

How are coastal households responding to climate change?

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Abstract

In Australia, shared responsibility is a concept advocated to promote collective climate change adaptation by multiple actors and institutions. However, a shared response is often promoted in the absence of information regarding actions currently taken; in particular, there is limited knowledge regarding action occurring at the household scale. To address this gap, we examine household actions taken to address climate change and associated hazards in two Australian coastal communities. Mixed methods research is conducted to answer three questions: (1) what actions are currently taken (mitigation, actions to lobby for change or adaptation to climate impacts)? (2) why are these actions taken (e.g. are they consistent with capacity, experience, perceptions of risk); and (3) what are the implications for adaptation? We find that households are predominantly mitigating greenhouse gas emissions and that impact orientated adaptive actions are limited. Coping strategies are considered sufficient to manage climate risks, proving a disincentive for additional adaptive action. Influencing factors differ, but generally, risk perception and climate change belief are associated with action. However, the likelihood of more action is a function of homeownership and a tendency to plan ahead. Addressing factors that support or constrain household adaptive decision-making and action, from the physical (e.g. homeownership) to the social (e.g. skills in planning and a culture of adapting to change) will be critical in increasing household participation in adaptation.

Key words:

Vulnerability
Resilience
Risk
Decision-making
Environmental hazards

1.0 Introduction

Adaptation is argued to be a shared responsibility that requires participation by multiple actors and institutions¹ and suggests associated obligations to manage risks (Adger 2003; Adger et al. 2005; McLennan and Handmer 2012). Hence, in order to understand the process of adaptation it is beneficial to understand the actions occurring across different societal scales (e.g. individual, household, government). To date, however, in many developed countries adaptation has focused on public institutions (Gibbs and Hill 2011; Keys et al. 2014) and there exists limited knowledge regarding adaptation at the household level (Berrang-Ford et al. 2011; Ford et al. 2011). This is despite consensus that household level capacities are critical for successful adaptation (Moser and Pike 2015; Wamsler and Brink 2014). The household is the unit of action that resides between individuals and society, where personal values, societal norms and institutional demands meet to influence decisions and behaviors (Collins 2015). Many crucial decisions that affect vulnerability, such as investment in insurance, choice of residential location and the efficacy and existence of features intrinsic to the household (e.g. fans, window shutters) are made by the household (Wilk 1993). The household, therefore, provides a venue for independent action that, while influenced by governance mechanisms, provides an opportunity for collective individuals to express their adaptive agency —limitations imposed in some rental contexts notwithstanding (Burby et al. 2003). The degree to which the household as a venue for adaptive action is, however, embraced remains unclear, calling for further investigation into the role of the household in climate adaptation (Hughes and Sarzynski 2015; Wamsler and Brink 2014).

The concept of shared responsibility has variously been applied to particular issues within specific nations. For example, within Australia, the concept of shared responsibility has traditionally been applied in wildfire management, where household self-reliance in the face of risk has been emphasized to reduce reliance on external agencies (McLennan and Handmer 2012). However, the concept has more recently been transferred to climate change adaptation (e.g. Commonwealth of Australia 2015; Council of Australian Governments 2011; DCCEE 2010a). Under the broader discourse of shared responsibility for climate adaptation, households are assigned responsibilities because they are considered 'best placed to manage the risks associated with their [own] assets' (DCCEE 2010a; p. 7). Further, households will bear the costs of action because 'it is not feasible for government to bear all costs or to make decisions on behalf of individuals... that are better placed to manage their own risks' (DCCEE 2010a; p. 7). The devolution of responsibilities to households is supported by the notion of subsidiarity, where responsibility and cost of action are passed to the lowest level able to undertake it effectively (Marshall 2008; Nalau et al. 2015). To facilitate effective participation in adaptation, the Australian government argues household capacity must be developed (e.g. Council of Australian Governments 2011; DCCEE 2010a).

In seeking to develop the capacity of households to respond to climate hazards, the Australian government via its National Climate Resilience and Adaptation Strategy states it will disseminate 'authoritative climate information' and ensure 'appropriate regulatory and market frameworks are in place' (Commonwealth of Australia 2015; p. 6). However, a focus on information provision assumes increased access to information will translate to informed household adaptive action. Such an assumption neglects consideration of the other factors shaping household capacity such as financial capital, perceptions of self-efficacy and risk perception (Grothmann and Patt 2005). To address deficits in capacity, the Strategy reports that the Government will 'support those who have limited capacity to respond....through policy design choices and the social welfare system' (p. 9). Yet in the absence of information on household's current adaptive response and influencing factors, the assumption that

¹ Here we define institutions following North (1990) as: the set of rules, formal and informal (e.g. property rights, constitution, contracts, regulations), guiding human behaviour.

household capacity needs to be developed and that information provision and policies targeting general capacity (e.g. financial capital) will adequately address this deficit, remain unsubstantiated.

This paper, therefore, addresses a gap in understanding of household adaptive action by drawing on evidence from two Australian coastal communities. The focus on the coastal zone reflects its importance to the Australian economy, its recognised exposure to a range of climate hazards (e.g. sea-level rise, erosion, heatwaves, severe storms), and its status as the residential location of choice for many Australian households, accounting for over 85% of the population (Australian Bureau of Statistics 2004). We examine adaptive actions implemented by households and draw on theories of adaptive capacity (e.g. Bohensky et al. 2010) to examine the factors associated with different household responses. In turn, we reflect on the concept of shared responsibility as a tool to engage households in a collective adaptive response. Further, by examining the type of actions taken and influencing factors, we generate insights regarding household capacity and response that may inform initiatives seeking to provide incentives for household action.

2.0 Methods

A mixed-methods approach incorporating survey questionnaire and semi-structured interviews was implemented to collect data on household responses to climate change and associated hazards. Household responses to the threat of climate change and experienced environmental hazards (obtained via survey questionnaire) were considered in relation to proposed household response strategies for three hazard scenarios (semi-structured interviews), providing data on actual and intended adaptive behaviours.

2.1 Case Study Communities

The case study sites of Mandurah (Western Australia) and Moreton Bay (Queensland), Australia, were purposively selected to incorporate diverse demographic, socio-economic and environmental characteristics argued to indicate significant potential vulnerability to climate hazards. The communities are 'coastal commuter' sea-change² communities, indicating that they are located within driving distance of a capital city centre, contain a high proportion of elderly residents and households of diverse socio-demographic characteristics (Gurran et al. 2008). Development in the coastal margins, including marina developments, has exacerbated the physical vulnerability of these sites. As such, each is reportedly vulnerable to sea-level rise and associated coastal erosion and flooding (DCCEE 2009); and adaptation is considered paramount to maintain social and environmental values (DCCEE 2010b). A climate change risk assessment has been conducted in each site (e.g. Burton et al. 2009; Elrick et al. 2009). In Mandurah, climate change studies and associated local government responses are communicated to residents through public information sessions, online reports, and State government impact assessments (City of Mandurah 2014). In Moreton Bay, hazard preparation advice is disseminated to the community predominately through two campaigns (Get Ready Queensland and Harden Up)³. Collectively, the social and environmental characteristics of the communities provide an opportunity to explore the influence of household characteristics, exposure to climate hazards, trust in authorities, perceptions of climate change, and State and local management policy on adaptive action.

2.2. Survey Questionnaire

The survey questionnaire was delivered (postal and hand-delivery) to properties randomly selected from a residential database. Of those delivered (2,220), 400 completed surveys

² Sea-change is a term used to describe lifestyle driven population growth in outer urban coastal regions.

³ <https://getready.qld.gov.au/>; <http://hardenup.org/about-harden-up.aspx>

were returned. The return sample delivered an acceptable relative standard error of +/-5%, following Krejcie and Morgan (1970). For each respondent household a reference person provided responses on behalf of the whole household. The reference person was chosen by asking for the household member who was over 18 years of age and who was next to have their birthday. The survey contained three close-ended questions gathering information on household action for climate change and environmental hazards. Survey respondents were asked what actions that they had considered or taken to 'reduce any harmful impacts from climate change (e.g. changes in temperature, rainfall or storm activity)' and taken to 'address the impacts of environmental hazards (e.g. severe storm activity, flood, sea-level rise, drought, heatwaves, bushfires)'. The pre-defined actions drew on literature specifying hazard and climate change adaptation strategies available to households (e.g. Kaiser et al. 2003; Three Regions Climate Change Group 2008). In addition, the option of 'other' was provided, leaving space for actions not documented.

To explore actions taken and influencing factors, pre-defined and 'other' actions were grouped into: (i) actions to mitigate climate change (via reduction in greenhouse gas emissions), (ii) actions to lobby for change and (iii) impact orientated adaptive responses (Table 1). Impact orientated adaptive responses (IOAR) were defined as actions taken to address risks associated with physical climate impacts; for example, reducing water use to address water scarcity, having an emergency management plan or moving house. The categories differ from existing typologies applied in adaptation research, as existing typologies are not applicable at the household scale (e.g. Biagini et al. 2014; Preston et al. 2011) or for multiple hazards (e.g. Poussin et al. 2014). Further, mitigation and actions seeking to influence risk governance are rarely incorporated as action categories. Rather focus is placed on, for example, distinguishing between drivers of action versus no action (e.g. Tan et al. 2014) or structural versus avoidance measures (e.g. Poussin et al. 2014). Mitigation and lobbying are, however, important response options available to manage climate risks (Klein and Juhola 2014) and are worthy of investigation given reports that households have difficulty distinguishing between mitigation and adaptation (Glaas et al. 2015; van Kasteren 2014) and that perceived responsibility for adaptive action is related to cross-scale risk governance (Bickerstaff et al. 2008).

Table 1: Actions and associated categories

A score for each action category was assigned by summing respondent's scores for all relevant individual actions (0 if action was not taken, 1 if action was taken). The resultant score in each action category was recoded into one of three categories based on the level of action taken: one where the household had taken little or no action, another where the household had taken mixed action, and another where the household had taken most or all of the individual actions. In addition, factors influencing actions argued to contribute to community resilience were explored. The Australian National Strategy for Disaster Resilience states that communities are resilient when they: understand the risks that may affect them; have taken action to prepare for disasters; taken steps to anticipate and mitigate disasters; work in partnership with local authorities, and understand the mechanisms and processes through which assistance may be offered (COAG 2012; Council of Australian Governments 2011). Therefore, pre-defined actions demonstrative of community resilience were selected for analysis, including: contacting government agencies, moving house, making property adjustments, owning a household emergency response kit and/or evacuation plan (refer to Supplementary Table 1).

Potential drivers of action were selected by drawing on theories of capacity and action, including asset-based (e.g. Emery and Flora 2006), socio-cognitive (e.g. Grothmann and Patt 2005) and resilience frameworks (e.g. Folke et al. 2002; Patterson 2002). As such, potential drivers of action analysed in the study included household characteristics (for example, household tenure, income, and case-study location) and normative perceptions,

including experiences and beliefs (Wolf et al. 2013; Wolf and Moser 2011), agent capability (Butler and Pidgeon 2011; Harrison et al. 1996), action effectiveness (Fishbein and Ajzen 1975), trust in others (Adger et al. 2005; Fatti and Patel 2013; Irwin and Berigan 2014) and collective-efficacy (Grothmann and Patt 2005; Hinchliffe 1996). For each question, the household respondent was asked to rate perceptions on a 4-point scale (e.g. level of trust), with an additional option for 'not sure'. The responses were recoded into two dichotomous (e.g. 1 = some trust in others; and 0 = limited to no trust in others).

Significant differences in the implementation of action across each action category were assessed using cross-tabulation tables and the Chi-squared (χ^2) non-parametric test of association. Proportional differences across each layer were examined using a Z-test. Multinomial regression models further analysed the claimed likelihood of action. To avoid problems associated with multicollinearity, the correlation matrix of all predictor variables was examined. No correlation higher than 0.40 occurred and therefore all predictor variables were included (following Bryman and Cramer 2001). All results reported are statistically significant at the $\alpha=0.05$ confidence level unless otherwise stated.

2.3 Semi-structured interviews

During the survey, households nominated their willingness to participate in a follow-up interview to obtain further detail on household actions for three hazard scenarios: a severe storm, heatwave and sea-level rise (Supplementary Table 2). Forty-five household representatives nominated to participate. As the respondents self-selected to participate, self-selection bias may impact the findings; however, in seeking to address potential bias a maximum variation sample was obtained by profiling the household characteristics of those that self-selected and selecting those that represented the diversity in the communities (following Ritchie and Lewis 2003). In total, seventeen semi-structured interviews were conducted over the telephone with residents in Mandurah (8) and Moreton Bay (9). During the interviews the respondent described: the impact each scenario would have on their household, how they would respond, who should have primary responsibility for preparing and responding, and what the household needs to enact the response. The scenarios represented hazards likely to have been experienced (i.e. heatwave and severe storm) and a hazard the case-study areas are vulnerable to (DCCEE, 2009) but have limited direct experience with (i.e. sea-level rise). Hence, a comparative assessment between action for current (or familiar) and future (or novel) climate hazards could be made.

Interview responses were transcribed verbatim and coded by question in NVIVO. Adopting an interpretive approach (Yanow and Schwartz-Shea 2006), thematic analysis was undertaken identifying key words and phrases and categorising the data to create ordered concepts. The actions cited were predominantly impact orientated adaptive actions, as the actions sought to address the impacts of the hazard scenario, and were categorised as either coping or adaptive responses. Following Porter et al. (2014) and Kent et al. (2013) coping responses included intuitive, inexpensive, and accessible responses taken at the outset of, and/or during, an extreme weather event, or in its immediate aftermath. Adaptations were defined as more complex, costly, and challenging anticipatory actions, taken in the absence of an imminent threat in order to protect the household or area from current or future risks.

3. Results

3.1 Survey findings: Actions households have taken

The most widely adopted actions by the surveyed coastal households mitigate the impacts of climate change. Less than half of the surveyed households had taken impact orientated adaptive responses (IOAR) (beyond reducing water use) or actions to lobby for change

(Figure 1). The actions most widely adopted include reducing water use (67%) or mitigating climate change by reducing energy use (66%) and adopting energy efficient technologies (63%) (Figure 1). Voting for a particular political party or candidate (45% of surveyed households) was the next most commonly adopted action to manage the threat of climate change and associated environmental hazards. Less than half of the surveyed households had taken the remaining IOAR. Forty per cent of surveyed households reported they had increased home insulation to address the threat of climate change. This is a high proportion given the costs associated and may reflect government incentives available, e.g. the Australian government's national home insulation scheme, which was promoted as a strategy to combat climate change. Collective action such as joining local recovery or conservation efforts was limited, while 13% of households reported they had moved house to avoid the impacts of climate change or environmental hazards.

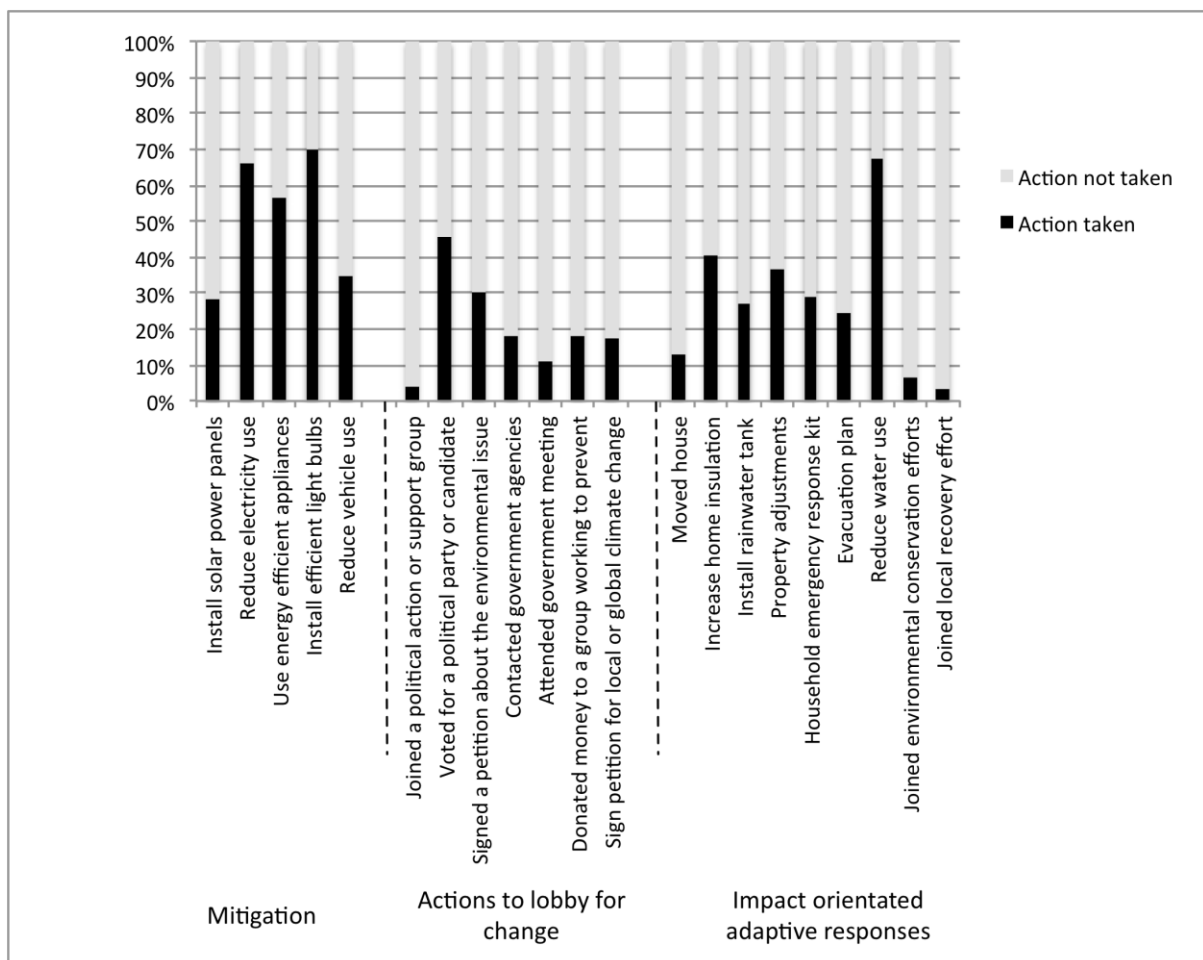


Figure 1: Proportion of surveyed households that had taken each action (total households = 400)

The implementation of action across each of the three categories was associated with perceptions of local area and household vulnerability, past exposure to an environmental hazard in the household's current location and a belief that climate change is influencing local area hazards (Table 2). A tendency to plan ahead was also associated with mitigation and IOAR, as too was homeownership. In both cases, households in rental accommodation were less likely to have acted.

Respondents that had taken most of the pre-defined mitigation actions had less trust in political leaders to act in the interest of their household and assigned lower perceived capability of government authorities to coordinate disaster response. This finding is in

contrast to other research on trust and pro-environmental behaviour, where trust in others is argued to increase the likelihood of action (Sara and Nurit 2014). Irwin and Berigan (2014) suggest that trust varies depending on cultural ties, where individualist cultures show a stronger positive relationship between trust and pro-environmental action. Following the definition of Irwin and Berigan (2014), the surveyed coastal communities could be classified as individualists; however, Australians have generally low levels of trust in governance agencies to act on climate change (Reser et al. 2012b). In this case, low trust appears to incentivise actions that mitigate climate impacts.

Table 2: Independent variables and their association with each category of action

The multinomial logistic regression results highlight factors influencing the likelihood that households had taken mixed action, or most or all actions, compared to those that had taken little to no action across each category (Table 3). The independent variables explained 21% to 28% of the variance in action (Table 3). While perceptions of vulnerability and past exposure to an environmental hazard were associated with action (Table 2), these factors did not explain the likelihood that a household had taken mitigation action or most to all of the IOARs—although they explained a two to seven fold increase in the likelihood of action to lobby for change (Table 3). The limited influence of past experience and perceptions of household vulnerability on the *likelihood* of more mitigation or IOAR may reflect generally low levels of perceived vulnerability within the case-study areas, where most households did not consider their local area (approx. 75%) or household (approx. 85%) vulnerable or very vulnerable to environmental hazards. Alternatively, the results may suggest that past experience and perceptions of household vulnerability have a non-causal relationship with the implementation of these actions.

Table 3 Prediction of level of action, by action category

As per the categories of action, factors associated with implementation of the individual actions argued to increase community resilience (moving house notwithstanding) was strongly associated with perceptions of local area and household vulnerability and past exposure to an environmental hazard (Table 4). Liaising with government officials is argued to increase community resilience by supporting knowledge transfer and collaboration (Council of Australian Governments 2011); however, in this case households contacting government officials had limited trust in political leaders to act in the interest of the household or to act on climate change (Table 4).

Binary logistic regression models seeking to identify factors and ratios of influence were statistically significant for all actions excluding having an emergency response kit; yet only explained between 12 and 15% of the variance in action. The likelihood that a household made property adjustments to reduce vulnerability to environmental hazards increased almost four fold if they were not in rental accommodation, while perceptions of household and local area vulnerability increased the likelihood that a household had an evacuation plan (3 fold) or emergency response kit (2 fold, significant to $p < 0.06$). Although not statistically significant at the 0.05 level, moving house to avoid the impacts of climate change or environmental hazards, was two-fold more likely if the household had limited trust in politicians to act in the interest of their household ($p < 0.06$) and did not believe individual households were capable of preventing harm from environmental hazards ($p < 0.06$) (Table 5).

Table 4 Independent variables and their association with selected individual actions

Table 5: Synthesis of factors associated with categories of action and selected actions indicative of community resilience

3.2. Interview findings: Actions households would take for hazard scenarios

The actions cited by interview respondents, regardless of the hazard scenario, predominantly represented intuitive, inexpensive, and accessible responses, which Porter et al. (2014) term coping responses. For example, modifying behaviours to avoid extreme heat periods, or removing loose items from the yard upon receipt of storm warnings (Table 6). To address the impacts of a severe storm, insurance, family and other social networks of support, as well as State Emergency Services were cited as part of the response strategy. Only for sea-level rise did household respondents cite a similar proportion of coping and more adaptive actions, including mitigation (cited by 25% of interviewed households) and moving from the area at risk. Moving to avoid sea-level rise was, however, only mentioned by households that considered it an accessible choice due to, for example, living in rental accommodation or because they were considering moving for reasons in addition to the hazard scenario (Table 6). While one respondent acknowledged the need to engage with governance authorities to manage the risk of sea-level rise, similar proactive actions were rarely cited as part of the response strategy. Rather, managing the threats posed by sea-level rise was considered a government responsibility.

The actions cited by interviewees constitute actions to respond to a hazard presented as an event requiring immediate action (e.g. leaking roof following severe storm) in contrast to the actions presented in the survey that can be taken to reduce vulnerability pre or post event by engaging in the governance of the risk, taking preparatory action (e.g. emergency response kit) or reducing exposure (e.g. moving house, property adjustments). The two differ and the former is likely to promote actions that cope with the impacts rather than prepare for the hazard. Therefore to facilitate comparison, interview respondents were asked what they would need to enact their response and any barriers to action, providing an opportunity to reflect on the factors that inform their choice of coping strategies. In most cases (85%), no external support or additional resources were perceived required to manage the severe storm or heatwave hazard scenario. In contrast, financial support was considered necessary to adapt to the impacts of sea-level rise. Therefore, despite a reliance on coping strategies pre and post impact actions to reduce vulnerability were rarely considered necessary. This may reflect low perceived vulnerability, perceived efficacy of coping strategies and/or a perception that the external factors that govern vulnerability (such as land use planning, post impact support services or mechanisms to offset risk, such as insurance) adequately manage the perceived risks.

Table 6 Actions, by type, cited as strategies to respond to the hazard scenarios

4. Discussion

Despite the recognised importance of local engagement in adaptation, household adaptive action in the case-study communities is limited. Pro-environmental actions to mitigate climate change and coping strategies to respond to environmental hazards are the dominant response to climate variability and change. These results are comparable with international and national adaptation assessments, including Berrang-Ford et al. (2011) who found government authorities take adaptive action while household responses arise as a reactive response to existing stimuli. Similarly, drawing on evidence from the United Kingdom, Porter et al. (2014) found households' predominately cope with climate hazards and autonomous household action is unlikely. Within Australia, a reliance on coping strategies to respond to climate hazards, such as heatwaves (Akompab et al. 2013; Banwell et al. 2012; Loughnan et al. 2014) and floods (Bird et al. 2013), and mitigation strategies to respond to the threat of climate change has also been documented (Dowd et al. 2012; Instone et al. 2013; Reser et

al. 2012a; van Riper et al. 2013). While risk perception is an important determinant of adaptive action, even communities exposed to severe climate hazards have not demonstrated a significant rate of adaptation comparative to coping (e.g. Bird et al. 2013).

On the basis therefore that adaptation is limited, what lessons can be drawn from this study for authorities seeking to promote adaptation at the household scale?

We found that the implementation of action was associated with perceptions of risk, climate change belief and past experience of a climate hazard, yet constraints on flexibility to act as a result of living in rental housing and limited forward planning for climate and non-climate related decisions within the household reduced the likelihood of more action (Table 5). The results extend other household scale adaptive capacity assessments, which have focused on objective characteristics (income, education, age) or perceptions of risk as determinants of single hazard response or mitigation action. By examining factors influencing action by action type we find, following Burch and Robinson (2007), that for one-way associations adaptation and mitigation are essentially driven by the same factors. However, the likelihood of more action to lobby for change is a function of risk perception; while home ownership, case-study location and a tendency to plan ahead increase the likelihood of more mitigation and IOAR. Further, for individual actions we found that household tenure remained an important determinant of action; while perceptions of household and local area vulnerability increased the likelihood that a household had an evacuation plan or emergency response kit. The findings concur with Unsworth et al. (2013) who linked threat appraisal with support for adaptation policy and Poussin et al. (2014) who found risk perception was not associated with structural or avoidance measures but with emergency preparedness measures. The findings also add further support to literature that argues household tenure is a determinant of adaptive action (e.g. Burby et al. 2003; Instone et al. 2013; Mee et al. 2014).

In short, the attributes associated with action differ by action type, but generally align to those reported by Marshall et al. (2014), including risk perception, skills in planning and flexibility to change. Equipped therefore with an understanding of actions taken and influencing factors, lessons may be drawn for authorities seeking to promote greater household participation in adaptation. These include: (i) social contracts and their influence action; (ii) social discourse and its role in promoting adaptive behaviours; and (iii) combining external metrics with communication to understand capacity for and barriers to action. Each is discussed in turn.

Social capital (e.g. bonding and bridging networks) is argued to increase community resilience by facilitating local and cross-scale collaboration (Council of Australian Governments 2011). We found, however, that while family networks are drawn on for support during severe climate hazards (e.g. severe storm or heatwave), less than 7% of respondents engaged in collective action to manage climate risks. In addition, cross scale collaboration was limited and when it occurred was most frequently undertaken by households with less trust in authorities to make 'appropriate' decisions. The drivers of limited participation in collective and cross-scale collaboration require further investigation, however social contracts (a tool for managing the relationship between citizens and states in western liberal democracies) are postulated as a primary mechanism by which adaptation to climate change proceeds (Adger et al. 2013; O'Brien et al. 2009). Within Australia, self-reliance is strongly promoted in hazard management and adaptation policy (Aldunce et al. 2015; Allen 2013) to reduce the 'unrealistic expectations and unsustainable dependencies' placed on government support services (Council of Australian Governments 2011; p. 2). Self-reliance advocates individual interests and action as opposed to collective interests and responses. Therefore, whether the narrative of self-reliance embedded within the discourse of shared responsibility in Australia sets a frame that opposes collaboration is a point worthy of further consideration. However, if community collaboration and partnerships are perceived

critical to resilience, a stronger emphasis on participation, community mindedness and collaboration within social contracts mediating adaptation may be required.

Second, the ratio of mitigation compared to actions to lobby for change and IOAR matches levels of advocacy for these responses at the household scale. For example, mitigation was more frequent than other action types even in instances when the cost of action was high (e.g. installing solar photovoltaic cells, increasing home insulation). Pro-environmental behaviours that mitigate greenhouse gas emissions have received significant policy attention and specifically targeted the household level (Kent 2009). In turn, the personalized discourse of household capability and responsibility for mitigation has contributed to social norms of resource conservation (Dowd et al. 2012). For example, Yoon et al. (2013) found that intentions to partake in mitigation were positively predicted by subjective norms. In comparison, in developed nations public institutions lead adaptation while households implement reactive coping responses (Berrang-Ford et al. 2011). As discussed, a discourse of personal responsibility for adaptation targeted at households is developing, yet it has not been accompanied with information on the types of responses households could or should be taking to enact this responsibility. Therefore, demonstrating adaptive actions households can take, the contribution of those actions to individual and community vulnerability reduction, and rewards when action is taken early (Moser and Pike 2015; Porter et al. 2014) will be an important step in generating discourse on the households role in adapting to climate risks. Such social discourse is argued important in contributing to engagement and subsequent action (Bushell et al. 2015; Nisbet 2009).

Finally, beyond further discourse on the importance of household adaptive action, the personal (e.g. values and beliefs) and contextual (e.g. public policy, climatic conditions) barriers that constrain action are numerous and varied (Stern 1999). Studies seeking to quantify influencing factors are often left with a high proportion of unexplained variance (e.g. Grothmann and Reusswig 2006) and this study was no exception. Consequently Stern (1999) recommends engaging households directly to discuss the factors inhibiting action. In turn, by combining external metrics with communication a greater understanding of capacity for and barriers to action is obtained. Enacting such an approach in this study revealed the perceived efficiency of coping strategies, competing priorities of concern, living in rental housing, limited capacity for, or interest in, forward planning and low risk perceptions influence adaptive behaviour. Therefore, to realise broader participation in adaptation, greater research attention should be placed on understanding and addressing the contextual (e.g. household tenure) and personal barriers (e.g. increasing awareness of risks, benefits of action and action efficacy, and skills in planning) shaping household adaptive choice.

Conclusion

To increase household participation in adaptation the Australian government advocates shared responsibility and, in conjunction, mandates the development of household capacity to facilitate action. The need to build household capacity has, however, been assumed in the absence of empirical evidence on household adaptive practice. To address this gap in knowledge we compiled evidence of household climate change response (from mitigation to actions that lobby for change and impact orientated adaptive responses) from two Australian coastal communities. The limited occurrence of adaptive action provides some support for the argument that capacity needs to be developed. However, risk perceptions and financial capital, which are often the targets of interventions seeking to incentivise action, are not the sole barriers to action. Rather, a narrative of shared responsibility emphasising self-reliance removes incentives for collaboration whilst missing opportunities to raise awareness of available adaptive choices and their contribution to vulnerability reduction. Demonstrating the rewards to householders, and society more widely, when adaptations are taken early will be an important facet of a broader narrative regarding the role of the household in adaption. In addition, the personal and contextual barriers that are variable within and between

communities require further research attention if greater household participation in adaptation is sought. In the interim, governments will have to remain vigilant and pursue adaptive actions and implement interventions at other scales to reduce community vulnerability to climate change.

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Reference

- Adger N (2003) Social Capital, Collective Action and Adaptation to Climate Change *Economic Geography* 79:387-404
- Adger N, Brown K, Tompkins E (2005) The Political Economy of Cross-Scale Networks in Resource Co-Management *Ecology and Society* 10:9
- Adger N, Quinn T, Lorenzoni I, Murphy C, Sweeney J (2013) Changing social contracts in climate-change adaptation *Nature Climate Change* 3:330-333
- Akompab DA, Bi P, Williams S, Grant J, Walker IA, Augoustinos M (2013) Heat Waves and Climate Change: Applying the Health Belief Model to Identify Predictors of Risk Perception and Adaptive Behaviours in Adelaide, Australia *International Journal of Environmental Research and Public Health* 10:2164-2184
- Aldunce P, Beilin R, Howden M, Handmer J (2015) Resilience for disaster risk management in a changing climate: Practitioners' frames and practices *Global Environmental Change* 30:1-11
- Allen M (2013) Deconstructing 'Resilience' in the Aftermath of Disasters in Australia *The Senshu Social Capital Review* 4:45-64
- Australian Bureau of Statistics (ABS)(2004) Year Book Australia, 2004. Australian Bureau of Statistics. <http://www.abs.gov.au/>. Accessed 16 February 2015
- Banwell C, Dixon J, Bambrick H, Edwards F, Kjellstrom T (2012) Socio-cultural reflections on heat in Australia with implications for health and climate change adaptation *Global Health Action* 5:1-9
- Berrang-Ford L, Ford JD, Paterson J (2011) Are we adapting to climate change? *Global Environmental Change* 21:25-33
- Biagini B, Bierbaum R, Stults M, Dobardzic S, McNeeley SM (2014) A typology of adaptation actions: A global look at climate adaptation actions financed through the Global Environment Facility *Global Environmental Change* 25:97-108
- Bickerstaff K, Simmons P, Pidgeon N (2008) Constructing responsibilities for risk: negotiating citizen-state relationships *Environment and Planning A* 40:1312-1330
- Bird D, King D, Haynes K, Box P, Okada T, Nairn K (2013) Impact of the 2010-11 floods and the factors that inhibit and enable household adaptation strategies. National Climate Change Adaptation Research Facility (NCCARF), Gold Coast, Queensland.
- Bohensky E, Stone-Jovicich S, Larson S, Marshall N (2010) Adaptive capacity in theory and reality: Implications for governance in the great barrier reef region. In Armitage D and Plummer D, editors. *Adaptive capacity and environmental governance*. Springer, Berlin Heidelberg.
- Bryman A, Cramer D (2001) Quantitative Data Analysis with SPSS Release 10 for Windows: A Guide for Social Scientists. Routledge, London
- Burby RJ, Steinberg LJ, Basolo V (2003) The Tenure Trap : The Vulnerability of Renters to Joint Natural and Technological Disasters *Urban Affairs Review* 39:32-58
- Burch S, Robinson J (2007) A framework for explaining the links between capacity and action in response to global climate change *Climate Policy* 7:304-316
- Burton D, Mallon K, Taygfeld P, Laurie E, Bowra L (2009) Scoping Climate Change Risk for Moreton Bay Regional Council (MBRC). Climate Risk Pty Ltd, Brisbane, Queensland.
- Bushell S, Colley T, Workman M (2015) A unified narrative for climate change *Nature Climate Change* 5:971-973
- Butler C, Pidgeon N (2011) From 'flood defence' to 'flood risk management': exploring governance, responsibility, and blame *Environment and Planning C* 29:533-547

- City of Mandurah (2014) Climate Change. City of Mandurah, <http://www.mandurah.wa.gov.au/climatechange.htm>. Accessed 17 February 2015
- Collins R (2015) Keeping it in the family? Re-focusing household sustainability *Geoforum* 60:22-32
- Commonwealth of Australia. 2015. National climate resilience and adaptation strategy, Commonwealth of Australia, Canberra, ACT.
- Council of Australian Governments (2011) National Strategy for Disaster Resilience: Building the resilience of our nation to disasters, Commonwealth of Australia, Barton ACT.
- Council of Australian Governments (COAG) (2012) Climate Change Adaptation: National Adaptation Priorities and Roles and Responsibilities. Commonwealth of Australia. <http://www.coag.gov.au/node/509>. Accessed 12 February 2015
- Department of Climate Change and Energy Efficiency (DCCEE) (2009) Climate Change Risks to Australia's Coast: A first pass national assessment. Department of Climate Change and Energy Efficiency, Commonwealth of Australia, Barton ACT
- Department of Climate Change and Energy Efficiency (DCCEE) (2010a) Adapting to Climate Change in Australia: An Australian Government Position Paper. Department of Climate Change, Commonwealth of Australia, Barton ACT
- Department of Climate Change and Energy Efficiency (DCCEE) (2010b) Developing a national coastal adaptation agenda: A report on the national climate change forum. Commonwealth of Australia, Barton ACT
- Dowd A, Ashworth P, Carr-Cornish S, Stenner K (2012) Energymark: Empowering individual Australians to reduce their energy consumption *Energy Policy* 51:264-276
- Elrick C, Travers A, Kay R (2009) Coastal Zone Climate Change Risk Assessment and Adaptation Plan: Summary Report. Report prepared by Coastal Zone Management Pty Ltd for the City of Mandurah, Western Australia
- Emery M, Flora C (2006) Spiraling-up: Mapping community transformation with community capitals framework *Community Development* 37:19-35.
- Fatti CE, Patel Z (2013) Perceptions and responses to urban flood risk: Implications for climate governance in the South *Applied Geography* 36:13-22
- Fishbein M, Ajzen I (1975) *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Addison-Wesley, Reading, MA
- Folke C, Carpenter S, Elmqvist T, Gunderson L, Holling CS, Walker B (2002). Resilience and sustainable development: Building adaptive capacity in a world of transformations *Ambio* 31:437-440.
- Ford JD, Berrang-Ford L, Paterson J (2011) A systematic review of observed climate change adaptation in developed nations *Climatic Change* 106:327-336
- Gibbs M, Hill T (2011) Coastal Climate Change Risk: Legal and Policy Responses in Australia. Department of Climate Change and Energy Efficiency, Commonwealth of Australia.
- Glaas E et al. (2015) Facilitating climate change adaptation through communication: Insights from the development of a visualization tool *Energy Research & Social Science* 10:57-61
- Grothmann T, Patt A (2005) Adaptive capacity and human cognition: The process of individual adaptation to climate change *Global Environmental Change* 15:199-213
- Grothmann T, Reusswig F (2006) People at Risk of Flooding: Why Some Residents Take Precautionary Action While Others do not *Natural Hazards* 38:101-120
- Gurran N, Hamin E, Norman B (2008) Planning for climate change: Leading Practice Principles and Models for Sea Change Communities in Coastal Australia. Report prepared for the National Sea Change Taskforce, The University of Sydney, New South Wales.
- Harrison C, Burgess J, Filius P (1996) Rationalising environmental responsibilities: A comparison of lay publics in the UK and the Netherlands *Global Environmental Change* 6:215-234
- Hinchliffe S (1996) Helping the earth begins at home: The social construction of socio-environmental responsibilities *Global Environmental Change* 6:53-62
- Hughes S, Sarzynski A (2015) Building capacity for climate change adaptation in urban areas: Editors' introduction *Urban Climate* 95: 1-66
- Instone L, Mee KJ, Palmer J, Williams M, Vaughan N (2013) Climate change adaptation and the rental sector. University of Newcastle, National Climate Change Adaptation Research Facility (NCCARF), Gold Coast, Queensland
- Irwin K, Berigan N (2014) Trust, Culture and Cooperation: A Social Dilemma Analysis of Pro-Environmental Behaviors *The Sociological Quarterly* 54:424-449

- Kaiser FG, Doka G, Hofstetter P, Ranney MA (2003) Ecological behavior and its environmental consequences: a life cycle assessment of a self-report measure *Journal of Environmental Psychology* 23:11-20
- Kent J (2009) Individualized responsibility and climate change: 'if climate protection becomes everyone's responsibility, does it end up being no-one's? *Cosmopolitan Civil Societies Journal* 1:132-149
- Kent N et al. (2013) PREPARE - The contribution and role of local and household level adaptation in overall UK adaptation, Part of the PREPARE Programme of research on preparedness, adaptation and risk, Final Report for project ERG1211 by Ricardo-AEA for Defra, Report reference Ricardo-AEA/R/ED58163/PREPARE R2/Issue 1.0.
- Keys N, Bussey M, Thomsen DC, Lynam T, Smith TF (2014) Building adaptive capacity in South East Queensland, Australia *Regional Environmental Change* 14:501-512
- Klein RJT, Juhola S (2014) A framework for Nordic actor-oriented climate adaptation research *Environmental Science & Policy* 40:101-115
- Krejcie R, Morgan DW (1970) Determining sample size for research activities *Educational and Psychological Measurement* 30:607-610
- Loughnan ME, Carroll M, Tapper N (2014) Learning from our older people: Pilot study findings on responding to heat *Australasian Journal on Ageing* 33:271-277
- Marshall G (2008) Nesting, subsidiarity, and community-based environmental governance beyond the local level *International Journal of the Commons* 2:75-97
- Marshall NA, Stokes CJ, Webb NP, Marshall PA, Lankester AJ (2014) Social vulnerability to climate change in primary producers: A typology approach *Agriculture, Ecosystems & Environment* 186:86-93
- McLennan B, Handmer J (2012) Changing the rules of the game: mechanisms that shape responsibility-sharing from beyond Australian fire and emergency management *The Australian Journal of Emergency Management* 27:7-13
- Mee KJ, Instone L, Williams M, Palmer J, Vaughan N (2014) Renting Over Troubled Waters: An Urban Political Ecology of Rental Housing *Geographical Research* 52:365-376
- Moser SC, Pike C (2015) Community engagement on adaptation: Meeting a growing capacity need *Urban Climate* 14:111-115
- Nalau J, Preston BL, Maloney MC (2015) Is adaptation a local responsibility? *Environmental Science & Policy* 48:89-98
- Nisbet MC (2009) Communicating Climate Change: Why Frames Matter for Public Engagement *Environment: Science and Policy for Sustainable Development* 51:12-23
- North DC (1990) *Institutions, institutional change and economic performance* Cambridge University Press, New York.
- O'Brien K, Hayward B, Berkes F (2009) Rethinking Social Contracts: Building Resilience in a Changing Climate *Ecology and Society* 14
- Patterson J (2002) Understanding family resilience *Journal of Clinical Psychology* 58:233-246
- Porter JJ, Dessai S, Tompkins EL (2014) What do we know about UK household adaptation to climate change? A systematic review *Climatic Change* 127:371-379
- Poussin JK, Botzen WJW, Aerts JCJH (2014) Factors of influence on flood damage mitigation behaviour by households *Environmental Science & Policy* 40:69-77
- Preston BL, Westaway RM, Yuen EJ (2011) Climate adaptation planning in practice: an evaluation of adaptation plans from three developed nations *Mitigation and Adaptation Strategies for Global Change* 16:407-438
- Reser JP, Bradley GL, Glendon AI, Ellul MC, Callaghan R (2012a) Public risk perceptions, understandings and responses to climate change and natural disasters in Australia, 2010 and 2011. National Climate Change Adaptation Research Facility (NCCARF), Gold Coast, Queensland
- Reser JP, Bradley GL, Glendon AI, Ellul MC, Callaghan R (2012b) Public Risk Perceptions, Understandings, and Psychological Responses to Climate Change and Natural Disasters in Australia and Great Britain. National Climate Change Adaptation Research Facility (NCCARF), Gold Coast, Queensland
- Ritchie J, Lewis J (2003) *Qualitative research practice: A guide for social science students and researchers* SAGE Publications, London
- Sara A, Nurit C (2014) Pro-Environmental Behaviour and Its Antecedents as a Case of Social and Temporal Dilemmas *British Journal of Education, Society and Behavioural Science* 4:508-526
- Stern P (1999) Information, Incentives and Proenvironmental Consumer Behavior *Journal of Consumer Policy* 22:461-478

- Tan Y, Liu X, Hugo G (2014) Exploring relationship between social inequality and adaptations to climate change: evidence from urban household surveys in the Yangtze River delta, China *Population and Environment* 36 (4):400-428
- Three Regions Climate Change Group (2008) *Your home in a changing climate: Retrofitting existing homes for climate change impacts*. Report for Policy Makers. Three Regions Climate Change Group, London
- Unsworth K et al. (2013) What about me? Factors affecting individual adaptive coping capacity across different populations. The University of Western Australia, National Climate Change Adaptation Research Facility (NCCARF), Gold Coast, Queensland
- van Kasteren Y (2014) How are householders talking about climate change adaptation? *Journal of Environmental Psychology* 40:339-350
- van Riper CJ, Kyle GT, Sutton SG, Yoon JI, Tobin RC (2013) Australian residents' attitudes toward pro-environmental behaviour and climate change impacts on the Great Barrier Reef *Journal of Environmental Planning and Management*
- Wamsler C, Brink E (2014) Interfacing citizens' and institutions' practice and responsibilities for climate change adaptation *Urban Climate* 7:64-91
- Wilk R (1993) Altruism and self-interest: Towards an anthropological theory of decision making *Research in Economic Anthropology* 14:191-212
- Wolf J, Alice I, Bell T (2013) Values, climate change, and implications for adaptation: Evidence from two communities in Labrador, Canada *Global Environmental Change* 23:548-562
- Wolf J, Moser SC (2011) Individual understandings, perceptions, and engagement with climate change: insights from in-depth studies across the world *Wiley Interdisciplinary Reviews: Climate Change* 2:547-569
- Yanow D, Schwartz-Shea P (2006) *Interpretation and Method: Empirical Research Methods and the Interpretive Turn*. M.E. Sharpe, Inc., United States of America
- Yoon JI, Kyle GT, Van Riper CJ, Sutton SG (2013) Testing the Effects of Constraints on Climate Change-Friendly Behavior among Groups of Australian Residents *Coastal Management* 41:457-469