.5.

Figure 2.5: Examples of question types included within the structured questionnaire

Closed Ternary 'YES, NO, UNSURE'

In your opinion, is climate change taking place in the region now? (Please circle one response)

1. Yes
2. No
3. Unsure

Horizontal Likert

How would you rate your knowledge of the environment in the region? (On a scale of poor 1, to excellent 5, please circle one response)

Poor		Moderate		Excellent
1	2	3	4	5

Vertical Likert

How would you describe your attachment to the community? (Please circle one response)

1. Not attached at all
2. Only slightly attached
3. Moderately attached
4. Very attached

Ranking

Who do you feel is most responsible for initiating a response to minimise any negative impacts of climate change in the region? (From the list, please rank from least responsible 1, to most responsible 5)

_____ Local government
_____ State government
_____ Federal government
_____ Individual community members
_____ Scientists

Open-ended

In your opinion, what impacts will rising sea-levels have on the community?

_____
_____
_____

2.2.2.1 Sampling

In considering the sampling method, Bostrom *et al.* (1994) discuss that the nature of the sample can either limit or justify the generalisability of results, which is particularly relevant for use by policy-makers. Specifically, this is related to the use of non-probability or probability sampling, respectively. In studies conducted by Bostrom *et al.* (1994), survey respondents were allowed to structure and define their own responses, which offered a clear perspective on conceptualisations and descriptions of the issues, albeit they lacked external validity and were not generalisable. Larger surveys on the other hand are generalisable but, due to uniform wording and potentially

unfamiliar key terms across a large number of people, may result in measurement error and be an unreliable guide to respondents' beliefs and priorities. It was decided that generalisable results were required, and as such, to increase the level of reliability of results a pre-test and critique was to be conducted on the questionnaire (section 2.2.3 below).

A systematic random sampling technique was used to identify survey participants. As Rea and Parker (2005, p. 115) discuss, "[t]he purpose of sampling is to be able to make generalisations about a population based on a scientifically selected subset of that population". In seeking to investigate societal perceptions on climate change impacts and adaptation within sea change communities, it was appropriate to conduct sampling within defined communities of the case study sites. Sampling theory justifies the use of one single sample to make inferences about large populations, rather than having to utilise several samples (Rea and Parker, 2005).

The sampling frame included all residential addresses within the defined study sites, that is: five southern Yorke Peninsula townships and 12 suburbs in Rockingham, with the survey being targeted at the heads of households. Due to the nature of specific individual property ownership, in the case of second (holiday) homes as per the rates databases, there was the possibility that there were one, two, or three or more names listed as the property's owners, and as such, all names were included the addressing on mail-out items. For this project, it must be noted that the generalisation can only be made about property owners within the two regions. In order to obtain the random sample, a complete list of all 'improved land' residential properties within the study sites was compiled based on information obtained from the most recent Local Government rates databases. Vacant, government owned, 'not improved', business and all other non-residential properties were excluded from the sampling frame. Deceased owners and addresses forwarded to real estate agencies within the rates databases were also excluded prior to sampling. Similarly, since some individuals within the sampling frame were the owners of multiple properties, these were further excluded to prevent the owner from being sampled more than once. Since the sampling frame targeted only property owners, it did not include residents within caravan parks or residents with rental tenure.

The study sites are sea change communities and include holiday areas and many households have both a primary property address, as well as a secondary postal address. In this respect, it was particularly beneficial for determining the 'type' of property owner so as to ensure that sampling error was minimal. For instance, a significant number of the dwellings are not

permanently occupied by the heads of households, that is, the property is considered to be a 'holiday' or 'investment home'. In cases where the property owner was not permanently residing in that particular home, secondary postal addresses were used in order to obtain a response. The homeowners, regardless of whether they are permanently residing at the property or not, will be required to assess the vulnerabilities created by climate change and be responsible for making decisions about adaptation based on these perceived vulnerabilities. A more detailed analysis will be presented in the results in Chapter 5.

2.2.2.2 Sample size

The sample size necessary for each of the case study sites will vary depending upon numerous factors. Generally, however, the greater the level of accuracy desired, the greater the sample size must be (Rea and Parker, 2005). Considering the population in the case study sites, according to Rea and Parker (2005) a population of less than 100,000 is considered small and requires a particular calculation (different to that used for larger populations) to determine sample size – that is, assuming that the sample is random and representative, and therefore valid. For this research, since the population of each of the case study sites is less than 100,000 (Rockingham n = 34,103; Yorke Peninsula n = 1,937), the sample size equation below was used (Figure 2.6). Since it is extremely likely that not all surveys will be returned prior to the closing date for responses, it is necessary to aim for a target sample size greater than that calculated from the equation, which was achieved by reducing the margin of error from 5% to 4%.

Figure 2.6: Sample size calculation for a population below 100,000

$$n = \left[\frac{Ž \sqrt{p\,(1 - p)}}{MoE} \times \sqrt{\frac{(N - n)}{(N - 1)}} \right]^2$$

Where:

- n is the required sample size
- N is the population size
- p is the true proportion (typically set at 0.5 to achieve the highest sample size)
- MoE is the margin of error (typically set in the 3.0 to 5.0% range, or 0.03 to 0.05)
- Ž is the z score which determines the level of confidence (most commonly set at 1.96 for 95% confidence or 2.575 for 99% confidence)

Source: Rea and Parker (2005, pp. 148-150)

For this research project, utilizing the above equation, the sample size of each of the case study sites is detailed in Table 2.3. From the calculations, a total of 1,048 residential addresses needed to be sampled, with 590 from Rockingham, and 458 from Yorke Peninsula. The respective numbers of residential addresses were selected at random from N (the population) for each study site.

Table 2.3: Mail-Out Survey Questionnaire Sample Size Calculations

	Yorke Peninsula	**Rockingham**
N (population of residential addresses)	1,937*	34,103*
Ž (confidence level)	1.96 (95%)	
p (true proportion)	0.05	
MoE (margin of error)	0.04 (4%)	
n (sample size)	458	590
Total	**1,048**	

Source: Author

** Data obtained from Local Government rates databases (June and July 2009 respectively)*

A preliminary analysis compared property addresses and postal addresses of the sample selections to gauge at the proportion of households with permanent dwellers and non-permanent dwellers deduced from occupied and unoccupied dwellings (permanent residents versus non-permanent residents, that is, those who are locals versus those who are holiday homeowners) on census night. This preliminary analysis confirmed that the sample drawn from the sampling frame was representative of the ratios of permanent and non-permanent residents, which will be discussed in Chapter 5.

2.2.3 Pilot study critique and pre-test

Pilot studies are generally employed to provide the researcher with advanced warning about possible pitfalls or to help identify where the actual study could fail, as well as to critique, test and validate the research instruments (Baker, 1999; Bourque and Fielder, 2003; Cargan, 2007; Fink, 2006). Pilot studies further allow the researcher to develop a more specific understanding of his/her research topic and to generate experiential learning in order to become more familiar with the methodological considerations of their work. Table 2.4 details the potential advantages of conducting pilot studies, as described by van Teijlingen and Hundley (2001).

Table 2.4: Reasons for conducting pilot studies

NOTE:
This table is included on page 65
of the print copy of the thesis held in
the University of Adelaide Library.

Source: van Teijlingen and Hundley (2001)

There were three primary research techniques that required a critique and pre-test prior to committing those techniques for use in the actual survey. These included:

5. The structured questionnaire, whereby the format, style and flow was tested to ensure that it was practical, user friendly, and sensitive to the local context, as well as to remove or alter any problems or limitations with the questions prior to investing greater resources on the actual survey;
6. Completion of the questionnaire in the respondents' 'own time' as well as the subsequent mail-back, whereby the practicality and logistics for respondents to return the questionnaire , as well as likely response rates was tested; and
7. Coding, collation and analysis of the data, whereby the researcher was also able to pre-test coding and collating the data for analysis in statistical software packages.

The questionnaire had been through significant drafting stages prior to the pilot study. It was reviewed and commented on by supervisors and fellow postgraduate students, as well as by the University of Adelaide's Ethics Committee, whereby it was subsequently approved for research purposes. The drafted questionnaire was accompanied by an information sheet, which had also been reviewed and accepted by the University of Adelaide's Ethics Committee. After this internal review period, only minor grammatical and formatting changes were made, and it was consequently determined that an external review should be utilised, in the specific format of the pilot study. For ease of testing, the pilot study critique and pre-test was conducted within one of

the main research project's case study sites, the District Council of Yorke Peninsula, due to its proximity and convenience of access to the researcher.

2.2.3.1 Pre-test

The pre-test was consequently conducted at the annual coastal council's network meeting for the Northern and Yorke Natural Resource Management (NYNRM) Board in South Australia. This was a day-long symposium designed to allow councillors, planners and managers from within the NRM region the opportunity to discuss coastal issues relevant in their council area, as well as to listen to guest speakers present on a range of emerging topics. Forty five people were present in total, most of whom were Local Government representatives involved in planning, community development and natural resource management, as well as State Government representatives from the South Australian Department for Environment and Heritage (DEH), Department of Primary Industries and Resources South Australia (PIRSA), South Australian Department of Planning and Local Government, Local Government Association (LGA), and Central Local Government Region of South Australia. In attending the symposium and engaging with participants, through the practical application of the pilot study the researcher was able to facilitate an opportunity for social learning (Wals, 2008).

At the symposium, a brief background presentation of this research was given to audience members to introduce the aims and concepts of the project, as well as to express the importance of the pilot study for the overall success of the actual mail-out survey. During the presentation, the questionnaire was distributed to audience members to be taken home, read, completed, commented on and posted back within four weeks. Questionnaires were pre-folded to fit into a reply-paid envelope that accompanied it so as to give the appearance that it had been received in the mail in an appropriately sized envelope also. Audience members were asked not to complete the pilot questionnaires during or directly following the presentation, but rather to take them home so as to replicate, as closely as possible, the actual survey completion process to be done by the sampled population in the broader study. Although it was assumed that this would result in less pilot questionnaires being returned than distributed, this challenge is inherent to any mail-out questionnaire. By completing the pilot at home it was assumed that the quality and legitimacy of responses would be increased.

A total of 31 pilot questionnaires were distributed, of which, despite instructions, 1 questionnaire was completed and returned at the end of the day. After the four week reply period there was a

total of 16 (51%) returned pilot questionnaires and none were received after the reply period. Only 13 (42%) were completed appropriately such that they could be analysed. Data from the returned questionnaires were coded and entered into statistical software packages for analysis. Representativeness of the sample was not important for the pre-test, nor was the fact that statistical significance could not be achieved due to its size. More importantly, frequencies and cross-tabulations were the primary output from the software, along with the critique of the format, style and flow.

The pilot study disproportionately counted males (69%), as well as those with tertiary (46%) and postgraduate (38%) educational qualifications. This was to be expected since the symposium primarily consisted of council planners, managers and Local Government representatives (ALGT, 2007). Almost one half (46%) of respondents were aged 50-59 years, and almost one third (30%) were aged 40-49 years. The researcher expected that particular responses would be biased since the pilot study respondents had been exposed to presentations regarding coastal issues all throughout the symposium, with some having professional experience in Local Government planning and NRM. As outlined previously, the critique of the questionnaire was one of the primary concerns of the pilot study, not the representativeness of the sample or the results.

2.2.3.2 Critique of the Questionnaire

Comments regarding the format, style and flow were primarily directed towards the length of the survey, specifically that it was too long. One respondent suggested that individual questions could be prioritised and then the 'least important' questions could be deleted so as to reduce questionnaire length and increase completion and return rates. This particular respondent indicated that they had previous experience in constructing surveys and that it may increase the overall completion and return rate. Roth and BeVier (1998), however, found that survey length had only a minor effect on return rates. Similarly, Dillman *et al.* (1993) assert that past research is inconclusive on whether survey length affects response rates, and whilst it may be generally assumed that using a shorter survey is 'better' than a longer survey in terms of response rates, such an assumption is not well supported in the experimental literature (Bogen, 1996).

Bourque and Fielder (2003) note that there are two key mistakes novice surveyors make in order to make surveys appear shorter: (i) they typically consolidate questions onto fewer double-sided pages, which can reduce the legibility; and (ii) they eliminate questions which would have gathered important information. It was decided that no questions were to be removed to reduce

the length of the survey. In fact, during the analysis a gap was found and, consequently, an extra binary question was added. Indeed, the mixed-methods utilised within the survey questionnaire allow for variations in the time constraints of respondents. Specifically, those who do not wish to spend a lot of time on the survey may complete as many of the quantitative closed questions as they wish, and not complete the typically more time consuming qualitative open-ended questions.

There were also several comments linked to the phrasing of questions, particularly those that were worded similarly whilst relating to different subject themes. It was commented that such questions were repetitive. For example, two questions asked respondents to consider negative climate change impacts in general (Q.12) and the more specific impacts of changes in sea-level (Q.21), and were intentionally designed in this manner so as to elicit the same thought processes for related themes. The first part of each question required participants to circle a number on a Likert scale of 1 to 5 corresponding to how willing to adapt they perceived the communities in the region to be (Table 2.5). The second part of each question required participants to explain briefly the reasoning behind why they thought the communities in the region were or were not willing to adapt. Confusion over similarly worded questions was reduced through non-sequential ordering:

Table 2.5: Example of two similarly worded questions

Q.12. In your opinion, how willing do you think the communities in the… region are, as a whole, to adapt to the negative impacts caused by climate change? (Likert scale of 1 to 5) Why is this, do you think? (Space provided for reasoning)
Q.21. In your opinion, how willing do you think the communities in the… region are, as a whole, to adapt to changes in sea-level? (Likert scale of 1 to 5) Why is this, do you think? (Space provided for reasoning)

The pilot provided the opportunity to experiment with binary and ternary questions, and particularly tested the usefulness of an ‘unsure’ option. The ‘unsure’ option was utilised in questions that generally referred to respondents observations of change. The addition of this option allowed for testing of whether or not ‘unsure’ was a legitimate alternative answer alongside a ‘yes’ or ‘no’ response (Fink, 2006). In this case, it is assumed that ‘unsure’ could be a common response in the broader survey due to the number of holiday and investment homes along the coast and the condensed time spent in the area by the owners. It was deemed necessary to

retain the 'unsure' option as it provided some indication of those people who were genuinely unaware of changes and/or were not permanent residents in the area.

Similarly, the pilot provided the opportunity to test particular styles and the usefulness of the responses gathered, for example, this was tested with questions concerning the assessment of one's adaptive capabilities (Q.10.a and Q.19.a respectively) (Table 2.6). Regarding the capability to adapt to climate change, the question was presented as a closed 'yes, no, unsure', with an 'if yes, how will you adapt' section to allow for explanation. Whereas capability to adapt to changing sea-levels was presented in a Likert scale of 1-5 format, with an 'if you think you are capable of adapting, how?' section to allow for explanation.

Table 2.6: Example of two different question formats

Q.10.a. Do you think that you are capable of adapting to changes in the environment as a result of climate change? (Closed Ternary Yes, No, Unsure) If yes, how do you think you will be able to adapt to changes in the environment as a result of climate change? (Space provided for reasoning)
Q.19.a. In your opinion, how capable do you think you are to be able to adapt to changes in sea-level? (Likert scale of 1 to 5) If you think you are capable of adapting to changes in sea-level, how exactly do you think you will be able to adapt? (Space provided for reasoning)

Although a 'yes, no, unsure' response provides a quicker and simpler format for respondents to work with, thereby leading to a greater question completion rate (Dyer, 1995), it failed to capture the variations of people's capability which is dependent upon the context, and did not provide enough contrast between individual respondents' perceived capabilities. From the test, a greater array of perceived capabilities was recorded, and thus allowed for greater cross-tabulation with other Likert-styled questions. From the trial statistical analysis it was determined that the 'yes, no, unsure' format was too restricting and therefore not as effective as a Likert scale. That is, the range of answers for this type of contextual question in which a Likert scale could provide allowed for a greater analysis of responses.

Pre-testing the mail-back technique provided some insight into the potential response rate to the survey and any practical problems inherent in the procedure for returning and collecting

questionnaires. Since the pilot study does not have a statistical foundation, an effective pilot study response rate cannot guarantee success in the broader study, although it does increase the likelihood of this success because it improves the internal validity of the questionnaire (van Teijlingen and Hundley, 2001). Confirming internal validity also increases confidence that particularly sensitive questions will neither cause offense nor undermine the broader response rate (Fink, 2006). Receiving completed questionnaires also let the researcher observe and become familiar with the practical nature of compiling returned surveys to ensure that the means for collecting larger volumes of mail were available and workable for both himself and the University Faculty. The pilot study further allowed an estimation of data collection costs, in terms of both administrative time and money (Bourque and Fielder, 2003).

A further important exercise in the pilot study was in coding and entering data from the completed questionnaires into statistical software packages since it enabled the researcher to familiarise himself with such processes, formulate a system of organisation and management, both in hard copy and electronically, and evaluate the success of the methods adopted for the collection and processing of questionnaires (van Teijlingen and Hundley, 2001). Completed questionnaires arrived in irregular quantities, for instance, such that the researcher needed to create a safe and manageable location for the hard copy surveys to ensure confidentiality and that they could be easily referred to at a later date. It further enabled the researcher to become familiar with these processes and determine if there were any ways in which these processes could become more efficient for the actual study. From an organisational perspective, it was found that the time-factor for preparing each questionnaire for the pilot study had also been underestimated by the researcher. Consequently, in considering the overall sample size (n = 1,048) for the broader mail-out study, it was concluded that more time was required than anticipated for preparing and personalising survey material (to be discussed below), and that more physical space for collating and storing the pre-dispatched surveys as well as returned surveys would most likely be needed.

2.2.4 Actual survey procedure

The mail-out survey procedure was conducted using a modified Tailored Design Method (Axford *et al.*, 1997; Dillman, 1978; 2000). The Tailored Design Method (TDM) utilises a more personalised approach in its format and in the administering of surveys to obtain higher response rates and increase the quality of responses. TDM seeks to maximise the quality and quantity of responses by attending to "every detail that might affect response behaviour" (Dillman, 1978, p. viii). As such, TDM bases its theoretical assumptions and approaches upon social exchange

theory, which is predicated on rewards, costs, and trust (Axford *et al.*, 1997), and extends itself by persuading potential respondents to participate through the use of social incentives such as personal attention and courteousness. In this way, for instance, envelopes, cover letters and other correspondence is personally addressed and individually signed.

TDM methodology primarily maximises the quality and quantity of responses in two key ways; first, by convincing respondents that there is a problem that exists which is of importance to a group they identify with or belong to, and that their help is needed in order to find a solution to that problem (Dillman, 1978). TDM extends its social incentives through careful wording of text and questions, the use of 'please' and 'thankyou', and the use of hand written signatures and stamped envelopes, which "convey the researcher's regard for the importance and value of each respondent's time and effort" (Axford *et al.*, 1997, p. 388).

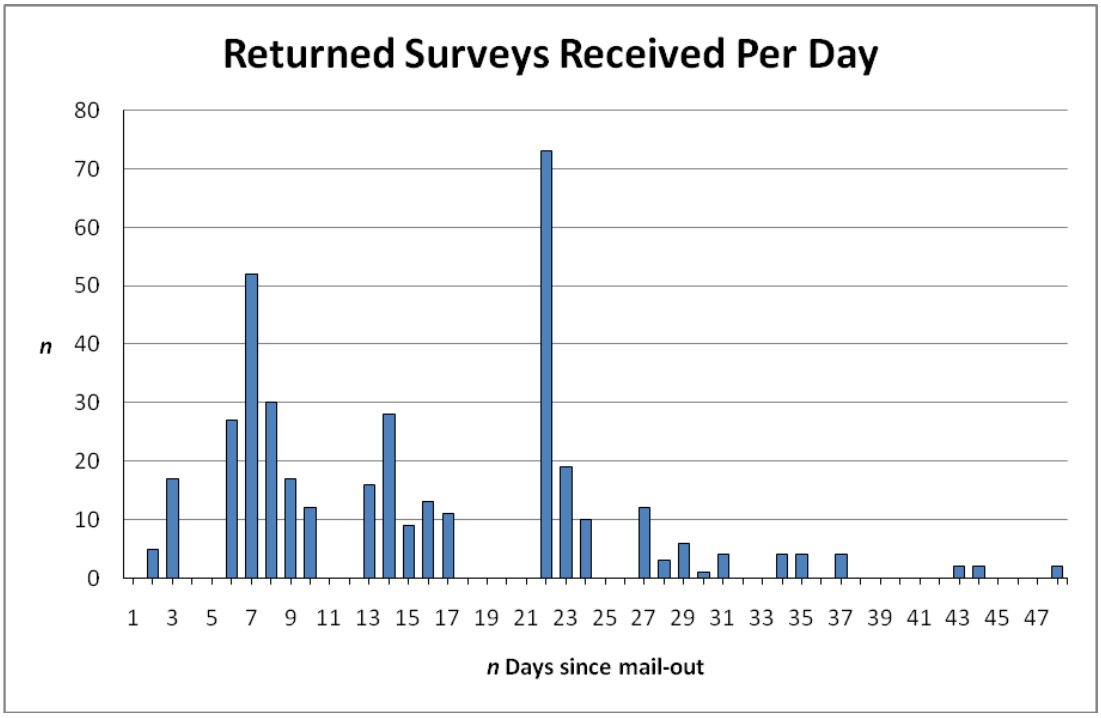
Secondly, and further to the efforts in motivating people to respond to the survey is the importance of attempting to contact potential respondents on multiple occasions to improve response rates (Dillman, 1978). Typically, TDM utilises a timed, five-contact sequence including a pre-notice letter, questionnaire, thankyou/reminder follow-up postcard, replacement questionnaire, and a final 'special' mode of contact. Each point of contact differs from the previous point of contact since, under social exchange theory, stimuli that varies are generally more powerful than repeating previously used techniques, in this way, each contact has a different look and feel to it (Dillman, 2000).

Dillman (2007) asserts that there is no one particular technique within the survey procedure that will boost response rates, but rather there are numerous techniques that must be applied simultaneously. In this research project, following the traditional TDM procedure with five points of contact was unattainable due to the financial limitations. Consequently the TDM approach was modified into a two-contact sequence utilising the questionnaire that included a detailed cover letter and reply-paid envelope, and a reminder/thankyou postcard dated and signed by hand in blue ink sent two weeks after the initial mail-out (located in Appendix 4). The postcard was designed to be easily read, since it does not require opening, and was timed to arrive after the initial contact loses its effect. Included in the reminder/thank you follow-up postcard was the option for the respondent, if they had lost or did not receive a questionnaire and required a replacement, or if they wished to 'find out' more information, to contact the researcher by telephone or email.

The questionnaire was mailed-out on Tuesday 20th October 2009. Although there is no strong evidence to suggest that time of year and day of week play a significant role in affecting response rates (Dillman, 2007), the mail-out was more likely to reach respondents if they were at home and if it was not a busy mail period. October does not overlap with any school holiday periods and it was assumed that respondents would not be away from their primary postal address, as per the rates databases. Similarly, Tuesday was selected since mail that accumulates at the post office over the weekend generally results in Monday being a busy day for outgoing mail (Dillman, 2007).

As detailed in Figure 2.7, the first returned surveys were received two days after initial the mail-out and numbers peaked one week after. The follow-up postcard was mailed two weeks after the initial mail-out. There is a second noticeable peak at three weeks after the initial contact, or one week after the postcard reminder. As Dillman (2007) explains, the effectiveness of postcard reminders vary, however, they can be attributable to response increases of between 6-25 percentage points. This second peak is likely a direct result of the follow-up postcard which served as both a friendly and courteous reminder to rouse peoples' memories, as well as a thank you note to those who had taken the time to respond.

Figure 2.7: Number of returned surveys received per day* after initial mail-out



(n = 383)

** Days corresponding to weekends could not have any returned surveys received*

Overall, of the 1,058 surveys mailed-out, a total of 383 were returned, giving a response rate of 36.2%. A total of 182 surveys were returned from Rockingham, giving it a response rate of 30.8% and a total of 201 surveys were returned from Yorke Peninsula, giving it a response rate of 43.8%. Of the 73 question variables (both closed and open-ended), 84% of the total returned surveys had more than 75% of the questions completed, and only 8% of the returned surveys had less than 25% of the questions completed. In comparing the completion rate between case study areas, 84% from Rockingham and 85% from Yorke Peninsula had more than 75% of the questions completed, whereas 8% from Rockingham and 5% from Yorke Peninsula had less than 25% of the questions completed. Chapter 5, 6 and 7 details the specific data analysis and results of the returned surveys.

2.3 The dimensions of research

The following sections provide a deeper theoretical background into the broader methodological considerations of this research project. First, there are typically four main dimensions in which a research project grounds itself (Neuman, 2006). These are based on:

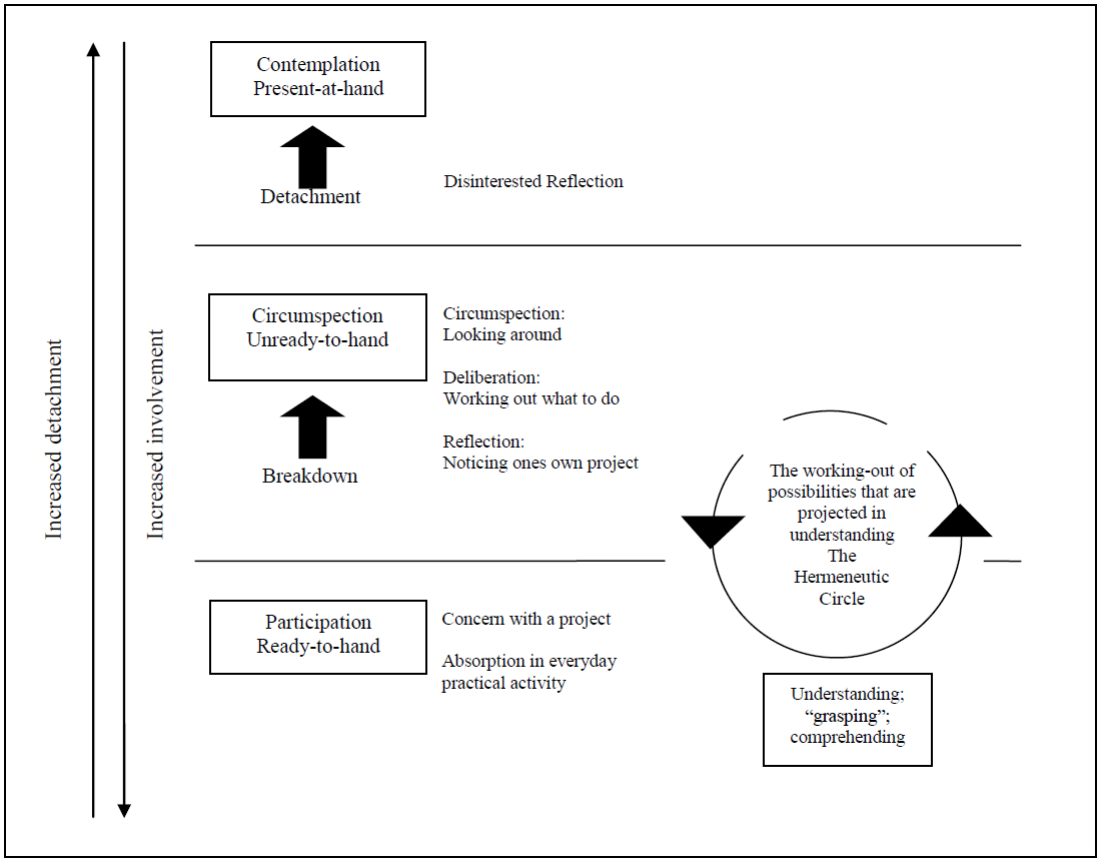
1. The audience;
2. The purpose;
3. Time; and
4. The techniques.

In understanding the dimensions of research one is more capable of deciding the style of research to undertake, and which type is the most compatible with the study design and data collection methods. In this sense, the dimensions can be thought of as decision-making 'steps' from which to further proceed in the research process (Neuman, 2006).

The first dimension relates to the audience and who consumes the findings or knowledge generated by the research. The second dimension relates to the purpose of the research and considers 'what', 'why' and 'how'. The third dimension considers the relationship that 'time' has with the study and how it is to be integrated into study design. Finally, the fourth dimension is a consideration of the specific individual or mix of particular techniques that are to be used in order to collect data and deduce or induce meaning from the data.

The following sections will describe in detail these four dimensions and link them to the particular methods used and components considered in this research project. It should be noted, however, that although the dimensions are described as 'steps' in the research process, they should not to be interpreted as part of a sequential step-by-step process. As Somekh and Lewin (2005) explain, the recognisable paradigms within which groups of researchers tend to work should not be characterised into 'types' that impose rigid step-by-step approaches with reference to research design. In reality, the four dimensions described above are parts of an iterative and cyclical process of learning and review, which fit more accurately within Heidegger's (1962) description of the hermeneutic circle (Figure 2.8).

Figure 2.8: Heidegger's overall philosophy and the Hermeneutic circle



Source: Kezar (2000, p. 387)

The Hermeneutic circle, or circularity of understanding, presupposes that we understand in terms of what we already know. Therefore, the more we engage, practice and reflect upon a topic, the more we come to broaden our knowledge and develop more specific understandings through repeated experience (Figure 2.8). As introduced in the previous section with reference to the construction of the questionnaire, a simplified and impromptu hermeneutic circle allowed the researcher to successively build on existing knowledge, as it was learned throughout the

preliminary stages of project design, and reflect upon it in order to refine the research techniques and generate a greater understanding of the research topic. Applying this framework to the four key dimensions of research, therefore, allows us to comprehend them more appropriately and thereby generate a more comprehensive and holistic research focus.

2.3.1 The audience for and use of research

Neuman (2006, pp. 23-24) suggests that research in the social sciences has had two distinct branches based on the audience, whereby some research holds a detached, scientific and academic stance, and other research a more activist, pragmatic and reform-oriented stance. As previously outlined, the distinction of research into two branches relates to the audience and the end-users of the research findings, referred to as basic or applied research respectively. Whilst the distinctions may also be known under different names and may be divided into further branches, this discussion, however, will refer to them as basic and applied.

In practice, as Brannen (2003b, p. 3) states, researchers find that their research process seldom conforms to the theoretical models that are detailed in methodology textbooks, and that it is unusual for epistemology or theory to be an exclusive determinant in deciding which method needs to be employed. Typically, there are organisational, fiscal and disciplinary issues that play a part in the determination of methods and theoretical frameworks, which are inherent and unavoidable in research due to the social context in which the research is performed (Brannen, 2003b, p. 17). In this research project for instance, fiscal limitations did not allow the survey procedure to adopt a more rigorous approach to TDM as developed by Dillman (1978; 2000; 2007), nor allow for a third case study site for 'triangulation' of data (to be discussed in next section) (Bryman, 2004).

2.3.1.1 Basic and Applied Research

One problem which surfaces from the above discussion, relative to issues of coastal vulnerability and adaptation, however, lies in the divide between basic and applied research. Basic research in a social setting is used to advance general knowledge through its provision of theories and ideas, whereas applied research is used to apply knowledge and adapt it to address real-time practical issues. In reference to the aim and objectives introduced in Chapter 1, this research connects itself to broader theories of strategic planning and management, and social learning, whilst at the same time attempting to 'bridge gaps' between local community members, leaders and decision-makers. In this respect, this research project has conflicting connections to both approaches.

Despite this research dichotomy, the issues regarding local capacity and willingness to adapt to climate change and development pressure, and the subsequent vulnerability this creates, exist as the dominant driver of this research. The divergent goals of basic and applied research results in a necessary commitment by the author to one of the research orientations based on how well that approach may answer the research questions over the other approaches (Miller and Salkind, 2002). Therefore, this research project will proceed from an applied research perspective due to its greater capability to encompass the research aim and objectives, such that it may better inform policy-makers.

Applied research is the predominant means through which to investigate a participants' perspective of a specific problem or phenomena so as to provide a solution for it – in such studies it is important to attempt to "explain what is happening" as well as why (Somekh and Lewin, 2005, p. 11). Neuman (2006) states that applied research can be employed in many different ways, one of which is known as applied 'action' research, whereby those being studied actually participate in the research process to both educate and utilise local knowledge (Wals, 2008). In this respect, the applied 'action' research focuses on empowerment issues and through this seeks to encourage stakeholder participation and increase awareness of the examined issues. By becoming participants *in* the research process, not just participants *of* the research, stakeholders are able to incorporate their own individual 'knowledge' into the project.

Applied 'action' research follows on from basic research inquiries, such that basic research sought "new knowledge in the answers to fundamental questions about social phenomena [and then] applied research hopes to show how this knowledge can be used to address a pressing problem" (Miller and Salkind, 2002, p. 3). Relevance is a key priority in such participatory 'action' research (PAR), whereby the outcomes of the project, which address a pressing problem at the local or community scale, are a product of an equalisation of power between the researcher and research participants, their participation *in* the research process itself, and the input of participants' 'knowledge' as derived from their experience (Neuman, 2006). One particular way in which explorations into participants' perceptions, knowledge, and experience was able to be enhanced in this thesis was through the use of subtle participatory research techniques, such as in the case of the pilot study critique and pre-test.

2.3.1.2 Participatory Action Research

Somekh and Lewin (2005) discuss a resistance towards rigidity in research design, and Noffke and Somekh (2005) describe how PAR can address some of these problems, particularly the divide between theory and practice. Similar to Kezar (2000), they discuss a cyclical process of integrating the development of practice with the construction of knowledge, rather than a linear one of producing knowledge and applying it in practice (Noffke and Somekh, 2005). A participatory approach, or PAR approach as it is often referred to, typically does not have a specific methodology and does not rely on an exact procedure or set of procedures to carry out the research process (Brienart, 2003). The motivation behind such an approach comes from "an impetus for change/innovation through deepening the participants' understanding of social processes and developing strategies to bring about improvement" (Noffke and Somekh, 2005, p. 91). In the case of the pilot study critique and pre-test, for instance, engagement and participation in the critique and pre-test provided symposium participants with an opportunity to become more knowledgeable about climate change as an important science-related societal issue, as well as to become competent in engaging, investigating, evaluating and resolving issues, and being motivated to do so (Volk, 1984). Since the pilot study participants were both coastal property owners and local/state government representatives, they were required to consider their personal risk, as well as that of their constituents, to potential climate change impacts and reflect on what adaptation options are available. By considering their own situation in regards to coastal risk, the pilot study built communication channels and provided ideas for how they may, as representatives of Local and State Governments, approach the issue in the future.

The traditional model for applied 'action' research frequently does not start with a research question, but rather an *ad hoc* understanding of a particular phenomena and a desire to further understand its elements (Noffke and Somekh, 2005). Through a PAR process the participants of the study, as assumed by the researcher, can become more aware of their own environment and learn to take action themselves to bring about improvement (Neuman, 2006). From here, with strong engagement and participation from those impacted by such phenomena in a cyclical form, research questions can be clarified, knowledge of the phenomena can form and grow, and more specific topics and issues can therefore be investigated (Noffke and Somekh, 2005). This again represents the process involved in an impromptu Hermeneutic circle, as described by Heidegger (1962).

PAR techniques are not solely concerned with data collection, they are equally concerned with the value of the knowledge that 'ordinary' people possess and can contribute (Brienart, 2003). Participatory research will often rely upon informal data collection methods that are both quantitative and qualitative in nature, methods that are determined by the specific purpose of the research, and what the individual researcher is attempting to accomplish. This leads into the second dimension of research, as described by Neuman (2006), which focuses on the purpose of research. In essence, this thesis is primarily utilising the concepts of PAR that provide an approach to research design which avoids rigidity, and allows flexibility. What this thesis does not do, however, is attempt to create an impetus for, or incite, change and innovation amongst the participants of the research, which is often a key motivation behind PAR.

2.3.2 The purpose of research

In considering the role of methods and theory in providing the kinds of information being sought, as well as the understanding required for research, it is useful to consider the purpose, or function, of the overall investigation. As discussed by Ritchie (2003), it is possible to identify several classifications of functions of research from a theoretical and applied research perspective. The four broad functions to social research are classified as: (i) contextual; (ii) explanatory; (iii) evaluative; and (iv) generative (Ritchie, 2003). This research project falls under, and contributes to, the contextual and explanatory functions.

2.3.2.1 Contextual and Explanatory Functions

The function of social investigation is considered contextual when research is aimed at identifying and describing 'what' exists and the manifestations of such 'things' in the context of the social world (Ritchie, 2003). From this perspective, with regards to the 'hazards-of-place' model, this research is functionally contextual since the research objectives are aimed at identifying the relationship between perceptions the study population has regarding vulnerability and adaptation, identifying the social factors that influence individual adaptation, and identifying motivating factors for risk reduction. Furthermore, this research is contextual since the respondents of the study are specifically considering their properties, communities and regions, and since the results can be useful to inform policy and decision-makers on potential areas to prepare for and manage climate change impacts.

The function of social investigation is considered explanatory when the aims of the research are focussed on the reasons 'why' phenomena occur, the linkages between phenomena, and the

underlying factors behind the occurrence of such phenomena (Ritchie, 2003). As such, the research can be classified as explanatory.

2.3.2.2 Research Ontology

This research project, similar to that described in works by Hammersley (1992b), will adopt a more subtle form of realism. From this 'subtle realist' ontological position, an individuals' subjective understanding of reality is obtained through their interpretations of the world as they perceive it, which can then be further interpreted by the researcher. The researcher recognises that there is an objective reality, however, it is only accessible to the researcher by means of the individual participants' interpretations (Snape and Spencer, 2003). Importantly, subtle realism rejects the notion that "knowledge must be defined as beliefs whose validity is known with certainty" (Hammersley, 1992a, p. 52). Such a position, as Bryman (2004, p. 277) describes, entails:

> *…recognizing that we can never be absolutely certain about the truth of any account, since we have no completely incontrovertible way of gaining direct access to the reality which it is based.*

The truth about certain phenomena, therefore, must be judged based on the adequacy of the evidence in support of them, such that it accurately represents the phenomena (Hammersley, 1992a).

Relevant to this research project is the discussion by Wisner *et al.* (2004) on the two primary methodological frameworks of risk and hazard research. Such literature is distributed along a continuum of epistemological positions ranging from the realist to constructionist approaches (Stallings, 1997; Wisner *et al.*, 2004). First, the realist approach considers risk as an objective hazard that exists independently of social and cultural processes, and second, the constructionist or subjectivist ideology incorporates social and cultural processes which actually branch into two varying approaches: a weak and strong constructionist, or subjectivist, approach. A weak approach regards risk as an objective hazard that is mediated through social and cultural processes, whereas a strong approach sees risk wholly as a socially, historically and politically constructed product. This research, whilst principally incorporating a subtle realist approach in terms of the objective hazard, does in fact acknowledge the subjectivist ideology in terms of the social construction of risk.

Subtle realist ontology assumes that reality is formed through one's perspective of it, but that there is an objective reality which exists independently of one's subjective perspective (Blaikie, 2007; Mays and Pope, 2000). Adopted from more specific qualitative ethnographic research, Hammersley (1992a) discusses the inherent problems behind having to commit to a competing epistemology based on naive realism (or positivism) and an ontology based on relativism (for example, various forms of constructivism and post structuralism). Whilst realism denotes that phenomena exist independent of human knowledge and that validity is an important criterion, there is "a possibility that we could be wrong about things" (Banfield, 2004, p. 54). Constructivism, on the other hand, asserts that social phenomena and their meanings are not pre-given, but are continually being constructed and revised (Bryman, 2004). Consequently, Hammersley (1992b) emphasises the fallibility of human knowledge, therefore, and argues that we should not have to choose between one position or the other. Rather, we can adopt subtle forms of realism to overcome the problems of the two positions.

As Snape and Spencer (2003) discuss, the researcher can examine the objective reality through a participants' individual subjective perspectives and interpretations of this reality. This examination allows the researcher to view and understand the relevant issues as they are perceived by the research participant, which naturally differs between individuals, thus constituting a diverse and multifaceted objective reality. An understanding of the nature of the multifaceted reality and the various experiences of individuals is ultimately the underlying aim of the research undertaken in this thesis. For example, different people living in flood prone areas experience varying degrees of impact based on their individual situations during a flooding event, consequently, this objective reality is the product of individual subjective experiences and perspectives. Such an investigation, it is argued, "adds richness to our understanding of the various ways in which that reality has been experienced" (Snape and Spencer, 2003, p. 19). The reality, in the case of this research, is taken to regard the community (through a random sample or property owners) and its perceived vulnerability to climate change impacts, as well as its perceived capability and willingness to adapt.

2.3.2.3 Research Epistemology

This research adheres most closely to a subjectivist epistemology whereby the researcher and the phenomena being researched are linked and not separate (Blaikie, 2007). Subjectivism asserts that it is the observer that imposes meaning on 'things', and therefore, different 'things'

may have different meanings from different observers (Blaikie, 2007). From this viewpoint, the researchers' values are present at each stage of the research process.

In line with the subtle realist ontology, there remains the ideal of objectivity which, although acknowledged as epistemologically impossible, is nonetheless a goal that the research endeavours to achieve so as to ensure a more rigorous and valid examination. There is also an acknowledgement in subjectivist epistemology regarding the importance of personal interpretations of an individuals' perceptions of reality, as well as the researchers' understanding and portrayals of such perceptions (Ritchie and Lewis, 2003). The subjectivist stance means that a researcher's own experiences form their subjective reality, and accordingly, their qualitative interpretations of a participant's reality will be different to other researchers'.

Criticisms of subjectivist epistemologies often include such acknowledgements that qualitative research findings frequently rely heavily on the researchers' views regarding what is significant and important in the phenomena being studied (Bryman, 2004). As a consequence it is generally argued that there are problems in replicating such qualitative aspects in studies, that it can be difficult to generalise findings to populations in other settings, and further that there may be a lack of transparency in the procedure the researcher followed to arrive at the study's conclusions (Bryman, 2004).

For this research project, through the use of a structured mixed-method mail-out survey questionnaire that is self-completed by the participant, the researcher is attempting to manage such criticisms by maintaining a strong degree of rigor, as per the subtle realist ontology, whilst simultaneously attempting to describe the participants' subjective perceptions of risk. Such criticisms of the subjectivist epistemology are also managed in this research project through the specific structuring of the rationale detailing the primary characteristics of the case study sites being studied.

2.3.3 'Time' in research

The third dimension of research as described by Neuman (2006) relates to the way in which time is considered and utilised within the research process. There are primarily three distinct approaches to considering time within a research project which is, again, largely influenced by the style of the research questions and the particular issues or phenomena under investigation. The three main approaches which consider time are commonly divided into cross-sectional

(instantaneous), longitudinal, or case study research. This project will employ a case study research approach so as to analyse the factors and issues which surface as a result of the research inquiry. Whilst a case study approach dominates within this project, different research projects will often display features of more than one research design (Bryman, 2004).

Cross-sectional research is research which observes phenomena at one point in time, taking a 'snapshot' of the world at that particular moment, from any number of individual cases. It is typically considered the simplest and most cost-effective approach; however, it lacks the ability to observe change over time because it is an instantaneous observation. Longitudinal studies, consequently, are research studies which observe phenomena at multiple points in time from any number of cases. Typically considered more complex and expensive, longitudinal studies have the ability to observe change over time in several different ways; in a time-series, as a panel study, or as a cohort study. Both cross-sectional and longitudinal research examines common features from many cases, and are primarily concerned with "patterns in the mass of numbers" (Neuman, 2006, p. 40).

The third distinct approach to consider the time dimension of research is that of the case study. Case study research is a more in-depth examination of one or more cases for a particular period or over a period of time. It differs from cross-sectional and longitudinal research in that a case study examines multiple features of each case. A case study "uses the logic of *analytic* instead of *enumerative* induction" and focuses on the multitude of factors which constitute the case, rather than the multitude of enumerative inferences (Neuman, 2006, p. 40). Cross-sectional and longitudinal studies, therefore, whilst adding to the case study approach utilised in this research project, will not be discussed in any further detail. The following section discusses in greater detail case study research.

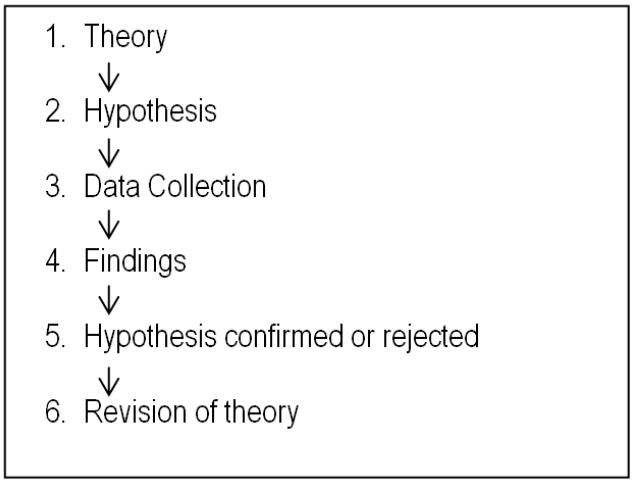
2.3.3.1 Case Study Research

Walton (1992, p. 122) claims that "[t]he logic of the case study is to demonstrate a causal argument about how general social forces shape and produce results in specific settings". In this respect, the demonstration of associations is intended to be one particular line of evidence in the development of 'meaningful generalisations' about specific social phenomena. The continual search for and identification of associations within a particular instance, therefore, strengthens the claims made about that specific phenomena (Flyvbjerg, 2006; Ruddin, 2006). Researchers need to be cautious in making claims, however, to ensure that they are modest in their suggestion of

the potential generalisability, whilst at the same time endeavouring to make an argument about both the specific setting and the wider universe (Walton, 1992).

Case study research, in fact, is often criticised for its lack of generalisability of results, however this should not the case (Flyvbjerg, 2006). Nonetheless, these criticisms are often overcome through an enhancement of external validity via the introduction of techniques such as random sampling (Bryman, 2004). Indeed, case study research frequently employs both quantitative and qualitative data collection techniques. One of the distinguishing features of case study research is the fact that it is the case itself that is the focus of the enquiry, such that the researcher is usually concerned with revealing the unique features of that case (Bryman, 2004). As evident in Chapter 1 and the preceding discussions, the research design and methods of data collection have been guided by specific research questions derived from the theory (Figure 2.9). Since the data collection techniques within this research project predominately utilise a quantitative approach, which is then followed by qualitative data collection (that is, in the questionnaire for example, closed questions followed by open-ended questions to provide further information and insight), the relationship between theory and the research, therefore, is deductive (Bryman, 2004).

Figure 2.9: The research process of deduction



Source: Bryman (2004, p. 9)

The research in this thesis differs fundamentally from approaches of longitudinal and cross-sectional research due to the utilisation of identical methods to two contrasting cases at a 'snapshot' in time. The logic of comparative design, utilised within this thesis, "implies that we can understand social phenomena better when they are compared in relation to two or more meaningfully contrasting cases" (Bryman, 2004, p. 53). Comparative case studies also enhance

external validity and replicability due to explicit procedures for sampling, administration of research instruments, and analysis. It is in this way, therefore, as Walton (1992, p. 122) concludes, that "case studies are likely to produce the best theory". Indeed, it would be expected therefore that there would be greater benefits in comparing many case studies, however, due to time and resource constraints within this research project, such a task was infeasible.

In terms of coastal vulnerability and adaptation, the case study approach is appropriate as it will help to identify the social factors that shape vulnerability and the capacities of individuals to adapt in both a changing climatic and demographic setting. As discussed in the rationale in Chapter 1, this research project seeks to explore individual perceptions of climate change risk, and how these effect peoples' willingness to adapt to change. Utilising the comparative case studies, this project will collect and analyse data to constitute a more integrated regional and sectoral assessments of impacts, risks and adaptations to climate change. These regional and sectoral assessments have been identified as necessary components of governmental decision-making processes (COAG, 2006). The research results are intended to further strengthen the lines of evidence which suggest that risk perceptions play a fundamental role in compelling or constraining action to address risks, such that they are factored more readily into the assessment of vulnerability at the local level. In order to assist in developing integrated vulnerability assessments of the 'total coastal system' at a more localised scale, therefore, a deeper understanding is required of social vulnerability at more regional scales, and one of its prime constituent elements; adaptive capacity.

One of the key policy concerns and research areas in need of attention, as discussed previously in Chapter 1 and further detailed by Lazarow *et al.* (2006), relates to an increased emphasis on the political and social drivers of change, and thus adaptation, in coastal communities. The drivers of change, in this instance, explicitly represent the multiple features of a specific case or number of cases at a particular time that are to be examined. Many of these changes are compounding and placing increasing amounts of pressure on coastal resources and the limited resources of Local Governments (Shepherd, 2005b). There are many coastal community settings around Australia that provide potential cases to examine perceptions of risk. Several concerns rest on how Local Government can act so as not to jeopardise their community's development whilst at the same time minimising risks and liability (McDonald, 2007). Although strong generalisations are difficult within case study research, they nonetheless contribute substantially to theory and to practicable policy development.

2.3.4 Techniques of research

The fourth dimension of research described by Neuman (2006) relates to the choice of one particular technique or a number of particular techniques in order to collect data. The techniques come in two categories: qualitative and quantitative. As Brannen (2003b, p. 3) describes, traditionally there is "a gulf" which appears to exist between the two. This dichotomy relates to the epistemology, 'middle range' theory, and methods used in the research process, however, the division more commonly relates to the research methods employed. This is not to say, however, that the use of a particular technique necessarily implies a commitment to a particular epistemology, rather, this is a tendency of association more so than a definitive and perfect connection (Bryman, 2004). The specific techniques employed for a research project will vary depending on the specific research questions or the issues being sought, which requires "skill, practice, and creativity to match a research question to an appropriate data collection technique" (Neuman, 2006, p. 41).

2.3.4.1 Quantitative and qualitative paradigms

Qualitative and quantitative paradigms differ primarily in the way they manage data, whereby simplistically; qualitative research collects data in the form of words whereas quantitative research collects data in the form of numbers (Neuman, 2006). Qualitative data is treated analytically whereas quantitative data is treated enumeratively (Brannen, 2003b). Furthermore, qualitative research aims to consider the concepts and categories of a particular entity or entities, whilst quantitative research aims to calculate the incidence and/or frequency of particular characteristics of an entity or entities.

Whilst it has been argued that it is only through qualitative research that we are able to study the world through the eyes of the people in it (Bryman, 2004), this is at odds, for example, with studies of attitudes in social surveys based on interviews and questionnaires. In reality, quantitative researchers frequently address meaning in their studies. In the debate between the use of a qualitative or quantitative research approach, whilst many researchers will consider themselves as belonging to one or the other paradigm due to their ontological or epistemological positioning (Ritchie, 2003), there are a number who willingly combine methods (Brannen, 2003b). Combining methods in research is more commonly referred to as a mixed-method approach. Further details relating to a combination of data collection methods and the way in which it can be utilised are discussed in the following section.

2.4 Mixed-method approach

The nature of quantitative and qualitative research in terms of a mixed-methods approach has had a substantial research focus in the social sciences, particularly in discussions of various research paradigms (Bryman, 2003). Burgess (1982) describes that employing multiple research strategies can assist in tackling the research problems through the use of a diverse range of methods, which captures in essence the concept of 'triangulation' as developed by Denzin (1970). Triangulation, in this context, refers to the use of differing methods and sources in order to assess and check the validity and integrity of conclusions drawn from data (Ritchie, 2003). Although mixed-methods approaches are beneficial in this respect, it must be acknowledged that the limitations inherent in the use of either the quantitative or qualitative paradigm individually will not immediately be resolved simply by employing a mixed-method approach (Bryman, 2004).

The debate within research communities regarding the combination and triangulation of a range of research methods has not only involved the mixture of qualitative and quantitative approaches but the debate has also involved discussions on the combination of two different methods from the one approach (Bryman, 2003; Ritchie, 2003). In the context of this research project, the author is of the view that there can be substantial benefit from utilising both qualitative and quantitative data collected as a result of a mixed-methods approach. Each of the two approaches provides its own unique and varying type of evidence, which, used in conjunction with the other can "offer a powerful resource to inform and illuminate policy or practice" (Ritchie, 2003, p. 38).

Greene *et al.* (2005) discuss that a better understanding can be gained through utilising a mixed-methods approach in the social sciences:

1. Understanding more defensibly through increased validity (triangulation) and fewer biases;
2. Understanding more comprehensively through the development of more complete interpretations of society and the view through more perspectives;
3. Understanding more insightfully through the creation of new ideas, concepts and perspectives; and
4. Understanding with greater value consciousness and a diversity of values through the inclusion of varied methods.

In the section to follow, a further discussion of the various mixed-methods approach details more specifically the viewpoint of the author and structure of this particular research project.

2.4.1 Triangulation through mixed-methods

The logic behind 'triangulation' stems from the ability to be able to cross-check the results of a project using one particular method against results obtained from another method (Bryman, 2004). Denzin (1970), describes triangulation as not only utilising a variety of methods and data, but also utilising a variety of investigators and theories in order to arrive at some conclusion over the validity and integrity of data conjectures. Brannen (2003a) furthers these discussions by examining multiple method, multiple investigator, multiple data set, and multiple theory triangulation.

Triangulation through multiple investigators refers to the research being carried out by several researchers, rather than an individual researcher, which draws on the many individuals' perspectives of the research topic and data collected bringing different insights to the group (Denzin, 1970). Triangulation through multiple data sets involve the use of different data either collected using different methods, or collected using the same method from differing sources or at differing times (Waltz *et al.*, 2010). The triangulation of multiple theories refers to the researcher using existing theories derived from prior research in order to test their own findings or, from an initial data analysis of a researchers' own work, a number of theories or hypotheses relating to the research problems may be derived, which in turn can then be tested by the researcher (Brannen, 2003a).

Multiple method triangulation refers to approaches that are considered to be 'within-methods' or 'between-methods' (Brannen, 2003a; Waltz *et al.*, 2010). There are, of course, both advantages and disadvantages of using either of these two approaches. 'Within-method' approaches utilise multiple techniques within a given method to collect, analyse, and interpret data, for example, using both interviews and observations that collect qualitative data. 'Within-methods' has the benefit of being able to being able to consider, internally, the multidimensional factors of a particular phenomena, but has no way of being able to control external validity. Alternatively, 'between-method' approaches utilise both qualitative and quantitative methods in the context of the same study, for example, a qualitative questionnaire and qualitative focus groups. 'Between-methods', therefore, is able to cross-validate comparable data leading to a more rigorous external validity.

Brannen (2003b) and Ritchie (2003) discuss the various ways in which qualitative and quantitative methods are actually utilised together and conclude that there are two primary ways

the inquiry can take place. Firstly, one of the approaches can precede the other approach, that is, one will be used as a follow-up approach to enhance the preceding inquiry, or one approach will be carried out prior in order to facilitate the other approach. Secondly, the two approaches can be carried out alongside one another or in tandem. The purpose of interconnecting the two approaches in one of the above ways is not necessarily to duplicate each approach's results, but rather to mutually reinforce results and "achieve an understanding [of the phenomena] that neither method alone can offer" (Ritchie, 2003, p. 37-43).

The main issue present in triangulation relates to whether or not the overall results converge, and it is the researcher's responsibility to attempt to identify any logical patterns evident in the results. Data analysis, in this instance, must therefore consider factors such as: whether or not each method used in data collection is reliable and valid in its own right; what weighting should each method receive in terms of its usefulness and importance to the project; what actually constitutes evidence of convergence since, for instance there are no universally accepted tests among methods; and if results are divergent, how does one account for such inconsistencies (Waltz *et al.*, 2010)?

Indeed, there are several key steps to consider the triangulation of data from mixed-methods approaches, as detailed by Waltz *et al.* (2010):

1. Each method used in the collection of data should be assessed for reliability and validity in its own right;
2. The data should be analysed separately based on its respective method of collection accordingly;
3. Any significant findings from the separate analyses should be checked for obvious convergence or divergence;
4. Any significant variables should be checked to reveal logical patterns from the use of different methods; and
5. If possible, the data behind the logical patterns should be combined and analysed using the appropriate statistical procedure.

This research project has utilised comparative case studies and self-administered mixed-method mail-out survey questionnaires, as such, this project is considered to have a multiple 'between-methods' approach.

2.5 Research position

The previous sections detailed the existing debate over the use of particular theoretical and methodological positions, approaches and techniques, and provided a brief rationale of the dominant issues and objectives of pursuing a research project. The following section outlines the author's stance in relation to the way theory, participants, data and issues of reality and subjectivity will be treated, demonstrating the appropriateness of the particular methodological positions chosen for use within this thesis.

2.5.1 Theoretical framework

Much of what has been discussed in the above sections relates to methodological theories. These theories are critical in terms of positioning the researcher's epistemology and ontology, however, in terms of social research they do not necessarily guide the collection of empirical evidence well (Bryman, 2004). It is the middle-range theories that operate between the broad methodological theories and the empirical findings of a research project. The intersection between substantive theory and formal theory, consequently, constitutes the theoretical base from which a research project 'launches' itself. Substantive theory relates to theory in certain empirical instances and may include specific topics such as, for instance, the social amplification of risk framework (SARF – see Chapter 4). Formal theory, on the other hand, is much more abstract and has a wider range of applicability to several topics such as, for instance, the theory of social learning.

Substantive theories are typically useful in providing a theoretical framework in order to test the validity of a specific research approach, however, this research does not aim to do so. Rather, the theoretical framework has been formed through the combination of the literature on responding to climate change, and the literature on public risk perceptions. A gap in the research has been identified regarding the human dimensions of climate change which has established that there is a need to consider social vulnerability assessment and, concomitantly, the literature on risk perceptions and adaptation to climate change provides the rationale for investigating this gap.

2.5.2 Participant perspectives

In considering the position of individual respondents of the self-administered mail-out survey questionnaire, knowledge and learning develop from experience (Kezar, 2000). In terms of

experiences of climate change impacts, they are directly and/or indirectly formed through physical exposure to impacts or through media messages and social exchange (Pidgeon *et al.*, 2003; Speck, 2010). As previously discussed (Figure 2.8), Heidegger's hermeneutic circle of understanding provides a simplified representation of this knowledge formulation process (Heidegger, 1962; Kezar, 2000). From this perspective, there is no innate or intuitive knowledge or concepts that participants in the study have regarding the research and its topic – as such, it is not *a priori*.

This is consistent with Neuman (2006), and follows that researchers adopting applied and PAR approaches assume knowledge is a product of one's experience, particularly the experience of socio-political acts. Whilst the research undertaken for this thesis does not directly utilise PAR to the extent that a 'solution' to the research problems is diagnosed collaboratively with stakeholders, it has in fact utilised key elements of the PAR approach and incorporated stakeholder input for the formation of the research instrument, as outlined in the earlier discussion on the pilot study critique and pre-test. The above directly relates to the empiricist assumptions within the subtle realist ontology adopted by the author. For instance, respondents' perspectives and knowledge of the coast, climate change and development in their community, as well as the concepts of vulnerability and adaptation, are solely derived from their experience of such phenomena. This knowledge is accessible to the researcher, however, since it is a representation of the participant's reality, the researcher must strive to remain objective in an attempt to maintain the plausibility and credibility of any claims made (Bryman, 2004).

Consequently, in applying this approach to the perspective of survey respondents, it results in an adoption of the principles of the theory of phenomenology. This theory, as Hjelle and Zeigler (1992, p. 421) discuss, asserts that:

> *We can never adequately understand human actions simply by examining objective, environmental conditions alone. Instead we must always look within the person and attempt to see the world from his or her perspective in order to approach an understanding of human behaviour.*

Indeed, the fundamental principles behind this theory are touched upon in the rationale described in the previous chapter, which asserted that much of the recent work on vulnerability and adaptation had not adequately directed attention towards the human dimensions of climate change, and that an exploration of local perceptions of climate change can be critical to the enhancement of understandings of adaptation (Kuruppu and Liverman, 2011; Nicholls, 1999).

2.5.3 Data

The data collection techniques employed to carry out this research project stem from a multiple 'between-methods' approach and include both qualitative and quantitative techniques. Table 2.7 shows how a mixture of both these techniques can contribute to this project in terms of fulfilling the research objectives and questions (Chapter 1.1) with respect to the functions of social research. Specifically, Table 2.7 highlights the rationale for utilising a particular approach based on the nature and purpose of enquiry, for instance, qualitative methods will be best suited to explore contextually the perceived opportunities, limitations and barriers to adaptation whereas quantitative methods are best suited to determine explanatorily the characteristics of those residents and any correlations that exist between the people and their perceptions.

Table 2.7: Contributions of Qualitative and Quantitative Methods to Research Functions

Functions of research	Qualitative methods utilised to explore/ understand:	Quantitative methods utilised to determine:
Contextual	• The perceived vulnerabilities of climate change • The perceived capacities, opportunities, limitations and barriers to adaptation	• The characteristics of those living in sea change communities • The extent to which various people perceive change (now & in the future)
Explanatory	• The factors that influences a community's adaptive capacity • Why some people may be more capable, willing and prepared to adapt, than others	• Characteristics/circumstances of residents that correlate with varying perceptions • Social factors (values & beliefs) associated with attitudes of vulnerability/adaptation

Source: Author, adapted from Ritchie (2003, p. 39)

Data have been collected in the form of both numbers and words, and consequently treated both analytically and enumeratively, demonstrating both a mixed 'between-method' and multiple data set triangulative approach. Utilising mixed-methods more appropriately engages the research questions since the concepts and issues to be explored represent new and emerging areas of research potential. Consequently, theory has been examined from a number of sources, demonstrating the use of multiple-theory triangulation, which will be discussed further in the following section. The data will be in the form of respondent knowledge based on their experiences and perceptions regarding vulnerability, adaptation, climate change, sea-level rise, storm surges, policy, development, population growth, and community cohesion.

For this research, within the self-administered mail-out survey questionnaire that was used, as discussed in previous sections, the data were collected through a combination of closed and

open-ended questions. Closed questions in the form of binary, ternary and 5-point Likert scales were the primary data collection technique used, followed by secondary open-ended questions allowing respondents to explain their particular closed question choice, if they so wished. The statistical software package *PASW Statistics 18.0.2* was used to analyse the quantitative data gathered from closed questions. Both the benefits and limitations of closed questions lie in their ability to provide the respondent with quick and easy-to-follow alternatives from a finite list of options, without them needing to provide any depth. Open-ended questions, on the other hand, allow this depth since they do not impose a structure on the participant's response thereby allowing them to fully express themself. Although open-ended questions allow for a respondent to raise issues that they themselves consider as 'salient', this has been described by some as simply allowing respondents to report 'superficial' issues rather than fundamental attitudes (Geer, 1991; Montgomery and Crittenden, 1977; Smith, 1989).

2.5.4 Reality and subjectivity

As previously discussed, the author has adopted the subtle realist ontology and a subjectivist epistemology for this enquiry. From this viewpoint, the author accepts an attachment to what is being researched whilst striving to remain objective. Similarly, the author accepts that the multifaceted subjective reality constructed from the objective reality by those being studied, in fact, adds to the understanding of the research topic.

This research and the researcher, consistent with subtle realist ontology, must aspire to have a somewhat objective stance and ensure that his own values and interests do not interfere with the respondents', such that they do not become key influential experiences to a respondent in his or her own subjective reality. Limitations of this research will be discussed in a later section. As Hammersley (2003, p. 44) explains, there is a:

> *…trade-off between, on the one hand, trying to make sure that one gets the relevant data and, on the other hand, the danger of reactivity, of influencing the people studied in such a way that error is introduced into the data.*

One of the key advantages of primarily utilising quantitative closed questions in the survey is that it explores social problems objectively and removes personal prejudices and bias, which is argued to assist in establishing valid information (Kumar, 1996; Sarantakos, 1998). Objectivity in qualitative research, on the other hand, is more difficult to achieve and differently understood since qualitative research is in a format that elicits information of one's perspective and experiences. Validity and objectivity in the qualitative instance exists when the findings are

generally acknowledged and appreciated by colleagues and society (Sarantakos, 1998). To assist in this validity and objectivity of this research project and the survey questionnaire, the qualitative open-ended questions have been positioned typically as secondary components to the quantitative questions to build information and insight around those quantitative aspects of the questionnaire.

Insofar as was possible, the structured survey questionnaire was designed using TDM principles to an attempt to objectively identify underlying processes involved in adaptation as a result of climate change risks, and prevent an intrusion of the researcher's influence (Dillman, 2007). It is this account of the individual's perceived risks posed by climate change and adaptive capacity, as per the individuals' account of reality, that become the object of the study and form the basis of the 'knowledge' and concepts derived from the study. Indeed, social investigations cannot be carried out in a 'moral vacuum', and hence the researcher acknowledges the difficulty in attaining overall research objectivity. Based upon the fact that since humans are subjective beings, therefore, social research cannot be solely and entirely objective (Bryman, 2004). As per the subtle realist ontological position, however, the researcher nonetheless has still attempted to maintain a sufficient degree of impartiality, particularly through the implementation of TDM survey principles (Dillman, 2007).

As outlined above, this research touches in the field of phenomenology since there is present the idea that "social reality has a meaning for human beings and therefore human action is meaningful" (Bryman, 2004, p. 14). This project examines the study of phenomena and human experience, that is, changing climatic conditions and development, and adaptation from the perspective of those under the influence of such phenomena on a day-to-day basis, therefore, it is phenomenological in nature (Somekh and Lewin, 2005). In this respect, the methodological techniques used in this study have attempted to allow the researcher to see 'things' from the respondents' point of view in order to explore how their perceptions of risk and adaptive capacity are the product of their interpretation of the world (Bogdan and Taylor, 1975). As such, the self-administered mail-out survey questionnaire of a random sample of coastal property owners provided a scientifically valid and cost-effective instrument through which to, as objectively as possible, explore perceptions of climate change risk in non-metropolitan Australian coastal communities.

2.6 Limitations

Many of the problems relating to the position of this research project have already been described in the respective sections above. There are, however, a number of other limiting considerations that have not been fully addressed. The following section details these limitations and elaborates on their implications.

Specifically, the survey targeted property owners in sea change communities, as opposed to residents or persons present on the night of the 2006 census, which has resulted in many non-permanent residents or second (holiday) homeowners from completing the questionnaire. Consequently, this research project has collected samples of property owners, not local residents, of the communities themselves and, therefore, generalisations of the results are meaningful only to the extent to which they represent the property owners of the communities. As such, the ABS 2006 census data may not be able to provide an adequate comparison with the demographic results of the returned surveys. Similarly, census data of the age of property owners may not be directly applicable to the results of the returned surveys, due to the local scale of the mail-out survey. Furthermore, since this survey has excluded those who do not own property, this also includes those disadvantaged through homelessness. Indeed, however, the aim of this thesis is to assess perceptions of vulnerability of property owners within the communities, not solely the residents who may be the most vulnerable.

In general, within survey work there are four key potential limitations in utilising random sampling techniques (Dillman, 2000), these are:

1. Sampling error, which arises from attempting to survey only some of the units in the survey population;
2. Coverage error, which is the result of a sample being drawn from an incomplete list of the population;
3. Measurement error, which is the result of an inaccurate, imprecise or incompatible response on behalf of one respondent compared with others; and
4. Nonresponse error, which arises when a significant proportion of the sample, who do not respond, have particular characteristics that are unrepresented by those who do respond.

Another limitation of this research is the potential bias created by personal perceptions, cognitions, and experiences. Indeed, these are many of the same biases that influence the

public's perceptions of risk. In line with Slovic's (1987) discussions, the author acknowledges that he will be exposed to such biases also, particularly when it is required to go beyond the limits of available data and rely on intuition for his own judgements, such as in the case of having to infer those with 'sceptical' attitudes from open-ended responses. Indeed, judgement plays a significant role in assessing vulnerability and these form the basis of discussions later. In many instances, although a distinction is made between judgements that are considered subjective and objective, for intricate hazards such as climate change, as Fischhoff *et al.* (1981, p. xii) describe:

> *Even so-called objective risks have a large judgemental component. At best they represent the perceptions of the most knowledgeable technical experts. However, even such experts may have an incomplete understanding.*

Therefore, and as discussed by Moser (2010a) also, the author acknowledges this limitation as fundamental, and does not assume that his expertise is itself void of bias.

Additionally, during the early stages of this project whilst developing the survey instrument with stakeholders, since the researcher presented his interest in exploring perceptions of climate change, it was necessary for him to be aware of the danger of unintentionally leading stakeholders to adopt his own views when providing the rationale to persuade the stakeholders to participate. For instance, the researcher may have inadvertently caused participants to shape 'normal' hazards as climate change events through an introduction of an expected increase in extreme weather events. Introducing concepts too deeply may cause an alteration in the respondents' notions of climate change, and result in them reporting, not their base-level perceptions, but rather what these new concepts have constructed. As van Aalst *et al.* (2008, p. 169) describe, introducing climate change:

> *…may induce people in the community to reinterpret 'normal' cycles and trends (some of which have long-term patterns) in that context… [and] can also produce inappropriate or misleading ideas about how such trends might be projected into the future*.

In order to reduce a potential factor of nonresponse bias, it was decided that the survey would not specifically reference 'anthropogenic climate change', but rather climate change, in general. This decision was partly due to the responses of one of the inappropriately completed pilot-study questionnaires, whereby the particular respondent appeared to reject the notion of climate change altogether, anthropogenic or otherwise. In this case, the pilot-study respondent did not appropriately complete the closed questions, but rather explained their contrarian viewpoint in the open-ended questions. Based on these responses, it was determined that if the questionnaire

allowed for respondent elaboration on their particular views and level of understanding of climate change, without specifically referencing the anthropogenic component (which is a contentious issue to some), 'scepticism' could be inferred from responses. Therefore, it was deemed that if the questionnaire was able to limit the potential for nonresponse bias principally to those who were deeply 'sceptical' of the anthropogenic drivers of climate change (a subset of the population discussed in Chapter 4.3), it would be able to reach a much broader cross-section of society. One limitation to arise from this approach, however, is that whilst the survey is able to reach greater numbers of people, it likely skews the results on vulnerability and adaptation. This limitation has implications for adaptation policies that may utilise the results, therefore, since the term 'climate change' was not specifically referencing the anthropogenic component.

Another key limitation in utilising self-administered survey questionnaires is that there is often a gap between the reported behaviour of an individual and their actual behaviour (Bryman, 2004). In many instances, surveys require respondents to express potential behaviour at some unspecified point in the future, and although this may translate into actual behaviour under the circumstances supposed in the survey, it does not guarantee it. In the case of this research, it is possible that the actions individuals said they would desire to undertake in certain circumstances are true; simply put, however, there is no way of knowing whether or not it is something they would in fact do, under those supposed circumstances.

In addition, issues that evoke strong feelings of obligation and responsibility, such as climate change, may result in a response bias whereby respondents report what they consider as desired behaviour sought by the researcher, as opposed to their true behaviour (Fischer and Fick, 1993; Furnham, 1986). It is typically assumed that surveys in general overstate respondent concern due to respondents' low likelihood to admit a lack of concern for environmental issues so as not to be seen as being ignorant and uncaring (Bord *et al.*, 1998; Sterngold *et al.*, 1994). Consequently, a further limitation drawn from the above discussion, evident within all survey research, is that of the interpreted accuracy of the implications of the results due to the social desirability of having concern for particular topics (Bord *et al.*, 1998; Fischer and Fick, 1993; Kidder and Campbell, 1970).

Potential response bias was minimised through communicating only essential information regarding climate change in both the questionnaire and preceding cover letter, such as the fact that climate change poses a risk and that the researcher wanted to survey perceptions, without

technically defining its parameters or going into detail about projections. As van Aalst *et al.* (2008) go on to discuss, bringing in discussions of climate change in this context can in fact be a significant catalyst for empowering people to recognise the future potential hazards and engage in risk reduction strategies such as adaptation and mitigation. Conversely, if people are predisposed to contest either the realities of anthropogenic climate change and/or governmental action, it may create further entrenchment into denial and compel them to oppose any response strategy, regardless of the precise nature of the strategy (Hobson and Niemeyer, 2012; Whitmarsh, 2011). For instance, it was evident that in several cases upon receiving returned questionnaires, even the invitation to participate in a study on 'climate change' evoked strong opposition (see Appendix 5). In either sense, inciting community members as a whole to address the issues of climate change and/or demand action from respective authorities was not the intention of this research and was therefore not pursued.

A limitation is also present in relation to respondents reporting of so-called 'superficial' issues in questionnaires as a result of these issues being beset upon the respondent more recently. This information, for example, may have been recently discussed or read by the individual, amongst friends, or viewed or heard in the media by the respondent, which perhaps tends to be more 'fresh' in the mind as opposed to the deeper, relevant or more 'salient' issues (Geer, 1991; Montgomery and Crittenden, 1977; Smith, 1989). Nonetheless, whilst some 'superficial' issues may take precedence over more 'salient' ones, they are valid perceptions at the particular 'snapshot' in time particularly if they form substantial cognitive elements of one's decision-making, at that point in time.

Further, although the more 'salient' issues are of greater interest and reflect the deeper attitudes of people, they are often overshadowed by a bias created by more memorable and available recent experiences (Liu *et al.*, 2008). This 'availability' bias does not in fact constitute a limitation, however, but rather constitutes a factor that shapes individual perceptions. Indeed, in all types of questions, either closed or open-ended, the substantive content of the responses to those questions is susceptible to the biases created by recent information (Geer, 1991). Consequently, a detailed discussion of numerous cognitive biases will be included in a later chapter.

There is an added limitation in this research related to the question of whether or not there is a time limit on the findings that are generated (Bryman, 2004). This time limit on findings would relate to whether or not certain factors have changed within the population which, for instance if

the study was replicated, would have a noticeable impact upon the results of the study. Since this research has explored the self-reported perceptions of climate change risk in two different types of sea change communities at one point in time, it cannot take into account any factors that may have influenced public perceptions between now and then. In this case, the research is said to be temporally specific and there is no way to resolve these issues unless, as indicated above, the study was replicated to incorporate longitudinal study components.

Following on from the above discussion of time limits, it must be acknowledged that the survey work for this research was carried out approximately one month before the results of the 'first pass' National Coastal Vulnerability Assessment (NCVA) were released to the public (DCC, 2009). The release of these results created a short period of heightened media attention on the implications of the findings of the NCVA, which may have altered the views of survey respondents. Subsequently, there was also a further period of heightened media attention when detailed sea-level rise maps were released to accompany the NCVA findings (OzCoasts, 2011), which may have similarly altered respondent views. Indeed, as described above, this aspect of uncertainty in the time limit for the validity of results is inherent to all temporally specific research, case study research or otherwise.

2.7 Summary

This chapter discussed the methodologies employed to conduct an exploration into public perceptions of climate change risk in coastal communities. Based on the multiple complexities of the 'coast', whereby there is a unique interaction between socio-economic systems, geomorphological systems, and ecosystems, this chapter demonstrates that a mixed methodology is the most appropriate approach to address the aims, objectives and research questions outlined in Chapter 1. In particular, this chapter outlined the particular methods that were used in order to fulfil the functions of an integrated coastal vulnerability assessment, explained the challenges arising from the research, and provided a detailed explanation of the particular techniques and procedures employed. This chapter also discussed the project's theoretical and methodological framework, as well as a consideration of the limitations and barriers. Ultimately, as discussed, it was concluded that the most suitable instrument to collect primary data was a structured mixed-methods mail-out survey questionnaire targeted at coastal property owners.

Chapter 3 – Vulnerability and Adaptation

The focus of discussion on climate change vulnerability and adaptation thus far has been conducted alongside a discussion of the unique complexities involved with coastal management and vulnerability assessment, which has revealed the need for a stronger inclusion of social vulnerability in such assessments. The discussion thus far outlined the discourse on adaptation, but more specifically adaptive capacity, and how an examination of such concepts can be utilised to form part of a social vulnerability assessment. Within this chapter, the importance of integrated vulnerability assessments is explained through their inclusion of the broader human dimensions of vulnerability and well-being. A review by National Research Council (NRC) of the US Climate Change Science Program (NRC, 2007, p. 5), for instance, concluded that:

> *Our understanding of the impacts of climate changes on human well-being and vulnerabilities is much less developed than our understanding of the natural climate system. Progress in human dimensions research has lagged progress in natural science, and the two fields have not yet been integrated in a way that would allow the potential societal impacts of climate change and management responses to be addressed.*

The following chapter presents a more detailed review of the literature which underpins this research project. To begin with, this chapter discusses the concept of vulnerability within an integrated framework and its development into numerous conceptual models, and then focuses on adaptation as an appropriate response strategy for reducing vulnerability and coping with the risks of climate change. Finally, this chapter details the current Australian State and Federal Government strategies to undertake vulnerability assessment, with reference to their particular methods of delivery, to further demonstrate the rationale.

3.1 A history of vulnerability

The concept of vulnerability has long been an effective analytical tool for evaluating states of susceptibility to harm, powerlessness to act, as well as system and individual marginality (Adger, 2006; Füssel, 2007b; Kasperson *et al.*, 2005; McFadden and Green, 2007). In addition, vulnerability has been a tool for assessing avenues whereby there may be opportunities to strengthen capacities to minimise harm and/or marginality and enhance well-being (IPCC, 2007a;

Smit and Wandel, 2006; Tompkins and Adger, 2005). Vulnerability analysis, therefore, is considered an integral component of understanding and managing risk (De Brujin *et al.*, 2007; Green and McFadden, 2007).

3.1.1 Conceptualisations of vulnerability

The concept of 'vulnerability' can be divided into the components of 'potential impact' and 'adaptive capacity', depicted in Figure 3.1. Here, the 'potential impact', or impacts of a hazard, can then be further broken down into the elements of 'exposure' and 'sensitivity'. 'Exposure' refers to the magnitude, frequency, duration and spatial extent of a hazard (Wisner *et al.*, 2004, p. 14), and 'sensitivity' describes the degree to which the system under influence is affected and can absorb some of the impact without suffering long-term harm (Adger, 2006; Füssel, 2007b; Sutherland *et al.*, 2005). 'Adaptive capacity', with respect to Figure 3.1, refers to the capacity of a system to adapt to a particular influence or hazard without drastically changing from its original function, structure or identity (Adger, 2006; Brooks *et al.*, 2005; Gallopin, 2006).

Figure 3.1: Components of vulnerability

NOTE:
This figure is included on page 100 of the print copy of the thesis held in the University of Adelaide Library.

Source: The Allen Consulting Group (2005)

Consequently, the vulnerability of a system is a function of exposure to stress, sensitivity to stress, and its adaptive capacity to cope with stress. Generally, the more a system is exposed to a hazard and the more sensitive a system is to such a hazard, the more vulnerable it is. On the other hand, the more adaptive a system is (the greater its adaptive capacity), the less vulnerable it is to a hazard. Within the scope of human livelihoods at the coast, where this thesis has its focus, a coastal system can be exposed to stresses such as sea-level rise, storm surge flooding and other natural disasters including cyclones, tsunamis, and king tides, as well as the

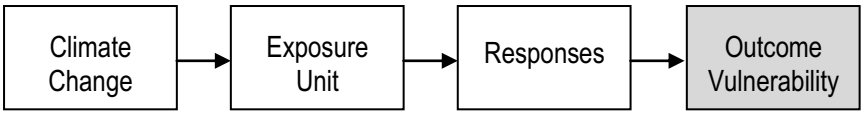
widespread effects of human activities. Many of these stresses and hazards, it has been projected, will be enhanced under climate change conditions (Pittock, 2009).

3.1.1.1 Approaches to vulnerability

Kelly and Adger (2000) begin their discussion on the concept of vulnerability through its use as a 'starting point', 'end point', or 'focal point' of an impact analysis, as introduced in Chapter 1. In terms of the risks climate change pose, an assessment of vulnerability can be described as the 'end point' of a sequence of analyses that begins with projections, moves on to scenarios and impact studies, and then finishes with an identification of adaptation options (Kelly and Adger, 2000). Conceptually, vulnerability as the 'end point' can best be described in the rudimentary formula: Vulnerability = Impacts – Adaptation (McFadden *et al.*, 2007). Here, vulnerability is defined as the residual consequences of an impact after adaptation has occurred (McFadden, 2007; McFadden *et al.*, 2007; Nursey-Bray, 2009; Shepherd, 2005b).

Similarly, Working Group Two of the IPCC (2007c, p. 21) define vulnerability as "the degree to which a system is susceptible to, and unable to cope with, adverse effects of *climate change*, including *climate variability* [sic] and extremes". As before, this definition distinguishes vulnerability as a residual quality in response to an externality, such that vulnerability is the 'end point' of some climatic event, and constitutes what Downing and Patwardhan (2004) display in their pseudo-equation: Risk – Adaptation = Vulnerability. 'End point' vulnerability to climate change can been interpreted as 'outcome vulnerability', as illustrated in Figure 3.2 (O'Brien *et al.*, 2007), and is a useful foundation on which to base efforts to determine the most effective means of promoting remedial action to minimise impacts and facilitate adaptation strategies (Kelly and Adger, 2000).

Figure 3.2: The Concept of 'Outcome Vulnerability'



Source: Adapted from O'Brien et al. (2007, p. 75)

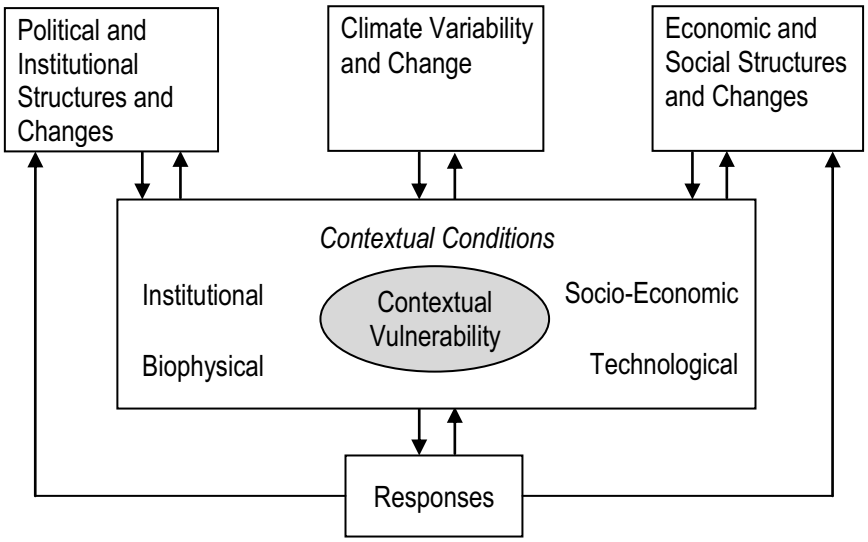
Vulnerability can also be conceptualised as the 'focal point' of a study. This is particularly the case in many studies within the food security or famine literature, as well as the natural hazards literature and some climate studies (Kelly and Adger, 2000). For instance, it has been argued that vulnerability can be considered an overarching concept in studies of food security and hunger

whereby there are three basic coordinates; the risk of exposure to stress; the risk of inadequate coping abilities to stress; and the risk of severe consequences due to stress and a slow or limited recovery from the stress (Watts and Bohle, 1993).

Vulnerability as the 'starting point' of an impact analyses can be used to identify sensitivities which may limit human capacity to respond to stress, and in this respect, the study is examining 'causation' of vulnerability, albeit not always directly (Adger, 1996). Kelly and Adger (2000) argue that vulnerability must be linked with a hazard or set of hazards, and as such, is intrinsically linked with exposure. Wisner *et al.* (2004) express this argument in the formula: Risk = Hazard × Vulnerability (R = H × V). As the 'starting point', therefore, and as discussed in Chapter 1, the examination of social vulnerability is not a function of hazard, rather it is hazard specific (Adger *et al.*, 2004; Brooks *et al.*, 2005). Specific strategies aimed at improving the capacity of people to respond to stress can be analysed in such a framework, whereby those with a limited capacity to cope with stress can have their sensitivities examined, constituting the beginning of an impact analysis.

The 'starting point' of climate change vulnerability studies can be interpreted as 'contextual vulnerability', since it is based on the multidimensional interactions between climate and society (O'Brien *et al.*, 2007). Figure 3.3 depicts that contextual vulnerability is a function of the particular institutional, biophysical, socio-economic and technological conditions within a given context. Climate variability and change will alter those contextual conditions, as well as any responses to minimise the impacts of those conditions, which in turn may further alter other process of change. From the perspective of contextual vulnerability studies, similar to that described in Chapter 1 in terms of the 'hazards-of-place' model of vulnerability (Cutter *et al.*, 2003), reducing vulnerability involves altering the "context in which climate change occurs, so that individuals and groups can better respond to changing conditions" (O'Brien *et al.*, 2007, p. 76).

Figure 3.3: The Concept of 'Contextual Vulnerability'



Source: O'Brien et al. (2007, p. 75)

Kelly and Adger (2000) discuss the concept of 'starting point' vulnerability through an investigation of the origin of the term itself and find its linguistic roots in the Latin *vulnus*, 'a wound', and *vulnerare*, 'to wound', but more specifically the Late Latin *vulnerabilis*, a term Roman soldiers would use to describe the state of the wounded soldiers on the battlefield; whereby since one is injured they are at greater risk of a further attack (Kelly and Adger, 2000). In the context of the, v*ulnerabilis,* the ways in which both climate and weather in the past have created system and individual 'injuries' or marginalities leaves them at greater risk of further 'attack' as a result of the future risks imposed by anthropogenic climate change. The 'wounded soldier' approach, therefore, as the 'starting point' of climate change vulnerability, assumes that addressing present-day vulnerability will reduce vulnerability under a future of changed climatic conditions (Burton *et al.*, 2002).

3.1.1.2 Definitions of vulnerability

As discussed in Chapter 1, the vulnerability concept and definition is strongly contested. One of the difficulties in attaining a universal definition rests in the relational nature of the term; specifically, 'vulnerability' needs to be used in context with an 'of', 'to' and 'because' so as to give it meaning (Adger, 2006). For example, 'what is the vulnerability of a town's water supply to contamination due to fertilisers and pesticides used in the catchment area of its reservoir?' Since the term 'vulnerability' is relational and context-specific, its meaning is given to it by those elements to which it stands in relation (McFadden *et al.*, 2007). Therefore, by attempting to universalise the meaning of 'vulnerability' we risk incorporating meaning into the word itself,

thereby demeaning those terms used in relation to it. A detailed list of definitions of vulnerability, nonetheless, is compiled in Appendix 1.

A key constraint in defining 'vulnerability', as it will be discussed in a later section with reference to 'adaptation', is the difficulty in classifying a suitable metric (Adger and Barnett, 2009), and as Adger (2006) explains, all research traditions have struggled to find one. As Kelly and Adger (2000) describe, it can be difficult to devise composite indices of vulnerability due to several factors. First, it cannot be assumed that current understanding of all the processes of vulnerability is sufficient enough to confidently construct the index. Second, some factors are more or less easily quantifiable than others and they may be over or under-emphasised, respectively, in the assessment process. Third, the linkages and interconnections between vulnerability factors are often insufficiently established to attribute appropriate weightings to the factors which in turn may further lead to inaccurate results.

With this struggle to determine a suitable metric has also emerged a debate over the correct balance between quantitative and qualitative data to assess vulnerability, and a further question regarding the actual possibility of quantifying vulnerability in the first place (Wisner *et al.*, 2004). The difficulty lies in the dynamic nature of the concept whereby vulnerability is constantly in a state of flux due to changes in elements associated with impacts and adaptation (Adger, 2006). The impacts of climate change will not be felt uniformly, they will vary both spatially and temporally, and the capacity for adaptation to minimise risk will vary geographically and socially at different scales (Moser, 2010b). Vulnerability, therefore, will remain troublesome to 'measure' in any form.

Kelly and Adger (2000) discuss quantification issues on the grounds of insufficient confidence in understandings of the processes that determine vulnerability. They first explain that a greater understanding of the determinants of vulnerability is necessary since they all cannot be reliably identified at present. Second, they explain that there are risks of disproportionately 'measuring' the determinants and therefore equating an 'incorrect value'. For example, over-emphasising factors that are traditionally used quantifiably, such as those incorporated in indexes of wealth, poverty, and land area, may lead to an analysis that overlooks the factors that are traditionally qualitative, such as traditional and cultural knowledge/wisdom of local climatic conditions. Third, the links between the determinants of vulnerability and overall levels of vulnerability are not

sufficiently established, which may make it difficult to assign weight to the factors in an analysis to determine the net effect of impacts.

In the classic sense of vulnerability as either a 'starting', 'end' or 'focal point' of an impact analysis, Kelly and Adger (2000) argue that the term is primarily defined by the existent state of a system, and not by the potential future hazard or stress. That is, the capacity of a system in its present state to respond to hazards. They define vulnerability, therefore, as "the ability or inability of individuals and social groupings to respond to, in the sense of cope with, recover from or adapt to, any external stress placed on their livelihoods and well-being" (Kelly and Adger, 2000, p. 328). Here, vulnerability focuses on the characteristics and constraints of the individual or group that exist, independent of any future hazard or stress, which hinder response capacities.

Adger (2006) follows on from the classical view discussed by Kelly and Adger (2000) above and defines vulnerability as a state of susceptibility to harm due to exposure to hazards and stresses associated with environmental and socio-political change, as well as the absence of the ability/capacity to adapt to such hazards and stresses. This definition implicitly adopts the view above in the sense that it is primarily the state of the system in question and its capacity to respond which determines the extent of impact from a hazard or stress, not necessarily the hazard or stress itself. McFadden (2007), on the other hand, notes that debates over definitions of vulnerability, as a result of the conflicting interests of stakeholders and processes within socio-ecological systems, are a function of the differing views of what the ideal environmental state should be. These stakeholders generally have different preferences for what course of action to take, and often have strongly held beliefs regarding the nature of their preferred course of action (Green and McFadden, 2007).

A useful definition of vulnerability is one that not only gives insights into the problem and an appropriate course of action, but is a definition that also carries sufficient shared meaning to enable stakeholders to communicate with one another (De Brujin *et al.*, 2007; McFadden, 2007). To allow for shared meaning of definitions of climate change vulnerability, the definition needs to be understood in terms of a discourse, since they influence how a problem is framed (Green and McFadden, 2007; O'Brien *et al.*, 2007). For instance, as Green and McFadden (2007) explain, if coastal vulnerability is defined as people unwisely deciding to live in hazard-prone areas, then it could be deemed that it is not the responsibility of the government should a hazard occur.

Alternatively, if vulnerability is defined as the result of a failure of emergency services, then it could be deemed that it is not the responsibility of any of the individual people.

Within the coastal zone, and within the specific context of this research project, traditional physical or social scientific viewpoints have dominated much of the vulnerability research, as the 'end point' vulnerability or 'outcome vulnerability', particularly with reference to the nature of change and the value of resources (McFadden and Green, 2007). A considerable degree of social science work conceptualises vulnerability in the form of population and settlement patterns along with economic wealth indicators (Kelly and Adger, 2000). For example, Zahran *et al.* (2008) considered geographic locations and populations with high percentages of socially vulnerable and disadvantaged persons in Texas to determine whether such populations experience significantly more casualties during flood events than others. Indeed, their models indicated that the odds of flood casualty increased with the vulnerability and geographical factors. Additionally, there has been considerable work contributed from a geomorphological perspective, for example, in restoring equilibrium after changes in wave energy or sediment loads and the time taken to do so (Pethick and Crooks, 2000). The literature also reveals that a significant amount of research on coastal vulnerability is in the context of sea-level rise and the related physical impacts that climate change will likely induce (McFadden and Green, 2007).

Overall, as Dolan and Walker (2004) distinguish, there are three overarching approaches to vulnerability derived from climate change and the natural hazards literature, including: (i) vulnerability as biophysical exposure to hazards; (ii) vulnerability as social constructed; and (iii) vulnerability as the integration of both biophysical and underlying social characteristics. Adger (2006, p. 390) explains the importance of the third and integrated approach by stating that the "inclusion of vulnerable sections of society and representation of vulnerable social-ecological systems within decision-making structures is an important and highly under-researched area". Furthermore, Adger (2006) also argues that despite the existence of limitations in theory, data, and methods, enough is known to provide strong information to decision-makers. Since adaptable and resilient societies better cope with physical as well as socio-political stress, it is in the policy and decision-makers' best interests to identify means to strengthen these elements within particular societies and groups of society, to hence reduce vulnerability.

3.1.2 An integrated vulnerability framework

Dolan and Walker (2004) discuss the limitations of applying either of the first two approaches to vulnerability, described in the above paragraph. They explain that: (i) as a measure of physical exposure, the degree of vulnerability may not necessarily be reduced simply by reducing exposure, as in the case of flood protection works, whereby the presence of such structures may encourage development in flood prone areas to increase the number of people exposed, and; (ii) as a purely socially constructed phenomena, vulnerability is determined by the inequitable distribution of damage and risk among groups of people as a result of social forces that constrain access to resources, and when protection from these forces takes precedence it results in a focus on how social vulnerability is produced, regardless of the nature of the exposure.

The third and integrated approach to vulnerability is a much more holistic approach, and therefore relevant to this research project. The integrated vulnerability framework considers the interrelated and interdependent characteristics of both the biophysical and social environments, whereby the 'internal' factors of a vulnerable system are combined with exposure to 'external' hazards (Füssel, 2007b). However, whilst there have been various attempts to classify an integrated definition, much of the work has actually centred on the biophysical perspective, whereby vulnerability is the 'end point', with socio-economic factors being examined as residual impacts after adaptation occurs (Burton *et al.*, 2002; Dolan and Walker, 2004; Harvey *et al.*, 1999; Klein and Nicholls, 1999). An integrated vulnerability approach is proposed in the framework developed by Dolan and Walker (2004) in Figure 3.4.

Figure 3.4: Integrated Vulnerability Framework

NOTE:
This figure is included on page 108 of the print copy of the thesis held in the University of Adelaide Library.

Source: Dolan and Walker (2004, p. 1319)

The integrated framework displayed in Figure 3.4 differs from many others since it compliments research that incorporates vulnerability as the 'starting point' of the examination, as opposed to the 'end point' typical of impacts-driven approaches (Dolan and Walker, 2004; Kelly and Adger, 2000; Smit and Pilifosova, 2003). Incorporating an integrated approach results in vulnerability as both "a physical risk and a social response within a defined geographic context" (Dolan and Walker, 2004, p. 1317). Therefore, building adaptive capacity is a valuable exercise to assist in reducing vulnerability (O'Brien *et al.*, 2007).

As per the integrated vulnerability framework, adaptive capacity is an inherent property of the system that is characterised by the ability of the system to respond, adjust, and cope with change, irrespective of what future changes may or may not occur. Adaptive capacity is then linked with existing decision-making processes in order to provide a more relevant approach at a local community level, which promotes capacity building to respond and adapt to climate change (Dolan and Walker, 2004).

3.1.3 Models of integrated vulnerability

The following section is a discussion of two key models of vulnerability, as employed within an integrated context: (i) the Pressure and Release model (PAR model); and (ii) the Access model.

3.1.3.1 Pressure and Release model

The progression of vulnerability, that is, the social processes creating vulnerabilities and the interactions with hazard events to create disasters (represented in subsection 3.1.1.1 as: R = H × V), is discussed through the use of the Pressure and Release model (PAR model) developed by Blaikie *et al.* (1994). Whilst these linkages are described as a progression of vulnerability, it must be noted that they do not, however, represent a sequence of cause and effect. The PAR model is premised on the idea that there are three features that link social factors and processes with biophysical exposure to hazard(s) to create vulnerabilities (Turner *et al.*, 2003; Wisner *et al.*, 2004). The vulnerabilities, as such, are the result of the interdependent relationship between the social and biophysical conditions within a particular local context, which can either cause a disaster, or bring about the risk of a disaster.

The progression of social factors and processes is known as the 'base vulnerability', displayed in the PAR model in Figure 3.5. Base vulnerability, as the 'starting point' of the assessment, is firstly described by the *root causes*, which are generally economic, demographic and political processes that are distant in a spatial, temporal and cultural sense. Specifically, the root causes arise from a political or economic power elsewhere, as a result of past history, or as a result of being overlooked or taken for granted due to 'distractions' in everyday livelihoods, which "reflect the exercise and distribution of power in a society" (Wisner *et al.*, 2004, p. 53).

Figure 3.5: The Pressure and Release model (PAR model) of vulnerability

NOTE:
This figure is included on page 109 of the print copy of the thesis held in the University of Adelaide Library.

Source: Adapted from Turner et al. (2003, p. 8075)

The existence of *dynamic pressures* combines with the effects of root causes to create *unsafe conditions* (Turner *et al.*, 2003; Wisner *et al.*, 2004). Dynamic pressures are described as contemporary, juxtaposed manifestations of more general, underlying economic, social and political relationships. Unsafe conditions arise because dynamic pressures channel the root causes, temporally and spatially, into such forms that they represent hazards facing people (Blaikie *et al.*, 1994). Dynamic pressures include forces such as rapid population growth or urbanisation, deforestation, declines in rainfall and soil productivity, war and other violence, as well as a lack of skills, training, and a lack of local markets, institutions and investments (Wisner *et al.*, 2004).

As Turner *et al.* (2003) explain, in the PAR model, which is primarily used to address disaster events facing social groups, unsafe conditions can be described as the spatial and temporal conjunctions of root causes and dynamic pressures. Unsafe conditions are expressed in terms of the vulnerability of people and relate to the biophysical environment, the local economic, social and political setting, and are highly dependent upon the initial welfare of the individuals or groups under examination (Wisner *et al.*, 2004). It is in this sense, as outlined earlier, that Wisner *et al.* (2004, p. 55) refrain from using the term vulnerable in reference to livelihoods, buildings and infrastructure, settlement locations, and instead utilise other synonyms so as to retain the significance of the word 'vulnerability' for use in relation to people and hazards.

Criticisms of the PAR model include that, despite its integrated nature, it still does not adequately address the coupled human-environment system with regards to the vulnerability of biophysical subsystems (Kasperson *et al.*, 2003b). Additionally, as Turner *et al.* (2003, p. 8074) critique, the PAR model does not provide sufficient detail on the "structure of the hazard's causal sequence, including the nested scales of interactions". Furthermore, the PAR model, compared to other integrated models, also tends to underemphasise feedback processes that may take place beyond what is analysed in the system (Kates *et al.*, 1985).

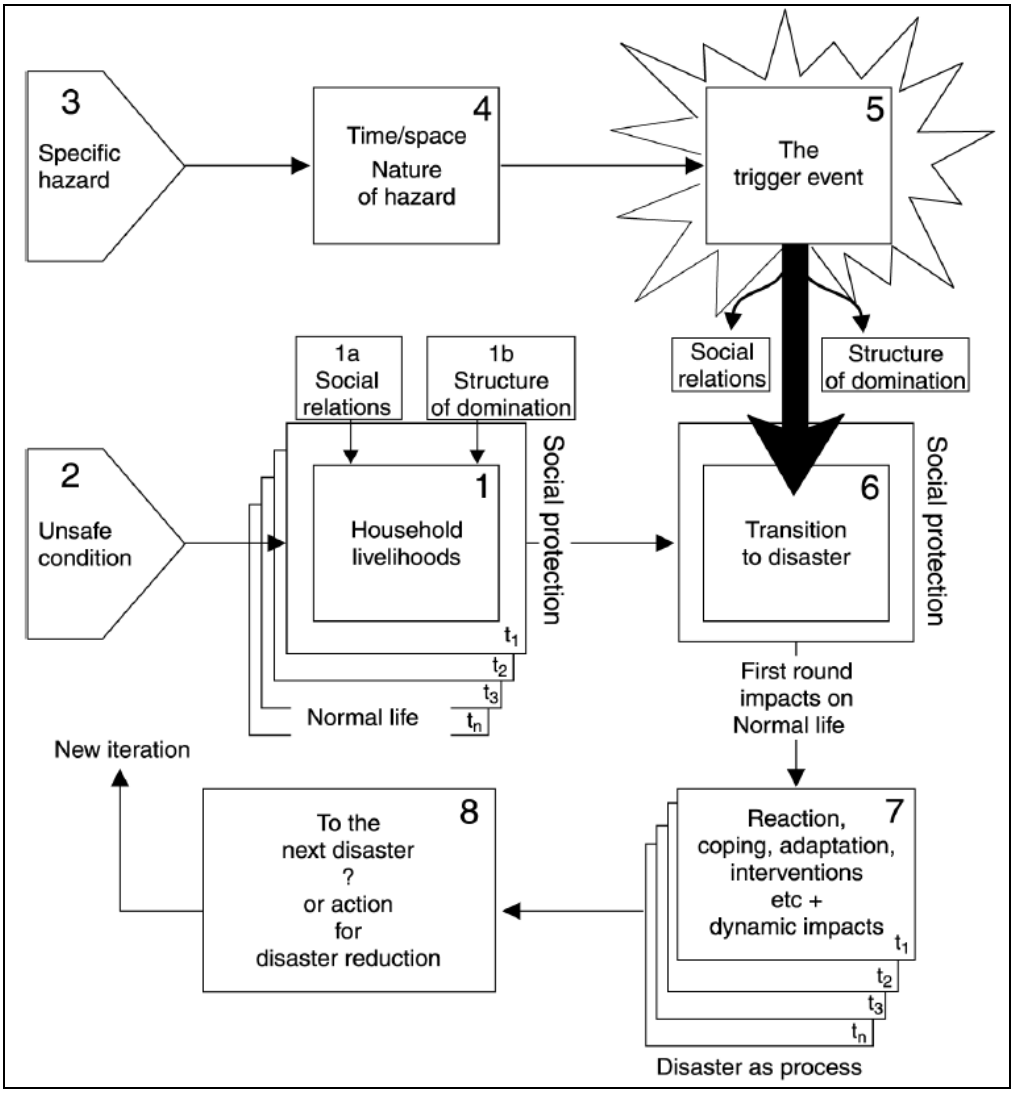
3.1.3.2 Access model

The second model of vulnerability is the Access model, discussed by Wisner *et al.* (2004), which expands on the principle factors of the PAR model. It is unique in that it is not only a separate model, but also a part of the PAR model since it explores, in greater detail, the interaction between root causes, dynamic pressures and unsafe conditions (that is, the social factors and processes) with the physical exposure to hazards that create the risk of a disaster (Füssel,

2007b; Turner *et al.*, 2003). The Access model is described as a more refined explanation of the role in which political and economic forces play in determining the root causes of unsafe conditions for a particular disaster (Cutter, 1996).

The Access model focuses on the impact and response process, and 'magnifies' how vulnerability is generated to begin with by the more specific social, economic and political processes (Figure 3.6). The Access model complements the PAR model since it illustrates particularly how "conditions need to change to reduce vulnerability and thereby improve… the capacity for recovery" (Wisner *et al.*, 2004, p. 50). As Wisner *et al.* (2004) explain, in many ways the Access model focuses on the precise pressure point whereby the interaction between the natural event and the longer-term social processes takes place. As such, the Access model represents the junction whereby *disaster* occurs in the PAR model depicted in Figure 3.5. The Access model 'magnifies' this disaster junction in the PAR model in order to overcome the criticisms that it does not explain, at the macro-level, the trajectory of vulnerability at various scales.

Figure 3.6: The Access Model of vulnerability in outline



Source: Wisner et al. (2004, p. 89)

There are eight numbered boxes within the Access model that characterise a set of closely related ideas, an event, or distinct process, with iterative causal linkages (Wisner *et al.*, 2004). Households (Box 1) are subject to unsafe conditions (Box 2) due to individual decisions made within the political-economic environment. Consequently, hazards (Box 3) are constrained to a particular time and space (Box 4), which results in *trigger events* (Box 5) occurring. The trigger event, as such, impacts upon society whereby individuals will *transition to disaster* (Box 6) based on the presence or absence of personal, collective and public social protection initiatives. Subsequently, individuals then respond to changed conditions (Box 7) through coping strategies, adaptations or interventions relative to the impacts. Next, based on the responses to the disaster, the question is posed as to whether there will be altered conditions of vulnerability due to the disaster, or whether there will be action taken for disaster risk reduction in the future (Box 8).

3.2 Adaptation and climate change

Adaptation is the second prime element in assessing vulnerability and has considerable policy relevance and concern (Kelly and Adger, 2000). In terms of human action on climate change impacts, adaptation is one of two distinct responses to the issue; the other being mitigation. Climate change impacts occurring today and those which are to occur in the future are, and will be the result of past emissions and other forms of environmental degradation, and there is a strong consensus that these impacts are irreversible and unavoidable (Adger and Barnett, 2009; Pelling and High, 2005a). In this respect, mitigation can only prevent further future human-induced climate change impacts, whereas adaptation can both assist in avoiding certain impacts and in coping with unavoidable impacts.

Adapting to current changes, and in preparation for future changes, is the only means of ensuring impacts on particular systems do not inflict devastating changes. Adaptation in this context is described as the "ability or capacity of individuals, communities and nations to handle the impacts and/or take advantage of opportunities from altered conditions" (IPCC, 2007a, p. 731). It must be noted, however, that similar to earlier discussions regarding the use of the term vulnerability, definitions of adaptation are also varied and contested. They differ due to the context in which the term is employed; such as who uses the term, what it is used for, as well as the 'type' of adaptation involved. Consequently, as Füssel (2007a, p. 267) explains, the diversity in adaptation contexts implies that there is "no single approach for assessing, planning, and implementing adaptation measures". Rather, adaptation must be flexible enough to apply the many different methodological approaches in order to produce knowledge relevant to the specific decision context (Füssel, 2007a).

Adaptation is often viewed as an alternative or complementary response strategy to mitigation (Füssel, 2007a; Wall and Marzall, 2006). There is now a general consensus that future hazards associated with climate change will be an increasing challenge, despite current efforts to prevent climate change and associated impacts (Adger and Barnett, 2009). In fact, it is increasingly being realised that adaptation is the only appropriate response to many climate change impacts occurring today and in the future (Grothmann and Patt, 2005). Adaptation has more recently become a mainstream topic of research and assessment from the point of view of reducing the vulnerability of groups of people to the impacts of climate change that are deemed inevitable (Adger and Barnett, 2009; IPCC, 2007c).

Working Group Two (WG2) of the IPCC Fourth Assessment Report (AR4) (2007a) condenses the varieties of adaptation described by Smit *et al.* (2000) and distinguishes three types: anticipatory; autonomous, and; planned adaptation:

1. Anticipatory adaptation, which "takes place before impacts of climate change are observed. Also referred to as proactive adaptation" (IPCC, 2007a, p. 869);
2. Autonomous adaptation, which "takes place in reactive response to climatic stimuli without directed intervention by a public agency" (Kulpraneet, 2012, p. 3); and
3. Planned adaptation, which is "the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state" (IPCC, 2007a, p. 869).

A number of other definitions of adaptation are compiled in Appendix 2, however, for the purposes of this research project, and in the context of global climate change, the working definition of adaptation follows that of Moser (2010b, p. 3) whereby adaptation involves:

> *…various responses by or interventions in a system that allow a system to avert or minimise the negative consequences of a perturbation or take advantage of beneficial ones arising from it.*

The initial formalised approaches to climate change adaptation were primarily driven from the top-down, whereby climate change scenarios derived from Global Circulation Models (GCM) are scaled-down and then 'applied' to specific cases (Burton *et al.*, 2002; Carter *et al.*, 1994). When utilised at local and regional levels, the effectiveness of such scaling-down of climate scenarios is often limited for two important reasons. First, such climate scenarios are, at best, generalised and simplified characterisations of the full spectrum of climatic variables in that they are limited to a narrow range of factors such as mean temperature, rainfall, and sea level (Smit *et al.*, 2000). Second, due to the vast array of site-specific conditions that can influence, including, but not limited to, geomorphological processes as well as demographic and geographic human settlement patterns, the impacts that future scenarios exert are highly uncertain at local scales, and lack relevance for individuals. As they have generally been applied, the linkages between top-down approaches and day-to-day adaptation to climate change have since been identified as inadequate (Huq and Reid, 2003; Rojas Blanco, 2006).

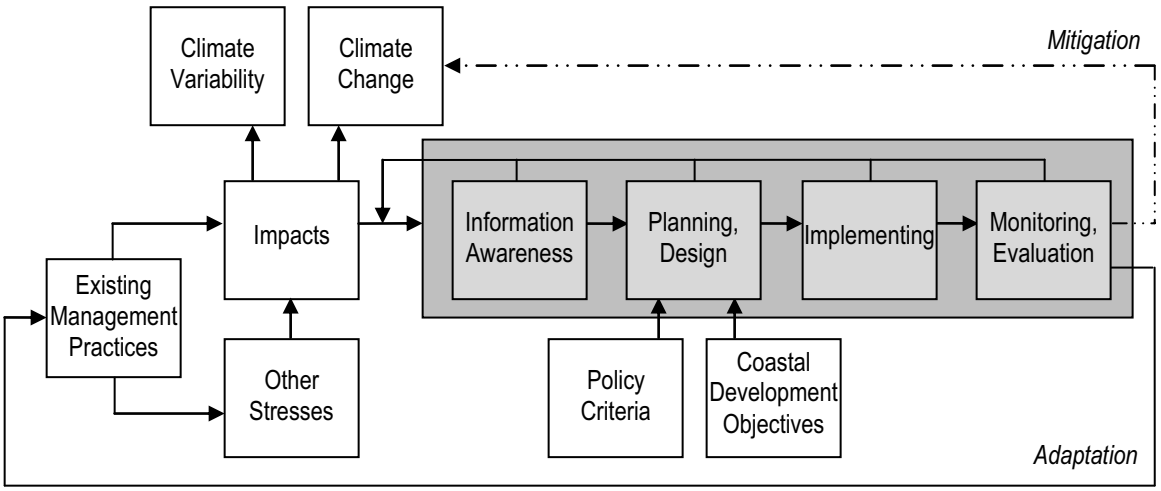
The United Nations Framework Convention on Climate Change (UNFCCC) promotes holistic climate change strategies that encompass both mitigation and adaptation options as being ideal.

The extent to which humans, society and natural ecosystems are at risk from climate change depends on the nature, rate and magnitude of change, and the ability of these impacted systems to adapt. In reference to temperature change, for instance, there is a significant possibility of the mean global temperature reaching 4°C or more above preindustrial levels by 2100; a significant overshoot of the 2°C target adopted by the European Union as the dangerous limit which should not be exceeded (Adger and Barnett, 2009; Parry *et al.*, 2009). As Adger and Barnett (2009) discuss, it may be possible for global human ingenuity to adapt to overcome warming of 2°C above preindustrial levels, however, it is far less certain whether widespread adaptation will be possible beyond this degree of warming. In this respect it can be argued, therefore, that it is necessary, or perhaps even more necessary, to examine adaptation responses just as it is necessary to examine emissions reductions and other mitigation schemes, particularly in the face of a future with climate uncertainty (Parry *et al.*, 2009).

Schneider *et al.* (2000, p. 204) discuss how natural climate variability can "mask slow trends" and subsequently delay adaptation and/or trigger maladaptive practices. They argue that high levels of natural variability in climate and weather conditions are likely to mask long-term anthropogenic climate change trends which will ultimately dissuade individuals from attempting anticipatory adaptation measures based on climate scenarios (Schneider *et al.*, 2000). As a consequence of such a high level of climatic 'noise', Schneider *et al.* (2000) argue that adaptations are likely to be delayed by decades, and that should variability be mistaken as a trend and vice versa, the risk of maladaptation increases significantly.

With reference to planned adaptation at the coast, Klein *et al.* (1999) have developed a conceptual framework that can be considered a multi-stage and iterative process, detailed in Figure 3.7. Within the shaded area of the framework are four iterative steps: (i) information collection and awareness raising; (ii) planning and design; (iii) implementation; and (iv) monitoring and evaluation. As the framework progresses, climate change and/or variability, along with other coastal stressors and conditions brought about by existing management practices, lead to potential and actual impacts. Mitigation efforts are enabled in order to negate the causes of impacts, or adaptation efforts in order to modify or limit impacts. It must also be noted, as per the figure, that the process of adaptation interacts with, and is conditioned by, the specific policy criteria and development objectives relevant to the location and scale of existing management practices. Autonomous adaptation, as introduced previously, is implied within the framework since it determines how impacts are made manifest in the first place.

Figure 3.7: Conceptual framework showing in the shaded area the iterative steps involved in coastal adaptation to climate variability and change



Source: Klein et al. (1999, p. 245)

In addition to giving adaptation more attention, it is also necessary to examine the capacity of systems to adapt, known as 'adaptive capacity', in order to identify strengths and weaknesses (Adger, 2006; Smit and Wandel, 2006), and to take advantage of opportunities to reduce risk (Gocklany, 2007; Vincent, 2007). Research on adaptation thus far has tended to focus on describing, categorising or analysing adaptive actions (Grothmann and Patt, 2005). Wall and Marzall (2006, pp. 377-378) state that the characteristics of adaptive capacity allow a particular system to "perceive change or threatening circumstances, evaluate them, decide on a solution path and both develop and adopt processes and tools to manage the risk, thereby maintaining itself throughout". Here, as Ford *et al.* (2006, p. 152) explain, "Adaptations are manifestations of a system's adaptive capacity". The adaptive capacity of a system, therefore, is a fundamental determinant of how vulnerable a particular system is to external and internal stress, particularly in terms of how it adapts to that stress.

Existing work in the adaptation field has built upon theory from social vulnerability and coping with risk developed in the natural hazards literature which, as Pelling and High (2005a, p. 1) argue, has formed "two contrasting but complementary analytical orientations". First, adaptation as adaptive capacity is explained in terms of the social, political and economic structures that shape entitlements to assets. Second, adaptive capacity as influenced by unequal power relations and information asymmetry that shape decision-making and control the distribution of adaptive capacity.

Yohe and Tol (2002), in considering an economic and social approach, in relation to the determinants of adaptive capacity, summarise some of the IPCC Third Assessment Report (TAR) findings (IPCC, 2001a). Specifically, Yohe and Tol (2002, p. 26) outline a variety of characteristics specific to different systems, sectors, and locations, which determine adaptive capacity:

1. *The range of available technological options for adaptation;*
2. *The availability of resources and their distribution across the population;*
3. *The structure of critical institutions, the derivative allocation of decision-making authority, and the decision criteria that would be employed;*
4. *The stock of human capital including education and personal security;*
5. *The stock of social capital including the definition of property rights;*
6. *The system's access to risk spreading processes;*
7. *The ability of decision-makers to manage information, the processes by which these decision-makers determine which information is credible, and the credibility of the decision-makers, themselves; and*
8. *The public's perceived attribution of the source of stress and the significance of exposure to its local manifestations.*

These determinants, as argued by Yohe and Tol (2002), play a key role in defining the social boundaries of coping ranges, or thresholds.

WG2 of the AR4 further identified a number of limits and barriers to adaptation (IPCC, 2007a). Of particular relevance to this research project is the AR4's discussion of informational and cognitive barriers, stemming from the psychological research literature, which will be discussed in Chapter 4. The report concludes that there are four main perspectives which constrain individual adaptation responses to climate change under uncertainty (IPCC, 2007a, p. 735):

1. *Knowledge of climate change causes, impacts and possible solutions does not necessarily lead to adaptation…*
2. *Perceptions of climate change risks are differing…*
3. *Perceptions of vulnerability and adaptive capacity are important…*
4. *Appealing to fear and guilt does not motivate appropriate adaptive behaviour.*

Whilst there will be a much more detailed discussion of the psychological research literature in Chapter 4, the AR4 summary (IPCC, 2007a) provides a useful precursor in highlighting that an individual's perceptions of risk and vulnerability, as well as their motivation and capacity to adapt will affect the degree to which behavioural change (adaptation) occurs. Additionally, whilst it may

be necessary for individuals to have awareness of an issue, as well as the knowledge, personal experience, and a sense of urgency of being personally affected, in order to instigate behavioural and policy change, they are insufficient by themselves (IPCC, 2007a).

Risk management is a key driving force behind adaptation studies from the viewpoint of risk associated with the impacts of hazards; that is, what impacts are likely, and what adaptations are likely to minimise impacts and produce beneficial outcomes from the changed conditions. As Beck (1992; 1999) expresses, through his works on the emergent 'risk society', modern hazards, including climate change, and much of the established risk logic has become destabilised. What remains, therefore, is an uninsured society incapable of preparing for worst-case scenarios since: (i) the actuarial probabilities of modern hazards are virtually incalculable; and (ii) their scale of impact is beyond the capacity of insurance capital, or their nature of impact cannot be remedied financially, such that when risk consequently increases, insurance protection decreases (Beck, 2010; O'Malley, 2003).

Climate change represents a new challenge to the world risk society, as Beck (2010, p. 260) puts it, since in light of the "historical logic of their national and international legal systems and scientific norms [societies] are prisoners of a repertoire of behaviours which completely bypasses the globality of ecological crises". The reactive and post-hoc nature of much of the political debate on climate change predominately ignores many of the conditions and ultimate causes that produced the issues in the first place (Beck, 2010). Adaptation, in the context of the working definition above, responds to this reactionary outlook through aversion and minimisation of harm through the anticipation of future impacts. There are three key questions that Smit *et al.* (2000) discuss in reference to the risks imposed by climate change and the potential strategy of adaptation to future impacts, that is:

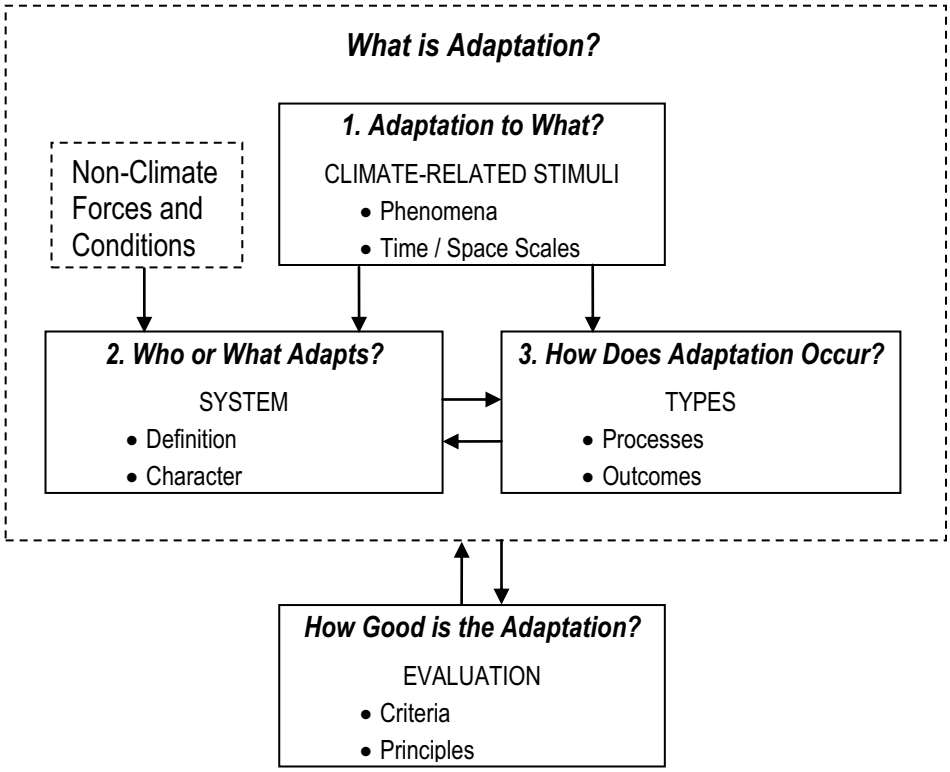
1. Adapt to what?
2. Who or what adapts?
3. How does adaptation occur?

Firstly, 'adaptation to what' refers to climate change and variability, or just climate in general, as well as the particular context, and spatial and temporal scale. Secondly, 'who or what adapts' refers to the characteristics of the "people, social and economic sectors and activities, managed or unmanaged natural or ecological systems, or practices, processes or structures of systems" (Smit *et al.*, 2000, p. 227). Thirdly, 'how does adaptation occur', which refers not only to the

process of adaptation itself, but also the resulting outcome or condition such that it implies a change in the system to become better suited to the new conditions.

In the view of Smit *et al.* (2000, p. 229), the above three key questions define the overarching query of "what is adaptation?" (Figure 3.8). It must also be noted that the additional step of 'how good is the adaptation?', or 'how sustainable?', is critical in the evaluation of particular responses for adaptive learning, such that recommended adaptation options or measures of success and progress can also be found. As previously discussed, suitable metrics for this evaluation may be difficult to identify, but usually take the form of costs, benefits, equity, efficiency, urgency and implementability (Smit *et al.*, 2000).

Figure 3.8: Gross anatomy of adaptation to climate change and variability



Source: Adapted from Smit et al. (2000, p. 230)

Climate change could be described as the quintessential stress or modern hazard in recent times that requires a concerted global adaptation effort. Indeed, an exploration of risk perceptions is warranted therefore, since, as Adger *et al.* (2009, p. 346) describe, "[h]istoric and current adaptation is and continues to be informed by perceptions and local knowledge based on previous experience of weather and climate" (Thomas *et al.*, 2007; Vedwan and Rhoades, 2001). A particular challenge is that a lack of specificity in climate scenarios does not enable the

assessment of impacts and subsequent adaptations to be as precise as policy-makers generally want (Burton, 1997). Smit *et al.* (2000, p. 229) describe how adaptations in the context of "the various manifestations of climate stimuli", which constitute the stress or hazard, have also been labelled 'doses', 'disturbances', 'events', and 'perturbations' (Burton, 1997). Stimuli includes, for example, changes in climate and weather conditions, ecological or human effects and changes as a result of climate and weather conditions, the risks and perceptions of risk relating to the changed climate and weather conditions, as well as the opportunities created by changes in such conditions (Smit *et al.*, 2000).

The stimuli described above constitute the overall climatic condition under which adaptations generally take place and represent the means through which certain elements of socio-ecological systems are exposed. As Smit *et al.* (2000) state, these stimuli can be placed into three broad temporal categories:

1. Long-term climate change;
2. Climate variability; and
3. Isolated extremes or catastrophes.

These stimuli and the categories to which they apply, however, are not independent of one another and need to be viewed as components of the larger climate system (Smit *et al.*, 2000). For example, isolated catastrophes are a 'normal' part of climate variability, generally constituting rare 'outlier' events amongst the more common short-term 'noise'. Overall, and when looking over long periods of time, however, the long-term trends of climate change are revealed.

Adaptation to climate change is both an element of impact assessment and a potential policy response (Schneider *et al.*, 2000; Smit *et al.*, 2000). In terms of impact assessment, a system's capacity for adaptation and likelihood for adaptive action needs to be addressed in order to separate initial impacts from residual impacts of climate change (Smit *et al.*, 2000). It must be stressed, however, that adaptive actions in systems are not only in response to climate stimuli, but also to a range of socio-political and economic stimuli (Smit *et al.*, 2000). There will always be some residual uncertainty when it comes to projected climate change risks and impacts, particularly at the upper end of the uncertainty range (Parry *et al.*, 2009), regardless of the amount of contingency planning.

From a research perspective, Adger (2006, p. 269) discusses how the objectives of the particular study, specific to the system on a case by case basis, will result in the formulation of different

"research needs, research methods and normative implications of resilience and vulnerability". Indeed, as Berkes and Folke (1998, p. 9) point out, "there is no single universally accepted way of formulating the linkages between human and natural systems", but what can assist in building these linkages is adaptive management. Adaptive management, as a framework for decision-making, has been described as an iterative process of learning from doing, which is able to cope "with the unpredictable interactions between humans and ecosystems that evolve together" (Adger, 2006, p. 269). In the context of climate change adaptation, this is particularly useful for decision-making under uncertainty as particular socio-ecological systems are exposed to, and experience disturbances and stress exacerbated by, the impacts of climate change (Tompkins and Adger, 2004). Ultimately, as Berkes and Folke (1998, p. 9) conclude, adaptive management "is the science of explaining how social and natural systems learn through experimentation".

Adaptation and the development of adaptation policies, in a practical sense, requires that actual adaptive behaviour be specified before any impact assessment or policy can be evaluated (Smit *et al.*, 2000), as per the three key questions posed above. Additionally, as part of the impact assessment it is crucial that the costs and benefits related to specific adaptations be estimated in order to assist in policy development. Furthermore, Smit *et al.* (2000) note that certain systems are more or less adaptable to particular climate stimuli than others, and that adaptations can result in alterations of sensitivity to particular stimuli.

As Pelling and High (2005a) discuss, at a global scale, the complexity of interactions within socio-ecological systems has an infinite variety of local manifestations making complete coverage of climate risk impossible. Therefore, as discussed previously, since risk depends in part upon the nature, rate and magnitude of change, as well as the adaptability of the impacted systems, the science of adaptation and its application to policy needs to be improved to consider a greater depth of stimuli (NRC, 2009).

3.2.1 Exposure

In utilising the model of vulnerability illustrated in Figure 3.1 above, whereby: Vulnerability = (Exposure X Sensitivity) – Adaptive Capacity, a key element involves the level of exposure to hazards of a particular type and magnitude, which reflects the likelihood of occurrence. Although not directly related to adaptation in the sense of the pseudo-equation, it can be argued that in order to reduce vulnerability, minimising the level of exposure decreases the extent which adaptation is relied upon. Füssel (2007b, p. 160) argues that such an approach to vulnerability,

which adopts a 'risk-hazard' approach, is often quite difficult to apply to people "whose exposure to hazards largely depends on their behaviour, as determined by socioeconomic factors". On the contrary, from a social vulnerability perspective, a 'political economy' approach to vulnerability examines the extent of an individual or groups exposure to multiple stresses, from both exogenous risks as well as from their own socio-economic situation (Adger, 1996; Füssel, 2007b). Regardless of the specific perspective, adaptation efforts are designed to minimise climate change impacts, and can therefore be directed to areas where there is the greatest level of exposure, as well as the least capacity to adapt (Smit and Wandel, 2006).

3.2.2 Sensitivity

Sensitivity, as the second key element within the model of vulnerability model of vulnerability illustrated in Figure 3.1, is generally described as the degree to which a system can be modified or affected by stress or perturbation. Sensitivity and exposure are closely related system properties and are an interaction of both the attributes of the stress or perturbation and the characteristics of the system (Smit and Wandel, 2006). Simultaneously, sensitivity is also quite separate from exposure since it is inherent to the system and exists prior to any disturbance (Gallopin, 2003; 2006). Here, both exposure and sensitivity do not take into account the moderating effects of adaptation (Torresan *et al.*, 2008). More recently, sensitivity has been expressed as the extent to which a system can absorb impacts without suffering long-term harm or without experiencing a significant change in system functioning (Adger, 2006); or as the degree to which a system is modified or affected by either an internal or external disturbance or set of disturbances (Gallopin, 2003). Again, the myriad of definitions of the key terms within the literature relates to the wide variety of uses, contexts, and fields of enquiry.

Simplistically, sensitivity can be viewed as a system 'threshold' which, if surpassed during a disturbance or stress, will then result in changes to the system; any stress inflicted below the 'threshold' is typically absorbed and relates to the concept of resilience (Gallopin, 2006). In reference to the literature on climate, sensitivity is the degree to which a change in one climate-related variable inflicts changes in another, directly or indirectly, either positively or negatively (IPCC, 2001b). For instance, the sensitivity of a sandy beach coastline to increases in the frequency and intensity of storm surge events would be dependent on the extent to which there is an available sand supply to replenish the beach after erosion has taken place (Hansom, 2001).

3.2.3 Resilience

Resilience has received significant attention in reference to a system's capacity to absorb shocks without drastically altering its primary functions, similar to that of sensitivity, as discussed by Adger (2006). Resilience, as adaptive capacity in the model of vulnerability illustrated in Figure 3.1, can also mean responding actively and positively to shocks (Giddens, 2009). From a social vulnerability standpoint, whereby vulnerability is inherent to the system and present prior to any stress, it is not necessary for a stress to occur for resilience (adaptive capacity) to be examined (Adger, 2006). Resilience, therefore, depends on both the severity of the stress and how the social system is organised with respect to its own resources, and in respect to other systems (Folke *et al.*, 2010). As such, there is a possibility of establishing and/or strengthening particular qualities (building resilience) to reduce a system's overall vulnerability.

Anthropologists adopted the resilience perspective in the 1970s where it became the theoretical foundation for the field of active adaptive ecosystem management. Since the late 1980s there has been an increasing shift to include coupled human-environment interactions, such as environmental psychology, human geography, and the social sciences (Holling, 1973). The concept has since seen a progression through research into complex systems theory, uncertainty and surprise, sustainability science, vulnerability and risk, as well as social learning and social resilience (Folke, 2006; Janssen *et al.*, 2006). Folke (2006), with reference to complex systems theory, emphasises the two interacting and interplaying cross-scale sides of resilience, whereby it has: (i) a sustaining quality; and (ii) a developing quality.

Evident in fewer discussions of resilience is the idea that there are prospects for renewal and re-organisation in the event of changes (Folke, 2006), described as 'sustaining' and 'developing' qualities in the above paragraph. It should be noted that there has been avoidance by scholars in regards to using terms such as 'recovery', and that there has been a preference for terms such as regeneration (Gunderson and Holling, 2002). It is argued that after a system experiences a disturbance, it is no longer the same system because it has developed. From this standpoint, it is assumed that shocks absorbed by the system have the potential to create new opportunities for innovation and development, provided the system is resilient enough. It is argued that by managing for resilient systems, there is a greater likelihood of sustaining desirable pathways for development in a future of uncertainty (Folke, 2006). In the context of climate change adaptation, therefore, a resilient community may be described as one that incorporates principles of adaptive management, is informed by iterative learning from previous management successes and

failures, is able to 'buffer' present-day disturbances and self-organise, which increases the community's ability to respond to long-term climate change (Brooks, 2003; Tompkins and Adger, 2004).

3.2.4 Reasons for concern

In more recent discussions of the necessity for adaptation strategies, there are a number of key issues that arise with respect to the viability, costs and social distribution of the burden of introducing any number of strategies at various scales to minimise climate change risk. Adger and Barnett (2009) describe four reasons for concern about adaptation to climate change, building upon the IPCC's reasons for concern (IPCC, 2001a), and the update from Smith *et al.* (2009). Specifically, as Adger and Barnett (2009) discuss, these concerns are in regards to:

1. Contractions and uncertainties in the window of opportunity for adaptation;
2. The difference between adaptive capacity and adaptive action;
3. The risk of maladaptation; and
4. Misguided measures of loss.

Underlying these reasons for concern about adaptation is the perception that there is widespread belief in the assumption that adaptation to climate change will be smooth, cheap, and easy to implement, however, as Adger and Barnett (2009, p. 2804) go on to explain:

> *The reality may be that adaptation to climate risks may be punctuated, messy, more costly than we are willing to pay, and be at odds with legitimate values and strongly held conviction concerning place and identity.*

Within and across human systems, the IPCC has identified that the emerging literature shows the distribution of adaptive capacity as representing a major challenge for development and a major constraint to effective adaptation strategies (IPCC, 2007a). Discussions of adaptive capacity in the past have typically involved technological and financial limitations within a system, and it is generalised that those who lack the financial ability to adapt swiftly and/or proactively are those with a low adaptive capacity, although this is not always the case. It has also been argued that a high income per capita is not considered to be a necessary nor sufficient indicator of adaptive capacity (Moss *et al.*, 2001), particularly due to the fact that having the capacity to adapt will not necessarily mean adaptive action will eventuate (Adger and Barnett, 2009). In addition to finances, technology, and economic development, there are social factors that have also been

identified as being strongly influential to adaptive capacity, including human capital, governance, community networks, values, traditions, and perceptions.

Of these social factors, the IPCC has acknowledged human cognition as a key limitation to adaptation responses, as well as to interpretations of danger and risk (Grothmann and Patt, 2005; IPCC, 2007a; Moser, 2005). As Grothmann and Patt (2005, p. 200) argue, policy-makers need to consider such aspects of adaptation. Bandura (1986, p. 19) explains how cognitive images of "desirable future events tend to foster the behaviour most likely to bring about their realization". As such, perceptions of minimal or nil future climate change impacts may hinder appropriate foresight and behaviour to prepare for change. Similarly, appropriate adaptation to climate change can be conceptualised as a capability, which signifies what Bandura (1986, p. 19) describes as representing foreseeable outcomes symbolically, whereby "people can convert future consequences into current motivators and regulators of foresightful behaviour".

Social barriers, limitations and costs regarding adaptive capacity and social vulnerability are not yet fully understood (IPCC, 2007c, p. 19), and gaps in the knowledge need to be filled to provide policy and decision-makers with information to administer the best possible adaptation plans (COAG, 2006). The challenge for research, as Adger (2006, p. 278) discusses, is interlocking explanations of cause and effect between disciplines linking vulnerability and adaptation for reducing vulnerability and increasing sustainability.

It is strongly argued that successful future adaptation options will diminish and associated costs will increase the more that climate change impacts increase (IPCC, 2007c). Fewer adaptation options will result in, and be the result of, a reduced social acceptance of future adaptation options. Additional research into understanding the social processes and elements to facilitate change, therefore, is required to reduce social vulnerability and increase adaptive capacity. Such research into adaptive capacity, as discussed by Wall and Marzall (2006), is valuable for government agencies focussing on capacity building, policy analysts, and other stakeholders concerned with community sustainability. This thesis addresses these areas of concern through its use of local contextual case studies, and through its exploration of individual property owners' perceptions of risk, including opportunities, limitations and barriers to adaptation.

3.3 Australian vulnerability and adaptation

The following section discusses the Australian Federal Government's approach to assessing the vulnerability of the entire Australian coastline, particularly through the 'first pass' National Coastal Vulnerability Assessment (NCVA), as well as national adaptation strategies and programs, facilitated through the National Climate Change Adaptation Research Facility (NCCARF). In addition, the following subsections outline the current vulnerability and adaptation studies, along with relevant NRM Board responses, for both South Australia and Western Australia, where the case studies of this research project are located.

3.3.1 Australian assessments

In Australia, there are numerous vulnerability studies currently being conducted, or that have been recently conducted, that have focussed on the coastal zone. Perhaps the most significant was the 'first pass' National Coastal Vulnerability Assessment (NCVA) (DCC, 2009; DCCEE, 2011) based on the approach of Sharples (2006), known as 'smartline'. The NCVA was an indicative 'first pass' assessment of the entire Australian coastline which identified 'fundamental vulnerability factors' such as low-lying coastal flats, open coasts, sandy beaches and dunes to assess the coastline's biophysical stability (Sharples, 2006). The coast was then classified into sections and deemed either 'potentially vulnerable' or 'not potentially vulnerable' to erosion as a result of sea-level rise and/or storm surge flooding. The results of the NCVA were first publicly released in December 2009, just over one month after the mail-out survey questionnaire utilised in this thesis was posted to participants (DCC, 2009).

The NCVA detailed the risk to settlements, based on a lower and upper estimate of sea-level rise risk: 55 centimetres and 1.1 metres above the mean high water (MHW) respectively. Utilising a 'bucket-fill' approach, as well as the Bruun rule, the NCVA could estimate the potential impact of sea-level rise inundation and erosion. The potential impact was calculated through an estimation of the number of residential properties exposed to inundation, quantified using Geoscience Australia's National Exposure Information System (NEXIS) (DCC, 2009). The 'bucket-fill' approach assume all land that lies below the specified sea-level rise estimates would be inundated, and the Bruun rule assumes that erosion of the coast inland is a one hundredfold factor of the height of sea-level rise (that is, a 1.0 metre sea-level rise will result in 100 metres inland erosion). Whilst this particular methodology has significant limitations, such as the counter-

influence of protection walls and isostatic land movement, at a national scale the NCVA represents a valid risk assessment due to its identification of priority 'hotspots'.

The NCVA was supplemented in June 2011 with a study to include sectoral risks to Australia's commercial buildings, light industrial buildings, and transport infrastructure due to sea-level rise (DCC, 2009; DCCEE, 2011). Figure 3.9 displays the state by state summary of these risks per sector in terms of estimated replacement value and concludes that the nationally combined upper estimate value is AU$226 Billion. Due to the lack of fine resolution data at regional and catchment scales, the NCVA could not effectively assess the impacts on the majority of estuaries, where a substantial proportion of residential communities are clustered (DCC, 2009) Furthermore, the NCVA did not assess the combined risk of catchment flooding and storm surge, that is, the coincident events of storm surge and high rainfall would lead to riverine or catchment-based flooding. However, it was noted that this should be an immediate priority (DCC, 2009).

Figure 3.9: Replacement value of Australian infrastructure for a 1.1 metre sea-level rise

NOTE:
This figure is included on page 127 of the print copy of the thesis held in the University of Adelaide Library.

Source: DCCEE (2011, p. 4)

Of particular relevance to this thesis is that the NCVA concluded that Yorke Peninsula in South Australia and Rockingham in Western Australia were among some of the potentially most vulnerable Local Government areas to sea-level rise inundation and erosion in Australia, based on the number of residential properties located within 55 metres and 110 metres of soft shore lines. Refer to the red highlighted portions of Figure 3.10 and Figure 3.11 for the specific Local Government findings (DCC, 2009). It must be noted that these estimates do not take into consideration the expected future development of residential stock within the regions and, therefore, cannot provide a comprehensive assessment of 'exposure' with respect to the numbers

of houses and persons at risk in the future. The conclusions in the report highlight the need to conduct more focussed regional assessments that integrate the human dimensions of change, such as that which will be detailed in this thesis.

Figure 3.10: Residential buildings within 55 and 110 metres of 'soft' shorelines in SA

NOTE:
This figure is included on page 128 of the print copy of the thesis held in the University of Adelaide Library.

Source: DCC (2009)

Figure 3.11: Residential buildings within 55 and 110 metres of 'soft' shorelines in WA

NOTE:
This figure is included on page 128 of the print copy of the thesis held in the University of Adelaide Library.

Source: DCC (2009)

As a further part of the NCVA, there are six detailed case studies under examination in various states with various focuses. The six case studies, as outlined by the DCC (2008), included:

- East Coast, Tasmania – the impacts on east coast rock lobster productivity interactions with fisheries management and flow-on effects to local communities.
- Kakadu National Park, Northern Territory – the impacts on river system dynamics in the Park, and the implications for government planning, management and policy responses.
- Pilbara Coast, Western Australia – the impacts on oil and gas infrastructure in the region, and the implications for government planning and approval processes.
- Yorke Peninsula, South Australia – the impacts on settlements, and the implications for government planning and approvals processes.
- Gold Coast, Queensland – the impact of sea-level rise on a coastal river system in a high growth catchment, with special reference to information requirements for planning and decision-making.
- Central and Hunter Coasts, New South Wales – the impacts on estuaries, their foreshores and ecosystems as a result of sea-level rise and flood events, and the implications for human settlements, infrastructure and land use planning.

The Department of Climate Change and Energy Efficiency (DCCEE), in conjunction with Geoscience Australia through the 'OzCoasts' website, produced a series of high-resolution sea-level rise maps to illustrate the potential risks of inundation to coastal settlements (OzCoasts, 2011). The areas mapped, which are available for the public to download via the 'OzCoasts' website, detail a low, medium and high-end emissions scenario consistent with the projections of the IPCC's AR4 (2007b) and include six metropolitan regions around Australia.

Following an indicative assessment, the NCVA has the option of allowing the 'potentially vulnerable' sections to undergo an indicative 'second pass' or site specific assessment, involving more detailed 'fundamental vulnerability factors' such as wave climate, tidal range, bathymetry, and exposure (Sharples, 2006). Furthermore, a 'third pass' assessment may be conducted if necessary to examine areas of the 'second pass' that are deemed potentially vulnerable, although this would involve an extremely large amount of high-resolution data and may not be financially viable (Sharples, 2006). It must be noted that the NCVA does not assess inundation levels as a result of sea-level rise and storm surge flooding since it does not include a digital elevation model (DEM) component.

Additionally, the Australian New Zealand Land Information Council (ANZLIC) – the Spatial Information Council, in conjunction with the Federal Government's Department of Climate Change (DCC), the Cooperative Research Centre for Spatial Information (CRCSI) and Geoscience Australia, is sponsoring the development of a national elevation data framework (NEDF). The NEDF's primary aim is to increase the quality of elevation data and digital elevation models (DEM), as well as provide access to high-resolution digital elevation data and other derived products that describe Australia's land and seabed. The Council of Australian Governments (COAG) identified that the NEDF needs to specifically develop high-resolution DEMs of vulnerable regions to better inform decision-making (COAG, 2006).

In terms of a framework for adaptation, COAG endorsed a 'National Climate Change Adaptation Framework', which identifies two priority areas for potential action; building understanding and adaptive capacity, and reducing vulnerability in key sectors and regions (COAG, 2006). The framework discussed the need to address substantial knowledge gaps and effective means to disseminate information for decision-makers, and the need to construct tools to assist in sectoral and regional assessments. The framework further identified key components of adaptive capacity and discussed further areas of action including the analysis of social and economic data and trends on select parts of Australia's coast, and coordinating impacts and adaptations programs in collaboration with stakeholders (COAG, 2006).

With an increase in available information relevant to climate change adaptation, it was determined that synthesising and disseminating this information was of a high priority. Consequently, in November 2007, the Federal Government, through the DCC, along with Griffith University committed to establishing and maintaining research networks under the 'banner' of the National Climate Change Adaptation Research Facility (NCCARF). The piece of research commissioned by NCCARF which relates most closely to the results in this thesis, involved a survey of community attitudes towards climate change to gain a broad understanding of how impacts will be felt by communities (Sweeney Research, 2010). The project utilised 3,000 telephone and internet surveys of a random sample of persons within Australian cities, over a two week period, in November 2009, which happened to be the same time that the results of the 'first-pass' NCVA were released. The findings of the NCCARF study will be discussed in comparison to the research conducted for this thesis, in Chapter 8.

In addition, the DCC has also provided funds for a 'Local Adaptation Pathways Program' (LAPP), whereby thirty three Australian Local Governments received up to AU$50,000 of first-round funding support to build their capacity to respond to the impacts of climate change. Out of the thirty three councils, twenty are coastal Local Governments. A second-round of LAPP funding provided seven groupings of councils (thirty one councils) up to AU$140,000 each. With the funding, councils are required to plan to investigate, utilising risk management techniques, how climate change will affect their current and future operations, alongside neighbouring councils, and produce an adaptation action plan that will link with the council's strategic plans as well as neighbouring councils' plans.

Building on this realisation of the growing need for adaptation strategies, the Climate Adaptation Flagship was established, under the CSIRO's national Research Flagships Program, to create AU$3 Billion a year in net benefits for Australia by 2030. The Climate Adaptation Flagship has developed linkages with universities, research institutions, and commercial companies around Australia, along with selected international partners, to conduct research in order to enable Australia to adapt to more effectively to the impacts of climate change (CSIRO, 2011). There are four research themes involving: 1. Adaptation pathways; 2. Sustainable cities and coasts; 3. Managing species and natural ecosystems, and; 4. Adapting primary industries, enterprises and communities. Of particular relevance to this thesis is the coastal theme, however, at the time of thesis writing, the research has yet to be finalised.

3.4.1.1 Summary

It has been identified that the global change science needs to improve linkages with decision-making needs, and that since human and biophysical systems and their vulnerabilities are linked, they should be researched accordingly (Turner *et al.*, 2003). What has been discussed thus far is that an assessment of the biophysical vulnerability of a system, by itself, is insufficient to encapsulate what may be required in the future, particularly in reference to adaptation, since "achieving practical steps to address climate change will demand some difficult political, social, and individual choices" (Lorenzoni and Pidgeon, 2006, p. 74). Indeed, it is necessary to examine the numerous and varied linkages both between, and within, the human and biophysical systems in order to have a comprehensive analysis of vulnerability.

Of particular interest to this research project is the work carried out for the National Sea Change Taskforce (NSTF), and the National Climate Change Adaptation Research Facility (NCCARF).

The NSTF has released a number of research reports and papers that deal with the challenges of the sea change phenomenon, and the steps to manage this change along with climate change pressures (Gurran *et al.*, 2008; Gurran *et al.*, 2005a; b; 2006; NSTF, 2004; 2006b; c; 2007). Whilst the reports are not specific examinations of social vulnerability to climate change, they do highlight many related issues which stem from a reduced capacity to adapt due to social disadvantage, the liability of future risks falling on the local councils, as well as increased insurance premiums (Harvey *et al.*, 2011). One of the characteristics of examples of 'leading practice' approaches to manage impacts of the sea change phenomenon, sought after in the NSTF's 2008 report, closely reflects a key objective of this project, as discussed in Chapter 1, which involves enhancements in the capacity of coastal communities to adapt to climate change impacts (Gurran *et al.*, 2008).

3.3.2 South Australian assessments

Within South Australia, the Local Government Association (LGA) of South Australia developed a 'local government climate change strategy' from 2008-2012, which identifies how climate change will affect council operations over the five year period (LGA SA, 2010). It is hoped that the strategy will consequently result in the production of climate change adaptation plans for individual Local Governments along with the integration of vulnerability data and adaptation strategies into council development plans. Notably, the 'Port Adelaide Seawater Stormwater Flooding Study' has been the most detailed report commission by a coastal metropolitan council, along with State Government partners, to use high-resolution DEMs take into account sea-level rise and land subsidence during the 21st century (Jacobi and Syme, 2005). Most recently, the LGA of South Australia has produced a guide for councils to assist in the development of their climate change adaptation plan (LGA SA, 2011).

In addition, the Climate Change Risk Management and Adaptation Program, funded through the LGA SA's Mutual Liability Scheme (MLS), examined the operational risks councils can encounter that are associated with climate change, and worked to complement the federal LAPP. The aim of the Program has been to capture the relevant risk and opportunity-related data that is based on predicted climate variables such that it will support councils to develop their own individual, or regionally-based, climate adaptation modelling and adaptation plans. The LGA SA have claimed that the Program has been successfully delivered to around one half of the total 68 councils within the state (LGA SA, 2010).

South Australia has had specific provisions within state planning policies, since the introduction of the *South Australian Coast Protection Act 1972*, to allow for sea-level rise pertaining to coastal development at the Local Government level (Harvey *et al.*, 2011). Current planning controls create a 'buffer zone' adjacent to the coastline which allow for a 30 centimetre rise in sea-level over 50 years plus an additional 70 centimetres for further sea-level rise and extreme storm events (CPB, 1992; Harvey and Caton, 2003).

The South Australian Greenhouse Strategy, entitled 'Tackling Climate Change', is the state's long-term response plan for climate change and has three broad themes: mitigation, adaptation and innovation (Government of South Australia, 2007a), and provides the means through which the state's *Climate Change and Greenhouse Emissions Reduction Act 2007* can be implemented. Of particular significance to this study is how strongly the strategy's main theme of adaptation endorses a more comprehensive approach to adaptation by building on existing expertise in the areas of science and research, community resilience and hazards (Government of South Australia, 2007a).

In reference to the six national case studies of the 'first pass' NCVA, South Australia's case study is located in Yorke Peninsula. This particular case study was a vulnerability assessment of the settlements to climate change impacts which considered the tradeoffs between current development pressure and mitigation, versus potential future liability to inform government planning and approval processes (DCC, 2008). At the time of thesis writing, the results of the study were yet to be publicly released.

3.3.3 Western Australian assessments

In Western Australia, the Office of Climate Change through the Western Australian Department of Environment and Conservation (DEC) has committed to invest AU$8.6 million over five years for a major initiative to help businesses and communities adapt to the unavoidable climate change impacts, with AU$4 million of the funds going directly towards research into such impacts through the Indian Ocean Climate Initiative (IOCI). The goal of the investment, as outlined in the climate change action statement entitled 'Making Decisions for the Future: Climate Change', is to provide better regional weather projections in order to allow businesses and people to plan and adapt to the changing conditions (Government of Western Australia, 2007b).

In reference to the six national case studies of the 'first pass' NCVA, the primary outcome of the Western Australian case study is to examine the impacts of climate change on the oil and gas industry within the Pilbara coastal region. The case study has been specifically aimed to assess the vulnerability of impacts on the infrastructure, productivity, and local communities, as well as to consider the implications for government planning and approval processes (DCC, 2008). At the time of thesis writing, the results of the study were yet to be publicly released.

It must be noted that Western Australia, similar to South Australia, has state planning controls for use by Local Government, which may restrict development along the coastline within areas that are expected to be at risk of inundation or erosion from sea-level rise and extreme storm events, particularly in the future (Freehills, 2010). In September 2010, the Western Australian Planning Commission (WAPC) decided to review its development setback guidelines to incorporate more recent projections of sea-level rise. The WAPC policy still incorporates a 38 centimetre sea-level rise by 2100, however, this is recommended to be changed to 90 centimetres by 2110 such that the setback guideline increases from around 100 metres to 150 metres (WAPC, 2010). This is of particular interest to this study since it highlights the significance of statutory regulations in the distribution of development control on the coast.

3.4 Summary

This chapter discussed the concepts of vulnerability and adaptation, building on the introduction of coasts and coastal vulnerability detailed in Chapter 1. It broke down both of the concepts into component parts of exposure, sensitivity, and resilience and discussed their relevancy to climate change studies; it concluded that the interconnectedness and complexities of these components warrants an integrated approach, particularly with respect to the unique interactions between the socio-economic system, geomorphological system and ecosystem at the coast. This chapter also examined the current array of coastal vulnerability and adaptation studies in Australia, as a whole, and then the two states whereby the case studies for this research project are located to demonstrate the gap in the literature, particularly in terms of the regional and local level coastal vulnerability assessments that focus on the human dimensions of change. From a top-down and policy-making perspective, it was evident that there had been a focus on the biophysical assessment of coastal vulnerability, and an acknowledgement of the need for an examination of the human dimensions of vulnerability at the local scale. Indeed, the human dimensions comprise

an important aspect of the integrated approach, and should consequently not be overlooked. As Voice *et al.* (2006, p. 3) discuss:

> *A full assessment of vulnerability requires consideration of the economic and social value of the goods and services, infrastructure or ecosystems at risk; combined with an assessment of resilience of the communities or ecosystems. The first requirement, however, is to identify and map the various components considered vulnerable and assess their respective risk of being impacted by climate change. Prior knowledge and expert assessment of the susceptibility of systems and the values at risk should enable selection for highest priority in assessment and thus a focused assessment process.*

Following the prior knowledge and expert assessment of the biophysical dimensions assessment of climate change vulnerability (discussed in both Chapter 1.4.4 and throughout this chapter), this thesis has identified two coastal case study sites whereby public risk perceptions can be explored in relation to biophysical climate change risks. This exploration of perceptions can improve our understanding of the human dimensions of climate change, and from here, a much more focussed and integrated assessment may be undertaken, for instance, based on the selection of highlighted priority areas as Voice *et al.* (2006) states above. The following chapter will now explore the concept of public risk perceptions and how they relate to the issue of climate change.

Chapter 4 – Risk

This chapter discusses one of the prime components of social vulnerability research, and the focus of this thesis – public risk perceptions of climate change, which will strongly influence levels of support for, or opposition to, related public policies. This chapter concentrates specifically on the gaps in the literature on the human dimensions of vulnerability by detailing the literature regarding perceptions of risk, and the influence such perceptions have on individual and group behaviour – indeed, this behaviour has an important role in determining the extent to which communities both adapt and mitigate climate change. This will lead the discussion into an examination of heuristics and biases, which are strongly involved in individual decision-making under uncertainty, and expand briefly upon how each of these may relate to emerging issues of climate change risk. This chapter then outlines specific climate change risk perception studies and concludes with a discussion on the way research into risk perceptions can better inform policy and decision-makers.

4.1 Risk perceptions

As outlined in Chapter 1, the IPCC discussed the need for social vulnerability analysis, and the need to include a greater emphasis on the human dimensions of vulnerability; such as cognition, values, attitudes, social networks, and perceptions (IPCC, 2007a). The NRC examines the IPCC's recommendations in reference to its US Climate Change Science Program, and concludes that a restructuring of its program is necessary so that existing research elements and crosscutting themes can contribute to scientific-societal issues in order to more fully embrace the human dimensions component (NRC, 2009).

These human dimensions have been identified as key limitations and barriers to successful adaptation to climate change and a strengthening of focused research is necessary (NRC, 2009; IPCC, 2007c). Although there is a tendency for overlap with some of the other elements outlined above including exposure, sensitivity and resilience, this is unavoidable due to the inherent interconnectedness of the nature of elements under the 'banner' of the human dimensions of climate change. Nonetheless, this overlap will be minimised through this project's focus on

generic indicators of social vulnerability that are specific to climate change impacts in coastal communities, particularly sea-level rise and storm surge flooding.

This research project explores one such element of the human dimensions of vulnerability: perceptions of risk, which is strongly influenced by social factors (Reser and Swim, 2011). Further, the degree to which members of the public perceive the risks of climate change, and specifically those who own coastal properties within physically vulnerable areas, has yet to receive significant research attention. As Leiserowitz (2005, p. 1433) states, "public risk perceptions can fundamentally compel or constrain political, economic, and social action to address particular risks". Jaeger *et al.* (2001, p. 106) further discuss that:

> *Individuals respond according to their perception of risk and not according to an objective risk level or the scientific assessment of risk. Scientific assessments are part of the individual response to risk only to the degree that they are integrated in the individual perceptions.*

Following on from Wisner *et al.* (2004), and their discussion of vulnerability as an inherent factor of the system, it is important to consider the literature on cognitive psychology and decision-making during uncertainty to examine the ways in which they constitute key elements of a system's inherent condition. The system, in this context, represents the 'community' in a broad sense. This research project primarily involves an exploration of public perceptions of climate change risk and how this may create, for example, conditions where there is an 'overreaction' or 'downplaying' of risk (Renn, 2011). As the IPCC (2007a) concluded, risk perceptions vary among individuals and groups within populations, and can act as barriers to responding and adapting to climate change.

In addition to scientific and technical assessments of risk, there is a variety of psychological, cultural and social factors that influence public perceptions of risk that include personal experience, affect and emotion, imagery, trust, values, and worldviews (Slovic, 2000b). Kahan and Braman (2006), for instance, describe four basic worldviews that people incorporate into their general social, cultural and political attitude towards the world. These classifications can lead people into perceiving risks differently and preferring different policy responses (Leiserowitz, 2006; Peters and Slovic, 1996). These worldviews are expressed as:

1. Hierarchical, whereby people are said to be group-oriented and consider high levels of prescribed social stratification and hierarchy;

2. Egalitarianism, whereby people are also group-oriented, but there are low levels social stratification;
3. Individualism, whereby people are individually-oriented and do not believe that many rules are necessary to govern behaviour; and
4. Communitarianism, whereby collective needs are more important than individual needs.

Worldviews, in this instance, provide a lens which "colours our general beliefs about society and the environment" that can act as barriers or drivers of the process of adaptation to climate change (Moser and Ekstrom, 2010, p. 22030). In America, for instance, Leiserowitz (2006) found that policy preferences were strongly influenced by such worldviews, whereby those holding pro-egalitarian beliefs found to be more likely to support national and international climate policies, and those holding anti-egalitarian, pro-individualist and pro-hierarchical were more likely to oppose such policies.

Much of the appraisal of information received about the risks and dangers of the biophysical world is mediated through the social world (Berger and Luckmann, 1967; Gergen, 2009). Reser and Swim (2011) summarise three theoretical frameworks that describe this mediation:

1. Social construction, which refers to how individuals 'construct' a shared reality of the world through social interactions that impose meaning and order onto certain entities. What constitutes a response to 'climate change', therefore, may be constructed by members of society through every day and ongoing conversations and exchanges;
2. Social representation, which refers to shared assumptions and understanding of the world, which includes "material culture expressions, images, texts, other information and communication technology products, and information environments that capture and reflect particular worldviews" (Reser and Swim, 2011, p. 6). These representations provide the framework for individuals to interpret and communicate their experiences with others; and
3. Social processes, which both attenuate and amplify understanding of particular phenomena (known as SARF, to be discussed later). It involves particular signals, in the form of signs, images or symbols, which interact with psychological, social, institutional, or cultural processes in ways that diminish or intensify risk perceptions.

Such a perspective for understanding the appraisal of risk is necessary since, as Leiserowitz (2005, p. 1434) explains, fundamentally, "public support or opposition to climate policies (e.g.,

treaties, regulations, taxes, subsidies) will be greatly influenced by public perceptions of the risks and dangers".

Growing concerns of environmental risk and degradation have increased the number of scientific research assessments on the effects of many hazards, and it is often thought that the publication of such assessments would elicit appropriate public action, however, this is generally not the case (Slovic *et al.*, 2000c). There are occasions where the publication of scientific risk assessments on occasion has led to swift public action, but they typically do not (Lawless, 1977; Slovic *et al.*, 2000c). In fact, there have been numerous analyses of the lack of public response to the issues of climate change (Bord *et al.*, 1998; Bulkeley, 2000; Dunlap, 1998; Kempton *et al.*, 1995; Read *et al.*, 1994; Rosa, 2001). One of the dominant themes which had emerged from these investigations was an emphasis on the public's lack of information on the causes of climate change. Although knowledge is necessary to generate a public response to climate change, it is not sufficient enough on its own (Norgaard, 2006).

The gap between an individual's assessment of risk and the scientific assessment of risk has been detected in several research fields, and is commonly known as the knowledge-deficit model (Kellstedt *et al.*, 2008). This model of expert versus lay judgement assumes that scientific risk assessments are both objective and correct, whereas the public's risk perceptions are subjective and inaccurate (Slovic, 2000c). As discussed above, it is also assumed that providing information on particular topics and risks will lead to increased public concern about such risks (Slovic, 2000c). Interestingly, in their research on environmental information regarding attitudes toward global warming and climate change in the US, Kellstedt *et al.* (2008) found that the knowledge-deficit model is inadequate for understanding mass attitudes about scientific controversies, such as climate change. In fact, it was found that the more information an individual had about global warming, the less concerned they were for it and the less responsible they felt for it – the exact opposite of what was expected (Kellstedt *et al.*, 2008).

Relatable findings are observed and explained regarding people's reluctance to buy insurance against natural hazards, whereby people exhibit the 'invulnerability syndrome' (Covello *et al.*, 1988; Weinstein, 1980). 'Invulnerability' is the result of an individual's subjective perception of risk being much lower than any official estimate, and "for a person unconvinced of the pending threat, protective measures are not warranted, and therefore a waste of money" (Jaeger *et al.*, 2001, p. 99). Research on risk perceptions, therefore, may help to understand how the public consider risk

and decide upon specific courses of action that have been mediated through formal and informal networks. The following section discusses environmental risk perceptions and the role that these perceptions play in predicting behavioural intentions and expectations, as well as their part in shaping environmental policy and management responses.

4.1.1 Background

It has been established that vulnerability and risk studies in the social sciences have focussed a significant amount of their attention on technological and economic risk, as well as natural hazards, and have generated a considerable knowledge foundation upon which to examine the changing nature of risk, and the way in which society views, assesses, and manages such risks (Pidgeon *et al.*, 2003). Slovic (1987) discusses the uniqueness of humans and society since, in addition to having the ability to sense and avoid harmful environmental conditions, we have the added ability to be able to systematise risk and learn from past experience. There are several factors that can 'misguide' these judgements of risk, however, which fall under the 'banner' of risk perception. For example, research reveals that the mass public can confuse stratospheric ozone depletion, greenhouse effects, and climate variability, and misunderstand the relationship between temperature and CO_2 (Bell, 1994; Bostrom *et al.*, 1994; Dunlap, 1998; Kellstedt *et al.*, 2008; Sterman and Sweeney, 2002).

Literature on environmental risk perception has had substantial attention since the late 1960s (O'Connor *et al.*, 1999) and much of the background to understanding risk perceptions has stemmed from the fields of geography, sociology, political science, anthropology and psychology (Slovic, 1987). Risk perceptions matter since they aide in predicting behavioural intentions (O'Connor *et al.*, 1999), and according to Slovic (1987), research origins in geographical studies have examined risk perceptions substantially in terms of human behaviour in response to natural hazards, but this has since broadened to also include technological hazards. Research attention has focussed on the nature of risk perception of numerous hazards simultaneously (Slovic, 2000b), the quantification and ranking of these perceptions, as well as the correlation between demographic, societal and attitudinal characteristics (Brody *et al.*, 2008; O'Connor *et al.*, 2002; Savage, 1993).

Sociological and anthropological research on perceptions of risk, on the other hand, have their origins in the study of social and cultural factors, such that peoples' responses to hazards are generally mediated influentially by those around them. Psychological studies on risk perception

have instead stemmed from empirical studies of probability and utility assessments, as well as decision-making processes (Slovic, 2000b). In particular, the study of heuristics and biases has formed a considerable foundation in psychological risk perception research, whereby people create mental strategies to simplify and make decisions based on memorability, representativeness, and affective qualities of risk events (Pidgeon *et al.*, 2003). Occasionally, these lay mental strategies are quite sophisticated, however, they may also be insufficient or misrepresent reality, which can hinder effective decision-making regarding risk (Finucane, 2009). These strategies, or mental models, will be discussed in the following subsection.

Risk perception is the way in which individuals and groups judge, interpret and calculate risk based on available evidence and experience on their potential losses and specific vulnerability associated with particular hazards (Sjöberg *et al.*, 2004; Slovic, 2000b). Due to the increasing incidence and importance of public participation in planning, researchers have noted that public risk perceptions often drive the development, or prevent the implementation of policy as much as scientific risk assessments (Brody *et al.*, 2008; Correia *et al.*, 1998; Slaymaker, 1999; Tierney *et al.*, 2001). It is for the above reason that this research is examining climate change risk perceptions, since it may help to assist in the design and implementation of more socially acceptable adaptation strategies.

Many modern hazards, however, due to their “elusive and hard to manage qualities” (Slovic, 1987, p. 280), are much more problematic to identify, characterise and quantify. One example of such a hazard is the result of technological uncertainty. Kasperson and Kasperson (1996, p. 96) describe this as the “complexification of risk”. The complexity of modern hazards, it has been argued, eventually led to the creation of the intellectual discipline of risk assessment. Risk assessment was traditionally dominated by the view that uncertainty is external, quantifiable, and able to be understood objectively (Smithson *et al.*, 2008). However, as Pidgeon *et al.* (2003) discuss, there has been a substantial shift towards ‘bridging the gap’ between scientific knowledge and the way in which the public assess risk and make decisions. As such, the prospect of broad-based social research on risk communication and community engagement is gaining considerable momentum and attracting greater support from institutions (Pidgeon *et al.*, 2003).

Additionally, significant and dramatic global events such as the 2001 terrorist attacks in New York in the United States, the 2004 Indian Ocean Tsunami, the 2011 Fukushima Daiichi nuclear

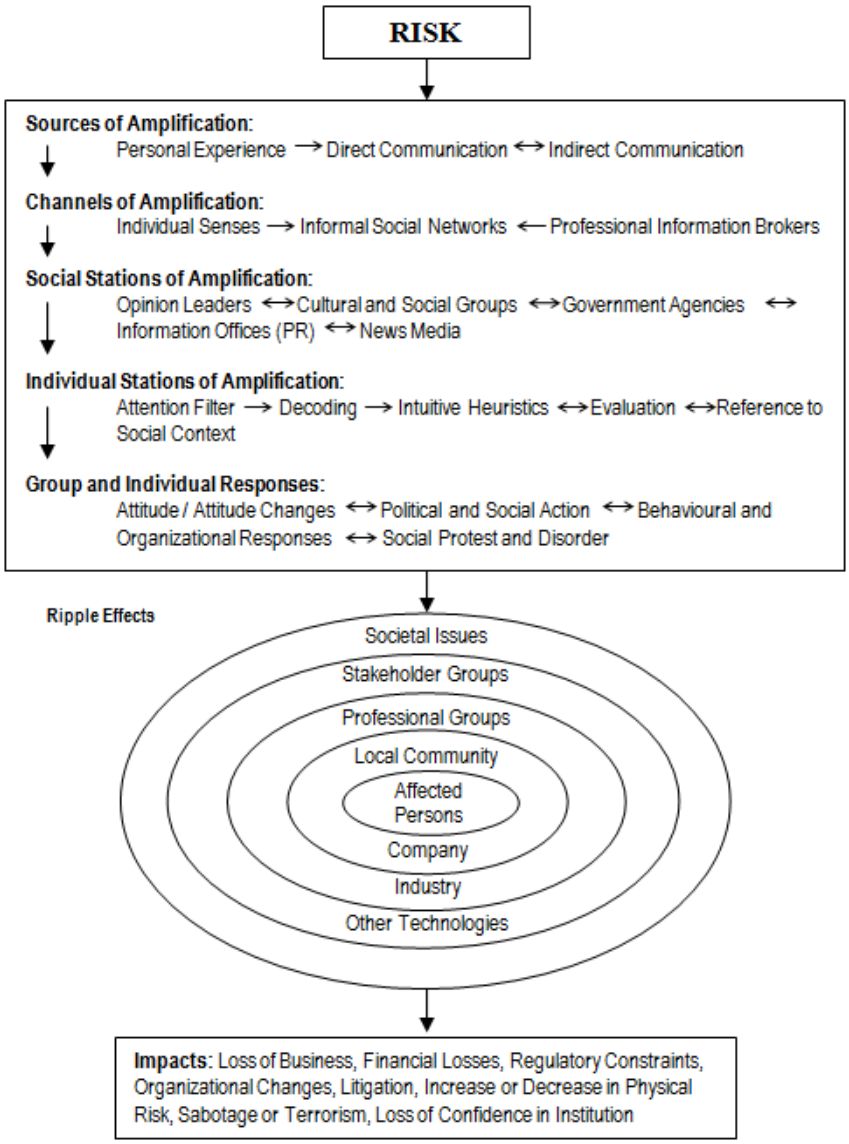
disaster in Japan, and the projected scenarios of global climate change and sea-level rise have further emphasised to authorities and managers the considerable interconnectedness of technical risk with social considerations, judgements and processes (Kasperson *et al.*, 2003a; Pidgeon *et al.*, 2003). The discipline, consequently, has now shifted focus due to this complexification. Indeed, much more importance has been given to "social constructions, subjective appraisals, qualitative and narrative accounts, and context dependence" evaluations of risk (Smithson *et al.*, 2008, p. 327). The endeavour, therefore, should be to continue to include these factors, as Slovic (2000b) concludes, since risk is inherently subjective, and even the most basic of formal risk assessments are based on theoretical models constructed using assumptions and inputs dependent upon judgements.

Despite these considerable research efforts, it has been suggested that risk perception and risk communication research remains quite fragmented in its theoretical basis (Pidgeon *et al.*, 2003). Pidgeon *et al.* (2003) assert that in order to obtain a more complete and systematic understanding of the social experiences of risk the discipline is in need of overarching and integrative approaches. To overcome these fragmentations, researchers from Clark University Massachusetts and Decision Research Oregon developed the social amplification of risk framework (SARF), which essentially considers the research findings from a wide range of study areas (Kasperson *et al.*, 1988). Amplification, in this respect, is both the intensification and/or attenuation of risk such that both 'overreactions' and the 'downplaying' of risk by individuals and groups can be explored (Renn, 2011). Many of these qualitative characteristics of risk are interrelated across a varying range of hazards. Renn (2011, p. 156) states that the SARF is premised upon the notion that "the social and economic impacts of an adverse event are determined by a combination of the direct physical consequences of the event and the interaction of psychological, social, institutional and cultural processes" (Kasperson *et al.*, 2003a; Kasperson *et al.*, 1988). The SARF was also targeted at broadly examining and describing the linkages between risk and hazard events and their interaction with social, cultural, psychological and institutional processes (Kasperson and Kasperson, 1996; Pidgeon *et al.*, 2003).

Figure 4.1 illustrates the social amplification and attenuation of risk framework (SARF). The process of amplification begins with the individual or group recognition of an adverse risk event or the actual physical incidence of an adverse event (Renn, 2008; 2011). The individual or group then selects specific characteristics of the adverse event and interprets them based on their perceptions to compile a message that is communicated to other individuals or groups (Renn,

1991). Primarily, the intensification or attenuation of the adverse risk event occurs when individuals or group representatives collect and respond to communicated messages to act as social 'amplification stations' (Renn, 2011). Due to behavioural responses and further communication of the adverse event, it is likely that the consequences extend beyond those primarily affected, such that secondary amplification effects are induced. These effects may be further amplified by the perceptions of social groups or institutions to produce third-order impacts which, through this distribution, create 'ripple effects' that flow on to other parties, distant locations or future generations (Kasperson *et al.*, 2000). Indeed, not only does this dissemination highlight social and political impacts, but it may also trigger or hinder positive changes for risk reduction (Kasperson *et al.*, 1988; Kasperson *et al.*, 2000; Renn, 2011).

Figure 4.1: Social amplification and attenuation of risk conceptual framework (SARF)



Source: Kasperson et al. (2000, p. 240)

As Kasperson and Kasperson (1996) discuss, society today does not typically learn about risk through direct experience, rather they learn through information systems and major agents or 'social stations' of amplification. Of particular importance to the shaping of individual and group perceptions is the mass media (Nisbet, 2009a; Speck, 2010). Kasperson and Kasperson (1996, p. 97) explain that this significance lies in the:

> *…extent of media coverage; the volume of information provided; the ways in which the risk is framed; interpretations of messages concerning risk; and the symbols, metaphors, and discourse enlisted in depicting and characterizing the risk.*

Similarly, social institutions, organizations, corporations, and non-governmental and political groups also occupy this space with respect to conceptualising, identifying, measuring and managing risks, as well as in terms of the risk's prominence with respect to political campaigns and social movements (Kasperson and Kasperson, 1996).

On an individual level, Slovic (1987) utilises factor analysis to investigate the relations between risk and hazard. There are two categories of risk derived from this work, which are deemed to have 'dread risk', or have an 'unknown risk'. 'Dread risk' is considered as that which is perceived to be uncontrollable, and have catastrophic and fatal consequences, whereas 'unknown risk' is that which is perceived to be unobservable, unknown, new, and delayed in its manifestation of harm. Climate change, in this instance, can be considered as both 'dread risk' and as 'unknown risk'.

For individuals and groups making decisions regarding such 'unknown' or new risks, intuitive heuristics assist in them in simplifying complex situations and arriving at some conclusion to inform their course of action. With 'dread' risk, a similar heuristic process is engaged, although, due to intense emotions, the focus is directed towards the adverse outcome as opposed to likelihood and, consequently, worst-case scenarios become emphasized. These two categories of risk derived from Slovic (1987) demonstrate a number of cognitive factors which can cause bias or influence these heuristics and create false or inaccurate scenarios and probabilities of risk. These factors are discussed in the following subsection.

As noted by Sjöberg (2003), individuals require a distinction between risk to themselves (personal risk) and risk to their community or others (general risk). A context for risk is necessary in order for individuals to clarify which definition of risk they choose to work with and, overall, is crucial to understanding the degree of rationality, or lack thereof, involved in people's decisions (Sjöberg,

2003). Indeed, it has been consistently found that personal risks are judged as smaller than general risks (Sjöberg, 2003; Slovic, 2000b). As a result of this divergence, the research presented in this thesis explores perceptions of risk for both the individual (personal) and towards the community (general).

In an attempt to bolster individual perceptions of climate change risk, efforts have been made in recent years to re-frame the issue and re-engage individuals (Moser, 2010b). This re-framing has communicated climate change as an issue of national security, economic well-being, public and individual health and well-being, as well as environmental sustainability (Nisbet, 2009a; b). One such re-framing has also focussed on climate change as being a moral imperative that involves personal responsibility, stewardship of the Earth, and humanitarianism (Moore and Nelson, 2010; Wardekker *et al.*, 2009). Markowitz and Shariff (2012) discuss that there are particular features of climate change, and the way in which it has been communicated to the public, that interact with the human moral judgement system and subsequently decrease individual perceptions of the issue as a moral imperative.

Table 4.1, compiled from Markowitz and Shariff (2012), lists six psychological barriers to the human moral judgement system as a result of climate change, and six psychological strategies to overcome them. In reference to the barriers: (i) the abstract nature of climate change deems it non-intuitive and cognitively difficult to grasp; (ii) the human moral judgement system reacts to intentional transgressions, not unintentional ones; (iii) the anthropogenic influence on climate change incites a self-defensive bias to reduce anxiety; (iv) the lack of definitive forecasts for change leads to unreasonable optimism; (v) the politicisation of climate change results in ideological polarisation; and (vi) the more dissimilar and socially distant the 'victims' of climate change are, the less morally obligated people feel.

To reinforce people's perceptions of climate change as a moral issue, strategies developed by Markowitz and Shariff (2012) can include: (i) framing climate change with more broadly held values; (ii) a focus on the costs imposed on future generations; (iii) motivating people through appeals to hope, pride and gratitude, not guilt, shame and anxiety; (iv) exercising caution with extrinsic motivation, such as economic benefits, since this approach may 'backfire'; (v) increasing identification with, and empathy for, future generations and people living in 'other' places; and (vi) highlighting the positive behaviour of individuals that act as 'models' for social norms.

Table 4.1: Psychological barriers and strategies to recognising climate change as a moral imperative

NOTE:
This table is included on page 146 of the print copy of the thesis held in the University of Adelaide Library.

Source: Author, adapted from Markowitz and Shariff (2012)

4.1.2 Heuristics and biases

There are many cognitive limitations that can lead to an underestimation, overestimation or even complete ignorance of risk. Current psychological understanding asserts that humans strongly rely on heuristics for decision-making during uncertainty. Heuristics simplify complex situations to assist in timely decision-making (Kahneman *et al.*, 1982). The influence of the classical model of rational choice, which was widely adopted and applied in economics, extended such that it can be identified within most academic disciplines (Gilovich and Griffin, 2002). The model of rational choice presupposed that an individual's decisions are based on a calculation of the optimal combination of both probability and utility (Gilovich and Griffin, 2002). The most significant theoretical development positioned in current understandings was through Simon's (1957) discussion of the unrealistic expectations of the rational choice model for human judgements. Instead, Simon (1957) proposed a model dubbed 'bounded rationality', which accounted for the limitations and computational capacities inherent to human decision-making abilities, and the simplifying mechanisms, known as heuristics, to cope with these limitations (Gilovich and Griffin, 2002; Slovic *et al.*, 2000c). Additionally, observations of consistent patterns of violations in rationality made it difficult to sustain the idea of rational choice, and the strategy changed to observe and discover hidden rationality within alleged irrational responses (Jaeger *et al.*, 2001; Jungermann, 1986).

Tverskey and Kahneman (1974) further developed the model of bounded rationality and initially described three general heuristics that are employed by individuals to assess probabilities and predict values during uncertainty. These are:

1. Availability;
2. Representativeness; and
3. Anchoring and adjustment.

These heuristics were proposed as a set of "highly efficient mental shortcuts that provide subjectively compelling and often quite serviceable solutions to such judgemental problems" (Gilovich and Griffin, 2002, p. 4). As stated, however, the solutions were just that – serviceable, not exact or perfectly accurate, thus there needed to be an explanation of when and why these errors exist (Gilovich and Griffin, 2002). Discussions mounted regarding heuristics as parallel to strategies people use deliberately in order to simplify judgemental tasks, or as automatic "natural assessment[s] that the [specific] problem evokes" which may not necessarily be used deliberately or strategically (Tverskey and Kahneman, 2002, p. 43).

There are two key general biases that are associated with heuristics (Gilovich and Griffin, 2002). The first is 'myopia', or short sightedness, whereby one generally fails to consider the long-term and often only considers the short-term such that it can harm one's interests (Sunstein, 2005). The second is where many people are, at times, unrealistically optimistic and will consistently overestimate positive gains, such as one's likely earnings, and underestimate negatives, such as personal risk or losses (Slovic, 2000a; Sunstein, 2005). As a consequence of such optimism, many low-level risks typically will not register in cognitive processes to the point where they may even be ignored. It has been suggested that such ignorance may be the likely result of one's attempt to avoid the anxiety that comes from comprehending inevitable risks (Sunstein, 2005). The broadness of the factors that people use to inform their judgements and perceptions of risk, however, makes it difficult to aggregate individual preferences and deduce common denominators.

The following subsections discuss the three 'general-purpose' heuristics within the literature, as identified by Tverskey and Kahneman (1974), and how they influence decision-making. The following sections identify links to climate change for each particular bias and stipulate their relevance for consideration within this thesis. It should be noted that this is a brief discussion and

many biases display significant overlap, which demonstrate the interconnectedness and complexities of these factors.

4.1.2.1 Availability

The availability effect is where individuals can estimate probabilities and frequencies utilising the ease of memorability of past experience and events (Jaeger *et al.*, 2001; Kahneman *et al.*, 1982; Slovic *et al.*, 2000a; Sunstein, 2005; Tverskey and Kahneman, 1973; 1974). The availability effect is described as where "one judges the probability of an event by the ease with which relevant instances are imagined or by the number of such instances that are readily retrieved from memory" (Slovic *et al.*, 2000c, p. 13). This hypothesis also implies that any factor which makes an event or hazard highly memorable or imaginable could significantly increase the perceived risk of that event or hazard, and as a result, could produce inaccurate assessments of probability (Slovic *et al.*, 2000a; Slovic *et al.*, 2000c; Sunstein, 2005). For climate change, a heightened media focus on natural hazards to the extent that it makes those hazard events highly memorable, may be an amplifying factor associated with climate change risks, through the expected exacerbation in the frequency and intensity of natural hazards.

Experiments of the availability effect have revealed biases related to retrievability of instances due to familiarity and salience, specifically, the more retrievable the more likely they are to be judged as more numerous or more probable. Similarly, tasks involving a search set, for example, reveal that the more available the context or occurrence is, the more likely there is to be an overestimation of frequency (Tverskey and Kahneman, 1973). Such familiarity and salience may be linked to misconceptions of climate change impacts as a result of weather events. In addition, imaginability plays an important role in the availability effect, particularly in real life situations, whereby if particular situations can be imagined as plausible, their likelihood may be perceived as such, despite any actual degree of likelihood (Kahneman *et al.*, 1982; Tverskey and Kahneman, 1974). Furthermore, availability experiments also reveal an illusory correlation, whereby the frequency of co-occurrence of two events is typically judged by the strength of the association between the two events (Kahneman *et al.*, 1982; Tverskey and Kahneman, 1973; 1974).

Availability biases, for example, have been demonstrated by Slovic *et al.* (2000a) in relation to low-probability, high-consequence events. In one US study, test subjects perceived the frequency of deaths in 'spectacular' events such as fire, which often claims multiple lives and attracts considerable media coverage, as considerably greater than the less 'spectacular' single-victim

drowning event, despite the frequency of both events being approximately equal. It was concluded from this study, and others, contrary to some assumptions, that intelligent and/or sophisticated individuals may not necessarily have more valid perceptions about the frequency of hazardous events than do naïve individuals (Kahneman *et al.*, 1982; Slovic *et al.*, 2000a; Tverskey and Kahneman, 1974). In fact, Tverskey and Kahneman (1971) note that, in a study of the design of psychologists scientific experiments, despite extensive formal training in statistics, psychologists typically rely upon their educated intuitions in making judgements, such that they had seriously miscalculated the amount of error and unreliability inherent to small samples of data.

4.1.2.2 Representativeness

Representativeness is where particular events experienced personally, or events that are associated with certain properties of another event, are judged as more likely to occur (Jaeger *et al.*, 2001), that is, to what degree is one event representative of another event? The primary notation, as Tverskey and Kahneman (1974) assert, is that representativeness is not affected by prior probability, or base-rate frequencies, of particular outcomes. Rather, probability is most often assessed by the degree to which an occurrence is representative of, or similar to, another. For example, if A is highly representative of B, the probability that A is caused by or causes B is judged to be high (Kahneman *et al.*, 1982). Often, representativeness is reduced to similarity, whereby "a person seems representative of a social group if his or her personality resembles the stereotypical member of that group" (Tverskey and Kahneman, 2002, p. 22).

Representativeness may exhibit itself through an overestimation of the extent to which the past is representative of the present and the extent to which solutions for past problems will be of use for present problems (Schwenk, 1984). For potential solutions to the problems caused or exacerbated by climate change, a representativeness bias may result in an overconfidence in applying past solutions to present and future issues. For instance, on an individual household scale, particularly in coastal areas, past solutions to erosion problems such as beach replenishment, and hard protection barriers and shields may not be appropriate in the future.

The discussion of representativeness so far does not cover the entire spectrum of the bias since there are also causal and correlational factors inherently involved (Tverskey and Kahneman, 2002), albeit, these will not be discussed in detail here. Firstly, experiments identifying the representativeness heuristic reveal an insensitivity to sample size, whereby subjects essentially

fail to appreciate the role of sample size, and consequently, their judged probabilities of certain occurrences are the same for samples of 1000, 100, and 10 people, for instance (Kahneman *et al.*, 1982; Tverskey and Kahneman, 1974). Similarly, representativeness experiments also reveal misconceptions of chance, whereby there is an expectation that a sequence of events, generated randomly, will represent characteristics of the overall random process, even when the sequence is short (Kahneman *et al.*, 1982; Tverskey and Kahneman, 1974).

Insensitivity to predictability is also revealed in experiments whereby evidence is given and outcome predictions are elicited. However, these predictions are often made regardless of the reliability of evidence, which impact on the expected accuracy of the prediction (Kahneman *et al.*, 1982; Tverskey and Kahneman, 1974). Similarly, individuals also reveal a strong illusion of validity whereby the confidence in their predictions depends on the degree of representativeness. Typically, this unwarranted confidence is produced by a 'good fit' between the predicted outcome and the information inputted (Kahneman *et al.*, 1982; Tverskey and Kahneman, 1974). Finally, examinations of representativeness also reveal misconceptions of regression, whereby people generally believe that "the predicted outcome should be maximally representative of the input" (Tverskey and Kahneman, 1974, p. 1128). Consequently for example, in behavioural studies, this can lead to an overestimation of the effectiveness of punishment, and an underestimation of the effectiveness of reward (Kahneman *et al.*, 1982; Tverskey and Kahneman, 1974).

4.1.2.3 Anchoring and adjustment

Anchoring refers to a process whereby an individual will use a starting point, or anchor, for an initial estimation of judgement, and adjust this judgement based on implications derived from any additional information acquired or the perceived significance of that information (Jaeger *et al.*, 2001; Slovic *et al.*, 2000a). These adjustments, however, are typically insufficient (Kahneman *et al.*, 1982; Tverskey and Kahneman, 1974). Chapman and Johnson (2002) explain three stages at which anchoring and adjustment may occur; first, information regarding the outcome is retrieved through memory or context; second, information is then integrated whereby the anchor may affect that integration or become part of the included information; and third, a judgement may be expressed on some external scale.

Experiments regarding anchoring and adjustment have revealed several biases which lead to an overestimation or underestimation of probability. Tverskey and Kahneman (1974, p. 1129) discuss the bias in the evaluation of conjunctive and disjunctive events, whereby typically, "the

chain-like structure of conjunctions leads to overestimations, [and] the funnel-like structure of disjunctions leads to underestimation". In this regard, for example, there is the tendency to overestimate the likelihood that a project will be completed on time, and conversely, there is the tendency to underestimate the likelihood of an overall failure in a complex system (Kahneman *et al.*, 1982).

Additionally, anchoring can create biases within assessments of subjective probability distributions. Experiments have shown that people tend to establish "overly narrow confidence intervals which reflect more certainty than is justified by their knowledge", which is, in part, attributable to anchoring biases (Tverskey and Kahneman, 1974, p. 1129). Climate change anchors, similar to discussions described above, may be based on the perception that if climate and weather has always fluctuated and that since events in the past were overcome, there is confidence in overcoming future problems. Similarly, there may be underestimates of the likelihood of 'failure' in aspects of everyday lives, such as loss to income and homes, as a result of future climatic changes.

4.1.3 Summary

There is a range of factors that influence individual risk perceptions, and while the discussion of heuristics and biases above highlights three key factors, it does not attempt to be an exhaustive list and is limited in highlighting the interconnectedness between them. Indeed, there is often considerable conflict within an individual's perceptions, and it is therefore virtually impossible to distinguish the driving force behind them, let alone attribute any single heuristic or bias to a particular decision. For this reason, the following section attempts to combine many of individual factors, heuristics and biases in the context of climate change, and broadly define each one.

4.2 Perceptions of climate change risk

This section explores the linkages between perceptions of climate change risk and the cognitive decision-making factors during uncertainty. First, it focuses on the uniqueness of weather and climatic occurrences in the past, with reference to the potential for changed conditions and decision-making under risk in the future. Second, it provides a discussion of the social amplification/attenuation of risk framework (SARF), introduced earlier, with respect to climate change risks. Third, it provides an examination of precautionary approaches towards problems with great uncertainty, whereby arguments for both action and inaction towards climate change

can be made. There is, of course, considerable overlap in many areas of the above points which not only provides evidence for the complexity of the problems faced, but demonstrates the need for an integrated and adaptive approach to resolve them.

4.2.1 Uniqueness of change

Future warming in this century is expected to be on a scale that is unprecedented in the era of modern human history (Tompkins and Adger, 2004). The challenges of climate change and associated impacts are such that the progression of trends is slow which can lead to a normalised habituation and expectancy, whereby they have not been experienced before by society and may typically be extremely subtle over consecutive years (Reser and Swim, 2011). That is, the unprecedented global warming trend over the last 200 years has been masked by 'typical' variability in year to year changes. Indeed, many changes may be considered as simply fluctuations in weather, or deviations from the mean, as opposed to overall and fundamental changes in climate (Halford and Sheehan, 1991). Consequently, responses to elements of variability, even those exacerbated under climate change, may not be perceived as departures from the norm or in response to a much larger issue.

Individuals and communities are already responding to climate change in much the same way that they have responded to climate variability throughout history (Adger and Brooks, 2003). For example, in some high latitude regions as a result of the direct physical impacts of climate change (Kolbert, 2006), such as that of Arctic Inuit communities who, in the face of changing climatic conditions and changing livelihoods, have demonstrated adaptability through traditional knowledge, strong social networks, flexibility in behaviour, and economic support (Ford *et al.*, 2006). In most other communities, however, and particularly those in Western industrialised nations, individuals respond to climate change based on how it is portrayed to them through formal and informal social discourses of climate change risk (Reser and Swim, 2011; Swim *et al.*, 2009). In addition, individuals respond to climate change based on how it is portrayed through the 'media lens' (Speck, 2010), which tends to be a powerful yet indirect representation of change. Within Australia, research has shown that the media has been the primary source of information and the main factor shaping people's awareness of climate change issues (Carvalho, 2010; Speck, 2010). Since the media is particularly pervasive in terms of influencing public opinion, this can have a deciding influence on policy formation and political actors (Cunningham and Turner, 1997; Speck, 2010).

The uniqueness of change primarily manifests itself through the observed rate of global change, and the uncertainty in the timing and extent of localised impacts of such changes. There is also the expectation that society will be surprised by climate-driven events, which science may not have the capability to warn about yet (Swim *et al.*, 2009). Challenges involving uncertainty in specific climate change impacts and their temporal onset, it is argued here, are similar to the challenges facing any individual or group in relation to hazards that have never or seldom occurred such that they cannot be recalled by memory to serve as an appropriate heuristic (Sunstein, 2005). For instance, the issue of flood hazard mitigation and experience can relate strongly to these challenges. Kates (1962, p. 88) discusses the difficulty inherent to the way individuals forecast their future flood potential in that they are "strongly conditioned by their immediate past and limit their extrapolation to simplified constructs, seeing the future as a mirror of that past". The non-linearity of the climate system, therefore, means that recently experienced events may not be accurate guides as to what society can expect in the future.

Much of the uniqueness of change is also due to the variety of ways in which climate change manifests itself through hazards that are incorporated into pre-existing mental models (Kempton *et al.*, 1995; Leiserowitz, 2006). As Swim *et al.* (2009, p. 28) describe, "[c]limate change is not a hazard *per se*, but a potential driver of many different hazards" with many place-specific impacts. Some hazards may inherently be more or less memorable than others and therefore skew judgements of inception and probability of occurrence. For instance, it would be expected that a drought, due to its gradual onset and offset, would be much less memorable, and therefore less accurately perceived than a flash flood (Slovic *et al.*, 2000c). Kirkby (1972) found that memorability of more salient natural events appeared to begin with an extreme event, which consequently clouded recollection of earlier events, from which later events were calibrated upon, not too dissimilar from the anchoring and adjustment heuristic. Further, salient images of negatives/losses attributed to particular hazards crowd out considerations of probability, such that "people tend to focus on the worst case, and neglect the probability that [the hazard] will [actually] occur" (Sunstein, 2005, p. 6).

The tendency to neglect probabilities may also occur for positives/gains, as well as negatives/losses. For climate change impacts, this probability neglect may be such that worst-case scenarios and 'surprises' are considered alarmist, and that best case scenarios, such as nil/minor impacts or even benefits, are considered optimistic (Sunstein, 2005). Whilst both of these scenarios lie at opposite ends of the range of possibilities, and are the least likely, they may

frequently be more salient than the more likely outcomes, such as those conveyed in probability distributions. Research has also shown that the vividness of images matters substantially in people's perceptions of risks, such that when an image of a bad outcome is dramatic and easily recalled, people will become more concerned about the risk, and hold the level of probability constant (Nisbett and Ross, 1980; Slovic, 2000b; Sunstein, 2005). A common factor here, in any case, is that what makes a hazard highly memorable or imaginable could increase its perceived risk, such as a recent news article, disaster film, documentary or lecture (Kahneman *et al.*, 1982; Slovic, 2000b; Slovic *et al.*, 2000c; Tverskey and Kahneman, 1974), such as with the release of the films *An Inconvenient Truth*, *The Day After Tomorrow* and *Ice Age: The Meltdown* (Kellstedt *et al.*, 2008).

There is both a growing body of scientific literature and consensus on climate change, as well as an increased exposure and awareness of the issue such that discussions have entered into popular culture (Kellstedt *et al.*, 2008). It is here where the ease of memorability and imagination play a challenging role in considering perceptions of climate change. Since public policy issues and themes are typically displayed in the mainstream media as being of conflict and debate, however, in considering climate change's overall scientific consensus, the media tends to not accurately reflect this consensus (Kellstedt *et al.*, 2008). What is quite an uncontested issue within the scientific community is portrayed as a much more balanced two-sided argument in the media. Therefore, the information people receive from the media might not heighten their efficacy, and sense of risk (Fischhoff *et al.*, 1981; Kellstedt *et al.*, 2008), particularly if the media reflections of the issues are not necessarily accurate, or if they represent the two lowest probability outcomes (worst-case and best-case).

Furthermore, on the issue of degree of climate change risk, there has been found to be bimodal responses whereby people tend to consider themselves as either safe or unsafe, and neglect the more pressing issue of likelihood of harm (Sunstein, 2005). Optimism may factor into these perceptions whereby certain risks are treated as if they are minute, and are even completely ignored on occasion, in order to feel safe and avoid anxiety (Baron, 2008; Slovic, 2000a). On an individual level it is quite canonical for people to ignore low level probabilities and worst-case scenarios, until the risk reaches a certain threshold, which is particularly the case when people decide on insuring against low-probability hazards (Baron, 2008; McClelland *et al.*, 1993). At a regulatory level, however, this is not the case. For climate change, there are no known probabilities of particular impacts at specific times or places, and no evidence to suggest that

nature will respond to future emissions scenarios in particular ways (Tompkins and Adger, 2005). Climate change decision-making frameworks based on known probabilities, therefore, are of little use (Tompkins and Adger, 2005) since individuals may not perceive the relevance of such probabilities, until catastrophic changes occur.

Climate change will drive a range of extremely dynamic and unique hazards. Humans are not able to rely on direct past experience of 'climate change', *per se*, due to the temporal scale of climatic changes in the past, and the fact that such changes are often embedded in natural variations. The 'noise' created by daily and seasonal variability in weather events (Halford and Sheehan, 1991), however, is where humans do have direct experience and can rely on past exposure in order to learn, particularly in the case of the risks from extreme weather events and natural disasters (Slovic *et al.*, 2000c). In the same way that memorability of past occurrences accounts for availability biases, weather and seasonal 'noise', as well as extreme and disaster events are a likely source of bias in the public's perceptions of climate change risk. An additional challenge presents itself through climate change uncertainty, whereby some of the facts, the exact shape of the problem, and particularly desired outcomes are unclear (Slovic, 1992). Climate change, therefore, presents potential hazards for which people must rely on theoretical and technical assessments of risk, as well as computer modelling and simulations in order to 'calculate' potential risk.

It is strongly conceded that studies in risk perception can lead to an improved understanding of how public perceptions of the risks posed by climate change operate within socio-political contexts. These studies are justified by the subsequent improved understanding of how the public may respond to actual climate change impacts or policy initiatives (Bord *et al.*, 1998). In terms of the design and implementation of climate change policies, the behaviour of individuals, in addition to the actions and reactions of others, play a key role in effecting how particular societies, and humanity as a whole, confront climate change (Dietz *et al.*, 2003; Kempton, 1991a; b; Renn, 2011).

4.2.2 Amplification/attenuation of risks

Indeed, the risks and benefits of climate change impacts as well as mitigation and adaptation policies can be amplified and/or attenuated, as per the SARF discussed earlier, by certain individual and societal factors. In fact, climate change is considered an example of where "both the risks of the problem as well as the risks of solutions are highly amplified" (Renn, 2011, p.

161). Indeed, the implications of the physical impacts of climate change will trigger economic losses, but so too will the actions to both mitigate and adapt to future consequences (Dietz *et al.*, 2010; Renn, 2011; Winter, 2006; Young, 2010).

The tendency for people to avoid losses may inadvertently be depriving themselves of benefits arising from the opportunities, not simply the risks, involved in mitigation and adaptation to climate change. Such 'loss aversion' is the tendency for people to attempt to avoid losses, rather than gain something advantageous (Sunstein, 2005). The concept of familiarity is also closely related to loss aversion, whereby people are much more willing to tolerate familiar risks as opposed to unfamiliar risks (Slovic *et al.*, 2000b; Sunstein, 2005). In terms of the familiarity of certain risk biasing judgements, familiar risks are inherent to everyday life, whereas new and unfamiliar risks may be concerning to individuals since it is difficult to assign probabilities to these risks and create new mental models to calculate their risk (Sunstein, 2005). Climate change impacts may be considered 'familiar' or 'known' and, if they are viewed as 'natural' and passively imposed on people (Brun, 1992), there may not be a cognitive link between anthropogenic forcing and issues of responsibility. Familiarity with weather events, for instance, may serve to reduce the perceived risks of climate change since many specific climate change impacts will be manifest in the form of more frequent and intensified weather events, albeit such attribution is difficult (Poumadère *et al.*, 2005).

Kasperson *et al.* (2003a) discuss the dynamic processes that underlie people's perceptions of, and responses to, climate change risk. In this particular instance, for example, the availability heuristic is quite usefully employed by individuals in simplifying decisions involving fear, whereby it can lead to serious errors in judgement relating to both insufficient reactions to large risks and excessive reactions to small risks (Sunstein, 2005). Within the SARF, risk is conceptualised as partly a social construct and as partly an objective property of a hazard (Renn, 2011; Rosa, 2003). In this respect, therefore, as with the previous discussions of generic indicators of vulnerability, risk is also considered context specific.

Risk amplification is a result of the processes that transform hazards and events from a low risk category, as assessed by experts, into something of particular societal concern. The opposite is risk attenuation, which occurs as a result of the processes that can reduce high risk category hazards and events, as assessed by experts, into something with considerably less societal concern. Theoretically, the SARF makes the assumption that risk events, including actual and

hypothesised events, are largely irrelevant and localised unless they are observed by and communicated between people (Kasperson *et al.*, 2003a). It is through social interactions that risk perceptions are both amplified and attenuated, and which 'ripple' through to others via further social interaction (Renn, 2011).

Renn (2011) explores the SARF as a metaphor, not as a causal theory, to assist the interpretation of data and insights from other studies and theories to provide a perspective of the human dimensions of the issue. In conjunction with other theories, the SARF is able to help understand the amplification/attenuation process. In utilising the SARF, Renn (2011) also incorporates two analytical concepts to complement its application: resonance theory, and; common pool resources. Resonance theory helps explain the mechanisms that lead to amplification/attenuation of climate change issues, and common pool resource problems help explain the reasons that motivate people to act on climate change.

With common pool resources, cognitive dissonance is one of the most extensively studied theories in social psychology and relates to the process by which people are motivated to reduce their dissonance (a state of mental conflict) by changing attitudes, behaviours and actions, as well as by justifying, blaming and denying (Festinger, 1957). Dissonance can occur when people are holding conflicting ideas simultaneously that are both inconsistent with a typical person's positive self-concept, such as: 'I am a successful person'; 'I am a good person', or; 'I make the right decisions', and that have negative consequences that were foreseeable and irrevocable (Aronson, 1969; Thibodeau and Aronson, 1992). Issues affecting common pool resources, such as in the case of climate change, therefore, may be downplayed by individuals and any risks denied in order to compensate for the difference between attitude and behaviour, and reduce levels of anxiety (Renn, 2011). For example, although people may believe in minimising their carbon footprint, they may not actually engage in such behaviour since they believe that any personal reduction will be compensated due to the overconsumption of others.

Renn (2011) introduces four key factors that attenuate the attention given to climate change:

1. There is confusion amongst the public between weather and climate, and a difficulty of communicating verifiable evidence of climate change and associated impacts;
2. Individual mental models are typically misleading of the causes and consequences of climate change, as well as of the requirements to prevent further future change;

3. Climate (in)stability is a global resource, and due to the characteristics of the tragedy of the commons there is often little motivation and incentive to change behaviour; and
4. Knowledge of climate change and having desirable social attitudes does not necessarily translate into environmentally conscious behaviour.

Overall, the SARF was developed to understand the reactions of individuals and organisations to the exposure of risk and, as such, it provides a useful framework for this thesis in terms of the heuristics employed at the individual level (Kasperson *et al.*, 2003a). In local contexts it can assist in bringing together community members' perceptions of risks and opportunities for adaptation with Local Government in terms of planning. While this research project will not examine the ripple effects of the amplification/attenuation process, the mixed-methods approach employed within the questionnaire has allowed the study participants to elaborate on such processes if, and when, they deem it appropriate. Risk perceptions are relevant in the identification of 'signals' in the communication process and it is these signals which have the potential to "become salient components of one's attitudes and to act as powerful motivators... or [become] downplayed in the public arena" (Renn, 2011, p. 158).

Observations of climate change risk perceptions, as well as the perceptions regarding potential resolutions, have seen these risks become amplified within all relevant policy arenas (Renn, 2011). Many of the conceptualisations of climate change, including misconceptions, have been amplified beyond the local context. Within developed nations, for instance, there has been much debate regarding the appropriate mechanisms through which to mitigate future climate change which, through uncertainties such as the rise in the cost of living to individual households, has undoubtedly amplified the economic risks of action, and downplayed the risks of inaction.

As the Stern review (2007) highlighted, however, the costs of preventative action to avoid serious climate change impacts are substantially less than the costs of damages thereby avoided. These upfront, *ex ante,* responses to climate change may indeed by amplifying losses more so than the benefits of future conditions. For instance, the costs of relocating coastal property due to the threat of sea-level rise, both financially and psychologically, may represent a loss that is perceived as much greater than any benefits gained by avoiding potential sea-level rise impacts altogether, and at some future point in time. Depending on how both the risks and resolutions have been framed, "the amplification process can oscillate between dramatizing the impacts of climate change and dramatizing the effects of mitigation" (Nisbet, 2009a; Renn, 2011, p. 161).

Therefore, a key message relevant to climate change policy from a social standpoint involving risk perceptions, on a range of geographic scales, is that of precaution due to uncertainty.

4.2.3 Precautionary approaches

International negotiations involving climate change issues have generally brought precautionary approaches to the forefront of much of the debate regarding mitigative and adaptive action. Precautionary approaches have primarily arisen through the recognition of risks to income and capital losses if no action was taken to prevent and/or adapt to future climate changes (Renn, 2011; Stern, 2007). Having been described as a "staple of regulatory policy" for several decades (Sunstein, 2005, p. 15), the 'precautionary principle' has increasingly received worldwide attention, particularly through its inception in numerous national and international policy debates involving how to conceptualise risk, health and the environment. Indeed, adaptation to climate change is inherently similar to the precautionary principle, particularly when it is anticipatory, since it is an "intervention taken to prevent or contain future risks" (Giddens, 2009, p. 164).

The precautionary principle's noteworthiness stems from its emergence in the United Nations 1992 Rio Declaration on Environment and Development, as Principle 15 (UNCED 1992). The definition was adopted and modified by the United Nations Framework Convention on Climate Change (UNFCCC) to become:

> *Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost.*

There are, of course, many definitions of the precautionary principle and many are not compatible with one another (Morris, 2000). The different understandings of these definitions can be thought of as being located along a continuum of understanding, with both strong and weak extreme interpretations at opposite ends (Sunstein, 2005). For instance, the weak interpretation of the principle is thought of as unobjectionable and important in the sense that, every day, individuals endeavour to avoid hazards that are far from certain, for example, such as avoiding walking in moderately dangerous areas at night, or avoiding fatty foods (Montgomery and Smith, 2000; Sunstein, 2005). On the other hand, the strong interpretations of the principle suggest that regulation is required in the event of any risk to health, safety or the environment, "even if the

supporting evidence remains speculative and even if the economic costs of regulation are high" (Sunstein, 2005, p. 24).

Depending upon the specific objectives, climate change action could locate itself in many spaces along the continuum of weak and strong precautionary approaches. To date, much of the literature on both interpretations has focussed on, at the weak end, whether the most optimal course of action is gaining further information and waiting before acting or, at the strong end, whether the possibility of worse than expected impacts should prompt more stringent immediate action (Bosetti *et al.*, 2009). For instance, since large expenditures themselves inherently carry risks, if society allocates large amounts of limited resources on reducing all speculative climate change risks, it may not be allocating those resources wisely and may quickly impoverish itself (Graham, 2001; Morris, 2000; Sunstein, 2005). In this case, such a precautionary approach is used to justify delayed action.

On the other hand, as Montgomery and Smith (2000, p. 402) suggest, with an intergenerational issue such as climate change, "[t]he role of adaptation becomes more important [since] time scales for impact[s] are very long". As Adger and Barnett (2009, p. 2800) state with respect to their reasons for concern about climate change adaptation, however, it is now being realised that perhaps the "window of opportunity for adaptation is smaller than previously imagined". In addition, in the context of climate change, the risk of catastrophe cannot be ruled out as insignificant, which justifies costly precautions – but at the same time acquiring knowledge is necessary to produce more information about the hazards (Sunstein, 2005). Sunstein (2005), therefore, concludes that the precautionary principle should not be utilised purely in situations posing unquantifiable risks of catastrophe, or because of uncertainty. Rather, an understanding of such situations does, in fact, justify taking particular precautions, but not where the expense of those precautions creates dangers.

A component in the discussion on climate change risk management has been on the need for a full or partial reversal of the burden of proof (Taylor, 2000). From this perspective, action/inaction may be considered harmful until proven otherwise. Consequently, proponents would need to prove that their activities, response measures, or policies will not cause serious environmental harm, and be effective in preventing and mitigating harm. Therefore, policy and decision-makers also bear a burden of establishing proof such that their strategies are, among other things, based on an assessment of potential costs and benefits in the short and long-term (Taylor, 2000). The

scope of such as assessment is consequently broadened beyond traditional economic cost-benefit analyses to include "non-economic considerations, such as the efficacy of possible options and their acceptability to the public" (Commission of the European Communities, 2000, p. 5).

It has been discussed above how a particular interpretation of the precautionary principle could, presumably, be used to justify delayed climate action (Montgomery and Smith, 2000). Such a weak precautionary approach, however, is being challenged by climate change's increasing prioritisation in public policy debates, as well as its salience on political agendas (Bosetti *et al.*, 2009). Typically, the precautionary principle has been argued strongly by advocates for immediate action, primarily due to the risks of irreversible changes and losses in the climate system, as well as socio-ecological systems (Adger and Barnett, 2009; Bosetti *et al.*, 2009). Despite the growing acceptance of the realities of climate change, there still remains a subset of the population who have doubts on various aspects of climate change.

4.3 Climate change 'scepticism'

Climate change scepticism has been associated with factors such as individual values and experience, worldviews and political orientation, as well as demographic characteristics (Whitmarsh, 2011). For example, studies have suggested that older people, males, those with low environmental values, that own cars, are less educated, and those who are politically conservative are more likely to be sceptical about climate change (Corbett and Durfee, 2004; Dunlap and McCright, 2008; Leiserowitz, 2005; Lorenzoni *et al.*, 2007; Poortinga *et al.*, 2011; Upham *et al.*, 2009; Whitmarsh, 2011).

The scepticism that is linked to certain characteristics described above, however, is not necessarily the outright rejection of human-induced climate change, which happens to be quite limited in the general public (Leviston *et al.*, 2011). Rather, scepticism here represents that of the greatest proportion of the public, who simply display some degree of uncertainty due to the perceived alarmism portrayed in the media, as well as doubts about the evidence and a distrust in particular information sources (Whitmarsh, 2011). In their study of climate change risk perceptions in two rural Australian communities with well-established forests and timber plantations, for example, Buys *et al.* (2012) note that those who were deemed sceptical tended to use terminology that implied natural causes, such as 'weather variability' rather than actually

attributing changing climatic conditions to anthropogenic climate change. This, they concluded, will likely hinder local and national climate change policy responses.

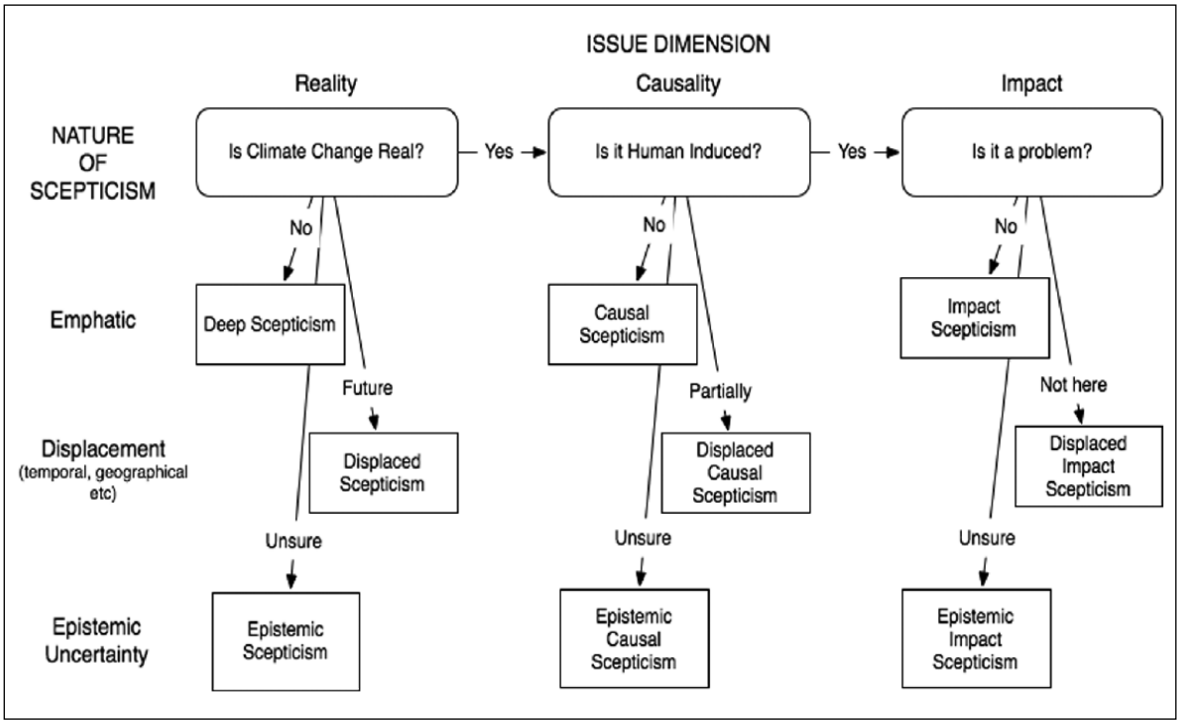
Although many surveys highlight heterogeneity in public attitudes to climate change, Whitmarsh (2011, p. 691) discusses that "the relative importance of these various individual characteristics in predicting climate scepticism has not yet been explored". Despite this, however, there is a substantial body of research which suggests that people generally desire to be a part of the solution to anthropogenic climate change (Bord *et al.*, 1998; Leiserowitz, 2006; O'Connor *et al.*, 1999; Semenza *et al.*, 2008; Zahran *et al.*, 2006).

The extent to which members of the public are sceptical about the seriousness and even existence of, human-induced climate change has predominately been gauged through opinion polls (Nisbet and Myers, 2007). Public opinion polls on issues relating to climate change will often vary considerably over time depending on the extent to which other, more pressing, issues take precedence in people's lives (Bord *et al.*, 1998; Nisbet and Myers, 2007). In addition, there is often difficulty in utilising international comparisons of opinion polls due to variations in question format and wording (Pietsch and McAllister, 2010). Nonetheless, such public opinion polls play a central role in the policy process due to the information they provide about the potential level of support particular policies will receive within a given electorate (Lorenzoni *et al.*, 2005).

Levels of climate change scepticism have been found to vary both within and between nations, despite a growing awareness of the issues of climate change worldwide and increased support in a range of mitigation and adaptation policies (Leiserowitz, 2007; Marquart-Pyatt *et al.*, 2011; Upham *et al.*, 2009). 'Scepticism' broadly refers to those with doubts about the reality of climate change, the human influence on the climate, or the necessity and effects of mitigation. Rahmstorf (2004) separates those who are 'sceptical' into three categories, as being either: (i) *trend sceptics*, who doubt that global temperatures are rising altogether; (ii) *attribution sceptics*, who may agree that global temperatures are rising but doubt that human activities are responsible; and (iii) *impact sceptics*, who may agree that global temperatures are rising and that humans activities are responsible, but doubt the seriousness of impacts. Initially developed as a typology to describe the arguments of an emerging counter-movement against mainstream climate science, it has been utilised to explore the attitudes of the general public (Poortinga *et al.*, 2011).

It is important to distinguish the various individual stances of scepticism, since there are stark differences between those who reject the fundamental notion of human-induced climate change, and those who are attitudinally uncertain about particular aspects of it (Poortinga *et al.*, 2011; Whitmarsh, 2011). Hobson and Niemeyer (2012) developed a flow diagram to illustrate the multiple forms that scepticism can take, displayed in Figure 4.2. They assert three issue dimensions: (i) *reality* (is climate change real?); (ii) *causality* (is it human induced?); and (iii) *impact* (is it a problem?) (Hobson and Niemeyer, 2012). These dimensions relate closely to the typology developed by Rahmstorf (2004) detailed above. Within each issue dimension, there are three possible stances ranging from *emphatic* or *deep* scepticism, denoting those who deny the reality of climate change outright, to *displaced* scepticism, denoting those who deny that climate change is taking place now or within their region, and *Epistemic* scepticism, denoting those who are unsure about the reality of climate change either way. Whilst Figure 4.2 is useful in separating people with the varying stances of scepticism, mapping specific people onto the different categories is infeasible since people have "a mix of viewpoints and were thus spread across categories" (Hobson and Niemeyer, 2012, p. 7).

Figure 4.2: Components of climate change scepticism



Source: Hobson and Niemeyer (2012)

It must be noted, however, that there are many terms used interchangeably to denote those who hold 'sceptical' views about individual, or numerous, aspects of climate change, including cynicism, denial, uncertainty and ambivalence (Poortinga *et al.*, 2011). Indeed, within the literature there is debate as to whether those who remain unconvinced of the existence, the human influence, or seriousness of change, should be regarded as 'climate deniers', 'contrarians', or 'sceptics' (Anderegg *et al.*, 2010a; Anderegg *et al.*, 2010b; O'Neill and Boykoff, 2010). This thesis, however, will employ the term 'sceptics' only in a broad sense, and will not attempt to distinguish responses to the mail-out survey questionnaire based on classifications. In fact, the questionnaire utilised in this research has not specifically attempted to determine the degree of 'scepticism' present in individuals, but rather has allowed for respondent elaboration on their particular views and level of understanding of the issue. In this way, the questionnaire is able to infer those respondents with sceptical attitudes (discussed in Chapter 2.6).

In Australia, the United Kingdom and United States, there has been a pattern of decreased belief in climate change over the past four years, similar to that being found in other Western industrialised nations (Leviston and Walker 2011). Leviston *et al.* (2011) suggests that this decrease could primarily be the result of the global financial crisis from October 2008, the failure to reach a global agreement at the United Nations climate change conference in Copenhagen in 2009, and the controversy surrounding stolen emails from the Climatic Research Unit at the University of East Anglia prior to the 2009 Copenhagen conference.

In the United States, a telephone-based Gallup poll of the public conducted in most years since March 2001 posed the question: *Do you think human activity is a significant contributing factor in changing mean global temperatures?* Table 4.2 reveals that the percentage of respondents who agreed with the consensus on human-induced climate change has varied, but generally declined slightly over the past ten years (Gallup, 2012). The most recent Gallup poll, conducted in March 2011, revealed that only 52% of the American public now agree with the consensus (Gallup, 2012).

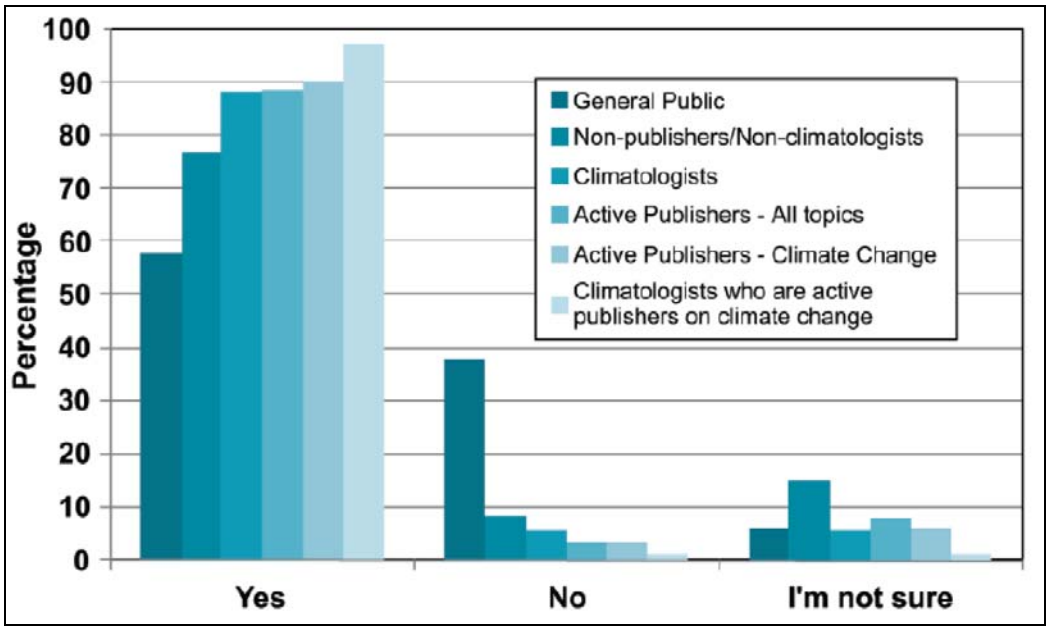
Table 4.2: American public opinion of the causes of increased global temperatures over the last century

NOTE:
This table is included on page 165 of the print copy of the thesis held in the University of Adelaide Library.

Source: Adapted from Gallup (2012)

Doran and Kendall Zimmerman (2009) subsequently incorporated the March 2008 Gallup poll results to compare the opinions of the public with the opinions of a group of Earth scientists derived from a web-based survey. It was found that as the level of active research and specialisation in climate science increased, so too did the agreement that human activity was a significant contributing factor in changing global mean temperatures, as detailed in Figure 4.3. Overall, 96% of climate specialists compared with 58% of the general American public agreed with the consensus on human-induced climate change (Doran and Kendall Zimmerman, 2009).

Figure 4.3: Is human activity a significant contributing factor in changing mean global temperatures?



Source: Doran and Kendall Zimmerman (2009, p. 22)

To examine the extent of 'scepticism' worldwide, in a 2006 telephone-based survey of members of the public from ten countries, respondents evaluated the threat posed by 'global warming' over the next ten years (Chicago Council on Global Affairs and WorldPublicOpinion.org, 2007). It was found that strong majorities in each of the ten countries considered 'global warming' an important or critical threat, and only small minorities in each considered it unimportant. This survey also investigated members of the public from thirteen countries on whether steps should be taken to address climate change now, or if we should wait until there is less uncertainty, and found that all but one country favoured immediate action (Chicago Council on Global Affairs and WorldPublicOpinion.org, 2007). In both cases, Australia ranked second overall with 69% of respondents considering climate change as a critical threat, and 92% in favour of action. In the same survey, 46% of respondents from the United States considered it a critical threat and 80% of respondents were in favour of action. Such surveys demonstrate the dynamic and ever-changing opinions and attitudes of the public.

In Australia, a mixed-method survey of the general public in August and September 2008, utilising discussion groups, as well as online and telephone surveys, was conducted by the Thermometer Survey research group. The survey found that 73% of respondents believe that the climate is changing due to human activity, with 14% believing that change is not due to human activity, and only 2% denying that any change is happening (Thermometer Survey, 2008). In addition, a February 2009 update of the survey found that 73% of respondents continued to believe that climate change exists and is the result of human activity, with 16% believing that change is not due to human activity, and 3% denying that any change is happening (Thermometer Survey, 2009).

Comparing the Thermometer Survey results of the Australian public in 2008 and 2009 (of 73% believing that climate is changing due to human activity) with Gallup poll telephone survey results of the Australian public in 2008 and 2010 revealed substantial discrepancies (Gallup, 2010). The percentage of respondents who believed climate change was the result of human activities fell from 52% in 2008 to 44% in 2010, and the proportion attributing climate change to natural causes increased from 21% to 31% (Gallup, 2010). It must be noted, however, that the Gallup poll allowed respondents the option of stating that climate change was the result of both human activities and natural causes. In this instance the proportion of respondents who believed change to be the result of both drivers increased from 20% in 2008 to 21% in 2010.

A number of surveys of the general Australian public's attitude towards climate change as a human-induced phenomenon, as well as those of the international surveys, are detailed in Table 4.3. Of those surveys that examine changes in attitudes over time, all show fluctuation and all but one revealed a decrease in the proportion of respondents who believe that climate change is the result of human activity. Indeed, as mentioned previously, the precise framing of questions in each survey tends to influence results. Leviston *et al.* (2011) assert that the general level of acceptance that climate change is human-induced depends upon several factors: whether or not there is a distinction between natural variation and human influence; whether or not there is a distinction between current and future climate change; whether it is asked if climate change *is not* occurring rather than asking if it is, and; whether or not respondents are allowed to indicate that climate change is partly caused by human activity.

Table 4.3: Compilation of public opinion poll results of percentages of people who believe that climate change is human-induced

NOTE:
This table is included on page 167 of the print copy of the thesis held in the University of Adelaide Library.

Source: Adapted from Leviston et al. (2011)

It is important to note that the survey instrument used in this research project did not attempt to distinguish the varying categories of scepticism amongst respondents. However, it was able to determine the percentage of respondents with 'sceptical' attitudes, and also differentiate between

'scepticism' and 'denial' based on the open-ended responses collated from various questions (Appendix 5), which will be detailed in Chapter 6.

4.4 Informing policy

Individual behaviour, combined as a whole with the behaviour of others, plays a substantial part in shaping how society engages with climate change issues, particularly in the design and implementation of new policies (Dietz *et al.*, 2003; Kempton, 1991b; Renn, 2011). Furthermore, a person's understanding of climate change, in general, underlies their willingness to act, and support policy, in response to it (Swim *et al.*, 2009; Zahran *et al.*, 2006). As a result, it is paramount that policy and decision-makers be aware of these understandings (Marquart-Pyatt *et al.*, 2011), particularly in relation to barriers to adaptation, such that they may provide structural support to overcome them, and concurrently work towards fostering individual empowerment and action to address climate change risks (IPCC, 2007a).

Vulnerability studies can improve the outcomes of policy decisions, particularly with reference to community engagement. As Lorenzoni and Pidgeon (2006, p. 74) discuss, if there is a failure to take "public values and views into consideration when taking decisions on climate risk management [it] will inevitably prove problematic, for several reasons". As they explain:

- Climate policies will require acceptance, or a certain degree of 'buy-in', from those who will be affected by their possible introduction.
- Risk communication efforts will need to factor in the different short-term and long-term considerations between policy and public timeframes.
- Policy implementation may be misunderstood, neglected or even opposed by the electorate.

Future vulnerability research that examines local level capacities, whereby there is variability and uncertainty in the local level impacts of climate change, therefore, needs to be grounded at the community level and involve local stakeholders and knowledge systems (Dolan and Walker, 2004; Rojas Blanco, 2006). Such engagement allows for a better assessment of how climate changes will be expressed and interpreted locally since scientific findings are able to be framed in a local context (Riedlinger and Berkes, 2001; Rojas Blanco, 2006; Usher, 2000). This may provide an improved foundation for decision-making and adaptive capacity building (Dolan and Walker, 2004).

Indeed, it has been well documented that a better understanding of individuals' and groups' perceptions of risk can more holistically inform policy decisions, and particularly so in reference to perceptions of climate change and policies promoting successful mitigation and adaptation strategies (Bord *et al.*, 1998; Bostrom *et al.*, 1994; Brody *et al.*, 2008; O'Connor *et al.*, 1999; Slovic, 1987). Crucial to efforts in the climate change arena, therefore, is an understanding of the human drivers of initiating, promoting and hindering change (Dietz *et al.*, 2010; Lorenzoni *et al.*, 2005; Renn, 2011).

Nisbet (2009a) contends that a predominant obstacle to growing public support for and achieving policy outcomes is with the framing of climate change, and further argues that the policy debate is rarely understandable, relevant and personally important for members of the public. Sceptic interest groups have capitalised on such failings in order to frame climate change as scientifically uncertain and economically destructive (Oreskes, 2004). Nisbet (2009b) goes on to argue that in order to successfully reframe climate change, the underlying science must remain true whilst approaches from research in communication and other fields are utilised to tailor messages to the existing attitudes, values and perceptions of various audiences.

A problem that surfaces with reference to communication of risk, and public campaigns that attempt to curb socially undesirable behaviours for common good, however, is that the communication of such issues can result in a defensive form of self-justification (a 'backfire' effect), which may actually strengthen the prevalence of the undesirable behaviour (Holland *et al.*, 2002). This defensive processing can be explained in part through confirmation bias. A confirmation bias is the tendency for individuals to search for, or interpret, evidence that is partial to their existing beliefs, expectations or hypotheses (Lorenzoni and Pidgeon, 2006; Nickerson, 1998). What stems from confirmation bias is that people usually overestimate the probable accuracy of their personal judgements – in part due to a failure to consider why such judgements would be inaccurate in the first place (Nickerson, 1998). It is for this reason why certain strong attitudes and beliefs are protected by the individual when information to the contrary is communicated (Holland *et al.*, 2002), and helps explain how self-justification typically emerges when people are reluctant to alter habitual behaviour (van Vugt *et al.*, 1996). According to Halford and Sheehan (1991), as a type of cognitive dissonance, it could mean that if there is a strong belief that a technological solution to climate change will be found, then it does not matter how much damage we do to the environment, since it will eventually be remedied. Any message to

change behaviour may therefore be disregarded as irrelevant, or as just another problem for science to solve.

The nature of climate change, aside from being described as a 'wicked' problem, presents a difficult challenge for both the public and the policy-maker, since impacts can be experienced both in the form of discrete events and as continuous environmental stressors (Reser and Swim, 2011). Discrete or acute 'climate change events' are to be manifest in the form of an increased frequency and intensity of extreme weather events, which are typically sudden and may not be anticipated or predictable (Bell *et al.*, 2001; Reser and Swim, 2011). A continuous or ambient stressor is characterised by the absence of a rapid onset of impacts and is long-term in scale such that it may go unnoticed either due to subtlety, or because people habituate such stressors (Bell *et al.*, 2001; Reser and Swim, 2011). As such, climate change can be understood "as an ambient stressor encompassing periodic acute stressor events" (Reser and Swim, 2011, p. 281).

As a disaster event, climate change presents a further challenge for the public and policy-maker due to its appearance as both a potential natural and technological disaster. That is, anthropogenic forcing of the global climate system is the product of technological processes and attributable to human behaviour, whilst climate change phenomena manifest themselves as natural disasters and are more sudden, cataclysmic, uncontrollable and acute (Reser and Swim, 2011). Technological disasters are more likely to foster anger, frustration and distrust, yet in the case of climate change if such disaster events are made apparent in the form of natural events, those emotions may not be triggered such that they evoke desired forms of behavioural change.

Many climate change impacts are projected to be in the form of chronic stressor conditions that are much more incremental and persistent in people's daily lives (Reser and Swim, 2011). Consequently, the implementation of new policy may be undermined by this noticeable 'duality' of climate change as both a discrete and continuous stressor, and as a potential natural and technological disaster. For example, literature relating to farmers' perceptions of climate change suggests that their perceptions and behavioural responses relate more to recent climatic events or trends as opposed to the long-term variation in average (worsening) conditions (Bryan *et al.*, 2009; Smit *et al.*, 1997; Thomas *et al.*, 2007). Whilst such memorability of recent events is consistent with the availability effect, as described earlier, it highlights the importance of time as a variable in perceiving environmental change in general (Bell *et al.*, 2001), as well as the challenge for policy to achieve concrete and timely outcomes.

Rojas Blanco (2006) contends that as the climate changes, it is likely that one of the key mechanisms by which a community will be able to adapt is through a strengthening of initiatives already under way and, therefore, a strengthening of existing social capital. From this standpoint, it will be beneficial in dissipating the need for policy-makers to attempt to either 'reinvent the wheel' and introduce unfamiliar risks within communities, or endeavour to develop a policy 'panacea' that may be framed inappropriately towards local-scale conditions. In this respect, a social learning approach to reviewing current projects enables the assessment and adjustment to account for climatic variations that were not initially considered, similar to the practical application of adaptive management (Holling, 1978; Walters, 1986). Pelling *et al.* (2008, p. 874) assert that by enabling a process of reflexive (social) learning and adaptation, organisations are "more likely to be able to respond to abrupt and unforseen threats and opportunities associated with climate change". Furthermore, as Rayner (2006) explains, the challenge is not simply the recognition of the need for more public engagement, but rather the identification of pathways through which multiple viewpoints and values can be brought into the decision-making arena to enable adaptive action. As such, studies of perceived risk within particular 'risk contexts' can offer insights into these viewpoints and values to aide in the operationalisation of policy (Lazarow *et al.*, 2006). An enhancement of current adaptation projects dealing with current vulnerability, therefore, becomes an integral component of community development that encompasses long-term sustainability to climate change "without the people feeling that they are being diverted from their concern about their daily survival" (van Aalst *et al.*, 2008, p. 172).

Pertinent to public policy is the influence of the scientific and 'anti-scientific' communities. Policy-makers and the media, however, have frequently asserted that climate science is highly uncertain (Oreskes, 2004). In general, there is a widespread and influential political obstacle to achieving sustainability in the form of an environmental backlash, dubbed 'brownlash', which aims to minimise the seriousness of environmental issues (Ehrlich and Ehrlich, 1998; McKenzie and Rees, 2007). Ehrlich and Ehrlich (1998) suggest that the success and undue influence of brownlash has resulted in a significant proportion of the public perceiving that the state of the environment and the rate in which it is changing are not causes for concern. Indeed, much erroneous information has been disseminated in a variety of forms, including "seemingly authoritative opinions in books, articles, and media appearances that greatly distort what is or isn't known by environmental scientists" (Ehrlich and Ehrlich, 1998, p. 11). A key challenge involves counteracting the influence that brownlash interventions, or anti-science, have

contributed to public discourse, although this represents a formidable political and social task (Chess and Johnson, 2007; McKenzie and Rees, 2007).

Markowitz and Shariff (2012) (as detailed in Table 4.1) argue that whilst communicating the need for action on climate change has proven challenging due to the way in which features of climate change interact with the human moral judgement system, it does not necessarily require inducing feelings of guilt, shame and anxiety. An alternative approach is through the encouragement of beneficial outcomes via potential lifestyle and policy change, rather than focussing on negative consequences of failing to adopt appropriate policy, which can 'backfire' and lead to lower levels of concern and engagement (Feinberg and Willer, 2011; Markowitz and Shariff, 2012). For example, in terms of the need for enhancing efficacy, or the individual self-belief in their own capability to make a difference, people with a low self-efficacy are likely to perceive themselves as unable to act on perceived threats (Bandura, 1977; Hines *et al.*, 1987). Research by Rimal and Real (2003a, p. 398) in health communication studies found that "individuals with indifferent attitudes, those with low risk perception and low efficacy beliefs, are least motivated to engage in self-protective behaviours". The campaigns designed to motivate these individuals, therefore, could focus on efficacy-enhancing strategies that instil confidence that people's actions can, and will, affect outcomes. For instance, communication strategies could attempt to highlight how "individuals can rise to the challenge of reducing the burdens of climate change for future generations through household or individual behavioural change" (Markowitz and Shariff, 2012, p. 245). Furthermore, since policy outcomes cannot be known in advance, there is the need for policies to be able to be tailored depending on "discoveries about what works, when, and where" (Finucane, 2009, p. 7).

In addition to informing adaptation policies, which aim to produce more acceptable and optimal policy responses, policy changes can also influence adaptation measures through unintended, yet advantageous, attitudinal changes. Such policy changes could prompt the search for new alternatives by introducing constraints that make old habits of adjustment unacceptable (Slovic *et al.*, 2000c). For instance, the introduction of Australia's water restrictions undermined the 'garden city' ideal that was central to urban planning (Randolph and Troy, 2008). However, de Vos (2004) found that attitudes of conservation and consumption in the face of water restrictions sparked Australians to find low maintenance solutions to such problems, for instance, including planning changes in plant species within gardens that are more tolerant to new, dryer, conditions.

In terms of identifying with a person in need, for instance, local policy responses to climate change risks have added impetus since those decision-makers at the local level know and can identify with the individuals or groups that may be affected by both climatic changes and the changes brought about by policy implementation. In this respect, the variety of local contexts and responses to global issues can assist in the identification of successful responses which, as Rojas Blanco (2006, p. 141) explains, when learned from "could be enhanced to function as national or even international policy frameworks". For example, a climate change adaptation policy driven at the local level, compared to a higher level, may positively affect the level of support for the policy due to the identifiability of those instigating it, with those who may suffer as a result of the impacts if no policy had been created.

4.5 Summary

Risk perceptions have been identified as key limitations and barriers to successful adaptation to climate change, and the complexities and overlap of many of the heuristics and biases discussed within this chapter have not only demonstrated the need for an integrated approach to tackling climate change, but an adaptive approach also, that is able to change as perceptions change over time. This chapter also provided a specific discussion on public scepticism about climate change, and how these attitudes have played a role in reduced action on climate change to conclude on the importance of communication and issue framing to facilitate individual and group behavioural change. Based on these discussions, the chapter then focussed on the interaction between climate change risk perceptions and the importance on the formation of new policy, and where there is much existing literature to suggest that an incorporation of risk perceptions research can assist in the communication and public understanding of risk, and consequently the acceptance of policies designed to minimise risk. The lessons to be learned for policy development, and consequently its communication, and hence acceptance or rejection, provides justification towards both integrated 'place vulnerability' assessment, and evidence-based policy-making.

Chapter 5 – Results: Respondent Demographics

This chapter discusses the demographic results of the mail-out survey questionnaire. It specifically compares each individual case study site, Yorke Peninsula and Rockingham, to highlight the key similarities and differences. The demographic characteristics are discussed further with respect to the most recent and relevant census data, to assess the representativeness of the returned questionnaires.

As discussed in Chapter 2, the mail-out survey questionnaire was structured with 36 closed and 13 open-ended questions. Responses to closed questions (as binary, ternary, or Likert scaled) are displayed through the use of graphs that detail the proportion of responses. Where there has been a trend or a statistically significant relationship found between the results of two particular closed questions, they are cross-tabulated and displayed in a graph. Responses to open-ended questions, on the other hand, are displayed in tables to list both the variety and frequency of response themes. Such tables will generally be accompanied with a further table listing examples of the key themes. It is important to note that the open-ended questions often resulted in responses that consisted of either one theme (a sole response), or as one of a combination of themes (*inter alia*), of which the frequency and number of themes outlined (*inter alia*) are listed.

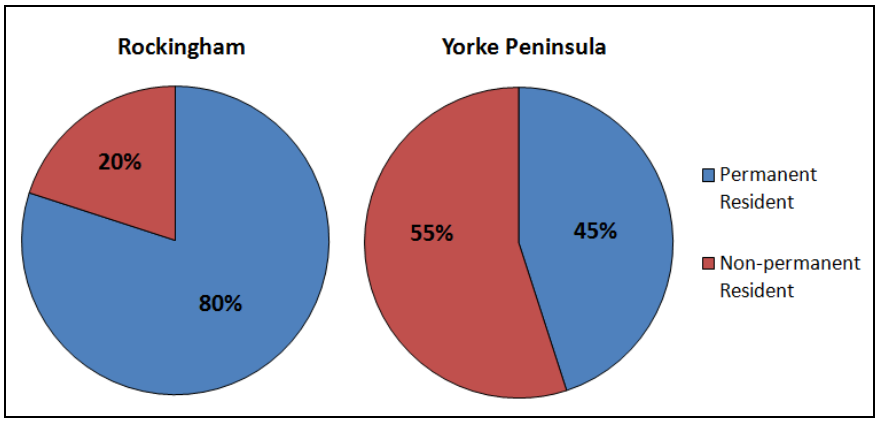
All analyses for statistical significance ($p < 0.05$) have either been conducted utilising Mann-Whitney U-tests (U), or Pearson's Chi-Square (χ^2). As discussed in Chapter 2, the case study sites, being two different sea change communities, had several key differences between the respondents from both the sample and returned questionnaires. As expected therefore, a statistically significant difference was identified between respondents in terms of region and permanent residence, given the nature of the two sea change communities ($U = 10771.0$, $p = 0.000$). In terms of statistically significant differences between the regions and other demographic variables, none were found. However, there are several other instances of statistically significant relationships between perceptions and demographic variables, particularly with respect to demographic variables of age (grouped as either under 60 years of age, and above 60 years of age) and education level (grouped as either high or low).

5.1 Survey demographics

5.1.1 Residency

Figure 5.1 outlines the distribution of respondents based on both region and residency (permanent or non-permanent) (χ^2 = 47.849, p = 0.000). Rockingham has 80% permanent residents, whereas Yorke Peninsula only has 45% permanent residents.

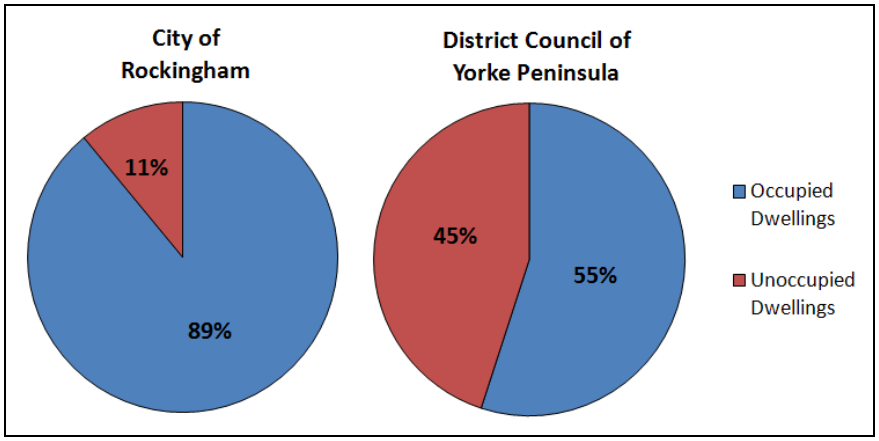
Figure 5.1: Regional variation of permanent and non-permanent residents from returned surveys



(Rockingham, n = 169; Yorke Peninsula, n = 197)

Figure 5.2 displays the proportions of occupied and unoccupied dwellings from the ABS 2006 census. Rockingham had 89% occupied dwellings, and Yorke Peninsula had 55% occupied dwellings.

Figure 5.2: Local Government ABS 2006 census variation of occupied and unoccupied dwellings

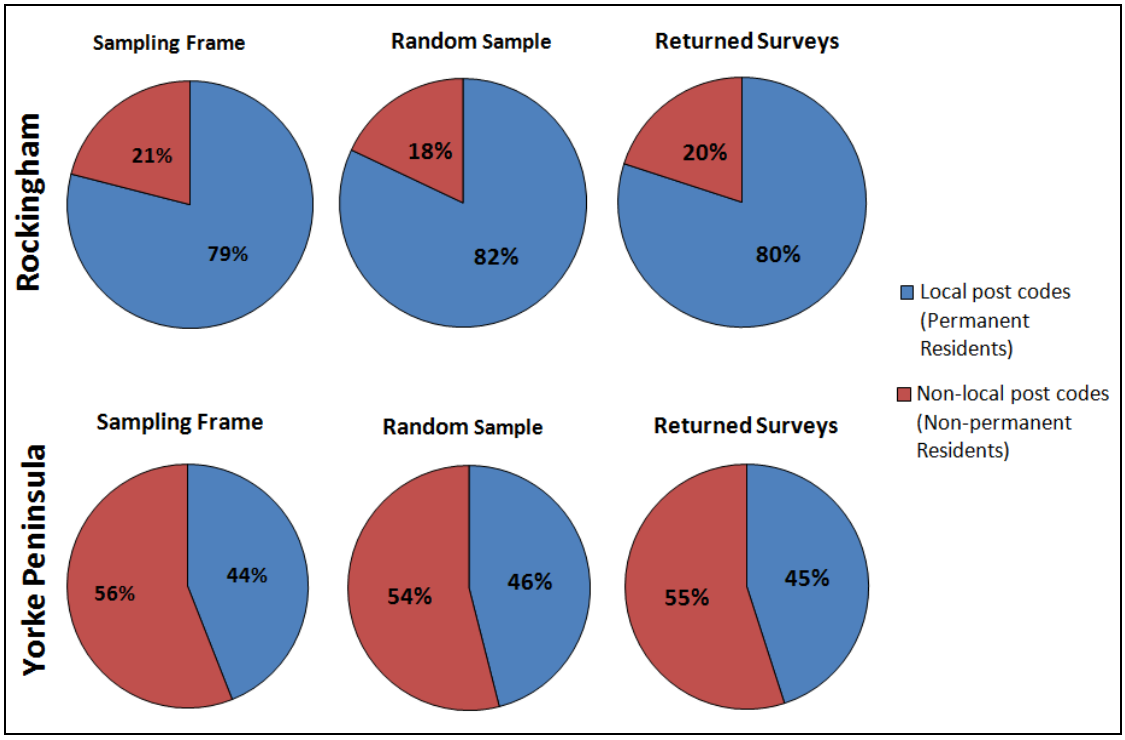


Source: Author, adapted from ABS (2006, Cat. No. 2068.0)

(Rockingham, n = 34,923; Yorke Peninsula, n = 8,834)

To examine the representativeness of the returned surveys in reference to the sampling frame and the random sample, it was necessary to determine the numbers of permanent and non-permanent residents at each stage. Within the sampling frame and the random sample, this number was determined by examining the postcodes of property owners from the council rates databases (up-to-date as of July 2009 for Rockingham, and June 2009 for Yorke Peninsula) as either local (located within the case study site) or non-local (located outside the case study site) postcodes. By cross-checking these postcodes, it was found that the returned surveys (from Figure 5.1) were highly representative of both the sampling frame and random sample (Figure 5.3). This method of examining the representativeness proved more effective than comparisons with numbers of occupied and unoccupied dwellings on census night (Figure 5.2), which were outdated (2006) compared to the council's rates databases (2009).

Figure 5.3: Regional variation of local and non-local post codes from sampling frame, random sample, and returned surveys

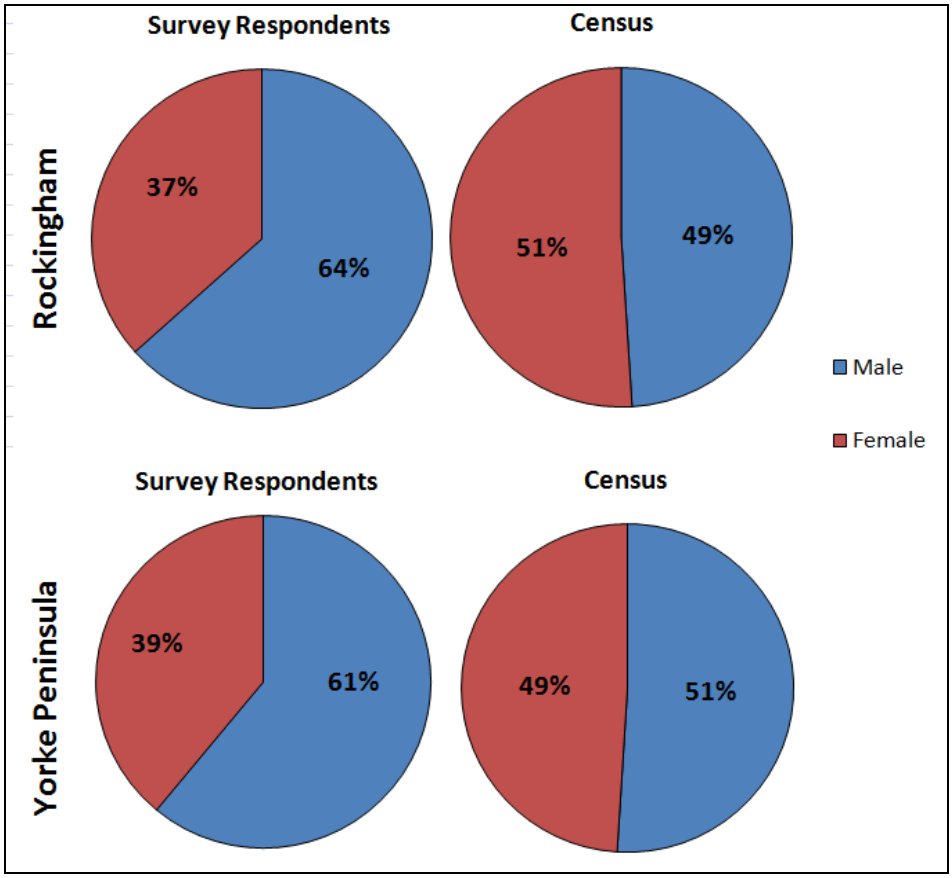


(Rockingham Sampling Frame n = 34,103, Random Sample n = 590, Returned Surveys n = 169; Yorke Peninsula Sampling Frame n = 1,937, Random Sample n = 458, Returned Surveys n = 197)

5.1.2 Gender

Overall, the ratio of males to females responding to the questionnaire was approximately 3:2 (Figure 5.4). The mailed-out envelope was addressed to persons as per the formatted name on the list acquired from council rates databases, which could have resulted in the addressing of one, two, or three or more names who were the property's owners. Furthermore, whilst gender comparisons of returned surveys with census data are not particularly relevant in this instance due to the nature of the survey questionnaires delivery, they do reveal the response bias towards male heads of households (Figure 5.4).

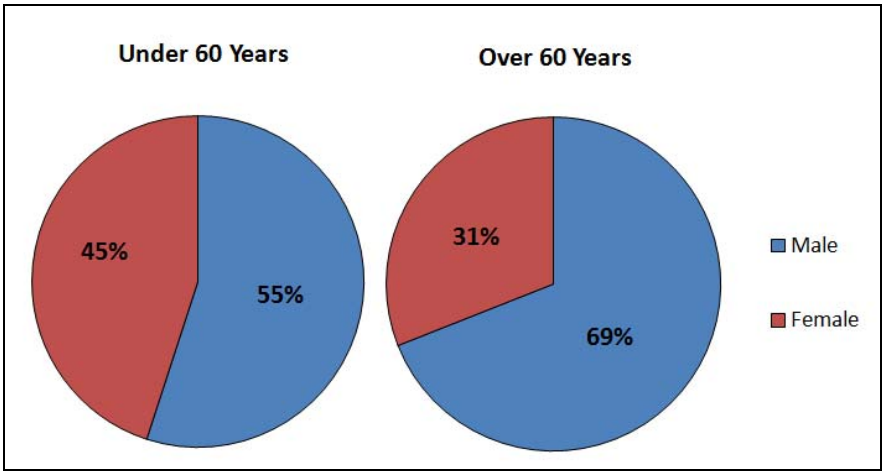
Figure 5.4: Regional distributions of gender derived from the survey and the ABS 2006 census



(Survey Respondents, Rockingham n = 160, Yorke Peninsula n = 184; Census, City of Rockingham n = 54,034, District Council of Yorke Peninsula n = 9,326)

Figure 5.5 shows that respondents over 60 years of age were more likely to be male ($\chi^2 = 7.627$, $p = 0.006$). It is likely that this difference is due to the fact that within family or couple households where the property owners are over 60 years of age, the male is most likely to be the head of household.

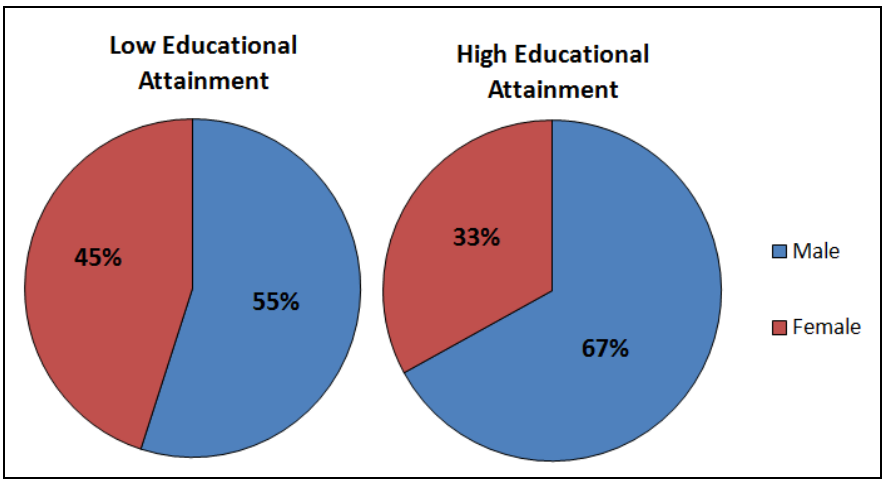
Figure 5.5: Gender variations by age groupings



(n = 344)

Figure 5.6 shows that male respondents were more likely to have higher education levels than females ($\chi^2 = 5.519$, $p = 0.019$).

Figure 5.6: Gender variations by educational attainment level

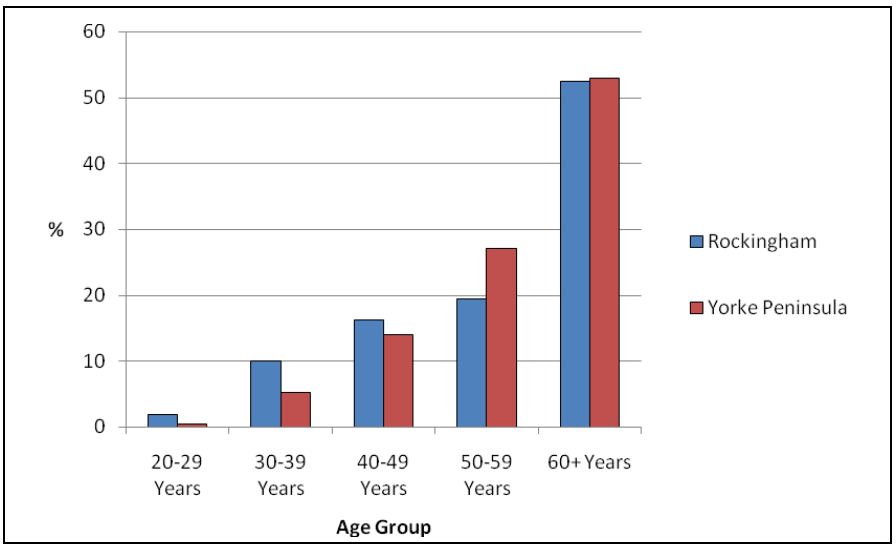


(n = 341)

5.1.3 Age

Figure 5.7 reveals that over 50% of respondents at both case study sites were over 60 years of age, with the largest variations between those in the 30-39 years and 50-59 years age group.

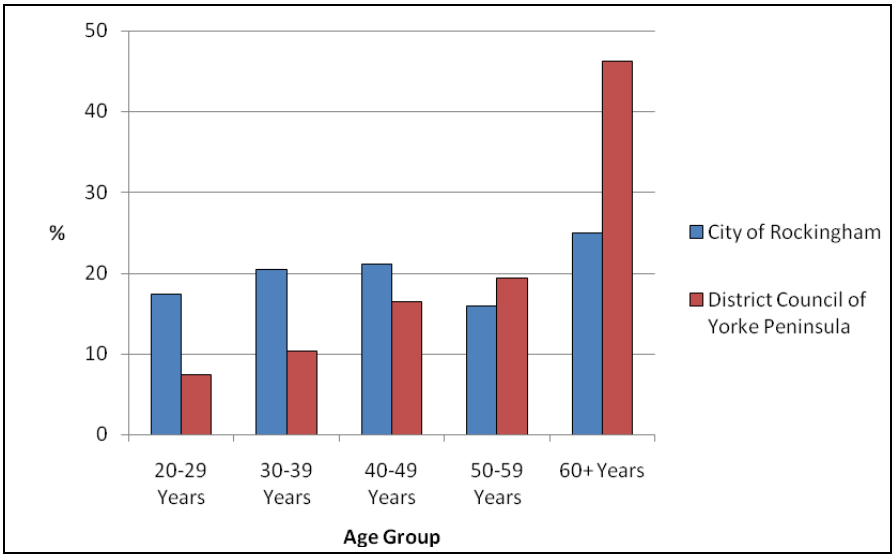
Figure 5.7: Regional distribution of age from returned questionnaires



(Rockingham, n = 160; Yorke Peninsula, n = 191)

Figure 5.8 reveals the overall age structure differences between permanent residents of 'coastal commuter' and 'coastal hamlet' style sea change localities from the ABS 2006 census. Notably, 46% of residents in Yorke Peninsula are 60+, compared with 25% in Rockingham.

Figure 5.8: Age profile comparison between ABS 2006 census data of case study regions

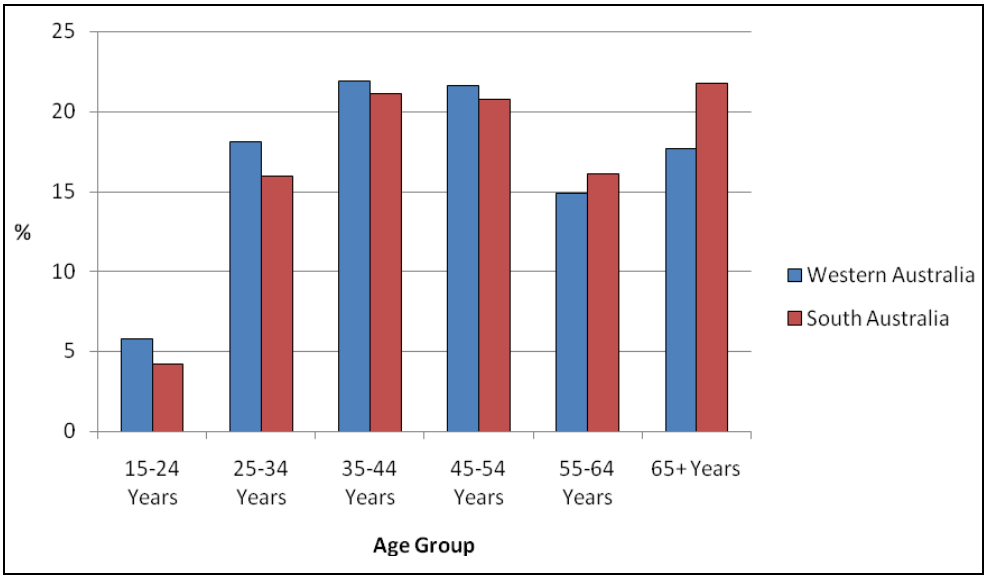


Source: Author, adapted from ABS (2007a; b)

(City of Rockingham, n = 54,034; District Council of Yorke Peninsula, n = 9,326)

Figure 5.9 displays the age profile of property owners on a state-wide basis from the ABS 2006 census, whereby the lowest property ownership is below the age of 25 in both states, and the highest property ownership for ages 35-54 years and 45-54 years in WA (22% each), as well as 35-54 years and 65+ years in SA (21% and 22% respectively). In comparing Figure 5.9 with Figure 5.7, whilst there appears to be a response bias towards over 60 year olds from the survey, it is likely that there is a real difference due to the numbers of retirees and pre-retirees in the sea change communities.

Figure 5.9: Age profile comparison between ABS 2006 census data of property ownership per state



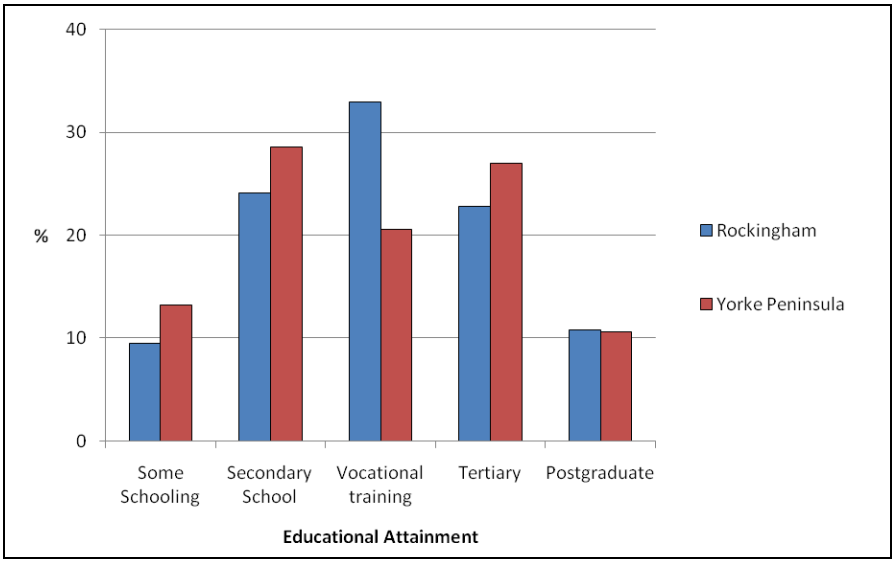
Source: Author, adapted from ABS (2006, Cat. No. 6530.0)

(Western Australia, n = 770,500; South Australia, n = 626,500)

5.1.4 Education and knowledge

Figure 5.10 reveals that proportions of respondents with vocational training (such as trades, traineeships or TAFE) is notably higher (12%) in Rockingham than Yorke Peninsula, with only smaller differences (less than 5%) in categories of schooling and tertiary studies.

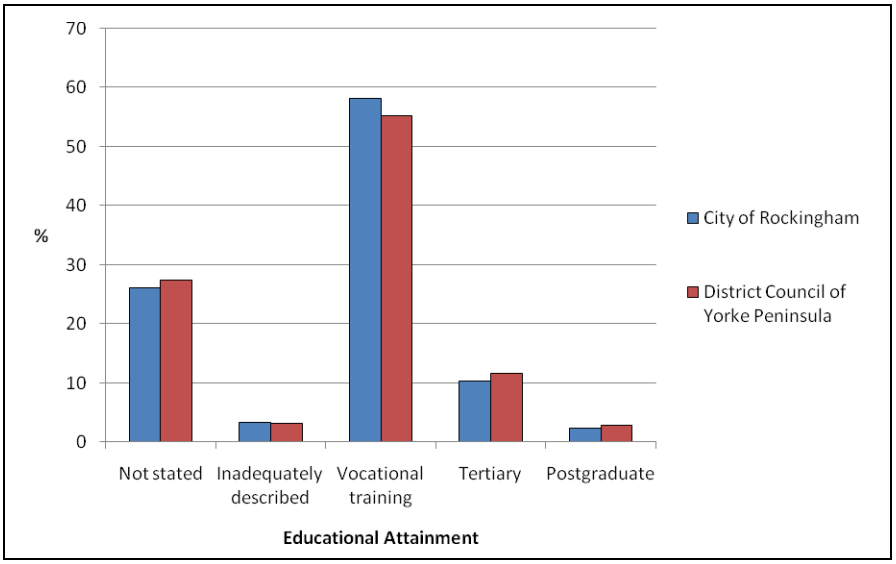
Figure 5.10: Regional distributions of educational attainment level



(Rockingham, n = 158; Yorke Peninsula, n = 189)

Figure 5.11 displays educational attainment levels from the 2006 census, which excludes those with only school-level qualifications (which is about 30-40% of respondents in Figure 5.10).

Figure 5.11: Education comparison between ABS 2006 census data of case study regions

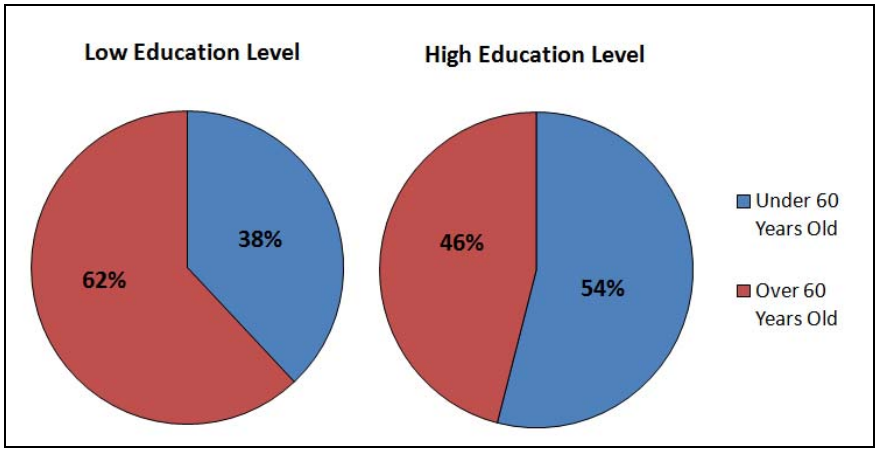


Source: Author, adapted from ABS (2007a; b)

(City of Rockingham, n = 29,651; District Council of Yorke Peninsula, n = 3,703)

Figure 5.12 reveals that those over 60 years of age were more likely to have a lower education level that those under 60 years of age ($\chi^2 = 8.232$, $p = 0.004$). Education levels were grouped into low education level (those who indicated secondary schooling or below) and high education level (vocational training or above).

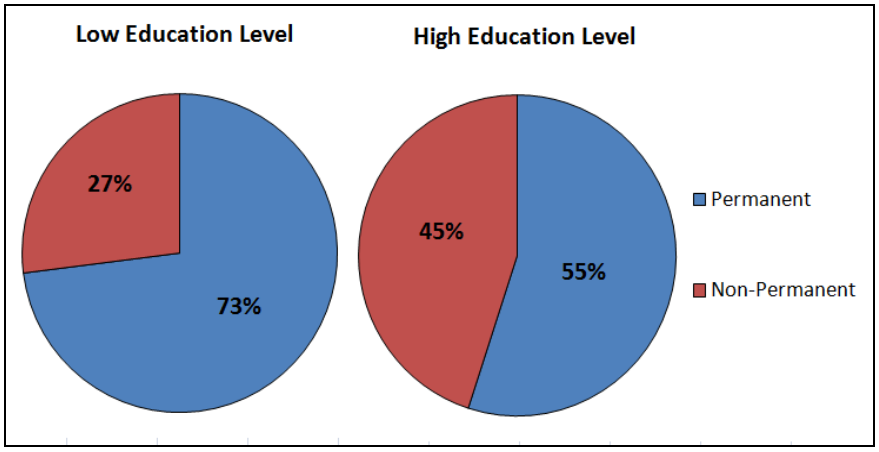
Figure 5.12: Educational attainment level by age groupings



(n = 346)

Figure 5.13 details that those respondents who indicated low education levels were more likely to be permanent residents, compared with respondents who indicated a high education level ($\chi^2 = 11.48$, $p = 0.001$).

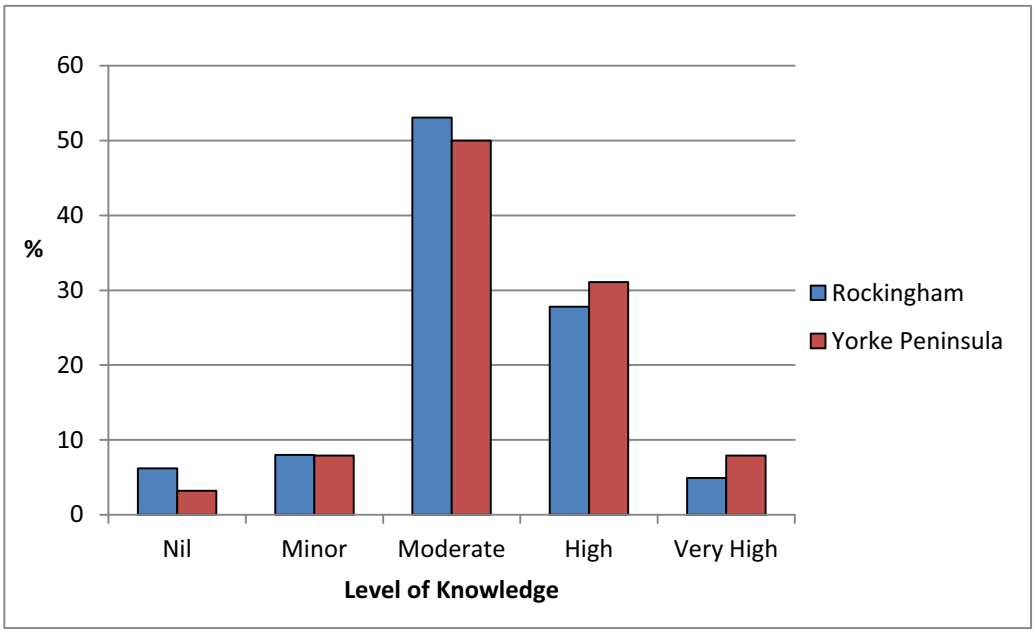
Figure 5.13: Educational attainment level by type of homeowner



(n = 345)

Figure 5.14 reveals that respondents generally considered their level of personal local environmental knowledge as moderate. Overall, almost 90% of all respondents considered their level of local knowledge as moderate to very high, with slightly more respondents perceiving high and very high levels in Yorke Peninsula.

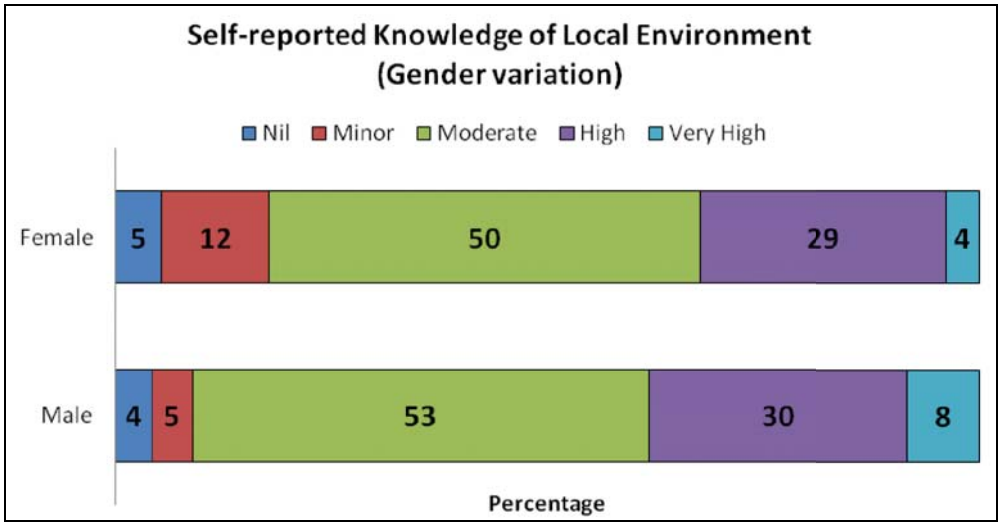
Figure 5.14: Regional variation of self-reported level of local environmental knowledge



(Rockingham, n = 162; Yorke Peninsula, n = 190)

Figure 5.15 details the variations whereby there are higher proportions of males that considered their knowledge of the local environment as high, compared with females (U = 12256.0, p = 0.043).

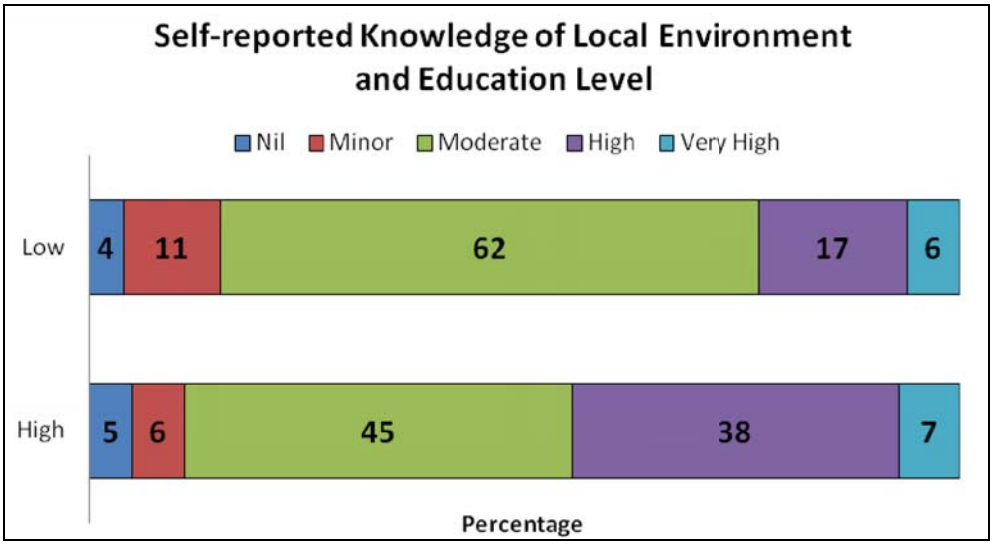
Figure 5.15: Self-reported level of local environmental knowledge by gender



(Male, n = 214; Female, n = 130)

Figure 5.16 displays that there is a greater proportion of those with high education levels (vocational training or more) claiming to have much higher levels of local environmental knowledge (U = 11272.0, p = 0.000).

Figure 5.16: Self-reported level of local environmental knowledge by education level

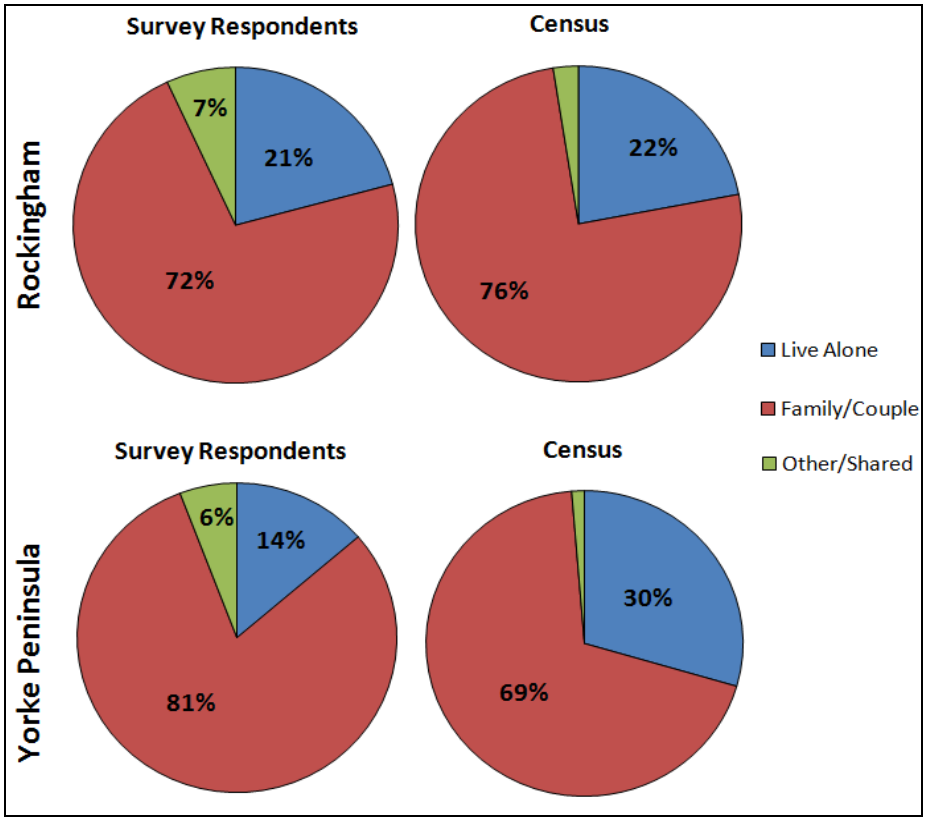


(n = 347)

5.1.5 Living arrangements and community

Figure 5.17 displays that the vast majority of respondents in Rockingham and Yorke Peninsula are living as a family or couple (72% and 81% respectively). In comparing the survey results to ABS 2006 census data, it can be observed that in Rockingham the overall proportions of respondents and their living arrangements are relatively similar. The largest discrepancy exists in the Yorke Peninsula comparison whereby the proportions of those who live alone has been underrepresented, and those who live as a family or couple have been overrepresented, in the survey. This discrepancy is likely the result of Yorke Peninsula having such a large proportion of holiday homes, which are owned by non-permanent residents such as families or couples, and are therefore not counted as residents in the region on census night.

Figure 5.17: Household living arrangements comparing survey respondents and ABS 2006 census data by region

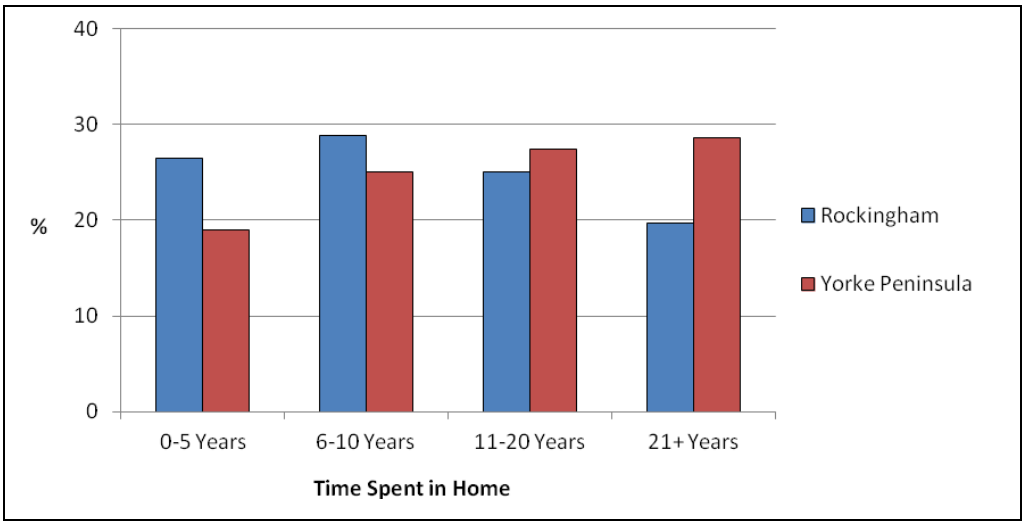


Source: Author, adapted from ABS (2007a; b)

(Survey Respondents, Rockingham, n = 159; Yorke Peninsula, n = 190; Census, City of Rockingham, n = 27,223, District Council of Yorke Peninsula, n = 4,528)

Figure 5.18 displays that Yorke Peninsula had a slightly greater proportion of respondents who have lived in the region for 10 or more years. Conversely, Rockingham had a slightly greater proportion of respondents who had lived in the region for 10 years or less.

Figure 5.18: Regional distributions of the amount of time spent in the home*

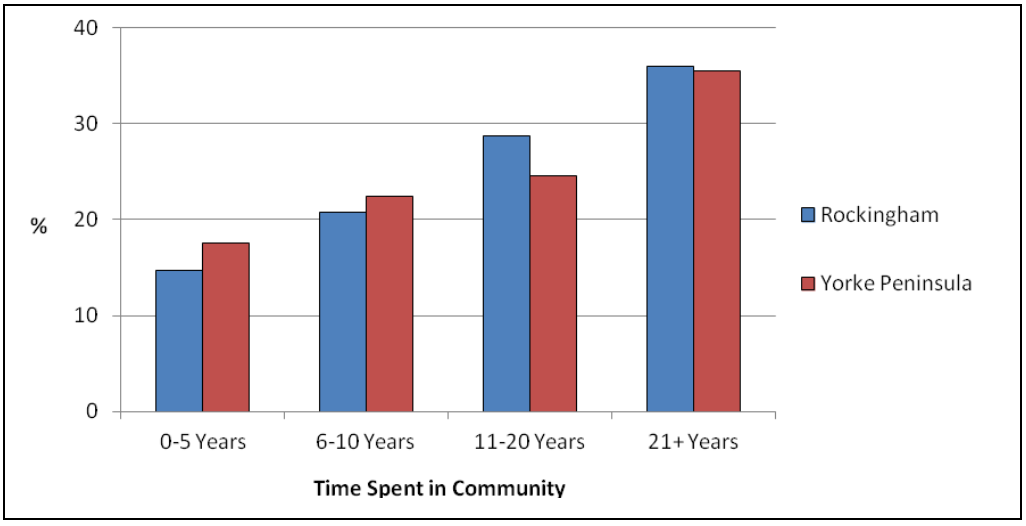


(Rockingham, n = 132; Yorke Peninsula, n = 84)

** Permanent residents only*

Figure 5.19 reveals that over one third of respondents indicated that they had been a part of the community for over 20 years, around one quarter indicated between 10 and 20 years, and over one third indicated less than 10 years.

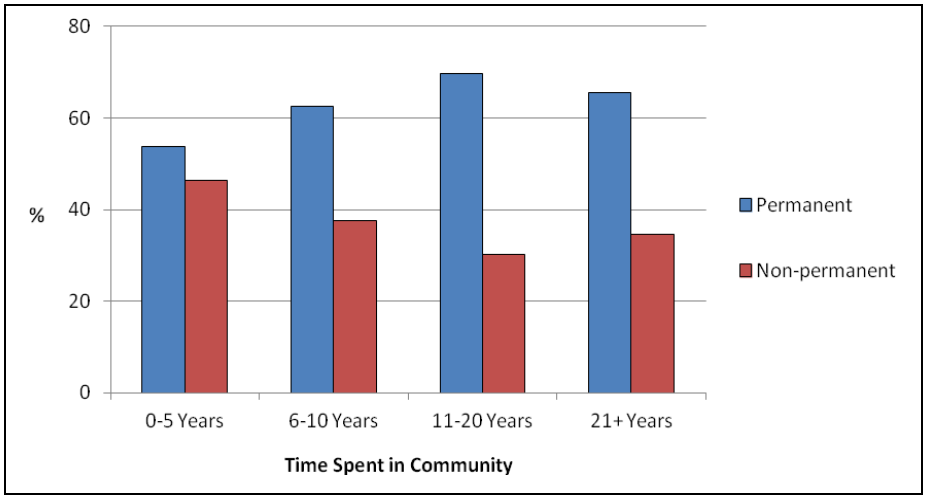
Figure 5.19: Regional distributions of time spent as part of the community



(Rockingham, n = 150; Yorke Peninsula, n = 183)

Figure 5.20 shows that the proportion of non-permanent respondents tends to decrease as the length of time spent in the community increases.

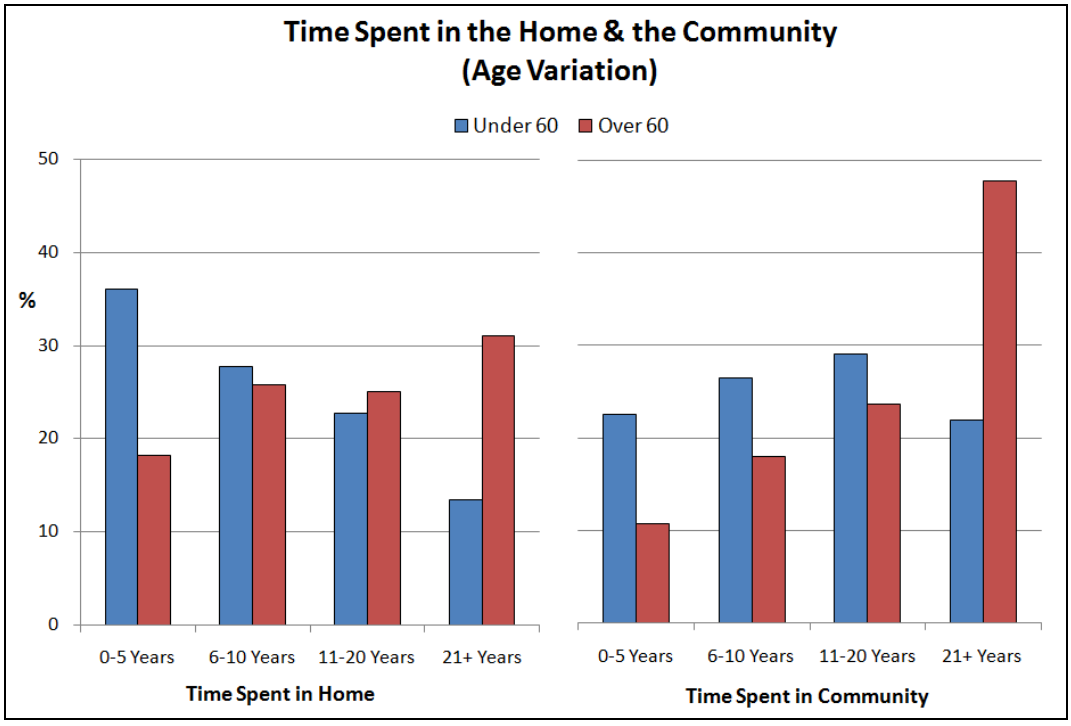
Figure 5.20: Time spent as part of the community by type of homeowner



(Permanent, n = 212; Non-permanent, n = 119)

Figure 5.21 shows that greater proportions of respondents over 60 years of age have been in the community longer (permanent residents only $U = 4086.0$, $p = 0.001$) and in their home longer ($U = 9362.0$, $p = 0.000$).

Figure 5.21: Time spent in the home/community* by age groupings

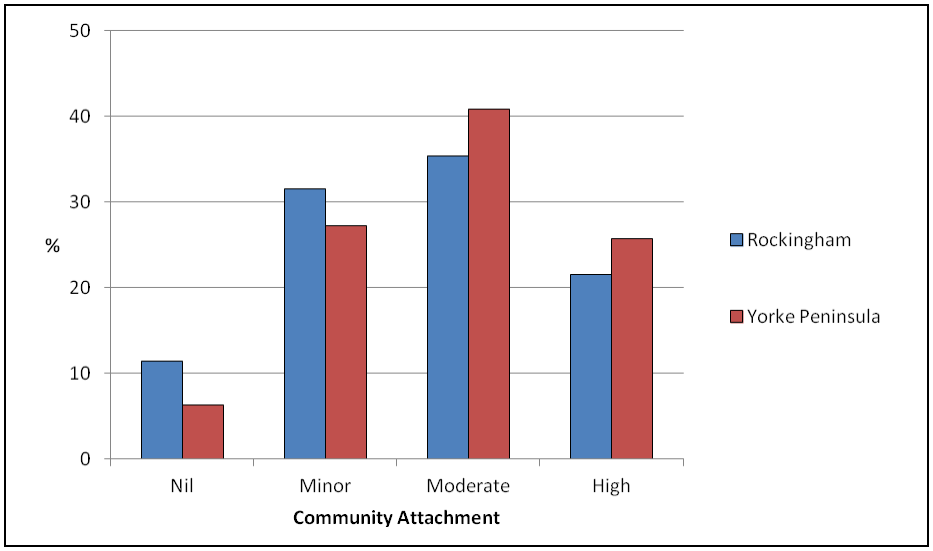


(Time spent in the Home, n = 229; Time spent in the Community, n = 329)

**Permanent residents only*

Figure 5.22 displays perceived attitude, or level of attachment, to the community and reveals that responses were relatively similar between the two case study sites, but slightly higher levels of community attachment are observed in Yorke Peninsula compared to Rockingham.

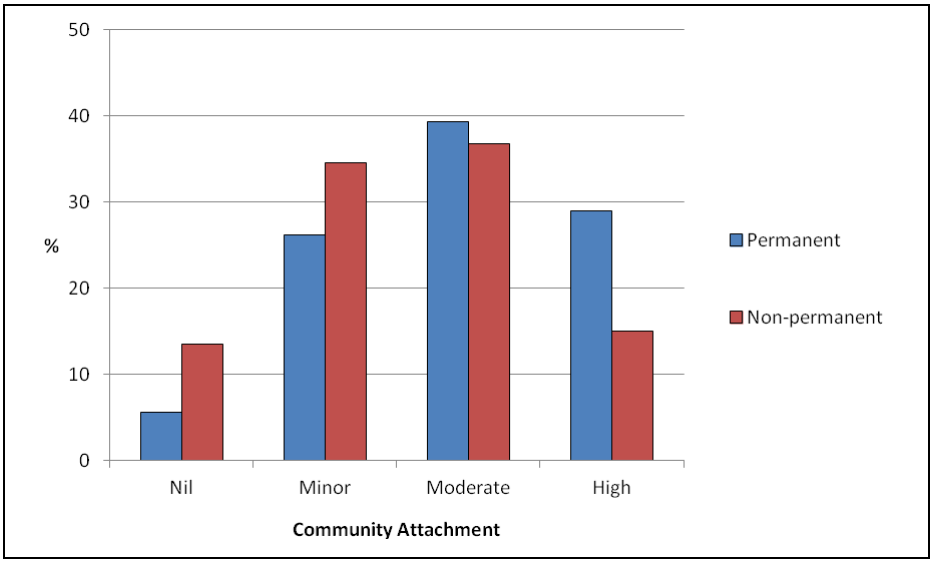
Figure 5.22: Regional variation of perceived attitude (attachment) towards the community



(Rockingham, n = 158; Yorke Peninsula, n = 191)

Figure 5.23 shows that permanent residents were more likely to have higher levels of attachment to the community, compared with non-permanent residents (U = 10998.0, p = 0.000).

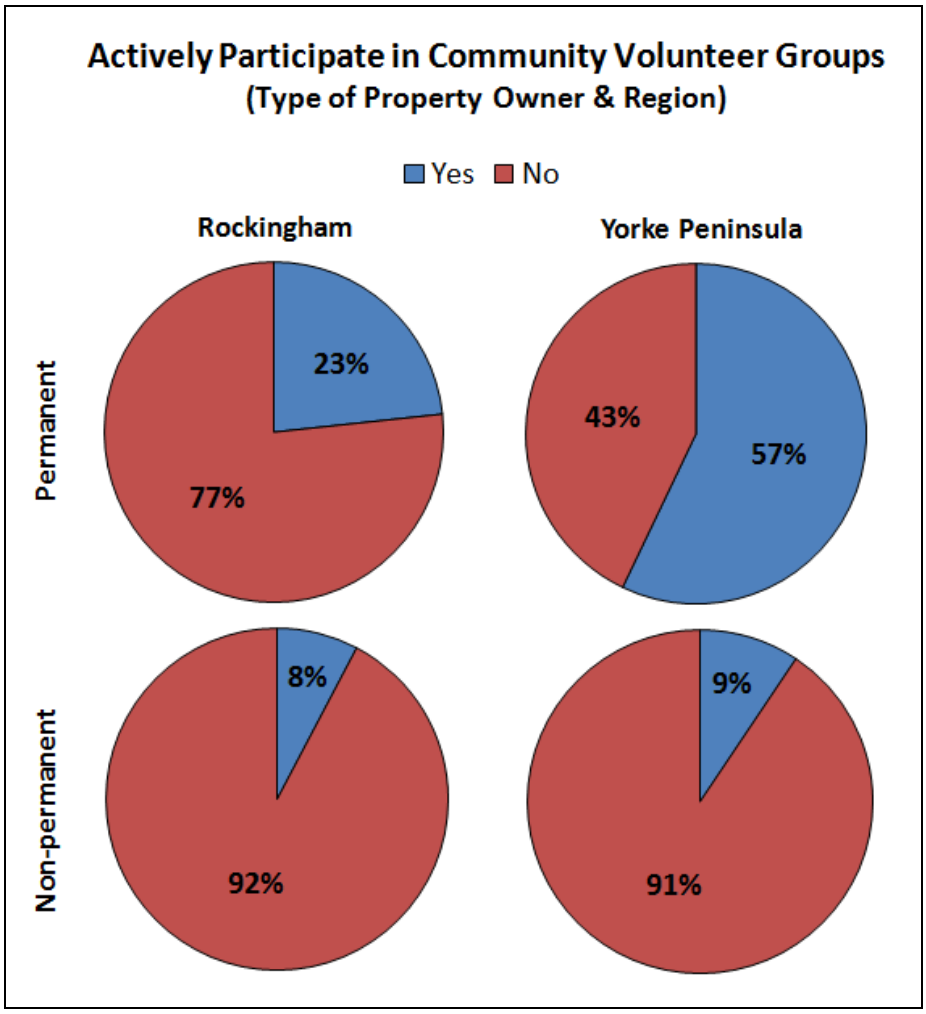
Figure 5.23: Attitude (attachment) towards the community by type of homeowner



(Permanent, n = 214; Non-permanent, n = 133)

Figure 5.24 displays volunteer activity in the community based on residency. Overall, fewer Rockingham respondents volunteered than Yorke Peninsula respondents ($\chi^2 = 4.605$, $p = 0.032$), compared with 37% of permanent resident and 9% of non-permanent residents ($\chi^2 = 32.031$, $p = 0.000$). For permanent residents in both communities, 23% of respondents claimed to participate in volunteer activities in Rockingham, compared with 57% on Yorke Peninsula ($\chi^2 = 25.170$, $p = 0.000$). For non-permanent residents, only 8% and 9% of respondents from Rockingham and Yorke Peninsula, respectively, claimed to participate in volunteer activities.

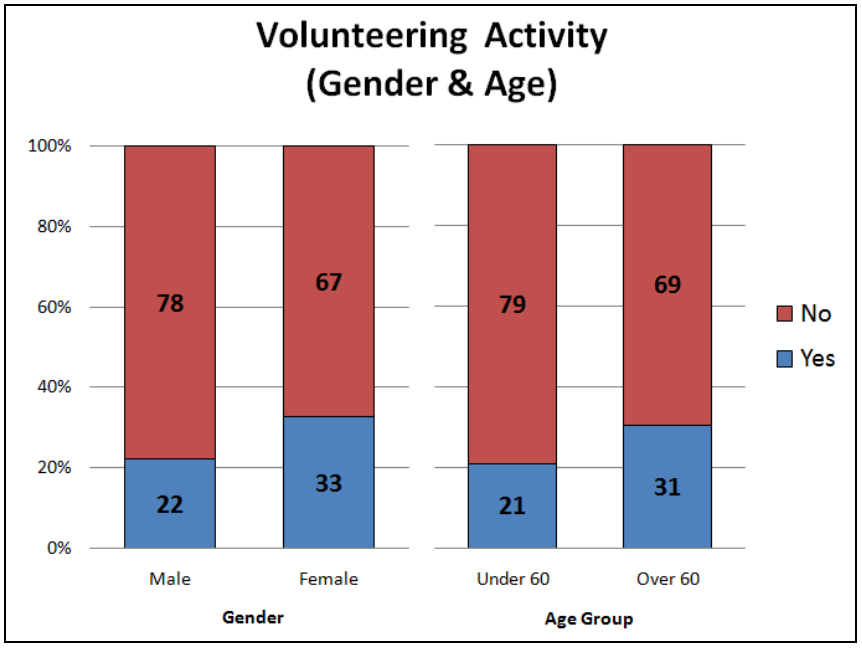
Figure 5.24: Respondent volunteer activity by region and type of homeowner



(Rockingham, permanent n = 129, non-permanent n = 26; Yorke Peninsula, permanent n = 84, non-permanent n = 106)

Figure 5.25 reveals that females are more likely to volunteer than males ($\chi^2 = 4.569$, $p = 0.033$), and those over 60 years of age are more likely to volunteer than those under 60 years of age ($\chi^2 = 4.119$, $p = 0.042$).

Figure 5.25: Volunteering activity by gender and age groupings



(Gender, n = 339; Age grouping, n = 345)

5.2 Summary

This chapter outlined the results of the mail-out survey questionnaire's demographic characteristics. The focus has been on determining the representativeness of the returned survey, as well as whether or not there are significant relationships between the key variables. Interestingly, despite the two case study sites being markedly different sea change communities, the results show that there are no significant differences between other variables. There were, however, several statistically significant variations in terms of age (grouped as under 60 and over 60 years of age), with respect to other demographic variables, along with education level (grouped as either high or low), and residency (as either permanent or non-permanent resident).

Chapter 6 – Results: Risk and Vulnerability

This chapter discusses the mail-out survey questionnaires results that specifically relate to the perception of risk within the first research objective, that is to:

1. Identify the relationship between perceived risks and perceived adaptive capacities of property owners within non-metropolitan coastal settlements in order to better understand their predisposition towards actions for reducing vulnerability to climate change.

Similar to Chapter 5, responses to closed questions are displayed in graphs, with questions displayed either independently or cross-tabulated, and open-ended questions are displayed in tables. A much more systematic and direct consideration of the implications of the results is discussed in Chapter 8.

6.1 Perceived risk

The first research objective was to identify the relationship between perceived risks and perceived adaptive capacities in two coastal settlements. There are numerous instances of statistically significant relationships of perceived risk between variables, particularly with respect to key variables such as concern about climate change, whether or not respondents believed if climate change is occurring now, and age (of either under 60 years of age, and above 60 years of age).

6.1.1 Climate change

In considering what the most serious negative impact of climate change would be (Table 6.1), respondents identified sea-level rise and flooding as the most serious. Decreases and changes in rainfall were the second most frequently cited impact, followed by coastal erosion. Although the question implied that participants report what they perceive as the *single most serious negative impact*, almost 10% of responses involved multiple impact themes per response (*inter alia*). Of the responses mentioned *inter alia*, almost all were reported as a pair. The category 'other' tended to include notions of 'scare mongering', 'climate change is a natural cycle of change', and 'climate change yet to be scientifically confirmed', which will be further discussed below.

Table 6.1: Perceived most serious negative impact of climate change

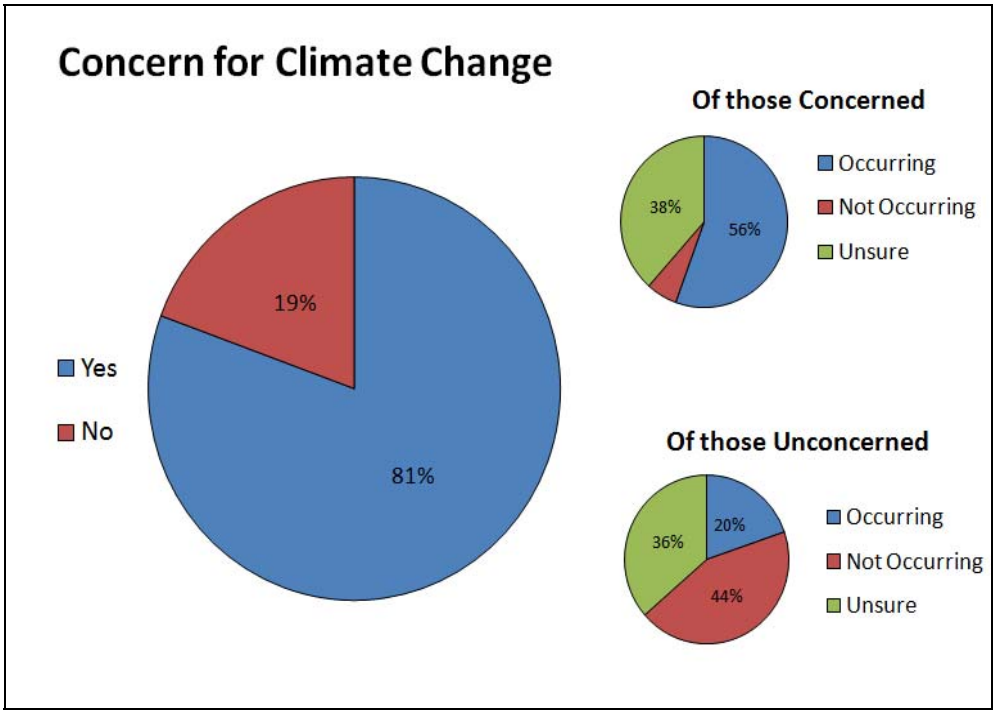
Most Serious Negative Impact of Climate Change	Mentioned *Inter Alia*	Sole Response
n of respondents	28	283
Sea-Level Rise & Flooding	4	72
Decreased/Changed Rainfall	10	37
Coastal Erosion	7	25
Pollution	2	18
Decreased Freshwater Availability	1	18
Changed Weather/Seasons	3	13
Drought	0	13
Increased Storminess	4	12
Marine Life	6	7
Terrestrial Habitats/Flora & Fauna	6	7
Over/Inappropriate Development	4	7
Don't Know	0	7
Industry	0	7
Agricultural Productivity	3	6
Increased Temperatures	8	5
Economy	0	3
Human Health	0	3
Desalination Plant	2	2
Bush Fires	1	2
Other	0	19

Themes per response mentioned *Inter Alia*	*n*
2 themes per response	25
3 themes per response	2
5 themes per response	1

(n = 311)

81% of all respondents were concerned about climate change (Figure 6.1). Of the 81% of those concerned, 56% believed climate change was occurring now, and 38% were unsure. Of the 19% of respondents unconcerned about climate change, 44% did not believe that climate change was occurring now, and 36% were unsure. Overall, however, 48% of all respondents believed climate change was occurring now, 39% were unsure, and 13% did not believe that climate change was occurring now. There was found to be a statistically significant difference between those concerned and those unconcerned in reference to whether or not they believed climate change was occurring (χ^2 =72.2, p = 0.000).

Figure 6.1: Overall concern about, and occurrence of, climate change



(Total n = 347; Of those Concerned n = 281; Of those Not Concerned n = 66)

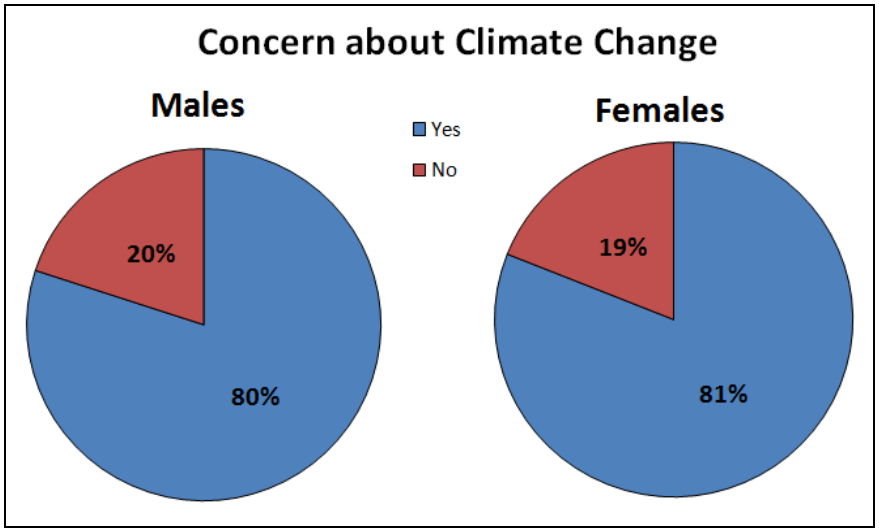
Table 6.2 lists examples of the open-ended responses whereby people demonstrated attitudes that were either sceptical of the notion of anthropogenic climate change, or denied the anthropogenic link in climate change altogether. The proportion of respondents exhibiting such attitudes within comments accounted for 5.7% of the total respondents (Rockingham *n* = 10; Yorke Peninsula *n* = 12) (see Appendix 5 for a list of all comments).

Table 6.2: Examples of attitudes of climate change 'scepticism' and 'denial' from selected open-ended responses relating to the most serious negative impact of climate change and questionnaire feedback

Category	Examples
'Scepticism'	"We believe that climate change is cyclonic and that not enough data has been recorded over a long period of time to prove climate change..." (Yorke Peninsula Respondent 306, age group Unknown)
	"I believe there has been and always will be climate change and am unsure how much change is from human activity. Whatever change occurs I think humans will adapt (this has been our secret to success)..." (Rockingham Respondent 254, age group 60+)
	"We should just prepare for changes rather than blame humans for climate change/sea-level rise. It might be just a natural cycle beyond our control." (Yorke Peninsula Respondent 135, age group 40-49)
'Denial'	"Climate change yet to be scientifically confirmed" (Rockingham Respondent 396, age group 60+)
	"Bullshit, leave what God created alone and do some honest work" (Rockingham Respondent 3, age group Unknown)
	"I don't believe mankind has anything to do with climate change, it has happened too many times in the past history when there was no manmade pollution…" (Yorke Peninsula Respondent 276, age group 60+)

Figure 6.2 shows that the proportion of both males and females concerned about climate change was essentially the same, with 80% of males and 81% of females.

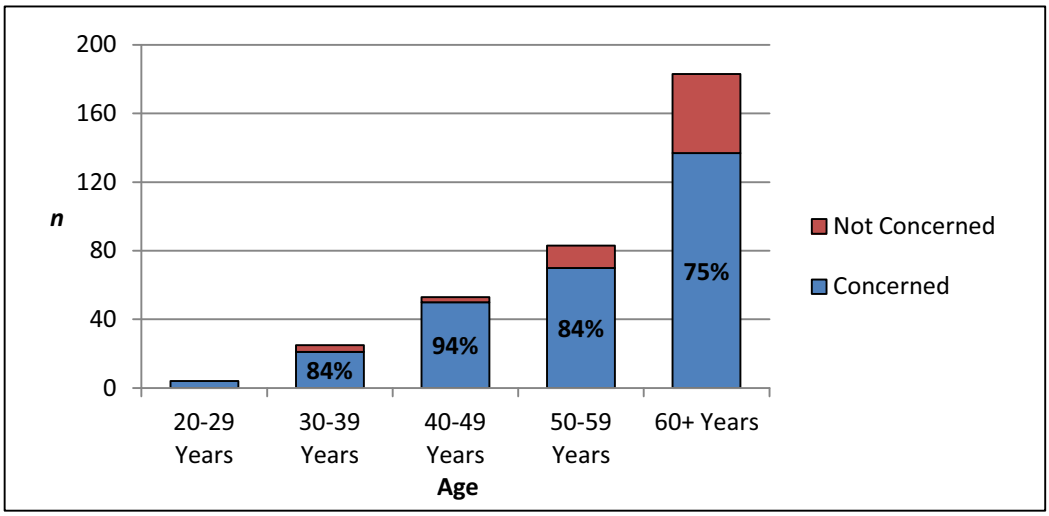
Figure 6.2: Concern about climate change by gender



(Male, n = 212; Female, n = 130)

Figure 6.3 shows that the lowest levels of concern about climate change are found within the 60+ years age group of respondents. It must be noted, however, that the 60+ age group constitutes over 50% of all respondents (Figure 5.7).

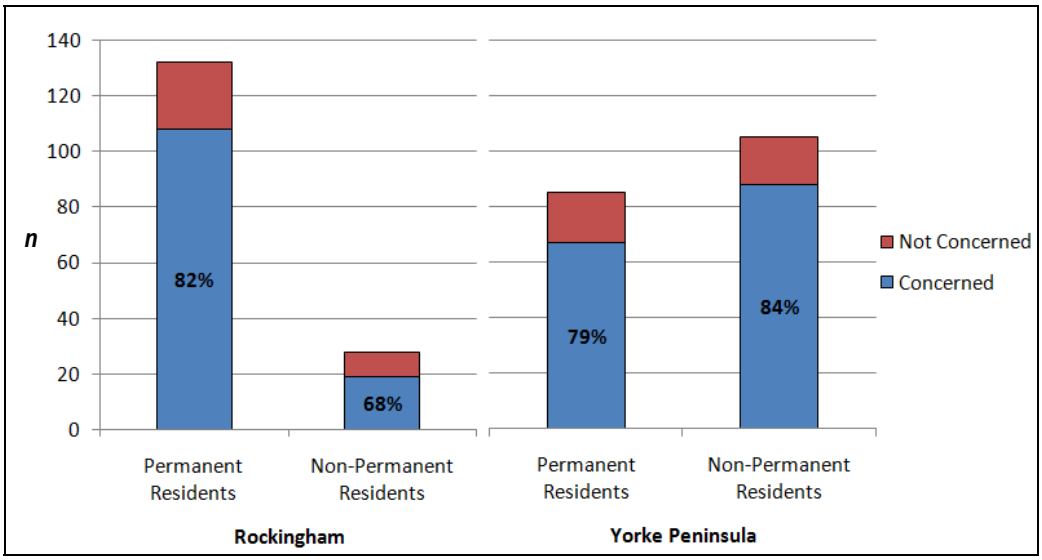
Figure 6.3: Indicated level of concern about climate change and age



(n = 348)

Figure 6.4 shows that, in Rockingham, permanent residents are more likely to be concerned about climate change compared with non-permanent residents. Conversely, in Yorke Peninsula, non-permanent residents are more likely to be concerned about climate change compared with permanent residents.

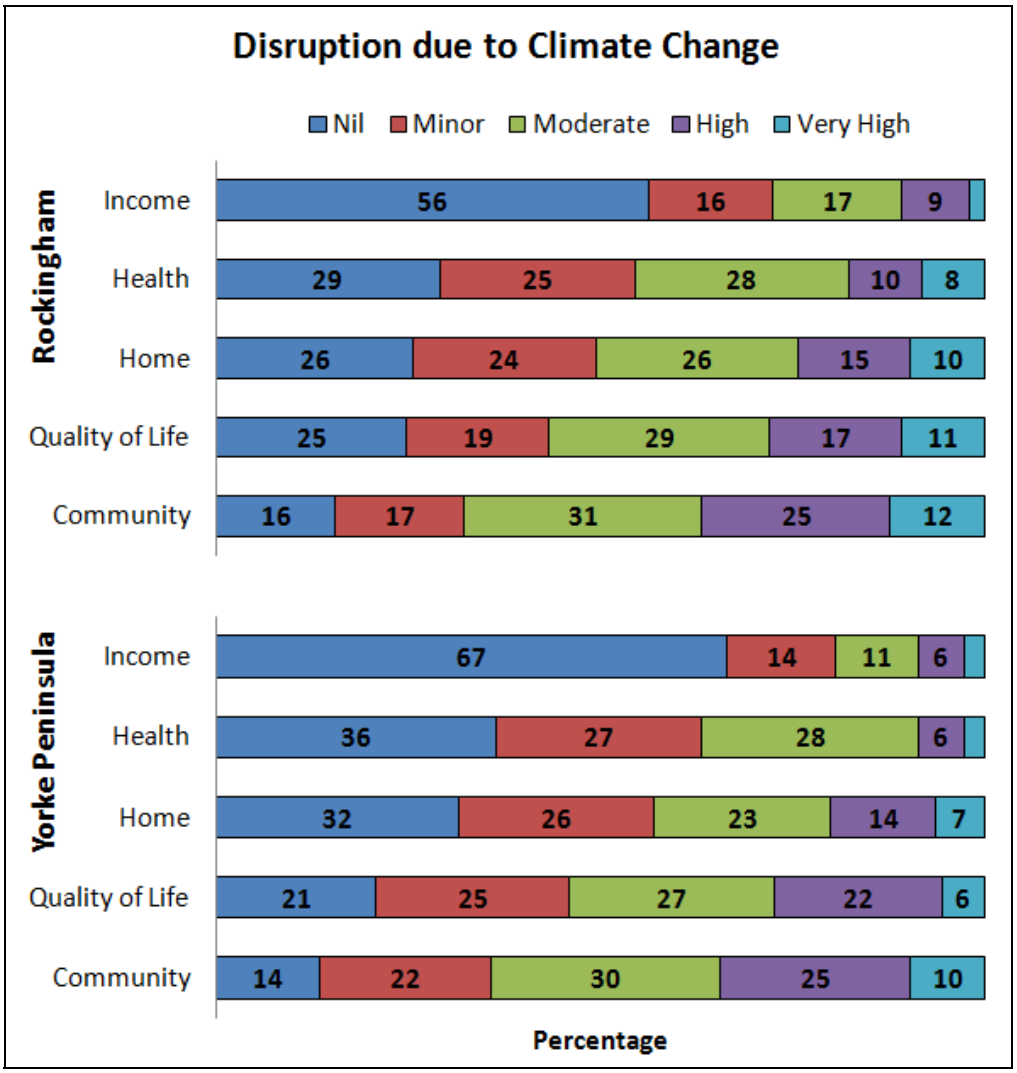
Figure 6.4: Regional variation of homeowner types in relation to indicated level of concern about climate change



(*Rockingham n = 160; Yorke Peninsula n = 190)*

Figure 6.5 shows the degree to which respondents expected climate change to cause disruption to their income, home, health, quality of life and community. At both case study sites, income was expected to be least disrupted by climate change whereas the community was expected to be most disrupted. There is a decrease in the proportions of those who expect climate change to have nil disruption as each element becomes more abstract and less tangible or personal (that is, from income through to community). Between the responses in terms of region and disruption to health, there is a statistically significant difference (U = 12900.5, p = 0.027). Specifically, 54% of Rockingham respondents indicated nil or minor disruption to health, compared with 63% of Yorke Peninsula respondents (9% regional variation).

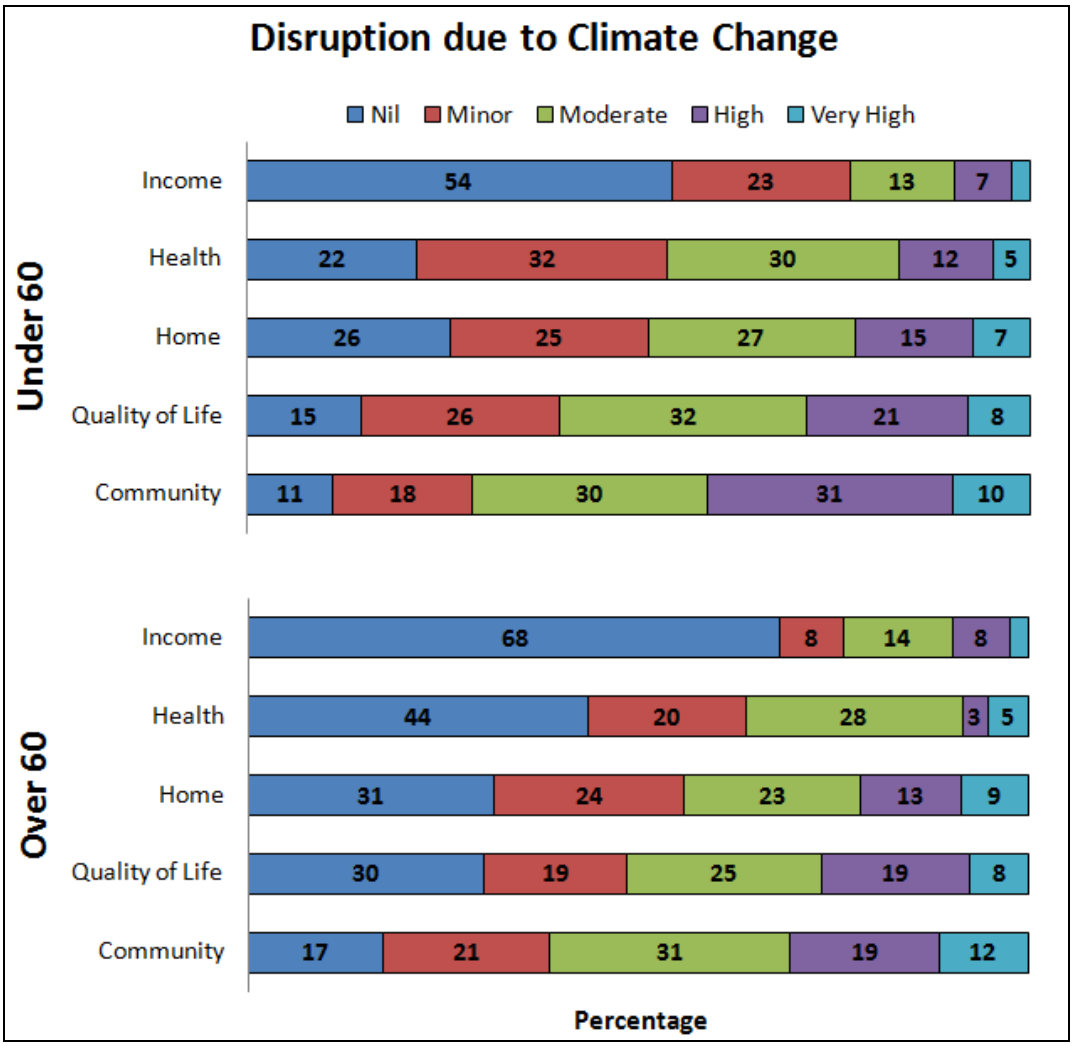
Figure 6.5: Regional variations of expected disruption due to climate change



(Rockingham Income n = 156, Health n = 158, Home n = 156, Quality of Life n =157, and Community n = 155; Yorke Peninsula Income n = 185, Health n = 187, Home n = 184, Quality of Life n = 183, and Community n = 184)

Figure 6.6 shows the variations in expected disruption based on age groupings of under 60 years and over 60 years of age. Respondents aged over 60 years were less likely to expect disruption to their health (U = 11543.5, p = 0.000) (10% variation), quality of life (U = 12535.5, p = 0.047) (8% variation), and their community (U = 12443.0, p = 0.045) (9% variation), compared with respondents aged under 60 years.

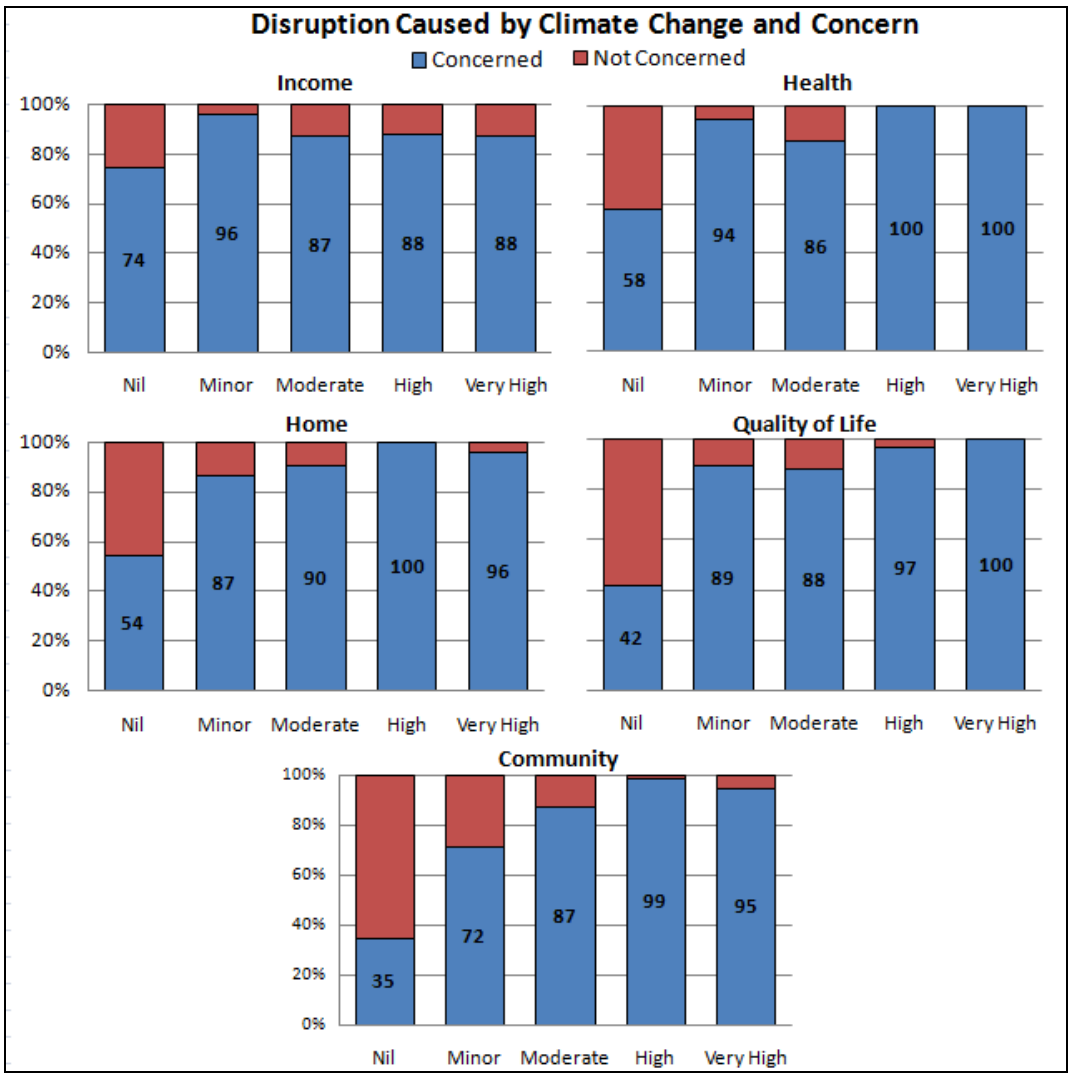
Figure 6.6: Expected disruption to due to climate change by age groupings



(Under 60 Income n = 166, Health n = 166, Home n = 166, Quality of Life n =165, and Community n = 163; Over 60 Income n = 173, Health n = 177, Home n = 172, Quality of Life n = 173, and Community n = 174)

Figure 6.7 reveals that proportions of respondents who were concerned about climate change increases as the level of expected disruption to particular 'elements' of people's lives increases. It was found that those who expect climate change disruption to be nil or minor are more likely to not be concerned about climate change. This difference was statistically significant for all variables (Income U = 7000.5, p = 0.001; Health U = 4821.5, p = 0.000; Home U = 3747.0, p = 0.000; Quality of Life U = 3218.5, p = 0.000; Community U = 3186.0, p = 0.000).

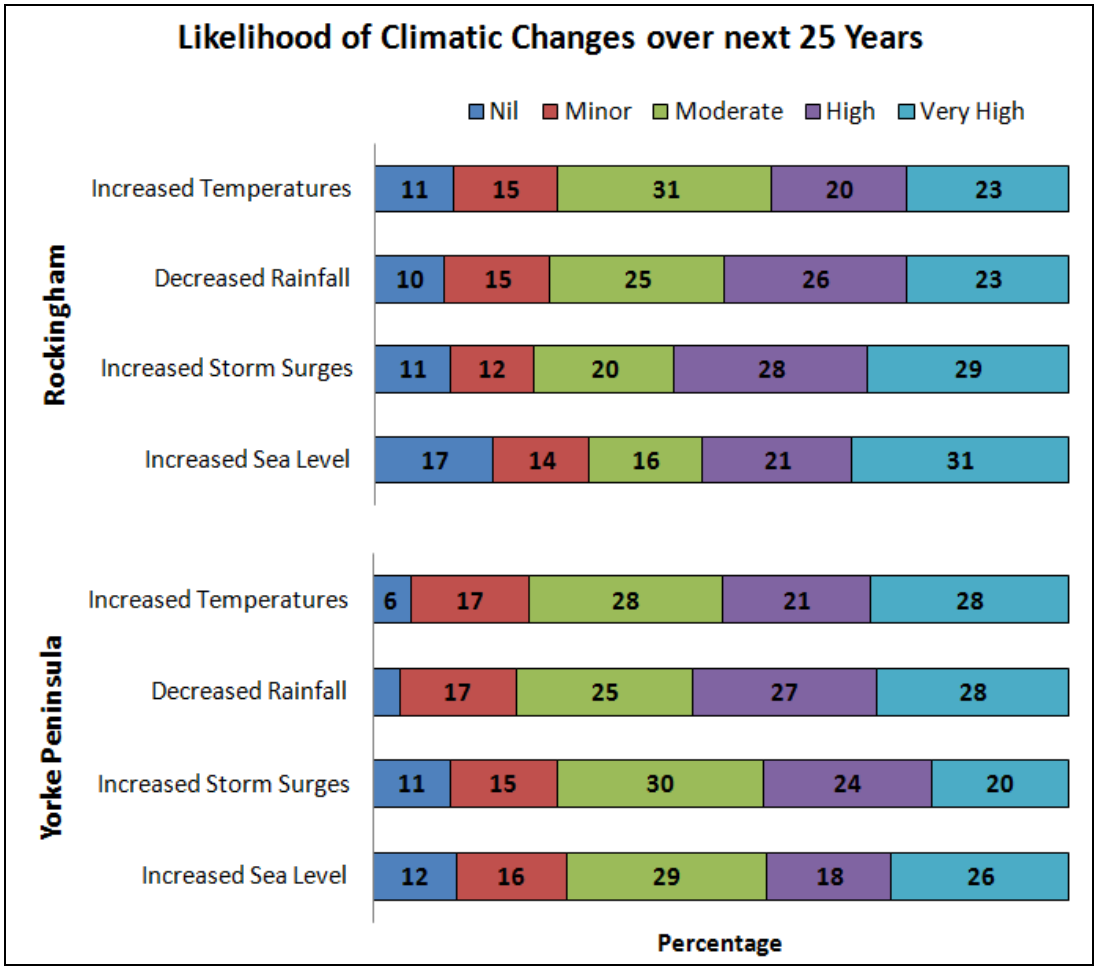
Figure 6.7: Expected level of disruption caused by climate change in relation to indicated level of concern



(Income n = 341, Health n = 345, Home n = 340, Quality of Life n = 340, Community n = 339)

Figure 6.8 shows how likely respondents consider particular climatic changes occurring within their respective region over the next 25 years. Variables of climatic changes included the likelihood of increased temperatures, decreased rainfall, increased storm surges and increased sea level. At both sites, between 43% and 57% of all respondents considered the likelihood of climatic changes to be high or very high and between 20% and 31% of all respondents considered the likelihood of changes to be nil or minor. There is a statistically significant difference between the respondents from each region with respect to the likelihood of increased frequency and intensity of storm surges (U = 12647.0, p = 0.039). Specifically, 44% of Yorke Peninsula respondents indicated a high to very high likelihood of storm surges over the next 25 years, compared with 57% of Rockingham respondents (13% regional variation).

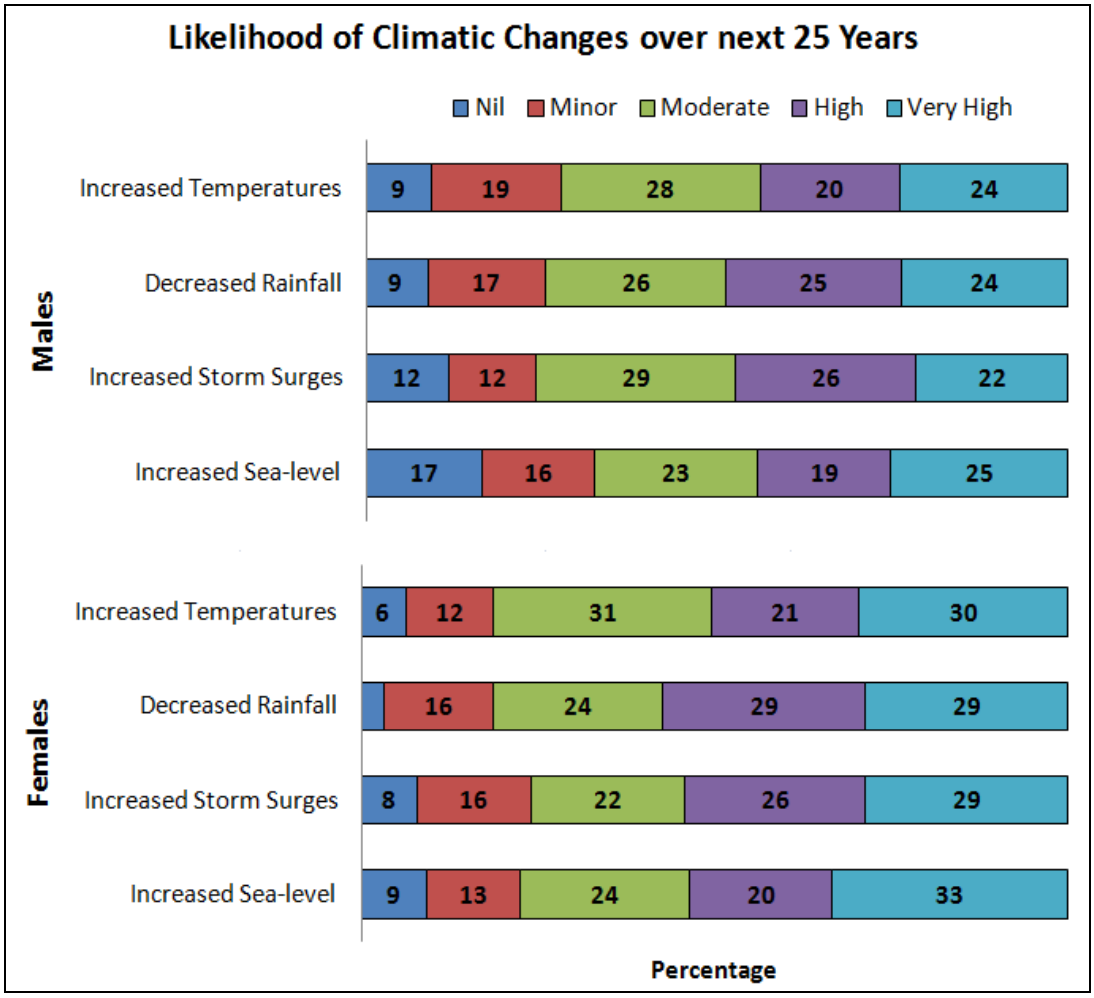
Figure 6.8: Likelihood of climatic changes occurring in the region over the next 25 years



(Rockingham, Increased Temperature n = 159, Decreased Rainfall n = 159, Increased Storm Surges n = 158, and Increased Sea Level n = 159; Yorke Peninsula, Increased Temperature n = 183, Decreased Rainfall n = 185, Increased Storm Surges n = 182, and Increased Sea Level n = 184)

Figure 6.9 shows that females consider the likelihood of climatic changes to be higher overall than males. A statistically significant difference was identified between the genders and perceived likelihood of increased sea levels (U = 11453.5, p = 0.029), whereby 33% of females compared with 25% of males considered the likelihood of increased sea levels as very high, and, conversely, 17% of males compared with 9% of females indicated nil likelihood of change over the next 25 years.

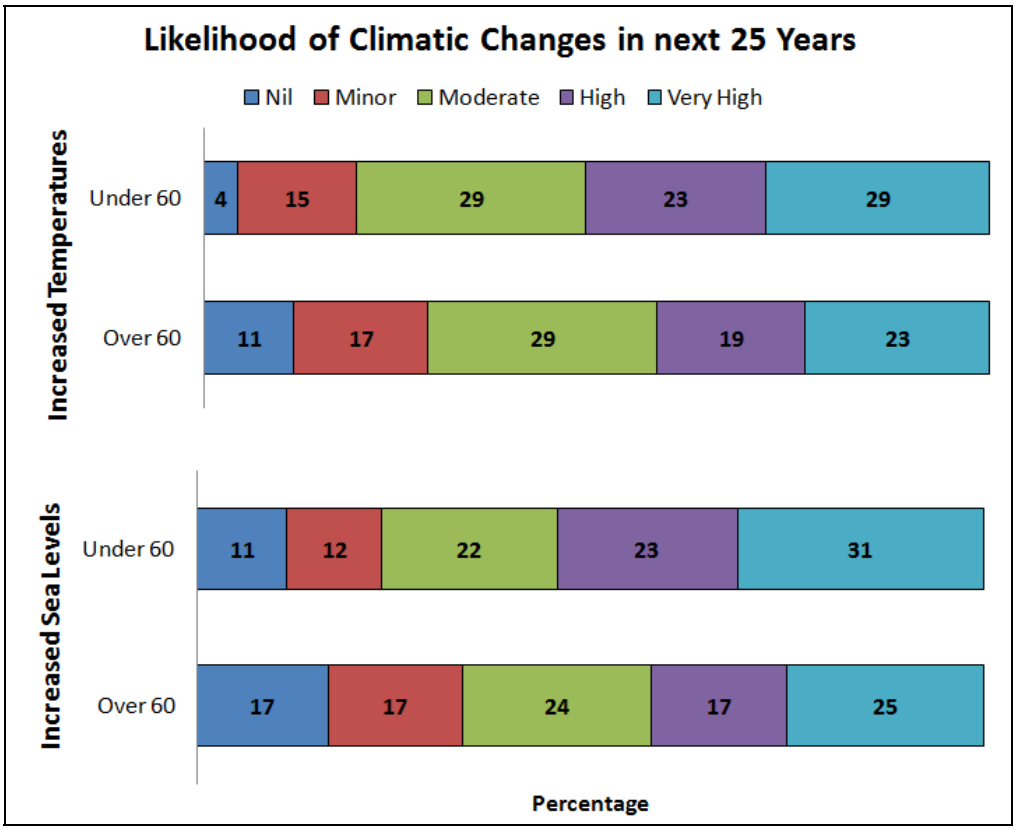
Figure 6.9: Gender variations of likelihood of climatic changes over the next 25 years



(Male, n = 206; Female, n = 129)

Figure 6.10 shows that respondents aged under 60 years considered the likelihood of increased temperatures to be greater compared to those respondents aged over 60 years (U = 12579.5, p = 0.035) (10% variation between age groupings). Respondents aged under 60 years also considered the likelihood of increased sea levels to be greater compared to those respondents aged over 60 years (U = 12570.5, p = 0.028) (12% variation between age groupings).

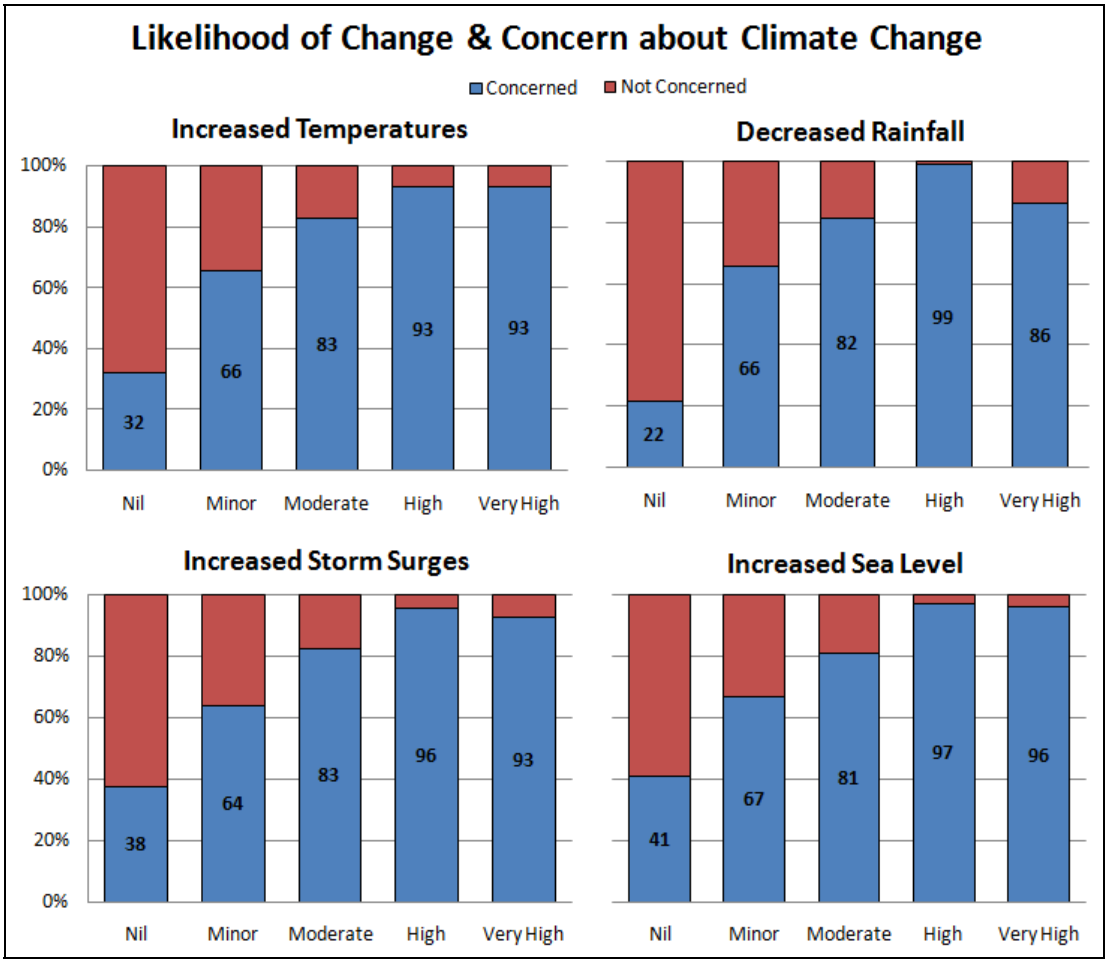
Figure 6.10: Likelihood of increased temperatures and sea levels by age groupings



(Increased Temperature, n = 340; Increased Sea Level, n = 341)

Figure 6.11 shows that the proportion of respondents concerned about climate change generally increases as perceived likelihood of increased temperatures, decreased rainfall, increased storm surges and increased sea level increases. Therefore, it is observed that the less likely respondents are to consider change occurring over the next 25 years, the less likely they are to be concerned about climate change. This difference was statistically significant for each variable (Increased Temperatures U = 4278.5, p = 0.000; Decreased Rainfall U = 4743.0, p = 0.000; Increased Storm Surges U = 3896.5, p = 0.000; Increased Sea Level U = 3428.0, p = 0.000).

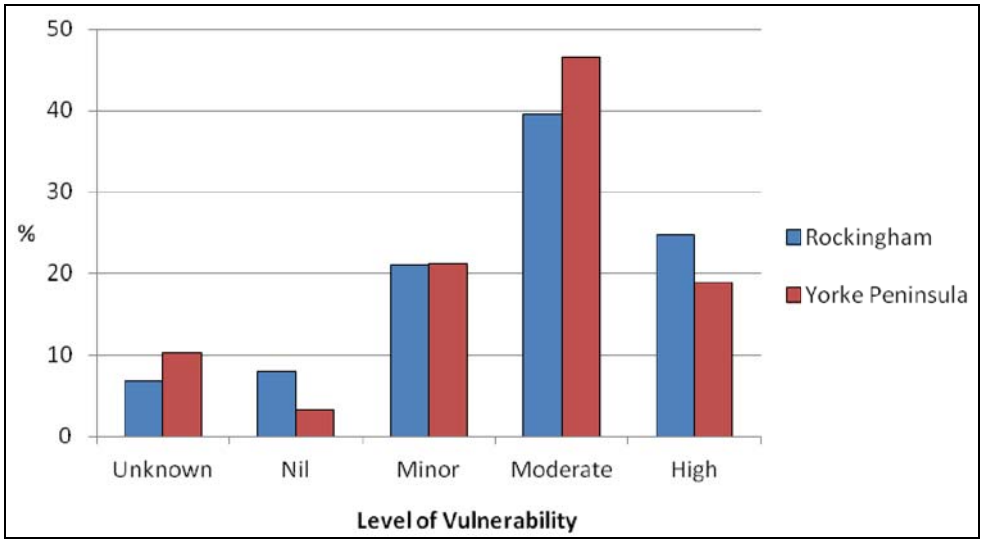
Figure 6.11: Overall likelihood of disruptions due to climate change in relation to indicated level of concern



(Increased Temperature n = 342, Decreased Rainfall n = 344, Increased Storm Surges n = 340, and Increased Sea Level n = 343)

Figure 6.12 shows that almost two thirds of respondents at both sites considered their communities as moderately to highly vulnerable to the impacts of climate change. Rockingham respondents were more likely to consider the community's vulnerability to be nil, and Yorke Peninsula respondents were slightly more likely to indicate unknown.

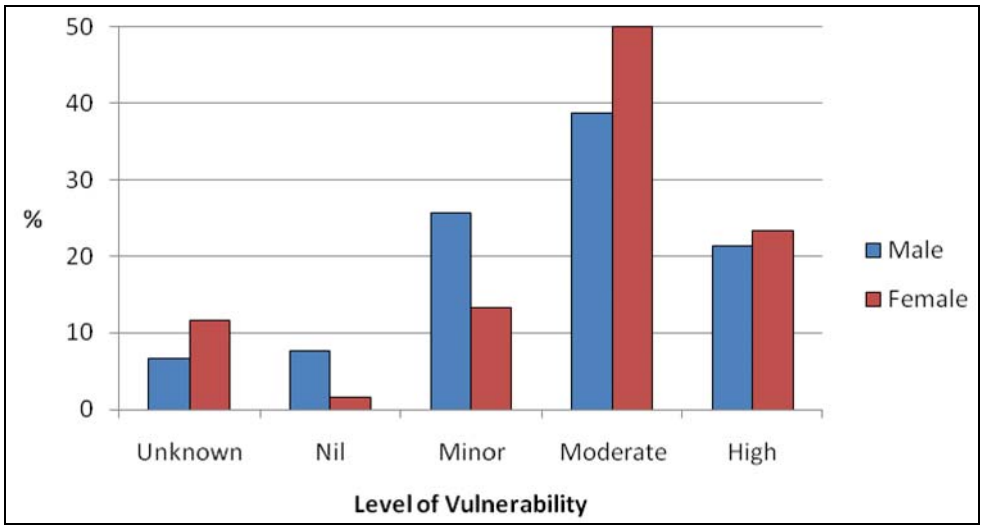
Figure 6.12: Regional variations of perceived community vulnerability to climate change



(Rockingham, n = 162; Yorke Peninsula, n = 185)

Figure 6.13 shows that females considered the community's vulnerability to climate change as greater than that reported by males (U = 10811.0, p = 0.001), and that females reported greater proportions of unknown than males.

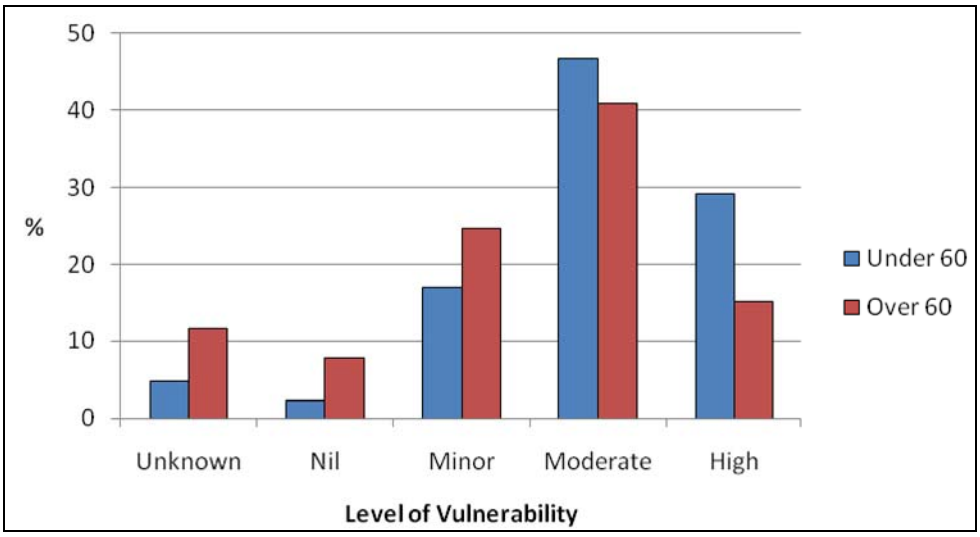
Figure 6.13: Gender variation of perceived community vulnerability to climate change



(Male, n = 210; Female, n = 128)

Figure 6.14 reveals that respondents aged under 60 years considered community vulnerability to be greater compared to those respondents aged over 60 years (U = 12938.5, p = 0.036).

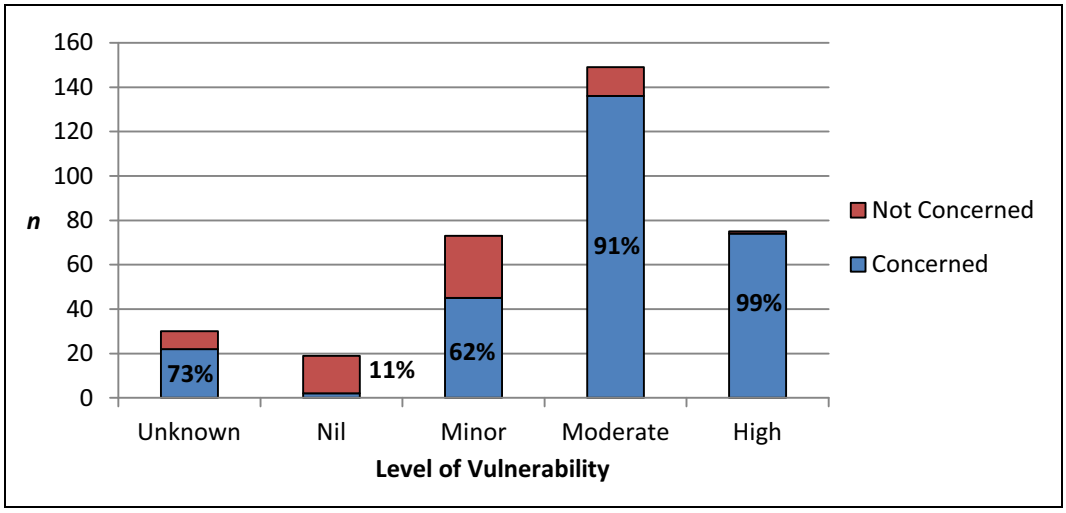
Figure 6.14: Perceived community vulnerability to climate change by age grouping



(Under 60, n = 165; Over 60, n = 179)

Figure 6.15 shows that if respondents have a greater propensity to be concerned about climate change they are more likely consider their community as vulnerable to climate change impacts, and vice versa (U = 4562.0, p = 0.000). Additionally, almost three quarters (73%) of those indicating that they were unsure about the community's vulnerability were concerned about climate change, and 11% of those who thought the community was not vulnerable were nonetheless concerned.

Figure 6.15: Community vulnerability to climate change in relation to indicated level of concern



(n = 346)

Table 6.3 shows whom respondents considered, in the community, to be the most vulnerable to negative climate change impacts. Coastal residents/properties and low-lying areas were stated as being the most vulnerable and constituted over one third of all single responses. Table 6.4 list how respondents predominately explained their choice and justified why they perceived that particular group to be most vulnerable. Although the question implied the reporting of a single group of people, over one third of all respondents listed multiple groups. In addition, it must be noted that some response themes do not specifically mention groups of people, as per the question specification, but instead include non-human entities such as businesses, services, and economies, as well as flora and fauna.

Table 6.3: Perceived most vulnerable to the negative impacts of climate change

Those Most Vulnerable to the Negative Impacts of Climate Change	Mentioned *Inter Alia*	Sole Response
n of respondents	120	174
Coastal Residents/Properties & Low-lying Areas	57	66
Farmers & Farming Community	72	29
Aged, Elderly & Retired	41	16
Everyone is Vulnerable	11	13
Children, Young & Future Generations	13	12
No One or Not Many People are Vulnerable	0	11
Low Income, Underprivileged People	14	6
Beach Users, Tourism & Beach Amenity	18	3
The Economy of the Local Areas	17	2
Coastal Businesses	10	2
People in Bush Fire Areas	1	2
Fisherman & Fishing Industry	24	1
Plants & Animals	5	0
Health Service Providers	2	0
Other	3	11
Themes per response mentioned *Inter Alia*		*n*
2 themes per response		84
3 themes per response		25
4 themes per response		10
5 themes per response		1

(n = 294)

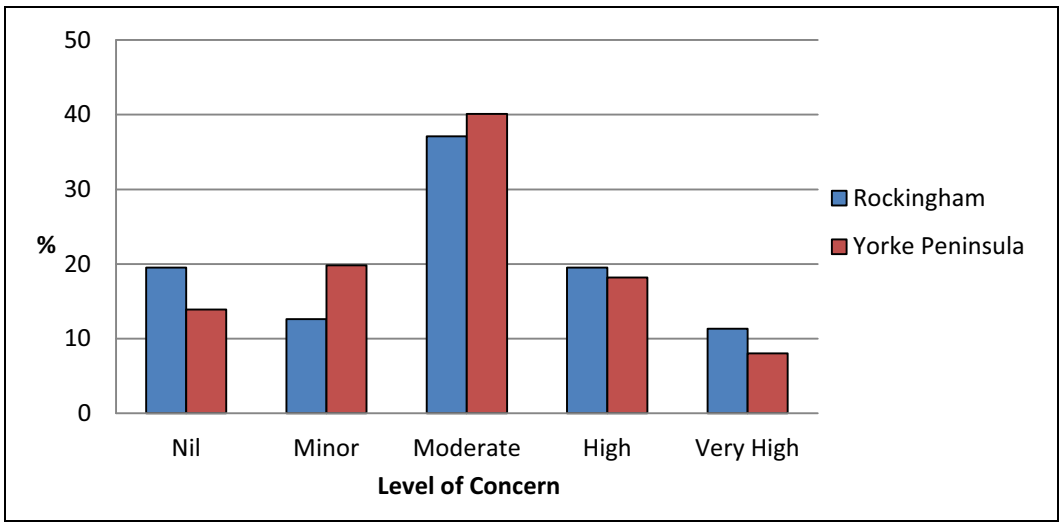
Table 6.4: Selected open-ended responses relating to who is most vulnerable to climate change

Coded theme	Examples
Coastal Residents/ Properties & Low-lying Areas	"Homeowners right on the low coastline areas. Land will be reclaimed."(Yorke Peninsula Respondent 187, age group 40-49)
Farmers & Farming Community	"Farmers – as we have already witnessed the extreme loss of topsoil, plus the damage all round owing to past drought conditions" (Yorke Peninsula Respondent 5, age group 60+)
Aged, Elderly & Retired	"Pensioners – these are the most vulnerable in our community and least able to effect any necessary changes, i.e., meaningful changes" (Rockingham Respondent 517, age group 60+)
Everyone is Vulnerable	"Everyone is vulnerable. Individuals try to save water, cut down on power usage and lots of other ways – but industry and people who think they are untouchable just carry on" (Rockingham Respondent 215, age group 60+)
Children, Young & Future Generations	"Our children and their children and their health and quality of life because if climate change is not addressed soon it could become an irreversible condition" (Rockingham Respondent 75, age group 60+)
Other	"whoever is the most fearful" (Yorke Peninsula Respondent 61, age group 60+)
No One or Not Many People Vulnerable	"There is in my opinion a lot of media hype on this subject and scare mongering. There will be changes but minor and all will adapt." (Yorke Peninsula Respondent 236, age group 60+)

6.1.2 Sea-level rise

Figure 6.16 reveals that over one third of both Rockingham and Yorke Peninsula respondents reporting being moderately concerned about sea-level rise.

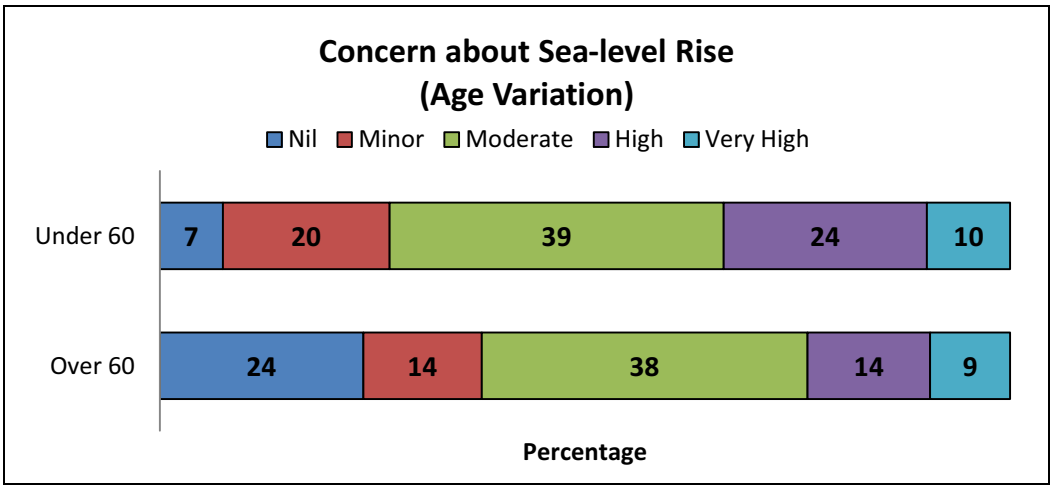
Figure 6.16: Regional variation of concern about sea-level rise



(Rockingham, n = 159; Yorke Peninsula, n = 187)

Figure 6.17 shows that a greater proportion of respondents aged under 60 years indicated high or very high levels of concern about sea-level rise, than respondents aged over 60 years (U = 12152.0, p = 0.004). Almost one quarter (24%) of respondents aged over 60 years indicated that they are not concerned about sea-level rise.

Figure 6.17: Concern about sea-level rise by age groupings



(Under 60, n = 160; Over 60, n = 183)

Table 6.5 reveals respondent explanations of their level of concern (worried or not worried) about sea-level rise. For responses that listed one reason (sole response), the most prevalent cause for concern was due to the loss of homes and lifestyle that sea-level rise would cause. Conversely, the most prevalent reason for minimal concern was that respondents could not perceive sea-level rise having a major impact. More than one third of respondents included multiple reasons for concern about sea-level rise (mentioned *inter alia*), with the loss of homes and lifestyle, and low-lying areas becoming flooded, being the most common response *inter alia*, as well as community/foreshore damage. Table 6.6 shows that respondents who were concerned generally indicated or implied that changes to sea level would occur in the long-term or at some point into the future, whilst those responses that discussed nil or minimal concern generally described the extent of sea-level rise, either current or future, as only minor or natural.

Table 6.5: Reasons for concern about sea-level rise

Why are you Worried/Unworried about Sea-level Rise?	Mentioned *Inter Alia*	Sole Response
n of respondents	98	180
Due to the Loss of Homes & Lifestyle	53	19
Because I cannot see it having a major impact	4	17
Due to Low-lying Areas becoming Flooded	53	15
Because the rates of Change are minor	15	15
Due to the Legacy (Intergenerational)	10	13
Community/Foreshore Damage	33	11
It's just a Normal Cycle of events	1	11
Because I'm Too old/Won't be alive to see change	6	10
There is Not Enough Info/Conflicting Info	3	9
I'm Not at Risk (My Property is Safe)	6	8
Because I can see Changes Occurring Now	1	8
Due to the Overall Impacts	3	5
Because there will be Loss of Habitats & Ecosystems	9	4
Because of a Lack of Leadership	2	4
Costs Involved (including personal)	1	4
Because of all the Vulnerable People	17	3
Due to Inappropriate Development	4	3
I'm Optimistic	1	2
Other	0	19

Themes per response mentioned *Inter Alia*	*n*
2 themes per response	75
3 themes per response	20
4 themes per response	3

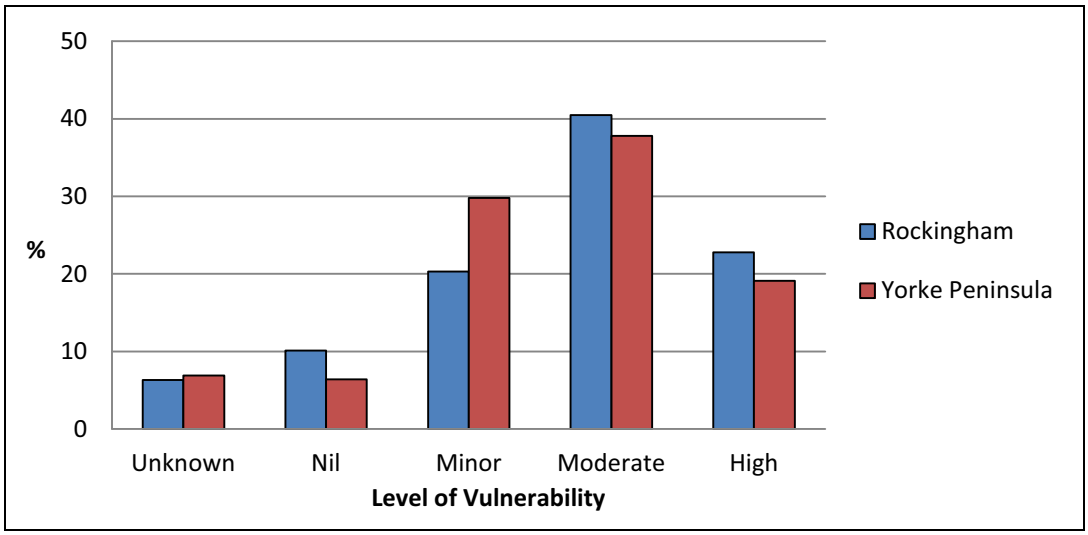
(n = 268)

Table 6.6: Selected open-ended responses relating to reasons for concern about sea-level rise

Coded theme	Examples
Due to the Loss of Homes & Lifestyle	"My home would become valueless if sea level rose leaving me homeless and without insurance to compensate" (Rockingham Respondent 358, age group 60+)
Because I cannot see it having a major impact	"I have not seen any evidence of it happening. Locals have not seen it over the last 50 years. Seas cannot rise in one part of the world and not in another." (Yorke Peninsula Respondent 42, age group 50-59)
Due to Low-lying Areas becoming Flooded	"SA has a lot of low lying coastal areas where a greater proportion of the population inhabit" (Yorke Peninsula Respondent 124, age group 60+)
Because the rates of Change are minor	"It will happen very slowly and give coastal home owners time to adapt or move away" (Yorke Peninsula Respondent 315, age group 40-49)
Due to the Legacy (Intergenerational)	"The impact will not effect me during my lifetime but will certainly effect my children during their lifetime" (Rockingham Respondent 75, age group 60+)
It's just a Normal Cycle of events	"The earth over eons has experienced sea level change, it is a natural part of the created world" (Yorke Peninsula Respondent 1, age group 60+)
Other	"A little worried in case the 'experts' (on the side of change occurring) are right" (Rockingham Respondent 380, age group 60+)

Figure 6.18 reveals that almost two thirds of respondents at both sites considered their communities as moderately to highly vulnerable to the impacts of sea-level rise. Rockingham respondents perceived slightly higher proportions of high, moderate and nil community vulnerability than Yorke Peninsula respondents, whereas Yorke Peninsula respondents reported higher proportions of minor vulnerability.

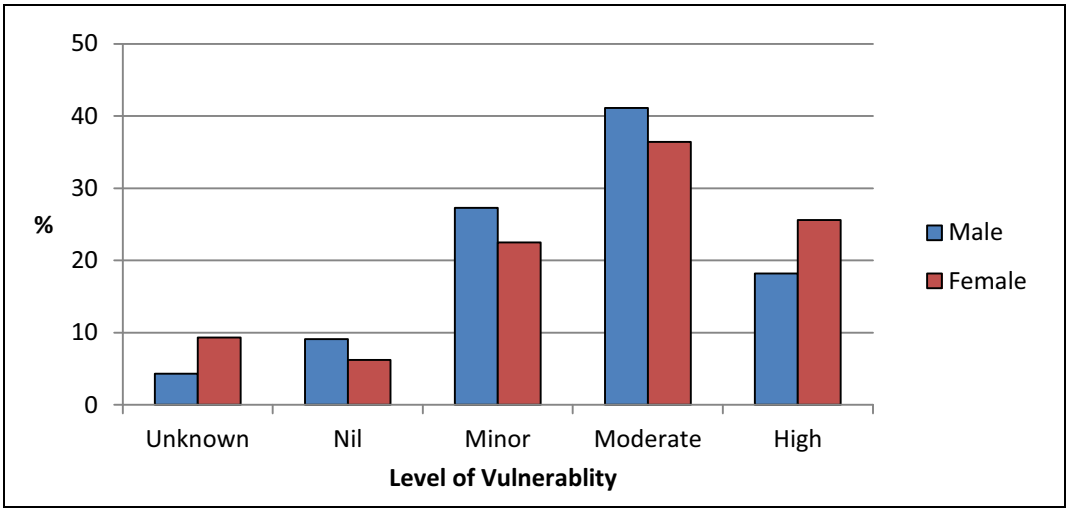
Figure 6.18: Regional variation of perceived community vulnerability to sea-level rise



(Overall, n = 346; Rockingham, n = 158; Yorke Peninsula, n = 188)

Figure 6.19 shows that females perceived a high level of community vulnerability to sea-level rise compared to males, and reported greater proportions of unknown vulnerability. Males, however, considered nil, minor and moderate vulnerability more so than females (U = 11487.5, p = 0.017).

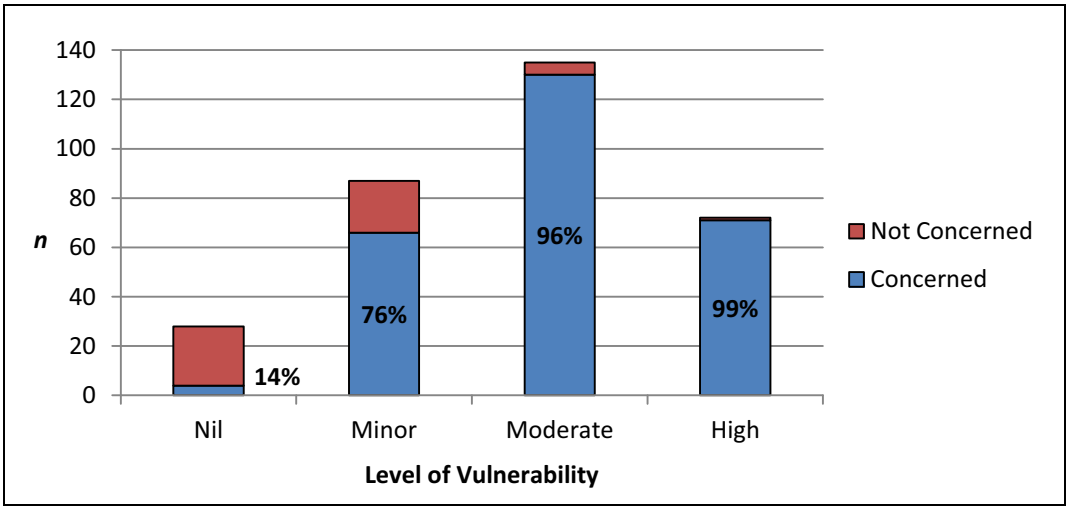
Figure 6.19: Gender variation of perceived community vulnerability to sea-level rise



(Male, n = 209; Female, n = 129)

Figure 6.20 reveals that respondents have the propensity to be concerned about sea-level rise because they consider their community as vulnerable to the impacts (U = 4343.5, p = 0.000). This is consistent with sea-level rise and flooding being considered as the most serious negative impact of climate change (Table 6.1).

Figure 6.20: Community vulnerability to sea-level rise and concern*



(n = 322)

** Collated from data of concern about sea-level rise (Figure 6.16)*

Table 6.7 list the impacts that respondents believed rising sea levels would have on their respective community. For responses that listed only one impact (sole response), the most prevalent was concerning damage to coastal homes. In second place, conversely, were those respondents who are not concerned about sea-level rise and consequently reported that there will be nil or only minimal damage. In general, impacts tended to be focussed on settlements and development. Table 6.8 provides examples of the open-ended sole responses.

Table 6.7: Perceived impacts of sea-level rise on the community

What impacts will rising sea levels have on the community?	Mentioned *Inter Alia*	Sole Response
n of respondents	115	190
Damaged Coastal Homes	57	27
Nil/Minimal Damage	3	24
Flooding	28	21
It just will (have an impact)	1	15
Relocation/Displacement of people	16	11
Depends on several factors	2	11
Damaged Community Assets/Infrastructure	35	9
Long term	4	8
Damage/Protection Costs etc	16	6
Reduced Land Area	7	6
Coastal Communities	5	6
Erosion	19	3
Bad for businesses (economy)	18	3
Changed way of life (social)	17	3
Reduced Tourism	14	3
Reduced Property Value	10	3
SLR not happening/normal cycle	1	3
Poor people	0	1
Natural habitats (environmental)	21	0
Farming decline	10	0
Don't Know	1	10
Other	0	17

Themes per response mentioned *Inter Alia*	*n*
2 themes per response	70
3 themes per response	35
4 themes per response	10

(n = 305)

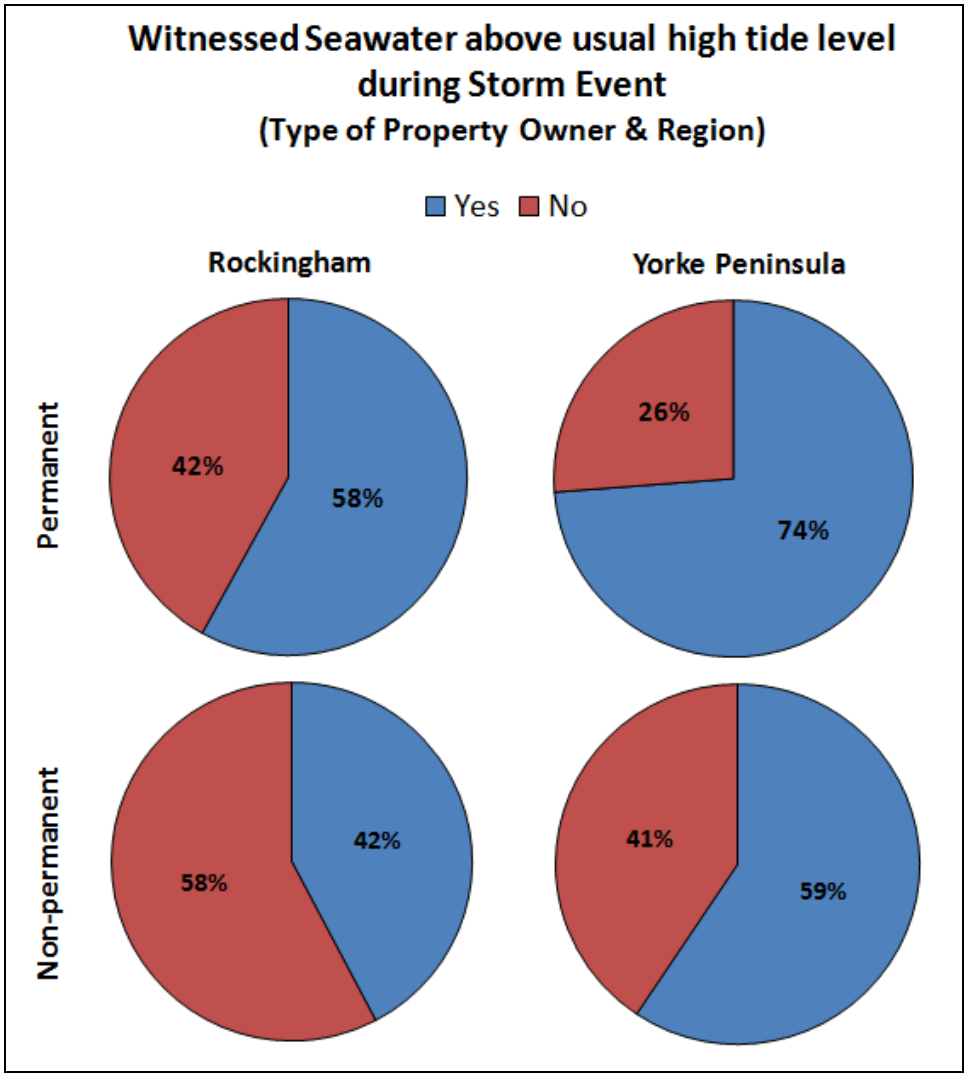
Table 6.8: Selected open-ended responses relating to the perceived impacts of sea-level rise

Coded theme	Examples
Damaged Coastal Homes	"The residents living on the sea front could in time be swept away" (Rockingham Respondent 323, age group 60+)
Flooding	"Some will have problems of flooding as they have built in unsuitable areas" (Yorke Peninsula Respondent 384, age group 60+)
It just will (have an impact)	"If it rises it will have a big impact" (Rockingham Respondent 468, age group 40-49)
Relocation/ Displacement of people	"Many people will have to move from their coastal homes" (Rockingham Respondent 445, age group 50-59)
Depends on several factors	"Could eventually be devastating depending on the level of the rise" (Rockingham Respondent 201, age group 60+)
Nil/Minimal Damage	"Shouldn't have any impact here" (Yorke Peninsula Respondent 11, age group 60+)
	"Very very little" (Rockingham Respondent 18, age group 60+)
Other	"It would shock many, considering there seems to be no plan of action. It would be chaotic" (Rockingham Respondent 340, age group 60+)

6.1.3 Storm surge

Figure 6.21 shows that 74% of permanent residents on Yorke Peninsula have witnessed the sea water above its usual high tide height, compared with only 59% of non-permanent residents (χ^2 = 4.303, p = 0.038). Whilst there is a similar trend for Rockingham respondents, with 58% of permanent residents having witnessed the sea water above its usual high tide height, compared with only 42% of non-permanent residents, this difference was not statistically significant.

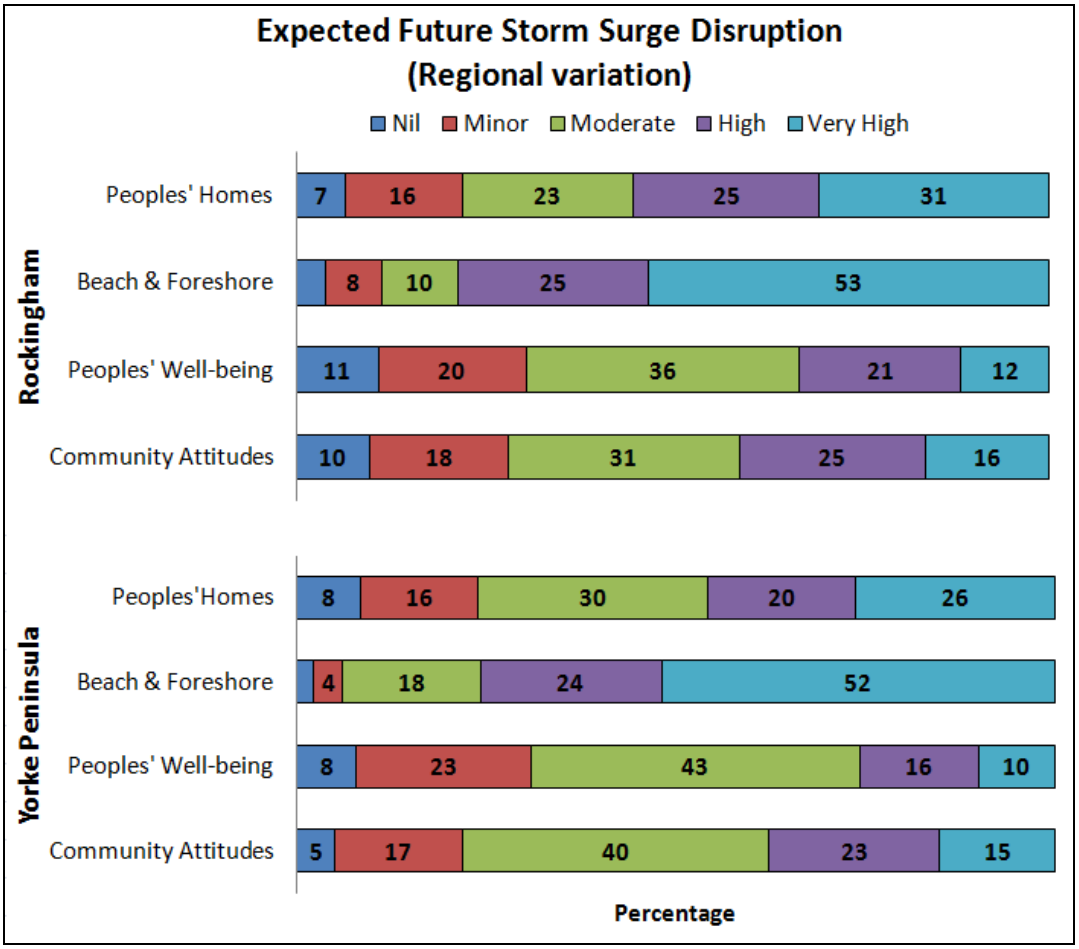
Figure 6.21: Regional variation of witnessing seawater above usual high tide level



(Rockingham Permanent n = 131, Rockingham Non-permanent n = 26; Yorke Peninsula Permanent n = 84, Yorke Peninsula Non-permanent n = 106)

Figure 6.22 reveals that over one half of respondents expect the beach and foreshore to be very highly disrupted by storm surges in the future, and that around one third and one quarter of respondents at Rockingham and Yorke Peninsula, respectively, expected peoples' homes to be very highly disrupted in the future.

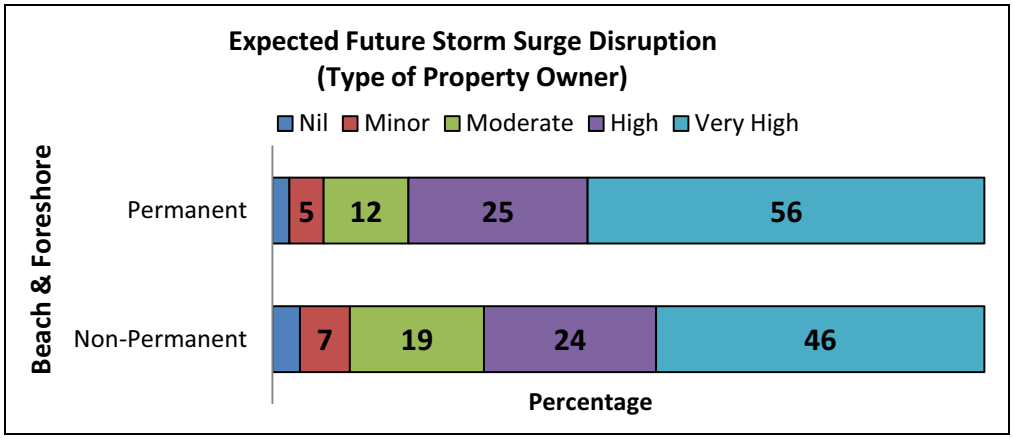
Figure 6.22: Regional variation of expected future storm surge disruption



(Rockingham, Peoples' Homes n = 154, Beach & Foreshore n = 158, Peoples' Well-being n = 154, and Community Attitudes n = 153; Yorke Peninsula, Peoples' Homes n = 179, Beach & Foreshore n = 181, Peoples' Well-being n = 178, and Community Attitudes n = 178)

Figure 6.23 reveals that permanent residents expected higher amounts of future storm surge disruption to the beach and foreshore than non-permanent residents (U = 11762.5, p = 0.036).

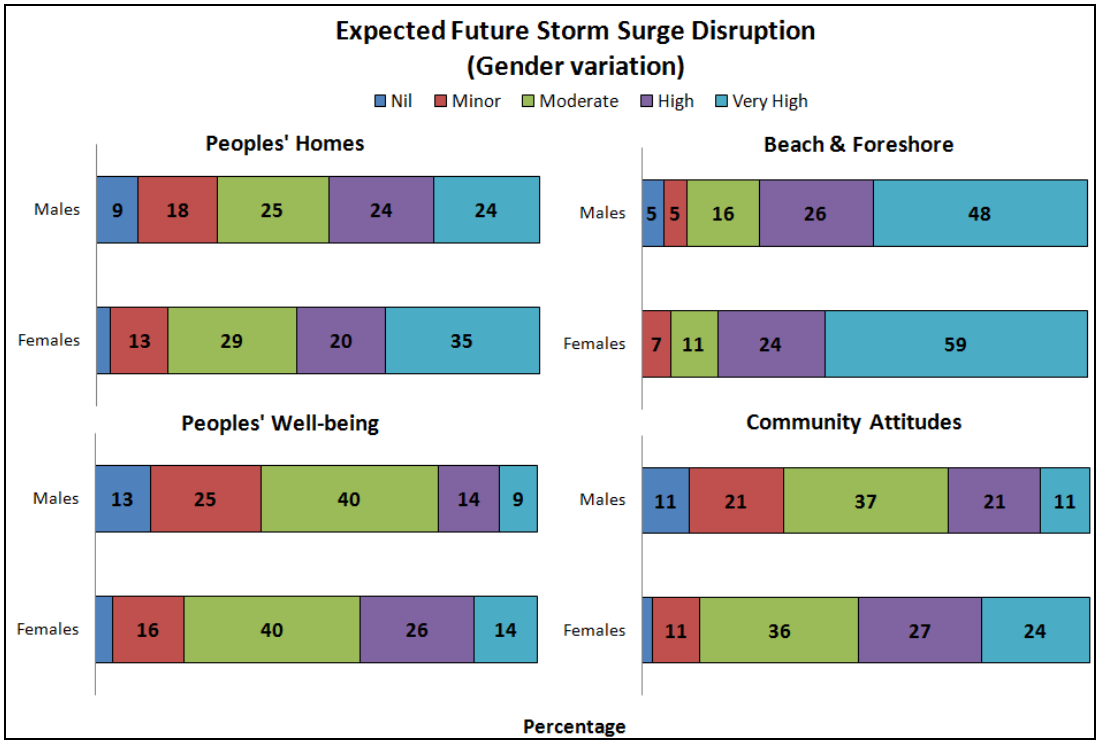
Figure 6.23: Storm surge disruption to beach and foreshore by type of homeowner



(Permanent, n = 210; Non-permanent, n = 128)

Figure 6.24 shows that female respondents expected future storm surge disruption to be greater than males (Peoples' Homes U = 10616.0, p = 0.017; Beach and Foreshore U = 11195.0, p = 0.028; Peoples' Well-being U = 9332.5, p = 0.000; Community Attitudes U = 8797.5, p = 0.000).

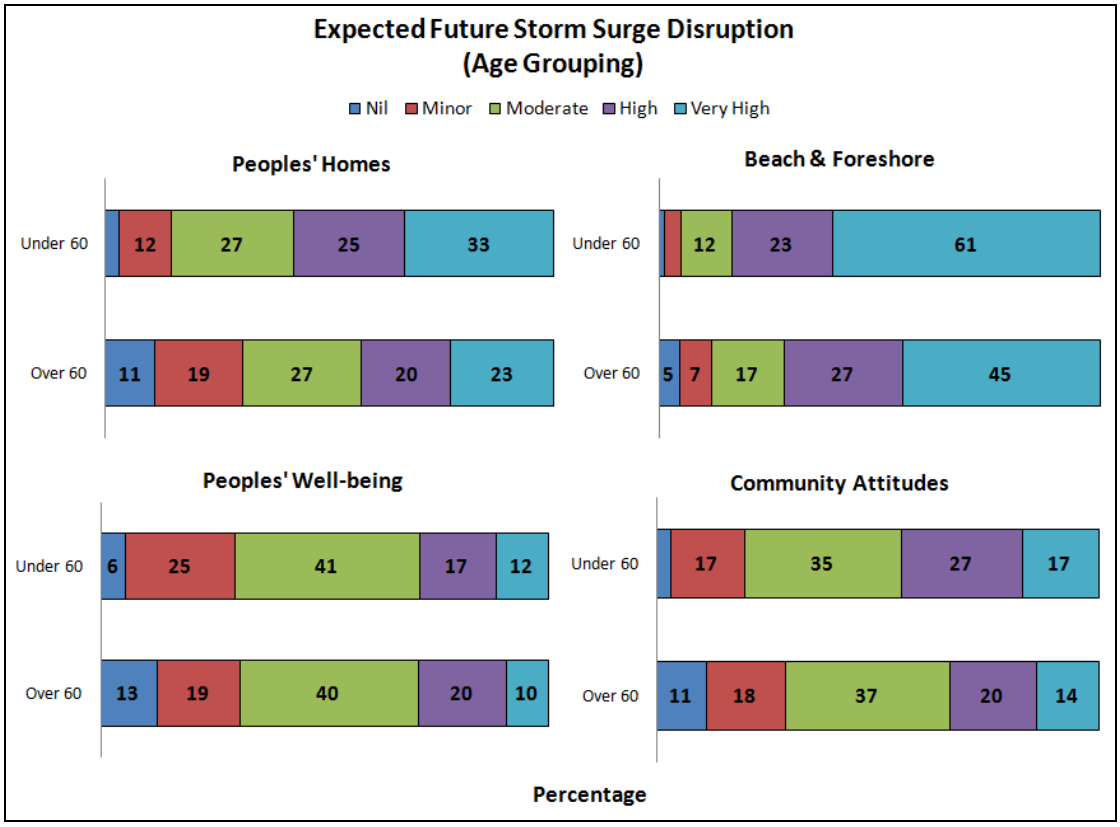
Figure 6.24: Gender variations of expected future storm surge disruption



(Peoples' Homes, n = 326; Beach & Foreshore, n = 332; Peoples' Well-being, n = 325; and Community Attitudes, n = 324)

Figure 6.25 reveals that respondents aged over 60 years expect less future disruption due to storm surges than those under 60 years. This difference was statistically significant for all variables except peoples' well-being (People's Homes U = 10853.0, p = 0.017; Beach and Foreshore U = 11646.0, p = 0.028; Community Attitudes U = 11605.0, p = 0.000).

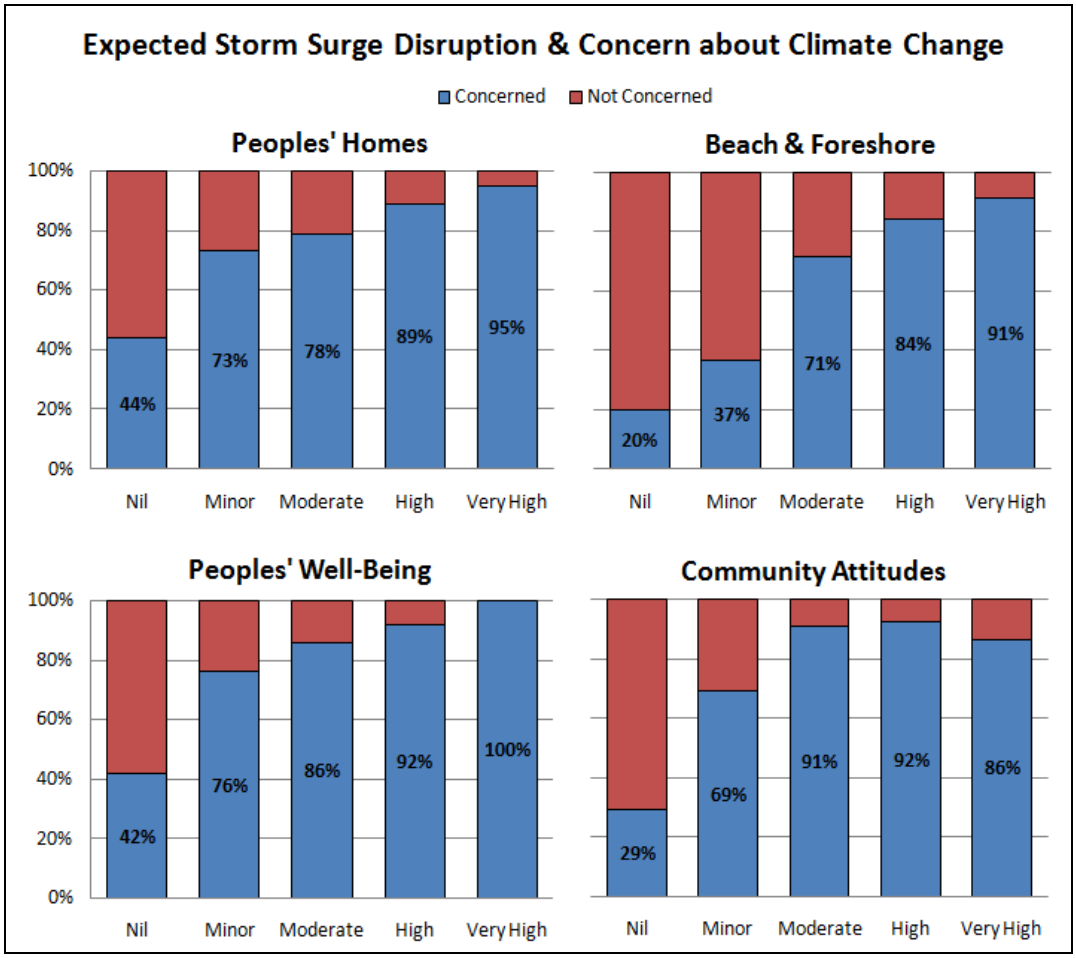
Figure 6.25: Expected future storm surge disruption by age groupings



(Peoples' Homes, n = 332; Beach & Foreshore, n = 338; Peoples' Well-being, n = 331; and Community Attitudes, n = 330)

Figure 6.26 shows that those who did not expect to see any, or only minor, disruptions due to storm surges were much less likely to be concerned about climate change. This difference was found to be statistically significant for each variable (Peoples' Homes U = 4447.5, p = 0.000; Beach and Foreshore U = 4404.5, p = 0.000; Peoples' Well-being U = 4198.0, p = 0.000; Community Attitudes U = 4549.0, p = 0.000).

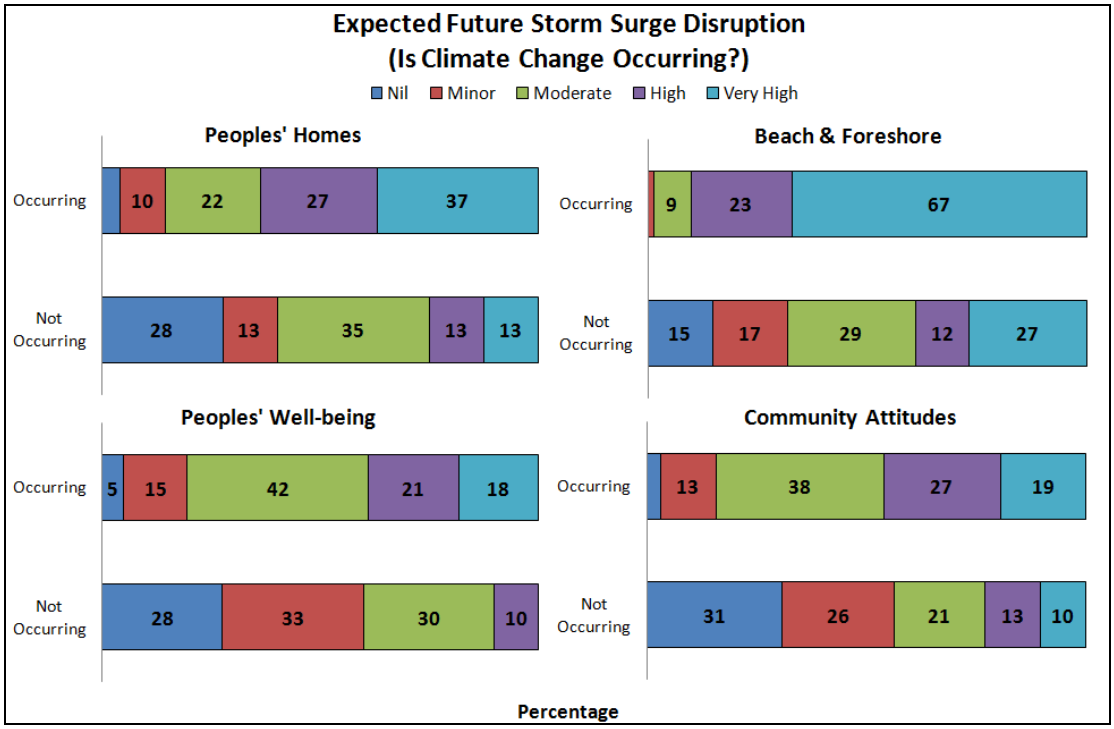
Figure 6.26: Expected future storm surge disruption in relation to indicated level of concern about climate change



(Peoples' Homes n = 333, Beach & Foreshore n = 339, Peoples' Well-being n = 332, and Community Attitudes n = 331)

Figure 6.27 reveals that greater proportions of those who believed climate change to be occurring were much more likely expect to expect greater levels of future storm surge disruption (Peoples' Homes U = 1786.5, p = 0.000; Beach and Foreshore U = 1489.0, p = 0.000; Peoples' Well-being U = 1564.0, p = 0.000; Community Attitudes U = 1796.0, p = 0.000). For expected disruption to the beach and foreshore, no respondents who believed climate change to be occurring now indicated that disruption would be nil.

Figure 6.27: Expected future storm surge disruption and occurrence of climate change

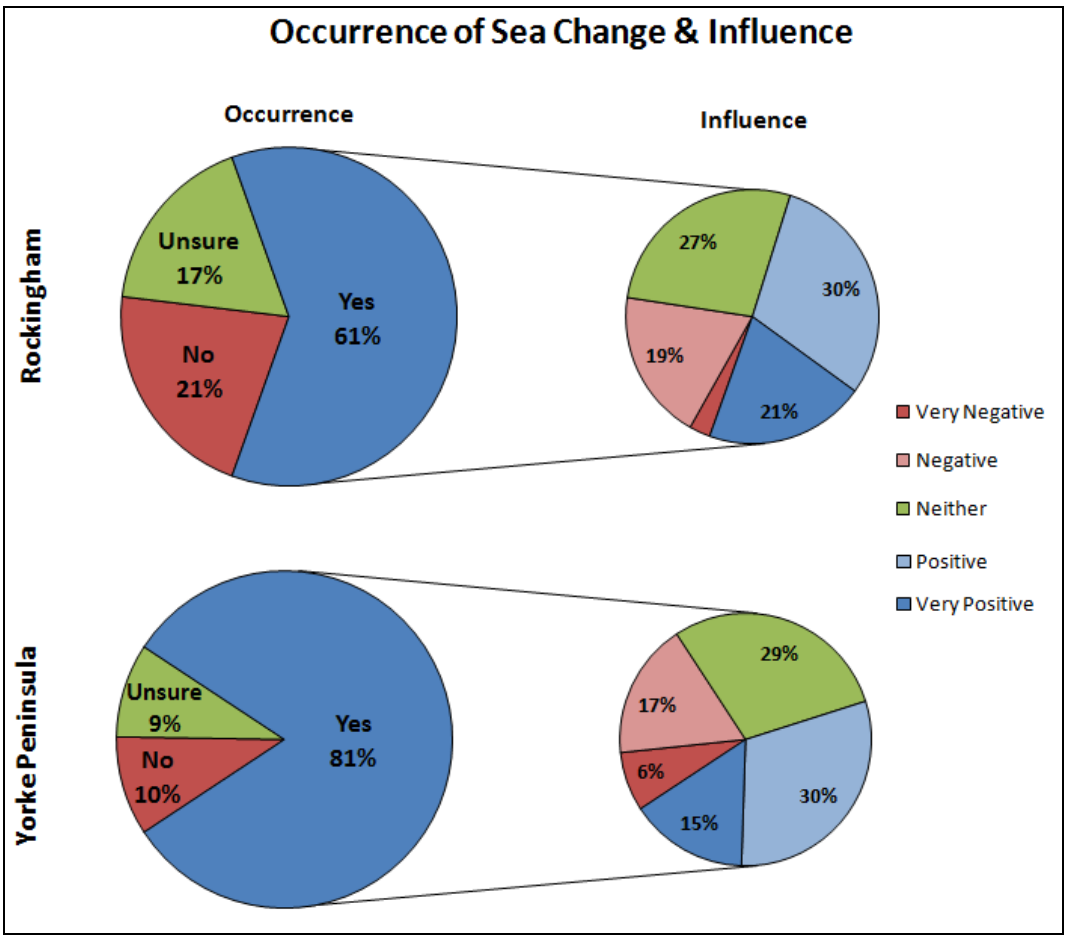


** excluding unknown (Homes n = 205, Beach & Foreshore n = 205, People's Well-being n = 204, and Community Attitudes n = 204)*

6.1.4 Sea change

Figure 6.28 shows that over 60% of Rockingham respondents and over 80% of Yorke Peninsula respondents believed the sea change phenomenon to be taking place within their respective regions. Rockingham respondents regarded its influence as slightly more positive than Yorke Peninsula respondents.

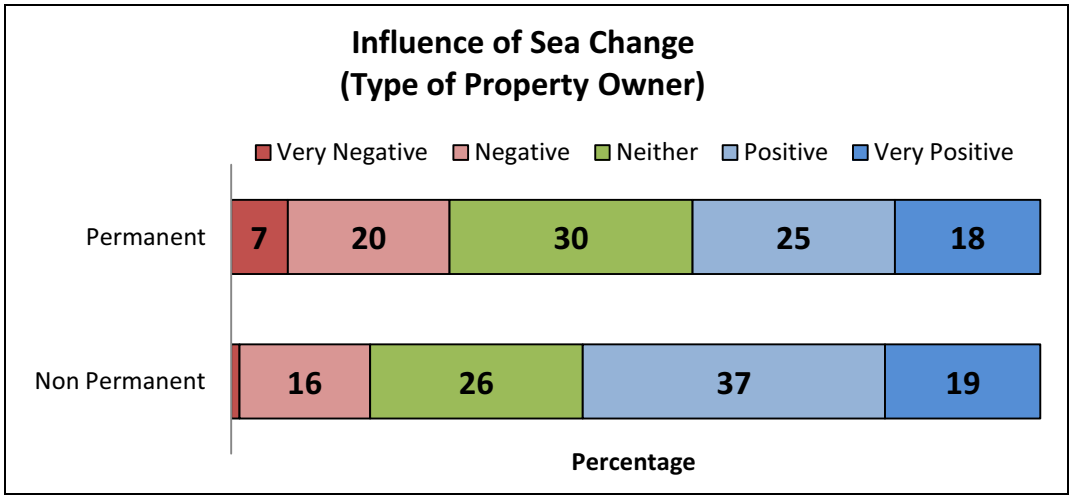
Figure 6.28: Sea change occurrence and degree of negative/positive influence



(Rockingham, Occurrence n = 159, Influence n = 92; Yorke Peninsula, Occurrence n = 189, Influence n = 146)

Figure 6.29 shows that 57% of non-permanent residents indicated that sea change has a general positive influence compared to 43% of permanent residents (U = 5815.5, p = 0.044). Further, 27% of permanent residents indicated a general negative influence compared with 17% of non-permanent residents.

Figure 6.29: Influence of sea change on communities by type of homeowner



(Permanent, n = 138; Non-permanent, n = 99)

Figure 6.28 shows that almost one half of responses detailing the influence of sea change included multiple negative or positive effects *inter alia*, as well as a combination of both positives and negatives *inter alia*. There were greater numbers of sole responses that were coded as 'other/off topic' than for other themes, which tended to demonstrate a misunderstanding of the sea change phenomenon (despite the questionnaire providing a brief definition). The most prevalent sole response indicating only one impact reflected the view that sea change brings with it a positive influence on lifestyle. Conversely, the observation that sea change brings with it inappropriate development was the most prevalent negative aspect of the phenomenon. In terms of those impacts mentioned *inter alia*, the most prevalent response was regarding the positive influence that sea change has on the local economy; followed conversely by the negative impact it had on the natural environment. Table 6.10 provides examples of the open-ended responses.

Table 6.9: Positive and negative impacts of sea change on the community

What impacts (positive or negative) will sea change have on the community?	Mentioned *Inter Alia*	Sole Response
n of respondents	81	99
Better Lifestyle	4	15
Brings Inappropriate Development	18	11
Better Community Facilities/Infrastructure/Services	19	8
Better Social Mix/Cohesion	16	8
Negative Environmental Impact	26	7
Increases Property Value/Development	8	7
Improves Local Economy	38	6
Puts Stress on Facilities/Infrastructure/Services	18	5
Brings with it City Problems	14	5
Brings in New Ideas/Skills	5	4
Brings Greater Government Attention	3	2
Property Becomes Too Expensive	4	1
Supports Schools/Education/Youth	4	1
Brings an Ageing Population	0	1
Other/Off Topic	0	18
Themes per response mentioned *Inter Alia*		*n*
2 themes per response		68
3 themes per response		11
4 themes per response		2

(n = 180)

Table 6.10: Selected open-ended responses relating to the positive/negative impacts of the sea change phenomenon

Coded theme	Examples
Better Lifestyle	"Cleaner way of life and simpler" (Yorke Peninsula Respondent 187, age group 40-49)
Brings Inappropriate Development	"Housing being built too close to the foreshore" (Rockingham Respondent 392, age group 60+)
Better Community Facilities/Infrastructure/ Services	"General improvement in facilities as a result of increased local population" (Yorke Peninsula Respondent 299, age group 60+)
Better Social Mix/Cohesion	"More helping hands" (Yorke Peninsula Respondent 227, age group 40-49)
Other/ Off Topic	"Tide changes (levels), wind and rain changes" (Rockingham Respondent 287, age group 50-59)

6.2 Summary

This chapter outlined respondent perceptions of the vulnerabilities, strengths, weaknesses, limitations and barriers with respect to climate change, sea-level rise, storm surges, and sea change. Interestingly, there were very few marked differences between the results based on case study sites and residency, suggesting that location and type of property owner does not significantly alter public perceptions of risk in these particular contexts. By differentiating the results into categories of the 'types' of risks, this chapter distinguished which particular components of future climate change impacts, as well as sea change stresses, play a greater role in affecting property owners' risk perceptions. In order to identify the relationship between perceived risk, vulnerability and adaptive capacity, these results will be discussed, alongside the results to be outlined next, in Chapter 8.

Chapter 7 – Results: Adaptation

This chapter discusses the results of the mail-out survey questionnaire that specifically relate to the second and third research objectives:

2. Identify social factors influencing individual adaptation in order to determine potential ways to increase the adaptive capacity of coastal property owners; and
3. Identify motivating factors for risk reduction in order to help society prepare and be willing to support adaptation to climate change and development pressures.

7.1 Adaptive capacity

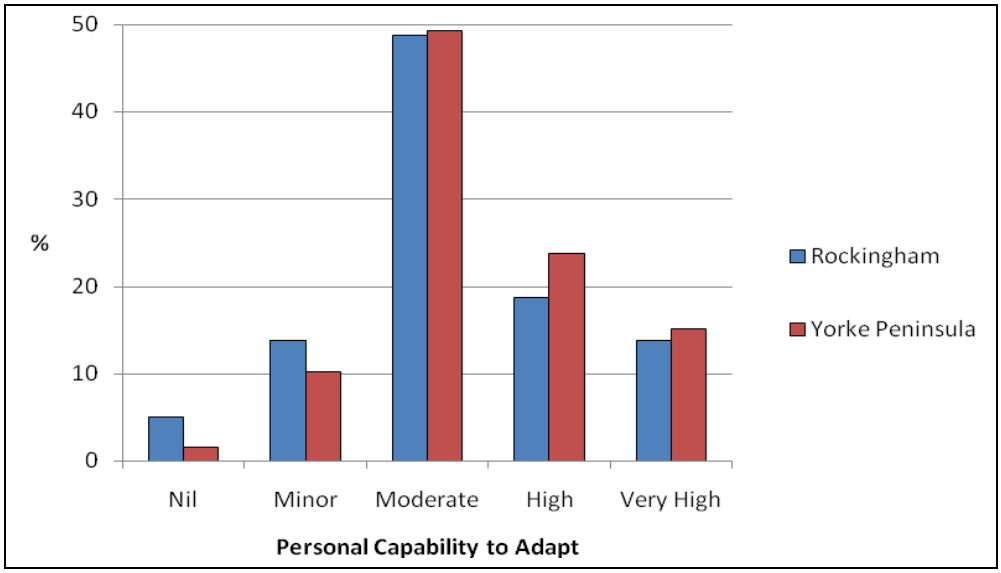
There are numerous trends present within cross-tabulations of the survey data, as well as instances of statistical significance, particularly with respect to key variables including:

- Concern about climate change;
- Whether or not respondents believe climate change to be occurring now;
- Age (of either under 60 years of age, and above 60 years of age); and
- Whether or not respondents had changed or were changing their lifestyle as a result of climate change.

7.1.1 Climate change

Figure 7.1 reveals that almost one third of Rockingham respondents and over one third of Yorke Peninsula respondents perceived their personal capability to adapt to climate change as high or very high. Almost one half of all respondents indicated a moderate capability to personally adapt.

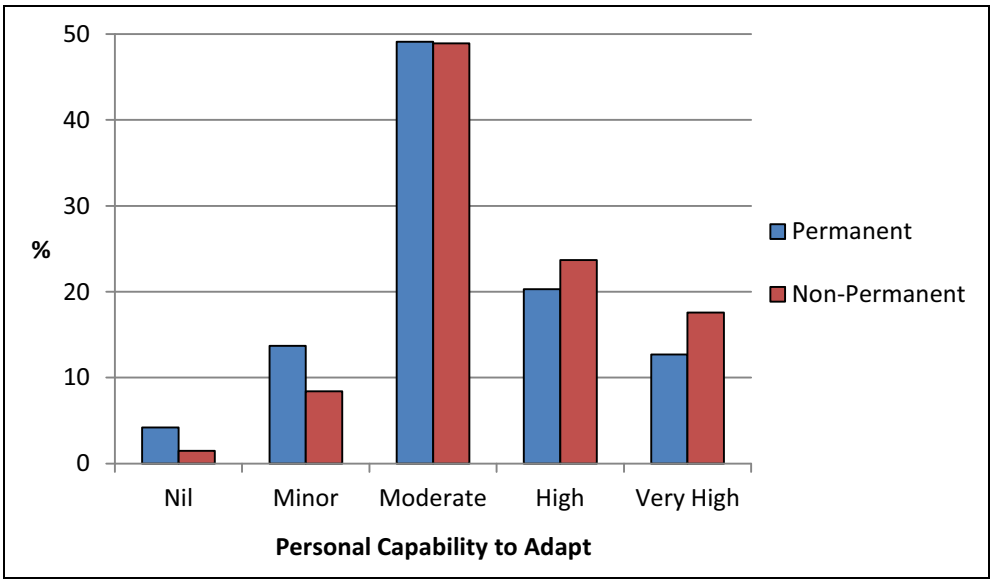
Figure 7.1: Regional variation of personal capability to adapt to climate change



(Rockingham, n = 160; Yorke Peninsula, n = 185)

Figure 7.2 shows that a greater proportion of permanent residents perceived their capability to adapt as high or very high compared with non-permanent residents (U = 12110.5, p = 0.033).

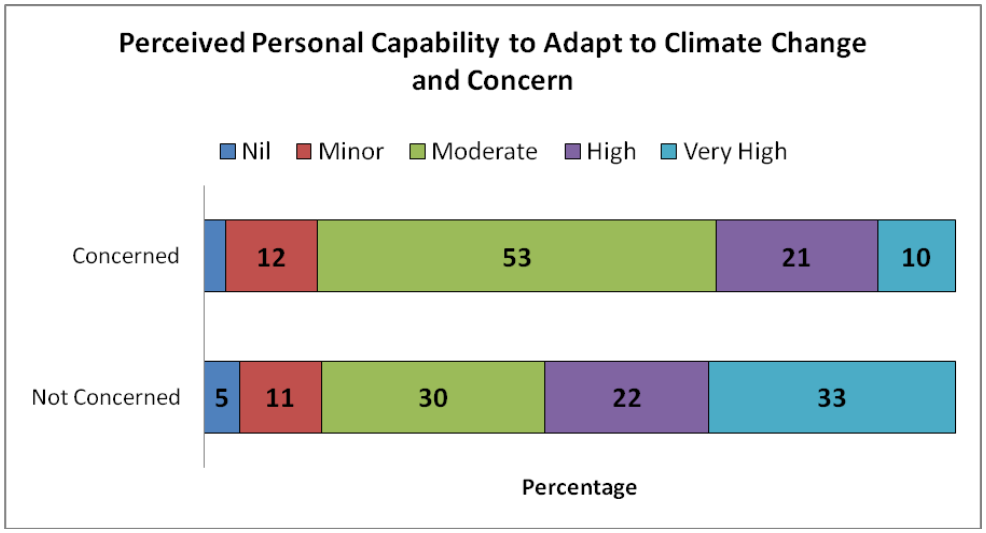
Figure 7.2: Personal capability to adapt to climate change by type of homeowner



(Permanent, n = 212; Non-permanent, n = 131)

Figure 7.3 reveals that those who are not concerned about climate change are more likely to perceive their capability to adapt to climate change as high or very high, compared with those who are concerned (U = 6850.0, p = 0.002).

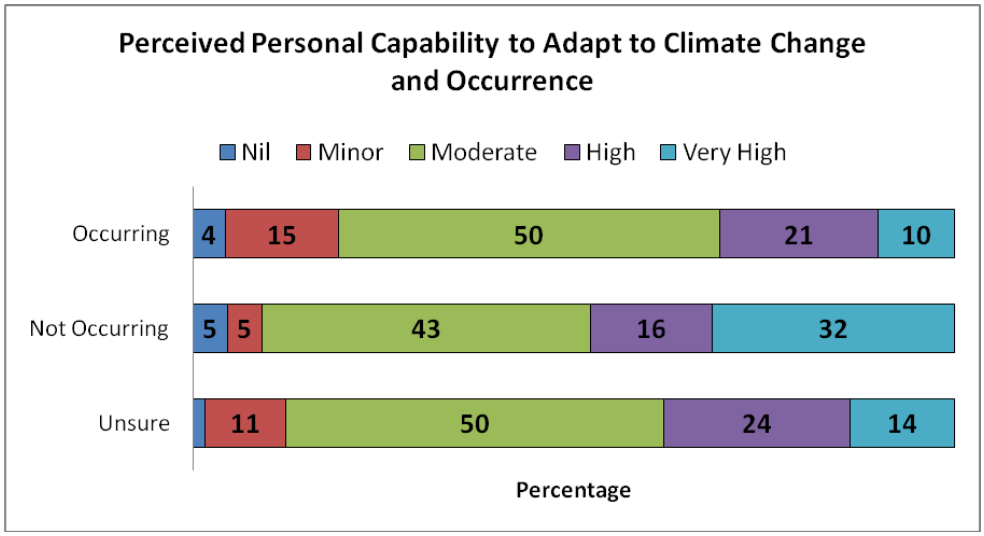
Figure 7.3: Personal capability to adapt to climate change in relation to indicated level of concern



(Concerned, n = 280; Not concerned, n = 64)

Figure 7.4 shows that those who do not believe climate change to be occurring now are more likely to perceive their capability to adapt as high or very high, compared with those who do believe it to be occurring, as well as those who were unsure (χ^2 = 18.359, p = 0.019).

Figure 7.4: Personal capability to adapt to climate change and occurrence



(Occurring, n = 168; Not Occurring, n = 44; Unsure, n = 131)

Table 7.1 reveals that almost one quarter of all responses about how respondents would adapt to climate change indicated that they would adjust their lifestyles to adapt, or that it would not be difficult to adapt. The option to move, sell and/or live elsewhere was the second most predominant sole response as a means to adapt to climate change. There was a large number of *inter alia* responses with multiple considerations, demonstrating that respondents did not necessarily only consider one means of adaptation, but several simultaneously. Table 7.2 provides open-ended examples of responses.

Table 7.1: Perceived means of adapting to climate change

If you are capable to adapt, how exactly will you adapt to climate change?	Mentioned *Inter Alia*	Sole Response
n of respondents	99	125
Adjust Lifestyle/It Won't Be Difficult to Adapt	15	50
Move, Sell, or Live Elsewhere	11	17
Won't Need To Change/Minimal Change	6	9
Need more Info/It Depends/Not Sure How	6	8
Make Changes/Additions To Household/Property	23	7
Be Flexible/Adjust	28	5
We Have No Choice But To Change	1	5
Follow Expert Advice/Information & Education	3	4
It's Beyond My Lifetime	3	4
Avoid Extreme Temperatures	9	3
Recycle/Better Waste Management	5	2
Be More Water wise/Collect Rainwater	49	1
Improved Garden Management	30	1
Use Solar Panels/Be Energy Efficient	26	1
Change Farming Practices	3	1
Family Assistance	1	1
Use Car Less/Better Fuel Efficiency	8	0
Insulate Property	11	0
Bushfire Management	1	0
Other	10	6

Themes per response mentioned *Inter Alia*	*n*
2 themes per response	63
3 themes per response	25
4 themes per response	8
5 themes per response	2
6 themes per response	1

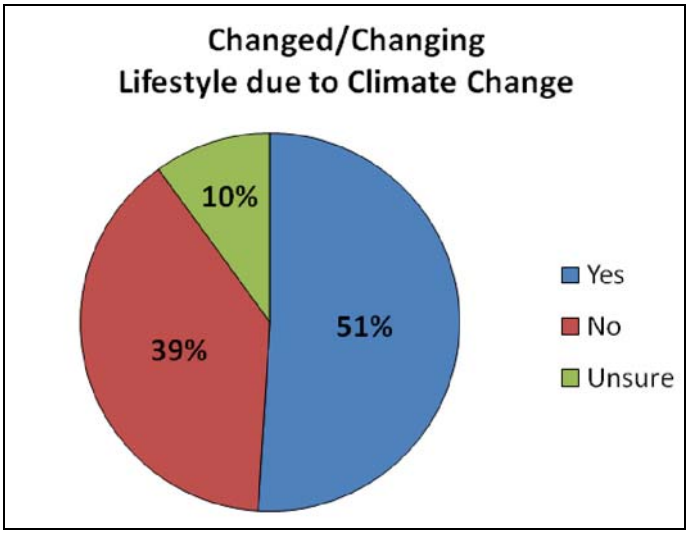
(n = 224)

Table 7.2: Selected open-ended responses relating to perceived means of adapting to climate change

Coded theme(s)	Examples
Adjust Lifestyle/ It Won't Be Difficult to Adapt	"I am confident of adapting to elements and am self sufficient" (Rockingham Respondent 155, age group 50-59)
	"Humans are adaptable creatures" (Yorke Peninsula Respondent 155, age group 60+)
Move, Sell, or Live Elsewhere	"Move to land higher than predicted sea-level rise and to sub-tropical areas predicted to have good rainfall" (Rockingham Respondent 244, age group 60+)
Won't Need To Change/ Minimal Change	"Not applicable, no adaptation is needed if there isn't a problem" (Rockingham Respondent 5, age group 30-39)
	"climate change has always occurred: I doubt the degree of change propleted [sic] by certain people" (Rockingham Respondent 18, age group 60+)
Need more Info/ It Depends/ Not Sure How	"I think we are all capable if we have the right information about climate change, and I feel it's up to you people to do that" (Rockingham Respondent 368, age group 60+)
	"Not sure, I would expect guidance from environmental scientists/government" (Yorke Peninsula Respondent 137, age group 30-39)
It's Beyond My Lifetime	"By not living long enough to appreciate serious effects" (Rockingham Respondent 402, age group 60+)
Other	"Pretty self sufficient on land"(Yorke Peninsula Respondent 123, age group 50-59)

Figure 7.5 shows that 51% of all respondents indicated that they had either changed, or are changing, their lifestyles due to climate change or in anticipation of climate change impacts, while 39% were not, and 10% were unsure.

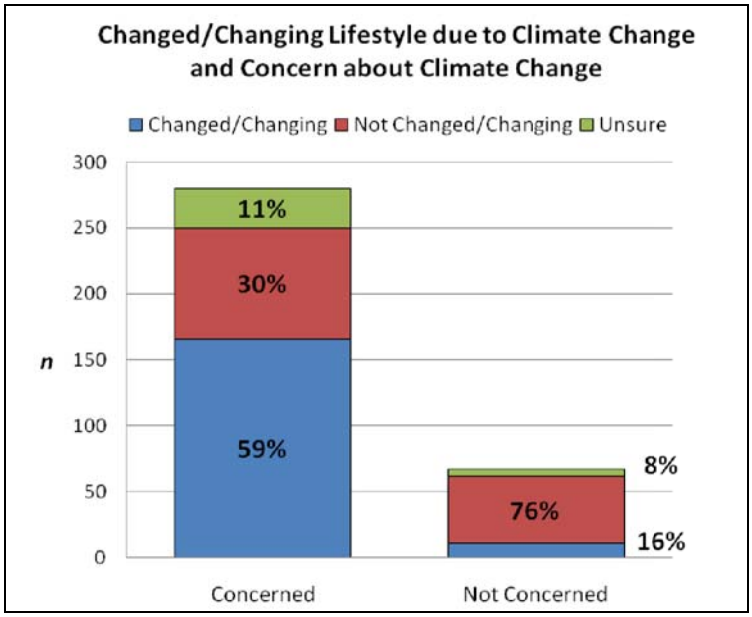
Figure 7.5: Changed/changing lifestyle due to climate change



(n = 348)

Figure 7.6 reveals that respondents who indicated they were concerned about climate change were much more likely to claim to have changed or be changing their lifestyle as a result of climate change ($\chi^2 = 49.601$, $p = 0.000$).

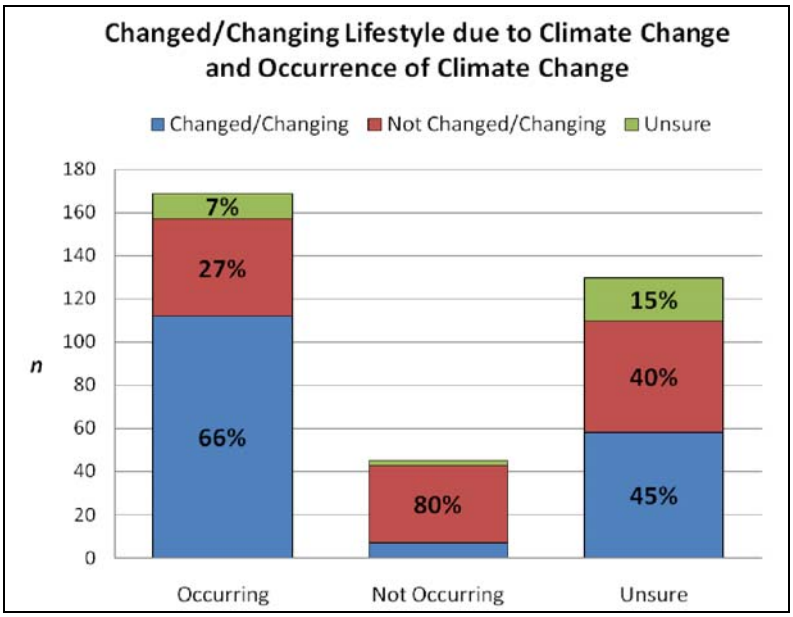
Figure 7.6: Change in lifestyle due to climate change in relation to indicated level of concern



(Concerned, n = 280; Not Concerned, n = 67)

Figure 7.7 reveals that respondents who indicated they believed climate change to be occurring were much more likely to claim to have changed or be changing their lifestyle as a result of climate change ($\chi^2 = 49.601$, $p = 0.000$).

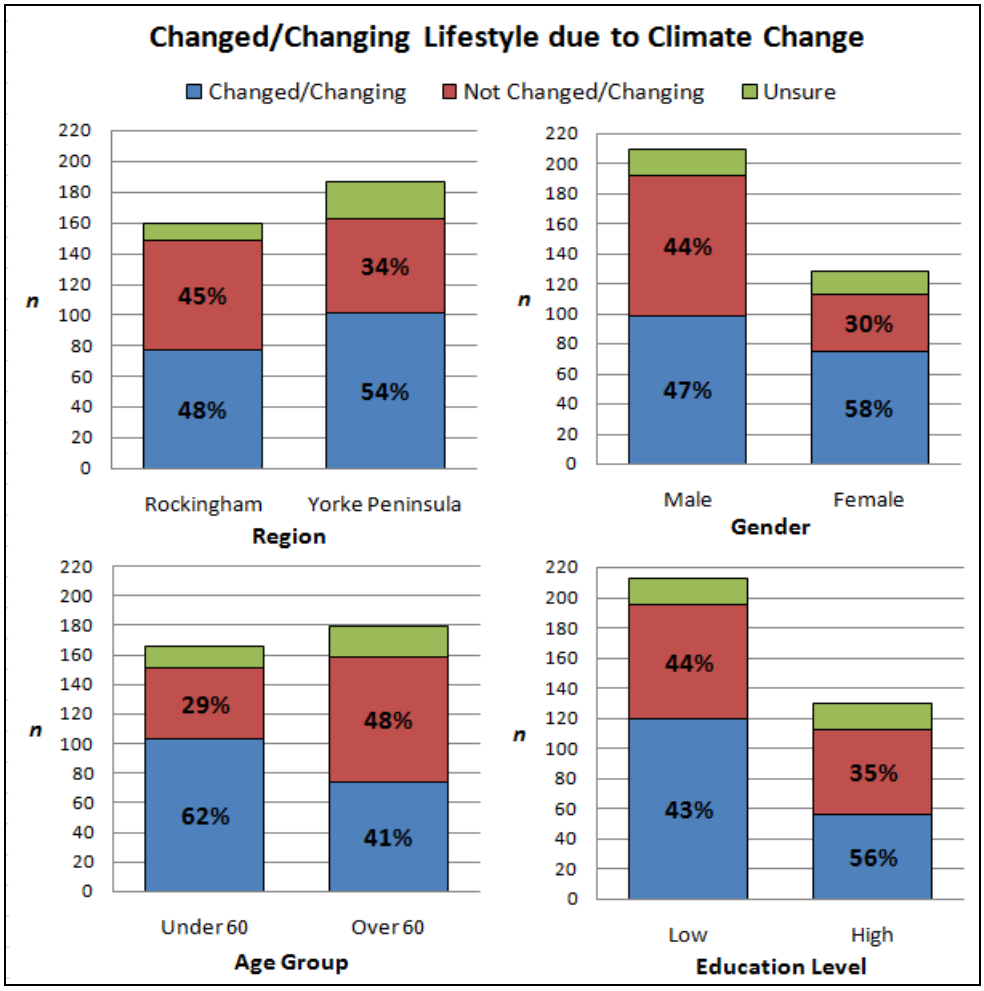
Figure 7.7: Change in lifestyle due to climate change and climate change occurrence



(Occurring, n = 169; Not Occurring, n = 45; Unsure, n = 130)

Figure 7.8 shows that Yorke Peninsula respondents were more likely to have changed or be changing their lifestyle as a result of climate change, compared with Rockingham respondents (χ^2 = 6.453, p = 0.040). Females were more likely than males to have changed or be changing their lifestyle (χ^2 = 7.599, p = 0.022). Those under 60 years of age were more likely than those over 60 to have changed or be changing their lifestyle (χ^2 = 15.291, p = 0.000). Those with higher education levels more likely than low levels to have changed or be changing their lifestyle (χ^2 = 6.024, p = 0.049).

Figure 7.8: Changed/Changing lifestyle due to climate change with variables of region, gender, age group, and education level



(Region, n = 348; Gender, n = 339; Age Group, n = 345; Education Level, n = 343)

Table 7.3 shows that, of those who considered themselves already changing their lifestyle as a result of the impacts of climate change, one quarter of responses were sole changes or potential changes, of which the most predominant response was to conserve and/or collect water (Yorke Peninsula *n* = 9; Rockingham *n* = 4). The remainder of overall responses comprised a combination of changes or potential changes mentioned *inter alia*. To collect and/or conserve water was also the most predominant response inter alia; therefore, around two thirds of respondents considered water management in general as a key change to lifestyle. Overall, the top six responses mentioned *inter alia* are changes or potential changes that can be typically associated with general principles of sustainability, therefore demonstrating that respondents considered multiple means of being able to change their lifestyle. Table 7.4 provides examples of the open-ended responses.

Table 7.3: Changes or potential changes to lifestyle as a result of climate change

If you have changed or are changing the way you live as a result of climate change, how?	Mentioned *Inter Alia*	Sole Response
n of respondents	127	44
Conserve/Collect Water	99	13
Increase Energy Efficiency	64	2
Improve Garden Management	45	3
Recycle	31	3
Solar & Renewable Power/Water	30	3
Use Car Less & Bus/Walk/Ride Bike	22	3
Be More Aware of Changes/Impacts	11	3
Adapt/Just Do It	0	3
Avoid High Temperatures/Sun Exposure	6	2
Use Insulation/Install Air Conditioning	10	1
Adjust Property/Home	7	1
Sell/Move	0	1
Minimising Carbon Footprint	12	0
Reduce Pollution	7	0
Educate Children	5	0
Live Away From The Coast	4	0
Reduce Meat Consumption	2	0
Other	4	6

Themes per response mentioned *Inter Alia*	*n*
2 themes per response	57
3 themes per response	41
4 themes per response	24
5 themes per response	4
6 themes per response	1

(n = 171)

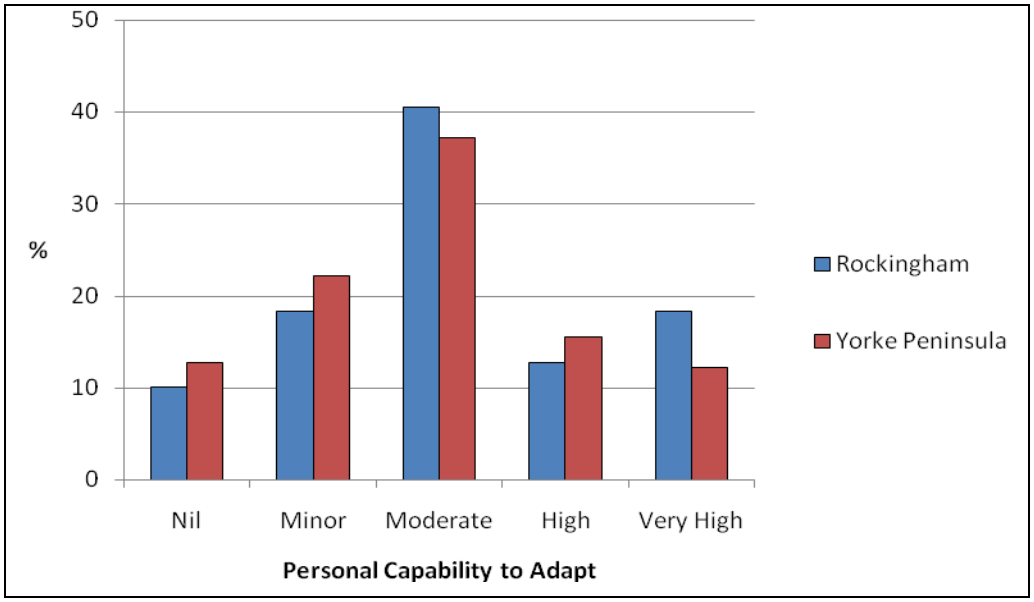
Table 7.4: Selected open-ended responses relating to changes to lifestyle due to climate change

Coded theme(s)	Examples
Conserve/Collect Water; Increase Energy Efficiency; Improve Garden Management; Recycle; Solar & Renewable Power/Water; Use Car Less & Bus/Walk/Ride Bike	"Usual recommended steps - reduce power and water usage, roof insulation, solar hot water systems, new light globes, recycling composting, new shower heads, reduced car usage, cycle/walk when possible etc. Also belong to local Coastcare group" (Rockingham Respondent 402, age group 60+)
Conserve/Collect Water; Use Insulation/Install Air Conditioning; Adjust Property/Home	"Increase water catchment and decrease usage by changing habits and garden areas. maintaining house insulation and surrounding veranda areas, etc" (Yorke Peninsula Respondent 399, age group 50-59)
Minimising Carbon Footprint; Live away from the coast	"We make property investments further away from the coast. We do everything we can in our home/lives to minimise our global footprint" (Rockingham Respondent 399, age group 40-49)

7.1.2 Sea-level rise

Figure 7.9 shows that, at both case study sites, personal capability to adapt to the impacts of sea-level rise is described as moderate by over one third of respondents, and as nil or minor, and high or very high by almost one third of respondents, respectively.

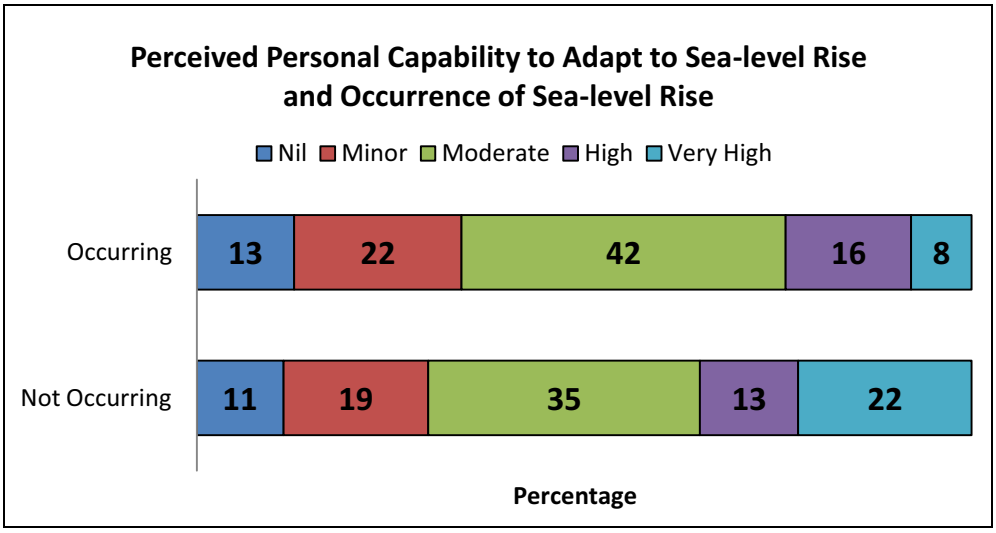
Figure 7.9: Regional variation of perceived personal capability to adapt sea-level rise



(Rockingham, n = 158; Yorke Peninsula, n = 180)

Figure 7.10 reveals that those who did not believe sea-level rise to be occurring were more likely to consider their personal capability to adapt as high or very high, compared with those who did believe sea-level rise to be occurring (U = 9718.0, p = 0.042).

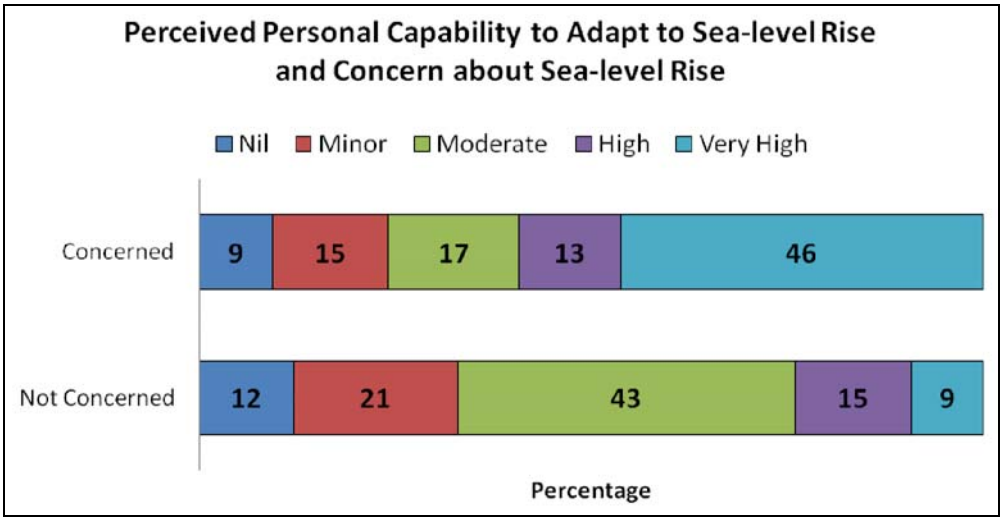
Figure 7.10: Personal capability to adapt to, and occurrence of, sea-level rise



(Occurring, n = 167; Not Occurring, n = 134)

Figure 7.11 reveals that those who are concerned about sea-level rise were more likely to consider their personal capability to adapt to sea-level rise as high, compared with those not concerned about sea-level rise (U = 4867.0, p = 0.000). This result is in direct contrast with results of personal capability to adapt to, and concern about, climate change (Figure 7.1).

Figure 7.11: Personal capability to adapt to sea-level rise in relation to indicated level of concern



(Concerned, n = 54; Not Concerned, n = 282)

Table 7.5 reveals that the most predominant means of adapting to climate change came from almost one third of respondents who believed they would adapt to sea-level rise by relocating elsewhere and/or selling their coastal home. Following this, 16%respondents considered themselves capable of adapting because they were not directly affected (not vulnerable) by sea-level rise. Only 9% of responses included multiples means (*inter alia*) of adapting to sea-level rise. Table 7.6 provides examples of the open-ended responses.

Table 7.5: Perceived means of adapting to sea-level rise

If you're capable of adapting to sea-level rise, how exactly will you adapt personally?	Mentioned *Inter Alia*	Sole Response
n of respondents	20	201
Move Elsewhere/Sell Home	5	65
I'm Not Vulnerable	6	35
Depends on Rate/Amount of sea-level rise	0	13
Protect/Defend	7	10
Acquire/Need more info	3	10
Too Old/Dead by then	3	8
Adapt/Just do it	0	8
Not Necessary (Rise not an issue/not happening)	1	6
Plan ahead/Together	4	4
Sea-level rise will be slow	3	4
Can't do anything	2	3
Adaptation will be slow	1	2
Need leadership	2	2
Costs play a role	3	0
Don't Know	0	15
Other	0	16
Themes per response mentioned *Inter Alia*		*n*
2 themes per response		20

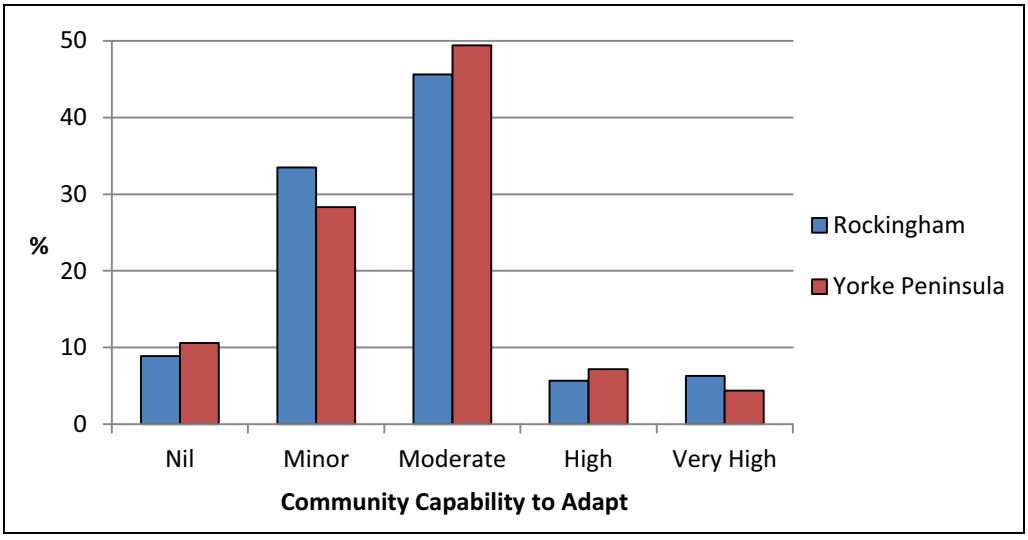
(n = 221)

Table 7.6: Selected open-ended responses relating to perceived means of adapting to sea-level rise

Coded theme(s)	Examples
Move Elsewhere/Sell Home	"I think that within the next 20 years we would have to consider relocating probably without much compensation or re-sale value. Obviously, but since we are in our 50s we'll probably be in a nursing home! I sincerely hope not however" (Yorke Peninsula Respondent 21, age group 50-59)
	"I love living near the ocean like most Australians, but would consider relocation if early evidence suggests a sea level rise is on the way" (Rockingham Respondent 547, age group 50-59)
I'm Not Vulnerable	"Won't affect us much at all as we live quite a few metres above sea level" (Yorke Peninsula Respondent 77, age group 30-39)
	"I don't live right on the beach" (Rockingham Respondent 77, age group 30-39)
Depends on Rate/Amount of SLR	"I would decide this if and when it becomes necessary" (Rockingham Respondent 229, age group 60+)
Too Old/Dead by then	"i will probably no longer be alive when it happens" (Yorke Peninsula Respondent 377, age group 60+)
Other	"I have faith in the various communities to adapt quickly, but little faith in the government to react quickly" (Yorke Peninsula Respondent 124, age group 60+)

Figure 7.12 shows that very few respondents perceived that their community's capability to adapt to sea-level rise would be high or very high, in contrast to their perceived personal capacity which was reported as more than double (Figure 7.9). Around two fifths of respondents at both sites (42% and 39% respectively) considered their community's capability to adapt as nil or minor.

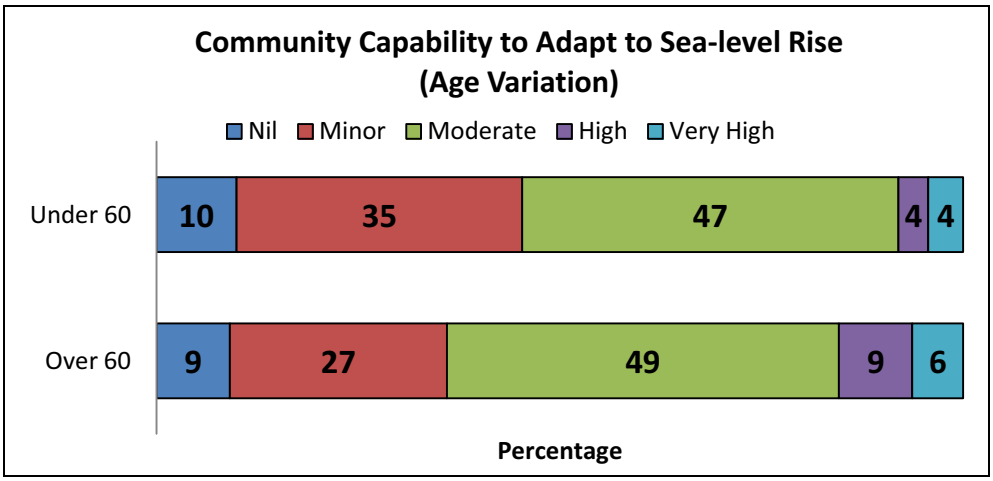
Figure 7.12: Regional variation of community capability to adapt to sea-level rise



(Rockingham, n = 158; Yorke Peninsula, n = 180)

Figure 7.13 shows that respondents aged over 60 years of age were more likely to perceive the community as being more capable of adapting to sea-level rise, compared with those respondents under 60 years of age, with greater proportions of respondents under 60 years of age perceiving the community's capability to be nil or minor (U = 12414.5, p = 0.043).

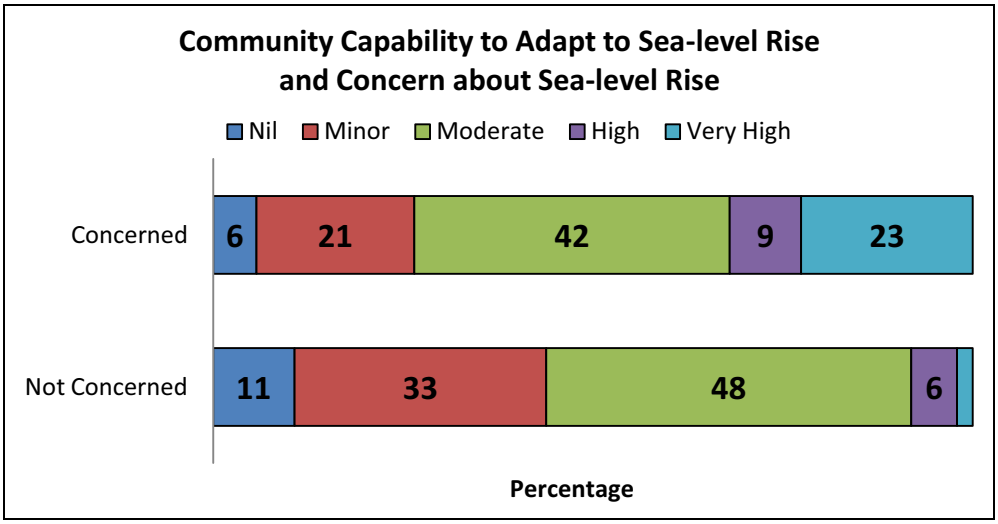
Figure 7.13: Community capability to adapt to sea-level rise by age grouping



(Under 60, n = 161; Over 60, n = 175)

Figure 7.14 reveals that respondents who were concerned about the impacts of sea-level rise were more likely to perceive the community as being capable of adapting to sea-level rise than did those respondents who were not concerned (U = 5147.0, p = 0.000). This result appears contradictory with the majority of other results in reference to capability to adapt to, and concern about, climate change (Figure 7.1).

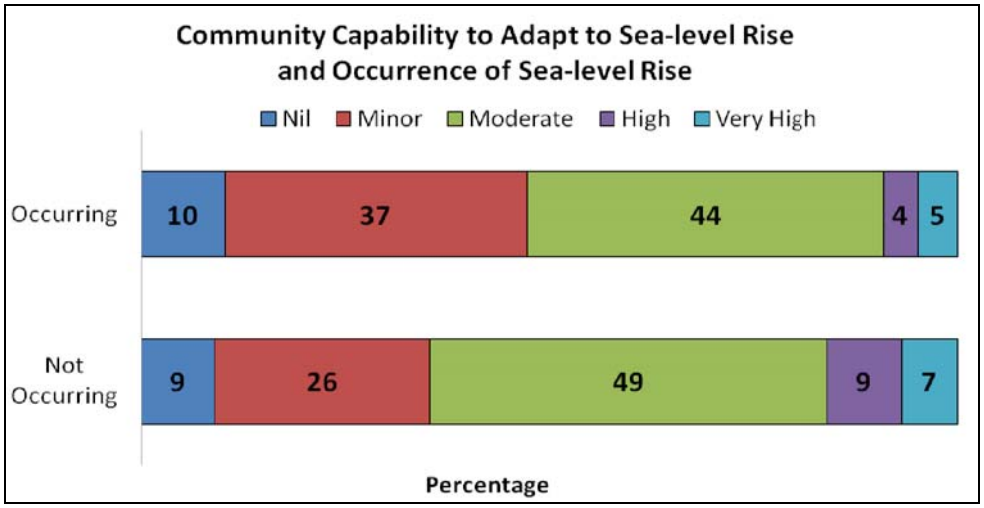
Figure 7.14: Community capability to adapt to sea-level rise in relation to indicated level of concern



(n = 334)

Figure 7.15 shows that those who believed sea-level rise to be occurring were less likely to consider their community's capability to adapt as high or very high, compared with those who did not believe sea-level rise to be occurring (U = 9588.5, p = 0.029).

Figure 7.15: Community capability to adapt to sea-level rise and occurrence of sea-level rise



(Occurring, n = 167; Not Occurring, n = 133)

7.2 Preparedness and willingness to adapt

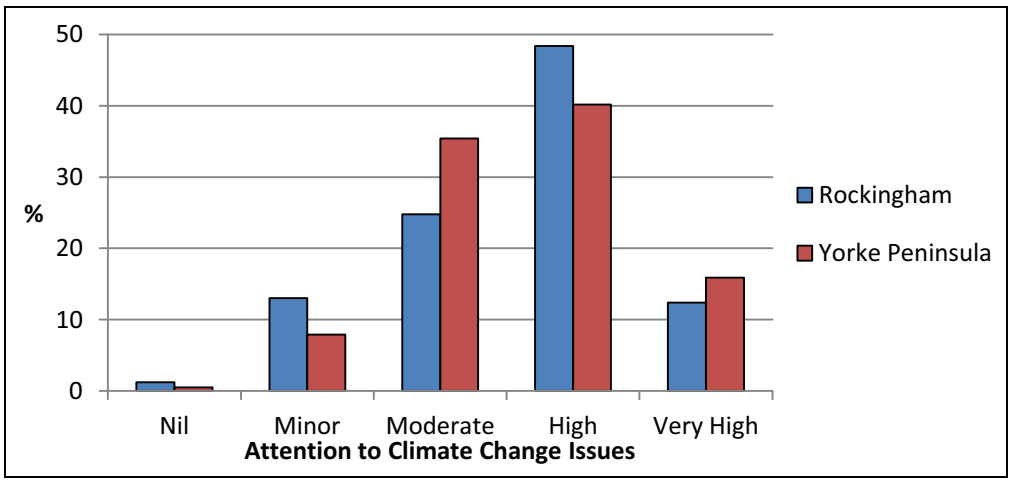
The third research objective was to identify motivating factors for risk reduction in order to help society prepare and be willing to support adaptation to climate change and development pressures. There are numerous trends present within cross-tabulations of the survey data, as well as instances of statistical significance, particularly with respect to key variables of:

- Concern about climate change;
- Whether or not respondents believe climate change to be occurring now;
- At what time scale sea-level rise is occurring;
- Gender (male or female); and
- Education level (high or low).

7.2.1 Climate change

Figure 7.16 shows that the majority of respondents reported that they had paid high to very high levels of attention to climate change issues.

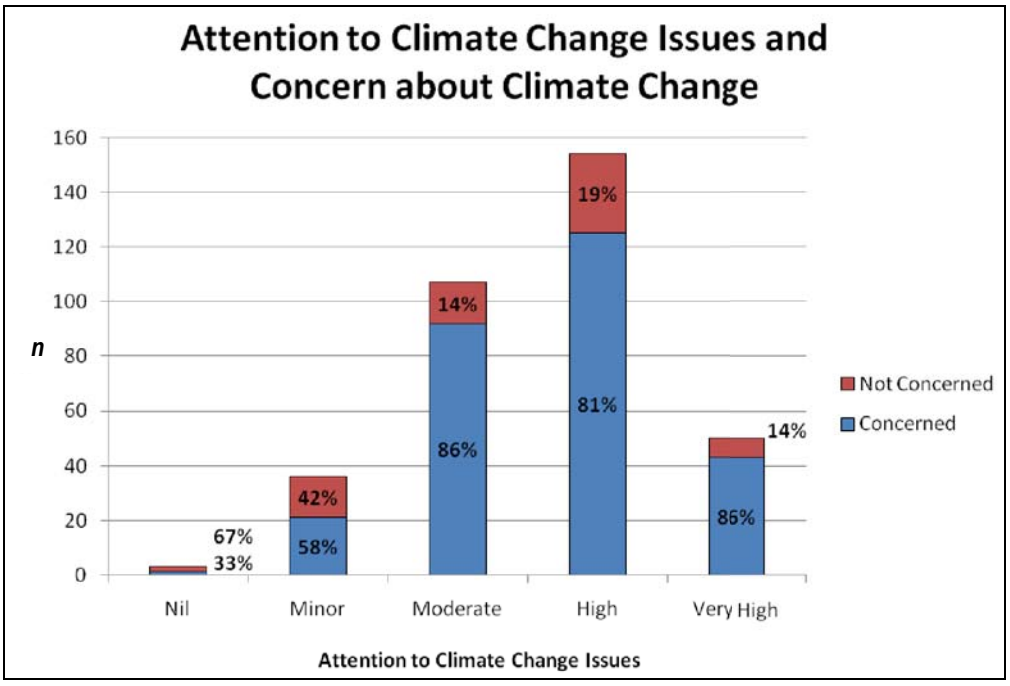
Figure 7.16: Regional variations of personal attention to climate change issues



(Rockingham, n = 161; Yorke Peninsula, n = 189)

Figure 7.17 shows that respondents who described their attention towards climate change issues as either nil or minor were less likely to be concerned about climate change, and vice versa, those who were concerned were more likely to have paid attention (U = 8135.5, p = 0.039).

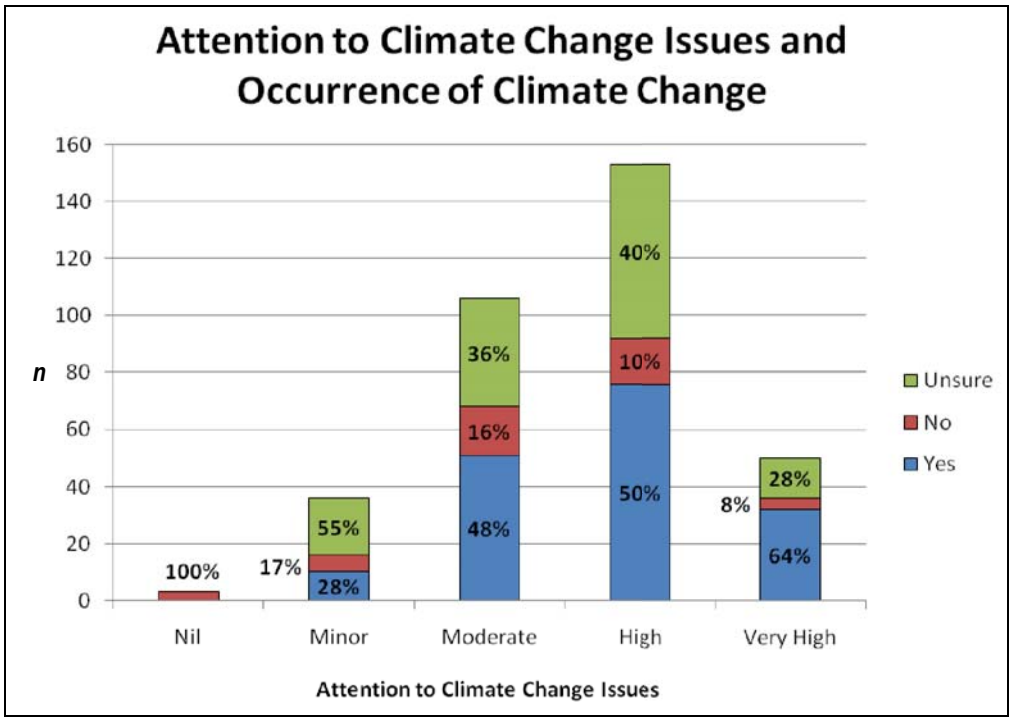
Figure 7.17: Attention paid to climate change issues in relation to indicated level of concern



(n = 350)

Figure 7.18 reveals that those respondents who considered climate change to be occurring were much more likely to pay attention to climate change issues, and vice versa (χ^2 = 32.731, p = 0.000).

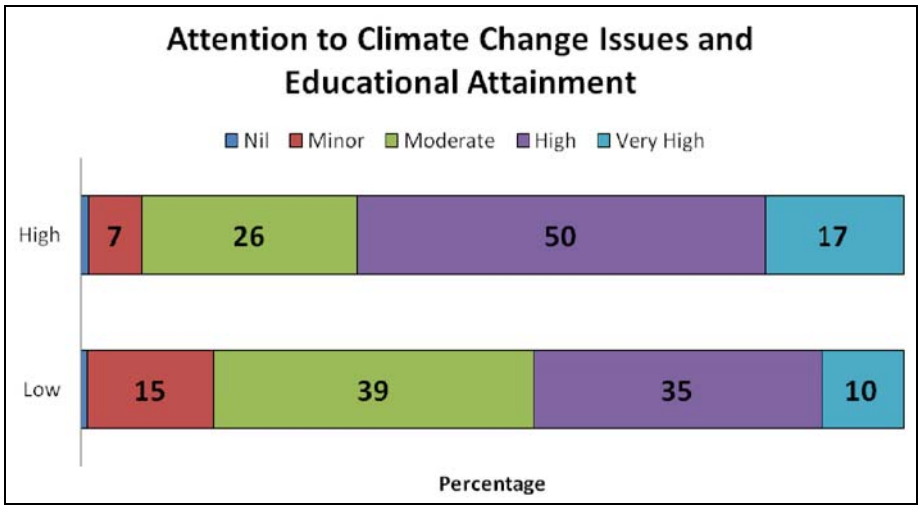
Figure 7.18: Attention paid to climate change issues and occurrence of climate change



(n = 348)

Figure 7.19 shows that respondents who reported having a higher education were more likely to pay attention towards climate change issues (U = 10723, p = 0.000).

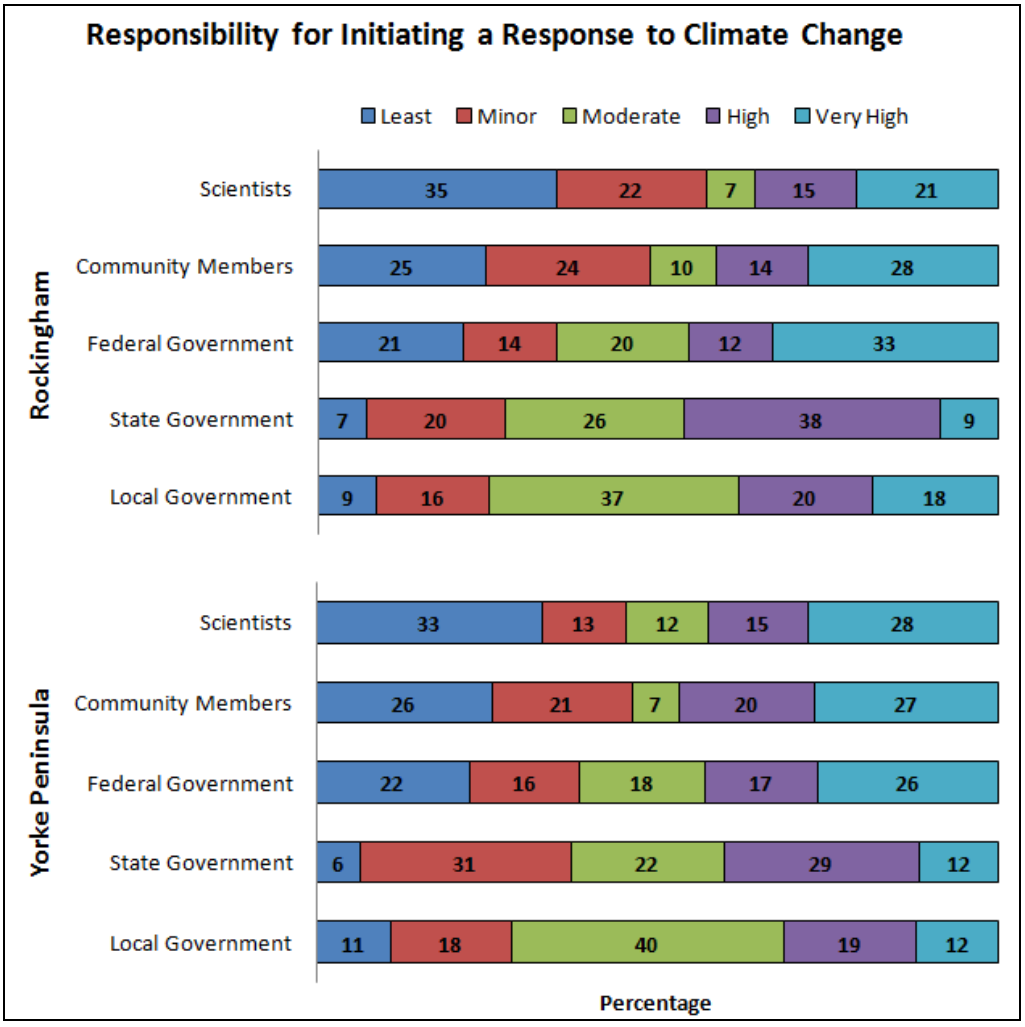
Figure 7.19: Attention paid to climate change issues and educational attainment



(n = 345)

Figure 7.20 shows that the greatest proportion of Rockingham respondents considered that the Federal Government is primarily responsible for initiating a response to climate change, compared to other authorities. Almost the same proportion of Yorke Peninsula respondents, however, considered scientists (28%), community members (27%), and the Federal Government (26%) as being primarily responsible. Furthermore, it is evident that Local and State governments were considered to have mid levels of responsibility at both case study sites.

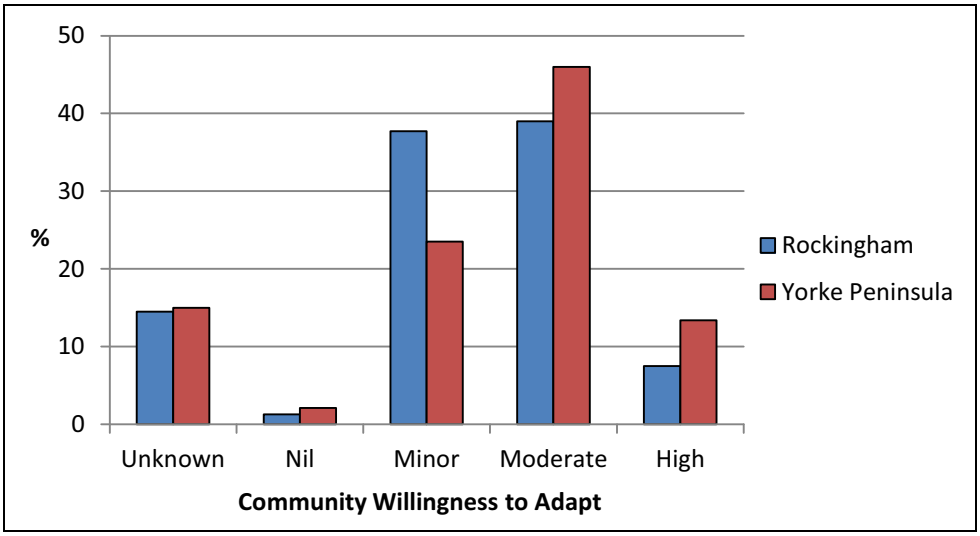
Figure 7.20: Responsibility of authorities for initiating a response to climate change



(Rockingham, Scientists n = 154, Community Members n = 154, Federal Government n = 154, State Government n = 152, and Local Government n = 152; Yorke Peninsula, Scientists n = 176, Community Members n = 175, Federal Government n = 174, State Government n = 174, and Local Government n = 175)

Figure 7.21 shows that Yorke Peninsula respondents were more likely to consider their community as willing to adapt to climate change, compared with Rockingham respondents (U = 12943.0, p = 0.028).

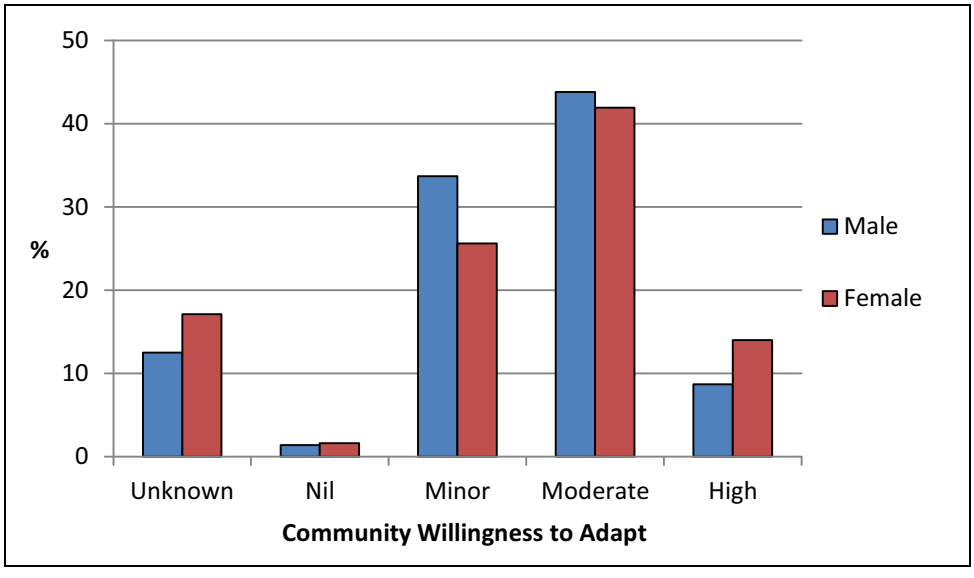
Figure 7.21: Regional variations of community willingness to adapt to climate change



(Rockingham, n = 159; Yorke Peninsula, n = 187)

Figure 7.22 shows that females were more likely to consider the community as more willing to adapt to the impacts of climate change than did males, and a greater proportion of females indicated that they were unsure about community willingness, compared to males (U = 11772.0, p = 0.045).

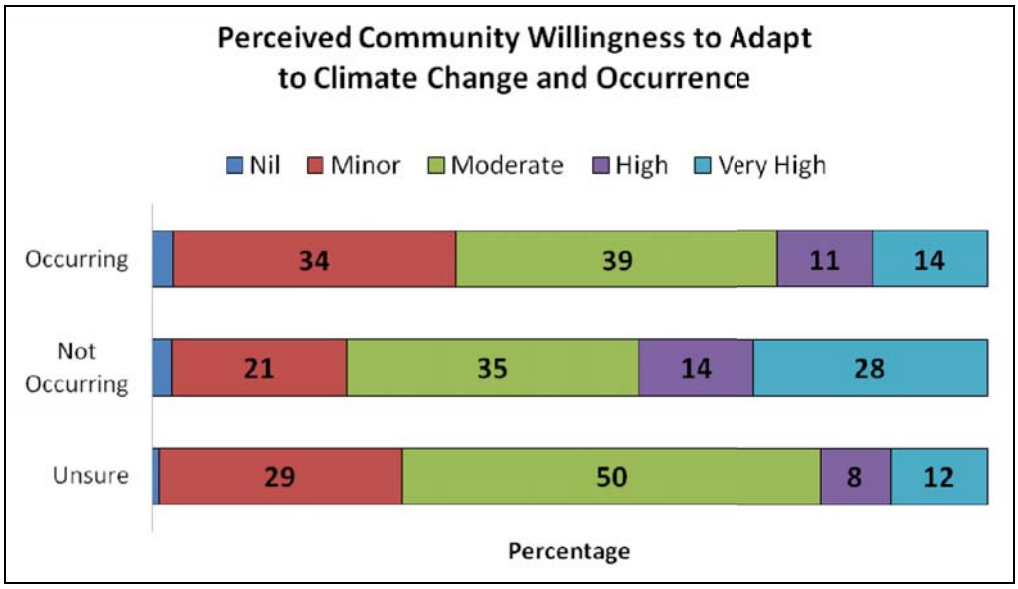
Figure 7.22: Gender variations of community willingness to adapt to climate change



(Male, n = 208; Female, n = 129)

Figure 7.23 reveals that those who did not believe climate change to be occurring now were much more likely to indicate that the community would be willing to adapt to climate change.

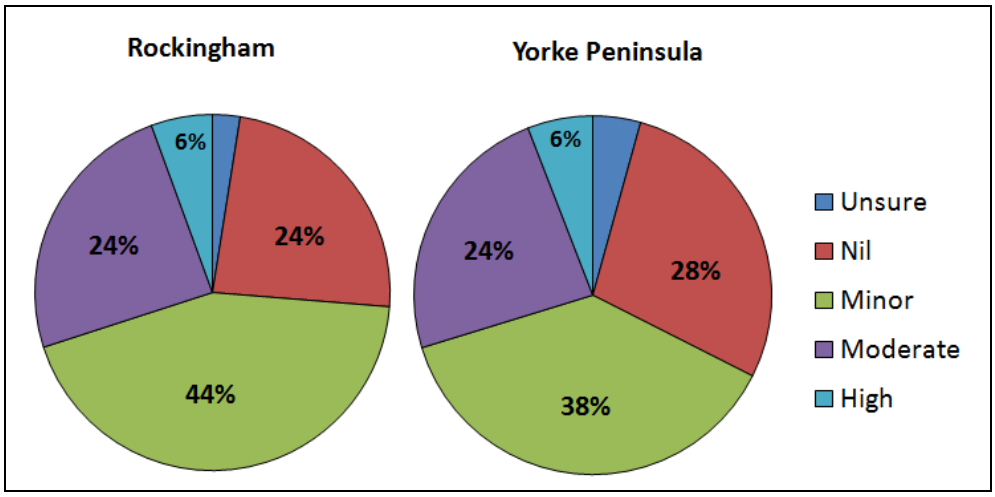
Figure 7.23: Community willingness to adapt to, and occurrence of, climate change



(Occurring, n = 168; Not Occurring, n = 43; Unsure, n = 131)

Figure 7.24 reveals that around two thirds of respondents at both sites have nil or minor confidence that climate change impacts will be dealt with appropriately by those responsible for minimising impacts.

Figure 7.24: Regional variations of confidence in authorities to deal with climate change



(Rockingham, n = 160; Yorke Peninsula, n = 185)

Table 7.7 lists why respondents would perceive the community as being willing or unwilling to adapt to climate change, with the most predominant sole response was that the community would need to be willing out of necessity. It was also reported that the community would be less willing to adapt, or not willing at all, because of 'apathy', they are 'lazy' and/or 'complacent' in nature, that there would be economic limitations restricting adaptation, or that there is simply a reluctance or resistance to change. Table 7.8 provides examples of the open-ended responses.

Table 7.7: Community willingness/unwillingness to adapt to climate change

Why would the community be willing/unwilling to adapt to climate change?	Mentioned *Inter Alia*	Sole Response
n of respondents	81	173
Necessity/Necessary	14	31
Apathetic/Lazy/Complacent	23	19
Economics/Costs/Priorities/Incentives	18	14
Don't want to/Reluctance/Someone else's problem	28	13
Climate Change not happening/no change	6	13
Uneducated/Unaware	17	10
Leadership	7	10
Slow Rate of Change/Effects unnoticed	5	9
Open to Change/Adaptation	9	7
Misinformation	8	5
Unable to Change/Adapt & Need Assistance	5	4
Uncertainty/Unconvinced	21	3
Concerned/Afraid	4	3
Won't affect me personally	6	3
There is no Consensus	5	2
Social Change takes Time	5	2
Don't Know	0	9
Other	0	16
Themes per response mentioned *Inter Alia*		*n*
2 themes per response		62
3 themes per response		19

(n = 254)

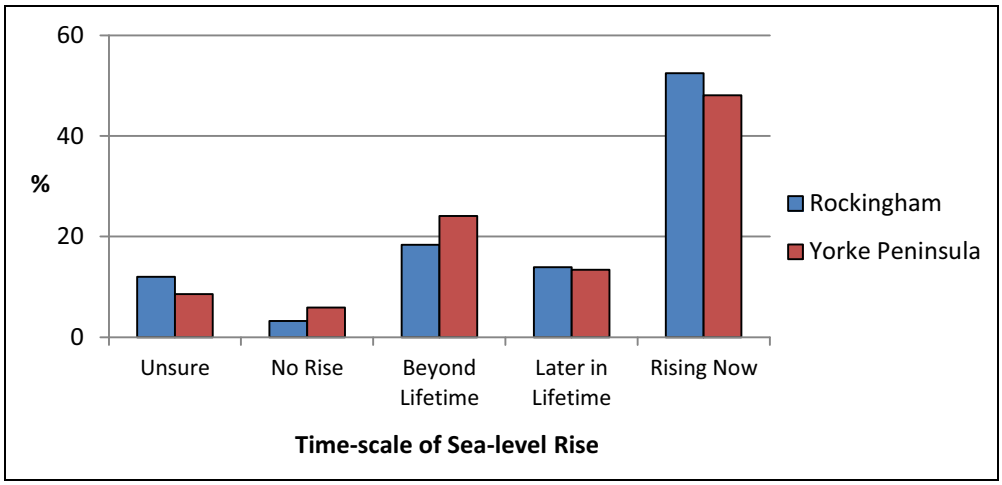
Table 7.8: Selected open-ended responses relating to reasons for community willingness/ unwillingness to adapt to climate change

Coded theme(s)	Examples
Necessity/ Necessary	"Whether you are willing or not is not an issue. You simply have to" (Rockingham Respondent 518, age group 50-59)
Apathetic/ Lazy/ Complacent	"Many younger Australians do not wish to be concerned about any dangers that may cause them concern" (Yorke Peninsula Respondent 5, age group 60+)
	"People in general I think care but most are lazy and anything that requires effort doesn't happen easily" (Yorke Peninsula Respondent 348, age group 40-49)
	"She'll be right attitude" (Yorke Peninsula Respondent 275, age group 60+)
Economics/ Costs/ Priorities/ Incentives	"People don't willingly change unless it affects them economically! Or they expect to be compensated for change" (Yorke Peninsula Respondent 148, age group 04-49)
	"People have more urgent issues than climate change" (Rockingham Respondent 287, age group 50-59)
Don't want to/ Reluctance/ Someone else's problem	"Too many people don't think they should have to modify their lifestyle. It is selfishness really" (Rockingham Respondent 281, age group 50-59)
	"Because people will not want to give up their lifestyle until they absolutely have to, i.e., its someone else's responsibility" (Yorke Peninsula Respondent 157, age group 60+)
Other	"Keeping things clean" (Yorke Peninsula Respondent 227, age group 40-49)
	"Very little signs of change in behaviours, gardens still high water usage, little use of solar power, still large number of large cars etc" (Rockingham Respondent 109, age group 40-49)

7.2.2 Sea-level rise

Figure 7.25 reveals that around one half of respondents at both case study sites believe that sea-level rise is occurring now, around 20% indicating that sea levels will rise beyond their lifetime, and less than 5% indicating that there has been no rise.

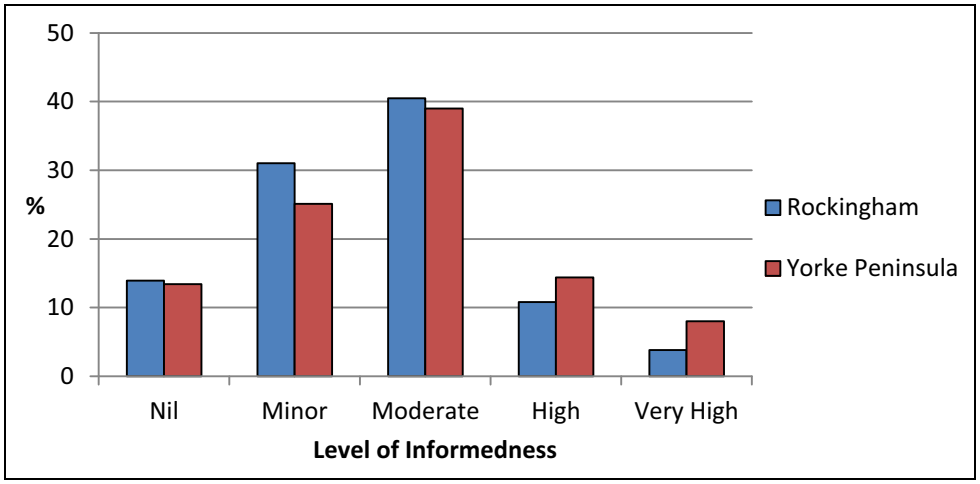
Figure 7.25: Regional variations of perceived time-scales of sea-level rise



(Rockingham, n = 158; Yorke Peninsula, n = 187)

Figure 7.26 reveals that the majority of respondents considered that they were not very informed, or only moderately informed about sea-level rise. One fifth of all respondents indicated that they are highly or very highly informed about sea-level rise.

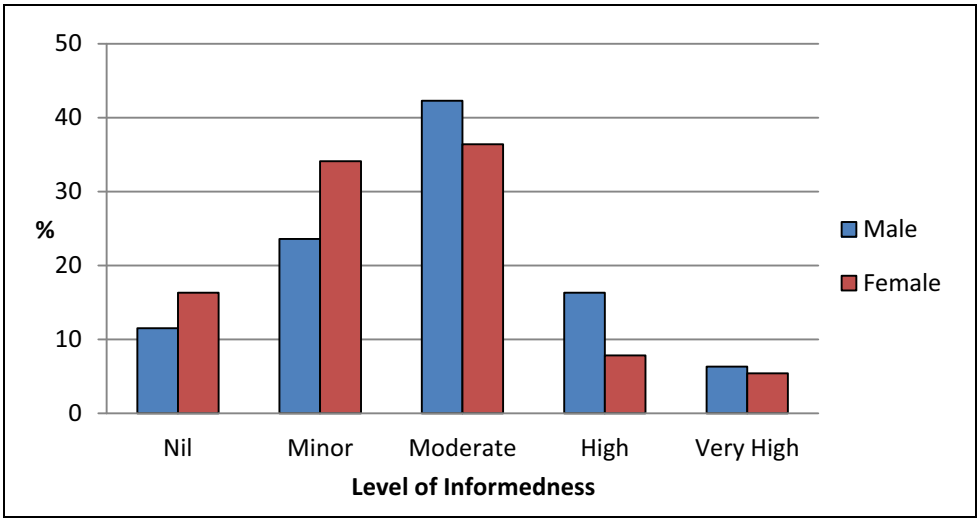
Figure 7.26: Regional variations of personal informedness about sea-level rise



(Rockingham, n = 158; Yorke Peninsula, n = 187)

Figure 7.27 reveals that males considered their informedness about sea-level rise as greater than that reported by females, and vice versa (U = 11075.5, p = 0.005).

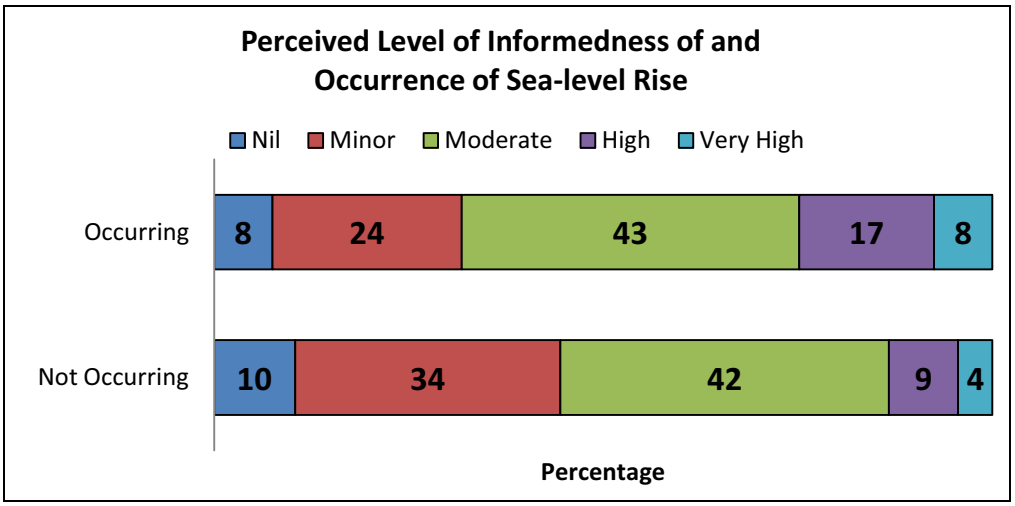
Figure 7.27: Gender variations of personal informedness about sea-level rise



(Male, n = 208; Female, n = 129)

Figure 7.28 reveals that respondents who believed sea-level rise to be occurring are more likely to report being more informed about sea-level rise, compared with those respondents who did not consider sea-level rise to be occurring (U = 9666.5, p = 0.006).

Figure 7.28: Informedness about, and occurrence of, sea-level rise

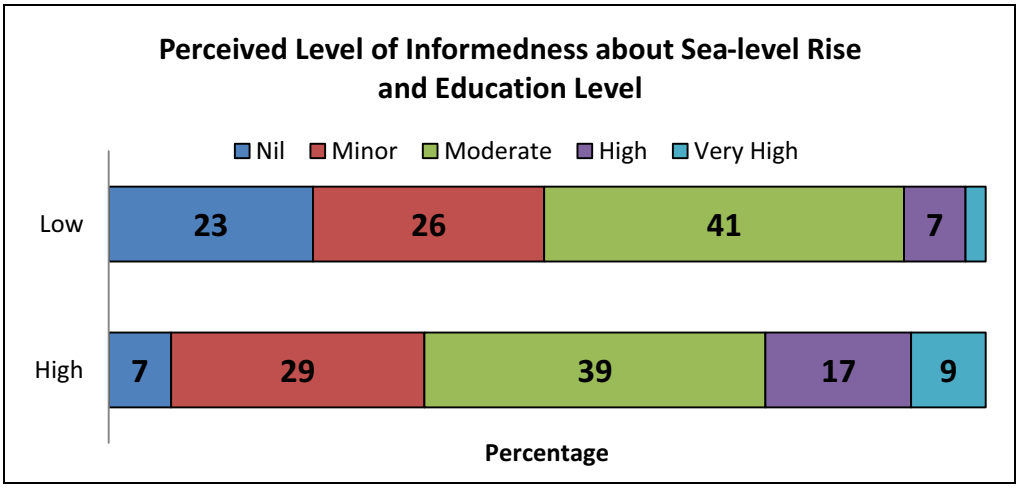


(Occurring, n =173; Not Occurring, n = 135)

** Collated from data of perceived timescales of sea-level rise (Figure 7.25)*

Figure 7.29 shows that respondents who indicated a high education level were much more likely to report being more informed about sea-level rise, compared with those respondents who indicated a low education level (U = 10158.5, p = 0.000).

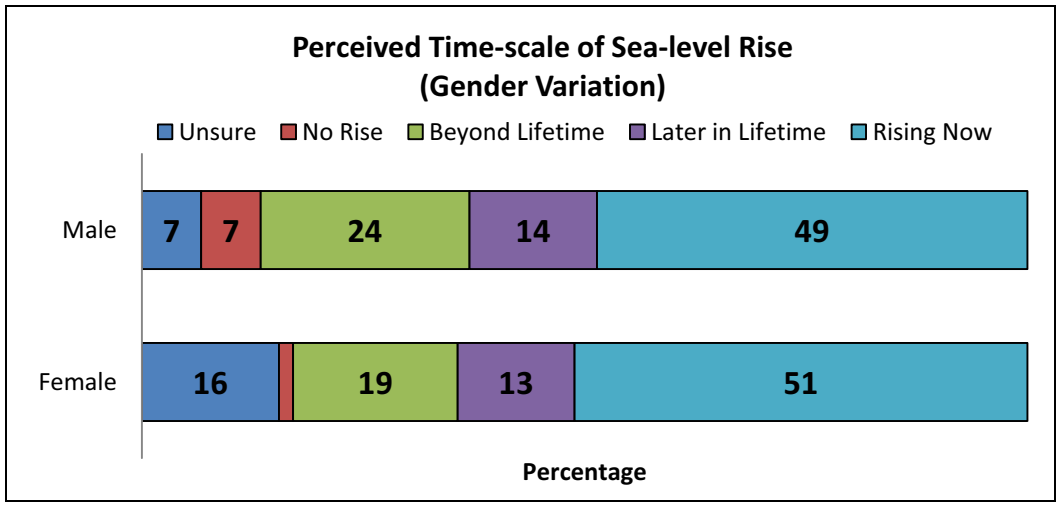
Figure 7.29: Education level variations of informedness about sea-level rise



(Low education, n = 129; High education, n = 211)

Figure 7.30 shows that females were more likely to be unsure with respect to the rate of sea-level rise compared to males, as well as slightly being slightly more likely to consider sea-level rise as occurring now (χ^2 = 11.674, p = 0.020).

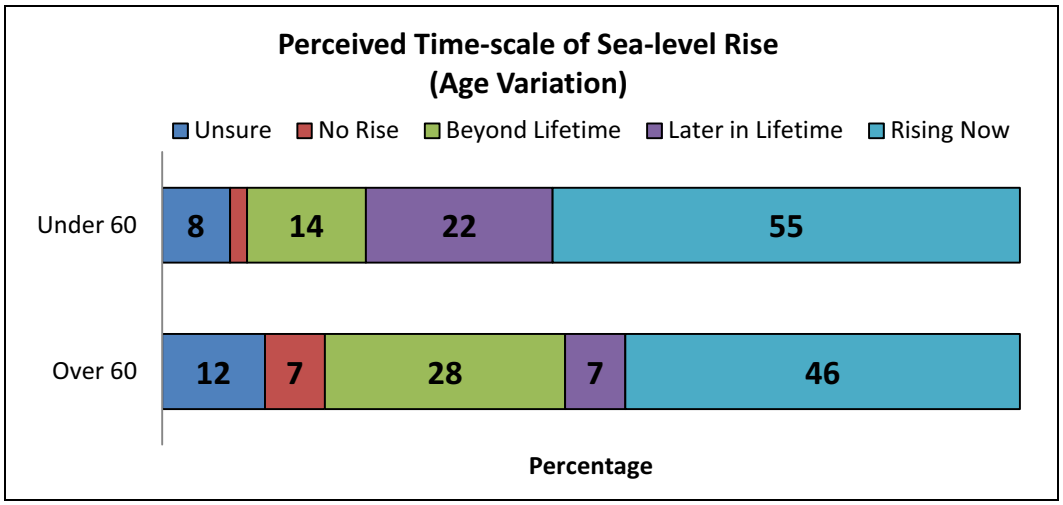
Figure 7.30: Gender variations of perceived time-scales of sea-level rise



(Male, n = 208; Female, n = 129)

Figure 7.31 reveals that respondents over 60 years of age were less likely to consider sea-level rise to be occurring now, and more likely to be unsure, compared to those under 60 years of age (χ^2 = 29.932, p = 0.000).

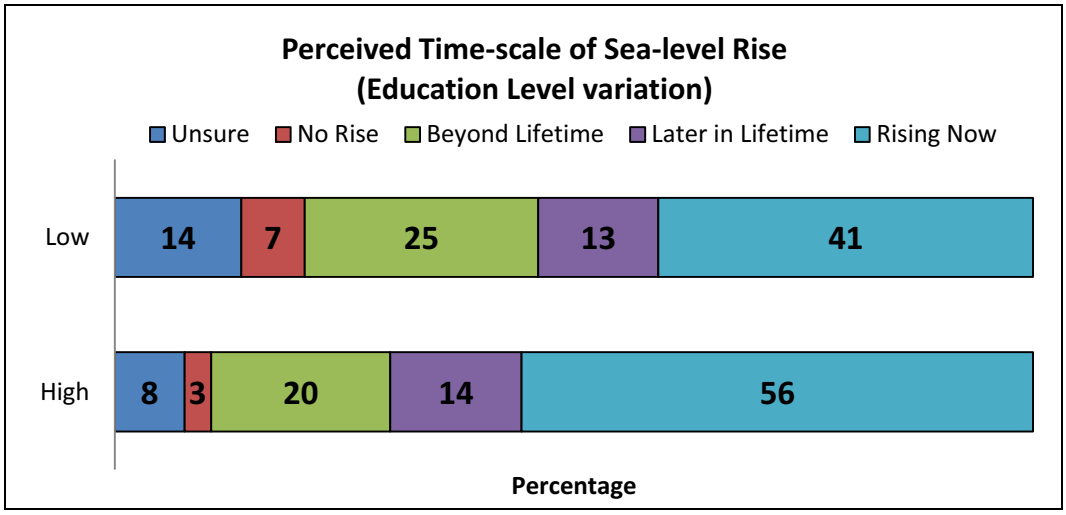
Figure 7.31: Age variations of perceived time-scales of sea-level rise



(Under 60, n = 163; Over 60, n = 180)

Figure 7.32 shows that respondents with a reported high level of educational attainment were more likely to consider sea-level rise to be occurring now, and less likely to be unsure, compared to those respondents with a low educational attainment (χ^2 = 11.061, p = 0.026).

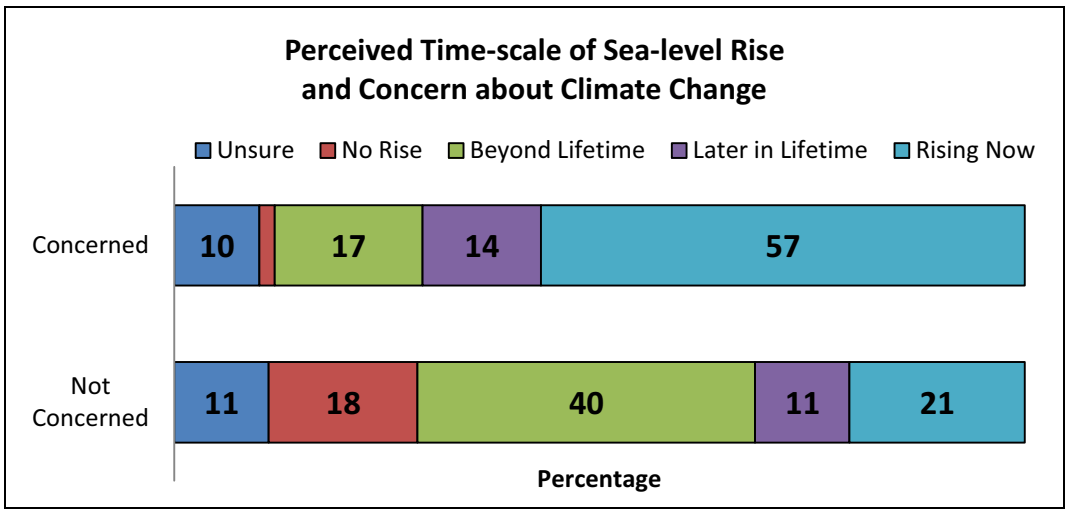
Figure 7.32: Education level variations of perceived time-scales of sea-level rise



(Low, n = 130; High, n = 210)

Figure 7.33 reveals that respondents who were not concerned about climate change were much more likely to be unsure about the time-scale of sea-level rise, consider sea-level rise to not be occurring, or that it would occur beyond their lifetime, compared with those who were concerned about climate change (χ^2 = 52.893, p = 0.000).

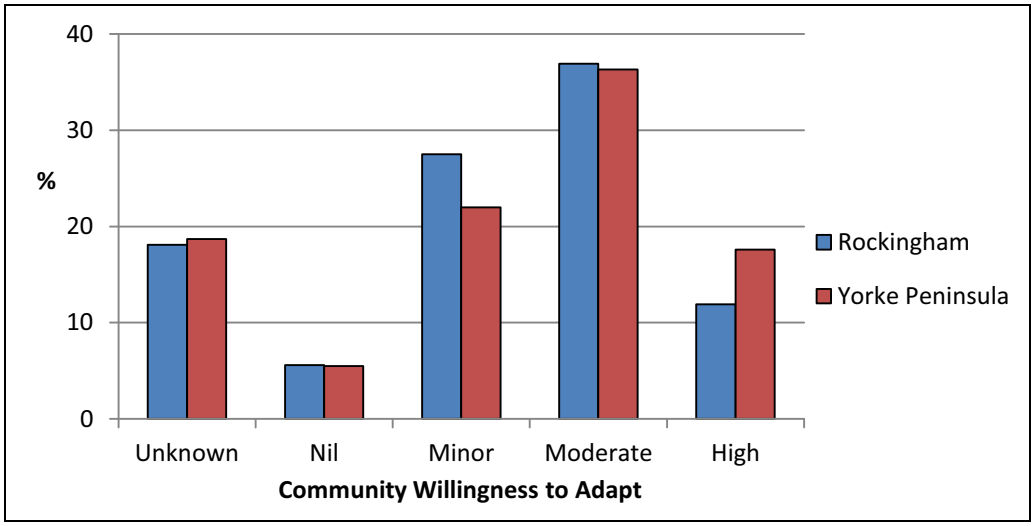
Figure 7.33: Perceived time-scales of sea-level rise in relation to indicated level of concern about climate change



(Concerned, n = 281; Not Concerned, n = 63)

Figure 7.34 shows that Rockingham respondents perceived the level of community willingness/unwillingness to adapt to sea-level rise as slightly lower than that of Yorke Peninsula respondents.

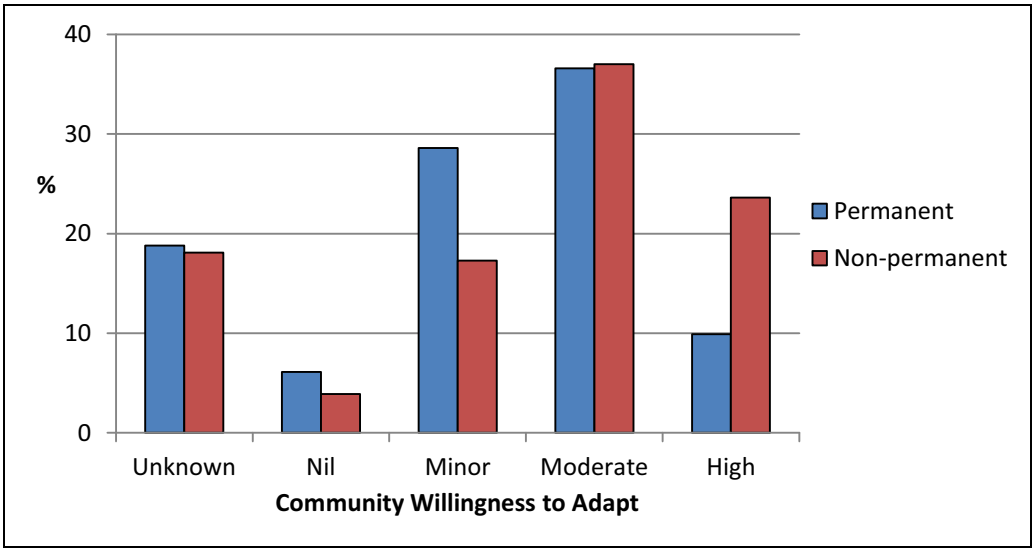
Figure 7.34: Regional variations of community willingness to adapt to sea-level rise



(Rockingham, n = 160; Yorke Peninsula, n = 182)

Figure 7.35 shows that permanent residents were more likely to perceive the community's willingness to adapt to sea-level rise as low compared with non-permanent residents, and vice versa (U = 11436.5, p = 0.013).

Figure 7.35: Perceived community willingness to adapt to sea-level rise by type of property owner



(Permanent, n = 213; Non-permanent, n = 127)

Table 7.9 lists how respondents would perceive the community as being willing/unwilling to adapt to sea-level rise. Over 90% of all respondents only identified one reason why they believed the community to be willing or unwilling to adapt to sea-level rise. Regarding those who considered the community as unwilling to adapt, 10% of the respondents regarded 'apathy' or 'complacency' as the sole reason, with almost a further 10% each believing that the community is waiting for signals of change to occur before they act, as well as that they are not informed enough to act. Regarding those who considered the community as willing to adapt, almost 10% believed that the community would adapt because it is their home and they would not want to see it damaged or be lost. Table 7.10 provides examples of open-ended responses.

Table 7.9: Community willingness/unwillingness to adapt to sea-level rise

Why would the community be willing/unwilling to adapt to sea-level rise	Mentioned *Inter Alia*	Sole Response
n of respondents	16	221
Apathy/Complacency	3	24
Since they're waiting for impacts to occur	2	22
Since it's their home/lifestyle	5	21
Not Informed Enough	4	21
It's not an immediate priority	3	19
No Choice	1	17
Too hard to change/Don't want to change	8	15
Since it will affect everyone	1	8
Denial/Intransigence	1	8
Adapting is Part of Life	0	7
Since it won't affect everyone	0	7
No Govt. leadership/Direction	1	6
Depends on several factors	1	4
Since there is/will be protection	0	3
Since they're aged	4	2
Unsure	0	17
Other	0	20

Themes per response mentioned *Inter Alia*	*n*
2 themes per response	14
3 themes per response	2

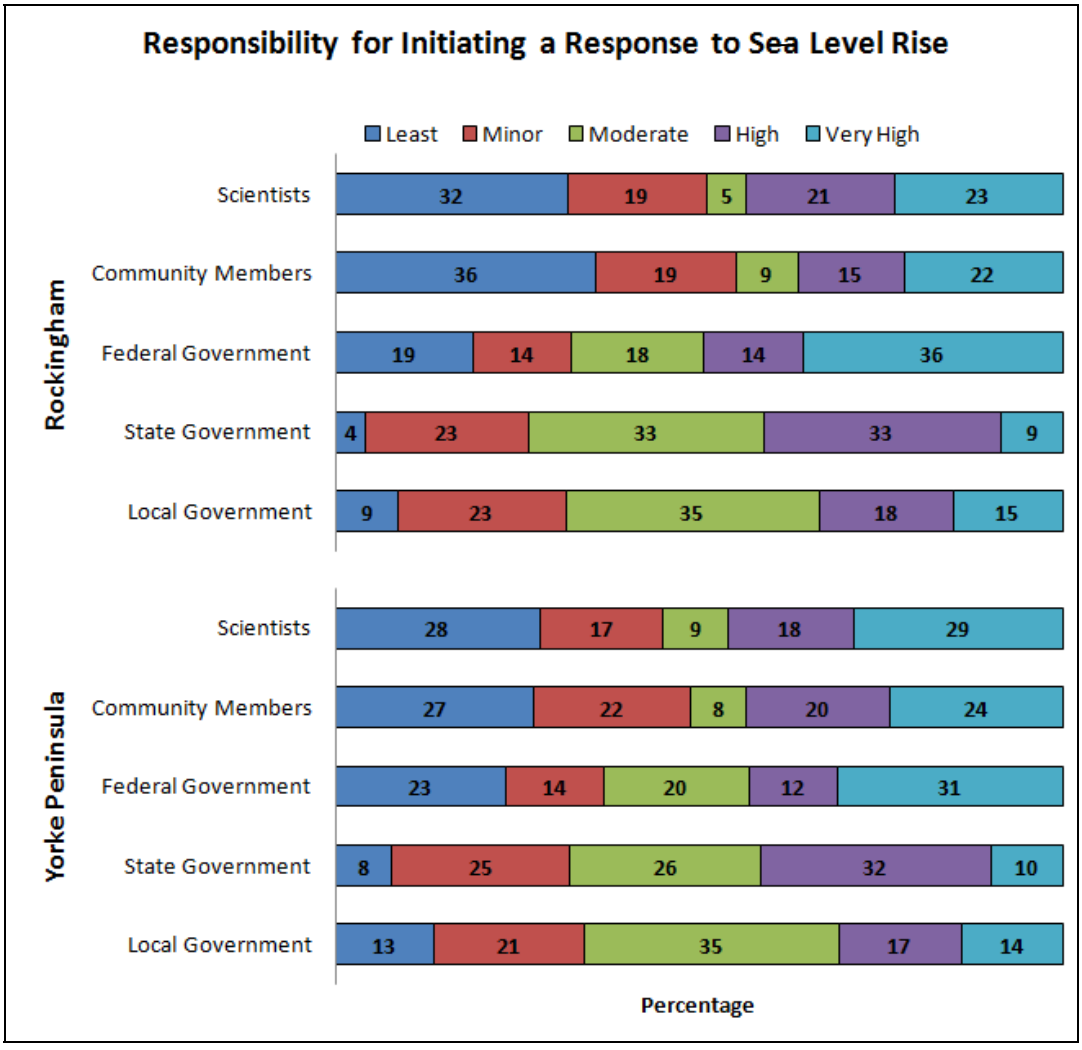
(n = 237)

Table 7.10: Selected open-ended responses relating to reasons for community willingness/ unwillingness to adapt to sea-level rise

Coded theme(s)	Examples
Apathy/ Complacency	"Because most people you talk to simply don't see that there's an issue, so stick their heads in the sand, so to speak. Money speaks - hence building idiotic marinas in the ocean when only 0.5 metres of sea level rise will severely compromise them" (Yorke Peninsula Respondent 21, age group 50-59)
Since they're waiting for signs of sea-level rise	"Until the effect of sea level rise is seen. It will not be accepted by the majority" (Rockingham Respondent 429, age group 60+)
Since it's their home/lifestyle	"I don't think people would like to see their communities lost and most people would help save their houses and communities" (Rockingham Respondent 436, age group 30-39)
	"We as a community over here would all help each other if we were confronted with a sea level rise" (Yorke Peninsula Respondent 360, age group 60+)
Not Informed Enough	"I think if everyone was informed of the facts they would have no hesitation in adapting to changes" (Yorke Peninsula Respondent 418, age group 30-39)
It's not an immediate priority	"Because they focus on today's lifestyle" (Rockingham Respondent 468, age group 40-49)
No Choice	"They won't have much choice in a coastal town" (Rockingham Respondent 402, age group 60+)
Unsure	"Not on the YP often enough to gauge a feeling" (Yorke Peninsula Respondent 242, age group 50-59)
Other	"What is the problem?" (Yorke Peninsula Respondent 415, age group 40-49)

Figure 7.36 shows whom respondents considered as primarily responsible for initiating a response to sea-level rise. The greatest proportion of respondents, at both case study sites, considered that the Federal Government is primarily responsible, compared to other authorities. Rockingham respondents considered community members as having the least responsibility for initiating a response to sea-level rise, whereas Yorke Peninsula respondents considered scientists as having the least responsibility.

Figure 7.36: Responsibility of authorities for initiating a response to sea-level rise

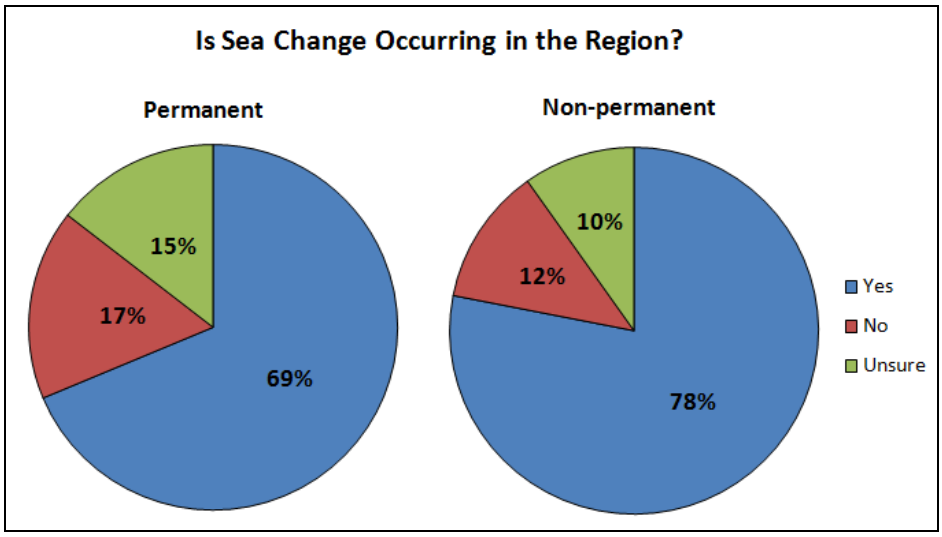


(Rockingham, Local Government n = 152, State Government n = 151, Federal Government n = 154, Community Members n = 151, Scientists n = 151; Yorke Peninsula, Local Government n = 172, State Government n = 171, Federal Government n = 171, Community Members n = 172, Scientists n = 171)

7.2.3 Sea change

Figure 7.37 shows that a greater proportion of non-permanent residents believe that sea change is occurring in the region in which they own property, compared with permanent residents in the region.

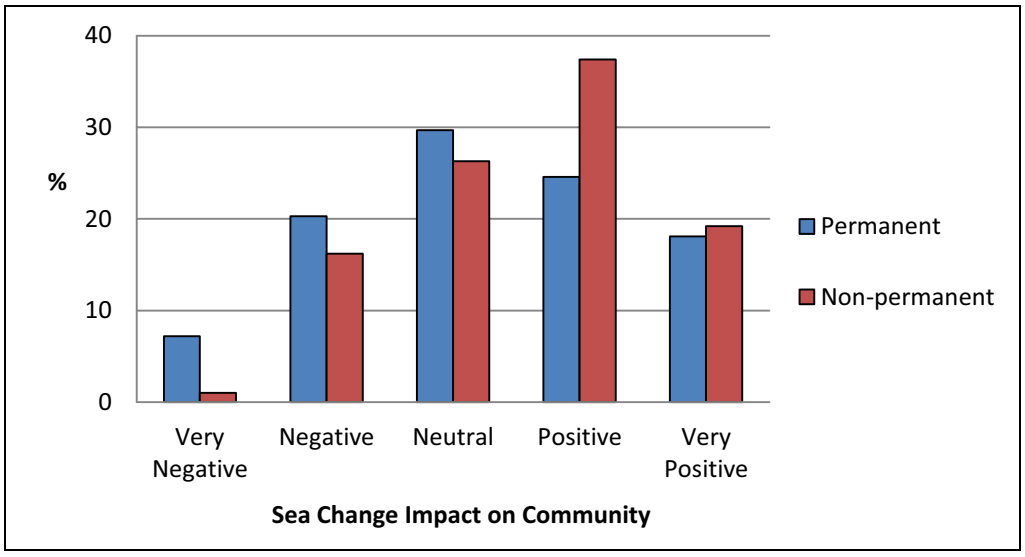
Figure 7.37: Sea change occurrence in the region by type of homeowner



(Permanent, n = 214; Non-permanent, n = 132)

Figure 7.38 shows that 57% of non-permanent residents believe that sea change has mostly positive impacts compared with 43% of permanent residents (U = 5815.5, p = 0.044).

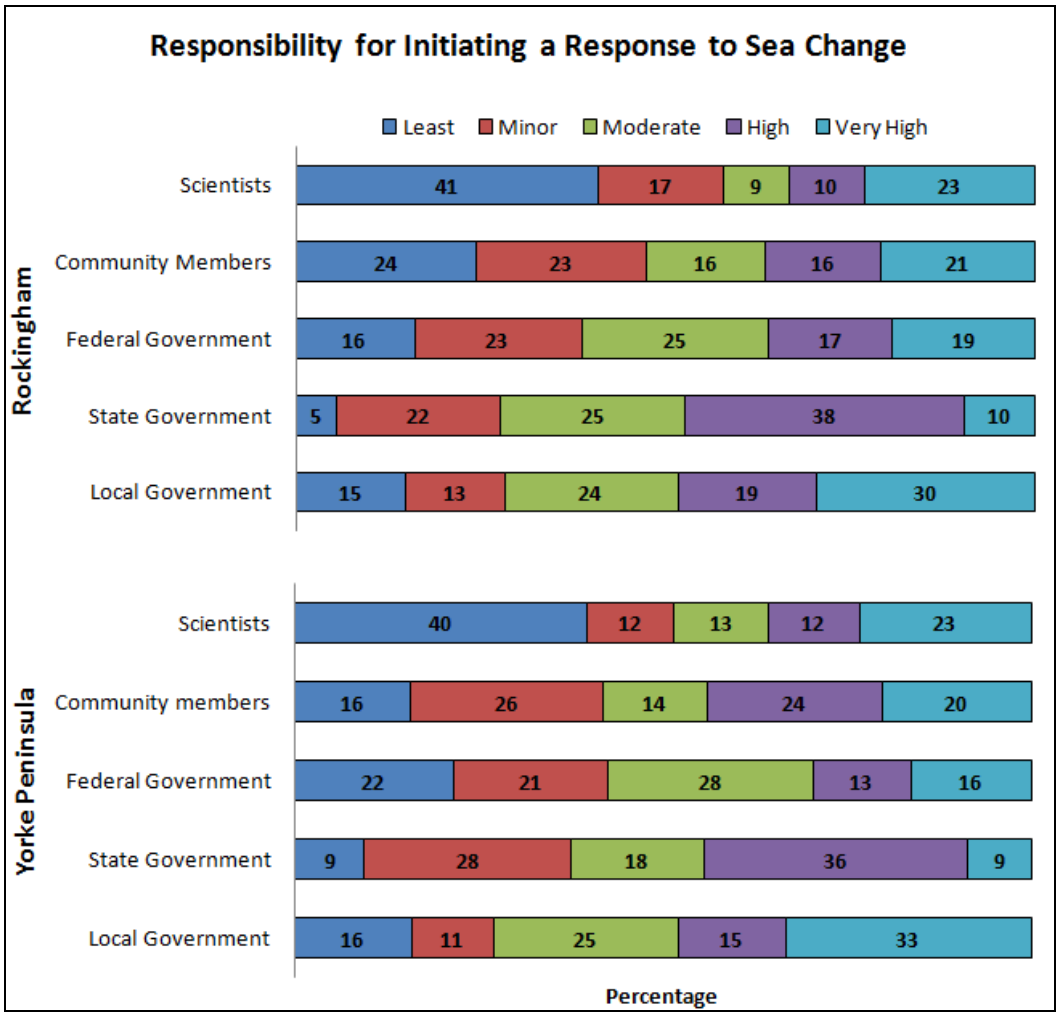
Figure 7.38: Influence of sea change on the community by type of homeowner



(Permanent, n = 138; Non-permanent, n = 99)

Figure 7.39 shows whom respondents considered as primarily responsible for initiating a response to sea change. At both case study sites, the Local Government was considered primarily responsible, and the State Government was considered to have the largest secondary role. Additionally, respondents at both case study sites considered scientists as having the least responsibility to initiate a response to sea change, similar to that observed for responsibility to initiate a response to climate change and sea-level rise, in Figure 7.20 and Figure 7.36, respectively.

Figure 7.39: Responsibility of authorities for initiating a response to sea change



(Rockingham, Local Government n = 149, State Government n = 148, Federal Government n = 150, Community Members n = 148, Scientists n = 147; Yorke Peninsula, Local Government n = 171, State Government n = 171, Federal Government n = 172, Community Members, n = 172, Scientists n = 171)

7.3 Summary

This chapter outlined how the survey respondents perceive their capacity to adapt to climate change and development pressure, as well as personal and their community's preparedness and willingness to adapt. Similar to the results presented in Chapter 6, there were very few marked differences between the results based on case study sites and residency, suggesting that location and type of property owner does not significantly alter public perceptions of risk in these particular contexts. Again, by differentiating the results into categories of the 'types' of risks, this chapter has been able to distinguish which particular components of future climate change impacts, as well as development pressures, play a greater role in affecting adaptive capacity and willingness to adapt. In order to better understand what factors influence adaptive capacity, as well as to provide assistance to those developing policy, the results outlined within this chapter, alongside the results outlined previously, will be discussed in Chapter 8.

Chapter 8 – Discussion and Conclusion

Based on the results and supporting literature discussed throughout this thesis and synthesised in the following chapter, this thesis concludes that the survey group are clearly more vulnerable than they perceive, and that this will undoubtedly have important implications for coastal management and climate change adaptation policy. There are, however, a number of opportunities that arise which may assist in supporting adaptation to climate change based on the discussion of the results in the context of supporting literature from a variety of disciplines. It is from this discussion that this thesis can conclude that adaptation to climate change can benefit substantially through the incorporation of an adaptive management framework, built upon the knowledge and evidence of the particular characteristics of 'place vulnerability' derived from risk perception studies. Specifically, the knowledge garnered through an investigation of 'place vulnerability' can enable a tailored evidence-based policy making approach to climate change adaptation which results in beneficial and acceptable socio-ecological outcomes. Based on these discussions, this chapter then recommends further research and also concludes there is a need for a greater understanding of the human dimensions of climate change adaptation through a focus on the assessment of social vulnerability to better inform policy and decision-makers of the way in which the public perceives risks.

8.1 Major findings

This research had hypothesised that there would be significant differences between the aggregate responses of coastal property owners between the two case study sites, since they represent two unique and spatially distant sea change communities. This hypothesis was premised upon the notion of 'place vulnerability' within an integrated vulnerability framework (Cutter *et al.*, 2003). Initially, the specific differences in proportions of holiday homeowners between the two communities was utilised to provide a key standpoint for generalisations about the two types of communities (Chapter 2.2.1). Secondly, the specific differences between the demographic variables of the two sea change communities, as per the ABS 2006 census data (Chapter 5.1), were utilised to provide another key standpoint for identifying generalised differences in perceptions. However, these expectations did not hold and therefore the null hypothesis can be accepted. Overall, there were very few marked differences in the results based

on case study sites and residency, suggesting that location and type of property owner do not significantly alter public perceptions of risk in these particular Mediterranean climatic contexts.

The climate change literature discussed throughout the first chapter revealed two primary research gaps to be filled (Chapter 1.5):

1. Identify the relationships between perceived societal risks, preparedness and willingness to adapt to climate change through an examination of the human dimensions of climate change; and
2. Contribute to regional and place-based vulnerability assessments through the identification of perceived vulnerabilities and potential avenues for adaptation.

Specifically, the literature discussed within the first chapter of this thesis demonstrated that a necessary step forward for vulnerability assessment, particularly in Australia, was for a greater inclusion of the social elements of vulnerability (constituting, but not limited to, adaptation and adaptive capacity), and that this should be combined with the biophysical elements already prevalent within such assessments. This was expressed in Chapter 1.5 in the form of the key research question: *How willing and capable are coastal property owners to adapt to climate change risks and associated vulnerabilities?* Consequently, this question was broken down into four sub-questions (Chapter 1.5, and displayed in Figure 2.1). Whilst much more in-depth discussions of the results and contributions of this research will take place in the later relevant sections, the sub-questions will now be briefly discussed in order to highlight the main contributions:

- *What are the perceived vulnerabilities of residents in coastal settlements in terms of climate change?* This research finds that most coastal property owners within the case studies of Rockingham and Yorke Peninsula acknowledge that their communities are moderately vulnerable to climate change and sea-level rise, with 81% of respondents indicating that they are concerned about climate change and sea-level rise. This research also finds that coastal inundation and flooding are reported as the most serious negative impacts of climate change in the communities, and that it will be the people living in the coastal and other low-lying areas whom are considered the most vulnerable (there was virtually no mention of the most vulnerable members within the community, such as the elderly, the young, and the poor). 48% of respondents consider that climate change is occurring now (13% do not consider it to be occurring, and 38% are unsure), between 43% and 57% consider climatic changes as highly and

very highly likely to occur in the next 25 years, and in the case of the beach and foreshore, approximately 52% expect that impacts will cause very high levels of disruption.

- *What are the perceived societal opportunities, limitations and barriers of climate change adaptation?* This research finds that almost one half of respondents are moderately confident in their capability to personally adapt to future climatic changes. However, many respondents do not necessarily see others in their community as being as willing to adapt as themselves. The opportunity here is that since many have confidence in their abilities, this will help them to realise their future potential for adaptation. This potential would be dependent upon the extent of guidance and direction given to them, preferably from sources and/or authority figures they trust. Simultaneously, however, this confidence may also be a limitation and even create barriers to adaptation, particularly if the self-confidence in their ability to adapt is unfounded and results in complacency.
- *What constitutes adaptation, how does it occur and what are the implications for government planning and policy-makers?* 51% of property owners within this study have changed the way they live as a result of, or in anticipation of, the impacts or potential impacts climate change. The actions that constituted adaptation, however, were primarily associated with issues and acts of increased household 'sustainability', such as conserving water, recycling, etcetera, as well as the notion that one simply needs to be more aware of the impacts of one's behaviour. The implications for policy-makers and future adaptation initiatives are such that since people have already made changes, and are currently making changes to their lifestyles with climate change as a motivating factor, this may provide the foundation for more substantial adaptation to be built upon in the future.
- *Can planners and policy-makers utilise knowledge of perceived vulnerabilities to better prepare society for change?* Overall, there were very few marked differences in the results based on case study sites and residency, which suggests that location and type of property owner do not significantly alter public perceptions of risk in these particular Mediterranean climatic contexts. Indeed, if these factors have only a very minor influence on personal risk perceptions and overall place vulnerability, then perhaps the way in which such communities are engaged with does not have to be too dissimilar. Specifically, the findings suggest that property owners may be much more alike in their perceptions of risk than they may believe. Such a finding could potentially become a

source of strength and solidarity within the community, particularly with respect to the realisation that if others within the community share common attitudes towards climate change, as well as the common desire and willingness to adapt, then they are not acting alone and are likely to have the support of their 'neighbours'. This contributes to the recommendation of a more tailored evidence-based policy making approach.

8.1.1 Perceived risk

It was evident that those respondents who are concerned about climate change differed markedly in their perceptions of risk compared with those who are not concerned. It was found that those who were more likely to be concerned about climate change were respondents who:

- Believe that climate change is occurring now.
- Believe that sea-level rise is occurring now, and are concerned about it.
- Expect substantial future disruption to their lives, and to the community itself, due to climate change.
- Consider the likelihood of climatic changes over the next 25 years as high.

Concern about climate change was virtually the same for both males and females (80% and 81% concerned respectively) (Chapter 6.1.1). However, the results show a tendency for males to have lower risk perceptions overall, based on lower levels of perceived likelihood of climatic changes, compared with females (Chapter 6.1). This is consistent with findings in similar research contexts, whereby there is often a subset of males who judge risks as extremely low, and who typically tend to be more highly educated, have higher household incomes, and are politically more conservative (Slovic, 2000d). However, this differed with results in recent research conducted by Buys *et al.* (2012) in a rural Australian forestry and plantation context, whereby males and older residents were actually more likely to describe their community as 'concerned' about climate change. Whilst explanations of the underlying causes of male/female variations in risk perceptions have been limited, reviews suggest that gender socialisation theory helps to explain much of the gap (Boeve de Pauw and Van Petegem, 2011; Davidson and Freudenburg, 1996). Here, females are usually concerned with 'natural' responsibilities, as primary caretakers of the home and family unit (Johnson, 2005). Since their concerns are typically associated with health and safety issues they are, as such, more risk averse, whereas males are stereotypically concerned within the arenas of business, politics, and science, and have the tendency to be risk takers (Finucane *et al.*, 2000; Flynn *et al.*, 1994; Gustafson, 1998).

Levels of community vulnerability to the impacts of climate change (Chapter 6.1.1) and sea-level rise (Chapter 6.1.2) were generally perceived as moderate to high (65% and 60% at both sites respectively). This result reveals that a majority of respondents do, in fact, acknowledge that the community in which they own property is vulnerable. The most serious negative impact of climate change was identified to be sea-level rise and flooding (with coastal erosion as third most serious), and that coastal residents and properties, as well as those in low-lying areas, would be the most vulnerable. These results reveal that respondents do in fact recognise the types of coastal risks involved under scenarios of climate change in their particular locations (place vulnerability). Indeed, based on responses of why these people were concerned about sea-level rise, the top three reasons included the loss of homes and lifestyle, that low-lying areas would become flooded, and because of the impact on future generations (Chapter 6.1.2). These results clearly show that people realise that they are vulnerable to climate change impacts. Of those not concerned about sea-level rise, interestingly, the top three reasons included that people did not perceive it as having a major impact, that the rates of sea-level rise are minor, and that it is just a normal cycle of events. These results, within this particular cohort of respondents, revealed scepticism in the severity of future climate change impacts (Chapter 6.1.2).

It was evident that there was a small group (5.7% or 22 out of 383 surveys – see Appendix 5) of respondents who are sceptical, in one way or another, about the reality, causality or impact of climate change (Chapter 6.1). Such attitudes were evident primarily within responses to the perceived most serious negative impact of climate change, and comments within responses of survey feedback (Chapter 6.1.1). The potential issues that arise from particular subsets of the population being sceptical about climate change, and therefore not perceiving themselves to be vulnerable, subsequently, is that preventative measures they may able to employ to minimise negative impacts may be viewed as redundant (as discussed by Jaeger *et al.*, 2001). For instance, in a study of elderly people's perceptions of heat wave risks, Wolf *et al.* (2009) found that within this relatively vulnerable group, if they generally do not perceive themselves to be vulnerable to external factors, they do little to adapt to them.

It is important to note that the survey did not require respondents to specify whether or not 'climate change' was in reference to the anthropogenic phenomenon or otherwise, and did not contain specific questions to gather such information (discussed in Chapter 2.6). Rather, the questionnaire allowed for respondent elaboration on their particular views and level of understanding, such that their 'scepticism', or lack thereof, could be inferred from responses.

Nonetheless, several comments were received indicating that respondents felt as though the survey did not allow for contrarian viewpoints. It is also important to note the potential for nonresponse bias in the survey, whereby persons sceptical about the reality of anthropogenic climate change may not have completed the survey, possibly out of a rejection of the notion of 'climate change' in general. This potential nonresponse bias is negligible, however, since the prevalence of scepticism identified in numerous opinion polls throughout the world has only been a small proportion of the overall population, in any case (Leviston *et al.*, 2011) (discussed in Chapter 4.3).

Respondents reported that they expected the more personal (tangible) elements (including income, health and home) of their lives to experience low levels of disruption from climate change (Chapter 6.1.1). In contrast, they expected the less personal (abstract) elements (including community and quality of life) to experience high levels of disruption. This finding is in line with the notion whereby certain aspects of one's life that are deemed as tangible are controllable and therefore able to be adjusted in the face of disruption, whilst that which is more abstract to the individual is considered less-controllable in the face of disruption (for example, see Brun, 1994; Sjöberg *et al.*, 2004). For instance, Kuruppu and Liverman (2010) found similar findings in their study of adaptation and mental models of rural coastal communities in Kiribati, whereby climate change impacts on water resources, viewed as an extension of past conditions of water stress, were deemed more controllable and less threatening, which allowed for certain levels of complacency in adaptation. Furthermore, the findings of this thesis are also consistent with other studies examining personal risk compared with general risk, whereby personal risks are judged as smaller than general risks (Sjöberg, 2003), as well as studies of identifiability, whereby 'known' victims may evoke stronger emotions in people than abstract ones (Hsu, 2007; Markowitz and Shariff, 2012).

It was found that those who believe that climate change is occurring now are more likely to expect disruption/damage to occur as a result of storm surges (Chapter 6.1.3). Similarly, those who perceived their respective communities to be vulnerable to climate change and sea-level rise impacts were more likely to be concerned about climate change. Specifically, females were more likely to perceive the vulnerability of communities to climate change and sea-level rise impacts to be higher than males (Chapter 6.1). Similarly, females expected a higher level of disruption caused by storm surges, and perceived a greater likelihood of sea-level rise, compared with males. As discussed above, these results are consistent with much of the literature regarding

gender variations that describe males as being typically more optimistic about risks than females (for example, see Finucane *et al.*, 2000; Slovic, 2000d).

Overall, in terms of the timeframes involved in the impacts of climate change, the findings of this thesis suggest that an individual person's age and lifetime was an important factor, since many respondents over 60 years of age discussed that they are too old to be highly concerned about climate change issues. In this instance, it is likely that the effects of climate change, as Reser and Swim (2011) explain, have been viewed by people as more relevant for future generations. In this thesis, it was found that respondents aged over 60 years were less likely to expect high levels of disruption to their health, quality of life, and their community as a result of climate change, compared to respondents under 60 (Chapter 6.1.1). In addition, respondents aged over 60 years were much less likely to consider the likelihood of increased temperatures and sea-level rise as high (Chapter 6.1.1), and considered the level of disruption caused by storm surges to be less than respondents under 60 (Chapter 6.1.3). Respondents aged over 60 years were also more likely to consider the community to be less vulnerable to climate change, and less likely to be concerned about sea-level rise compared to respondents under 60 (Chapter 6.1.2). This finding is particularly important given the proportion of elderly residents in sea change communities, and due to their potential reluctance to consider climate change as an immediate issue, therefore – which may have implications in terms of their acceptance of related public policy. In this case, for instance, they may be unwilling to cooperate and resist the introduction of new policy initiatives, particularly if there is no direct benefit for them within their lifetime.

Yorke Peninsula respondents tended to consider the likelihood of increased temperatures and decreased rainfall as higher than Rockingham respondents (Chapter 6.1.1). Rockingham respondents, on the other hand, tended to consider the likelihood of increased sea levels and storm surges as higher than Yorke Peninsula respondents. This difference may reflect public knowledge and attention towards drought conditions in the Yorke Peninsula region compared with Rockingham. Indeed, drought conditions can have a substantial impact on farming and therefore people's incomes, livelihoods, and mental health and well-being (Alston and Kent, 2004; Berry *et al.*, 2011; Bi and Parton, 2008), and in this case it may amplify concerns about the likelihood of those particular climatic changes. Here, the additional factor of drought may be contributing to this particular aspect of the Yorke Peninsula's 'place vulnerability', such that there is an availability bias towards increased temperatures and decreased rainfall due to recent past experience with such weather conditions.

Greater proportions of permanent residents reported witnessing storm surge events in the past, compared with non-permanent residents (Chapter 6.1.3). This is likely due to the fact that permanent residents in these communities are much more likely to witness such an event due to greater time spent in the region, along with the fact that it is a clearly distinguishable 'event'. This was particularly the case for Yorke Peninsula residents (Chapter 6.1.3), whereby permanent residents are especially likely to witness storm surge events more often than non-permanent residents. Because such 'coastal hamlet' towns typically have major roads running parallel to, and in close proximity of, the beach and foreshore (Lothian, 2005; Williams, 2009), therefore, there is likely a bias present when storm surges do occur.

Similarly, in terms of expecting future disruption due to storm surges, permanent residents reported greater expectations of disruption than non-permanent residents (Chapter 6.1.3). As before, it is likely that permanent residents have experienced a greater number of storm surge incidents in the past, compared with non-permanent residents, who may only frequent their coastal property during holiday seasons or on weekends. Such a result could be consistent with the availability heuristic, whereby the recollection of previous storm surges, or indeed damage to the beach and foreshore, is likely to be more readily available to those who have experienced storm surges first-hand. Alternatively, accounts of previous storm surges may be amplified via social discourse with other community members, albeit this may also serve to attenuate the effects of storm surges, as discussed by Kasperson *et al.* (2003a). The finding within this thesis, therefore, is important in terms of the notion of 'place vulnerability' in such sea change communities, whereby non-permanent residents may have a slightly reduced level of perceived risk to such concrete 'events', as opposed to the more gradual or subtle climatic changes expected with the majority of other climate change impacts.

Greater proportions of Yorke Peninsula respondents believed the sea change phenomenon to be occurring than Rockingham respondents. However, Rockingham respondents regarded its influence as slightly more positive than Yorke Peninsula respondents. This may be due to the fact that Rockingham's utility in terms of providing families with new and cheaper housing and associated jobs within commuting distance to the state capital of Perth, is a substantial 'pull' factor for people to move to the region, as with many 'coastal commuter' locations (Gurran *et al.*, 2005a). Yorke Peninsula, on the other hand, is a 'quieter' sea change region of 'coastal hamlets' which, particularly during peak holiday times, can cause disruption to and crowding of what is usually a 'sleepier' location (Gurran *et al.*, 2005a). In line with the above notion, it was found that

non-permanent residents were more likely to consider the sea change phenomenon as having a positive influence on the community compared to permanent residents (Chapter 6.1.4). It is reasonable to assume that those who are non-permanent residents perceive their visits to the community as having a much more positive influence on the region, for instance, through boosts to the local economy and property development (Saint Onge *et al.*, 2007). On the other hand, permanent residents may believe that sea change is much more of a negative influence, since they are more accustomed to the 'quieter' lifestyle and perhaps dislike what the non-permanent holiday homeowners bring with them to the communities, for instance, traffic and local business congestion, as well as waste collection issues, rubbish and litter (Gurran *et al.*, 2005a).

8.1.2 Adaptive capacity

It was evident that there were several demographic characteristics which were linked to respondents perceiving both themselves and their community's adaptive capacity as high, as well as linkages with responses to perceived vulnerability. It was found that those who considered their adaptive capacity as high were more likely to:

- Not be concerned about climate change.
- Be permanent residents.
- Be concerned about sea-level rise.

Respondents who were not concerned about climate change were much more likely to perceive their personal capability to adapt to climate change as high (Chapter 7.1.1). This reveals a high degree of self-efficacy, or personal confidence in their ability to adapt (adaptive capacity) and make a difference to their situation, despite risk. There are several possible explanations for this finding. First, respondents considered their capability to adapt to climate change as sufficient enough to not be concerned about any negative impacts of climate change. This explanation appears consistent with research showing that there is a tendency for optimism biases with hazards that are deemed controllable by personal action (Slovic, 2000a; Weinstein, 1989). Kuruppu and Liverman (2011), for example, found similar instances of over-confidence in the ability of coastal rural communities in Kiribati to adapt to climate change, whereby high self-efficacy beliefs were based on past experiences and success in managing water resources. This belief tended to preclude any need for anticipatory adaptation initiatives, and in fact acted as a barrier to forming adaptation intentions.

Another possible explanation for this high degree of self-efficacy can be found in research by Buys *et al.* (2012, p. 243), whom noted a 'rural resilience sub-theme' in their examination of perceptions of rural forestry and plantation communities in Australia, whereby there was belief that "rural communities have dealt with worse in the past and will in the future, and thus, worrying about–and preparing for–the *possible* impacts of climate change is pointless". In this particular instance, it was assumed that the community would just adapt and cope as necessary (Buys *et* al., 2012). These attitudes are consistent with the majority of views of respondents in this research in terms of the perceived means of adapting to climate change (Chapter 7.1.1) whereby, whatever happens, the individual would simply adjust their lifestyle and adapt. This finding, therefore, confirms an optimism bias.

A high degree of self-efficacy (confidence) in respondents' individual adaptive capacities to climate change could also stem from a perception that climate change is not an immediate problem and, as such, is removed from space and time, whereby it is not in the 'here' and 'now' (Adger *et al.*, 2009). Similar to the discussion of Kuruppu and Liverman (2011) above, if past management of environmental issues by respondents, such as coping with water scarcity issues, storm surges, heat waves and so on, have created a belief that past actions were sufficient, then they may not need to consider future adaptation options since they will cope as they did before. Additionally, there may also be the simultaneous belief that there is still time to take action and prevent climate change from happening, and therefore there is optimism that society can adapt to any future climatic changes when they arise, or that there will be technological remedies that will assist in both mitigation and adaptation (Hobson and Niemeyer, 2012). Both of these explanations are likely to be the case with respondents at the case study sites explored within this thesis.

Respondents who were permanent residents were more likely to consider themselves as being capable of adapting to climate change, compared with non-permanent residents (Chapter 7.1.1). In terms of open-ended responses to 'how' individuals would personally adapt to climate change (that is, if they perceived themselves as capable), almost one quarter of all responses indicated that people would simply adjust their lifestyles to adapt, or that it would not be difficult to adapt, without specifically detailing any particular adaptation initiatives. As mentioned above, the case may be that people are not concerned about climate change because they are confident they can, and will, adapt to climate change when it becomes necessary to do so. This is an important finding because people may be assuming that signs of vulnerability will appear early and act as a

'warning signal' for them to begin taking the appropriate forms of adaptive measures (for example, see Slovic, 2000a; Weinstein, 1987) or, as expressed indirectly in some of the open-ended responses, that they expect to be advised on the appropriate forms of adaptation from the authorities when the need arises. Recent research, however, has shown that people do occasionally misinterpret the intended messages about climate change outcomes as being less likely than actually reported, whereby the uncertainty communicated leads to optimism (Budescu *et al.*, 2009).

Whilst the processes behind optimism towards climate change risk are not yet fully understood, it does suggest that "the less definitive and incontrovertible the conclusions, the more room there is for individuals to infer unreasonably optimistic outcomes" (Markowitz and Shariff, 2012, p. 244). The findings of this thesis and the literature discussed above suggest that the messages used to communicate climate risk are not only important to justify and encourage behavioural change, but to reduce the uncertainty and optimism that leads to complacency about risk in the first place. Additionally, since the degree of adaptive capacity varied depending upon whether or not the respondent was a permanent and non-permanent resident, it is likely therefore that, the type of sea change community (which has varying ratios of permanent and non-permanent residents) will be a minor factor in determining the degree of willingness of the individual to adapt to climate change. This finding, consequently, reveals that engagement with different sea change communities should consider these permanent and non-permanent resident ratios in order to facilitate the development of more locally relevant and socially acceptable climate change policy.

Over one half of all respondents stated that they have changed or are changing their lifestyle as a result of, or in anticipation of, the impacts of climate change (Chapter 7.1.1). It was also found that respondents who are not concerned about climate change are much less likely to have changed or be changing their lifestyle as a result of climate change. This particular finding confirms the concept within risk management that when "people fail to be alarmed about a risk or hazard, they do not take precautions" (Weber, 2006, p. 103). Furthermore, it was found that females, respondents under 60 years of age, and those with higher educational attainment levels were much more likely to have changed or be changing their lifestyle as a result of climate change. These findings also confirm notions that females, young people, and those who are more educated are more likely to exhibit pro-environmental behaviours and attitudes (Kollmuss and Agyeman, 2002; Scott and Willits, 1994; Stern *et al.*, 1993; Tindall *et al.*, 2003; Zelezny *et al.*, 2000).

Open-ended responses to 'how' individuals have changed or are changing as a result of climate change, were predominantly a combination of changes or potential changes mentioned *inter alia.* Interestingly, 10 out of the 18 (55%) response themes gathered were associated with general principles of sustainability such as 'conserve water', 'manage the garden better', 'recycle', 'insulate home', and 'drive the car less'. This finding is important because it suggests that such sustainability issues and practices at the household-level have already been mainstreamed and are therefore able to be built-upon and re-visioned to include a broader scope of proactive adaptation actions. This is also an important finding in terms of the uptake of pro-environmental and adaptive behaviour by individuals since an understanding of existing behaviours and potential behavioural change, it has been argued, could lead to the development and operationalisation of more effective and sophisticated resilience polices (Lazarow *et al.*, 2006; Reid *et al.*, 2010).

Perceived personal and community capability to adapt to sea-level rise was more likely to be high for respondents who were concerned about sea-level rise (Chapter 7.2.2). This result is in direct contrast with results of personal capability to adapt to, and concern about, climate change, discussed above. In terms of the open-ended responses to 'how' individuals would personally adapt to sea-level rise, almost one third of all responses indicated that people would sell their home, and/or move elsewhere. These results suggest that the different perceptions between climate change and sea-level rise may be due to the way in which the two issues have been framed. For instance, the notion of adapting to climate change may be perceived as an abstract concept that is focussed on intrinsic lifestyle changes (as discussed by Weber, 2006). Adapting to sea-level rise, rather, may be envisaged in more 'concrete' terms since it is more about one's physical location or proximity to the coast, which can be easily remedied and therefore may be less of an issue for individuals (Weber, 2006). Respondents, as such, may be concerned about sea-level rise and accept that relocating may be necessary, but find it more difficult to conceptualise adaptation to climate change beyond those general sustainability practices mentioned above. Providing examples of appropriate adaptation to the public, therefore, may prove beneficial since it will assist individuals in visualising adaptation pathways that are more 'concrete'.

Respondents over 60 years of age considered the community more capable of adapting to sea-level rise compared with respondents under 60 years of age (Chapter 7.2.2). Those aged over 60 years may perceive the 'community' in which they are a part of as a more cohesive group than

those under 60 years of age. Whilst there has been no research in Australia to suggest an explanation, in the UK, for example, perceived levels of community cohesion have generally been higher amongst older people (DCLG, 2010a; b). Furthermore, in terms of community group cohesion and coastal zone management outcomes, Tompkins *et al.* (2002) found that communication through cohesive social networks were an important element in developing more robust management institutions. Here, a cohesive community is one where there is common vision and values, as well as a sense of belonging (CCRT, 2001). This is an important finding since it has been argued in the literature that cohesive communities "are better equipped to deal with local social problems than fragmented communities" (Lee and Earnest, 2003, p. 132). Cohesion, in the context of local climate change adaptation initiatives, as Tompkins and Adger (2004, pp. 16-17) found in Trinidad and Tobago, introduced the potential for "more flexible localized adaptive responses… [whereby] Open lines of communication meant that small modifications in behavioral norms at the community level could be instigated through group processes rather than through more formalized institutional change".

8.1.3 Preparedness and willingness to adapt

The results show that those who are concerned about climate change are much more likely to pay attention to climate change issues, and vice versa (those who were not concerned are more likely to pay much less attention) (Chapter 7.2.1). Furthermore, a person's level of education was also found to be significant with respect to the amount of attention they paid to climate change issues, whereby those with higher educational attainment levels are more likely to pay attention, and vice versa. It has been well established, however, that even if people are aware of environmental issues, it will only become a personal issue when, and if, they feel threatened (Conacher, 1980). What remains uncertain is whether the concern for climate change stems from the information obtained when 'paying attention to climate change issues', or whether the higher levels of attention to the issues of climate change are the result of being concerned about the issue in the first place. In the case of the latter, this is an important factor since individuals may only be paying attention to messages that simply reinforce pre-existing attitudes and mental models (Leiserowitz, 2006; Lorenzoni and Pidgeon, 2006).

The link between concern about climate change and attention paid to climate change issues, and vice versa, further emphasises the insufficiency of the knowledge-deficit model, which is the notion that providing information on an issue will lead to education and motivation to act on the issue (Kellstedt *et al.*, 2008). The case may be that those who are not concerned about climate

change may simply not pay attention to information that is provided to them through a range of mediums. Providing more and more information on climate change issues in the future, it has been argued, may simply be 'preaching to the converted', unless issues are framed and communicated effectively such that it is relevant to the audience's pre-existing interpretations of the issue (Nisbet, 2009a; Wiseman *et al.*, 2010). It is necessary to conduct further enquiries in order to determine respondents' sources of information on climate change, with a particular focus on those who are not concerned, but who indicated high levels of attention to climate change issues.

Overall, more than one half of respondents considered their community's willingness to adapt to climate change as moderate to high, however, Rockingham respondents perceived their community's willingness as slightly less than that perceived by Yorke Peninsula respondents (Chapter 7.2.1). While this trend (Yorke Peninsula over Rockingham) also occurred in reference to perceptions of the willingness of communities to adapt to sea-level rise, it was not statistically significant. These findings are similar to that of Buys *et al.* (2012), whereby respondents of (forestry-dependent) rural communities in Australia were confident in the ability of the local farming community to adapt to climate change or variability in weather. In this case, Buys *et al.* (2012, p. 246) noted that there was a tendency for complacency, described in the Australian colloquial expression of "she'll be right, mate". This attitude was similarly found in the open-ended responses of this research in terms of the reasons for the perceived unwillingness of the community to adapt to climate change (Chapter 7.2.1). Gender variations of the willingness of communities to adapt further revealed that females are more likely to perceive their community's willingness as greater than that perceived by males. Additionally, females are also more likely to be unsure about the community's willingness to adapt to sea-level rise, compared to males.

Respondents who did not believe climate change to be occurring now were much more likely to indicate that the community would be willing to adapt to climate change compared with those respondents who did believe climate change to be occurring (Chapter 7.2.1). Whilst this result was not statistically significant, it reveals that this cohort of the population have greater confidence in the willingness of their community than those who actually believe that climate change is occurring now (Chapter 7.2.1). In this context, therefore, this suggests that how an individual perceives the intentions of their 'neighbours' to engage in adaptation to climate change may, in fact, influence the extent to which that individual is personally concerned about climate change.

Male respondents were more likely to consider their level of informedness about sea-level rise (Chapter 7.2.2) as greater than that reported by female respondents. Those who indicated having a high education level were more likely to be better informed about sea-level rise, compared with those respondents who indicated having a low education level. Additionally, those who believe sea-level rise to be occurring now were much more likely to consider themselves as being informed about sea-level rise (Chapter 7.2.2), compared with those respondents who did not consider sea-level rise to be occurring. It is unclear, however, whether the belief that sea-level rise is occurring is the result of being informed about sea-level rise, or whether considering oneself as being informed about sea-level rise is the result of believing it to be occurring now.

Female respondents were more likely to be unsure about the rate at which sea-level rise was occurring, as well as slightly more likely to consider sea-level rise to be occurring now, compared with male respondents (Chapter 7.2.2). Those people who indicated that they had a high level of education were much more likely to perceive sea-level rise as occurring now, compared with respondents who indicated that they had a low education level. Furthermore, respondents aged under 60 years of age were much more likely to perceive that sea-level rise was occurring now, compared with those over 60 years of age (Chapter 7.2.2). Also, those respondents who reported that they were concerned about climate change were much more likely to consider sea-level rise to be occurring now, compared with those not concerned about climate change (Chapter 7.2.2). As before, what remains uncertain is whether the concern for climate change and sea-level rise stems from the perceptions that sea-level rise is occurring, or whether the belief that sea-level rise is occurring is the result of being concerned about climate change or sea-level rise.

Non-permanent residents (holiday homeowners) were much more likely to indicate higher levels of perceived community willingness to adapt to sea-level rise, compared with permanent residents. Non-permanent residents may consider the permanent residents of the non-metropolitan community as being more willing to adapt to sea-level rise because there is a perception that the permanent residents in these rural locations are cohesive, community-oriented and ‘close-knit’ (as discussed by Connell and McManus, 2011). For non-permanent residents, the natural aesthetics of the sea change community were likely to be one of the primary reasons for purchasing a holiday home in the region in the first place (see Burnley and Murphy, 2004). As such, non-permanent residents are likely to consider the natural coastal environment and aesthetics of the area as valuable and being worthy of protection (Kelly and Hosking, 2008).

Non-permanent residents were most likely to self-identify as 'sea changers' and consider that their impact on the region is positive (Chapter 7.2.3). Specifically, it is likely that they believe the local economic benefits of their purchase of property (holiday home) and/or their visitation to the region outweighs any negatives impacts they have on the community (Kelly and Hosking, 2008). This is particularly relevant for Yorke Peninsula, since the region is a 'coastal hamlet' community with greater proportions of non-permanent residents. Permanent residents, on the other hand, may be more likely to be aware of the negative or neutral impacts after the peak holiday periods, since they witness first-hand the change over such periods and it is possible that, as discussed by Ford (2001) they have expressed, at times, negative attitudes towards the 'sea changers'.

In differentiating authorities whom respondents considered primarily responsible for initiating a response to climate change and sea-level rise, at both case study sites it was evident that there is polarisation between the views of respondents with respect to scientists, community members, and the Federal Government (Chapter 7.2.1 and Chapter 7.2.2). As well as being considered primarily responsible for initiating a response to climate change and sea-level, these three 'authorities' were simultaneously considered to have the least responsibility by large proportions of respondents. These differences could reflect the respondents' views of the dichotomy between concepts of bottom-up versus top-down management (Kettunnen, 1997; Pulzl and Treib, 2007). Furthermore, it was evident that there was disagreement as to the role of scientists in being responsible for providing solutions to climate change issues whereby, it has been explained by Roux *et al.* (2006), they may be viewed as supposed instigators of change, as opposed to their typical role as being purely knowledge providers. This is an important finding which suggests that large portions of the public expect scientists to play a much more active role in issues of climate change and community engagement. The findings of this thesis suggest new forms of engagement with the community that draw on scientists and other 'authority' figures to help frame the risks and practical solutions appropriately to build trust and encourage behavioural change.

Respondents considered the Local Government as being primarily responsible for initiating a response to the sea change phenomenon, and the State Government was considered to have the largest secondary role (Chapter 7.2.3). This finding, compared to that of perceived responsibility for initiating a response to climate change and sea-level rise, suggests that homeowners are aware of the localised nature of issues arising from sea change, and expect Local Government to respond in some way. Building upon issues of engagement, discussed in the previous paragraph, it is also clear that local level authorities need to play a more active role in engaging with their

respective communities, as members of the community themselves, to build trust and confidence in their decision-making.

Over two thirds of respondents were not confident or only minimally confident in the ability of authorities to deal with climate change impacts (Chapter 7.2.1). This relates similarly to research findings in the UK from Lorenzoni *et al.* (2007) with respect to people's perceptions that there has been limited political action by Local, National and International Governments with respect to climate change. This perception was subsequently found "to be a significant barrier to engagement [of climate change issues] amongst [their] respondents" (Lorenzoni *et al.*, 2007, p. 453). Furthermore, Lorenzoni *et al.* (2007, p. 453) discuss that, in general, their observations appear to "resonate with a deeper, more widespread distrust in government and politicians in the UK". Indeed, overall levels of trust in government in developed nations worldwide have declined in recent years (for example, see Bean, 2005; Dalton, 2005; Donoghue and Tranter, 2012). In an Australian poll in October 2011, for instance, 18% of Australians reported that the most important problem facing the country today is "better government", compared to only 5 % in March 2010 (McAllister, 2011, p. 6). Again, the finding of this thesis, and the literature discussed above demonstrates that an important issue for climate change adaptation relates to trust in authorities, and particularly trust in government. It is paramount, therefore, that decisions and policies relating to climate change that are made in the near future engender such trust since the timeframes available for mitigation and adaptation have been greatly reduced. Indeed, further delays and distrust will not result in acceptable outcomes for both the global and local level issues of climate change mitigation and adaptation.

8.1.4 Demographics

The key demographic characteristics that were found to differentiate respondents were:

- Gender (male or female).
- Age (under 60 or over 60).
- Education level (high or low).

Overall, it is apparent that differences in personal and individual lifestyle factors have tended to be key factors influencing public risk perceptions, rather than the type of sea change community. It is possible to infer, therefore, that it is unnecessary to distinguish risk perceptions between the sea change communities where respondents own property. It must be noted that the term

'community' was not defined within the survey and therefore, respondents may have had differing views about the extent of their particular 'community'. Within the survey, however, the term 'community' was used within the context of the particular sea change locality as a whole – that is, Rockingham or Yorke Peninsula, which implied the specific geographic location for each group of the respondents.

8.1.4.1 Residency

Overall, there was a significant difference between the two case study sites with respect to the proportion of permanent and non-permanent (holiday homeowner) residents, albeit whilst the precise proportion was unknown at the time of sampling, this result was expected and necessary to provide a marked contrast between the two sea change communities (Chapter 2.2.1). Rockingham had 20% of respondents report that they were non-permanent residents, whereas Yorke Peninsula had 55% of respondents report that they were non-permanent residents (Chapter 5.1.1). Whilst differentiating the type of property owner revealed varying responses in some question areas, including age, education, community attachment, and volunteer activity, it was not a factor that was found to significantly alter the way in which respondents perceived risk.

Families and couples constituted around three quarters of the total responses, which was relatively consistent with ABS 2006 census data for the two regions (Chapter 5.1.4). Overall, around one third of respondents at both case study sites indicated that they have been a part of the local community for over 21 years, as either a permanent or non-permanent resident. The proportion of non-permanent respondents tended to decrease as the length of time spent in the community increased. Consistent with patterns of ageing in sea change communities (Gurran *et al.*, 2005b), it was found that permanent residents over 60 years of age were much more likely to have lived in the community for over 21 years, and similarly, all respondents over 60 years of age were much more likely to have been a part of the community for over 21 years.

Permanent residents at each case study site were found to be more attached to the local community than non-permanent residents, with Yorke Peninsula respondents indicating slightly higher levels of attachment overall (Chapter 5.1.4). This result is consistent with international findings of perceived community cohesion as greater in rural areas (DCLG, 2010a). It is likely that this higher level of overall attachment (that is, a sense of community) could stem from the fact that Yorke Peninsula has historically been a popular holiday destination for South Australian (typically Adelaide) residents and, as such, has had a long history of visitation to accrue such a

level of attachment. Residence time was found to be higher for residents of Yorke Peninsula (Chapter 5.1.4), and indeed, community attachment has been found to increase depending on the individuals' length of residence in a particular place (Lewicka, 2011; Sampson, 1988). In contrast, since Rockingham is a region that has had significant growth in recent years due to it being an affordable satellite suburb of the Perth metropolitan area (Gurran *et al.*, 2005a), as such, residents may not have had sufficient time to become as strongly attached. Furthermore, it has been found in other studies that higher levels of community attachment has been associated with participation in community affairs, such as one's involvement in volunteering organisations (Cuba and Hummon, 1993; Kelly and Hosking, 2008). Interestingly, volunteer activity was found to be higher for permanent residents than for non-permanent residents at both case study sites, but particularly so for Yorke Peninsula residents (Chapter 5.1.4), where the level of attachment was greater.

8.1.4.2 Gender

Overall, the ratio of males to females was 3:2, compared with ABS 2006 census data indicating a ratio of 1:1 (Chapter 5.1.2). Given that the survey targeted heads of households and that males typically identify themselves as such (Baxter, 2002; Johnson, 2005), this result was expected. Male respondents made up the majority of the over 60 years age group, as well as making up the majority of those with high education levels (Chapter 5.1.2). Male respondents were also found to be less likely to volunteer in the community, compared with females (Chapter 5.1.5), which is also consistent with the findings of the ABS (2006b).

Male respondents tended to perceive themselves as being slightly more knowledgeable of the environment than female respondents, and this was particularly the case for those who indicated having a high level of education (Chapter 5.1.4). This variation could, in part, be the result of traditional gender roles (Boeve de Pauw and Van Petegem, 2011). In terms of the relationship between gender and employment, males typically perform 'outdoor' jobs (farmers/fisherman/ labourers) compared with females, and therefore may consider themselves as more familiar with the natural environment (Boeve de Pauw and Van Petegem, 2011; Davidson and Freudenburg, 1996; Finucane *et al.*, 2000; Johnson, 2005). It is important to note, therefore, that within family and couple households whereby there are two adults of differing genders, there is likely to be variations in perceptions of risk. As a consequence, the extent to which households engage in adaptation will based on variable and possibly conflicting risk perceptions between two heads of households.

8.1.4.3 Age

Due to the two types of sea change communities the case studies represented, it was expected that there would be differences in the age of persons between the case study sites (Chapter 5.1.3) (Burnley and Murphy, 2004; Gurran *et al.*, 2005b). This variation between sites was established on the basis of the comparison of estimates of the two Local Government areas (ABS, 2007a; b; 2012), as well as a comparison between the returned survey data with council rates databases. The age structure difference between the two Local Government areas (ABS, 2007a; b; 2012) highlights the key differences between 'coastal commuter' and 'coastal hamlet' style sea change localities. However, the distinction between 'coastal commuter' and 'coastal hamlet' was not evident in the survey results, whereby proportions of respondents in all age groups were not significantly different when comparing the two case study sites (Chapter 5.1.3). These differences specifically relate to the fact that it has been established in the literature that 'coastal commuter' localities both attract and cater more for young families, whereas the 'coastal hamlet' localities both attract and cater for retirees, weekend holiday makers, and second (holiday) homeowners (Gurran *et al.*, 2008; Gurran *et al.*, 2005a). In this instance, it is reasonable to assume that when families purchased the property, they would have taken into account factors such as commuting distance to places of employment and nearby education facilities, family relations, and affordability (Burnley and Murphy, 2004; McKenzie, 2006). In contrast, it has been established that those respondents whose property is a holiday home would have more likely been considering its purchase for seasonal or occasional use (Saint Onge *et al.*, 2007).

There appears to be a response bias towards property owners who are over 60 years of age, and particularly so in Rockingham (Chapter 5.1.3). Whist this bias was expected due to the age profile characteristics of 'sea changers' in general (as either retirees or pre-retirees), it was more prominent than anticipated since retirees (those over 65 year olds) are no longer considered the major drivers of coastal population growth (DSEWPaC, 2011; Gurran *et al.*, 2005a; NSTF, 2006a; Trewin, 2004).

The relationship between age and residency was significant when grouped into categories of over 60 and under 60 years of age (Chapter 5.1.3). The age and residency differences highlight the many, and perhaps conflicting, personal priorities that these different people have to consider when thinking about future climate change risks (Giddens, 2009; Lorenzoni *et al.*, 2007). In addition, age was a significant factor in terms of participation in volunteering activity, whereby those respondents over 60 years of age tended to volunteer more than those under 60 years of

age (Chapter 5.1.5), which is not the case in the findings of the ABS (2006b) whereby people aged 35–44 years were most likely to volunteer (43% participation rate), and people aged 45-54 years were second most likely (39% participation rate).

8.1.4.4 Education and knowledge

Compared with 2006 census data (ABS, 2007a; b), there was an overall response bias in the returned surveys towards those with higher educational attainment levels, particularly tertiary and postgraduate qualifications, which represented around 25% and 10% of the respondents respectively (Chapter 5.1.4). There was also an under-representation of those with vocational qualifications, which represented around 25% of respondents (Chapter 5.1.4). Both case study sites recorded around one third of property owners with either tertiary or postgraduate qualifications, compared with less than 15% according to census data throughout both Local Government areas. As before, it must be noted that the returned mail-out survey data is representative of property owners, not persons present on census night (as per the ABS 2006 census data). Therefore, it is likely that, due to the presence of non-permanent residents within the survey, this bias is probably due to those who are better educated more likely having greater disposable incomes (albeit income data was not collected in this study) to afford a second (holiday) home and be more inclined to participate in environmental surveys (Kennedy *et al.*, 2009; Schmallegger *et al.*, 2011; Wilkie, 2007).

Educational attainment levels were more likely to be high if respondents were under 60 years of age (Chapter 5.1.4), which was expected given the fundamental shift towards higher levels of education in Australian society, as a whole (DEEWR, 2009). Non-permanent residents tended to have higher levels of education than permanent residents, and since greater incomes are typically associated with higher levels of education (Kennedy *et al.*, 2009; Wilkie, 2007), they are more likely to be able to afford a second (holiday) home (Schmallegger *et al.*, 2011).

8.1.5 Overall representativeness of the study

The representativeness of the proportions of permanent and non-permanent residents from the returned surveys, and the mail-out sample itself, was demonstrated through comparisons with the sampling frame derived from Local Government case study rates databases (Chapter 5.1.1). A limited variance of 10% was found between proportions of permanent and non-permanent residents in the returned sample and the ABS 2006 census data of occupied and unoccupied dwellings throughout both of the entire Local Government areas (Chapter 5.1.1) (ABS, 2006a).

Indeed, as outlined in the methodology, the sampling frame included property owners within coastal portions of the Local Government areas, not property owners from within the entire Local Government area. This limited variance was expected since the census data was not as up-to-date as the councils' rates databases, and also since there has been growth in these areas in terms of both amenity migration and housing development (ABS, 2012; DSEWPaC, 2011; NSTF, 2010). Nonetheless, the sample was shown to be valid and thus the results are reliable.

Rather than risk perceptions being substantially different based on case study site and residency, there were close similarities between them. These similarities were particularly in reference to many of the demographic variables (Chapter 5.1), which could, in part, be due to a nonresponse bias, however, this is unlikely given the representativeness described above. Nonetheless, for instance, young families were not fully represented in the results when compared to census data perhaps because they have other priorities which prevented them from finding time to complete the survey. In some instances, there was also found to be consistency in terms of risk perceptions between the types of property owners (Chapter 6.1), which may stem from the similarities in the demographic characteristics of the survey's respondents (again, perhaps, due to nonresponse).

8.2 Policy implications

This research has identified relationships between perceived risks and perceived adaptive capacities of individual property owners' in terms of climate change risk. In particular, this has enabled a better understanding of the predispositions people have towards taking actions to reduce their vulnerability to climate change. Such insights can better inform policy decisions, particularly in reference to policies that aim to promote successful climate change adaptation strategies (Bord *et al.*, 1998; Bostrom *et al.*, 1994; Brody *et al.*, 2008; O'Connor *et al.*, 1999; Slovic, 1987). Since the behaviour of individuals plays a substantial part in shaping how society engages climate change issues, particularly in the design and implementation of new policies (for example, see Dietz *et al.*, 2003; Kempton, 1991b; Renn, 2011), a person's perceptions of how climate change will impact them, in general, underlies their willingness to act and support policy in response to it (Swim *et al.*, 2009; Zahran *et al.*, 2006). As discussed throughout this thesis, it is paramount, therefore, that policy and decision-makers be aware of these public perceptions to design policies that are socially acceptable, geographically relevant, and predispose individuals to adapt to climate change. The findings in this thesis, that property owners consider themselves

vulnerable, are confident in their ability to adapt, but do not necessarily know specifically how to adapt, consequently creates a new concept for climate change risk assessment that demonstrates a willingness to adapt amongst individuals which needs to be capitalised on in order to build mitigation and adaptation 'momentum'. In particular, the findings suggest a policy approach that enables one to proactively engage with climate change solutions through a range of options and pathways. These options could vary in terms of their depth of impact and benefits to climate change mitigation and adaptation, as well as cost, and be implemented by individuals to the extent to which they are willing and capable.

It must be acknowledged, however, that although risk perceptions will change over time, as demonstrated by numerous surveys of public belief in climate change over the years (Nisbet and Myers, 2007), these perceptions are legitimate representations of phenomena. Indeed, whilst the survey data analysed in this thesis was collected during October 2009 and the individual respondents' views may have changed since then, the data nonetheless still represents a valid 'snapshot' in time of substantial cognitive elements of how property owners perceived the risks of climate change (Nursey-Bray *et al.*, 2012). The planning challenges of shifts in perceptions overtime, for instance, in terms of policy that results in regulations and/or restrictions to new and existing property, will likely impact upon the expectations and attitudes of individuals based on the extent to which the property owner is affected or expects to be affected. Consequently, since these shifts in perceptions overtime will impact upon the acceptance of coastal policies, it will require planners and policy-makers to balance appropriately the need to plan for climate change adaptation at the coast simultaneously alongside changing risk perceptions, and other potentially conflicting considerations, including local economic development and tourism objectives, for example. These implications demonstrate that adaptive management would be an appropriate framework for decision-making in the coastal planning process due to the uncertainties described above.

Consistent with research conducted by NCCARF (Sweeney Research, 2010), which took place just over one month after the survey questionnaire utilised in this thesis was mailed-out, males and those over the age of 60 (over 55 years of age within the NCCARF study) were the subset of the population that appeared most sceptical towards climate change. This demonstrates that communication of climate change, thus far, may not have been as effective for this group when compared with others. Indeed, there has been a substantial influence from the organised 'brownlash' movement, which has undermined much of this communication (Ehrlich and Ehrlich,

1998; Leiserowitz *et al.*, 2010; Oreskes, 2004). Policy-makers can be informed by lessons learned about such social factors affecting individual risk perceptions and decision-making. The implications of this are such that communicators will be required to 'tailor' and/or 'frame' the message of climate risk to this portion of the population such that they will be more receptive to suggestions of adaptation initiatives, should policy-makers wish them to have a greater likelihood of the uptake of such initiatives.

Rojas Blanco (2006) has explained that emerging or modified climate change policy that utilises an evidence-based approach is less likely to be met with resistance from the public and more likely to be socially acceptable. The evidence for these approaches can be gained from insights of research such as that detailed in this thesis, and would help to overcome many of the local coastal planning challenges. For instance, as Finucane (2009, p. 7) discusses, the "outcomes of policy measures cannot be known in advance, but policies can be modified based on discoveries of what works, when, and where". This research, as such, has provided an insight into the ways in which those who own property in non-metropolitan coastal locations, within Mediterranean climatic areas, perceive the risks of climate change such that policies can be adapted overtime. Since there are many similar 'types' of communities to the case studies utilised in this research located along the Australian coast, and that there were not marked differences between responses from people from the different 'places', the findings of this thesis suggest that practical evidence-based action can be tailored towards the predispositions, expectations and perceptions of those people, and modified/adapted as further evidence of success and failure is obtained.

This study shows that those who believe climate change to be occurring now are much more likely to perceive the likelihood of increased temperatures, decreased rainfall, increased storm surges and increased sea-level as high or very high, over the next 25 years. Further to this, they are also much more likely to pay attention to climate change issues, and be changing the way they live as a result of climate change. These findings are consistent with the predominant belief in the developed world that information about climate change which is not congruent to existing beliefs will be dismissed or denigrated (Adger *et al.*, 2009). The ramifications of this for those who do not consider climate change to be occurring, do not pay attention to climate change issues, and those who are not altering their lifestyle, is that "even if provided with information about how to adapt, people who do not believe adaptation is necessary are highly unlikely to retain or act on this information" (Adger *et al.*, 2009, p. 346). In other words, irrespective of the extent of information provided, it is extremely difficult to change attitudes that have become entrenched

(Whitmarsh, 2011). Nonetheless, since there are benefits of adapting to climate change that extend beyond those that are climate change related, for instance, such as reduced costs due to increased efficiencies and other long-term benefits from pollution reduction (for a discussion, for example, see Bosetti *et al*., 2009; Garnaut, 2011; Johnson and Hope, 2012; Kulpraneet, 2012; Stern, 2007; Watkiss *et al.*, 2005), the findings of this thesis suggest that such benefits may be able to be communicated more effectively to appeal to those who are less willing to engage with 'climate change', *per se*, because they appear to be aligned with pre-existing attitudes.

51% of property owners within this study have changed the way they live as a result of, or in anticipation of, the impacts or potential impacts climate change. It was found that these actions, in fact, are primarily associated with issues of 'sustainability', as well as the notion that one is simply in need of being more aware of the impacts of one's behaviour. This has important implications for future adaptation initiatives, since it is evident that people are already making changes to lifestyles with climate change as a motivating factor. As Adger *et al.* (2009) discuss, the effectiveness of enabling initiatives that will result in adaptation will depend, in part, on how an individuals' motivation to act can be harnessed. Since this study did not examine the linkages between specific motivations and actions or whether there were further motivations for change, it cannot comment on the effectiveness of what enabled respondents to undertake changes to their lifestyle. It does, nonetheless, offer an insight into existing motivations for change, whereby future policy and planning initiatives may be able to utilise existing platforms of change to 'piggyback' on initiatives and approaches that have proven successful elsewhere (for example, see Someshwar, 2008; Vogel and O'Brien, 2006). For instance, increased household energy efficiencies, such as energy saving appliances and reduced usage, that result in reduced energy costs overall may be an avenue from which individuals can be encouraged to 'take the next step' and invest in alternative energy sources and improved insulation for their home. Such 'encouragement', however, would need to come in the form of incentives and opportunities created by those 'authorities' that people trust and look to for leadership. The challenges for planners, however, relate to the management and balancing of conflicting considerations with broader local development objectives, as well as state-level strategic plans, since there is a strong possibility that tailoring plans and policies at local levels could result in inconsistencies with those broader objectives and strategies.

This research suggests that confidence in one's personal capability to adapt to climate change and associated impacts can be both a potential strength and weakness. An individual's self-

efficacy, or the belief/confidence that they can control events that affect them, is critical in realising the potential for people to act on climate change (Adger *et al.*, 2009). In this sense, a high level of self-efficacy towards adaptation can be a predicator towards behavioural change, with appropriate direction and support from those whom are trusted to provide that direction and support. The opportunity here is that since there is confidence in the abilities of individuals to adapt, this will help them to realise their future potential for adaptation, if managed appropriately. At the same time, however, confidence due to scepticism in the severity of climate change impacts or the anthropogenic links may impede the uptake of appropriate adaptation initiatives. Here, this confidence may be a limitation and create barriers to adaptation, since if such self-confidence is unfounded and results in complacency towards risk, it may create further vulnerabilities to the impacts of climate change and even public resistance towards plans and policies that attempt to reduce risk and minimise negative impacts.

As was evident in the findings of this study, overall personal capability to adapt to climate change and sea-level rise was perceived as moderate, with slightly higher levels for adaptation to climate change than sea-level rise. If this high self-efficacy translates into complacency, as mentioned above, it may in fact lead to large proportions of the population believing themselves to be exempt from future climate change risk, which, in a changing climate, is highly undesirable. The implications of such an attitude are that these individuals or groups of people may possibly "miss [the] limited window of time and opportunity to successfully implement climate change resilience strategies" (Buys *et al.*, 2012, p. 246). For instance, from a broader study of complacency in Norway, it was found that in situations where there are perceived to be no risks, there is little, if any, adaptation undertaken (O'Brien *et al.*, 2006). This is an important finding of this thesis because it suggests that if optimism results in complacency, then adaptation policy may be deemed unnecessary by the individual. It is critical, therefore, that the level of concern accompanied with such optimism is high enough to elicit an appropriate adaptation response, whilst not creating a sense of hopelessness – this will be a challenge and requires more consideration.

This study has implications for the uptake of climate change policy since individual perceptions of risk, and the mental models people have created to assist with decision-making during times of uncertainty, are most significant at the local level and on daily timescales. As Senge *et al.* (2010, p. 254) discuss, with reference to the habitual mental models people use to assess risk, the problem is not that the models are used in an abstract sense, but rather in "their pervasive

influence in our daily lives". As revealed in this study, this influence may be more of an issue for those respondents who were sceptical towards climate science or denied an anthropogenic link, those who viewed climatic changes as being removed from space and time, and those who had not altered their lifestyles due to climate change. In order to overcome this influence and to predispose the public towards changing behaviours and/or supporting policy change, there is a need for positive reinforcement. This form of 'encouragement' may be found in the evidence from strategies of moral suasion proposed by Markowitz and Shariff (2012) (Chapter 4.1). Here, Bostrom and Fischhoff (2007, p. 38), for example, propose to:

> *…use or develop mental models and ways of framing the climate issue that suggest the right cause(s), trigger…an affective response that makes remedial action desirable, and also suggest appropriate actions or solutions.*

Two related themes observed throughout many open-ended responses were in relation to a perceived reluctance of others in the community to adapt or change behaviour due to financial/economic reasons, as well as the belief that climatic changes were either unnoticed, not known to be occurring, or not occurring at all. Renn (2011), however, particularly in respect to common pool resources such as the atmosphere, has discussed that in order to overcome these types of motivational issues there needs to be a combination of provisions for economic incentives, positive attitudes (including feedback on actions already undertaken), and a range of options for potential pro-environmental action. Again, similar to the strategies put forward by Markowitz and Shariff (2012), the findings of this research suggest that providing a range of varied options and incentives for the public and individual households to engage in pro-environmental behaviour, including climate change adaptation, may assist in their uptake. This thesis also proposes, therefore, that any options and incentives included within climate adaptation strategies be based on the predispositions, expectations and perceptions of the target community. Additionally, since the findings of this thesis suggest that property owners may be much more alike in their perceptions of risk than they may believe, this realisation could potentially become a source of strength and solidarity within the community. In particular, if it is known to individuals that others within the community share common attitudes towards climate change, as well as the common desire and willingness to adapt, then there is reinforcement that the individual is not acting alone. Such a realisation is likely to engender a feeling that the one's 'neighbours' are of the same mindset and will consequently support positive action on climate change.

Relevant to these themes is where Sommer (1972) proposes to take advantage of the Weber-Fechner phenomenon in changing detrimental environmental behaviours. This phenomenon suggests that for a new stimulus to be perceived as different from a present stimulus, the intensity of its change required is proportionate to the present stimulus. Simply put, there is often resistance to engage in 'environmentally friendly' behaviour since the perceived change in lifestyle is too substantial. In addition, any form of environmental change that is perceived as rapid is more easily detectable than change that is slow. Bell *et al.* (2001) recommend that for positive environmental behaviours, if changes in lifestyles are small enough so as to go unnoticed, subtle changes over time may be able to be made that could have great positive impacts on the environment. The viability of this approach in terms of promoting the success of political parties' policies is difficult, however, since subtle rates of lifestyle change may not accrue enough environmental benefits within the short political timeframes of democratic nations, such that they can assist to secure re-election of the parties involved. A combination of both subtle and more substantial changes, therefore, may be suitable.

The cognitive challenges of climate change and associated impacts are demonstrated by the way in which Ornstein and Ehrlich (1989) discuss detrimental environmental conditions in general, whereby the human brain cannot easily perceive slow changes, the long-term implications of such changes, nor the connections between isolated and immediate events. Addressing detrimental environmental conditions with similar characteristics, such as climate change, therefore, will often prove problematic. Ornstein and Ehrlich (1989, pp. 74-75), consequently use the metaphor of the 'boiled frog syndrome' to explain humanity's lack of immediacy in adopting more stringent policy to aide in environmental crises. Within the metaphor, a frog, which has no sophisticated temperature sensors in its skin, that is "placed in a pan of water that is slowly heated will be unable to detect the gradual but deadly trend… [and] will sit still until [it dies]". Furthermore, Gordon and Suzuki (1991, p. 40) discuss that, like the frog within the metaphor, humans face an unprecedented future with anthropogenic climate change, whereby our "senses are not attuned to warnings of imminent danger". As the impacts of climate change continue to worsen over the coming years, the dangers will become more apparent and the desire to act increased due to the immediacy of the problems and impacts. At this point in time, however, critical environmental thresholds may have been crossed.

This research also has implications for the ways in which vulnerability studies can improve the outcomes of policy decisions with reference to community engagement. When making decisions

on climate risk management, Lorenzoni and Pidgeon (2006) discuss how a failure to engage and incorporate public views and values into consideration will prove problematic since: (i) climate policies will need to be socially acceptable; (ii) communication efforts will need to consider the varying public and policy timeframes involved in the short-term and long-term; and (iii) the implementation of policies may be opposed, neglected or even misunderstood. As discussed above, the findings of this thesis contributes to the recommendation of a more tailored evidence-based policy making approach.

Future vulnerability research that examines local level capacities, whereby there is variability and uncertainty in the local level impacts of climate change needs to be grounded at the community level and involve local stakeholders and knowledge systems (Dolan and Walker, 2004). Such engagement allows for a better assessment of how climatic changes will be expressed and interpreted locally since scientific findings are able to be framed in a local context (Riedlinger and Berkes, 2001; Usher, 2000). This may provide an improved foundation for decision-making and adaptive capacity building (Dolan and Walker, 2004). Bostrom and Fischhoff (2007) explain that one option to assist in overcoming such a hurdle is to improve current understanding of how different people understand and use metaphors and analogies for climate change. They discuss that since this idea is predicated on the fact that metaphor and analogy are fundamental to our ways of interpreting and reacting to the world, a greater understanding will allow policy-makers and communicators to more successfully utilise them to foster acceptance and support of climate policies. Indeed, the process of engagement utilised for the pilot study critique and pre-test within this project provided an initial formal interaction with councillors, planners and managers from within the NRM region of the Yorke Peninsula case study site, in order to effectively frame the research objectives and evaluate the research instrument. Such engagement facilitated an opportunity for social learning to occur, and further enhanced both the researcher's and the key stakeholders' knowledge regarding issues of climate change and coastal vulnerability in a two-way process.

8.3 Recommendations for future research

There are 5 key recommendations for future research, which include:

1. Incorporating further case studies for replication and triangulation;
2. Undertaking longitudinal studies;
3. Examining information sources and levels of trust;
4. Finding examples of adaptation for individuals to 'model' behaviour on; and
5. Examining incentives and motivations to adapt.

The first recommendation is to replicate the methods and research instruments utilised in this thesis to incorporate a broader range of sea change communities in order to provide a more in-depth exploration of risk perceptions through further triangulation of data. This replication could specifically target an extra sea change community located along the east coast of Australia within a Mediterranean climatic regime. These particular sea change communities are where a much greater number of people reside and where property and canal development has been extensive in recent years (Abbs and McInnes, 2004; Burton, 2007; Burton and Dredge, 2007). Ideally, triangulation of data from a third case study would have provided a much deeper exploration of perceived risk across a greater array of spatially distant locations and varying community 'types', as detailed by Gurran *et al.* (2005a) (Chapter 1.3.6). Such a case study was not feasible due to the constraints of this research, however, it is recommended in future work.

Furthermore, it is also recommended that replication of this project's overall research approach be undertaken, in order to apply the conceptual 'hazards-of-place' model to other specific climate change risk contexts. For instance, this research approach could be replicated to explore risk perceptions within three different communities situated within a tropical climatic regime. In a tropical context, the key potential climate change impacts are more specific, but not limited, to cyclone risk, for instance, and consequently would provide a marked contrast to the risks present within Mediterranean climatic regimes. This replication and triangulation would allow key notions of 'place vulnerability' to be tested, based on the 'known' biophysical risks in these contexts. The differences between the results of the 'types' of sea change communities in this project were not significant, that is, the results of the two case study sites were similar, in fact, despite them representing uniquely different communities. Since the expectation that the two case studies would vary significantly did not hold, as such, carrying out this replication would determine

whether the project's overall results can further provide 'meaningful generalisations' (Peet, 1998; Rea and Parker, 2005).

Following on from the first recommendation, due to the importance of understanding climate change public opinion, as both a guide for policy development and motivation for individual adaptation, the second recommendation is that longitudinal studies of perceived risk also need to be conducted (Marquart-Pyatt *et al.*, 2011; van Aalst *et al.*, 2008). As Marquart-Pyatt *et al.* (2011, p. 40) discuss, "the research community is hampered by lack of an ongoing data series with large representative samples, including questions repeated over time". Such longitudinal studies are essential to better understand the underlying drivers of how the public perceive risks, as well as how and why this may change over time. In the context of the results of this research, longitudinal studies would allow for further refinement of the survey instrument such that it may be developed into a more concise tool for use by Local Government/communities to conduct their own risk perception research. Similar to the ways in which toolkits have been developed for use in specific local contexts in the areas of community-based public health, disaster preparedness and vulnerability assessment (Allen, 2006; Flax *et al.*, 2002; Kuruppu and Liverman, 2011), the research approach employed here represents a robust methodological framework whereby the survey instrument can be utilised as a cost-effective tool for application at the local level.

The third recommendation is that sources of information utilised by the public be more closely examined, as well as the varying levels of trust in these sources of information, and trust in 'authorities' (Poortinga and Pidgeon, 2003; Slovic, 1993; 2000d). This research project only investigated self-reported levels of general environmental knowledge and attention paid to climate change issues, and did not delve into the particular information outlets that people used to acquire knowledge. Similarly, this research project did not delve into issues of the levels of trust in those sources of information, nor their degree of authority on the matter. Rather, this research project only investigated who the authorities were, from a prescribed list, that were deemed to be the most responsible for initiating a response to minimise the impacts of climate change, sea-level rise and sea change. By recommending that information sources and levels of trust be examined, those insights may be used to further inform the ways in which climate change is framed within public dialogues, such that it identifies where trust has been eroded and needs to be re-established (Carvalho, 2010; Marquart-Pyatt *et al.*, 2011).

The fourth recommendation is that further research is needed to identify current examples of adaptation to climate change at the local level to provide inspiration for an adoption of similar means elsewhere, as well as to further generate innovation. This does not mean that successful examples will or should result in the creation of prescriptive frameworks to address adaptation from being developed but, rather, that they should be used to offer conceptual guidance for motivation and creativity. Due to the realisation that climate change impacts will be disproportionately felt amongst society and occur at a variety of spatial and temporal scales, it is clearly understood that there will not be an adaptation panacea. Indeed, it is expected that since there will be numerous and varied successes to adaptation, as well as failures, once identified these examples may be able to be enhanced to assist national and even international adaptation policy frameworks (Rojas Blanco, 2006). Lessons from the literature on social learning may provide a further avenue for research on the theoretical basis of this recommendation, whereby learning can take place through witnessing modelled behaviour. Indeed, as Bandura (1977, p. 22) asserts, "learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do". In the context of climate change, and the need for adaptation over the coming decades, society is going to need examples of appropriate adaptation and behavioural change elsewhere to base its own adaptations on.

The fifth recommendation stemming from the research findings is that since individual property owners from both case study areas perceived themselves as being quite capable of adapting to the impacts of climate change and sea-level rise, the range of available adaptation options should be consistent with this perceived self-efficacy in order to generate outcomes that are felt to be contributing positively and significantly. A range of incentives and motivation to adapt, therefore, need to be accessible to allow people to partake in adaptive actions. This is established among risk communication theories which suggest that an interaction between perceived efficacy and perceived relevant threat can bring about subsequent action (Bostrom and Lashof, 2007; Rimal and Real, 2003b; Witte, 1994). Motivations to undertake action, therefore, are a critical component underlying the decision of whether or not to adapt, particularly when considering common pool resources (Renn, 2011). While this research has been limited in its approach to identifying such motivating factors, it is recommended that much more explicit investigations be undertaken, in order to categorise what factors are significant, relative to what actions have been carried out.

8.4 Conclusion

This thesis has argued that future vulnerability and adaptation research work should build upon generic indicators of social vulnerability to climate change by examining case studies in order to determine the extent to which their broad results can be generalised. It has utilised the 'hazards-of-place' model as a conceptual guide to approach issues of social vulnerability and, since it utilised comparative case studies, overall place vulnerability (Cutter *et al.*, 2003). It has been well established that the biophysical risks to Australia's coastline, under numerous climate change scenarios, are substantial in terms of potential economic losses. The vulnerability literature, however, has identified a gap in the extent of knowledge regarding social vulnerability. What remains to be established, therefore, is how property owners in vulnerable coastal communities perceive the risks of climate change. Non-metropolitan coastal property owners have been the focus of this research since they will not only be affected by the physical impacts of climate change, but they will also be effected by the policies that will be put in place to assist society, as a whole, to adapt.

Public perceptions and interpretations of the dangers of climate change, as well as the subsequent policy, are based on interconnected psychological, social, moral, institutional and cultural processes (Dessai *et al.*, 2004), as well as the scientific and technical descriptions of danger (Leiserowitz, 2005). Future climate change 'events', such as projected impacts and potential adaptations, cannot be determinants of behaviour. Rather, the cognitive representations of future climate change events "can have a strong causal impact on present action" (Bandura, 1986, p. 19). For this reason, risk perceptions are significant elements of the socio-political context within which policy-makers operate (Leiserowitz, 2005).

This study has differed from many existing vulnerability assessments by collecting primary data from coastal property owners via a mixed-methods mail-out survey questionnaire, and exploring their perceptions of a number of climate change related risks and adaptation issues at a local 'community' level. The question of whether or not climate change policy will be met with resistance will be determined by the extent to which members of the public perceive the risks of climate change as constituting an unacceptable level of risk, and hence necessary to act upon (Fischhoff *et al.*, 1981; Vogel *et al.*, 2007). More simply put, these perceptions will fundamentally compel or constrain action to address risk (Leiserowitz, 2005), since climate policies will require a certain level of 'buy in' from the public to be successfully implemented (Lorenzoni and Pidgeon, 2006). While the assessment of public risk perceptions discussed in this thesis provides a

'snapshot' of property owners within two sea change communities at one point in time, and although these perceptions are likely to change over time, it has nonetheless provided an insight into social vulnerabilities not recognised elsewhere (Nursey-Bray *et al.*, 2012).

This thesis has examined risk perceptions and argued that policy should be tailored to suit the context of the community such that it may be both physically effective (that is, reduce the community's vulnerability) and socially acceptable. This thesis has also argued that there has been considerable research attention focussed on examining components of biophysical vulnerability, whereas the socially created vulnerabilities are in need of greater attention to provide a more holistic examination of risk (Cutter *et al.*, 2003; Mileti, 1999). Consequently, an understanding of both the biophysical and the social components of vulnerability analysis is vital for advancing sustainability and, for Australia, meeting the goals set by the COAG (2006) endorsed National Climate Change Adaptation Framework. This study, as a result, has contributed to understandings of the human dimensions of climate change to enable shifts towards more strategic coastal planning and management.

In accordance with the aim of this research, as outlined in Chapter 1.1, perceptions of coastal climate change risk were compared and contrasted within and between the property owners of two non-metropolitan coastal communities. In order to better understand the interrelationships between the biophysical and social components of vulnerability, a comprehensive, multi-disciplined and multi-method approach was required. Using primary and secondary quantitative and qualitative data collected from two distinct coastal settlements in Australia, this study has explored the relationship between factors that determine social vulnerability, particularly adaptive capacity and willingness to adapt.

This thesis has revealed that the limitations of scope in the bulk of biophysical vulnerability studies currently being undertaken can be overcome through an assessment of the human dimensions of change, which complement these existing studies. This thesis offers the particular methods and survey procedures as a means to inform evidence-based policy regarding local climate change adaptation strategies. Therefore, it has contributed to current knowledge such that it will assist in the facilitation of strategies aimed at local adaptation to climate change, as well as support broader shifts towards more strategic coastal planning and management. Given the nature of climate change policy solutions required in the future and the changing dynamic of coastal populations, the conclusions of this thesis are relevant for Australian policy and decision-

makers to consider a more tailored evidence-based approach to adaptation policy formulation (Banks, 2009; Nisbet, 2009a; Reser *et al.*, 2011).

In terms of recent demographic change both within and between Australian coastal communities, particularly in regards to the sea change phenomenon and the effect these demographic changes have on localised decision-making, it is paramount that large-scale prescriptive policy be avoided. Since public risk perceptions fundamentally compel or constrain action to address risk, the question confronting those managing the coast relates to whether society has the capability to adapt to changes as a result of climate change (Bell *et al.*, 2001; Leiserowitz, 2005; Slovic, 2000b; Thom, 2007). This thesis has explored the ways in which individual coastal property owners perceive the risks of climate change since, ultimately, they will be the ones required to cope with both actual changes in climate, as well as the changes in the political climate.

The findings of this research reveal that people who own coastal property are generally concerned about climate change and associated impacts, and are subsequently motivated to adapt. The specific types of adaptive actions that people envisaged undertaking, however, tended to be more in line with practices of environmental sustainability, rather than climate change adaptation. Furthermore, this study also details trends consistent with the majority of risk perception research, notably that personal risk tends to be evaluated less than risk to others (which is especially evident for males, persons with low education levels, and persons over 60 years of age), and that people have confidence in their own abilities, but not so much confidence in the abilities of the authorities. It is critical, therefore, that in order to prepare Australia's coastal communities for future climate change impacts, adaptation initiatives that are tailored to the local 'community' level, where they are most relevant, are paramount. At a practical level, the results outlined in this thesis support the inclusion of a range of personal views and beliefs when engaging the public in the risk assessment process. Therefore, by integrating the varied risk perceptions of the community within the decision-making process, it will allow policy-makers to frame adaptation initiatives to be more inclusive of the attitudes and values of those affected by change, as well as make policies more socially acceptable so that their implementation is more likely to succeed.

Appendices

Appendix 1: Definitions of vulnerability

Compiled by Author

From: Cutter, S.L., 1996, 'Vulnerability to environmental hazards', *Progress in Human Geography*, 20 (4), pp. 529-539.	
Vulnerability is the threat (to hazardous materials) to which people are exposed (including chemical agents and the ecological situation of the communities and their level of emergency preparedness). Vulnerability is the risk context.	Gabor and Griffith, 1980, 'The assessment of community vulnerability to acute hazardous materials incidents'. *Journal of Hazardous Materials*, 3, pp. 323-33.
Vulnerability is the degree to which a system acts adversely to the occurrence of a hazardous event. The degree and quality of the adverse reaction are conditioned by a system's resilience (a measure of the system's capacity to absorb and recover from the event).	Timmerman, P., 1980, 'Vulnerability, resilience, and the collapse of society', *Environmental Monograph No. 1*, Institute for Environmental Studies, University of Toronto, Toronto.
Vulnerability is the degree of loss to a given element or a set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude.	United Nations Disaster Relief Organisation (UNDRO), 1982, *Natural disasters and vulnerability analysis*, office of the United nations Disaster Relief Coordinator, Geneva.
Vulnerability is the degree to which different classes of society are differentially at risk.	Susman, P., O'Keefe, P., and Wisner, B., 1984, 'disasters: a radical interpretation', In Hewitt, K., editor, *Interpretations of calamity*, Allen & Unwin, Boston, pp. 263-284.
Vulnerability is 'the capacity to suffer harm and react adversely'.	Kates, R.W., 1985, 'The interaction of climate and society', In Kates, R.W., Ausubel, J.H., and Berberian, M., editors, *Climate impact assessment*, SCOPE, 27, Wiley, New York, pp. 3-36.
Vulnerability is the threat or interaction between risk and preparedness. It is the degree to which hazardous materials threaten a particular population (risk) and the capacity of the community to reduce the risk or adverse consequences of hazardous materials releases.	Pijawka, K.D., and Radwan, A.E., 1985, 'The transportation of hazardous materials: risk assessment and hazard management', *Dangerous Properties of Industrial Materials Report*, September/October, pp. 2-11.
Vulnerability is operationally defined as the inability to take effective measures to insure against losses. When applied to individuals, vulnerability is a consequence of the impossibility or improbability of effective mitigation and is a function of our ability to detect the hazards.	Bogard, W.C., 1989, 'Bringing social theory to hazards research: conditions and consequences of the mitigation of environmental hazards', *Sociological Perspectives*, 31, pp. 147-168.
Vulnerability is the potential for loss	Mitchell, J.K., 1989, 'Hazards research', In Gaile, G.L. and Willmott, C.J., editors, *Geography in America*, University of Columbus, Ohio, pp. 410-424.

Appendix 1 continued

Distinguishes between vulnerability as a biophysical condition and vulnerability as defined by political, social and economic conditions of society. She argues for vulnerability in geographic space (where vulnerable people and places are located) and vulnerability in social space (who in that place is vulnerable).	Liverman, D., 1990, 'Vulnerability to global environmental change', In Kasperson, R.E., Dow, K., Golding, D., and Kasperson, J.X, *Understanding global environmental change: the contributions of risk analysis and management*, Clark University, Massachusetts, Worcester, The Earth Transformed Program, pp. 27-44.
Vulnerability has three connotations: it refers to a consequence (e.g., famine) rather than a cause (e.g., drought); it implies an adverse consequence (e.g., maize yields are sensitive to drought; households are vulnerable to hunger); and it is a relative term that differentiates among socioeconomic groups or regions, rather than an absolute measure of deprivation.	Downing, T.E., 1991, *Assessing socioeconomic vulnerability to famine*, *A report to the US Agency for International Development (AID),* Famine Early Warning System (FEWS) Project. Washington, DC: AIDS/FEWS, and Providence, Rhode Island, Alan Shawn Feinstein Hunger Program, Brown University.
Vulnerability is the differential capacity of groups and individuals to deal with hazards, based on their positions within physical and social worlds.	Dow, K., 1992, 'Exploring differences in our common culture(s) the meaning of vulnerability to global environmental change', *Geoforum*, 23, pp. 417-436.
Risk from specific hazard varies through time and according to changes in either (or both) physical exposure or human vulnerability (the breadth of social and economic tolerance available at the same site).	Smith, K., 1992, *Environmental hazards: assessing risk and reducing disaster*, Routledge, London.
Human vulnerability is a function of the costs and benefits of inhabiting areas at risk from natural disaster.	Alexander, D., 1993, *Natural disasters*, Chapman & Hall, New York.
Vulnerability is the likelihood that an individual or group will be exposed to and adversely affected by a hazard. It is the interaction of the hazards of place (risk and mitigation) with the social profile of communities.	Cutter, S.L., 1993, *Living with risk*, Edward & Arnold, London.
Vulnerability is defined in terms of exposure, capacity and potentiality. Accordingly, the prescriptive and normative response to vulnerability is to reduce exposure, enhance coping capacity, strengthen recovery potential and bolster damage control (i.e., minimise destructive consequences) via private and public means.	Watts, M.J., and Bohle, H.G., 1993, 'The space of vulnerability: the causal structure of hunger and famine', *Progress in Human Geography*, 17(1), pp. 43-67.
By vulnerability we mean the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard. It involves a combination of factors that determine the degree to which someone's life and livelihood are put at risk by a discrete and identifiable event in nature or society.	Wisner, B., Blaikie, P., Cannon, T., and Davis, I., 2004, *At risk: natural hazards, people's vulnerability, and disasters*, Routledge, London.
Vulnerability is best defined as an aggregate measure of human welfare that integrates environmental, social, economic and political exposure to a range of potential harmful perturbations. Vulnerability is a multilayered and multidimensional social space defined by the determinate, political, economic and institutional capabilities of people in specific places at specific times.	Bohle, H.G., Downing, T.E., and Watts, M.J., 1994, 'Climate change and social vulnerability: the sociology and geography of food security', *Sociological Perspectives*, 31, pp. 37-48.

Appendix 1 continued

Vulnerability is the differential susceptibility of circumstances contributing to vulnerability. Biophysical, demographic, economic, social and technological factors such as population ages, economic dependency, racism and age of infrastructure are some factors which have been examined in association with natural hazards.	Dow, K., and Downing, T.E., 1995, 'Vulnerability research: where things stand', *Human Dimensions Quarterly*, 1, pp. 3-5.
Vulnerability is viewed as the sum of the impacts remaining after adaptation strategies have been considered	Kelly, P.M., and Adger, W.N., 2000: Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climatic Change,* 47, 325-352.

Appendix 2: Definitions of adaptation

Compiled by Author

"…adaptation refers to adjustments in ecological-social-economic systems in response to actual or expected climatic stimuli, their effects or impacts." And ""Adaptation" refers to both the **process** of adapting and the **condition** of being adapted."	Smit, B., Burton, I., Klein, R.J.T., and Wandel, J., 2000: An anatomy of adaptation to climate change and variability. *Climatic Change,* 45, 223-251.
Adaptation can refer to natural or socio-economic systems and can take technological, economic, legal or institutional forms; it can be targeted at specific climatic variables or risks; or it can be in response to or in anticipation of such a variable or risk, or be independent or designed	Pelling, M., and High, C., 2005: Understanding adaptation: what can social capital offer assessments of adaptive capacity? *Global Environmental Change,* 15, 308-319.
"Adaptation is generally perceived to include an adjustment in social–ecological systems in response to actual, perceived, or expected environmental changes and their impacts."	Janssen, M.A., and Ostrom, E., 2006: Resilience, vulnerability, and adaptation: A cross-cutting theme of the International Human Dimensions Programme on Global Environmental Change. *Global Environmental Change,* 16, 237-239.
Adaptation is the "ability or capacity of individuals, communities and nations to handle the impacts and/or take advantage of opportunities from altered conditions"	(IPCC, 2007a, p. 731)
Adaptation "incorporates the idea of recovery from the effects of external forcing and the capacity of the system to absorb pressures towards change"	McFadden, L., 2007: Vulnerability analysis in environmental management: widening and deepening its approach. *Environmental Conservation,* 34, 195-204.
Adaptation to climate is the process through which people reduce the adverse impacts of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides	Burton, I., 1992, 'Adapt and Thrive', Canadian Climate Centre unpublished manuscript, Downsview, Ontario.
Adaptation involves adjustment to enhance the viability of social and economic activities and to reduce their vulnerability to climate, including its current variability and extreme events as well as longer term climate change	Smit, B., editor, 1993, *Adaptation to Climatic Variability and Change*, Environment Canada, Guelph.
The term adaptation means any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change	Stakhiv, E., 1993, *Evaluation of IPCC Adaptation Strategies*, Institute for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, VA, draft report.
Adaptation to climate change includes all adjustments in behaviour or economic structure that reduce the vulnerability of society to changes in the climatic system	.Smith, J.B., Ragland, S.E., and Pitts, G.J., 1996, 'A process for evaluating anticipatory adaptation measures for climate change', *Water, Air, and Soil Pollution*, 92, pp. 229-238.

Appendix 2 continued

Adaptability refers to the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes of climate. Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of change in conditions	Watson, R.T., Zinyowera, M.C., and Moss, R.H., 1996, *Climate Change 1995: Impacts, Adaptations, and Mitigation of Climate Change: Scientific-Technical Analysis*, Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge.

Appendix 3: Mail-out survey questionnaire pack



PARTICIPANT INFORMATION SHEET

Coastal Vulnerability and Adaptation in Australia

Dear Sir/Madam,

Your household in Rockingham/Yorke Peninsula is one of a small number in which people (the principle householder) are being asked their opinion on the issues of climate change. It was drawn in a random sample of coastal households in the local government area. We would like to find out whether or not you see yourself and your community as being vulnerable to climate change and sea-level rise, and how capable and willing you think you will be to adapt to changes in the environment. It is important that each questionnaire be completed and returned.

The number of Australians moving to live on the coast is growing steadily. The forecasted impacts of climate change and sea-level rise show that a large number of the coastal population will be vulnerable to these impacts in the future. These impacts have the potential to greatly affect where we live and the way we live, however, we don't really know much about what people like yourself perceive to be an issue and what this means for coastal planning. I'm sure you agree that it is better to be safe than sorry and one way to be safe and prevent negative effects of climate change and sea-level rise is to be capable of adaptation and to have the capacity and willingness to adapt to impacts.

I want to assure you that the study will be confidential and your responses will not identify you, or any other person or organisation, unless you choose otherwise. The questionnaire has an ID number for mailing purposes only, which is there to let us know whose questionnaires are returned, and who may wish to be further involved in the project.

The questionnaire will be relatively short and take approximately 10-15 minutes. If you could, I ask that you return the survey within two weeks, or as soon as possible, using the enclosed envelope. If you choose to participate in this research project you are at liberty to withdraw at anytime, and withdraw any survey material that you have provided, up until the completion of the research. By completing and returning the survey, you are giving consent for it to be used in this project.

If you would like to have a copy of the final results made available to you please inform me using the space provided at the end of the questionnaire.

If you have any concerns or queries, I am more than happy to answer them, alternatively, my supervisor Professor Nick Harvey can also be contacted. Please refer to the attached independent complaints form if any other queries arise.

Thank you for your assistance.

Sincerely,

Chris Button,

Contact Details

Mr Christopher Button PhD Research Scholar Department of Geography & Environmental Studies University of Adelaide, South Australia Ph: XXXX XXX XXX Email: christopher.button@adelaide.edu.au	Professor Nick Harvey Executive Dean Faculty of Humanities & Social Sciences University of Adelaide, South Australia Ph: (XX) XXXX XXXX Email: nicholas.harvey@adelaide.edu.au

OFFICE USE ONLY
ID_____

Coastal Vulnerability and Adaptation in Australia: Perceptions of climate change and capacity to adapt

A questionnaire for coastal homeowners



The University of Adelaide

Department of Geographical & Environmental Studies

South Australia, 5005

1.a. Regarding your property in Rockingham/on the Yorke Peninsula, is this your primary place of residence or a holiday home? **(Please circle <u>one</u> response)**

1 **Primary place of residence (Go to b)**

2 **Holiday home (Go to d)**

b. Approximately how long have you lived in your home?_____YEARS

c. Including yourself, what is the total number of people living in your home?_____PERSON(S)

d. How long have you been a part of the community?_____YEARS

e. If this is a holiday home, how often do you visit the in Rockingham/Yorke Peninsula?_____Time(s) per year

2. How would you rate your knowledge of the environment on the in Rockingham/Yorke Peninsula? **(On a scale of poor 1, to excellent 5, please circle <u>one</u> response)**

Poor		Moderate		Excellent
1	2	3	4	5

3. How much attention have you paid to climate change issues facing South Australia? **(Please circle <u>one</u> response)**

1 **No attention** – I don't really listen to anything on climate change

2 **A little attention** – I have heard about climate change in the media but not explored the issue much further

3 **Moderate attention** – I have heard about climate change and occasionally discuss the issues with family, friends and colleagues

4 **Some attention** – I listen to climate change issues in the media and discuss these with my family, friends and colleagues

5 **A lot of attention** – I explore and discuss the issues of climate change frequently and I regularly pay close attention to issues in the media, books and documentaries

4. In your opinion, what are the ***two most serious negative impacts*** of climate change in the Rockingham/Yorke Peninsula region?

a. The most serious impact_____

b. The second most serious_____

5.a. Are you concerned about climate change? **(Please circle <u>one</u> response)**

1 **Yes**
2 **No**

b. In your opinion, is climate change taking place in the Rockingham/Yorke Peninsula region now? **(Please circle <u>one</u> response)**

1 **Yes**
2 **No**
3 **Unsure**

6. Who do you feel is most and least responsible for initiating a response to minimise any negative impacts of climate change in the Rockingham/Yorke Peninsula region? **(From the list, please rank from least responsible 1, to most responsible 5)**

Rank (1, 2, 3, 4 or 5)	
_____	**Local government**
_____	**State government**
_____	**Federal government**
_____	**Individual community members**
_____	**Scientists**

7. How do you expect climate change to disrupt the following elements of your life? **(Please rank from no disruption 1, to high disruption 5)**

	(Please circle appropriate response)				
	No disruption		**Moderate disruption**		**High disruption**
Your income	**1**	**2**	**3**	**4**	**5**
Your health	**1**	**2**	**3**	**4**	**5**
Your home	**1**	**2**	**3**	**4**	**5**
Your quality of life	**1**	**2**	**3**	**4**	**5**
Your community	**1**	**2**	**3**	**4**	**5**

8. How likely do you think the following climate change impacts are to occur in the Rockingham/Yorke Peninsula region in the next 25 years? **(Please rank from not likely 1, to extremely likely 5)**

	(Please circle appropriate response)				
	Not likely		**Moderately likely**		**Extremely Likely**
Increased temperatures	**1**	**2**	**3**	**4**	**5**
Decreased rainfall	**1**	**2**	**3**	**4**	**5**
Increased storm surges	**1**	**2**	**3**	**4**	**5**
Increased sea-level	**1**	**2**	**3**	**4**	**5**

9.a. In your opinion, how vulnerable are the communities in the Rockingham/Yorke Peninsula region to the negative impacts caused by climate change? **(Please circle <u>one</u> response)**

1 **Not vulnerable**
2 **Only slightly vulnerable**
3 **Quite vulnerable**
4 **Highly vulnerable**
5 **I don't know**

b. Who would you see (that is, groups of people, types of people etc) in the community as being the most vulnerable to the negative impacts of climate change, and why?

_____
_____
_____
_____

10.a. In your opinion, how capable do you think you are to be able to adapt to climate change? **(On a scale of not capable at all 1, to very capable 5, please circle <u>one</u> response)**

Not capable at all		Moderately capable		Very capable
1	2	3	4	5

b. If you think you are capable, how exactly do you think you will be able to adapt?

_____

_____

_____

11.a. In your opinion, have you changed or are you changing the way you live as a result of the impacts of climate change? **(Please circle <u>one</u> response)**

1 Yes
2 No (Go to 12.a.)
3 Unsure (Go to 12.a.)

b. If yes, how have you changed or how are you changing the way you live and what are the reasons for doing so?

_____

_____

_____

12.a. In your opinion, how *willing* do you think the community is, as a whole, to adapt to the negative impacts caused by climate change? **(Please circle <u>one</u> response)**

1 Not willing at all
2 Only slightly willing
3 Moderately willing
4 Very willing
5 I don't know

b. Why is this, do you think?

_____

_____

_____

13. How confident are you that any negative impacts of climate change will be dealt with by those most responsible to minimise impacts? **(Please circle <u>one</u> response)**

1 Not confident at all
2 Only slightly confident
3 Moderately confident
4 Very confident
5 I don't know

14. In your opinion, how informed are you in terms of your knowledge on sea-level rise? **(On a scale of not informed at all 1, to very informed 5, please circle <u>one</u> response)**

Not informed at all		Moderately informed		Very informed
1	2	3	4	5

15. In your opinion, at which of the following time scales is sea-level rise occurring? **(Please circle <u>one</u> response)**

1 Sea-level rise is not happening
2 Sea-levels will rise sometime beyond my lifetime
3 Sea-levels will rise later in my lifetime
4 Sea-levels are rising right now
5 I don't know

16.a. How worried are you about sea-level rise and the possible negative impacts it may have? **(On a scale of not worried at all 1, to very worried 5, please circle <u>one</u> response)**

Not worried at all		A little worried		Very worried
1	2	3	4	5

b. Why are you worried or not worried?

_____
_____
_____

17. In your opinion, how vulnerable are the communities in the Rockingham/Yorke Peninsula region, as a whole, to the negative impacts caused by sea-level rise? **(Please circle <u>one</u> response)**

1 Not vulnerable
2 Slightly vulnerable
3 Vulnerable
4 Highly vulnerable
5 I don't know

18. In your opinion, what impacts will rising sea-levels have on the community?

_____
_____
_____

19.a. In your opinion, how capable do you think you are to be able to adapt to changes in sea-level? **(On a scale of not capable at all 1, to very capable 5, please circle <u>one</u> response)**

Not capable at all		Moderately capable		Very capable
1	2	3	4	5

b. If you think you are capable of adapting to changes in sea-level, how exactly do you think you will be able to adapt?

_____
_____
_____

20. In your opinion, how capable do you think the communities in the Rockingham/Yorke Peninsula region are, as a whole, to be able to adapt to changes in the environment as a result of sea-level rise? **(On a scale of not capable at all 1, to very capable 5, please circle <u>one</u> response)**

Not capable at all		Moderately capable		Very capable
1	2	3	4	5

21.a. In your opinion, how *willing* do you think the communities in the Rockingham/Yorke Peninsula region are, as a whole, to adapt to changes in sea-level? **(Please circle <u>one</u> response)**

1 Not willing at all
2 Only slightly willing
3 Moderately willing
4 Very willing
5 I don't know

b. Why is this, do you think?

_____
_____
_____

22. Who do you feel is most and least responsible for initiating a response to minimise any negative impacts of sea-level rise? **(From the list provided, please rank from least responsible 1, to most responsible 5)**

_____ **Local government**
_____ **State government**
_____ **Federal government**
_____ **Individual community members**
_____ **Scientists**

23. In your time in Rockingham/ the Yorke Peninsula region, have you ever witnessed the seawater above its usual high tide level during a storm event? **(Please circle <u>one</u> response)**

1 Yes ⟶ **If you have, approximately how many times?**_____
2 No

24. How do you think that storm surge events in the future will impact the following elements in the community? **(Please rank from no impact 1, to serious impact 5)**

	(Please circle appropriate response)				
	No impacts		**Moderate impacts**		**Serious impact**
People's homes	1	2	3	4	5
The beach & foreshore	1	2	3	4	5
People's well-being	1	2	3	4	5
Community attitudes	1	2	3	4	5

25.a. How would you describe your attachment to the community in Rockingham/the Yorke Peninsula? **(Please circle <u>one</u> response)**

1 Not attached at all
2 Only slightly attached
3 Moderately attached
4 Very attached

b. Do you actively participate in any volunteer groups in the community?

1 Yes ⟶ **If you do, can you list them?** _____
2 No _____
_____

26.a. 'Sea change' is a phenomenon which is described as the movement of people to more desirable coastal locations outside of state capital cities for lifestyle reasons. Do you think 'sea change' is occurring in communities in Rockingham/on the Yorke Peninsula? **(Please circle <u>one</u> response)**

1 Yes
2 No (Go to 27.a)
3 Unsure (Go to 27.a)

b. If yes, do you think the impacts of this 'sea change' are generally positive or negative? **(On a scale of very negative impacts 1, to very positive impacts 5, please circle <u>one</u> response)**

Very negative		Neither negative nor positive		Very positive
1	2	3	4	5

c. Can you list any of these impacts (either negative or positive)?

_____
_____
_____

27.a. Are you aware of any other substantial changes in Rockingham/on the Yorke Peninsula in recent times? **(Please circle <u>one</u> response)**

1 Yes
2 No (Go to 28.)
3 Unsure (Go to 28.)

b. If yes, what changes have you observed?

_____
_____
_____

28. Who do you feel would be most and least responsible for initiating a response to minimise any negative impacts 'sea change' will have in Rockingham/on the Yorke Peninsula? **(Please rank from least responsible 1, to most responsible 5)**

_____ **Local government**
_____ **State government**
_____ **Federal government**
_____ **Individual community members**
_____ **Scientists**

29. Please circle your age group.

1.	**0-19 years**	**4.**	**40-49 years**
2.	**20-29 years**	**5.**	**50-59 years**
3.	**30-39 years**	**6.**	**60 years +**

30. Please circle your gender.

1 **Male**
2 **Female**

31. What is the highest level of formal education you have completed? **(Please circle <u>one</u> response)**

1 **None**
2 **Primary/some Secondary School**
3 **Secondary School**
4 **Vocational/Technical Training**
5 **Tertiary**
6 **Postgraduate**

32. Which category best describes your home life? **(Please circle <u>one</u> response)**

1 **Live alone**
2 **Live in shared accommodation**
3 **Single parent**
4 **Couple with children**
5 **Couple (no children)**
6 **Other** _____

Please turn over

Is there anything else that you wish to tell us about climate change, sea-level rise, coastal storm surges or 'sea change'? If so please use the space provided below.

Alternatively, is there anything you personally feel may help us in the future to understand how people can become better prepared to adapt to climate change impacts? We would appreciate any comments, either here, or in a separate letter. Thankyou.

Thankyou for completing the questionnaire

Please remember to post it back in the enclosed envelope

If you would like a copy of the results emailed to you please write your email address:

Or, if you would like a copy of the results posted to you please tick: ☐

If you would like the opportunity to be involved in a follow-up interview please tick: ☐



THE UNIVERSITY OF ADELAIDE
HUMAN RESEARCH ETHICS COMMITTEE

COMPLAINTS PROCEDURE FORM

CONTACTS FOR INFORMATION ON PROJECT AND INDEPENDENT COMPLAINTS PROCEDURE

The Human Research Ethics Committee is obliged to monitor approved research projects. In conjunction with other forms of monitoring it is necessary to provide an independent and confidential reporting mechanism to assure quality assurance of the institutional ethics committee system. This is done by providing research participants with an additional avenue for raising concerns regarding the conduct of any research in which they are involved.

The following study has been reviewed and approved by the University of Adelaide Human Research Ethics Committee:

Project title: ***Coastal Vulnerability and Adaptation in Australia***

If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the project co-ordinator:

- Name: **Professor Nick Harvey**
- Telephone: **(XX) XXXX XXXX**

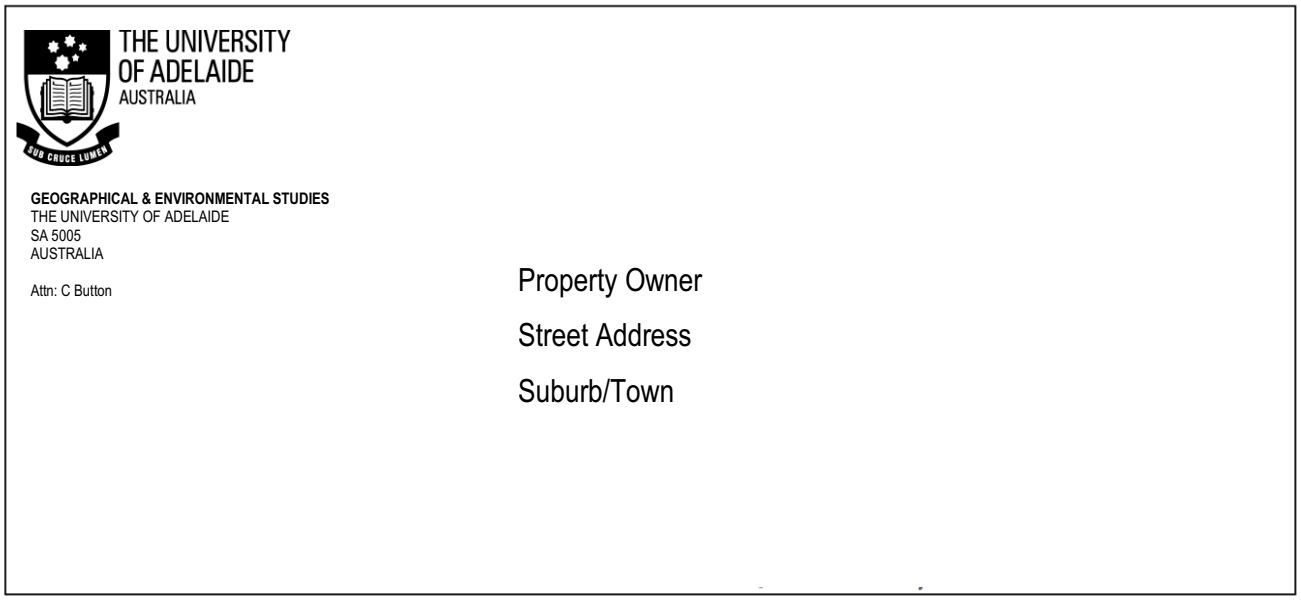
If you wish to discuss with an independent person matters related to:

- Making a complaint, or
- Raising concerns on the conduct of the project, or
- The University policy on research involving human participants, or
- Your rights as a participant

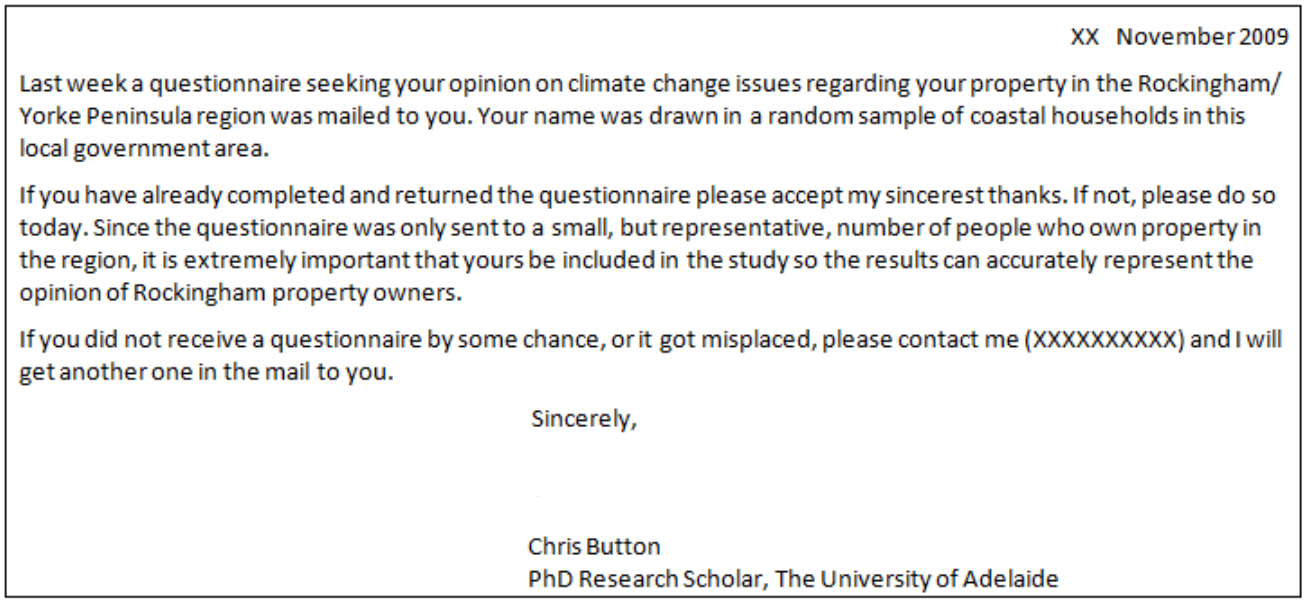
Contact the Human Research Ethics Committee's Secretary on phone (XX) XXXX XXXX

Appendix 4: Mail-out survey reminder/thank you postcard

Front:



Back:



Appendix 5: Open-ended responses displaying anthropogenic climate change 'scepticism' and 'denial'

"1. Climate is and has always been changing. 2. In spite of the spin of governments and vested interests and bias scientific proofs. There is much doubt about the human/animal input for climate change..." (Rockingham Respondent 18, age group 60+)

"I believe there has been and always will be climate change and am unsure how much change is from human activity. Whatever change occurs I think humans will adapt (this has been our secret to success)..." (Rockingham Respondent 254, age group 60+)

"What of the scientific theories that global warming is not even happening?" (Rockingham Respondent 435, age group 20-29)

"… I have noticed no climate change issues in our area whatever. Climate change is controversial but to me is not an issue in this area in future years. Also sea levels are not changing to any degree to be a worry…" (Rockingham Respondent 360, age group Unknown)

"Bullshit, leave what God created alone and do some honest work" (Rockingham Respondent 3, age group Unknown)

"We have not responded as we do not agree with the climate change drama. We feel the questions are such that you get the desired answers!" (Yorke Peninsula Respondent 307, age group Unknown)

"I have not seen enough evidence to believe that we are in dire straits… to me, climate change has varied over the last century and we are still in this cycle." (Rockingham Respondent 459, age group Unknown)

Email letter (Yorke Peninsula Respondent 375, age group Unknown)

"I don't believe mankind has anything to do with climate change, it has happened too many times in the past history when there was no manmade pollution…" (Yorke Peninsula Respondent 276, age group 60+)

"We should just prepare for changes rather than blame humans for climate change/SLR. It might be just a natural cycle beyond our control." (Yorke Peninsula Respondent 135, age group 40-49)

"One gets sick of all the so called experts pontificating about this and I feel it has become a very lucrative industry…" (Rockingham Respondent 422, age group 60+)

"Climate is always changing. We will probably have warmer and cooler and hotter and drier periods over the next 100 years. Encroaching seas, sea-level rise, land subsidence are always issues and always have been issues…" (Yorke Peninsula Respondent 185, age group 50-59)

"…climate change is naturally occurring. The effects of climate change have been dealt with since time began. I am sure today's society will be able to handle it just as well as in the past, hopefully better." (Rockingham Respondent 5, age group 40-49)

"Much exaggerated" (Yorke Peninsula Respondent 291, age group 60+)

"You have made the assumption that [climate change] is happening. Whilst it probably is, there is probably not a lot we can do" (Rockingham Respondent 245, age group 50-59)

"Climate change yet to be scientifically confirmed" (Rockingham Respondent 396, age group 60+)

"I am concerned that the governments presume and promote climate change etc but are still prepared to consider a marina…!! I am also concerned that this survey presumes in its questions "climate change" etc… Don't alarm people unnecessarily…" (Yorke Peninsula Respondent 364, age group 60+)

"…we are of the opinion that there is insufficient hard data to indicate climate change is occurring. To us, we are not aware of universal acceptance by the scientific community there is climate change." (Yorke Peninsula Respondent 237, age group 60+)

"People's fear of it" (Yorke Peninsula Respondent 61, age group 60+)

"We believe that climate change is cyclonic and that not enough data has been recorded over a long period of time to prove climate change..." (Yorke Peninsula Respondent 306, age group Unknown)

"This has been going on since the world first began. Ice age etc." (Yorke Peninsula Respondent 164, age group 60+)

"…is climate change real or is it a hoax? People I know (educated) strongly believe it is a giant hoax." (Yorke Peninsula Respondent 41, age group 60+)

(Rockingham n = 10; Yorke Peninsula n = 12)

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