Participatory mapping for adaptation to climate change: the case of Boe Boe, Solomon Islands

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Critics of top-down, expert-driven approaches to adaptation suggest the need for tools and methods capable of addressing the gap between scientific and local understanding of climate change. After a lengthy period in which participatory mapping in the context of climate change was overlooked, attention has now turned to Participatory Three-Dimensional Modelling (P3DM) for adaptation planning. P3DM consists in a community-based process resulting in a 3D-scaled and geo-referenced relief model. Because of its relative accuracy and the possibility of being translated to Geographic Information Systems (GIS), P3DM adds credibility to locally produced content and provides a platform for multi-stakeholder dialogue. Through the analysis of a case study in Boe Boe, Solomon Islands, this paper explores how P3DM may be utilised for integrating indigenous and scientific knowledge systems while minimising risks that perverse power dynamics will jeopardise the effectiveness of the participatory process. This paper combines results from literature analysis with interviews.

Keywords adaptation, climate change, knowledge systems, participatory mapping, P3DM, Solomon Islands

Introduction

The participatory creation of maps started in the 1980s and has become widespread. Map-making includes a wide array of methods ranging from ephemeral maps drawn on the ground to sketch maps, from three-dimensional relief models to online collaborative maps. The potential of participatory mapping in the context of climate change adaptation has been overlooked both in the literature and in practice. The limitations of top-down, expert-driven approaches to adaptation to climate change suggest, instead, a need to identify tools or methods which are capable of integrating the bottom-up contributions of affected communities and merging scientific and traditional knowledge systems. Participatory three-dimensional modelling (P3DM) provides a credible medium through which communities might assess needs and analyse spatial-related problems, and effectively communicate them to planners, policy-makers and scientists (McCall 2008:3).

Public participation has been on the climate agenda since 1992. However, issues of participation and inclusive governance have often been dealt with uncritically (Few et al. 2007). This paper uses the case of Boe Boe in the Solomon Islands to investigate the potential of P3DM for adaptation planning, and identifies the conditions necessary for an effective and meaningful participatory process. It offers not only an original contribution to the debate on adaptation but also to that on public participation, in particular to studies concerned with the ‘tyranny of participation’ (Cooke and Kothari, 2001:3).

The paper will firstly show how literature on adaptation and participatory approaches to development converge and combine. It will provide a general overview of the strengths of P3DM and anticipate its risks and limitations. The case of Boe Boe will be critically analysed in light of the capacity of P3DM to merge indigenous and scientific knowledge and of the implications of the power dynamics that participatory processes entail. Finally, the concluding section offers a reflection on the significance of this study.

Methodology

This paper provides a qualitative analysis based on the case study method. This can be defined as an in-depth study of a single unit (a relatively bounded phenomenon) which provides the basis for generalising across a large set of phenomena (Gerring, 2004). The case of the Boe Boe community, Solomon Islands, represents the first application of P3DM in the context of adaptation to climate change. The investigation is based on the combination of eleven semi-structured interviews, written exchanges and documentary analysis. Semi-structured interviews were preferred over other methods for their flexibility. Many questions and hypotheses arise during the process of interviewing; and the interviewer is also able to clarify ambiguities and return to earlier points. This bidirectional mode of communication encourages a more spontaneous and richer flow of information. Interviews were conducted in two rounds. Project staff and Participatory Geographic Information Systems (PGIS) experts were interviewed few months after the modelling exercise. Then the information gathered was corroborated by Boe Boe villagers and by the Choiseul province climate change officer one year after the conclusion of the exercise.

From top-down to bottom-up approaches to climate change adaptation

The long-term dismissal of adaptation in the climate agenda has been the result of a top-down approach based on the pollutionist paradigm (Schipper and Burton, 2009). In the early years of UNFCCC, the sense of urgency for reducing GHG emissions outweighed the awareness of the inevitability of adaptation. In fact, even if GHG emissions totally stopped today we would be still committed to deal with the negative impacts of climate change. It was only in 2001, at COP 7 in Marrakesh, that adaptation gained prominence in climate change policy. A recognition of the limitations of the pollutionist paradigm has drawn attention to bottom-up approaches to adaptation.

The pollutionist paradigm

The pollutionist paradigm consists of an expert-driven technocratic approach based on global impact models. Impact models start from a probabilistic mathematical ocean-atmosphere global circulation model (GCM) which inputs its results (changes in temperature and precipitation) into crop models whose output (change in yields) is in turn fed into economic models that determine adaptation needs. It is not surprising that scientists framed the climate change problem in biophysical terms and based their assessments upon a deterministic chain of causal relationships. This approach oversimplifies the complex effects of climate change and ignores issues of community vulnerability, capacity and resilience.

Technical limitations

Temperature and precipitation data on which climate models are based are not regularly updated and, as with any model, can only provide a simplified representation of reality. In developing countries climate information and services are often inadequate due to poor meteorological infrastructure and human resources capacity. The small-scale geographic focus and long-term timescale of predictions are of little use to communities. Planning adaptation to climate change requires fine spatial resolutions (e.g. catchments), whereas GCMs accuracy decreases as spatial scales become finer (i.e. larger) (Hewitson and Crane, 1996:86). Another fundamental weakness of GCMs lies in their incapacity to capture extreme weather events. Though climate scenarios show average changes in temperature, precipitation and sea level, this represents a simplified characterisation of the full array of climate variables (van Aalst et al. 2008:166). Understanding the effects of climate extremes is essential when dealing with adaptation in low-lying and Small Island Developing States (SIDS). Furthermore, adaptation decisions require information about the combined impact, duration and intra-seasonal variability of extreme events that GCMs are not able to provide (Schipper and Burton 2009:385). Following the pollutionist paradigm, experts have favoured agronomic strategies and focused on engineering and technological solutions to the climate change challenge. Finally, GCMs simplistically assume that people will undertake every adaptation option available, overlooking the fact that there might be cultural, behavioural and social constraints to adaptation (van Aalst et al. 2008:167).

The global discourse

Another stream of literature based on a constructivist approach to global environmental governance has investigated the political implications of the construction of climate change as a global systemic problem. According to the constructivist approach to knowledge formation we understand the world through socially, culturally and historically determined assumptions and values (Jasanoff, 2010:236). 'We know we have global environmental problems because scientists and political actors jointly construct them in global terms' (Taylor and Buttel, 1992:406). Climate change is presented as naturalised, spatially and temporally unbound and detached from human experience (Jasanoff 2010:406). Such a construction is charged with consequences. The idea of climate change as a global problem displaces the notion of community. Firstly, it bolsters the idea of a 'unitary and not a differentiated "we"' suffering equally from the impact of climate change (Taylor and Buttel, 1992:406). Secondly, it encourages a fatalist approach where affected parties are 'spectators' or passive victims (*ibid.*). Expert-driven approaches have contributed to a narrative linking 'extra-ordinary', 'un-predictable', and 'un-certain' phenomena to regions described as 'under-developed', 'over-populated', 'un-informed', and 'un-prepared' (Gaillard, 2010:221). According to this interpretation, expert-driven approaches have favoured the disempowerment of affected communities (Polack 2008.17).

Despite the above caveats, it is important to note that global climate models are an indispensable source of information for adaptation planning and play a stabilising role for policy-makers in the face of uncertainty.

Completing the picture: bottom-up approaches

Bottom-up approaches to adaptation – also known as community-based adaptation (CBA) – consist of community-led processes founded on traditional knowledge and local capacity (Ayers, 2011). CBA operates through multi-stakeholder participatory processes involving local communities, development practitioners, experts and policy-makers (Ayers and Forsyth, 2009:24). It follows the wider trend of opening environmental policy to public participation, and is supported by several official documents arguing in favour of grassroots involvement in climate change decision-making. Suggestions that stakeholders participate in addressing climate change date back to the United Nations Framework Convention on Climate Change (UN 1992, Art.6 p.17). However, the concepts of '*glocal'*, *multifaceted governance* or *multi-stakeholdership* have entered discourses of global environmental governance more recently (Bäckstrand and Lövbrand, 2006:55). Among the conditions for enhancing adaptive capacity, the IPCC Third Assessment Report (2001:899) cites 'active participation by concerned parties especially to ensure that actions match local needs and resources.' UNDP guidelines for the formulation of climate change adaptation strategies encourage stakeholders' engagement, including grassroots stakeholders' participation. Chapter 26 of Agenda 21 – a programme of action to achieve sustainable development at the local, national and global level prepared at the Rio Earth Summit (UNCED 1992) – supports the recognition and strengthening of the role of indigenous knowledge and communities. The UNFCCC National Adaptation Programmes of Action (NAPA) system is based on the idea that the assessment of vulnerabilities and the identification of adaptation solutions should be action-oriented, country-driven and encourage multi-stakeholder endorsement. However, only few SIDS have submitted their NAPA, and their participation has mostly gone so far as a simple declaration of principles. The inclusion of different actors in climate change decision-making has an ethical value. This is recognised in a rights-based approach to climate justice where procedural fairness is ensured only if those likely to be affected the most have the right to take part in decisions related to their livelihoods (Polack, 2008:16). Inclusiveness can promote feelings of satisfaction and self-confidence, in contrast to the sense of fatalism and victimisation that top-down approaches can engender (Adger et al. 2006:192). When climate change is defined as a *local* problem, the affected parties are more willing to address the problem since their actions are perceived to be personally valuable (Jasanoff, 2010:241). Although it is rarely defined as adaptation to climate change, local communities have accumulated long-term experience of climate variability and other environmental changes. In the absence of historical weather data, the memories of their elders are often the only source of information on climate trends (IIED 2009:18). An acknowledgement of the added value of traditional knowledge combined with evidence of failure of top-down blueprints have boosted consensus for participatory approaches to development (Ayers 2011:65). However, as the next section argues, participatory processes are far from being immune to failures and misconceptions.

Participatory approaches to development

Participatory methods known under the umbrella term of Participatory Learning and Action (PLA) include seasonal calendar[2], transect walking and diagramming[3], participatory mapping, household surveys, participatory videos[4] and theatre[5]. Participatory mapping has been the most widespread PLA method. It is now applied beyond the rural context where it was pioneered, and has spread to natural resources management, land tenure issues, and disaster risk reduction.

> *Maps have been used to make visible and legitimate the invisible complex environmental knowledge, needs and claims of people disenfranchised and misrepresented.* (Rochelau in Brosius et al. 2005:328)

Participatory mapping finds its roots in participatory rural appraisal, disaster risk reduction and participatory activist research. However, rather than an open challenge to vested interests it consists of a more nuanced peer-to-peer dialogue.

But despite its evident advantages, there are also strong disincentives to adopting participatory approaches. The fact that these processes can be time-consuming, depart from conventional procedures, and are often unpredictable discourages development practitioners and suggests that participatory processes should not be adopted uncritically (Cooke and Kothari, 2001:17).

The politics of participation

Participatory processes are inevitably influenced by those who fund, commission and use them. The word 'participation' is often used as a nice label to favour project endorsement by all stakeholders including donors and beneficiaries. In most cases participatory processes take the form of consultation, or merely consist of informing the community that they are taking place. Yet, in order for it to be considered meaningful, participation should instead swing between transformative (or interactive) and self-mobilising participation (Arnstein, 1969; Pretty, 1994). In transformative participation, development practitioners work as a catalysts and co-learners. In self-mobilising participation, local people become owners or controllers whereas the outsider works as a supporter (Few et al. 2007: 49). The attribution of participatory processes to one or the other category ultimately depends on power dynamics (Cook and Kothari, 2001; Cornwall and Pratt, 2003). Power dynamics develop both within the community (e.g. between genders or different ethnic, religious and class groups) and between communities and the outsiders.

The role of the outsider

The late 'discovery' of participatory mapping has been attributed to the sceptical attitude of development practitioners and researchers – the outsiders – believing in a supposedly superior 'Western' knowledge. As Chambers posed it, treated as incapable, poor people behaved as incapable (1994b:963).

Outsiders may negatively affect the process by taking up people's time, raising expectations, extracting information for their own benefit (for example, favouring biopiracy, mining or logging activities), or extracting information to be used against participants. Fox et al. (IIED 2006:103) report the experience of a woman in Indonesia who facilitated the mapping of her village for the purpose of selling the land to foreigners. The ethical implications of mapping do not exclusively relate to what to map, but also who to map with and where (Gaillard, 2011 pers.comm). For example, women's decision to take part in such a process may lead to them being beaten by their husbands. Finally, outsiders' choices and attitudes can influence internal power dynamics.

Internal power dynamics

Risks from internal power dynamics are associated with face-to-face interaction and openness to the public. For example, the group dynamics associated with mapping may lead people to take more risky decisions than normal, or decisions that perhaps result from guesses about the wishes of other participants (Cooke and Kothari, 2001). Moreover, respect of social hierarchies and intimidation by more educated and powerful members of the community may lead to self-censorship or manipulation. If we apply these considerations to the context of adaptation to climate change, adaptation decisions risk being taken by those who have the knowledge and resources to adapt, and therefore might not be as vulnerable to climate change. In addition, different people have different perceptions of climate change. For example, *Tanner et al.* illustrate that in the Philippines men seem more sensitive to agricultural-related hazards, whereas women are more concerned about social problems (IIED 2009:25). Because of school education, children have a better understanding of climate change than adults and have a right to participate because of being affected by both current and future impacts (*ibid*.). Chambers (1994a) advises against considering participation intrinsically good regardless of who participates and who gains.

Integrating indigenous and scientific knowledge

An overview of the literature on adaptation to climate change and participatory approaches to development leads to the conclusion that neither pure top-down nor bottom-up approaches can work on their own. As Gaillard (2011 pers.comm.) suggests, 'communities can do much, and much more than *we* usually expect; but they cannot do everything.' For example, greater unpredictability of climate events may reduce the effectiveness of indigenous knowledge in anticipating and dealing with climatic changes (IIED 2009:4).

Achieving integration of indigenous and scientific knowledge seems necessary, but it can be hampered by mistrust and suspicion among the stakeholders involved (Huq and Reid 2003; IIED 2009; Gaillard 2010). Scientists often see local knowledge as subjective, intangible, unscientific and therefore invalid. They find it difficult to understand a form of knowledge that is 'embedded in local history, local memory and local networks' (Gaillard, 2011 pers.comm.). At the same time, however, many communities exhibit little confidence in scientific data. The necessary integration of such diverse worldviews can be possible if adequate tools and methodologies are available for multi-stakeholder dialogue. These tools would allow scientific data to be verified against local data, and provide a medium for local communities to communicate credibly with policy-makers. At the same time, climate information should be conveyed at the local level in a culturally compatible way without causing confusion and anxiety (van Aalst et al. 2008). The rest of this paper will present P3DM as a possible response to these challenges.

Participatory three-dimensional modelling (P3DM)

Participatory modelling refers to a mapping process resulting in a 3D relief model in carton board where geographical features and landmarks are visualized through the use of paint, yarns and pushpins. The data represented on the model are first captured via digital photography, then geo-referenced and plotted through on-screen digitising procedures. The possibility of import from and export data to GIS makes P3DM particularly suitable for the integration of scientific and indigenous knowledge systems.

Strengths of P3DM

P3DM may be considered a democratic method. In an ideal situation the blank model is built by teenage students from local schools, whereas information is later added by older informants (Giacomo Rambaldi, 2010:31). In 3D models everybody works around the same table and is free to put his hands on the model (Gaillard, 2011 pers.comm.; Rambaldi, 2011 pers.comm.). Such manual group work leads to less eye contact and verbal dominance that might be intimidating in certain traditional cultures (Chambers, 2006). Moreover, the visual and tactile experience enhances learning (Rambaldi, 2010:7). Cognitive psychologists explain that participatory approaches that employ the third dimension favour a deeper connection with external landscapes and facilitate the elicitation of tacit knowledge, knowledge that we are not aware that we have (*ibid*). Further advantages of P3DM include making abstract concepts such as vulnerability and capacity visible and tangible (Gaillard, 2011 pers.comm.). Using locally-available material can ensure cultural compatibility and cost-effectiveness. The models tend to be large in size, and in line with good practice recommendations, are left with the community and can be updated by stakeholders. Because of being scaled and geo-referenced, they can be credibly used to communicate and negotiate with local authorities and with private actors with economic interests in the area. The versatility of P3DM makes it applicable to any issue with a spatial dimension. Further advantages include both the fun and the sense of pride derived from engagement in the exercise (Rambaldi and Callosa, 2002).

GIS component

The use of Geographic Information Systems (GIS) can provide a response to those criticising attempts to represent complex and dynamic realities on a bi-dimensional static grid (Rochelau in Brosius et al. 2005:328). Bi-dimensional maps display only a limited amount of information, typically spatial information. GIS technology, instead, allows the overlaying of large volumes of both quantitative and qualitative geo-coded data (Brosius et al. 2005:314). Information displayed can range from geo-physical landscape and household characteristics to hazard and socio-economic vulnerability. Data generated by GIS can also be fed into 3D models to enrich stakeholders' discussions (Rambaldi and Callosa, 2002). However, the application of GIS in a developing country context presents ethical challenges. Once digitalised, the map becomes an open access resource (*ibid*.). This might be an advantage since knowledge-sharing is fundamental to spreading good adaptation practices (Gaillard and Maceda, 2009:116). On the other hand, since the model might report sensitive information, the use of GIS raises issues of privacy and confidentiality. Other risks include the possibility of technological overload[6] if local users are not trained in GIS (Brosius et al. 2005:314).

P3DM for adaptation planning: the case of Boe Boe

Background

Boe Boe is a tiny coastal village of 50 households located in the North-West region of the Choiseul Province of Solomon Islands. The Solomon Islands are classified as SIDS, countries recognized by the IPCC (2007) as being among the most vulnerable to the impacts of climate change although contributing the least to GHG emissions. These countries have a very weak voice in climate negotiations in relation to decisions directly related to their survival.

Boe Boe's society is based on customary landownership and traditional institutions (Hardcastle and James, 2011). By owning all land from reefs to ridges, the community has a fundamental role in land-use decision-making. Although the village can be considered relatively resilient – due to rich biodiversity, secure land tenure, cash benefits from old logging concessions, strong leadership and community cohesion as well as good level of education – it presents vulnerability factors common

to small island communities. Geographical and geological factors include its location on the Pacific 'Ring of Fire', and the presence of very high steep slopes and narrow coastal plains.
Climate change is predicted to increase sea-level rise and the frequency of storm surges. This is likely to damage mangroves, sea bed grass, coral reefs and the associated biodiversity. Saline intrusions will impact the already scarcely fertile soil (IPCC 2007). Moreover, sea-level rise affects coastal routes and access points to land from the sea. Climate change is accordingly likely to threaten the livelihoods of Boe Boe villagers, who primarily depend on reefs and mangrove ecosystems (Ririmae, 2011).

The project
This project should be understood in light of a wider initiative called 'Building the resilience of communities and their ecosystems to the impact of climate change in the Pacific' of the Lauru Land Conference of Tribal Communities and Partners with Melanesians funded by the Australian Government/AusAid Partnership and implemented through The Nature Conservancy (TNC). The P3DM exercise took place in February 2011 in concert with other participatory activities including participatory videos, household surveys and shoreline walks. The Boe Boe P3DM is a pilot project underpinned by the idea of sharing knowledge and experiences of how different communities have been dealing with the impacts of climate change in Melanesia[7].

The process consisted of two components. Students and community volunteers traced, cut and pasted different layers of carton boards which were later consolidated in a 3D blank model using crêpe paper and glue. After the physical construction, people from the village began to visualise and add their local spatial knowledge on the model. As a parallel process, a GIS expert developed a Digital Elevation Model (DEM) of the village, which reflected the features represented on the relief model and illustrated 'what-if scenarios' of sea-level rise of 50, 100 and 200 cm. The participatory 3D model became the focal point for discussion and interpretation of the community's challenges. The P3DM exercise can be considered part of an ecosystem-based approach to adaptation to climate change which emphasises the key role of ecosystems' conservation in strengthening resilience. It presented sea-level rise scenarios and suggested that the area protected from sea-level rise was quite small. The process stimulated discussion on the depletion of natural resources and increased awareness, especially among women, that strengthening the resilience of the local ecosystems was not only necessary for them but for the generations to come. Discussion also included consideration of other more pressing challenges such as that of logging and mining.

> *The combined use of the relief model and the digital model 'allowed a real-time integration of science with local knowledge.* (Hardcastle and James, 2011)

Towards the integration of different knowledge systems

Indigenous knowledge
Conserving traditional knowledge has proved fundamental. The modelling exercise provided a means for transmitting knowledge about natural, historical and cultural heritage. For example, the model showed the routes that women use to paddle to the gardens and mangroves in order to collect food and shellfish for their daily meals. This helped participants to understand the possible time and economic costs associated with increased sea-level rise. Villagers identified 'tambu' sites whose

protection ensures the sustainability of fisheries and farms, and which have a spiritual value. Conserving traditional knowledge has proved fundamental in the face of disasters. The habit to take shelter under overhanging rocks on higher grounds in order to survive to the onslaught of strong winds has given an advantage to people of Solomon Islands; whereas people of Fiji have increased their vulnerability by modifying their traditional housing conditions[8](Mercer et al. 2007:250). Traditional knowledge has proved precious also in response to non climate-related events such as earthquakes and tsunamis. The people of Simeulue Island, Indonesia, survived the 2004 Indian Ocean tsunami because of a story accounting for a similar event happening in 1907, which advised 'running to the hills after prolonged shaking of the ground' (McAdoo in Mercer et al. 2007:251). Furthermore, elders can explain why landscape has changed over time. Solomon Islander Ellen Taqevala, 74 years old, although not having seen a map before, provided an accurate description of how the village had been relocated from the top of the hills down to the coast to escape the Japanese invasion during the Second World War (Ririmae and Hardcastle, 2011). However, memory is fragile, and this should be taken into account when interpreting traditional knowledge. When asked about historical trends, people tend selectively to remember erosion episodes from large storms, forgetting accretion during calm periods, and overestimating coastal change (Leon, 2011 pers.comm.).

Limitations to integration

Although the community model-making and illustration of climate scenarios happened simultaneously, the potential of P3DM for merging different knowledge systems has not been fully exploited. In fact, while the DEM was used to refine and ground-truth features on the relief model, the information elicited from the model has not been transferred to GIS. The only effort to integrate the information gathered at the grassroots level into a more sophisticated 'scientific' map has been a partial transfer to photomaps[9] (Leon 2011 pers.comm.). Bearing in mind the risks of using GIS in a development context, the full integration of the community model into a GIS digital map is particularly important in the context of climate change. By overlapping vulnerable conditions and impacts, a GIS multi-layered map may favour a dynamic and more comprehensive understanding of risk.

The role of the outsider

The case study seems to be in line with the '3Ts' rule: transparency and time as a condition for trust (IIED 2006:16). A successful interaction with the community was possible because the P3DM process formed part of an engagement developed over the last fifteen years. The long-term commitment in the area has led to a deeper understanding of community needs and expectations as well as a process of confidence building. The fact that many of the people working for TNC are from Choiseul Province, as well as the intermediation of the Lauru Land Conference of Tribal Communities (LLCTC) – a trusted and recognized organisation – have contributed to a strong relationship. Preliminary workshops and meetings were instrumental in not raising expectations. The fact that everybody, including TNC staff, could speak Pijin helped overcoming language barriers. A decision to hold most of the meetings in the evening in order to avoid disrupting people's daily activities was also important.

The process was open-ended, without any off-the-shelf target or goal. Boe Boe provides an example of genuine participation shifting from interaction to self-mobilisation. Although the project initial idea was to ensure a statistically representative sample of participants, de facto participation resulted in a free flow of stakeholders. Eventually it was necessary having several facilitators next to the model, ready to provide support when community members showed interest (Hardcastle, 2011 pers.comm). This is different from a common problem with participatory processes where participants are *selected* by local leaders and project facilitators (Maceda et al. 2009:76). However, there could be certain disadvantages in a free flow of participants. Working in an informal setting increases the possibility of conversations being side-tracked towards alternative discussions, or conversations being interrupted (Mercer et al. 2008:179). This can make information retrieval and decision-making complex and long.

Internal power dynamics

In Boe Boe the Chief of the community is the unquestioned leader and exercises strong governance. The massive participation in the P3DM of over the half of the community can be explained by the fact that Chief David 'gave his blessing' (Hardcastle, 2011 pers.comm.). He had a crucial role in gathering participants and keeping them involved and motivated throughout the process. It is without doubt that people would feel uncomfortable speaking against the leader and would never act against his will. However, even though they may not overtly disagree, the P3DM helped participants present their position in a more subtle way. The physical presence of an external entity (the model) created a situation where people were talking to the model, not directly to the Chief (James, 2011 pers.comm.). In addition, the game dimension of the P3DM created a space where rigid hierarchic structures were easier to breach. When participants were asked what was missing from the model and if anything was misplaced, the appealing and at the same time challenging character of the request encouraged everybody to talk, regardless of their position (Hardcastle, 2011 pers.comm.).

Conclusion

The purpose of this paper has been to bring attention to the potential of P3DM in the context of climate change adaptation, and to outline the possible risks and limitations from this process. To this end, key aspects of participatory adaptation planning – namely the integration of indigenous and scientific knowledge and the role of power dynamics – were used as a theoretical framework for setting up the interviews and informing the case study analysis. By using the case of Boe Boe, this work underlines the potential of P3DM in integrating indigenous and scientific knowledge. Moreover, P3DM might capitalise on the benefits from participation while minimising the risk that both external and internal power dynamics jeopardise its meaningfulness. The case study demonstrated the emergence of a rising interest in the use of P3DM for adaptation planning, and identified the conditions needed for an effective process. The investigation outlined that:

> *…participatory spaces are not neutral: they are created spaces that provide opportunities for agency and inclusion but also exclusion.* (Ayers, 2011:66)

The direct involvement of the LLCTC and the long-term commitment of TNC in Choiseul, as well as the adherence to basic principles of ethics set the basis for trust and reciprocal understanding. The game characteristics of the participatory mapping process broke down the rigid hierarchies of a customary society, allowing local people, policy-makers and scientists to come face-to-face in an informal and unthreatening way. The combination of the community discussion with

demonstrations of 'what if' scenarios of sea-level rise confirms that P3DM is able to bridge top-down and bottom-up approaches to adaptation by creating a space for mutual learning.
Further research is necessary in order to overcome technical barriers to the integration of indigenous and scientific knowledge such as the downscaling of climate information to a scale compatible with community information as visualised on the relief model. Despite the complexity offered by GIS, models or maps are not suitable for visualising information such as client-patron relationships, gender-related inequalities or the importance of social networks. Both favourable and potentially perverse power dynamics should be anticipated and taken into account when doing map work. In this regard the household survey provided an extremely important source of information, confirming that participatory mapping should not be used as a stand-alone tool but it works better when integrated with other methods.

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[2] A seasonal calendar is used to show changes in livelihoods over the year and to show the seasonality of agricultural and non agricultural workload, forage, food and water availability, income, diseases, expenditures, and cultural activities (For more details see FAO PRA tool box, http://www.fao.org/docrep/003/x5996e/x5996e06.htm#6.2.7. Seasonal Calendar).

[3] Transect walking is a spatial data-gathering exercise which entails taking a walk with community members through an area of interest, observing and asking, seeking to identify problems and solutions. The results of the walk are later represented on a transect map or diagram.

[4] Participatory video consists in providing capacity building and skills in video-making in order to give participants the opportunity to voice concerns, explore issues and present reality from an inside perspective. Moreover, the ease of sharing allows locally produced films to become powerful advocacy tools.

[5] Participatory theatre is a form of theatre where the rigid division between audience and performers disappears. The two parties interact and the audience has the opportunity to reflect, ask clarifications and propose solutions to community problems, and finally become agent of change.

[6] It is possible to have technological overload when a system is too complex for local needs, the operator does not have adequate skills to manage the system or the users are not adequately prepared to understand its links with local reality (Brosius et al. 2005:314). Moreover, if not adequately trained, participants may miss the link between the three-dimensional model and its GIS version.

[7] Melanesia includes Marshall Islands, Solomon Islands and Papua New Guinea.

[8] Traditional wood and straw huts (*bure*) were extremely resistant to wind with deeply buried strong hardwood posts, steeply angled, four-sided roofs and secure bindings (Campbell 1984 in Mercer et a. 2007:250). The addition of nails and iron roofing in the 20th century has resulted in more vulnerable bure (*ibid*.).

[9] Photomaps are geometrically corrected and geo-referenced aerial photographs upon which transparencies delineating land uses and other community information can be overlapped (IIED 2006).