Perceptions of Risk among Households in Two Australian Coastal Communities

CARMEN E. ELRICK-BARR1*, TIMOTHY F. SMITH1, DANA C. THOMSEN1 and BENJAMIN L. PRESTON2
1Sustainability Research Centre, University of the Sunshine Coast, 90 Sippy Downs Drive, Sippy Downs, Qld 4556, Australia.
2Climate Change Science Institute, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA.
*Corresponding author. Email: celrick@usc.edu.au

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Abstract
There is limited knowledge of risk perceptions in coastal communities despite their vulnerability to a range of risks including the impacts of climate change. A survey of 400 households in two Australian coastal communities, combined with semi-structured interviews, provides insight into household perceptions of the relative importance of climatic and non-climatic risks and the subsequent risk priorities that may inform household adaptive action. In contrast to previous research, the results demonstrated that geographic location and household characteristics might not affect perceptions of vulnerability to environmental hazards. However, past experience was a significant influence, raising the priority of environmental concerns. Overall, the results highlight the priority concerns of coastal households (from finance, to health and environment) and suggest to increase the profile of climate issues in coastal communities climate change strategies need to better demonstrate links between climate vulnerability and other household concerns. Furthermore, promoting generic capacities in isolation from understanding the context in which households construe climate risks is unlikely to yield the changes required to decrease the vulnerability of coastal communities.

KEY WORDS climate change; adaptation; vulnerable; environment; hazard

Introduction
An increasing volume of research suggests coastal communities are vulnerable to the impacts of climate change (e.g., Intergovernmental Panel on Climate Change (IPCC), 2013; Burkett and Davidson, 2012; DCCEE, 2009). Increased storm surge, extreme weather events and sea-level rise can pose threats to public health, safety, and employment in the coastal zone (Nicholls et al., 2011; Burkett and Davidson, 2012). The potential severity of the impacts, spread of vulnerability within communities, and importance of the coastal zone to national economies have driven an agenda for action to prepare coastal communities for the impacts of climate change (DCCEE, 2010: pg. 8). Hence, several recent programs target adaptation in coastal communities. For example, in the United States the Climate Ready Estuaries program sought to assess climate impacts and implement adaptation strategies (Environmental Protection Authority (EPA), 2013), while in Australia the Local Adaptation Pathways Program sought to raise the capacity of Local Governments to identify and treat climate change risks in coastal communities (Department of Environment, 2014).
Despite the focus on the adaptation of coastal regions, there exists limited knowledge of coastal residents’ perceptions of risk and hazard-related concerns. In addition, few studies integrate coastal climate risk perceptions with other household concerns (although see Bennett et al., 2015). Studies have sought to understand residents’ perceptions of climate change (Leviston and Walker, 2011a; 2011b; Leviston et al., 2013; Reser et al., 2012) and coastal residents’ perceptions of individual coastal climate risks (Kellens et al., 2011; Combest-Friedman et al., 2012; Button, 2013); however, perceptions are measured in isolation from other issues of concern at the household scale. As with other regions, concerns of households in coastal regions extend beyond the natural environment and include concerns such as employment, education and health (Doss et al., 2008). These issues may take priority over coastal climate risks. In addition, change in policy or adaptation action implemented at different scales may indirectly affect these competing concerns.

Understanding household perceptions and the relative priorities accorded to climatic and non-climatic risk will aid in developing effective policy responses to coastal hazards (e.g., the development of adaptive capacity and associated adaptation strategies), as perceptions tend to shape individual behaviour (Slovic, 1987; Lindell and Hwang, 2008) and management strategy preferences (Slovic, 1987; Steg and Sievers, 2000; Peacock et al., 2005; Button, 2013). The household is a valuable unit of analysis for perceptions of climate risk because the household is the unit of action that resides between individuals and society, where personal values, societal norms and institutional demands (e.g., government policies) meet to influence investment and consumption choices (Collins, 2015). Consequently, the household as a collective, rather than a single individual, makes many of the decisions that influence vulnerability including level of insurance cover, household location, water and electricity use, and patterns of consumption more generally (Shandas et al., 2012). Even when decisions are formally taken by one member of the household, they may affect (and/or be affected by) the way the household shares other decisions (de Palma et al., 2011). As such, the household scale of organisation has significant influence on the likely climate impacts expected for groups of individuals located within this scale.

Yet while the available literature outlines how household characteristics might affect risk perceptions to individual risks (Brody et al., 2007; Filatova et al., 2011; Badola et al., 2012; Baumann and Schernewski, 2012; Combest-Friedman et al., 2012; Roca and Villares, 2012; Larson et al., 2013), it does not provide insight into the priority of climatic versus non-climatic risks for coastal households, or how the ordering of these concerns varies by household characteristics, past experience or geographic location (Doss et al., 2008). Therefore, it provides only a partial understanding of how household priorities may shape decision-making and behaviour in coastal regions.

This paper presents empirical data regarding perceptions of risk in two Australian coastal communities at the household scale. The objective of the study is to explore the influence of selected factors on household risk perceptions as a first step in understanding how risk priorities may inform household adaptive action. We commence this paper with a review of risk perceptions relevant to household behaviour to position the study within the field of risk perception studies conducted to inform climate change adaptation policy. We then outline the methods adopted to evaluate household risk perceptions in the two Australian coastal communities. Finally, results are discussed, highlighting variation in risk perceptions within and between the communities, before outlining key considerations for policy and research.

**Perceptions of risk and adaptive behaviour**

Public perceptions of risk can compel and constrain political, social and economic action (Leiserowitz, 2010). Consequently, understanding why the public construe and prioritise some risks, what attributes promote risk preferences (Reser et al., 2012) and how risk preferences inform decision-making and behaviour (Leiserowitz, 2006) has been a focus of studies that seek to inform public policy, from pro-environmental and sustainability assessments to hazard management (e.g., Peacock et al., 2005; Lindell and Hwang, 2008). Assessments of risk perception also inform climate change policy, in part because climate impacts are uncertain, temporally variable and often perceived as distant, providing a complex mix of attributes that challenge views on the what constitutes a public concern. In turn, limited concern for climate risk can impede policy action, because support or opposition to climate policy is influenced by perceptions of the risk and dangers of climate change (Leiserowitz, 2006).
Public perceptions of climate change risk were initially explored to determine levels of acceptance and belief; however, focus transitioned from wanting to know what the public perceives as a risk, to who perceives the risk and why (Leiserowitz, 2010). Consequently, the social, cultural, and political context of risk perception, including socio-demographic factors (i.e., gender, race, income, and education), cultural factors (i.e., trust, social values, and worldviews) (Leiserowitz, 2010) and emotive factors (affect, agency, experience) are increasingly analysed to explain variation in risk perceptions. The examination of socio-demographic factors builds on asset-based theory that argues that social and economic resources enable effective responses to environmental risks (Johnson, 1997; Scoones, 1998; Heltberg et al., 2009; Nelson et al., 2010b). This framework assumes that a low asset base prevents positive voluntary adaptive behaviour and therefore heightens risk perception (Peacock et al., 2005). In accordance with this framework, a number of studies have argued that women, ethnic groups, low income, and low educated residents have higher risk perceptions due to a lack of power and resources (Riad et al., 1999; Peacock et al., 2005). The framework is predominately applied in hazard management studies that explore household or individual perceptions and response to select climate risks (i.e., floods) but is also applied in climate change studies, including Below et al. (2012) and Safi et al. (2012), who found that social and financial capital of the household, education, and gender of the head of the household influenced perceptions of climate risk and determined whether adaptive action was taken. As these studies show, interest in placed not only on who perceives climate change as a risk, but also how risk perception influences individual and collective action to mediate the risk.

The cultural and emotive factors that influence risk perceptions are reflected in heuristics, which individuals rely on to make decisions in complex and uncertain situations because they simplify the situation and assist in timely decision-making (Kahneman et al., 1982). For example, the availability heuristic refers to risk judgements where the recurrence of an event is inferred by drawing on proximal cues, such as the mental availability of relevant events (Pachur et al., 2012). According to this premise, households that have recent experience of an environmental hazard have heightened perceptions of risk. Further, it is argued that any factor that makes an event or hazard memorable may increase the perceived risk of that event or hazard (Slovic et al., 2000). Therefore, direct experience is not necessary for heightened risk perception, because, for example, a media focus on natural hazards also has the potential to make hazard events highly memorable, amplifying risk perception (Button, 2013). Similarly, representativeness is a heuristic in which events experienced personally, or associated with properties of another event, are judged as more likely to occur. In contrast to the availability heuristic, perceptions are not formed based on ease of recall; rather, perceived probability is assessed based on the similarity of the event to others experienced personally (Kahneman and Tversky, 1972). This can lead to overestimation of the extent to which the past is representative of the present or future and the contribution of solutions that addressed past problems to address present problems (Schwenk, 1984).

Drawing on theories of risk perception and behaviour, climate adaptation researchers have demonstrated a link between household risk perceptions for select hazards (e.g., flooding) and the adoption of adaptive action (Grothmann and Reusswig, 2006; Harvatt et al., 2011; Koerth et al., 2013). However, there remains a proportion of variance in the delivery of action that is not explained by either socio-demographic characteristics or perceptions of risk (Grothmann and Reusswig, 2006); and few studies consider the comparative priority of climate risks compared to other household concerns. Focusing solely on perceptions of climate risk to the exclusion of other socio-economic concerns has been identified as a ‘critical weakness in local adaptation strategies’ (Hjerpe and Glaas, 2012: 471). An understanding of the multiple concerns facing households, and their relative priority, can allow for the design and prioritisation of adaptation strategies that address multiple stresses (Bennett et al., 2015), whilst also informing engagement strategies to frame environmental stressors in a way that has meaning to those expected to act (Spence and Pidgeon, 2009).

In this study we recognise risk perceptions are variable, changing in response to changes in the household’s internal (i.e., stage in life-cycle, change in family unit, employment and educational change) and external environment (i.e., global and local politics, climatic change and variation). While drivers of change in perceptions of risk over time have been explored (Leiserowitz, 2010; Pidgeon, 2012), of equal
importance are the factors that influence variation in risk perceptions within a community at a point in time. For example, (i) past experience (Anderson-Berry, 2003; Lindell and Hwang, 2008; Kellens et al., 2011); (ii) household characteristics (Schwartz, 2006; Safi et al., 2012); and (iii) geographic location (Peacock et al., 2005; Brody et al., 2007; Kellens et al., 2011) have been identified in the literature as factors that influence household risk perceptions and, in turn, behaviour. As household engagement in climate risk management is increasingly sought (e.g., Council of Australian Governments, 2011), understanding factors that influence variation in risk perceptions provides important information to guide strategies that will promote household action and/or acceptance of action implemented by others.

Methods
A case study approach was adopted to obtain information on household risk perceptions. Case studies are widely adopted in risk perception and adaptation research (i.e., Kellens et al., 2011; Kreibich, 2011; Linnekamp et al., 2011; Safi et al., 2012; Fatti and Patel, 2013). The strength of comparative case studies, as adopted here, is the ability to identify risk preferences within households, between households, and within the community (Moser, 1996). A combination of qualitative and quantitative data was collected, following other risk perception and adaptation studies focused on the household scale (i.e., Tucker et al., 2010; Linnekamp et al., 2011).

Case study sites
Two Australian case-study communities potentially exposed to coastal hazards – the City of Mandurah, Western Australia and Moreton Bay Coastal Region, Queensland (Figure 1) – were purposefully selected as case study sites based on a consideration of area-level demographic and socio-economic data, settlement history, development, and environmental issues. The sites were selected to explore assumptions regarding the relationship between household characteristics, risk perception and propensity for adaptive action. For example, as outlined in the second section, income, age distribution, homeownership, and gender are argued to influence risk perceptions (Schwartz, 2006; Safi et al., 2012). The sites contain households of

![Figure 1 Case study areas, Mandurah Western Australia and Moreton Bay Coastal Region Queensland.](image-url)
varying incomes, high unemployment, and, as ‘sea-change’ communities (Gurran et al., 2008), there is a higher proportion of elderly residents than urban city locations (Table 1). These attributes represent aspects of social vulnerability that are argued to increase vulnerability to climate risks (Gurran et al., 2005; Productivity Commission, 2012). Further, because the communities contain households of social advantage and disadvantage, variation in risk perceptions within and between the communities can be explored.

In addition, the sites are physically vulnerable to climate risks such as sea-level rise and associated coastal erosion and flooding due to high levels of development in the coastal margin (Burton et al., 2009; DCCEE, 2009; Low Choy et al., 2012). Those residing in locations vulnerable to climate risks are argued to recognise their vulnerability and therefore have higher perceptions of risk (Brody et al., 2007). Yet, despite the recognised vulnerability to the impacts of changing climate (DCCEE, 2009; Low Choy et al., 2012), the sites do not have a history of exposure to extreme climatic (disaster) events (i.e., storms, floods, heatwaves). Consequently, perceptions of vulnerability may be reduced.

The City of Mandurah has over 42 km of coastline and a 136 sq. km estuary, which is an internationally recognised RAMSAR listed wetland. Urban development in the coastal and estuarine margins has been extensive and rapid. Mandurah contains approximately 30 000 households, dominated by a high proportion of elderly residents. Due to its coastal development legacy, the City’s local government authority has focused on coastal management issues such as sand removal and re-pumping, the maintenance of the estuary-ocean channel training walls, and other coastal protection works. The City was proactive in addressing climate change, hosting the first locally driven climate change conference in Australia in 2007 and undertaking a coastal vulnerability assessment in 2008 to inform development requests.

The Moreton Bay Coastal Region is situated in the Moreton Local Government Area. Here early development centred on the bay, an important transport route for ships, before becoming a well-recognised location for tourism and recreation. Today, the Moreton Bay coastal region contains approximately 50 000 households and is characterised by spatially diverse demographic areas (i.e., areas of high aged population and other areas with young families; areas of high unemployment and other areas with a high concentration of high socio-economic households). The Moreton Bay Regional Council was one of the

Table 1 Select comparative statistics of the two case study areas.

<table>
<thead>
<tr>
<th></th>
<th>City of Mandurah Western Australia</th>
<th>Moreton Bay coastal area</th>
<th>Queensland</th>
</tr>
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<tbody>
<tr>
<td>Land area</td>
<td>174 sq. km</td>
<td>252 sq. km</td>
<td></td>
</tr>
<tr>
<td>Number of households (2011)</td>
<td>26 458</td>
<td>52 720</td>
<td></td>
</tr>
<tr>
<td>Housing density</td>
<td>153 per sq. km</td>
<td>139 per sq. km</td>
<td></td>
</tr>
<tr>
<td>Population (2011)</td>
<td>67 227</td>
<td>129 886</td>
<td></td>
</tr>
<tr>
<td>Population density</td>
<td>405 people per sq. km</td>
<td>443 people per sq. km</td>
<td></td>
</tr>
<tr>
<td>Distance from major city centre</td>
<td>Approx. 70 km</td>
<td>Approx. 30 km</td>
<td></td>
</tr>
<tr>
<td>Age dependency ratio1 (2011)</td>
<td>64.5</td>
<td>47</td>
<td>57.5</td>
</tr>
<tr>
<td>Old age dependency ratio1 (2011)</td>
<td>33.5</td>
<td>28.9</td>
<td>24.7</td>
</tr>
<tr>
<td>Single parent households (2011)%</td>
<td>15.8</td>
<td>14.5</td>
<td>19.5</td>
</tr>
<tr>
<td>Renting (2011)%</td>
<td>31.3</td>
<td>29.2</td>
<td>37.1</td>
</tr>
<tr>
<td>Single person households (2011)%</td>
<td>24.9</td>
<td>23.8</td>
<td>24.7</td>
</tr>
<tr>
<td>Household income less than $600 wk⁻¹ (2011)%</td>
<td>30.3</td>
<td>21.1</td>
<td>15.7</td>
</tr>
<tr>
<td>Household income more than $3000 wk⁻¹ (2011)%</td>
<td>8.7</td>
<td>14</td>
<td>6.7</td>
</tr>
<tr>
<td>Unemployed (2011)%</td>
<td>7.1</td>
<td>4.7</td>
<td>9.8</td>
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</table>


1 Age dependency ratio (% of working-age population) is the ratio of dependants (i.e., people younger than 15 or older than 64), to the working-age population (i.e., those aged 15–64).

2 The old age dependency ratio is the ratio of people aged 65 years and over to the working age population (i.e., those aged 15–64).
first Queensland regional councils to undertake a climate change risk assessment in 2009 (Burton et al., 2009).

Data collection
A survey questionnaire of residents in the two case study areas was used to generate data at the household scale. The postal survey was delivered to households randomly selected from a list of residential addresses provided by respective Local Government Authorities. The list of addresses was sampled selecting every fifth address in the Moreton Bay sample and every third address in the Mandurah sample. To increase the response rate, hand-delivered surveys were distributed in each case study area. Target areas for hand-delivered surveys were determined based on the proportion of returned surveys in each suburb. Within target suburbs, streets were randomly selected and every 5th property was approached and asked their willingness to participate in the survey. If the household declined, the adjoining property was approached. If the household accepted, the 5th adjoining property was approached. In total, 1797 postal surveys were distributed, 970 in Moreton Bay and 929 in Mandurah. In addition, between August and October 2012, 223 people agreed to complete the survey in Moreton Bay and 270 in Mandurah when approached by study members’ hand delivering the survey. In total, 400 completed survey responses were received (representing approximately 10% response rate for postal survey and 30% response rate for hand-delivered survey), covering 0.6 per cent of all households in Mandurah and 0.4 per cent of all households in the Moreton Bay Coastal Region.

Of the respondents, 54 per cent were male with a mean age of 56 years, slightly higher than that recorded for both survey areas at the 2011 census (Baum et al., 2013). Further, in comparison to the 2011 census, survey respondents were more likely to be homeowners (owning their home outright), less likely to rent, but representative of the number of homeowners paying a mortgage and family types (i.e., couples with dependent children, couples without dependent children, single person and single parent households). As part of the survey, respondents nominated their willingness to participate in follow up interviews. Forty-six survey respondents agreed to participate. Household characteristics (i.e., income, family type, homeownership, education and age) were profiled to select interviewees that represented diverse types. The diversity in household types sought to capture differences in understanding within the coastal communities. A total of 31 households were contacted between August 2013 and February 2014 and 17 agreed to participate in an interview (eight in Mandurah and nine in Moreton Bay).

Interviews focused on three scenario events to allow greater depth of analysis of contextual issues. Interviewees were asked to detail the impact a severe storm, heatwave and sea-level rise (Table 2) would have on their household, their response strategy, capacity needs and barriers to action, actors with primary responsibility for preparing and responding to the climate risk and overall priority of the climate risk comparative to other concerns facing their household. Of particular focus in this study was the final question, where the comparative priority of the scenario hazard was compared to other issues of concern to the household. Interviews took between 15 and 40 minutes and were conducted over the telephone. The hazard scenarios were concise and described the direct impacts of the hazard. Indirect impacts were not described allowing for household interpretations, whilst

<table>
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<tr>
<th>Table 2 Scenarios presented to interviewees.</th>
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<tr>
<td><strong>Severe storm:</strong> A severe summer storm hits [Moreton Bay/Mandurah]. Storm impacts include high winds, loss of power, localised flooding, fallen trees and damaged power lines. Your household loses power until midday the following day and you experience minor roof damage, which results in limited water damage in the living room of your home.</td>
</tr>
<tr>
<td><strong>Heatwave:</strong> There is a heat wave in [Mandurah/Moreton Bay]. The impacts include health issues such as heat stress, water restrictions, trouble sleeping at night, and limited opportunities for outdoor recreation. During the heat wave, your household has a power blackout that lasts for several hours.</td>
</tr>
<tr>
<td><strong>Sea-level rise:</strong> SLR in [Mandurah/Moreton Bay] creates gradual inundation in low-lying areas and will occur incrementally over time. SLR can also exacerbate coastal erosion through raised water levels that affect higher areas of the coastal dune. SLR may result in some areas of the region being ‘cut-off’ from others where roads and services are located in low-lying areas. In addition, there may be instances of damage to infrastructure located in low-lying areas or on the coastal fringe.</td>
</tr>
</tbody>
</table>
providing consistent baseline impacts from which to generate interpretations. The scenario hazards were selected based on document review (i.e., Australian Attorney-General’s Department Disaster Database and local risk assessment reports) on the basis of their prevalence in the case study sites. Two scenarios represented climate risks previously experienced (i.e., heatwave and severe storm) and a third represented a hazard to which the case-study areas are vulnerable (DCCEE, 2009) but with which they have less direct experience (i.e., sea-level rise).

In the survey, participants were presented with a list of climatic and non-climatic issues with the potential to affect their household and asked to rate the likelihood and consequence of each on a five-point Likert scale. The climatic and non-climatic issues listed in the survey were constructed in accordance with the asset-entitlement framework (Adger and Kelly, 1999) (refer to Figure 2) and included issues that might influence the financial (i.e., job loss), social (i.e., loss of contact with friends or family), human (i.e., illness or injury), technological (i.e., internet access) and/or natural capital (i.e., decline in local natural environment) of the household or local area. The asset-entitlement framework has been traditionally applied in developing countries where the relevance and salience of capitals to livelihoods is different to that of developed countries; however, it is also widely adopted in assessments of risk perception and adaptive capacity in developed country contexts (see for example Nelson et al., 2010a; Nelson et al., 2010b; Harvatt et al., 2011). By applying the asset-entitlement framework to define climatic and non-climatic risks, it was possible to evaluate reported assumptions regarding asset entitlement and risk perception in the Australian coastal zone. In addition, survey participants were provided the opportunity to identify the issue of most concern to their household, leaving space for options not pre-defined. Survey participants also rated their perceived exposure to several natural environmental hazards on a five-point Likert scale (for example, severe storm activity, cyclone, bushfire, flood, drought, heatwave, sea-level rise).

The nature of survey-based assessments is that respondents can interpret questions differently. A pilot-trial of the survey was implemented in Moreton Bay to identify ambiguous or unclear questions and statements. Despite this, terms used to described the climatic and non-climatic risks might be interpreted differently; for example, ‘natural environment’, ‘serious strain’, ‘limited availability’, ‘decline in quality’ (refer to Figure 2). In most cases, qualifying information was provided to clarify statements (i.e., ‘Environmental problem (e.g., coastal erosion, sea-level rise) threatens the safety of your home’; and ‘Decline in quality of the natural environment (e.g., a loss of native plants or animals, pollution of air, water or soil)’; and interviews provided an

Figure 2  Risk priority of the 14 pre-defined issues that may affect household well-being, in priority order (highest to lowest). Note: Priority ranking calculated as sum of ordinal risk priority rating.
opportunity to explore varying interpretations for three selected hazards.

In this study risk perceptions were explored to provide insight into propensity for adaptive action and capacity to act, rather than to uncover general trends in community perceptions of climate change (i.e., the survey did not contain questions such as ‘Do you consider your household is vulnerable to the impacts of climate change’). Therefore, the approach differs to other climate change risk perception studies (i.e., Lorenzoni and Pidgeon, 2006; Leviston and Walker, 2011a; Reser et al., 2012); but follows climate change adaptation research that explores hazard risk perception to assess capacity to respond to a changing climate (i.e., Linnekamp et al., 2011; Fatti and Patel, 2013). By focusing on the impacts of a changing climate, such as environmental hazards including heatwaves and severe storms, we obtained perceptions of risk for recognised events. This approach addresses concerns that climate change is often difficult for people to conceptualise and relate to their daily activities (Lorenzoni and Pidgeon, 2006) and is often considered to affect others in distant places rather than a personally threatening risk (Leiserowitz, 2010). In addition, households were asked to rate the perceived influence of climate change on the nature and severity of environmental hazards in their local area.

Data analysis
Risk is a product of the likelihood an event will occur and the consequence of the event. Therefore, the likelihood and consequence ratings assigned to the pre-defined climatic and non-climatic issues were combined to assign a risk priority rating (low, medium, high or extreme) per issue, applying a standard risk matrix (i.e., ISO 13000: 2009) (Table 3).

Table 3  Risk priority matrix, following ISO 13000: 2009.

<table>
<thead>
<tr>
<th>1: Insignificant</th>
<th>2: Minor</th>
<th>3: Moderate</th>
<th>4: Major</th>
<th>5: Catastrophic</th>
</tr>
</thead>
<tbody>
<tr>
<td>5: Almost Certain</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>4: Likely</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>3: Possible</td>
<td>4</td>
<td>6</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>2: Unlikely</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>1: Rare</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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Data were analysed using standard statistical software (SPSS), qualitative data analysis tools (NVIVO), and Geographic Information Systems (ArcGIS). Two-way tables were constructed to measure the association between selected categorical variables such as household characteristics (income, education and family type), past exposure to climate hazards, and risk perceptions. Due to the multiple-choice and rating structure of the survey, proportional differences across each layer were examined using a Z-test. Analysis of variance (ANOVA) showed differences in risk perception between case-study areas. Spatial association in perceptions of vulnerability by residential location was assessed using spatial autocorrelation in ArcGIS. All results reported are statistically significant at the $\alpha = 0.05$ level.

Results and discussion
In the case study communities, perceptions of climatic risks relative to other household concerns were low (Figure 2). These results partly reflect the assertions of Gattig and Hendrickx (2007) and others (Hendrickx and Nicolaïj, 2004), where concern about economic risks (as a personal risk) is prioritised over environmental risks (non-personal risks); although in contrast to Gattig and Hendrickx’s assertion, the same priority was not given to health risks as these were prioritised after a severe climatic event (i.e., storm, flood, bushfire) (Figure 2). Severe storm activity was the climate hazard households in both case-study areas perceived they were most frequently exposed, but this did not translate to high perceptions of vulnerability to environmental hazards generally. Rather, perceived vulnerability to environmental hazards was low, with $\sim 55\%$ of surveyed households rating their local area as of average vulnerability ($\sim 55\%$), and $25\%$ of households assigning ‘not very’, or ‘not at all’ levels of vulnerability.

To further explore household priority concerns, survey respondents were provided the opportunity to identify the priority issue affecting their household well-being. The costs of
lving (i.e., rising price of electricity), global financial insecurity, superannuation, job security, health concerns and the lack of training and apprenticeships for young people, were identified. Social issues such as divorce, family illness, and associated financial implications, were also raised as priority concerns. Environmental issues were not prominent; water pollution was one of the only environmental concerns raised. The results suggest low perceptions of vulnerability to environmental hazards comparative to other household priorities. However, the results collectively reflect responses across the two case-study areas potentially masking variation due to coastal context, such as varying exposure to different climate risks and different policies and action to address climate risks implemented by local and State government. Therefore, comparisons were made between the two case-study regions.

Variation in risk priority by case-study location
Perceptions of local area vulnerability did not differ significantly between Mandurah and Moreton Bay, nor did perceptions of financial (i.e., inability to pay bills or cover financial expenses, not being able to raise $2000 for an emergency), social (i.e., strain in family ties) or health risks (i.e., serious illness or injury). However, mean perceptions of risk for ‘severe climate event damaging the home’ ($\chi^2 = 19.36, p < 0.01; F = 16.67, P < 0.01$) and for ‘an environmental problem threatens the home (i.e., sea-level rise or erosion)’ ($F = 4.34, P < 0.05$) were higher in Mandurah than Moreton Bay. Further, perceived exposure to select environmental hazards differed, where exposure to heatwaves ($\chi^2 = 46.27, P < 0.01$), severe storm ($\chi^2 = 15.2, P < 0.01$) and bushfire ($\chi^2 = 22.56, P < 0.01$) was higher in Mandurah; and perceived exposure to floods ($\chi^2 = 18.9, P < 0.01$) and drought ($\chi^2 = 17.7, P < 0.01$) was higher in Moreton Bay.

The results indicate priority hazards within the coastal communities and also generally higher concern for climate hazards in Mandurah than Moreton Bay. This is accompanied by higher mean perceived vulnerability of the household to environmental hazards in Mandurah ($F = 6.32, P < 0.05$). The results raise questions regarding why perceptions of household vulnerability are higher in Mandurah than Moreton Bay, while there are no significant differences in perceived vulnerability of the local area. This is potentially a function of the perceived capacity of institutions to manage local area risk; the types of hazards considered to affect the area and/or perceived household capability to manage risk. To explore the drivers of variation in more detail, household perspectives on the severity of the impact of three scenario hazards (severe storm, heatwave and sea-level rise) were gathered. Similar responses were provided by interviewees in Mandurah and Moreton Bay with respect to perceived impact on the household, perceived responsibility to act and perceived capacity to respond, suggesting differences in perceived vulnerability by case-study area are limited when the impact scenarios remain constant. Therefore, variations are potentially a product of different interpretations of ‘severe climatic event’, ‘environmental problem’ or ‘vulnerability’.

Overall, the results indicate that perceptions of vulnerability to environmental hazards, whilst higher in Mandurah than Moreton Bay, are generally lower for environmental risks than for personal risks (i.e., finance, health). Therefore, while exposure and vulnerability of coastal communities is a priority issue for researchers, coastal managers and decision-makers (Nicholls et al., 2007; DCCEE, 2009; Nicholls et al., 2011; Burkett and Davidson, 2012), these results indicate that it may not be an issue that directly concerns coastal residents on a day-to-day basis. As a result, the decisions and behaviours of coastal households may not be shaped by perceptions of high vulnerability in the absence of severe weather warnings or other prompts that directly raise the profile of climate related risks. For example, as interviewees noted:

[The priority of a storm] would be very low, but I guess it depends on the time of the year or the weather forecast. [ID 292]
If we were in storm season, in winter, and there were storms around or forecast, or a cyclone coming down the coast or whatever, then it would go to a much higher priority. But I suppose I have never had a severe storm damage – and complacency being a major Australian trait – I would say that it wouldn’t be a [high priority] unless something was imminent. [ID 275]

Moderate to low perceived vulnerability to environmental hazards in the surveyed coastal communities has the potential to impede household proactive action to mediate climate risks. Consequently, further responsibility may be passed to governance authorities that seek to promote household action or gain support for government led action. Therefore, the influence of contextual factors on risk perceptions was explored to
ascertain if proposed relationships between risk perceptions and (i) past experience, (ii) household characteristics and (iii) geographic location held true in the two coastal communities. The findings highlight within and between case variations in risk perceptions, providing a basis to support household action, as well as an understanding of the suitability of frameworks that propose relationships between asset availability, risk perceptions and action (such as the asset-entitlement framework) in the Australian coastal zone.

### Past experience

Button (2013) asserts that coastal residents do not have direct experience of climate change, per se, due to the temporal scale of climatic changes. However, they do have direct experience of daily and seasonal variability, including extreme weather events, and can rely on past exposure to make judgements about vulnerability (Slovic et al., 2000). As a result, those that have experienced a hazard in their current location are expected to have higher perceptions of vulnerability (Weber, 2006; Kellens et al., 2011). The results of this study were consistent with the findings of Slovic et al. (2000) and Kellens et al. (2011); households that had been exposed to a natural environmental hazard in their current location had heightened perceptions of local area vulnerability.

In addition, the priority of the 14 pre-defined climatic and non-climatic risks (Figure 2) was compared for households that had experienced an environmental hazard in their current location versus those that had not. In accordance with the availability heuristic, the surveyed coastal households that had experienced a hazard in their current location assigned higher priority to environmental related risks than those that had not (Table 4). This extended beyond storm events to cover other local environmental and planning issues that may affect the household directly or indirectly. Personal risks such as financial and health concerns remained a higher priority than environmental risks for households without hazard experience.

Some authors argue that extreme events are a source of bias in the public’s perceptions of climate change in the same way that the frequency or timing of past events accounts for availability biases (Slovic et al., 2000; Button, 2013). In other words, households that have been exposed to natural hazards are expected to have higher concern for climate change. However, Weber (2010) found personal experience only heightens concern if the event experienced is perceived to be related to the issue of concern (i.e., environmental hazards are perceived to be related to changes in climate). Across the total sample of surveyed households in the two case study areas, a majority considered the impact of climate change on environmental hazards in their local area to be limited or absent (Table 5); however, those that had experienced a hazard in their current location were more likely to view climate change as a key-influencing factor (Table 5). In contrast, regardless of past exposure to an environmental hazard, there was no significant difference in the perceived influence of climate change on environmental hazards for households in Mandurah or Moreton Bay when examined by case-study area. Therefore, the high priority assigned by survey respondents to natural hazards as a result of past experience did not uniformly transfer to heightened perceptions of climate change influencing natural hazards in their local area. Adger et al. (2009) suggests that long-term behavioural learning is constrained for

<table>
<thead>
<tr>
<th>Risk Priority</th>
<th>Household has experienced hazard in current location</th>
<th>Household has not experienced hazard in current location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A severe climatic event (storm, bushfire, flood) damages your home</td>
<td>Inability to pay bills or cover financial expenses</td>
</tr>
<tr>
<td>2</td>
<td>Change in local develop guidelines affect the quality of your living conditions or the value of your home</td>
<td>Not being able to raise $2000 for emergency</td>
</tr>
<tr>
<td>3</td>
<td>Decline in quality of the natural environment</td>
<td>Serious illness or injury</td>
</tr>
<tr>
<td>4</td>
<td>Serious illness or injury</td>
<td>Job loss and difficulty regaining employment</td>
</tr>
<tr>
<td>5</td>
<td>Inability to pay bills or cover financial expenses</td>
<td>A severe climatic event (storm, bushfire, flood) damages your home</td>
</tr>
</tbody>
</table>

*Note: Priority ranking calculated as sum of ordinal risk priority rating.*
households that do not link experiences of extreme weather events to climate-related future occurrences and this has implications for household adaptive capacity (i.e., the ability of the household to adapt to climatic hazards).

Household characteristics

In the Australian coastal communities surveyed no direct relationship between perceptions of local area vulnerability and household characteristics (income, education, family type or age) was identified. Furthermore, household’s perceptions of risks such as change in development guidelines affecting their property or severe climatic event threatening their home, revealed no relationship to household characteristics. In contrast, household asset-base influenced risk perceptions for job loss, inability to access education, and loss of private transport. For example, low-income households had significantly higher perceptions of risk for the ability to pay bills on time than higher income households.

The findings suggest that generalised assumptions regarding household characteristics and risk perceptions do not extend to environmental hazards but hold true for risks impacting other household considerations. This finding is in contrast to literature that examines household characteristics and risk perceptions for specific event types (Riad et al., 1999; Peacock et al., 2005). In other words, when a natural disaster strikes, household differences are argued to influence the choices made and the capacity to manage risk (Riad et al., 1999). The findings suggest that the coastal residents are either generally unaware of their own vulnerability to environmental hazards, or despite living in different circumstances have common perspectives regarding their vulnerability (see also Wolf et al., 2010).

This poses questions for vulnerability research that identifies the most vulnerable people and places through a combination of physical vulnerability and socio-demographic data (Fekete, 2009; Nelson et al., 2010b; Tan and Chadbourne, 2014). Such studies neglect the coping strategies that are applied by those residing in the communities as well as residents own perspectives of their vulnerability.

Geographic location

Drawing from psychological distance theory, geographic location is argued to influence risk perception – with those that reside in high risk areas being more risk adverse than those that live beyond high risk zones (Brody et al., 2007). Events that are temporally, socially, or geographically close to a person are argued to be more tangible; and this results in greater likelihood to adopt behaviours to mitigate the problem. However, within the coastal communities surveyed, households’ perceptions of their vulnerability to environmental hazards were not spatially associated (i.e., those living close to the coastline had similar perceptions of vulnerability to environmental hazards than those residing further from the coast). Therefore, the geographic coverage of the case study area, with households situated between 70 metres and 8.2 kilometres from the coast, did not affect their views on vulnerability to environmental hazards. This was further demonstrated in interviews. Households living close to the coast did not perceive they were vulnerable to the impacts of sea-level rise:

I don’t think it would actually affect our household, but where we live we are right on the beach. And in Mandurah we have canals.

### Table 5

Household perceptions of the influence of climate change on natural hazards in their local area and proportional differences in perceptions by past exposure to an environmental hazard.

<table>
<thead>
<tr>
<th>How much do you think climate change is influencing the environmental hazards in your local area?</th>
<th>Household has experienced an environmental hazard in their current location?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All surveyed households</td>
</tr>
<tr>
<td>To a great extent</td>
<td>12%</td>
</tr>
<tr>
<td>To a moderate extent</td>
<td>28%</td>
</tr>
<tr>
<td>To a limited extent</td>
<td>38%</td>
</tr>
<tr>
<td>Not at all</td>
<td>16%</td>
</tr>
<tr>
<td>Not sure</td>
<td>6%</td>
</tr>
</tbody>
</table>

*Indicates proportions that are significantly different from each other at the α = 0.05 level.
and stuff so I think it would affect the town but it wouldn’t actually affect the things I do day-to-day. [ID 292]
I can’t see it happening, even though I am two streets from the beach, because you have to go down a slight hill and then up a slight hill. It would have to be absolutely extreme, like a tsunami or something like that . . . I just cannot imagine it. [ID 307]
Consistent with a majority of recent studies, these results add further weight to the assertion that climate change remains for most a temporally and spatially distant issue that is seen to threaten people in other places of the globe or those born far into the future (Lorenzoni and Pidgeon, 2006), rather than a salient and pressing personal risk (Adger et al., 2009; Pidgeon, 2012).
Implications and conclusion
Several adaptation programs have emerged targeting coastal communities identified as vulnerable to the effects of climate change. However, while the link between risk perception and behaviour is recognised (Tucker et al., 2010; Wheeler et al., 2013), there is limited understanding of the comparative risk priorities of households in the Australian coastal zone. To begin to address this gap, this paper presented empirical data regarding perceptions of risk in two Australian coastal communities at the household scale. The results highlight three important implications for policy and research.
First, variation in risk perceptions between the two coastal communities was limited.4 Larger variation in risk perception was identified within the communities rather than between the communities, on the basis of variation in household characteristics, such as stage in life cycle, social and economic asset-base (affecting the priority of non-climatic risks), and past exposure to a climate risk. Therefore within community variation in risk perception is important when designing strategies to engage households in climate risk management. A uniform approach is unlikely to have saliency for all households.
Second, and in accordance with point one, there is variability in the risk perceptions of coastal households within small geographic areas (i.e., the same local government area) based on past exposure to climate hazards. Without past exposure to an environmental hazard, households prioritise day-to-day concerns such as financial welfare and health, over environmental concerns.
Conversely, those previously exposed to environmental hazards have a higher concern for environmental issues. This concern extends beyond the risk event previously experienced to other environmental concerns. As it is neither feasible nor desirable to expose households to climate hazards to increase their awareness of such events, Button (2013) suggests awareness raising via communication activities to heighten risk perceptions and promote individual action or acceptance of action implemented by others (i.e., State or local government). However, people only have a limited capacity for concern (Weber, 2010). Therefore, awareness raising may not deliver the outcomes sought by risk managers and instead transfer complacency (O’Neill and Nicholson-Cole, 2009; Weber, 2010). Further, awareness raising can reduce acceptance of climate information within sectors of the community based on pre-existing perceptions and values (Adger et al., 2009). Consequently, linking climate hazards to the every-day concerns of households, such as finance and health, may be a more effective strategy to raise the profile of climate related issues in the coastal zone (Spence and Pidgeon, 2009). This concept is consistent with mainstreaming adaptation, where policy makers and development agencies seek ways that managing climate risk can be pursued in combination with other more routine decisions, rather than treating climate risk as a separate issue (Klein et al., 2007). This approach may also address point one above, by targeting priority issues of concern. For example, for climate mitigation this has involved increasing the visibility of household energy use through smart-metering (Spence and Pidgeon, 2009), while for adaptation it could involve highlighting the cost-benefit of flood insurance, information disclosure on environmental risk (i.e., flood risk) at point of sale for residential properties (Climate Risk, 2014), or making households aware of potential climate risks on superannuation savings based on their investment portfolio.
Third, in contrast to existing environmental hazards literature (Peacock et al., 2005; Kellens et al., 2011), this paper demonstrates that geographic location and household characteristics may not affect perceptions of risk to environmental hazards. This is due to contextual factors that inform subjective risk perceptions of coastal households. Subjective risk perceptions are a combination of awareness of objective risks, expectations about households’ exposure to risks, and households’ ability to mitigate (ex
3. The return sample was smaller than the target sample; 2. The Moreton Bay Coastal Region captures the coastline

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