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ORIGINAL ARTICLE

Climate change vulnerability assessments as catalysts for social learning: four case studies in south-eastern Australia

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Abstract Technical assessments of vulnerability and/or risk are increasingly being undertaken to assess the impacts of climate change. Underlying this is the belief that they will bring clarity to questions regarding the scale of institutional investments required, plausible adaptation policies and measures, and the timing of their implementation. Despite the perceived importance of technical assessments in 'evidence-based' decision environments, assessments cannot be undertaken independent of values and politics, nor are they capable of eliminating the uncertainty that clouds decision-making on climate adaptation As such, assessments can trigger as many questions as they answer, leaving practitioners and stakeholders to question their value. This paper explores the value of vulnerability/risk assessments in climate change adaptation planning processes as a catalyst for learning in four case studies in Southeastern Australia. Data were collected using qualitative interviews with stakeholders involved in the assessments and analysed using a social learning framework. This analysis revealed that detailed and tangible strategies or actions often do not emerge directly from technical assessments. However, it also revealed that the assessments became important platforms for social learning. In providing these platforms, assessments present opportunities to question initial assumptions, explore multiple framings of an issue, generate new information, and galvanise support for collective actions. This study highlights the need

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for more explicit recognition and understanding of the important role social learning plays in climate change vulnerability assessments and adaptation planning more broadly.

Keywords Adaptation · Climate change · Risk assessment · Social learning · Vulnerability assessment

1 Introduction

In recent years there has been exponential growth (Eakin and Patt 2011; Preston and Westaway 2010; Preston et al. 2011b) in the amount of research published on climate change adaptation and vulnerability assessments. This reflects not only the increased number of assessments undertaken, but the related interest in this approach as a way of assisting communities, industries, and local governments to plan and adapt to climate change.

Adaptation planning can be defined as the process of planning for policies and measures to moderate harm, or exploit beneficial opportunities, in response to actual or expected climatic stimuli or their effects (IPCC 2007). Technical assessments of climate change vulnerability and/or risk are often considered a critical step in this process because they aid in the identification, analysis and evaluation of the impacts of climate change on natural systems, human activities and or human health and well-being (IPCC 1994).

The process of adaptation planning is often guided through the use of normative 'adaptation frameworks' including those by UK Climate Impacts Programme (Willows and Connell 2003), and the United Nations Development Programme (UNDP—GEF 2003; Lim and Spanger-Siegfried 2004). Such frameworks represent an idealised process for adaptation planning that includes technical assessments of vulnerability and/or risk as one of many steps in the adaptation process.

A typical adaptation framework is depicted in Fig. 1. The starting point in the process is often some form of scoping activity or study that establishes the context and framing for adaptation. This is subsequently followed by a detailed assessment of vulnerability and/or risk that may also include consideration for the system's capacity to adapt to anticipated consequences (i.e. adaptive capacity). Adaptation frameworks also include activities associated with the identification of adaptation options, prioritisation of those options and, in theory, implementation. Within this general paradigm of adaptation, technical assessments are associated with the second step within this adaptation framework, where drivers of change are integrated with understanding of system values, objectives, and critical thresholds to inform understanding of potential consequences and their relative importance.

In practice, the adaption process is far more complex than is depicted in such idealised frameworks. The process often merges multiple steps, runs them in parallel, or skips steps all together. In addition, as many frameworks now acknowledge, adaptation planning is iterative in nature and as new information becomes available it becomes necessary to revisit parts of the framework (Willows and Connell 2003; Lim and Spanger-Siegfried 2004). This iteration may be structured, such as the completion of a 'first-pass' assessment that broadly identifies system vulnerabilities and risks, followed by a 'second-pass' even as far as a 'third-pass' assessment that characterise potential consequences and manages opportunities in greater detail (Sharples et al. 2008). Presumably, by completing multiple circuits of the adaptation planning cycle, each pass moves stakeholders closer to key decision points. However, iterative adaptation processes may be unstructured and unfold over a long-time period with intense periods of activity (often triggered by a formal project or initiative),

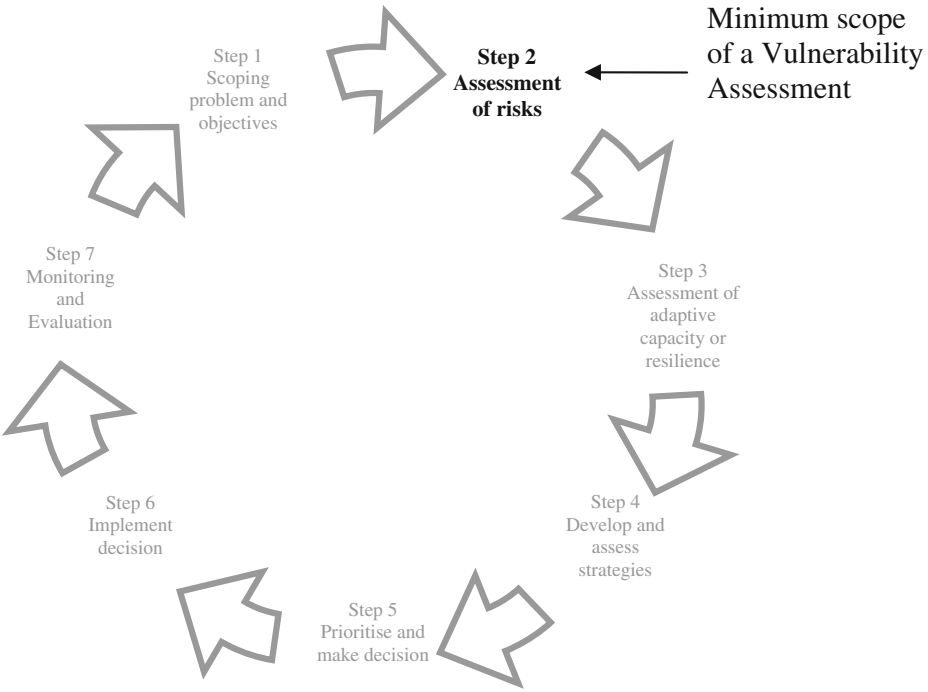

Fig. 1 The steps or activities typically included in climate change adaptation frameworks. Adapted from (Willows and Connell 2003)

which are followed by periods of reflection, monitoring or evaluation. Multiple iterations of this adaption planning cycle is akin to 'adaptive management' (Walters and Holling 1990) in the management of climate change where decisions are monitored, priorities redirected as new information becomes available.

Although the adaptation frameworks and heuristics used in practice by stakeholders often possess common elements, they are applied differently in different contexts. This manifests in assessments of vulnerability and/or risk, which may be highly heterogeneous in terms of their scope, investment of resources, conceptual models, and specific methods and tools (Preston and Kay 2010). This is apparent even when assessments adopt a common framework (Preston and Kay 2010). The process of giving meaning to the challenges of climate change within a particular context is called framing (Fünfgeld and McEvoy 2011). The initial 'framing' of technical assessments by researchers and stakeholders participating in the assessment is critical when defining the problem and deciding on a methodology to use. For example, when the assessment is framed as the end point of adaptation processes (as opposed to just one step in the framework), assessments risk becoming an academic exercise of risk identification, with little engagement with stakeholders about the implications of climate change consequences and how they may be ameliorated. This reduces the relevance of the assessment for decision-making. In contrast, when technical assessments are framed as a potential starting point for a more extensive, goal-oriented adaptation process, information regarding climate change consequences can be evaluated within a decision context, and therefore may have greater likelihood of triggering policy responses. Hence, while the concept of an objective and 'value free' assessment may appeal to values of scientific and technical credibility, by failing to incorporate the normative influences of stakeholders,

assessment can fail to be relevant and miss opportunities for collective action in response to assessment findings.

Despite evidence of rapid growth in climate change adaptation planning across a range of geopolitical scales, critical examinations of this evidence suggest planning has yet to translate into substantive adaptation policies and measures (Berrang-Ford et al. 2011; Preston et al. 2011a). This has contributed to increased scrutiny of the value of technical assessments for facilitating adaptation to climate change. Increasingly, questions are being raised regarding the value of information derived through climate assessments (Hinkel 2011). Such criticism is reminiscent of a persistent dialectic regarding whether 'objective' science is able to close down policy debates over appropriate responses to climate change (Braun and Kropp 2010; Martin and Richards 1995), and, at a broader philosophical level, if and how science supports policy (Brunner 1996; Jasanoff and Wynne 1998; Sarewitz and Pielke 1999). Hence, while technical assessments are increasingly being undertaken in support of adaptation planning (Preston and Kay 2010), researchers and practitioners must question the extent to which they facilitate adaptation and if so, how.

1.1 Climate change vulnerability assessment and social learning: literature review and framework

It can be argued that the value of climate change assessments lies in their ability to produce actionable information and to facilitate a willingness in communities and managers to undertake these actions. One theory that explains and describes the social processes that can lead to collective action is social learning. Increasingly a social learning perspective is being proposed for adaptation to natural resource management issues because it is undertaken among multiple stakeholders across scales giving it two key advantages. Firstly it is important where the problem is complex and a diversity of values are held by stakeholders (Martin et al. 2010; Ison 2009). Secondly, it valuable where uncertainty is high (Walters and Holling 1990). In the natural resources management sector where diverse values exist alongside high uncertainty, multi scale social learning is increasingly gaining interest over more expert-based teaching (Pahl-Wostl 2009; Pahl-Wostl 2002; Muro and Jeffrey 2008; Blackmore et al. 2007). However, this shift to social learning based approaches in natural resources management and sustainable development is relatively slow in the area of climate change adaptation. There are notable exceptions including Martin et al. (2010) who provides case studies of social learning from an Australian perspective, Collins and Ison (2009) who edited a special edition in 'Environmental Policy and Governance' and a small number of authors in the academic literature. Some of the published literature considers social learning and climate change from the perspective of evaluating adaptation processes (Cundill and Fabricius 2009; Eakin and Patt 2011), while Siebenhüner (2006) specifically looks at learning between members of the Intergovernmental Panel on Climate Change. Published literature also considers how social learning could be incorporated into or is an intrinsic part of existing adaptation approaches. Gidley et al. (2009) considered social learning in participatory futures methodologies, O'brien et al. (2010) looked at the linkages to social learning and disaster risk management meanwhile Cundill and Fabricius (2009) drew attention to the fact that social learning is an essential part of adaptive management. The majority of literature in social learning considers case studies in climate adaptation using a social learning framework in water resources (Martin et al. 2010; Wilder et al. 2010) wildlife management (Armitage et al. 2011) and agriculture (Martin et al. 2010; Pelling and High 2005). Existing literature rarely considers adaptation focussed across multiple sectors as is found at the local government scale. This research will fill this gap by exploring social

learning at the regional (or local government) scale, across a wide range of issues where adaptation planning provides the platform for learning.

'Social learning', also commonly referred to as 'collective learning', is a concept with divergent theoretical roots which has been used in widely different contexts. In environmental management fields, social learning is used as both an analytical and facilitative framework to support collective decision making and action to address complex natural resource management problems (Pahl-Wostl and Hare 2004; Keen et al. 2005). Although defined in many ways, it is generally viewed as a process that "*emerges from experience and/or human interaction during which people's different goals, values, knowledge and points of view are made explicit and questioned to accommodate conflicts so that collective action can be taken to tackle a shared problem*" (Groot and Maarleveld 2000). Social learning acknowledges the role of debate and at times conflict which is an important part of transformational learning (Tjosvold 1991) in promoting 'thinking outside of the box'.

One of the most useful conceptualisations of social learning is that of different cycles or 'loops' of learning (Table 1). Single-loop learning entails a change in skills, practices, and actions to meet existing goals and expectations. As such, there is only an adjustment or correction of errors. By contrast, second-loop learning involves reflection on the assumptions that underlie action. Finally, triple-loop learning involves a more deep-seated questioning and changing of the values, norms and social structures that underlie and/or govern operating assumptions and actions. One type of learning is not better than another. In an ideal world a combination of the three types of learning would best help actors navigate complexity and change (Röling et al. 2002).

In the context of climate change adaptation, single loop learning reflects upon whether an adaptation process and/or its constituent elements are 'right' or appropriate for a given context. This may include consideration for the 'right' way to plan for climate adaptation, the 'right' framework to use to guide decision-making, or the 'right' way to conduct an assessment of vulnerability or risk. Single-loop learning may involve minor adjustments to an adaptation process such as improving upon, or using a new tool to communicate risk. Alternatively it may involve more radical change in adaptation planning such as incorporating an assessment of adaptive capacity or discarding a top down framing for adaptation and assessment in favour of a bottom up or participatory process. Whilst single loop learning can be associated with radical changes in the approach used, it doesn't question the

Table 1 Questions and the purpose of single, double and triple loop learning. adapted from (Flood and Romm 1996; Groot and Maarleveld 2000)

	Single loop	Double loop	Triple loop
Question asked	Are we doing things right?	Are we doing the right things?	What is the right thing to do?
Purpose of learning	How to do things the right way	How to do the right things	Finding out what are the right things to be doing.
What is learned	• How to correct errors • Change in skills, practices, and actions to meet existing goals and expectations	Need for reflection on framing of problem & goals, and assumptions regarding how goals can be achieved.	Questioning and changing of values, norms and social structures underlying/ governing problem framing, goals, assumptions and action

underlying assumptions. Instead it is the domain of double loop learning to questions what are the right things to achieve for a well adapted society and the domain of triple loop learning to challenging the underlying values, goals or structures of human adaptation.

During the research, only single loop learning was discovered and this dictated the scope of the paper. Whilst other loop learning is important, double and triple loop learning is relatively rare (Johnston and Kortens 2010) and difficult to detect without the use of long-term longitudinal studies which was not possible in this research. Although difficult to monitor and classify, double loop and triple loop are important because they can lead to large shifts in approach and investments. For example, one may learn that detailed data regarding vulnerability or risk has little or no influence on the decision making process, which leads to a cycle of double loop learning regarding the utility of vulnerability assessment within adaptation frameworks.

Social learning can be considered at multiple scales, with each scale contributing to a different cycle of single, double, or triple loop learning. For example, at the scale of the broader adaptation planning process single-loop learning can revolve around the appropriate framework to guide adaptation planning processes, the order of different steps in the process and how much effort is spent on each. Social learning may also be examined at individual steps *within* the adaptation framework. This learning includes the right way to undertake a vulnerability assessment. At an even smaller scale, the right tool or method such as the way to best map vulnerability (Preston et al. 2011b) may be considered. However learning is not only about better ways to undertake a process. It also includes learning around content—what people or places were found to be vulnerable, and what strategies should be explored further.

The goal of this paper was to use a social learning framework to explore learning in vulnerability assessments, specially four assessments undertaken in south eastern Australia. It monitored when learning occurred and considered what aspects of the process and context allowed this to occur. It describes what was learnt, the context in which learning occurred, and similarities and differences between four adaptation planning processes in south eastern Australia. In doing so, it fills a gap in understanding the importance in social learning in smoothing the transition from information to policy and role in can play in adaptation to climate change.

2 Methodology

To explore the role of social learning in climate change adaptation planning, four technical assessments of vulnerability and/or risk that were conducted in south eastern Australia were used as case studies. This exploratory research used the case study approach because it provides detailed information around vulnerability assessments applied in different contexts. However, as for all case studies, the subjective nature of information collected means that it is hard to make generalisations for other contexts.

2.1 Selection of case studies

The case studies were diverse in terms of why and how they were conducted, particularly with regard to who was involved and what formal role those actors played. Although the case studies were based on discrete assessment activities, these activities represent, either explicitly or implicitly, an ongoing process of adaptation planning. As such, aspects of the case studies considered in this paper were not limited to the assessment itself, but included any step within the adaptation process that had also been undertaken. While they all shared in common an assessment of risks (step 2) they didn't strictly follow the normative

adaptation framework in Fig. 1. Some undertook the scoping and the assessment of risks in parallel while others skipped an assessment of adaptive capacity. At the time of study, all were in the early stages of adaptation planning and few actions, if any, had actually been implemented or observed.

All of the case studies involved assessments undertaken at the local (i.e., 'council') or regional governance scales (Fig. 2). Two of the case studies were initiated by regional organisations of councils (Sydney Coastal Councils Group in New South Wales and the Western Port Greenhouse Alliance in Victoria). One was conducted by a large metropolitan council (City of Melbourne, Victoria) and the final case study was undertaken by a group of researchers in a rural local council (Alpine Shire).

2.2 Background on the case studies

The case studies varied in their funding, how they were implemented and who was involved. Details of the case studies are summarised in the Appendices. Appendix A provides details of how the assessments were framed, the goals and where it was undertaken. Appendix B lists the scoping, assessment and evaluation activities undertaken as part of the assessment.

The Western Port case study was conducted under the auspices of the Western Port Greenhouse Alliance (WPGA) with approximately AUD 500,000 in funding from both federal and state agencies. The WPGA represents five councils cooperating in pursuit of climate change assessment and policy development for mitigation and adaptation. The

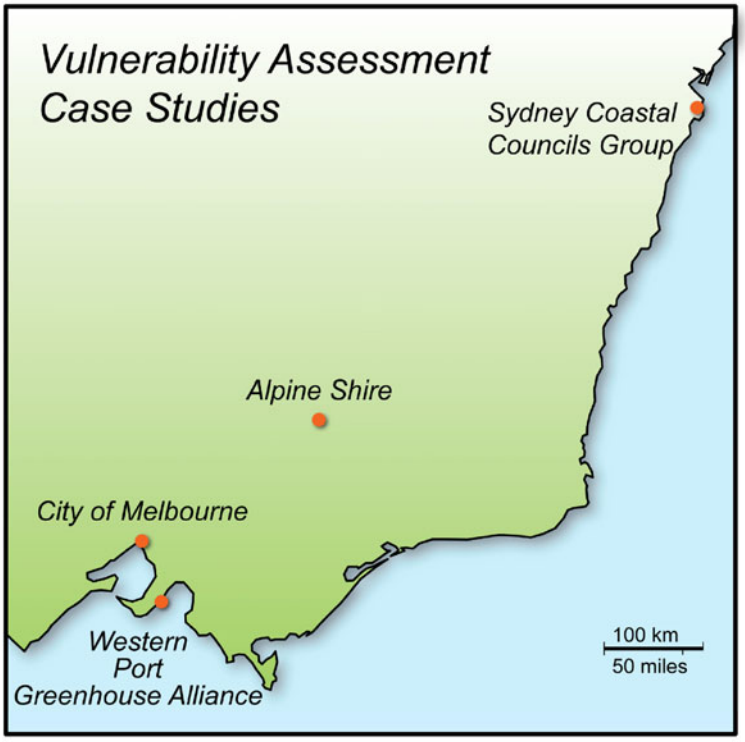

Fig. 2 Case Study locations in south eastern Australia

project was preceded by a scoping study undertaken by stakeholders ranging from managers of coastal infrastructure to catchment and natural resource managers. This led on to a regional scale assessment of climate change impacts to WPGA member councils that produced technical reports with maps illustrating at-risk locations as well as quantitative assessments of existing assets potentially exposed to different climate hazards. Staff from member councils subsequently used this information to prioritize risks to councils and identify potential adaptation options. The project team included a mix of academic researchers and private consultants with considerable support provided by a full time coordinator employed by the WPGA, as well as guidance from a stakeholder reference group comprised of officials from local, state, and federal government. The perceived hazards in the region included the threat of sea level rise on coastal infrastructure, intense rainfall and flooding, fire, heatwave and drought.

The Sydney case study was conducted under the auspices of the Sydney Coastal Councils Group (SCCG), a Regional Organisation of Council (ROC) in the metropolitan Sydney area comprised of 15 councils that collaborate on coastal issues of interest to member councils. The study was funded under the same federal initiative as the Western Port project and therefore received comparable funding. The project produced a vulnerability assessment including maps illustrating the relative vulnerability of different areas to different climate hazards. A second output was a series of council-specific systems diagrams capturing council staffs' collective mental models of the interconnection between the various climate hazards, impacts, and management opportunities based upon a series of workshops. The project also analysed the capacity of councils to adapt considering both opportunities as well as institutional barriers. The project team included a range of academic researchers with a steering group guiding the project. The potential types of problems were similar to the Western Port case study although it pursued an alternative approach to the technical assessment of vulnerability and it considered not just the potential impacts of climate change on human settlements but the adaptive capacity of local governments to adapt given the institutional and governance contexts in which they find themselves.

The Melbourne case study only covered one local government area - the Melbourne City Council. It had a smaller geographical area to cover than the other assessments and received only one fifth of the funding mostly from branches within the council. The assessment was focussed on potential risks faced by the council and the priority adaptation responses that could be implemented, although it was not limited to council's risks. It also considered that effective adaptation was unable to be achieved without empowering the community. The assessment also included consideration of how impacts could cascade across different urban systems, particularly both primary as well as secondary impacts associated with climate change, (e.g.. the impact of sea level rise on not just bridge clearances but also on the potential loss of major boating events in the area). The project was conducted by private consultants with only limited technical input from the council and other stakeholders. The problems considered were similar to the Western Port and Sydney assessments but included high wind speeds whilst excluded bushfire (which was less relevant for a highly urbanised area).

The Alpine Shire case study was conducted on a quite modest budget and was primarily pursued as an academic exercise undertaken by doctorate students. The assessment focussed on stories of past change using participatory approaches that engaged a diverse range of residents and asked them to contribute their knowledge of past climate related events through interviews. The assessment began with the support of an elected councillor, yet changes in council meant that it ultimately struggled to gain support more broadly within council. The problems explored included flooding in one of the towns, post-fire flash flooding, along with a range of impacts on the tourism sector.

2.3 Data collection and analysis

In order to explore social learning within the case studies, interviews were held with 33 interviewees spread across the four case studies. A purposive sample was developed first from lists of names provided by project managers and combined with a snow ball approach (Babbie 2010) during the interviews to provide referrals of further interviewees. Interviewees were selected to participate in interviews on the basis of meeting at least one of the following three criteria:

- employed in an organisation responsible for developing the vulnerability assessment;
- employed by an organisation which was a stakeholder in the assessment which either provided information into the assessment or was potentially impacted by recommendations of the assessment;
- residents or other community members with some familiarity of the assessment or were ultimately impacted by climate change.

Interviewees were chosen based on eliciting people with a range of technical and non technical backgrounds, and who had both favourable and unfavourable opinions of the case study. All core project team members were interviewed. However, because of such a large number of stakeholders in some case studies not all stakeholders were interviewed for each case study.

All interviewees that participated were contacted by telephone and informed about the study, the other case studies, and the expected outcomes from the research. They were asked if they gave permission for the interviews to be recorded and for comments they made to be directly quoted. The interviews were between 30 min and 3 h in length.

The interviews used open-ended questions that focused on what interviewees perceived to have worked or not worked during the assessment process and the substantive outcomes that were achieved. The questions were:

1. What new knowledge or information did the project generate?
2. Did any of the stakeholder groups change their actions in response to the project?
3. Were the outcomes for your organisation what you expected at the beginning of the project?
4. In the end, what was the ultimate goal in developing this new knowledge or implementing these new actions? Who benefited from it?
5. In your opinion, how important was your project in helping to achieve this ultimate goal compared with other external drivers or barriers?
6. If you had to give advice to a similar group conducting a similar assessment what would you say about:
    - What assisted the development and implementation of this project, or made it relevant and how?
    - What hindered the development or implementation of this project, or made it inadequate and how?
    - What improvements could be made to be more efficient, effective and adaptive to emerging issues?

Interview transcripts were analysed using NVIVO (Babbie 2010) which is software designed for qualitative research. Responses were coded and grouped into emerging themes around key lessons.

3 Results and discussion

The NVIVO analysis of the case studies and the evidence they provided for social learning, led to the identification of a number of learning elements that cut across the range of case studies, suggesting they represent core elements of social learning within adaptation planning. In addition, these elements of social learning were associated with an individual step within adaptation planning, and or associated with the overall framing of adaptation planning itself. The key lessons learnt from the case studies at both scales are illustrated in Fig. 3. It was found that often similar lessons were learnt in multiple case studies albeit in slightly different ways. The number of case studies reporting a particular lesson is listed in

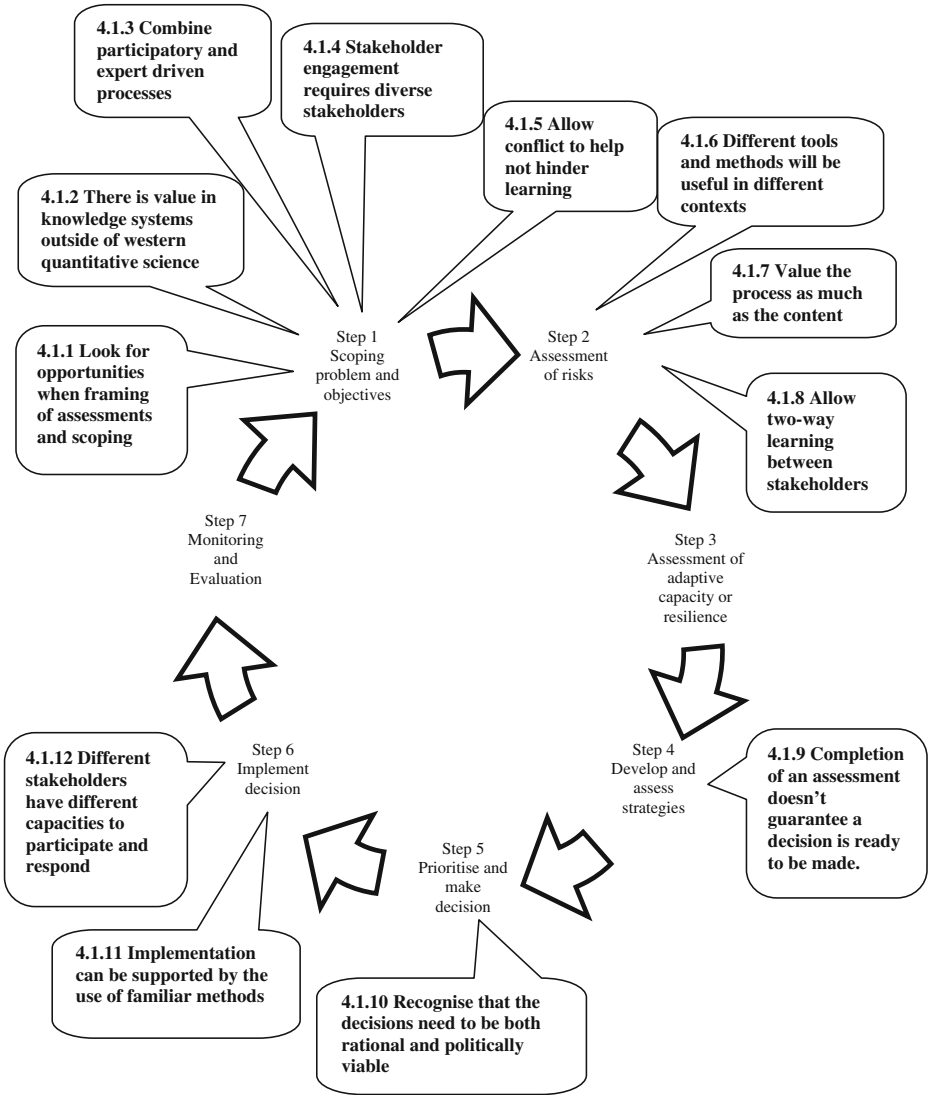

Fig. 3 The main single loop lessons from the cases studies

Appendix C. Some lessons such as the value of diverse stakeholders and the role of two way learning between stakeholders and researchers were reported in all four case studies while lessons such as the need for decisions to be politically viable was less commonly reported.

3.1 Negotiating the scope and framing of assessments

The design of an assessment is not only rational but also opportunistic. Assessments are framed around both what rationally is the efficient way to undertake an assessment, and what is necessary to engage stakeholders and thus sustain the project in the long term. Projects without access to resources and support will ultimately struggle. Meanwhile, it makes sense to reorientate assessments to take advantage of opportunities when they arise.

The Western Port case study was originally framed to include the assessment of social and ecological consequences and opportunities for adaptation. However, the funding initiative under which the study was conducted targeted human settlements and not ecological systems. Two interviewees noted that this led to a pragmatic decision to narrow the scope of the assessment to exclude ecological systems despite an agreement made during the initial scoping that a broader framing was in fact desirable to some stakeholders. This highlights the influence of definitions of assessment boundaries on assessment processes and outcomes as well as the somewhat malleable nature of those boundaries.

3.2 The value of alternative knowledge systems

Keen et al. (2005) states that a failure to recognise multiple constructions of knowledge is the greatest impediment to social learning. Two interviewees from different case studies reflected this when they commented that specialised and high resolution scientific knowledge around the type and magnitude of impacts was not always the best way to engage stakeholders and facilitate action. They believed that local knowledge was also important for complementing western science because it helped stakeholders visualise and plan for the future in their own community.

In the Alpine Shire case study, the research invited local residents to share local knowledge of past impacts of climate and responses. Following this knowledge sharing, many of the researchers interviewed expressed the view that local knowledge was an important complementary knowledge source to scientific knowledge for integrated assessments. While the Alpine shire case study used a participatory approach through which local knowledge is intrinsically valued, it is worthwhile also looking in detail at the Western Port where the importance of ‘citizen science’ was noted.

In the Western Port study, one participant noted the importance of ‘citizen science’ as a locally based form of scientific knowledge. The interviewee mentioned that ‘citizen science’, or measurements by everyday citizens, could be used to quantify the impacts of climate change. Citizens regularly measure things such as changes in milk production, rainfall measurements (eg by farmers) or seasonal distribution of birds as recorded by bird watchers. Another interviewee in Western Port observed that local knowledge was important to provide evidence of past climate change impacts (e.g. erosion on beaches) because it was something residents stood up and took notice of.

3.3 Combining participatory and expert driven approaches

The aforementioned perspectives on the utility of citizen science suggest it is insufficient to rely solely on expert driven processes. However, as two of the researchers interviewed

found, it is equally inadequate to rely on participatory approaches to facilitate collective action.

The Alpine Shire case study focussed on a participatory approach and sought to limit the bias and subjectivity which is inevitable when working for a politically influenced council. This focus on participation was based on evidence that these approaches have substantive (provides a richer picture of the problem that leads to outcomes), instrumental (increases acceptance of decisions) and normative benefits (stakeholders have the right to participate in decision making) compared to more technocratic approaches (Stern and Fineberg 1996). In taking a participatory approach, the beneficiaries and other stakeholders had a significant involvement in the research process resulting in research theoretically focussed on their needs. This case study focussed on the framing and analysis of the problem of climate variability (natural or otherwise) rather than actual climate change.

Many stakeholders were disappointed in the outcomes from this participatory integrated assessment and questioned the usefulness of participatory approaches. Although the assessment's practitioners communicated likely impacts from climate change to the community through public meetings, they unfortunately ran out of funding before the process could facilitate the development of concrete solutions for the local community. In the absence of the vital steps in the adaptation framework associated with decision-making (Fig. 1, steps 4 and 5), development and communication of solutions or actions (Fig. 1, steps 6), participants were left unsure of how to carry the assessment of impacts forward into adaptation responses.

This was made worse by the fact that in maintaining the freedom to be critical of council, it resulted in minimal council involvement in the process and hence failed to provide a linkage to policy. However, this linkage would not necessarily have ensured success due to the capacity of the council to respond at the time. As one of the interviewees mentioned, even if there had been effective engagement with council, staff turnover, the loss of the original champion and an almost constant change in leadership made it even more difficult to pursue adaptation policies and measures.

Despite the deficiencies in the Alpine shire case study of linking bottom up to top down processes, it did succeed in showing the research community that participatory approaches could complement the more traditional expert driven impact or risk assessment process.

The problem in the Alpine shire was less around the participatory or technocratic nature of the approach and as much around institutions – in particular the capacity for authoritative organisations to engage and drive the assessment from above. Top down processes driven by higher levels of governance have the advantage that they have the authority to implement decisions and ensure structures are compatible with actions. However, bottom up processes ensure that decisions have the support of the community because they reflect the goals and understanding of stakeholders at the local level.

The lesson was that top down approaches are necessary to ensure assessments are linked with policy, but participatory approaches are needed to ensure the communities goals are reflected in the decisions. In other words, assessments need to include both expert, and non-expert participants while gaining ownership by higher (top down) and lower (bottom up) governance levels.

3.4 Stakeholder engagement

The stakeholders and governance structures affected the ability for assessments to gain traction and generated positive, substantive outcomes. However comparisons between the stakeholder engagement in the various case studies is difficult due to the wide range of stakeholder engagement approaches and governance structures apparent in the different case

studies. Some used multi-stakeholder committees/groups as a reference group, most had a steering committee that provided oversight for the project, and all had a project team actually undertaking the technical tasks. Generally, projects engaged stakeholders with a range of expertise, responsibilities, experience and often across multiple stakeholder groups. Stakeholders were engaged through meetings and workshops, circulation of communications materials, drafting and review of documents as well as other communications such as media releases.

There was a varied response in the case studies in terms of engagement processes used and the actions undertaken as a direct result of vulnerability assessments. The Alpine Shire assessment engaged a broad range of residents who lived in the area, yet a number of interviewees believed that nothing had come out of the assessments. The Melbourne case study engaged a range of stakeholders with responsibilities in the council and interviewees reflected that while progress was made on council goals, there was limited impact outside of the council's immediate responsibilities. Meanwhile the Sydney assessment engaged stakeholders from multiple departments within councils and its members reported that the project helped to stimulate action at the level of state government with respect to sea level-rise policy.

Arguably, the most successful of the case studies in facilitating action was the Western Port assessment. It was successful in leading on to further activities as diverse as assessments of regional food security, community preparedness to extreme weather, and coastal planning. It is interesting to consider stakeholder engagement as something contributing to its success. Firstly, it was diverse in the range of stakeholders, it engaged stakeholders from multiple council areas, state government departments and other experts. Secondly it had more resources dedicated to this part of the assessment process, some of which were funded externally through the councils. Thirdly there were multiple opportunities for interaction between stakeholders and or project members. This was not only at formal workshops, but less formal group meetings, one-on-one briefings and during presentations to a range of groups. Finally, Western Port also involved stakeholders in a separate scoping stage which provided time for interviewees to reflect on what was being undertaken and begin to build their own capacities to deal with the challenge.

On the other hand, the Sydney assessment held more workshops with more member council stakeholders but these did not include representatives from other levels of government or other external groups. In addition, there was little opportunity for multiple interactions over time and the steering group was geographically spread over the country making coordination more challenging.

3.5 Learning facilitated by conflict

In a number of case studies, it was observed that conflict could have positive effects. In one case study it was found that conflict triggered increased dialogue and in another it helped promote swifter action.

In the Melbourne case study, conflict among stakeholders emerged in association with information on sea level rise in a new multi-use development in the former docklands. The level of sea level rise was strongly contested by a key development organisation (VicUrban) coordinating substantial investment in the area. However, this conflict promoted dialogue between the state agencies around coastal planning and it was observed that this debate was unlikely to have happened otherwise. It also highlighted that the assessments approach to framing climate risk as an issue for the council alone was inappropriate considering the highly interconnected nature of organisations and substantial commercial interests working in the area.

In the Sydney case study, conflict resulted when one of the project reports was released to the mainstream media and made it to the front page of the local newspaper. While the impact of this media coverage is debatable, one of the interviewees firmly believed that it was due to this coverage on the assessment that swift action ensued on a draft policy on sea level rise by state government.

While conflict is an important social learning, particularly double and triple loop learning (Tjosvold 1991), it does not always mean that all lessons from conflict are positive. While positive outcomes were achieved in the above examples, conflict could just have easily lead to decreased levels of trust between the various organisations and ultimately had negative repercussions on adaptation.

3.6 Appropriate tools, methods or approaches

The case studies revealed how the initial framing of the problem could influence what tools and methods were selected and what was achieved through undertaking the assessment. There were common themes around the characteristics of tools and methods considered useful (or less useful). For example, there was a consensus that vulnerability mapping and the visual presentation of vulnerability hotspots was a valuable tool. However, some interviewees felt that vulnerability maps were only one of many tools used in assessments and there were lessons around the usefulness of other tools and methods.

The Western Port assessment yielded divergent views around the storm surge modelling used to assess coastal vulnerability, due to concerns about spatial resolution and uncertainty in the information. In addition, delays in the delivery of model results held up progress on the assessment, yet some interviewees perceived such information as not being critical to the assessment process. Nevertheless, most agreed that the quantitative comparison of impacts to different infrastructure across multiple hazards via the use of radar plots as well as the subsequent normative interpretation of those data via stakeholder-led risk assessment process were useful exercises.

In Sydney, while the vulnerability maps generated for the project were generally applauded, the use of more qualitative research methods and the systems analyses met with mixed reviews. One participant believed that the vulnerability mapping was the only relevant part of the assessment and that qualitative research lacked credibility because it was based on quotes from people and not “objective” facts. Whereas another participant said that the mapping only revealed what they already knew and that “a bit of naval gazing” around institutional barriers through qualitative research was equally valuable. There was also debate around the value of complex systems diagrams illustrating the relationship between multiple risks (e.g. stormwater impacts and increased impervious surfaces). A few interviewees thought the diagrams were horrendous and called them ‘horrendograms’ because they were overly complex and difficult to interpret and understand. Another respondent suggested that even if the ‘horrendograms’ themselves were of limited value, the process by which there were generated was valuable. This value of process over content was a commonly emerging theme.

A number of assessments also used a risk assessment framework which was found to be relatively successful. One interviewee provided a possible reason for this, in that risk frameworks were already familiar to most stakeholders and could be readily incorporated into their existing view of the world. They didn’t need to learn a new framework and were able to immediately understand what the implications of the findings were.

When looking at the value or otherwise of tools and methods it is important to remember that different interviewees have a subjective understanding of what happened due to using

different 'mental models' to selectively filter not only their perceptions of the world but understanding around what defines success or failure. For example, information providing a complex understanding of socio-environmental systems could empower those who have been grappling with complexity and are able to use it to give them a framework with which to work. Others could actually find the same experience of complexity overwhelming and challenge their confidence in themselves with the result that they disengage from the process, leaving it to the experts. The same system analysis could be interpreted entirely differently by different people. For one person, bringing in the experts may have created expectations that everything under control and relieved them of the need to individually act while for the other it provided an opportunity to have increased control over a highly complex area. The challenge in the design of assessments is to be simple enough to be understood but complex enough to further learning around climate change adaptation.

3.7 Balancing content and process

A common theme across the case studies was that detailed data were harder to obtain and less useful than originally expected. Many interviewees, particularly those involved in the Sydney and Western Port assessments, confessed that they initially hoped that assessments would provide sufficient detail to give a clear understanding of impacts and the timing, and location of appropriate responses. However, assessments proved to be more diagnostic regarding hotspots and trends than prescriptive in terms of definitive information or optimal management responses.

Nevertheless, some interviewees concluded that the process of undertaking assessments was as valuable as the output generated in the form of vulnerability maps or estimates of climate change consequences. This can be explained by the valuable opportunity assessments provided for interaction between stakeholders to explore ideas, develop solutions and understand how adaptation fits into the bigger picture. While detailed impact information was sought it was noted by one interviewee that gathering data regarding climate change vulnerability, impacts and risk wouldn't solve the problem and, in fact, the focus in assessment should always have been on the process of bringing people together. This belief was reflected in interviewees in the Western Port, Sydney and Melbourne case studies whose beliefs regarding the goals of the process, and the appropriate balance between technical content and the engagement process, evolved over the course of the projects. They observed that what was important was bringing together diverse stakeholders and galvanising employees within organisations to work towards common goals. This was perceived as a requisite first step in developing the institutional capacity to apply technical information regarding vulnerability and risk in adaptation policies and measures.

While the value of the engagement process was increasingly recognised, it is not to say that the information was irrelevant. Interviewees across the Western Port, Sydney and Melbourne case studies said that it was common for the synthesis of information around impacts to provide the impetus for stakeholders to meet and deliberate over adaptation responses that lead to collective action around key risks. One participant noted that while information on impacts didn't solve the problem it did play an important role in catalysing stakeholder engagement: *"The sooner we had the data the sooner we had council buy-in"*. This can be explained using the concept of learning platforms (Maarleveld and Dangbégnon 1999) that consider vulnerability assessments as a social arena where collective actions are developed. The promise of information and data around risks and impacts of climate change helped to increase awareness amongst participants to the problem and encouraged participation in these learning platforms.

3.8 Facilitating two-way learning

The case studies demonstrated the potential value in creating opportunities for two-way learning, with stakeholders learning from 'experts' two-way (and vice versa) but also stakeholders learning from each other. The regional scale of the Sydney and Western Port case studies promoted such two-way communication, particularly between stakeholders across the various participating councils. Staff from councils had the opportunity to learn not only from the technical assessment, but they could also share information with, and learn from, other councils and stakeholders two-way. For example, the interactions between councils in Western Port lead to peer pressure on the less progressive councils to implement actions sooner than they perhaps would have had they not been participants in the project.

The case studies also demonstrated that technical assessments provide opportunities for experts to learn from policy makers and other stakeholders about the institutional contexts in which practical adaptation occurs. Researchers learned what is salient to stakeholders, how to communicate to non-scientific audiences and how to best facilitate a processes so that stakeholders learn from each other. For example, the Sydney Coastal Councils Group Secretariat played the role of knowledge broker in the Sydney assessment, relaying to experts the appropriate level of detail and complexity for the intended audience while simultaneously promoting the potential value of such expert knowledge to stakeholders. Similarly, in the Alpine Shire, researchers learned that the research community's interest in framing assessment and adaptation around climate change common was radically different to that of the community who were concerned about climate *variability and extreme events*. The focus on variability reflects an interest in existing climate hazards such as wildfire events, post-fire flooding, and changes in seasonality and subsequent effects on tourism and livelihoods. The participatory action research principles used to design the adaptation planning process in the Alpine Shire allowed two-way learning to occur and for the problem to be reframed and to evolve over time (although funding ran out before it could be completed).

At times there were barriers which revealed that some approaches might be more conducive to two-way learning than others. In the Melbourne case study, both the client (council) and consultant mentioned that the consultant undertook most of the assessment with only limited input from the client. The main interaction between the consultant and client was at workshops and in the review of draft reports. The consultant reflected that although this particular client was very accommodating, the 'traditional' client consultant relationship in general results in assessments lacking the ability to adapt as new lessons emerge. This suggests that the potential value of implementing flexible assessment approaches is often outweighed by pressures to complete assessments on time and on budget making it difficult for two-way learning to occur. On the other hand, processes for the solicitation of expert knowledge are often well-engrained within government institutions, while other approaches for acquiring knowledge that are more conducive to co-learning, such as participatory action research, are more foreign and may be inconsistent with planning timelines and organizational precedent and experience.

Another barrier to two-way communication is that policy makers and their political leaders risk being criticised by their electorate if they admit they don't have all the answers and apply an alternative theory-in-use based around learning and revision of goals (Argyris and Schön 1974). Governments are often concerned that they will appear incompetent through taking a more transparent, learning oriented approach, and fear that mistakes will be punished rather than valued (Lawrence 1998).

3.9 Linking assessment to decision-making

A key learning for interviewees was that even after an assessment is complete, there is not always a clear and agreed path forward for adaptation policy. Rather, adaptation planning is an ongoing process in which knowledge is constantly evolving despite inherent limits to knowledge, time, and resources. While assessments can improve the breadth and or depth of understanding around climate impacts, it was common for stakeholders to feel unprepared to make decisions because they felt there was too much uncertainty and gaps in the information. Yet, assessments pursued to reduce an organizational 'knowledge deficit' invariably uncover new deficits of knowledge, and therefore undermine their own utility for facilitating policy action. For example, all case studies identified new information and proposed areas of research that are necessary before decisions can be made to invest in action. Translating technical assessments into policy action would therefore seem to necessitate a mechanism by which stakeholders can escape this paradox. While interviews with stakeholders involved in the case studies indicated that the majority preferred to delay action until more information was available, the concept of 'bounded rationality' (Simon 1957) informs us that there will always be gaps due to limitations on access to information, cognitive limitations of the minds, and the finite amount of time in which to gather information and make decisions.

3.10 Role of science in rational decision making

All case studies reflected attempts by organizations to find an optimal solution through apply a 'rational' decision making process within climate adaptation planning. However, it can be considered equally 'rational' to follow a decision making process that maximises the benefit to the decision maker (based on their values, beliefs and emotions) and not for the greater good of the community. One lesson from the assessments was that decisions to invest resources could be as much based around politics as they were around what rationally was most at threat.

One of the project coordinators in the Western Port case study questioned the decision to invest resources into areas that were not identified as the highest priority risks based upon the assessment. However, through the discussion, it was revealed that there were political needs that guided these decisions. In this case, managing infrastructure risks from sea level rise in an area where a controversial marina development was planned became the focus of attention and effort. This decision to invest in managing sea level rise was contrary to the scientific assessment that ranked bushfires as a much higher risk. While the decision was made in a certain context, political priorities can change and lead to a different framing of the problem. For example, in the wake of the 'Black Saturday' bushfire in Victoria in early 2009, councils likely have a heightened awareness around the risk of bushfires. As such, had the Western Port assessment been conducted after, rather than before, 'Black Saturday', the manner in which stakeholders prioritized their efforts would perhaps be different. Hence, the rationality of decision-making is context dependent and the entire decision-making context must be explored if one is to understand the full range of knowledge as well as values that are underlying decisions.

The assumption often held in the research community is that adaption planning decisions needs to invest the most resources in the most vulnerable. However, as noted above, that is not always what actually happens. Researchers in the policy sciences help explain why this doesn't always occur. Researchers (Braun and Kropp 2010; Martin and Richards 1995; Engelhardt and Caplan 1987) point out that many seemingly intractable controversies such as climate change adaptation are both a cognitive controversy (i.e. conflict related to

competing knowledge) as well as a social controversy (i.e. conflict related to values and politics). The more controversial a decision, the more 'indisputable' the science needs to be (Martin and Richards 1995) in order to defend a policy decision. These decisions of adaptation planning are often highly (socially) controversial due to different values and underlying ideologies (Lowe 2006). Given we are dealing with inherently social processes; it challenges the assumption that highly detailed quantitative assessments will help us adapt.

3.11 Transparency of approach

The use of familiar methods and tools in the assessment of vulnerability and/or risk was observed to assist in stakeholder engagement in the assessment process and subsequent implementation of assessment recommendations. For example, the Western Port assessment benefitted from framing its technical assessment in a risk management context. Risk management is a paradigm for institutional decision-making with which Australian local governments are quite familiar. A risk management approach may therefore assist stakeholders in aligning assessment processes and outcomes with existing council practice (e.g. risk registers or risk management software). This was observed by two interviewees in the Western port case studies who felt that participation in adaptation was more likely to continue when the concepts and methods used were already familiar.

In contrast, framing technical assessments in the context of vulnerability appeared to pose greater challenges. While vulnerability has a vernacular meaning that is readily understood within organizations, the research community has emphasized the importance of attaching specific meaning to the term vulnerability and distinguishing it from other concepts such as risk or resilience that have similar vernacular meanings. Attempts to operationalise such academic definitions of vulnerability in technical assessments, particularly the incorporation of adaptive capacity as a determinant of vulnerability, led to confusion among stakeholders involved in the Sydney assessment. One interviewee believed the academic framing of vulnerability confused stakeholders possibly because the outcomes of the assessment didn't align with the 'mental models' of stakeholders. Again, this suggests that differences between researchers and stakeholders with respect to framing pose barriers to learning, and therefore the closer assessment processes and outcomes can be harmonized with those with which stakeholders currently understand and use, the greater their perceived utility.

3.12 Differential responses of stakeholders

The quality of an assessment combined with a stakeholder engagement plan will not guarantee its uptake where the capacity of stakeholders to respond to the information is limited. Both the Western Port and Sydney assessments reported that responses by stakeholders were highly varied due to differences in the capacity of stakeholders to participate in and implement actions.

One interviewee in the Western Port study observed that some of the WPGA member council's were actively engaged in the assessment across all levels within the organisation. In some cases groups, such as climate change taskforces or project teams responsible for adaptation plans, were set up after the assessment and continued to work on adaptation policies and measures. Another reflected that some councils were not actively engaged and assessment findings only made it as far as the environmental branch of council while the focus of majority of the organisation remained on 'roads, rates and rubbish'.

It was not only among different councils where varied responses were observed. The Western Port, Sydney and Melbourne assessments all had different impacts on state

government organisations. For example, one participant in the Western Port case study observed that the assessment recommendations had been acted upon at the local level, but not at the state government level. In contrast, an interviewee from the Sydney case study observed that the recommendations around sea level rise managed to successfully disseminate upwards to state government even though they were not formally engaged. In their belief, this success was due to the extensive media coverage the assessment received.

3.13 Emergence of double loop learning

While the limitations of the methodology used to analyse the case studies meant that only single loop learning could be considered, some double loop questions were, nevertheless apparent. In particular, the case studies raised questions regarding the type of planning approaches or principles that are right for organizations and society-at large, and whether the current approaches around proactive risk management are in fact adaptive. This is because they assume it is possible to have a clear understanding of the direction (if not magnitude) of change. Double loop learning could challenge the assumptions around proactive risk management based approaches and provide alternatives in the form of robust decision making or risk- hedging which are arguably more suitable under high levels of uncertainty (Stafford-Smith et al. 2010).

Double loop learning could also result in a changed understanding of the way collective actions are facilitated that is not limited to good information but a good social learning process. While not sufficient by itself, social learning is necessary to provide the mechanism through which assessment outputs are translated into actions.

4 Conclusions

While there is value in identifying assessment methods appropriate to the decision context and producing new knowledge around risks and responses. The quantitative assessment of vulnerability and risk is only one outcome from assessments. However, other outcomes derived from the process itself, may in fact be more useful for driving adaptation actions. Although based on a small number of case studies, this paper guides the practitioner to consider the importance of process and context when undertaking assessments. It shows that while the content of assessments can fall short of expectations, the process of undertaking an assessment plays an important role in catalysing social learning and collective action. In other worlds, vulnerability assessments provide the platform upon which social learning can occur and are of value irrespective of whether assessments are able to prescribe optimal management responses or provide objective information.

Platforms of learning provide the opportunity and structures necessary for groups of stakeholders to get together to share knowledge, ideas and debate or deliberate over actions, all of which are important to help communities respond to a complex and changing world. With the refocus on facilitation of social process rather than technical process, the framework selected becomes less important compared with ‘how it is implemented’ and ‘who is engaged’. The careful design of stakeholder engagement processes becomes important so that diverse stakeholders are included and a safe environment is created where differences of opinion can be aired freely and conflict aired and resolved.

Results showed that social learning (single loop) occurred in the four case studies. Some was around new content while other lessons were around better processes for learning. While the case studies provided valuable insight into the types of single loop learning

observed this research didn't consider in detail other types of learning, notably double or triple loop learning. All three types of learning—single, double and triple—are important and play different roles. Double and triple loop learning are particularly important for transformational change when new approaches are needed making it an important area of further research. While not a focus of the study, double loop learning's were starting to emerge that challenged assumptions around traditional planning approaches in a highly uncertain environment.

This study stopped short of exploring in detail how learning occurred, who was learning what and why adaptation planning was initiated in the first place. Neither did it make normative judgements around the value of learning or explore cases where learning could be considered negative (i.e. maladaptive). Longitudinal research is recommended into these areas across diverse (and constantly changing) stakeholders in equally diverse contexts. This is a challenging task, but without reflecting on the role of the social learning processes in the adaptation planning process and knowing how to facilitate learning processes, assessments risk being left on the shelf and failing to assist the communities they were intended to help.

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Appendix A

Table 2 Background on the vulnerability assessments undertaken

	Western Port	Sydney	Alpine Shire	Melbourne
State	Victoria	New South Wales	Victoria	Victoria
Funding:	approx AUD$500,000	approx AUD$500,000	2 PhD researchers both over 3 years	approx AUD$100,000
The project	risk assessment for 5 Urban and peri-urban Councils through an alliance	vulnerability assessment for 15 Urban and peri-urban Councils through a Group	PhD projects using participatory action research in one rural council area	risk assessment for one large urban Council
Framing and Engagement approach	Long term impacts on human settlements in member councils.	Long term impacts on human settlements in member councils.	Extreme (climatic) events and their impact on communities.	Long term impacts on primarily human settlements in councils.
	Top down but with broad engagement across multiple stakeholder types.	Top down but focussed on a single type of stakeholder	Bottom up with broad community engagement	Top down with limited engagement across stakeholder types
Core values of project champion	Council group needs to be Environmentally Sustainable	Council needs to manage financial liabilities and risks	Academic research	Council needs to manage financial liabilities and risks

Appendix B

Table 3 Process of undertaking the vulnerability assessment

	Western Port	Sydney	Alpine Shire	Melbourne
Scoping	Separate scoping process with a detailed needs analysis	Consultant brief and proposal	Desktop review and PhD proposal including input from one elected councillor	Consultant brief and proposal
Assessment approach	• vulnerability maps	• relative vulnerability maps	• Interviews with residents around past climatic events	• Risk assessment for social and physical systems
	• Systems diagrams (radargrams)	• adaptive capacity maps	• Timeline of events	• Diagrams of cascading impacts
	• risk assessment for individual councils	• Systems diagrams	• technical and policy analysis of impacts due to climate related hazards	
		• Interviews with councils around barriers to change		
Engagement approach with key stakeholders	• Council workshops to prioritise risks	• Officer level Council workshops to develop systems diagrams and communicate risks		• Council workshop with invited key stakeholders
	• Scenario planning workshops	• Full group council committee meetings		• Public release of report
	• Community presentations	• Print media articles		• Meetings between state and local agencies around sea level rise
	• Council Newsletters/ brochures	• Council Newsletters		
	• Reference group meetings			
Evaluation	Formative project evaluation	Post-project evaluation	None formally	Technical review

Appendix C

Table 4 List of lessons learnt and number of case studies in which the theme was identified

	Number of case studies in which issue was raised
4.1.1 Look for opportunities when framing of assessments and scoping	2
4.1.2 There is value in knowledge systems outside of western quantitative science	2
4.1.3 Combine participatory and expert driven processes	1
4.1.4 Stakeholder engagement requires diverse stakeholders	4
4.1.5 Allow conflict to help not hinder learning	2
4.1.6 Different tools and methods will be useful in different contexts	2
4.1.7 Value the process as much as the content	3
4.1.8 Allow two-way learning between stakeholders	4
4.1.9 Completion of an assessment doesn't guarantee a decision is ready to be made.	3
4.1.10 Recognise that the decisions need to be both rational and politically viable	1
4.1.11 Implementation can be supported by the use of familiar methods	2
4.1.12 Different stakeholders have different capacities to participate and respond	3

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