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ORIGINAL ARTICLE

Variation in perception of environmental change in nine Solomon Islands communities: implications for securing fairness in community-based adaptation

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Abstract Community-based approaches are pursued in recognition of the need for place-based responses to environmental change that integrate local understandings of risk and vulnerability. Yet the potential for fair adaptation is intimately linked to how variations in perceptions of environmental change and risk are treated. There is, however, little empirical evidence of the extent and nature of variations in risk perception in and between multiple community settings. Here, we rely on data from 231 semi-structured interviews conducted in nine communities in Western Province, Solomon Islands, to statistically model different perceptions of risk and change within and between communities. Overall, people were found to be less likely to perceive environmental changes in the marine environment than they were for terrestrial systems. The distance to the nearest market town (which may be a proxy for exposure to commercial logging and degree of involvement with the market economy), and gender had the greatest overall statistical effects on perceptions of risk. Yet, we also find that significant environmental change is underreported in communities, while variations in perception are not always easily related to commonly assumed fault lines of vulnerability. The findings suggest that there is an urgent need for methods that engage with the drivers of perceptions as part of community-based approaches. In particular, it is

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important to explicitly account for place, complexity and diversity of environmental risk perceptions, and we reinforce calls to engage seriously with underlying questions of power, culture, identity and practice that influence adaptive capacity and risk perception.

Keywords Adaptation · Community-based adaptation · Fairness · Risk perception · Solomon Islands · Climate change

Introduction

In circumstances where community-based approaches are prioritised as a means of environmental governance, perceptions of environmental change and risk have important consequences for fair adaptation. While enabling place-based adaptation actions that are appropriate to the scale of environmental impacts, participatory and decentralised approaches do not automatically guarantee the rights or entitlements of poor or marginalised groups (Cote and Nightingale 2012). Studies have repeatedly demonstrated how underlying power relations and cultural values create a complex context in which governance and management interventions can unwittingly contribute to elite capture (e.g. Peet and Watts 2004). Within this, the role played by variations in perceptions of change and risk has particular significance, limiting response options and curtailing the capacity to adapt of marginalised or less powerful groups (Cutter et al. 2003; Cutter and Emrich 2006; Jones and Boyd 2011; Ensor et al. 2015).

Studies of environmental risk perception rarely focus on the "contexts and characteristics of people and places" and "do not adequately account for societies and scenarios in the under-developed world" (Walker et al. 2014:710). At the same time, initiatives aiming to foster adaptive responses to environmental change have tended to overlook the importance of context-specific change and perceptions of risk, focusing instead on a single change, and treating all communities as the same (Dodman and Mitlin 2011; Bennett et al. 2015). While frequently adopted as a scale of study and action, communities are not homogenous units. They can differ in their geography and natural resources, types of livelihood activities and use of different environmental systems and in their sense of place, social-cultural practices, beliefs, norms, histories and politics. All of these factors shape localised constructions of environmental risk and the decisions made in response (Venables et al. 2012; Granderson 2014; Rodríguez-Carreras et al. 2014; Walker et al. 2014). Recent calls for more empirical studies on the local nature of environmental change recognise that science and modelling cannot capture these local processes and that multiple exposures unfold and are experienced differently between and within communities (Bennett et al. 2014b; Walker et al. 2014).

Community-based alternatives to top-down governance are invoked precisely to account for this diversity and to harness local understandings of change (Green et al. 2010), and community-based adaptation approaches in particular have received increasing attention among researchers and practitioners (Ensor et al. 2016; Ensor et al. 2014; Spires et al. 2014; Forsyth 2013; Dodman and Mitlin 2011). Local ecological knowledge can provide information about slow and rapid climate and ecological changes at the community level (Sagarin and Micheli 2001; Couzin 2007; Alexander et al. 2011) and also play an important role in defining the way environmental change is interpreted and understood as risk (Adger et al. 2013; Brook and McLachlan 2008; Naess 2013; Aswani and Lauer 2014). Yet as studies of adaptive capacity have revealed, social, historical, political and institutional variations within and between communities can determine the distribution of benefits and costs that flow from community-based approaches (Ensor et al. 2015). Differences in perception of environmental change and risk interact with these variations, adding to the challenge of developing community-based approaches that are both fair and effective.

In this paper, we illustrate that variability in perceptions of risk and change reveals important avenues of enquiry for research and practice if community-based adaptation is to be both equitable and effective. Our study focuses on perceptions of multiple environmental changes and risks among resource-dependent coastal communities in Solomon Islands. We examine six locally recognised, major environmental and resource systems relevant to the livelihoods of coastal communities. During fieldwork, community respondents were asked to describe changes they had perceived or observed in their lifetime across these systems. Based on these data, individual differences in perceptions of change and risk were investigated in nine communities by combining a detailed household survey with a systematic ethnographic interviewing process. The survey data were analysed statistically to assess how perceived changes depend on characteristics of each respondent. Our approach shows that different groups perceive environmental risks differently, within and between communities.

In the Pacific context, it is widely recognised that cultural and spiritual values, individual experiences, and traditional resource management practices have significant implications for perceptions of risk and the ability to adapt (Granderson 2017; Warrick 2016; Weir et al. 2016; Nunn et al. 2016; Mortreux and Barnett 2009). These factors can vary significantly between communities and across scales, leading to calls for adaptive approaches to be pursued at the community scale. Participation of communities can support the development of culturally appropriate responses to environmental change that acknowledge the significance of spirituality and sense of place in natural resource management decision-making, while supporting traditional decision-making structures to respond

to the pace and complexity of contemporary challenges (Nunn et al. 2014; Nunn et al. 2016, Buggy and McNamara 2015). Crucially, community-based and participatory approaches are seen as a strategy to draw in the extensive ecological and biocultural knowledge which is found on Pacific small islands and which has underpinned localised resilience and adaptability (McMillen et al. 2014; Remling and Veitayaki 2016). Yet, despite this tradition of resilience, the need to understand how best to support effective community-based responses is all the more essential in the Pacific, where climate variability and extremes are common yet the processes that lead to climate change are often not recognised at the local level (Weir 2016; Nunn et al. 2014; Remling and Veitayaki 2016).

The next section reviews the literature on perceptions of environmental change and risk. We then provide a brief background to the environmental systems and communities where the surveys were conducted. The mixed methods approach is summarised in the subsequent section. Since the focus of this paper is on the qualitative implications of the findings, we refer readers to the electronic supplementary material for more detailed information about the statistical analysis. We present our findings and discuss how this may affect small coastal communities' localised responses to environmental change. In so doing, we hope to reveal the complexity of the community as a venue for development practitioners working to foster collective community-based responses and fair adaptation to ongoing environmental changes.

Perceptions of environmental risk and change

Perceptions of change and risk are shaped by people's everyday lives and what they do, their social and political-economic settings and their relationships and networks (Kuruppu and Liverman 2011; Wolf and Moser 2011; Walker et al. 2014). Social hierarchies such as gender may also shape perceptions of change and risk insofar as these designate people's place and power in communities and shape their livelihood practices and access to resources (Lebel et al. 2017; Bee 2016; Razavi 2009; Cole et al. 2014; Sarapura and Puskur 2014). Identity has been found relevant in shaping perceptions of change and risk (Frank et al. 2011; Wester-Herber 2004). Frank et al. (2011) illustrate how farmers might perceive risk through an identity lens, "such that farmers' perception of themselves in relation to others shapes how they interpret threats to their wellbeing and livelihoods" (Frank et al. 2011: 75). Identity is often interlinked with sense of place, which itself may mediate the way change and risks are understood (Fresque-Baxter and Armitage 2012; Rodríguez-Carreras et al. 2014; Sachdeva 2016). Granderson (2014) argues for greater engagement with the interpretive social sciences in offering a more holistic account of risk. She suggests that risk is bound up in people's "shared values and worldviews, their sense of place, justice and accountability, discourses and power, deeply enmeshed in the cultural and political processes at the community level" (Granderson 2014: 59). Such perspectives draw attention to the limitations of assuming risk assessment by individuals, communities and groups as a straightforward responsive pathway to action and that the various barriers to adaptation and behavioural change intervene only after risk is appraised or constructed (Grunblatt and Alessa 2017; Stern 2016; Grothmann and Patt 2005; Tucker et al. 2010; Gifford et al. 2011; Adger et al. 2013).

Perspectives informed by psychological theory have drawn attention to how cognition and emotion lead to systematic biases in how people appraise risk, how they perceive their own capacity to respond and weigh up the costs and benefits of action (Slovic 1987; Grothmann and Patt 2005; Breakwell 2010; Granderson 2014; Frank et al. 2011). Alongside material and structural barriers to adaptive responses (and ignorance of a problem), much has been written about limited cognition and how it can create "dragons of inaction" (Gifford 2011). These include "environmental numbness" (Gifford 2011: 292) when there are too many cues to monitor, valuing the present while undervaluing distant risks, scepticism and uncertainty about change, external locus of control, cognitive dissonance and denial (Kollmuss and Agyeman 2002; Feygina et al. 2010; Gifford et al. 2011; Morton et al. 2011; Smith et al. 2011; Whitmarsh 2011; Navarro 2017).

While urgent, the complexity associated with risk perception should give reasons for adaptation practice to be cautious. Efforts at community-based decision-making may become unfair through elite capture or the marginalisation of the perspectives held by those who are least powerful. Framings of perceptions of risk by more dominant groups may prevail or go unchallenged (e.g. local elites who speak for community members or community members that reproduce elite discourses), leading to exclusion of groups (and their knowledge or values) based on hierarchies of gender, age, ethnicity, religion and socio-economic position that are reinforced through norms and practices of decision making (Dodman and Mitlin 2011; Cote and Nightingale 2012). Moreover, heterogeneity in social-cultural backgrounds and perceptions make community-based collective action challenging (Varughese and Ostrom 2001). Pluralism in experiences and perceptions of environmental change and their risks within communities may raise tensions in aligning constructions of risk and enabling collective responses. Intra-community differences in perceived changes may lead to uncertainty which may reduce the intention to act, increase individualism (Morton et al. 2011) and increase conflict (Rodríguez-Carreras et al. 2014).

In examining justice dilemmas in adaptation to climate change, Paavola and Adger (2006: 594) conclude that fair adaptation requires "putting the most vulnerable first and equal participation of all". The community scale has been

identified as an appropriate venue for fair adaptation, as participatory methods can be used to engage with the poor and vulnerable, resulting in a form of adaptation that is "more attuned to local needs, and consequently better able to reduce vulnerability to climate change" (Forsyth 2013). Community-based adaptation to environmental change (CBA) focuses on "a community-led process, based on communities' priorities, needs, knowledge and capacities" (Reid et al. 2009: 13) that requires practitioners to explore climate and environmental change impacts and responses in partnership with communities, drawing out local knowledge and understanding of the complex relationship between environmental hazards and livelihoods (Pringle and Conway 2012). Community perceptions are relied on to identify local manifestations of environmental change. However, the complexity of this task is often underestimated in the existing literature. For example, a critical examination of perception is absent in a review of literature that focus on the challenges to CBA (Forsyth 2013; Spires et al. 2014), despite agreement that "[e]xisting knowledge and experience of changes within communities need to be acknowledged as starting points for opening up conversations about adaptation." (Spires et al. 2014: 9). Critical engagement with the underlying social and cultural dynamics at play in risk perception is essential if the central role of local knowledge in community-based adaptation is to yield the presumed benefits for equity in adaptation processes and outcomes.

In the following study, we focus on the perceptions of risks and environmental change among different social groups in different communities in Solomon Islands, investigating the extent and nature of variations in perception in and between village settings. In so doing, we illustrate the highly differentiated assessments of risk that community-based adaptation must account for and reinforce calls for adaptation to engage seriously with underlying questions of power, culture, identity and practice that inform adaptive capacity and risk perception, as well as cut across communities and localities in often unexpected ways.

Background

This article draws on a study that was carried out in nine villages across Western Province of Solomon Islands, including in Roviana (Nusa Hope, Kindu, Nusa Banga, Olive) and Vonavona lagoons (Kinda), Marovo lagoon (Niniveh, Bopo, Bareho) and Vella Lavella Island (Leona) (Fig. 1). Lagoon systems are extensive in Western Province and comprise diverse socio-ecological systems. Marovo lagoon in the southeast consists of small islands and a raised double barrier reef (Albert et al. 2007). It is rich in biodiversity and is the largest saltwater lagoon in the world covering some 700 km^2 (Hviding 2005). Roviana and Vonavona lagoons are located in South New Georgia of the Western Province. The Roviana lagoon is shallow, approximately 50 km long, and enclosed by raised coral reef islands between 2 and 3 km offshore (Hamilton and Walter 1999). Vonavona lagoon is smaller than Roviana and has a somewhat different topography.

The sense of identity among Western Province inhabitants is strongly connected to the multiple cultural groups that inhabit the islands, their shared church community and inherited chiefly system that govern a community's land and sea resources (Aswani et al. 2015; Bennett et al. 2015). The islands are home to around 77,000 people speaking up to 16 major languages, 8 of which are found on South New Georgia (Bennett et al. 2015; Hamilton and Walter 1999). The Roviana lagoon is unusual in being populated by closely related tribal groups who speak a common language in multiple villages along the mainland and barrier island (Hamilton and Walter 1999). The common language (Roviana) is also spoken in Vonavona, while the more distant populations inhabiting Vella Lavella Island and Marovo lagoon belong to different language groups (Bennett et al. 2015). Vella Lavella Island is located west of New Georgia, near Ghizo, and the communities here are coastal, exploiting very different land- and seascapes to those living on the lagoons. All the communities in the study area are of Melanesia descent, distinguishing them from Gilbertese communities whose members are Micronesian immigrants brought to the Solomon Islands during the 1960s by the British colonial government. A detailed ethnographic discussion of the communities in this study can be found in Aswani et al. (2017a).

Across the sites, community leaders exercise control over the use of and access to natural resources within their particular customary land and sea territories, although changing demographic and consumption patterns coupled with large-scale resource extraction ventures are increasingly eroding these customary systems. In particular, the economy of the Solomon Islands has long relied on logging royalties based on extraction at up to five times the sustainable rate. Corruption, mismanagement, failures of regulation and enforcement and mistrust among tribal groups have all combined to mean that the benefits of logging have not been felt at the community level. Rather, the industry has driven habitat loss, landslides, erosion and watershed damage, undermining local livelihoods, access to nutrition and women's control over resources (Walters and Lyons 2016). The subsistence economy still plays a central role in the life of people in Western Province, but some livelihood activities, such as coral collection for building materials, fishing pressure and sedimentation from poor land practices and logging, are negatively affecting the lagoon and coral reef systems. There are temporary and permanent marine closures throughout the sites, selected in response to declining marine resources, and to conform to local socio-cultural (e.g. death and feasting) and economic realities (e.g. need for case for school fees). The "success" of community-governed closures has been dynamic and varied,

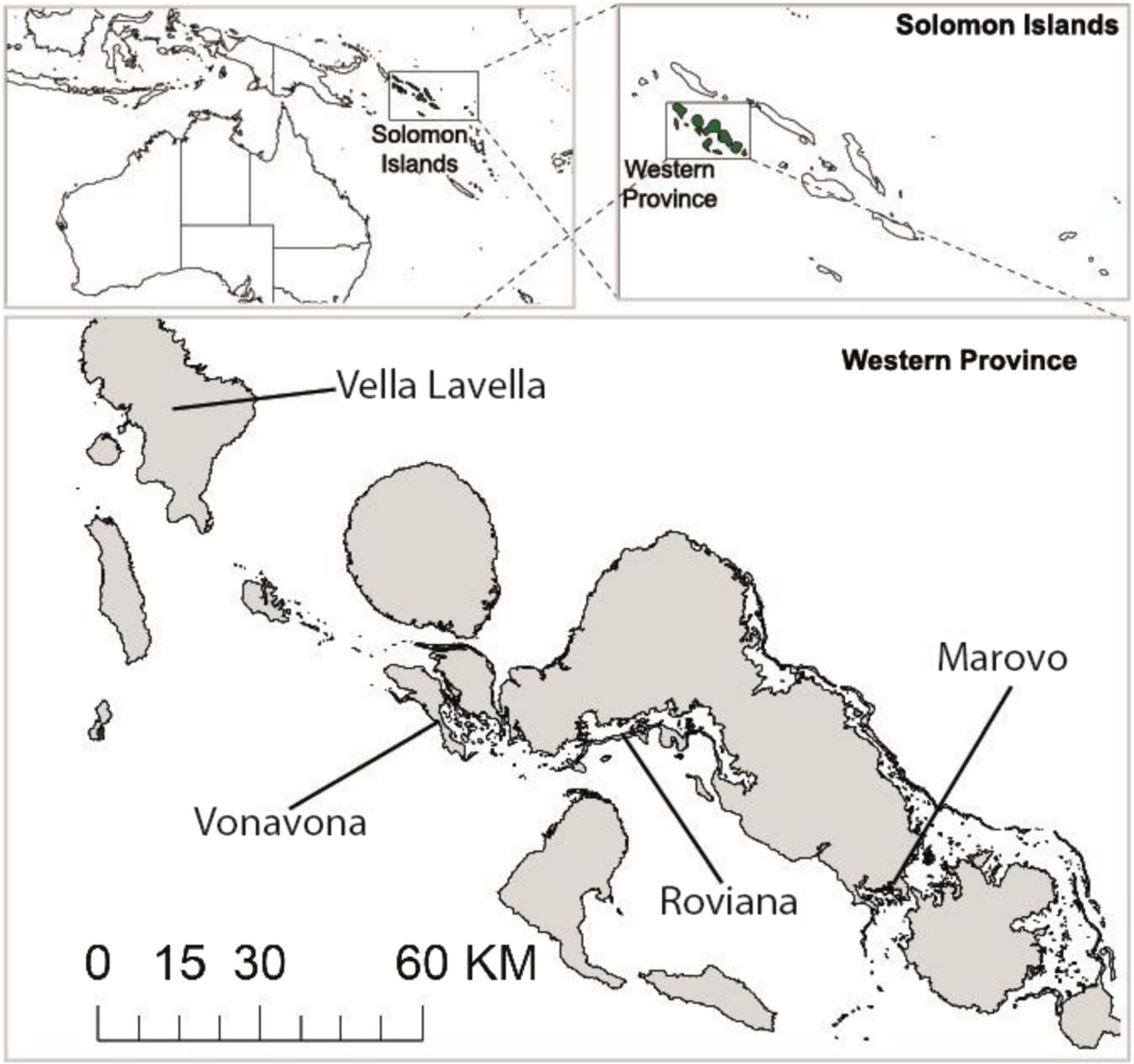

Fig. 1 The Solomon Islands archipelago and Western Province research area

due to political, religious, leadership and tenure disputes and competing priorities. Hence, some closures have been socially and biologically successful while others have not (Aswani et al. 2017).

Methods

Fieldwork concentrated on six locally recognised, major environmental and resource systems relevant to the livelihoods of coastal communities in western Solomon Islands. These included the following: open sea (ocean outside the lagoons and coral reefs), outer reef (outside lagoons and intertidal zone of the barrier islands), lagoon (pools, channels, shallow and mid-depth coral reefs and reef drops), terrestrial (non-agricultural ecosystems such as forests and mangrove), agriculture (plots and gardens) and weather. A total of 231 semi-structured interviews were conducted across the nine villages in 2011 in the local "lingua franca" known as Solomon Islands Pijin. The project leader and team were aware that for some, Pijin would not be the language they are most familiar with. The risk that this could be exclusionary was ameliorated as the leader and team were people local to the region with extensive experience working with the majority of these villages for over two decades. Interviews (50 per village; 25–60 years old and not from the same household) were conducted one-to-one using techniques to encourage less confident

participants (women and youth). Respondents were selected from across age ranges identified as important life stages. Overall, 40% of respondents were female and the mean age of respondents was 43 (SD ± 12) years. It is important to note here that our sample was purposive, and generalisations beyond the communities at the sites are limited.

Respondents were asked to describe and list the changes they had perceived or observed in their lifetime across the six environmental and climatic systems. A "free-listing" approach was used (Bernard 2011), where respondents were asked to spontaneously list as many perceived changes as they could for each system. The goal was to identify locally significant definitions and examples of change. An assumption was made that the first responses were the most important and relevant change recognised by the respondents. Questions were asked about perceptions of change rather than perceptions of risk to allow for responses to be either negative or positive and because the term "risk" can have "multiple rationalities, imaginaries and practices attached to it" (Granderson 2014). To account for risk, a follow-up question was asked about whether the change was considered to be a problem or an opportunity. However, between 95 and 100% of changes were classed as problems in each system (open sea = 97.3%, outer reef = 100%, lagoon = 100%, terrestrial = 94.9%, agriculture = 98.9%, weather = 97.7%). Changes were each coded into a common set of responses.

Data were collected on the characteristics of individual respondents, including their age, educational level and gender, so that it could be determined statistically whether these characteristics affected the changes each person perceived. Further details about these characteristics can be found in the Electronic Supplementary Material (ESM) at Appendix 1. These data were then used to build multinomial logit models (MLMs) to examine differential perceptions of change within and between the communities and their systems. Each environmental system was modelled separately, resulting in six final models that are presented in the results section and in Appendices 4 and 5. MLMs were selected because they are capable of assessing how perceived changes depend simultaneously on functions of multiple variables (in our case, the respondents' characteristics) (e.g. Croissant 2012). The results in the following section are therefore presented in terms of the probability (generated by the MLMs) that a particular respondent will perceive a particular change (for example, the probability that a male respondent would perceive "no change" in their environmental and resource system). Moreover, additional variables can be considered, allowing exploration of, for example, the probability that a male respondent would perceive no change in their environmental and resource system at different distances from a market town. In each case, the probability is model-generated (by the MLM). Additional information about the statistical analysis can be found in the ESM at Appendix 2.

Results

The results of all MLMs are summarised in Table 1. In the table, the top 3 changes for each system are shown and the probability of perceived changes identified according to gender, distance to market town and so on. As Fig. 2 illustrates, the visual analysis of the models provides a more detailed analysis of the effect of the multiple variables. In the following, the open sea system is analysed via Fig. 2 and a narrative description of findings. In the interests of brevity, the remainder of the results is presented in terms of a narrative description only, with visual analysis similar to Fig. 2 available for each system in the ESM at Appendix 4. The detailed statistical output for each model is available at Appendix 5 (ESM).

For the open sea system, only gender and distance to market town were statistically significant. The detailed impact of these variables is shown in Fig. 2 and the detailed statistical output in Appendix 5 (see ESM Appendix 5 Table 5). Neither age nor educational level influenced any of the responses from research participants. As Fig. 2 illustrates, males were more likely to have perceived change than females, who were much more likely to offer a no change response. Distance to market town had a substantial influence on choice, and, as the distance from the market increased for each village, both men and women were more likely to report having seen a change. The largest change reported by men was that there were "less fish or that fishing was more difficult". The probability of men saying that they had seen this change increased the further away from market they lived. The other important change that men reported having seen was that "currents were getting stronger". The probability that men reported this also increased with distance to market town.

In the outer reef system model, only gender was statistically significant (see ESM Appendix 4, Fig. 4 and Appendix 5 Table 6). Women were more likely to say that there had been no change than men. Men considered "habitat damage" to be the next most important change, followed by "less fishing/fishing more difficult" while these two observed changes were reversed among the female respondents.

In the lagoon system, only years of education and distance to market were statistically significant (ESM Appendix 5 Table 7), age and gender having little discernible effect. Greater distances to market towns made people more likely to say there had been no change in the lagoon. The interviewees were also more likely to say that there had been no change if they had had less education. More varied reasons were cited for change in the lagoon than in the other systems examined. The two main reasons for change examined in this system ("dirtier/more turbid water" and "less fish/fishing was more difficult") were both relatively rarely cited (~ 10%), and the probabilities that these would be chosen diminished with distance to market.

In the terrestrial (land ecology) system, the most appropriate model included distance to market town, gender and

Table 1 Summary of the top three changes perceived by Western Province communities for each environmental system and the statistically significant explanatory variables selected by the stop-wise model-selection process (AIC). General descriptions of the trend are given using >, <, or ~ to indicate greater than, less than, or no difference. NS = not significant. M = men, W = women, Near = nearer to market town, Far = further from market town, E6 = 6 years education, E9 = 9 years education, F = fisher, NF = not a fisher

System		Top 3 changes	Probability of perceived environmental change selected				
			Gender	Dist. to market town	Education	Occupation	Age
Open sea	1	No change	M < W	Near > far	NS	NS	NS
	2	Less fish/fishing is harder	M > W	Near < far			
	3	Stronger current	M < W	Near < far			
Outer reef	1	No change	M < W	NS	NS	NS	NS
	2	Less fish/fishing is harder	M < W				
	3	Habitat damage	M > W				
Lagoon	1	No change	NS	Near < far	E6 > E9	NS	NS
	2	Turbid water		Near > far	E6~E9		
	3	Less fish/fishing is harder		Near > far	E6~E9		
Terrestrial	1	Less vegetation	M > W	Near < far	E6 < E9	NS	NS
	2	No change	M > W	Near ~ far	E6 > E9		
	3	Logging increase	M < W	Near > far	E6 > E9		
Agriculture	1	Lower crop productivity	NS	NS	E6 > E9	F < NF	NS
	2	More pests			E6 < E9	F < NF	
	3	No change			E6 < E9	F > NF	
Weather	1	More rain	NS	Near < far	NS	NS	NS
	2	Unpredictable seasons		Near > far			
	3	No change		Near > far			

education level (ESM Appendix 5 Table 8). The age of the respondent did not significantly affect perceptions. No change was the most frequently selected. Women were more likely to say there had been no change than men. Similarly, people with less education were slightly more likely to say there had been no change. The most likely change reported was that there was "less vegetation" and women were slightly more likely to say this, as were people who lived further away from the market town. The other common change reported was that "logging had been introduced". There was little effect of gender on this, but people who lived closer to the market town were more likely to give this response.

In the agricultural practices system, occupation (i.e. whether the respondent identified him/herself as a fisher or not) and educational level were the only significant variables influencing perception of change (ESM Appendix 5 Table 9). Neither gender nor distance to market had any significant effect on choice, and it should also be noted that in this system, very few changes were noted by the respondents overall in comparison to the other systems we examined (ESM Appendix 3

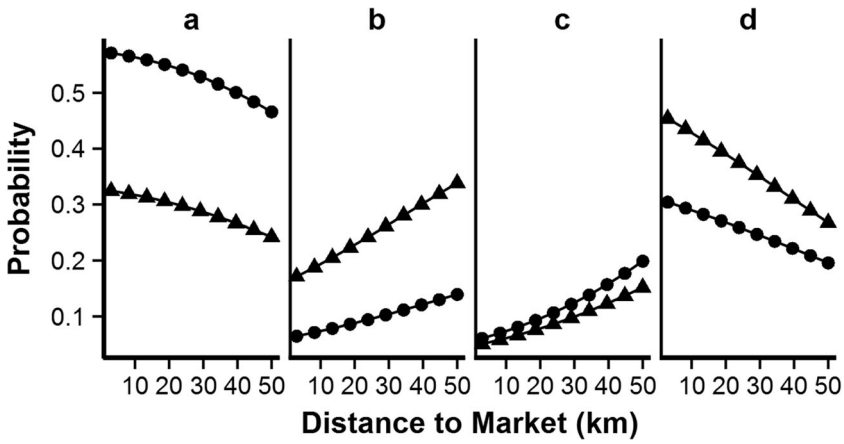

Fig. 2 Open sea: probabilities for perceived changes made by male (triangles) and female (circles) respondents, from villages of varying distances to market town (km). Perceived changes were (a) no change, (b) less fish/fishing is harder, (c) stronger current and (d) other

Table 4). Those who identified themselves as fishers were more likely to say there had been no change than people who did not fish. Also, those with more education were also more likely to say there had been no change to agriculture. The most common response for both educational levels was that crops were "less productive", and this was affected only weakly by type of employment. The other most common response was that there were "more pests" in agricultural systems. Non-fishers and those with more education were slightly more likely to give this response.

For the weather system, the only statistically significant predictor was distance to market (ESM Appendix 5 Table 10): age, gender, employment and educational level all made no difference. The most likely changes in weather that people reported were that there was "more rain" and that "seasons had become more unpredictable". People who lived further away from the market town were much more likely to say that there was more rain nowadays and less likely to say that "seasons were more unpredictable".

Discussion

This study has documented the local perceptions of environmental change in small resource-dependent coastal communities of Solomon Islands. The aim has been to contribute empirical research and respond to calls for more studies on the local nature of environmental change, and how changes may be perceived differently across communities and among individuals who vary in geography, livelihood activities and social-cultural practices (Bennett et al. 2014a, b; Walker et al. 2014). Interestingly, environmental changes in Western Province were not readily perceived, particularly in marine systems, and perceptions of environmental risk in the different environmental systems were unevenly distributed between and within communities. These findings in turn give rise to questions about the underlying patterns of power, culture and identity, which we explore in the section below. We then follow with a discussion of what these findings mean for community-based and "fair" adaptive responses.

Empirical findings

People of western Solomon Islands were more likely to perceive environmental changes in the terrestrial and agricultural environment and with weather patterns than they were for the marine environment systems (open sea, outer reef and lagoon). When changes in the marine systems were perceived, the variety of changes described by people was greater than for the other systems. The most commonly perceived change in all three marine systems in this study was reduced fish catches, yet only 20% of people gave this response. This is unexpected given documented fish declines, the high dependence on and use of the sea and the detailed and rich knowledge of the marine environment and sophisticated social-ecological habitat classification systems in the communities studied (Lauer and Aswani 2010). In a practical sense, changes in marine environments are less visible than terrestrial environments, but change may also be masked or explained by environmental variability which is not perceived as a risk (Green et al. 2010). The marine ecosystems of Solomon Islands have been shown to be resilient, absorb impacts and rapidly recover from ecological disturbance (Lauer and Aswani 2010; Lauer et al. 2013).

There are multiple potential explanations for this widespread failure to recognise changes in marine resources. In general, people are not very good at perceiving slow and incremental changes (Kollmuss and Argyman 2002), often referred to as "shifting baselines" which "normalise" the environmental changes that are occurring (Pauly 1995; Saenz-Arroyo et al. 2005; Pinnegar and Engelhard 2008; Turvey et al. 2010). This may be compounded by changes in fishing practices and "effort creep" as fishers are travelling to more distant fishing grounds and spending longer fishing (Albert et al. 2015), and there have been marked improvements in gear technology (Lauer and Aswani 2010). Cultural practices may also be relevant here. Communities can attribute variations in catches in the region to magic or charms which bestow success or unluckiness, possibly affecting the way risk is appraised. Variation in catch may also be explained by one's social behaviour, or the behaviour of relatives, especially female kin. While there is a widely held assumption that those people who depend on the environment and live a subsistence lifestyle will readily observe environmental change, this has been shown not to always be the case (Green et al. 2010; Kuruppu and Liverman 2011). These findings give further weight to this alternative narrative of local knowledge of livelihoods resources, suggesting a need for further research effort both to understand the driving forces of risk perception and to build a more realistic picture of the potential for local knowledge to inform community-based adaptation.

People's perceptions of environmental change were quite strongly affected by the community they lived in, specifically the distance their community was to the nearest market town. It was expected that people's perceptions would differ across communities as the use of environments and threats to environments differ (Kuruppu and Liverman 2011; Rodríguez-Carreras et al. 2014). Distance to market town was a significant explanatory variable for four of the six environmental systems: the open sea, lagoon, terrestrial and weather systems. People who lived far from town were much more likely to have perceived a change in the open sea (less fish and stronger currents) but had observed little change in the lagoon. In contrast, people living close to town were more likely to have said they had seen changes in the lagoon (less fish or dirty water). People close to town perceived the greatest change in the terrestrial system to

be the introduction of commercial logging (compared to those far away who perceived less vegetation as the greatest change), which may indicate the localisation of the industry around urban centres, its contribution to urban economies and/or its drawing on local labour. This suggests that "distance to market" is a proxy for, among other factors, proximity to and/or involvement in commercial logging. However, it should be noted that logging is generally a transitory phenomenon, which may last up to a decade, while the market town remains. Elsewhere in the Pacific, distance to market has also been shown to be an important predictor for prevalence of highly extractive fishing practices, suggesting a wider socio-economic significance for markets in the region (Cinner 2005; Cinner and McClanahan 2006). This points to the importance of investigating place and the character of local political ecologies in future studies that aim to understand the way change and risk is perceived (Rogan et al. 2005; Davenport and Anderson 2005).

There was high variation in environmental perceptions within communities. The largest documented distinction in livelihoods within subsistence communities in Solomon Islands is between men and women (Weeratunge et al. 2011); so unsurprisingly, gender was the greatest (statistical) intra-community variable influencing what people say about environmental change. This finding is consistent with theoretical work and empirical studies that have identified the gendered perceptions of change and risk (Gustafson 1998; O'Connor et al. 1999; Combest-Friedman et al. 2012; Tyler and Fairbrother 2013; Wright 2014; Lebel et al. 2017; Bee 2016). Women were less likely to perceive changes in the marine systems outside the lagoon (the open sea and outer reef) but just as likely as men to perceive changes within the lagoon. It is commonly held by government fishery officers that men "fish" and women "glean" (for invertebrates), and the national statistics show 90% of men and 50% of women are engaged in fishing (JICA 2010). However, there are significant variations between provinces and communities (Ramofafia et al. 2007; Prange et al. 2009; Boso and Schwarz 2009). In the lagoons of Western Province (our study site), women are avid fishers. They are reputed for their fishing skills and would be just as likely as men to perceive changes. However, outside the lagoon, fishing is "big game" and the domain of men (Aswani 2014). The statistical data on men and women's perceptions or concerns is thus consistent with their degree of practical engagement in particular livelihood activities.

In the agriculture system, both men and women tend gardens, but women do most of the agricultural work (Weeratunge et al. 2011; Kruijssen et al. 2013). In contrast to the coastal system, where gendered livelihood practices correlate with gendered risk perception, men and women in the terrestrial system have similar risk perceptions. This warns against simplistic assumptions of a relation between the gendered character of environmental knowledge and risk on the one hand and the livelihood practices of men and women on the other. The social and cultural norms that set out the place of men and women in livelihood practices are underpinned by power relations in the household as well in communities and society as a whole (McKinnon et al. 2016; Cote and Nightingale 2012), shaping who has access to and control over resources, knowledge and discourses and thus likely affecting how environmental change is perceived and by whom. For example, in this case, domestic institutions may be at play in mediating gendered knowledge, resulting in shared of perceptions of change and risk around (shared) gardening activities. Thus, institutional relations and the deep-rooted social and cultural norms that inform and are reinforced by them need to be explored alongside more readily observable characteristics of gender and livelihood.

Fair adaptation

Securing fairness through a focus on vulnerability and participation in communities means recognising that adaptation unfolds in complex social settings. Social and cultural relationships, embedded in the transactions that shape everyday life and often overlaid on discriminatory or poorly resourced state services, entrench differences in people's capacity to adapt, within and between communities (Ensor et al. 2015). Our findings illustrate further complications that arise due to variations in perceptions of change within and between groups that are differently situated in social, cultural and political terms (Kuruppu and Liverman 2011; Wolf and Moser 2011; Walker et al. 2014). Evidence from our study therefore supports existing research that argues for the significance of perception in adaptation (Walker et al. 2014; Granderson 2014; Bee 2016). We draw attention to the role that may be played by deep rooted social and cultural norms, informed and reinforced by institutional relations, in determining when and why risks are perceived as significant and how they are acted on (Granderson 2017; Warrick 2016; Weir 2016; Nunn et al. 2016; Mortreux and Barnett 2009). Examining these in context is best pursued through qualitative inquiry. The challenge for those supporting community-based approaches is therefore considerable: while the interests of fairness suggest that it is necessary to surface the underlying causes of patterns of perception, the process of so doing may reveal or lead to greater heterogeneity in perception within a community setting. This, in turn, may raise tensions within communities, increase uncertainty and reduce the potential for the forms of collective action necessary for community-based adaptations to be enacted (Varughese and Ostrom 2001; Rodríguez-Carreras et al. 2014). Effective community dispute resolution mechanisms can reduce this risk to collective action but are absent in the study area (Aswani et al. 2017).

The subtle processes through which risks are normalised or prioritised according to social, cultural or political influences are not accounted for when CBA focuses on participation in terms of representation and voice. In our results, this problem is illustrated where communities apparently fail to perceive the effects of environmental change. If environmental change

is going unnoticed when it is incremental and/or occurring in communities with a strong sense of place, then CBA's reliance on local experiences of change as a measure of the risk is called into question. Further, how and when gender similarities or differences in risk perception arise (for example, in relation to agricultural systems) must be disentangled, to establish whether they are due to similar experiences of change or a reflection of underlying community power dynamics. Failure to do so may undermine efforts that are intended to deliver fairness, such as through prioritisation of the risks expressed by the most vulnerable groups such as women. Simple inclusion, through the introduction of participatory processes, may well not be enough overcome deep rooted patterns of marginalisation (Cote and Nightingale 2012). Relations of power, when embedded in formal regulations, social and cultural norms and everyday practices may inform and reinforce gender (or other) identities while simultaneously driving marginalisation and exclusion. Supporting fairness and social equity in such situations demands intensive development approaches that attend to empowerment, self-reflection and Freirean "conscientization" (Freire 1970; see for example Dyer 2017 on gender roles and empowerment approaches in Solomon Islands). This is significant not least because such approaches are unusual within CBA (Ensor 2014; Dodman and Mitlin 2011).

The results of our study reveal how risk perceptions can vary significantly within and between small communities that exist within a relatively small locale. Overall, perceived environmental change may be grounded in practical, cognitive and/or social-cultural factors, and it may be related to a lack of or denial of perceived risk to livelihoods (Gifford 2011; Smith et al. 2011). In this context, survey data alone is insufficient for identifying local changes that lead to designing adaptation pathways. Mixed methods, including ethnographic and ecological techniques, may be required to reveal the complex relationships between change, risk and how perceptions are formed and to disentangle environmental variability, shifting baselines and discourses (Ensor et al. 2016). Such an approach would go beyond vulnerability and risk assessment methods currently prevalent in the Pacific region (Hay and Mimura 2013). The observed intra-community variability, particularly between men and women, support the view that communities cannot be assumed to be homogenous in perception (Kuruppu and Liverman 2011; Wolf and Moser 2011; Walker et al. 2014) any more than they are in power (Agrawal and Gibson 1999; Kumar 2005; Dodman and Mitlin 2011; Forsyth 2013). Yet, as Dodman and Mitlin (2011) note, there is a tendency for intra-community variability to be ignored when the focus of participatory development is firmly on the "community". Intra- and local inter-community differences in perception need to be appreciated as part of this picture, with consequences for the design of CBA processes that seek to account for heterogeneity.

Conclusion

The findings reported here contribute empirical data from Solomon Islands to a growing literature that emphasises the significance of perception in experiences of environmental risk and change. In Solomon Islands, data gathered through mixing household survey and free-listing interviews, and statistically analysed using multinomial logit models, provided insight into inter- and intra-community perceptions. Unexpected findings include a low (20%) perception of reductions in fish catches despite documented declines, among a population that has a high dependence on and use of the sea and detailed and rich knowledge of the marine environment. Perceptions of change were strongly linked to the community in which the respondent lived, yet there were also high variations in perceptions of environmental change within communities and between communities in a particular locale. Gender was a significant predictor of variation, yet gender also operated differently between agricultural and fishery system contexts. This complicated picture of similarity and variation in perceptions of environmental change inevitably intersects with social, cultural and power relations and has particular consequences for those who look to the community scale as a venue for fair adaptation. Community perceptions are relied on in community-based adaption to identify local manifestations of environmental change. Yet, in Solomon Islands, we find that significant environmental change is underreported in communities, while variations in perception are not always easily related to commonly assumed fault lines of vulnerability, such as gender. If community-based adaptation is to prioritise the interests of the most vulnerable through participation, then appreciation of and approaches to analyse heterogeneity within and between communities will have to extend to include perceptions of change.

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