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The nature and utility of adaptive capacity research

Image: NSW State Emergency Service

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Executive summary

Adaptive capacity refers to the ability of a system to respond to change and has become widely acknowledged as a fundamental component of vulnerability to climate change. The aims of this project were to: (i) assess the interpretation of, and approach to, adaptive capacity research among a range of disciplines; (ii) critique case studies in which an attempt is made to assess adaptive capacity of a community, region or sector; (iii) assess the utility of the concept for decision-making; and (iv) to make recommendations to improve synergies between climate change adaptation researchers and decision makers. The purpose of this second report (one of two for the project) is to present the findings of an online survey and key informant interviews of climate change researchers and decision makers.

Data collection consisted of two parts: (i) an online survey; and (ii) key informant interviews. The online survey targeted 39 adaptation e-networks, including: international climate change research centres and institutes; non-government organisations; government agencies that focus on adaptations to climate change; and the eight NCCARF Adaptation Research Networks. Two hundred and ninety nine people responded to the online survey. Key informant interviews targeted both climate change adaptation researchers and decision makers. Of the 15 of the 25 researchers identified as key informants agreed to participate, while only four of the 15 decision makers identified as key informants agreed to participate. However, participants represented a range of geographic scales of focus (eg. local, regional, national and international), and while the majority of respondents were Australian (15 of 19 respondents), there was also representation from the UK, USA, and Europe.

Online survey results show little difference in the conceptualisation of adaptive capacity among researchers from a range of disciplines. Anthropocentric conceptions (eg. focused on addressing social vulnerability) dominated comments within most disciplines, while a systems view (eg. focused on addressing the various social and environmental dimensions of vulnerability) is also evident, but dominates in the biological sciences.

The two disciplinary fields found to be most positive about a socio-ecological future with respect to adapting to climate change are those relating to the creative arts and writing, and the physical sciences. The two most negative disciplinary fields are law and legal studies, and philosophy and religious studies. All disciplinary fields shared the dominant belief that power/agency to create the future lies both internally (i.e. within individuals) and externally (i.e. within society).

Both the literature review and survey results support the proposition that the next frontier to challenge the assumptions underlying adaptive capacity research relates to holism born out of resilience and systems thinking. A shift across all disciplines from the dominant anthropocentric view of adaptive capacity to a holistic systems view based on resilience science is likely and may change the understanding of adaptive capacity. The literature review, survey and key informant interviews all suggest that the approaches and methods used for adaptive capacity research tend to show: (i) paradigm shifts from mono-disciplinarity to trans-disciplinarity; (ii) linear one-way research by scientists for practitioners, to participatory research; and (iii) actor-orientated to systems-orientated conceptualisations of adaptive capacity.

The findings of the key informant interviews support the literature review regarding the proposition that multi-disciplinary research methods and diverse ways of knowing (eg. scientific, local, and indigenous knowledge sources) are needed to understand adaptive capacity. The key informants' comments about knowledge gaps put the greatest emphasis on the need to focus on context-specific research, as well as, the socio-cognitive factors of adaptive capacity.

The literature, case studies and survey results indicate that adaptive capacity research has enhanced the knowledge base of decision makers for effectively devising policy, planning and implementing adaptation strategies. While over half of the decision makers (55%) surveyed considered that responding/adapting to climate change impacts is now core business within their policy/decision-making, 72% of decision makers agree with the statement that more effective ways are needed for building their organisation's capacity to adapt and become more resilient to climate change impacts. This suggests ongoing demand for mainstreaming adaptive capabilities within management organisations.

Furthermore, 65% of decision makers rated the concept of adaptive capacity as useful in directing their programs. In contrast, 16% of researchers rated the application of adaptive capacity programs undertaken by communities, organisations and governments as ineffective (inclusive of partly ineffective and strongly ineffective), 17% took a neutral position, and only 39% believed adaptive capacity programs are partly effective. However, from the literature review, it was apparent that insufficient attention has been given to monitoring and evaluation of adaptive capacity programs.

Context and uncertainty are recurring themes for decision makers around the utility of adaptive capacity. The survey results indicate that adaptive capacity research is occurring largely across scales and systems at the State/Provincial level when considering socio-ecological systems. The least effort is occurring at the local scale when studying biophysical systems: the sphere where the literature review found the greatest need (more environmental information is needed for local governments to be effective adaptors and policy makers). Key informants also raised the need for further research to understand the effectiveness of interventions at the appropriate scale, barriers to adaptive capacity, and how governance drives success or failure of adaptations and adaptive capacity interventions in an uncertain world.

Knowledge gaps in adaptive capacity research from the literature review and key informant interviews indicates considerable convergence, although additional and perhaps more marginal issues are identified from both sources (Table 1).

Table 1: Summary of knowledge gaps

Knowledge gaps indentified from the literature review and key informant interviews	Knowledge gaps indentified from the literature review	Knowledge gaps indentified from the key informant interviews
• Adaptive capacity assessments. • Adaptation option assessments – monitoring performance. • Socio-cognitive factors of adaptive capacity across scales from the individual to the collective. • Adaptive capacity building effects from action research. • Systems approaches to adaptive capacity interdependencies.	• Evolving approaches and methodologies for adaptive capacity research. • Holistic approaches - methods to integrate Indigenous knowledge (past and current adaptive practices) with *contemporary* adaptive science.	• Understanding the generic determinants of adaptive capacity – particularly understanding individual agency within social systems. • Understanding barriers to adaptive capacity – particularly related to governance and policy development. • Identifying vulnerability across scales. • Understanding peoples (cohorts) different adaptive capacities. • Understanding ecological systems.

The report concludes with four recommendations for improving synergies between climate change adaptation researchers and decision makers. The recommendations consist of: (i) improved integration of adaptive capacity considerations with adaptation plans; (ii) support of research on the various dimensions of adaptive capacity (eg. at various scales; as well as, in various social and biophysical contexts); (iii) organisational capacity-building initiatives; and (iv) monitoring and evaluation of adaptive capacity changes. Other generic recommendations in the form of guiding principles are also provided to better assist end-user relevance of climate change adaptation research, and to improve approaches to decision-making.

1 Introduction

1.1 Purpose of report

This report is the second of two for the "Assessment of the Nature and Utility of Adaptive Capacity Research" project, undertaken as part of the National Climate Change Adaptation Research Facility (NCCARF) Synthesis and Integrative Research Programme. The research objectives are to:

- Assess the interpretation and approach to adaptive capacity research among a range of disciplines;
- Assess the utility of the adaptive capacity concept for decision-making for adaptation policy and planning; and
- Develop recommendations to improve synergies between climate change adaptation researchers and decision makers.

1.2 Structure of the report

The appendices core the details of the research. This includes methods used, (2) detailed discussion of results from both the online survey and the key informant interviews, (3) a copy of the online survey, (4) concept maps form the analysis of the key informant interviews, (5) materials associated with the interviews, (6) example quotes from the interviews, and (7) generic recommendations for researchers and decision makers.

In the interest of being succinct, the report makes considerable use of the appendices in presenting the detailed methodology and results. The report itself consists of five sections. The **introduction** defines the purpose and report structure; as well as, providing a definition of adaptive capacity and explaining the limitations of the study. The **reflections** provides the lead author's perspective on adaptive capacity research and its utility for decision-making. The **synthesis** integrates findings from the four elements of this study: the analysis of the literature, the analysis of an online survey and the analysis of the key informant interviews. **Recommendations** for improving synergies between climate change adaptation research and decision making are presented along with summary **conclusions**.

1.3 Definition of adaptive capacity

For the purposes of this report, the IPCC Third Assessment Report (2001, p.982) definition of adaptive capacity is used as starting point, being "The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences". This definition was also adopted by the UK Climate Impact Programme in 2003. Alternative definitions are used by UN/ISDR (2004): "A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster. Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management" and Lim *et al.* (2005): adaptive capacity "... is the property of a system to adjust its characteristics or behaviour, in order to expand its coping range under existing climate variability, or future climate conditions ... The adaptive capacity inherent in a system represents the set of resources available for adaptation, as well as the ability or capacity of that system to use these resources effectively in the pursuit of adaptation". The common elements of the definition relate to ability to respond or adjust to change. The definitions differ in the specificity on the bounds and elements of adaptive capacity. For example, the UN/ISDR definition is explicit about reduction of risk, while the IPCC definition also caters for the ability to take advantage of opportunities.

1.4 Limitations

This study represents a scoping study on the conceptions of adaptive capacity and its utility for decision-making. The resources allocated to the project allowed for: (i) a literature review (over 200 documents sourced, over 50 annotated, and a short critical review); (ii) an online survey (299 respondents); and (iii) key informant interviews (19 respondents). The research focused on understanding emerging themes from the various data sources (largely via qualitative methods). Among other areas, further research is needed to test the findings among a broader sample (eg. random sample of decision makers); as well as, to better understand the causal relationship between adaptive capacity and adaptation outcomes.

2 Reflections

Adaptive capacity now figures prominently in discussions of climate change adaptation. However, while there have been significant advances in theoretical discourses of adaptive capacity (such as the need for inclusion of context-specific considerations in adaptive capacity, as opposed to a cursory reduction to generic determinants), there are relatively few empirical studies of adaptive capacity to test these theoretical assumptions. One area that has received very little attention is in understanding the relationship between various determinants of adaptive capacity (eg. how does wealth, education, resources and social capital interact in particular geographic and social settings?).

Decision makers remain focused on adaptation plans and strategies. However, as these adaptations start being implemented (and assuming there is adequate monitoring and evaluation in place), there is little doubt that the acknowledgement of the need to better integrate adaptive capacity understandings and initiatives will be paramount to the actual ability of society to respond to climate change.

Lastly, when mitigation is finally recognised as an adaptation (i.e. it is the ultimate form of planned adaptation, which occurs over different temporal scales to most other [popular] notions of adaptation), adaptive capacity is likely to be expanded to be known more broadly as response capacity, and the link between the various types of adaptation (eg. planned, autonomous, immediate, long-term, anticipatory) will likely broaden the understanding of societal capacity to respond to (climate) change.

3 Synthesis

In this section, the findings from the first report "Critical Review of Adaptive Capacity Literature" (Daffara, et al., 2010), the online survey, and the key informant interviews are compared and discussed. The discussion focuses on the project's research objectives in assessing:

- The interpretation and approach to adaptive capacity research among the range of disciplines; and
- The utility of the concept of adaptive capacity for decision-making on adaptation policy and planning.

3.1 Conceptions of adaptive capacity research

The analysis of the online survey participants' definition of adaptive capacity shows that anthropocentric views dominated comments from within most disciplines. In addition, a systems view of adaptive capacity exists in most disciplines, although dominant in the biological sciences (Figure 1). More specifically, anthropocentric views dominated comments from within all disciplinary sub-groups, including the environmental sciences (67%) (except mathematical sciences, biological sciences, engineering and philosophy and religious studies). While the systems view is dominant in the latter disciplinary areas, the engineering and philosophy and religious studies sub-groups are very small (three and two respondents respectively).

Within biological sciences, a systems view was expressed in 41% of comments received, followed by anthropocentric (35%) and biophysical views (24%). A biophysical view of adaptive capacity was expressed by only seven respondents (4%), with over half of these coming from those whose primary training was in biological science. As large shifts between first discipline and current discipline did not occur, the analysis did not re-examine conceptions of adaptive capacity based on current disciplinary fields.

Conceptions of adaptive capacity were explored in relation to the current research or decision-making context of respondents. The work contexts that participants could choose were biological systems (excluding people), social-systems (economic and cultural) or socio-ecological systems. Of those respondents supplying both pieces of data, most consider their work to be in socio-ecological systems (43%), followed by social systems (39.2%) and biophysical (17.7%). Research in all three spheres is carried out by respondents from a range of disciplinary backgrounds, although biophysical systems research remains the domain of those from biophysical science backgrounds. However, the converse is not true. That is, researchers trained in environmental, biological, physical and mathematical sciences are active in each of the three research contexts (Figure 2).

An anthropocentric view is dominant among respondents working in all three system contexts, even within the biophysical system work context, where a systems view was expressed by an equal number of respondents (Figure 2).

For the future development of the concept of adaptive capacity, a proposition drawn from the literature review is that the next frontier may be a greater appreciation of holism born out of resilience systems thinking (Daffara et al., 2010, p. 7). This proposition is supported by the survey data (Figure 13), which shows that the current dominant view of adaptive capacity to climate change is anthropocentric. A shift across all disciplines to a holistic systems view based on resilience science is possible, likely and may change understanding of adaptive capacity.

Indicators of a shift are evident in the literature review and online survey. The review of the discourse suggests that the approaches and methods used for adaptive capacity research tend to show paradigm shifts from mono-disciplinarity to trans-disciplinarity; linear one way research from scientists to practitioners to participatory research; and actor-orientated to systems-orientated conceptualisations of adaptive capacity. The online survey supports the methodological shifts by signalling that current methodological approaches are characterised by:

- Inter-disciplinary research (85%);
- Generation of applied knowledge (case studies) (75%);
- Generation of mixed knowledge (quantitative and qualitative) (65%);
- A focus on socio-ecological systems (43%), and;
- Action research (participatory social learning) (30%).

In contrast to the online survey, the NVivo content analysis of the key informant interviews shows that the issue of inter-disciplinary collaboration, as a means of addressing knowledge gaps or advance the concept of adaptive capacity, had very low concurrency (4 references by 2 informants). This suggests that either appropriate research engagement is assumed and expected, or that this result reflects researchers' blind sides. For those who did comment, the message is clear that due to the multi-dimensional nature of adaptive capacity, a better understanding of it can only come from interdisciplinary research.

3.2 Utility of adaptive capacity

The critical review of adaptive capacity research literature examined the usefulness of the concept to decision makers and drew three main conclusions. Drawing from the reviewed case studies, the first is that adaptive capacity research has enhanced the knowledge base of decision makers to better implement adaptation strategies. The second is that multi-disciplinary research methods are needed to understand adaptive capacity. The third is that context and uncertainty are recurring themes for decision makers and the utility of adaptive capacity.

3.2.1 Enhancement of decision maker knowledge

The first proposition, that adaptive capacity research has enhanced the knowledge base of decision makers, is supported by decision makers who participated in the online survey, while the assessment by researchers is more varied. Recapping, 85% of policy/decision makers rated the concept of adaptive capacity as useful (inclusive of very useful, useful, or somewhat useful) in directing their programs (Table 16). In contrast, 16% of researchers rated the application of adaptive capacity programs undertaken by communities, organisations and governments (Table 14) as ineffective (inclusive of partly ineffective and strongly ineffective). Of the researchers, 17% took a neutral position and only 39% think adaptive capacity programs are partly effective. The literature review

highlighted a need for greater emphasis on the monitoring and assessment of adaptive capacity programs.

While over half of policy makers (55%) considered that responding/adapting to climate change impacts is core business within their policy/decision-making sphere (Table 15), 72% agree with the statement that more effective ways are needed for building their organisation's capacity to adapt and become more resilient to climate change impacts (Table 17). These results suggest that there will be ongoing demand for mainstreaming adaptive capabilities within organisational systems.

The majority of key informants (74%) generated comments (31 references) that adaptive capacity is poorly understood by decision makers. Only three informants, all of whom are researchers, gave feedback (6 references) on how the concept is understood by decision makers. This seems consistent with the survey results that show researchers are doubtful about the effectiveness of adaptive capacity programs. However, decision makers interviewed did express how the concept might be more useful, subject to more research to address knowledge gaps.

3.2.2 Multiple perspectives are needed

The literature review found that more innovative approaches are needed to better understand and contextualise adaptive capacity. These draw on different disciplines and types of knowledge, and can accommodate multiple perspectives and varying value systems and worldviews. However, this proposition was not explicitly explored by the survey and key informant interviews, the findings tend to support the need for multi-disciplinary and participatory research methods focussed on case studies that contextualise adaptive capacity and generate multiple forms of knowledge (different ways of knowing). Accommodating and facilitating multiple perspectives and worldviews to understand adaptive capacity, requires a concomitant pluralistic worldview of responsibility from the individual to the collective. This worldview was frequently evident in the survey sample when the most important socio-ecological resilience factors, in terms of levels of social prescription, were examined[1].

The findings of the interviews also support the literature review. The key informants' comments about knowledge gaps put the greatest concurrency on the need to focus on context-specific research[2] as well as the socio-cognitive factors of adaptive capacity[3]. These two identified areas of further research, when combined, aim to unpack diverse value systems, worldviews and behaviours operating within a context-specific system.

3.2.3 Context defines utility and barriers

The literature review found that issues relating to context (particularly in terms of scale and culture) and uncertainty emerge as key themes in research focusing on the utility of adaptive capacity for decision makers and barriers to its application in response to climate change. The survey results show that the major adaptive capacity research effort across scales and systems (Table 11) is occurring at the State/Provincial scale investigating socio-ecological systems. The least effort is occurring at the local scale, studying biophysical systems: the sphere where the literature review found the greatest need (more environmental information for local governments to be effective adaptors and policy makers) (Leitch and Robinson, 2009; SMEC Australia 2009; Smith et al., 2008; ICLEI Oceania, 2008).

Key informants also raised the need for research to enhance understanding of the effectiveness of interventions at the appropriate scale, barriers to adaptive capacity and how governance is a major driver of success or failure of adaptations and adaptive capacity programs[4].

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[1] 39% of respondents indicated a balance or trade-off of personal rights and moral obligations. Similarly, 40% of the coded comments related to the latter question called for a balance of multi-scale responses from human consciousness shifts to rules (46 references out of 128).

[2] 11 out of 19 informants generated 27 references within the *knowledge gap* tree node that had a total of 171 references. Therefore 16% of coded references in regard to addressing knowledge gaps related to more context specific research.

[3] 8 out of 19 informants generated 23 references within the *knowledge gap* tree node that had a total of 171 references. Therefore 13% of coded references in regard to addressing knowledge gaps related to understanding the socio-cognitive factors of adaptive capacity.

[4] 12 out of 19 informants generated 24 references within the *effectiveness of adaptive capacity* tree node that had a total of 148 references. Therefore 16% of coded references in regard to improving the effectiveness of adaptive capacity strategies related to improving foremost governance arrangements.

3.3 Knowledge gaps

To provide a summary of the knowledge gaps in adaptive capacity research from the literature review and key informant interviews, this section is presented in three parts. The first discusses those areas of further research identified by both sources. The second part presents knowledge gaps mentioned only in the literature review. The third part highlights knowledge gaps mentioned only by the key informants. The aim is to identify issues with most concurrency compared with more marginal issues. Concurrency here means the level of agreement measured by the number of informants who raised the issue (as coded using NVivo). The average concurrency for the discussed knowledge gaps is 6.58[5].

3.3.1 Agreed areas for adaptive capacity research

Four areas for further adaptive capacity research or development are common to both sources.

- Adaptive capacity assessments - further development of robust evaluation protocols and tools for adaptation action plans, policies and measures. Among the key informants, this knowledge gap is related to two separately coded issues: (i) the need *for benchmarking tools and indicators of adaptive capacity*; and (ii) improved *adaptation options assessments*, which use indicators of adaptive capacity. Comparing these issues results in a relatively high concurrency (13 of 160 informants). Six informants reiterated this gap when they discussed *monitoring performance* as a way to improve the effectiveness of adaptive capacity strategies for decision makers.
- Socio-cognitive factors - better understanding of socio-cognitive factors affecting adaptive capacity. Among the key informants, this knowledge gap is related to two separately coded issues: (i) generally, what are the *socio-cognitive factors of adaptive capacity*; and, more specifically, (ii) understanding the relationships between institutional cultures and adaptive capacity. The combined concurrency of these issues is eight of 160 informants – just over the median concurrency. Three informants linked socio-cognitive factors of adaptive capacity with the individual scale.
- Action research - stakeholder participation in the planning, design, implementation and monitoring of adaptation projects. Action research that engages stakeholders, inherently is context specific (e.g. whether by sector or scale). This was tested by running a compound coding query to see if informants, when they spoke of *context specific determinants of adaptive capacity* also related this to research engagement with stakeholders. However, no cases were found. When asked about ways of improving the utility of adaptive capacity for decision makers, five informants did discuss the idea of using research engagement with stakeholders to promote knowledge transferability and learning outcomes; however, this is below the median concurrency.
- Linkages - systems approaches to understanding adaptive capacity interdependencies. Seven key informants raised this issue (similar to the median concurrency) as either the need to better understand the linkages between determinants or the interaction of the attributes of adaptive capacity in the system. To understand these systemic interdependencies, implies that inter-disciplinary collaboration is required. The NVivo content analysis however did not show a strong relationship between the two areas of further research, as *interdisciplinary collaboration* has a very low concurrency within the sample (only 2 informants). Similarly, only two informants also related the issue of more context specific research to understanding the system interactions of the determinants of adaptive capacity.

3.3.2 Areas for adaptive capacity research identified only in the literature

Only two areas of further adaptive capacity research or development were found in the literature review include:

- Continuing evolution - the concept of adaptive capacity continues to evolve and the current research focus is on rigorous processes for, rather than metrics of, adaptive capacity. In contrast to focussing on approaches and methodologies for adaptive capacity, eight key informants called for more research into understanding the metrics (generic or context specific) of adaptive capacity. This may signal some research inertia within the field.
- Holistic approaches - methods to integrate Indigenous knowledge (past and current adaptive practices) with *contemporary* adaptive science. This area was not explicitly discussed by the key informants as a knowledge gap. However, two informants did refer to Indigenous communities in the context of understanding their vulnerability to climate change. This lack of dialogue on from key informants may indicate that the objective of seeking research methods to integrate Indigenous knowledge with Western science is culturally sensitive and is at the margins of adaptation research.

[5] The median frequency of informants who discuss a particular coded knowledge gap. It is calculated by dividing the total frequency of cases coded under the tree node *knowledge gaps* (79) by the number of knowledge gap nodes (12).

3.3.3 Areas for adaptive capacity research identified only by key informants

Five areas of further adaptive capacity research or development were raised only by the key informant interviews include:

- Generic determinants - understanding the generic determinants of adaptive capacity. Notwithstanding the claim made in the literature review that research has progressed from focussing on generic determinants of adaptive capacity, the fourth highest number of text references (19) generated by nine key informants raised the need to learn more about them. This issue has above average concurrency among the group and the content analysis shows that a key theme is more understanding about individual agency within social systems.
- Barriers - understanding barriers to adaptive capacity. This knowledge gap, raised by seven key informants, has an average concurrency among the group. Informants who talk about the barriers to adaptive capacity often relate this issue to governance, institutions and/or decision-making. Therefore, overcoming barriers to adaptive capacity has a strong relationship to good governance and policy development.
- Identifying vulnerability across scales. The NVivo content analysis shows that eight key informants raised this issue – a slightly above average concurrency. Often, informants proposed the need to identify the most vulnerable populations for different contexts to guide priorities for adaptation responses.
- Understanding peoples' (cohorts) different adaptive capacities. This issue has below average concurrency among key informants (5). Understanding cohorts' adaptive capacities is dependent on context-specific research with the potential to influence subsequent adaptations.
- Understanding ecological systems. This issue has below average concurrency among the key informants (3), and all the informants who raised the issue had a biophysical sciences background. The main issue is the need for ongoing research into the climate change impacts on ecological systems, the adaptive capacity of biota and how to avoid ecological thresholds (tipping points) or change the sensitivity of the threshold in the system. This knowledge undoubtedly frames vulnerability and adaptive capacity assessments and is an integral part of actors designing adaptation programs.

4 Recommendations

Based on the findings of the literature review, online survey and key informant interviews, four key recommendations on how to improve the synergies between climate change adaptation researchers and decision makers are presented. Two other sets of guiding principles are provided in appendix 7, and consist of generic recommendations designed to improve approaches to incorporating adaptive capacity components into research and decision-making. The first provides benchmarking research meta-criteria that NCCARF can use to ensure its National Adaptation Research Plans are addressing the theoretic and applied dimensions of the concept of adaptive capacity within socio-ecological systems. The second provides operational guiding principles for decision makers to improve the effectiveness of adaptive capacity strategies and actions. The meta-criteria and principles collectively form both sides of a metaphoric coin, essentially maintaining synergies between and from the vantage points of the researcher and decision maker.

4.1 Recommendations based on the findings

1. Integrate adaptive capacity into adaptation plans: The current focus on the development of adaptation plans by decision makers (eg. Local Adaptation Pathways Program) is not being informed by research on adaptive capacity (i.e. the feasibility of the success or failure of those plans). Significant adaptation investment and time may be lost without this coupling;
2. Various dimensions of adaptive capacity research should be supported: To date, very few empirical studies exist in relation to adaptive capacity determinants, both in terms of societal adaptive capacity, and that of other species. A major gap exists in understanding the relationships between various dimensions of adaptive capacity in specific places;
3. Implement initiatives to build organisational capacity to respond to climate change: 72% of decision makers identified capacity constraints within their organisation as affecting their organisation's ability to respond to climate change; and
4. Monitor and evaluate adaptive capacity: Given the complexity and unpredictability of many dimensions of various socio-ecological systems affected by climate change, there is value in monitoring and evaluating various adaptive capacity interventions. This recommendation is also consistent with literature on adaptive management of socio-ecological systems to enhance resilience.

5 Conclusions

Adaptive capacity has emerged as a key consideration for climate change adaptation. The findings of the online survey show little difference in the conceptualisation of adaptive capacity among researchers from a range of disciplines. Minor differences exist between biological sciences (who tend towards a systems perspective) and other disciplines who take more of an anthropocentric conception of adaptive capacity. It was also perceived that both individual and collective response was needed to respond to climate change. Similarly to the literature review findings (Report 1), both the online survey respondents and key informant interviews suggest that future approaches to adaptive capacity research may need to place more emphasis on holism born out of resilience systems thinking. Similarly, a shift across all disciplines from the dominant anthropocentric view of adaptive capacity to a systems view based on resilience science is likely and may change the understanding of adaptive capacity. The literature review, survey and key informant interviews all suggest that the approaches and methods used for adaptive capacity research tend to show paradigm shifts from mono-disciplinarity to trans-disciplinarity; linear one-way research by scientists for practitioners to participatory research; and actor-orientated to systems-orientated conceptualisations of adaptive capacity. Knowledge gaps were identified in particular in relation to context-specific research, as well as, the socio-cognitive factors of adaptive capacity. These two identified areas of further research, when combined, aim to unpack the diverse value systems, worldviews and behaviours operating within a context-specific system.

Adaptive capacity interventions and knowledge was considered most robust at the State/provincial spatial scale. However, the literature review and some comments from online survey respondents identified more application and research needed at the local scale in particular – especially because of context-specific influences on adaptive capacity perceived to be operating at that scale. Decision makers were more confident (than researchers) that adaptive capacity research was enhancing their ability to effectively devise policy, and plan and implement adaptation strategies. However, responses by key informants and findings from the critical literature review suggest that insufficient attention has been given to monitoring and evaluation of adaptive capacity programs.

Recommendations for improving synergies between climate change adaptation researchers and decision makers can be achieved through: (i) greater integration of adaptive capacity considerations in adaptation plans; (ii) participatory research approaches to understanding various dimensions of adaptive capacity; (iii) initiatives to improve organisational capacity to respond to climate change; and (iv) inclusion of adaptive capacity considerations in monitoring and evaluation activities.

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Appendix 1 Methods

The understandings of researchers and decision makers responding to climate change were sought regarding the concept of adaptive capacity and its usefulness. The purpose of the research was to help the research team make recommendations to improve synergies between climate change adaptation researchers and decision makers. Two methods were used to collect qualitative responses. First, an anonymous online survey was conducted; secondly, key informant interviews explored issues raised in the survey results. The online survey was broad in scope regarding adaptive capacity concepts and worldviews, while the key informant interviews were used to elicit more detailed understanding of the future directions of adaptive capacity research and its utility for decision-making.

1.1 Online survey methods

The objectives of the online survey were to identify

- disciplinary-specific conceptions of adaptive capacity and how they differ;
- different methodologies and methods applied to adaptive capacity research; and
- perceptions of the utility of the concept of adaptive capacity for decision-making.

1.1.1 Timing of surveys in the context of political developments

The online survey was available from the 3rd to the 30th of September 2009, before the publicised political debate in the Federal Parliament regarding the proposed Australian Carbon Pollution Reduction scheme and the change in policy direction/support for the scheme by the Australian Liberal Party, which led to the scheme being blocked in the Senate. However, many of the respondents to the online survey were from outside of Australia. The key informant interviews were conducted between the 23rd of November and the 1st of December 2009; before the United Nations Climate Change Conference in Copenhagen (7-18 December 2009). The timing of both surveys, in the context of wider national and global debates, no doubt, had some influence on some participants' responses. However, speculations on how and why is not part of the scope of this research. These socio-political contexts and their influences through the media will add to the complexity of researchers' and decision makers' understandings of adaptive capacity to climate change.

1.1.2 Target group participation

The online survey targeted international research centres and institutes, non-government organisations, government agencies that focus on adaptations to climate change, and the eight NCCARF Adaptation Research Networks (e.g. human health, and terrestrial biodiversity) (total n=39 networks). The questionnaire (Appendix 1) was developed using the software 'Opinio' and was used to collect responses relating to the concept of adaptive capacity, the perceived effectiveness of adaptive capacity programs and plans, and the personal worldviews of respondents. Opinio was also used to generate reports of the quantitative survey results.

While a response rate for the survey cannot be calculated because it is not known how many potential respondents actually received the survey through their online networks, 299 individuals partly completed the survey and 160 fully completed it. Possible reasons for participants not completing the survey include competing priorities for time and attention, the secure access process for saving and re-opening questionnaires, and a lack of understanding or acceptance of the rationale for some of the questions (Appendix 2). Most cross tabulations were conducted only for questions toward the first half of the survey data where completion rates were high.

1.1.3 Content analysis

Thematic analysis of the text of survey and interview responses was carried out with two content analysis tools Leximancer and NVivo. Leximancer was used to generate concept maps of the combined answers collected for each qualitative question via the online survey and key informant interviews. The connectivity or co-occurrence of concept words in each text was also examined. NVivo

was used to manage the data for both survey instruments; a separate casebook was created for the online survey respondents and key informant interviews, so that the relationship of attributes might be tested with the comments received.

The first round of NVivo manual coding of the texts was done prior to the generation of Leximancer concept maps so that coding occurred organically without a preconceived structure of themes or concepts (a grounded theory approach[6]). The online survey text was only coded with "free nodes". The second round of NVivo coding of the key informant interviews organised the "free codes" into a structure of "tree nodes". The Leximancer concepts maps were used to ensure key themes were not missed in the NVivo coding. The final coding structure mirrors the main objectives of the study (i) future conceptual development of adaptive capacity; (ii) improvement of adaptive capacity programs; and (iii) cross-cutting issues.

1.1.4 Rationale for questions

The online survey aimed to collect data related to participants':

- Conceptions of adaptive capacity;
- Disciplinary backgrounds;
- Themes of adaptive capacity research;
- Worldviews regarding agency in creating the future;
- Beliefs on the most important socio-ecological resilience factors;
- Degree of optimism about the future;
- Spatial scales of work or research; and
- Usefulness of the concept of adaptive capacity related to climate change for decision makers.

Collecting data about conceptions of adaptive capacity is central to the research purpose. Definitions of adaptive capacity reveal whether alternative perspectives of the concept exist. For example, Nelson et al. (2007) argue that the traditional perspective of adaptive capacity from the environmental change literature is actor-orientated, whereas the resilience perspective is systems orientated. "Adaptation is concerned with actors, actions and agency and is recognized as an ongoing process" (Nelson et al., 2007, p.398). The systems perspective sees that "the ability to adapt is a function of system characteristics, which are captured by the concept of resilience (p.400). Nelson et al.'s research provided the theoretical framework for coding the participant's definitions of adaptive capacity as being anthropocentric, systems-orientated, or more narrowly biophysically-orientated. This provided a simple way of linking current conceptualisations of adaptive capacity with research traditions.

Data about the researchers' and policy makers' disciplinary backgrounds allows examination of potential relationships between participant's technical paradigms and their conceptions of adaptive capacity, and worldviews about our socio-ecological futures. Participants' first discipline and current discipline were collected as well as the current work contexts, described by system focus biophysical, social or socio-ecological systems.

Questions regarding participants' worldviews of agency, social prescriptions and optimism need to be considered in concert. Polak (1973), as cited by Inayatullah (2002, p.5, 78), established the fundamental relationship between vision and social progress. He argued that the concept of a positive *vision* or *the image of the future* with the opportunity for individual or collective agency; is necessary for a culture to advance and avoid decline. For this reason, the online survey sought to collect participants' feelings about the degree of optimism about our socio-ecological future with respect to climate change (Question 10) as well as their worldviews about where the power/agency lies to create the future (Question 6).

[6] Patton, MQ 2002, Qualitative Research & Evaluations Methods. Sage Publications, Thousand Oaks, CA, USA.

Using Thompson et al.'s (1990) socio-cultural viability theory[7], the inter-relationship of degrees of group power/agency (internal to external) and degrees of group collectiveness (low to high levels of rules/social prescription) describe five abstract social groups or cultural paradigms egalitarians, individualists, fatalists, hierarchists and hermits. Adger et al. (2009), citing O'Riordan and Jordan[8] (1999), argue that "cultural theory is a useful tool in demonstrating that individuals' preferences are attached to different worldviews, and this has implications for adaptation to climate change" (p.346). The profound differences in attitudes between worldviews mean that it is difficult to agree on how to respond to an issue or problem. Thompson et al's(2009), theoretical framework drove the formulation of Question 8. Here, we sought to capture participant's beliefs about the narrowly defined resilience factors determining socio-ecological systems, based on a scale of social prescription. Some respondents criticised the framing of this question and the authors agree that resilience is determined by a complex interaction of system variables. Notwithstanding, this does not negate the importance of understanding how perceptions of social prescription within a group affect its resilience. As such, levels of social prescription required for resilient socio-ecological futures were posited for participant's feedback. The range (not a clear ordinal scale) of social prescription used in the survey was:

- Comprehensive prescriptions and regulatory control of human actions;
- Mainly through rules and regulations;
- A balance/tradeoff of personal rights and moral obligations (social sanctions);
- Mainly through human ingenuity and creativity; and
- Human consciousness (personal and social ethics) and spirit.

Stoll-Kleemann et al. (2001) argue that some social actors "maintain the gap between attitude and behaviour with regard to climate change norms" by using psychological "denial or displacement" (shifting blame to external agencies) (p.111). As argued by Grothmann and Patt (2005), this supports the need to understand the shifts in power/agency between scales from the individual to institution and their relationships to the socio-cognitive factors of adaptive capacity.

Cross-scale issues and dynamics of the applicability of adaptive capacity are well-established (Adger et al. 2005). While some generic determinants of adaptive capacity may be aggregated between scales, many may not and are context and or scale specific (Vincent 2007). As such, the online survey sought to collect participants' spatial scales of work or research (Questions 3 and 21) to get a sense of where the current effort is focused within systems and between scales.

Finally, the online survey aimed to collect perceptions of the effectiveness of adaptive capacity building programs (Question 17). Since adaptive capacities (resources and the ability to employ those resources) are prerequisites to adaptation (Nelson et al., 2007, p.402), it follows that the operational usefulness of the concept to adaptors/decision makers is important to achieving desired adaptation outcomes. The rationale for this line of inquiry draws on Nelson et al.'s (2007) proposition that the "outcome of adaptation processes is system adaptedness, the level of effectiveness in the way a system relates with the environment and meets the normative goals of system managers and stakeholders" (p.400). On this basis, the survey also questioned participants about how strongly they believe that ways that are more effective are needed for building their organisation's capacity to adapt (Question 28).

[7] Thompson M, Ellis R, Wildavsky A (1990) Cultural Theory. Westview Press. Boulder

[8] O'Riordan T, Jordan A (1999) Institutions, climate change and cultural theory: towards a common analytical framework. Glob Environ Change 9:81–93

1.2 Key informant interview methods

The objectives of the key informant interviews were to

- Understand further, perceptions of the concept of adaptive capacity and its usefulness; and
- Explore recommendations to improve synergies between climate change adaptation researchers and decision makers.

The conceptual development and the application of adaptive capacity to climate change were explored in short telephone interviews, focused on the following two questions

(1) Our literature review identified a number of knowledge gaps. From your experience, how does the concept of adaptive capacity need to be developed further?

(2) How could the effectiveness of adaptive capacity programs be improved?

The methods of analysis (see Content analysis, p.15) generated a final coding structure that mirrors the main objectives of the study (i) future conceptual development of adaptive capacity; (ii) improvement of adaptive capacity programs; and (iii) crosscutting issues (Table 2).

Table 2 Final coding structure of content analysis of key informant interviews

1st tier of theme coding (N = coded references)	*2nd tier of theme coding (N = coded references)*	*3rd tier of theme coding (N = coded references)*
Future conceptual development of adaptive capacity (167) (i.e. areas for further research (knowledge gaps))	• Context specific determinants of adaptive capacity (27) • Benchmarking tools and metrics of adaptive capacity (24) • Socio-cognitive factors of adaptive capacity (23) • Generic determinants of adaptive capacity (19) • Interaction of attributes of adaptive capacity (16) • Adaptation options assessments (14) • Barriers to adaptive capacity (14) • Identifying vulnerability across scales (12) • Understanding the relationships between institutional cultures and adaptive capacity (8) • Peoples (cohorts) different adaptive capacities (6) • Interdisciplinary collaboration and sectoral transferability (4) • Ecological systems (4)	
Ideas for the improvement of adaptive capacity programs (148)	• poor understanding of adaptive capacity among decision makers (31) • governance (24) • awareness (self/organisational) of decision/policy makers responsibilities (24)	-

1st tier of theme coding (N = coded references)	*2nd tier of theme coding (N = coded references)*	*3rd tier of theme coding (N = coded references)*
	• learning strategies (16) • policy integration and branding (13) • monitoring performance (11) • research engagement of stakeholders (9) • interventions at the appropriate scale (8) • current usefulness of the concept (6), and • decision-making support systems (6).	
Crosscutting issues (145)	• Adaptive capacity across different scales (66)	- Individual (24) - Local community (10) - Region (6) - Institution (6) - Multiple scales (5) - Temporal scale (5) - International (3) - Single enterprise (3) - Nation (2) - Sector (2)
	• Institutional issues and models (40)	- Socio-cognitive factors (11) - Funding (10) - Transferability (9)
	• Priority of response in adaptations and building adaptive capacity (39)	- Based on vulnerability (20) - Based on timeframe (temporal scale) (8) - Based on public confidence (6)

2.1.1 Target group participation

Forty key informants were invited to participate (Researchers n=25; Decision makers n=15), based on their experience in climate change adaptation research (publications) or involvement in decision-making (e.g. policy development). The identities of informants are not disclosed, although their research organisations or policy institutions are globally recognised. Potential key informants were invited via email to participate in a telephone interview (for further details of the invitation and interview process see Appendix 5). Nineteen informants agreed to be interviewed (Researchers n= 15; Decision makers n=4). The regions represented include Australia (n=15), UK (n=2), USA (n=1) and Central Europe focussed on developing regions (n=1). Of the four decision makers, two each work at the national and local government levels. The thematic focuses of the researchers are diverse, covering the biophysical, social, and socio-ecological systems. The phone interviews were digitally recorded and then transcribed by an independent service provider.

2.1.2 Content analysis

As discussed in the methods section for the online survey, the key informant responses were also analysed through Leximancer and NVivo for emergent themes relating to the focus of the study (i.e. conceptions of adaptive capacity and its utility for decision-making).

Appendix 2 Results

2.1 Online survey results

2.1.1 Conceptions of adaptive capacity

Participants' definitions of adaptive capacity (n=178) can be categorised by how they are conceptualised or framed by different perspectives. NVivo content analysis (manual coding) identified three conceptions (i) an anthropocentric view of adaptive capacity; (ii) a biophysical or biological sciences view of adaptive capacity; and (iii) a systems view of adaptive capacity. A fourth category (n=8) could not be coded as the comments were nonsensical. How these perspectives relate to other factors such as disciplinary backgrounds or methodological approaches are discussed in the next section (Figure 1).

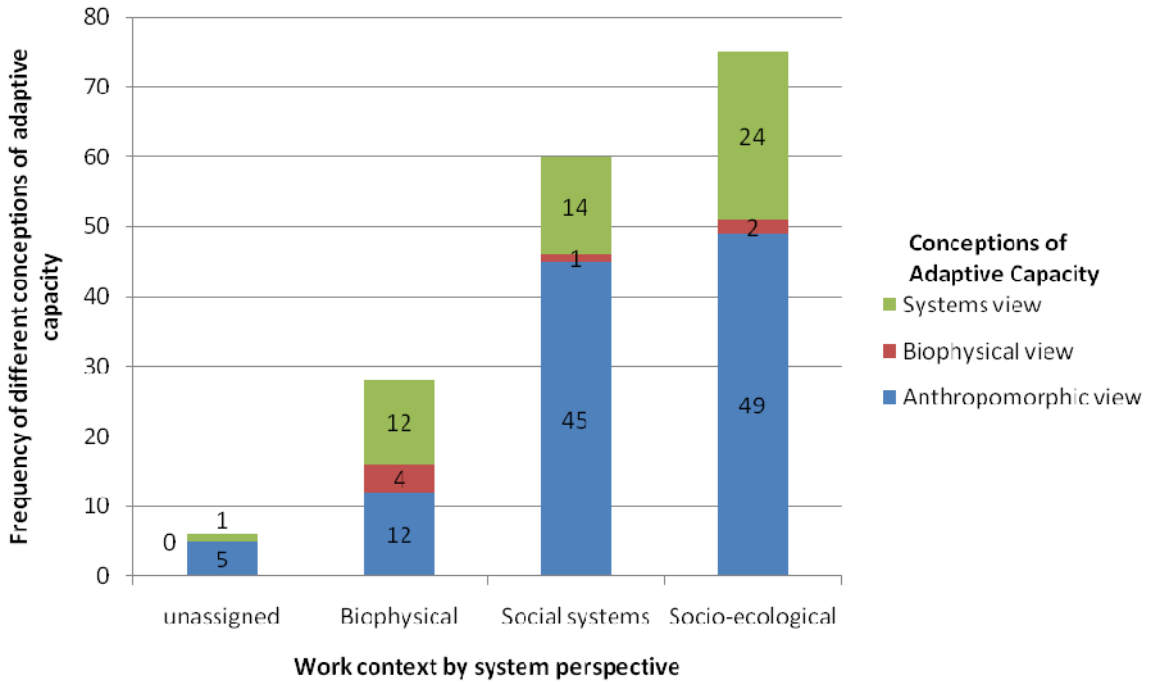

Figure 1 Conceptions of adaptive capacity by current work context (system)

The majority of respondents (111 of 170, 65%) viewed adaptive capacity as a human or actor orientated concept. An example of this type of conception is

> Capacity (ability and opportunity) of people, communities or organisations to make changes that will reduce their susceptibility to climate change (Respondent 36305, Researcher).

The frequency of respondents that framed adaptive capacity within a systems paradigm was lower (52 of 170, 31%). An example of this type of conception is

> The ability of a system to adapt to changes (perturbations) in the environment in which it exists and depends on. This is somewhat general and would differ depending on what sort of system we are talking about i.e. ecological, social or social-ecological (Respondent 36592, Researcher).

Finally, a small number of definitions (7 of 170, 4%) were conceived within a biophysical perspective – a specifically defined system. An example of this type of conception is

> How well an organism can change to rapidly changing condition (sic). How flexible they are to change (Respondent 36797, Researcher).

or

> The ability for macro (sic) and microcosms to adapt to an ever changing environment (Respondent 36772, Researcher).

Leximancer content analysis identified the following key themes in participants' definitions of adaptive capacity. A theme is considered key where the connectivity to other concepts is greater than ten percent

- Change (*change, climate, adapt, resources*) (100% connectivity with other concepts);
- Ability (*ability, respond, opportunities, basic*) (43% connectivity);
- Communities (*communities, system, individual, cope, systems*) (28% connectivity);
- Capacity (*capacity, adaptive, knowledge*) (20% connectivity); and
- Conditions (*conditions, changing, people, climatic*) (15% connectivity).

A Leximancer concept map of participant's definitions of adaptive capacity is shown in Appendix 4. For each theme (circle) the concepts of interest that co-occur are shown within the theme circle. They are also written in the list above in brackets after the theme name.

The map shows a resemblance to the IPCC 2007 report's definition of adaptive capacity in terms of referring to the main concepts used in the definition. That is, the 'ability' of a 'system' to 'respond' to 'climate change', in terms of both behaviour and 'resources', is necessary for 'effective' 'adaptation' and also can take advantage of 'opportunities' from new 'conditions'.

2.1.2 Disciplinary backgrounds

Respondents to the online survey included

- Researchers (e.g. climate change adaptation) (135 respondents), 45.1%;
- Policy/decision makers (e.g. directing adaptation programs) (40 respondents), 13.4%;
- Both a researcher and policy/decision maker (23 respondents), 7.7%; and
- Not answered (101 respondents), 33.4%.

In terms of adjusted relative frequency, the majority of participants were researchers (68.2%).

Question 3, which asked within which system context did the participants research or make decisions, revealed a similar concentration of work effort in the social and socio-ecological systems, with less effort, by half, in biophysical systems (Table 3).

Table 3 System contexts within which researchers or decision makers work

Choices	*Absolute frequency*	*Relative frequency*
Biophysical systems (excluding people)	33	17.6%
Social systems (economic and cultural)	74	39.6%
Socio-ecological systems	80	42.8%
Total	**187**	**100%**

Participants currently working in the field of climate change mainly work in multi-disciplinary areas with a socio-ecological focus followed by the environmental sciences and studies in human society (Table 4).

Table 4 Participant's top five disciplines in which they currently work

Choices	*Absolute frequency*	*Relative frequency*
Other (multi-disciplinary, socio-ecological focus as determined from the comments)	44	23.5%
Environmental sciences	42	22.5%
Studies in human society	28	14.9%
Agricultural and veterinary science	12	6.4%
Biological sciences	11	5.9%
Total	**137**	**73.2%**

The data support the argument by Daffara et al. (2010), based on a review of the literature, that the majority of climate change adaptive capacity research is currently occurring in inter-disciplinary contexts. Whether research is trending towards trans-disciplinarity remains unclear.

Disciplinary background (first trained in) does not affect how the concept of adaptive capacity is framed (Figure 2). The anthropocentric view of adaptive capacity is dominant in most disciplines, although the systems view of adaptive capacity is also prevalent but dominates in the biological sciences.

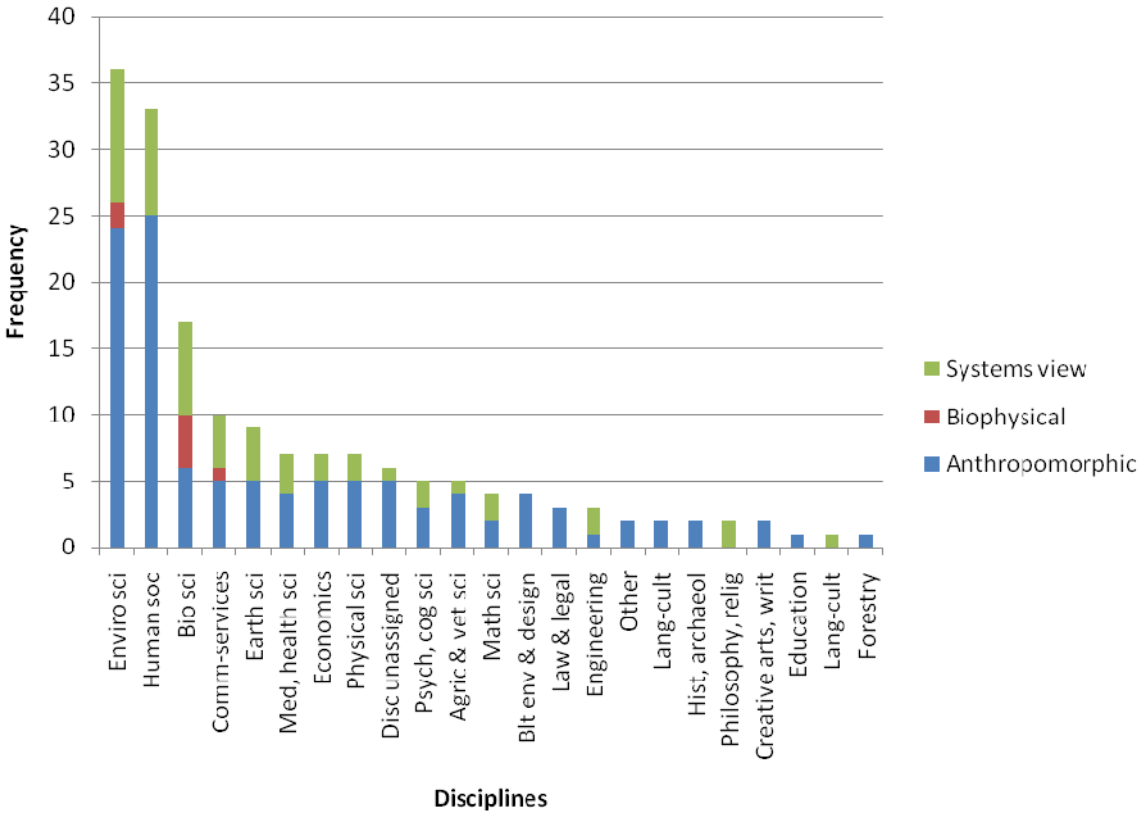

Figure 2 Conceptualisation of adaptive capacity by discipline

2.1.3 Themes in adaptive capacity research

In response to Question 12, researchers indicated the methodological approaches used in their research. No one methodological approach dominated, although interpretivist and critical approaches were more common than positivist approaches driven by hypotheses (Table 5).

Table 5 Methodological approaches used by researchers

Choices	*Absolute frequency*	*Relative frequency*
Action research (proactive social learning and action)	64	29.5%
Hypothesis driven research	56	25.8%
Interpretative enquiry (e.g. ethnography)	46	21.2%
Critical analysis (e.g. critical ethnography)	35	16.1%
Other	16	7.4%
Total	**217**	**100%**

In response to Question 13, 85.4% of respondents who identified themselves as researchers (117 respondents) indicated that they tend to conduct interdisciplinary research, while only 6.7% (20 respondents) focus on disciplinary research.

Researcher orientation to knowledge generation was dominated by mixed (qualitative and quantitative) knowledge (65%, 89 respondents), while qualitative versus quantitative orientations were similar (19%, 26 respondents, and 16%, 22 respondents, respectively) (Table 6). The dominance of a mixed orientation might be expected when adaptive capacity research often requires the integration of both the biophysical and social sciences. Given this orientation and that 75% of researchers (102 respondents) indicated that their knowledge generation is developed through case studies, it appears that the majority of adaptation research is context specific.

Table 6 Orientation to knowledge generation and form of knowledge

Choices	*Absolute frequency*	*Relative frequency*
Question 14 Orientation to knowledge generation		
Mixed knowledge	89	65.0%
Qualitative knowledge	26	19.0%
Quantitative knowledge	22	16.0%
Total	**137**	**100%**
Question 16 Form of knowledge		
Applied (i.e. case studies)	102	75.0%
Fundamental (i.e. knowledge generation excluding case studies)	34	25.0%
Total	**136**	**100%**

In response to Question 18, researchers and policy/decision makers identified the main areas of concern or activity in which they worked (participants could select more than one). The options provided in the survey are based on the NCCARF research themes[9]. The predominant area of activity occurs within social, economical and institutional dimensions (Table 7).

[9] Accessed from http://www.nccarf.edu.au/adaptation-research-networks

Table 7 Researchers' activity within NCCARF themes

Choices	*Absolute frequency*	*Relative frequency*
Social, economical and institutional dimensions	93	30.4%
Primary industries	47	15.4%
Settlements and infrastructure	34	11.1%
Marine biodiversity and resources	34	11.1%
Water resources and fresh water biodiversity	32	10.5%
Terrestrial biodiversity	25	8.2%
Human health	21	6.9%
Emergency management	20	6.5%
Total	**306**	**100%**

2.1.4 Worldviews regarding agency in creating the future

When respondents were questioned about where they thought power or agency lies to create the future, the overwhelming response is that power/agency is both internal and external (134 respondents, 73.63%, (Figure 3).

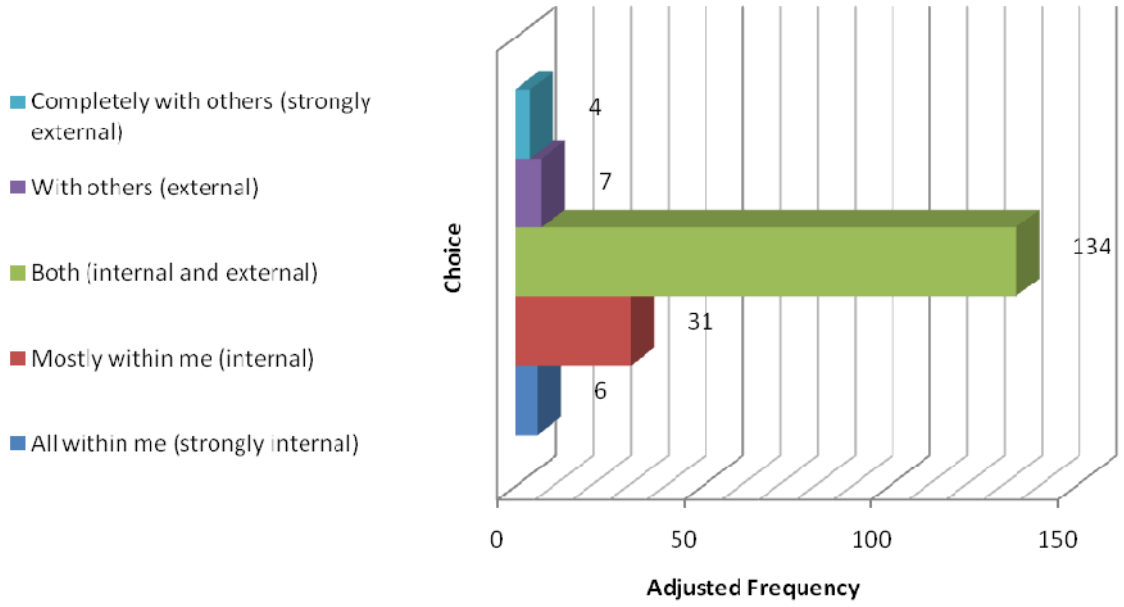

Figure 3 Power / agency to create the future (Question 6)

Respondents were able to provide explanatory comments about their choice of answer for their power/agency worldview. Thematic coding of these comments using NVivo identified three main worldviews about where the power/agency lies to create desired futures

- A mix of internal and external forces (80 references);
- Agency lies within (internally) (11 references); and
- Agency lies with others (externally) (6 references).

Typical responses that represent the worldview that power/agency to create desired futures lies both internally and externally are

> I believe each individual should be responsible for their own actions, yet creating the future I want to see (global peace and prosperity on a healthy planet) will require others (Respondent 36128, Researcher).
>
> The power/agency to create the future will be increasing in both internal and external because the internal agency could support information to the external power, as the external provide policy to other internals (Respondent 36844, Researcher).
>
> As an individual I can only achieve so much - to a large extent I am constrained by existing social structures, such as capitalism as an economic system, and neo-liberalism as the dominant ideology (Respondent 36582, Researcher).

Responses that represent the worldview that power/agency lies within the individual are

> We are what we think - it is the only thing we can control in life. We also end up where we focus our attention and so much of where we end up has been of our own creation - with the help of others (Respondent 36597, Researcher).
>
> Policy lags behind community sentiment and therefore action begins with people's values and beliefs and if these are strong and empowered then the most dynamic changes occur when there is a belief and a cause for action (Respondent 36703, Researcher).

Responses that represent the worldview that power/agency lies externally, outside the individual are

> All realities are socially constructed and the individual has limited agency (Respondent 36581, Policy/Decision maker).
>
> Laws and regulation and financial investments are what will change human behaviour to respond to climate change, and I believe that the general population is able to change with the RIGHT external mechanisms (Respondent 36846, Researcher).

Using a Leximancer content analysis of the explanatory comments shows that the main concept themes are (Appendix 2, Figure 10)

- Individual (*individual, change, actions, policy, behaviour)* (100% connectivity with other concepts);
- Future (*future, create, internal, believe*) (57% connectivity);
- External (*external, power, agency, capacity, society)* (64% connectivity);
- Others (*others, influence)* (42% connectivity);
- Control *(control, decisions, beyond)* (40% connectivity);
- Government *(government, personal, take)* (26% connectivity);
- Social *(social, structures)* (22% connectivity).

Leximancer content analysis of comments regarding where the agency to create the future lies, shows a relationship between the concepts “external” and “internal”. There is a 57% likelihood of co-occurrence for “internal” where “external” has been mentioned. This supports the previous data that the dominant view of the survey participants is that agency to create the future is a dynamic mix of internal, individual, and external, social forces – a multi-scalar worldview of agency.

If worldviews influence research paradigms, then it follows that a multi-scalar perspective of agency would transfer into a similar notion of adaptive capacity. The power of actors to create the future is assumed to be related to their adaptive capacity to respond in an environment of uncertainty. Therefore, if actors hold the belief that agency is multi-scalar, ranging from internal beliefs to external social structures, then adaptive capacity research would likewise occur across scales. Three queries (matrix or cross tabulations) were run to test this relationship between agency worldview and multi-scalar approaches to adaptive capacity. Cases were cross tabulated between agency worldviews and (i) systems contexts; (ii) type of research; and (iii) spatial scales.

Cross tabulation of agency worldviews and research contexts (Table 8) shows that the highest incidence of cases for each research context occurs at the mixed agency worldview, with most cases in the socio-ecological systems research context 73.7% of respondents (59 respondents), who also indicated that they believe the power/agency to create the future is mixed (internal and external).

Table 8 Cases cross tabulation of agency worldview and research contexts

	Research context (Q.3)		
Worldview of Agency (Q.6)	***Socio-ecological systems***	***Biophysical systems (excluding people)***	***Social systems (economic and cultural)***
Unassigned	0	1	4
Both (internal and external)	59	21	54
Mostly within me (internal)	12	9	10
All within me (strongly internal)	2	1	3
With others (external)	5	1	1
Completely with others (strongly external)	2	0	2

Cross tabulation of the variables agency worldviews and type of research (Table 9), shows that 63.0% of researchers (85 respondents) who indicated that they believe the power/agency to create the future is mixed (internal and external), also indicated that they tend to do interdisciplinary research.

Table 9 Cases cross tabulation of agency worldview and type of research

	Type of research (Q.13)	
Worldview of Agency(Q.6)	***Interdisciplinary***	***Disciplinary***
Both (internal and external)	85	15
Mostly within me (internal)	21	4
All within me (strongly internal)	5	1
With others (external)	4	0
Completely with others (strongly external)	2	0

The third cross tabulation (Table 10) shows that the highest frequency of cases for all spatial scales occurred where participants also indicated that they believe the power/agency to create the future is mixed (internal and external). Of those who focus on the local, State/provincial, national and international scales; the percentage of participants who indicated they have a mixed agency worldview is 77.5%, 71.1%, 74.5% and 77.3%, respectively.

Table 10 Cases cross tabulation of agency worldview and scales of participants' work

	Spatial scales (Q.21)			
Question 6 Worldview of Agency	***Local***	***State/Provincial***	***National***	***International***
Both (internal and external)	62	69	79	58
Mostly within me (internal)	11	17	19	12
All within me (strongly internal)	3	2	3	2
With others (external)	1	6	4	2
Completely with others (strongly external)	3	3	1	1

The quantitative evidence from the online survey suggests that a relationship exists between "agency worldview" and "adaptive capacity" research, particularly that a multi-scalar, mixed perspective of agency transposes into a systems view, multi-disciplinary, multi-scalar, conceptualisation of adaptive capacity.

2.1.5 Beliefs on the most important socio-ecological resilience factors

Respondents chose the most important factor on which the resilience of socio-ecological systems depends in terms of the levels of social prescription in the system. The range of social prescription (see Rationale for questions, p.5) includes (i) regulatory control of human actions; (ii) a balanced mix of personal responsibility and social sanctions; and (iii) attributes such as creativity, human consciousness and collective spirit.

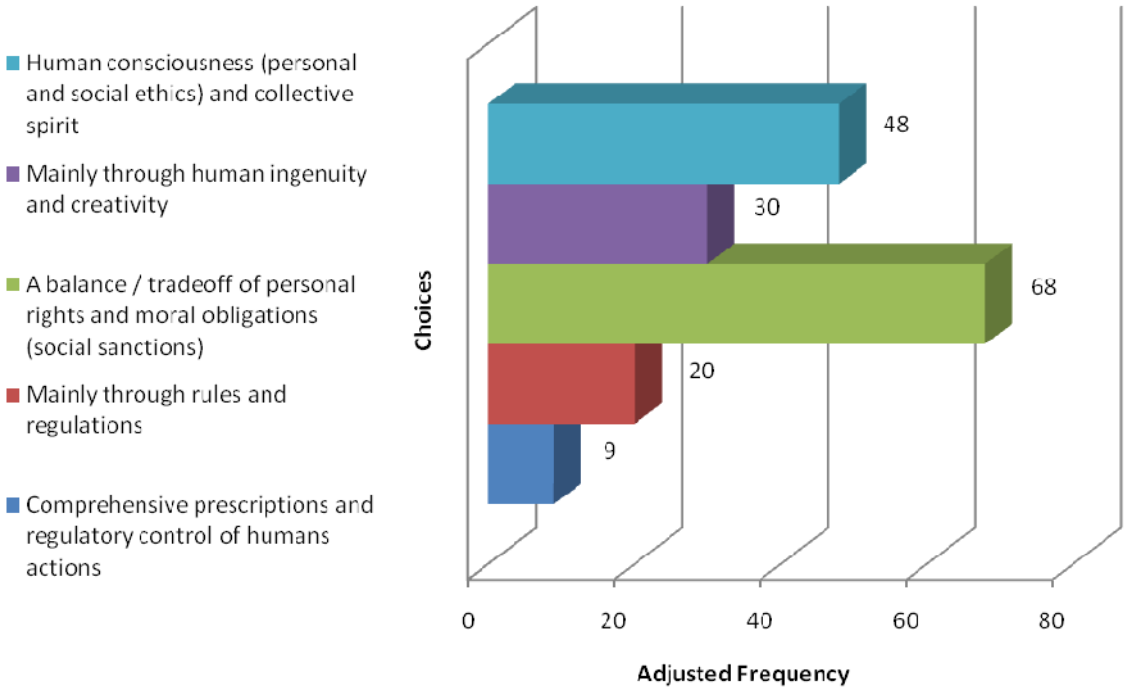

Figure 4 Beliefs about resilience factors (Question 8)

NVivo content analysis of the comments to the question relating to socio-ecological resilience factors identified four main factors

- A balance of multi-scale responses from consciousness shifts to rules (46 references);
- Human consciousness shifts, ingenuity and or creativity (41 references);
- Regulatory and legislative action (33 references); and
- Innovative technological solutions, products or services as adaptations (8 references).

Responses that represent the belief that socio-ecological resilience depends on multi-scale responses are

> Society as a whole needs to form the views regarding climate change that then transfer to the policy makers to apply and then for the human ingenuity and creativity to achieve the outcome (Respondent 36437, Researcher).
>
> I'd say it is through a combination of all, rather than a dependency on one (Respondent 36564, Researcher).
>
> All of the above have a significant role, the balance depending on the time-frame and relevant local, regional or global scale (Respondent 36908, Researcher).

Responses that represent the belief that socio-ecological resilience depends on socio-cognitive qualities (consciousness, creativity) are

> We need to find ways to engage the hearts and minds of people if we are to guide our ingenuity toward more sustainable endeavours (Respondent 36597, Researcher).
>
> It will take a remarkable shift in consciousness from the 'universal' to the 'ecological' for any real change to take place (Respondent 36708, Both researcher/policy maker).
>
> Resilience requires a shift away from goal-centric behaviour, to accept change and develop the required flexibility to cope with it, so we can avoid extreme dynamics in socio-ecological systems. This is a big change from current culture of rationalism-driven models and one that depends on developed consciousness (Respondent 36822, Researcher).

Responses that represent the belief that socio-ecological resilience depends on regulation include

> There needs to be legislation or government policy to assist in creating the right framework/environment within which this personal change can occur (Respondent 36392, Policy/Decision maker).
>
> Rules and regulations provide frameworks for societies to work and such frameworks can include the concepts of resilience (Respondent 36846, Researcher).
>
> We are ruled and driven by our laws. If we want change it needs to be done through the laws of the land (Respondent 36867, Researcher).

A response that represents the belief that socio-ecological resilience may be influenced by our technological innovation is

> ...science can offer some technological solutions (Respondent 36128, Researcher).

Leximancer content analysis of the explanatory comments shows that the main concept themes are (Appendix 4, Figure 13)

- Human (100% connectivity to other concepts);
- Resilience (73% connectivity);
- Change (53% connectivity);
- Ingenuity (51% connectivity);
- Regulations (48% connectivity);
- Believe (16% connectivity);
- Individual (13% connectivity);
- People (13% connectivity); and
- Systems (11% connectivity).

Leximancer content analysis of the text shows significant concept relationships between resilience, awareness and regulatory control. There is a 57% likelihood of co-occurrence for “awareness (environmental and human consciousness)” where “resilience” has been mentioned. Similarly, there is a combined 44% co-occurrence for the words “regulatory” and “regulations” where “resilience” is mentioned. This supports the previous data (Figure 4) that the dominant view of the online survey participants is that resilience of socio-ecological systems depends on multi-scalar interventions from regulations to human consciousness development. This shows the importance and close relationship of human consciousness development with regulatory change to solve collective problems within a resilient society. Quotations from the respondents in support of the latter position are

> Regulatory control of human actions, without a change in human consciousness and collective spirit, I am not so sure (Respondent 36128, Researcher); and
>
> We must find a medium between the human consciousness/collective spirit and our moral obligations (Respondent 36772, Researcher).

2.1.6 Degree of optimism about the future

When asked how they feel about a long-term socio-ecological future, respondents were divided between being optimistic versus pessimistic. Around 22% indicated that they did not know, or, based on their comments, were uncertain or had conflicting feelings of optimism and pessimism.

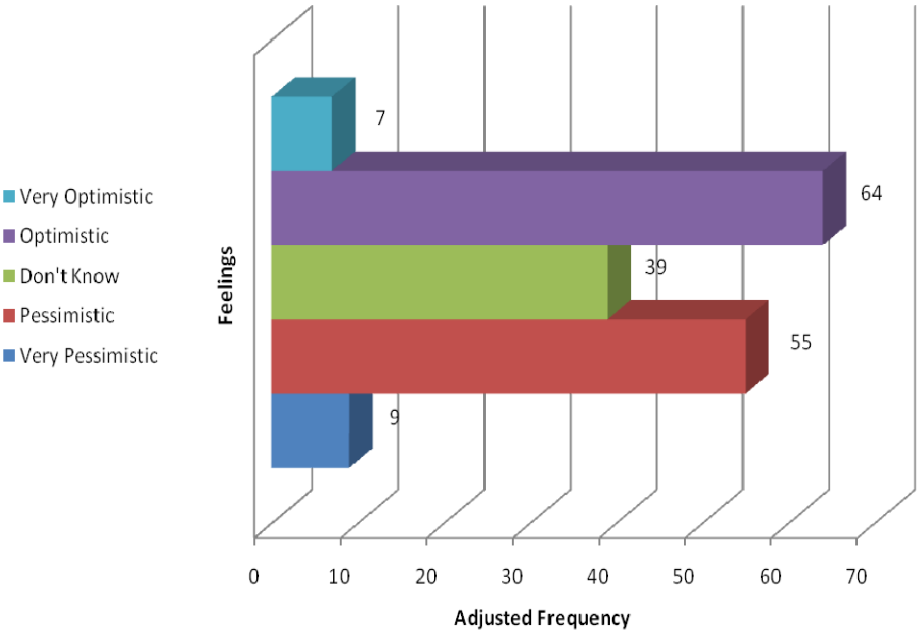

Figure 5 Image of the future (Question 10)

Similarly, NVivo content analysis of the comments regarding the future identified three response types

- Negative feelings/image of the future (30 references);
- Conflicted feelings/image of the future (22 references); and
- Positive feelings/image of the future (21 references).

The comments are likewise closely split between positive, negative and conflicted images of the future, even when cross tabulating the distribution of coding by participant type (Figure 6).

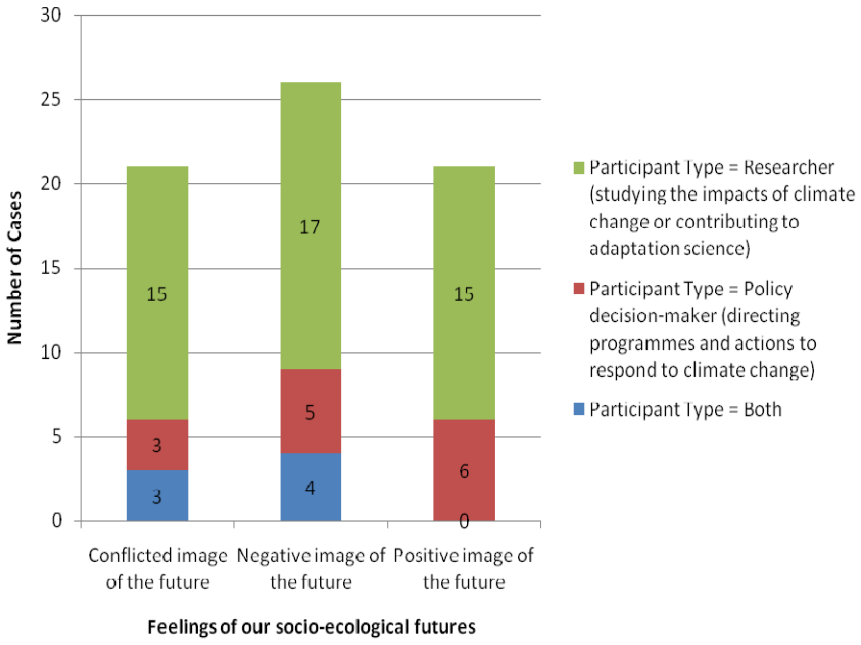

Figure 6 Image of the future by respondent type (NVivo content analysis of comments)

Responses that represent a pessimistic image of the future include

> Ultimately, however, many aspects of global ecological systems continue to decline, often due to not one, but multiple threats. Governments and governance (across different scales) have largely been ineffectual in mitigating these threats or reversing declines, and while there is some degree of societal concern, that concern is disproportionate to the scale of global environmental decline (Respondent 36494, Researcher).
>
> I have now concluded that humans are unable and/or unwilling to restructure the economic system in ways that might give us some chance of returning to a safe climate (Respondent 36585, Researcher).
>
> We ruin everything and the population has exceeded the capacity for which a balance and sustainable life on Earth can exist (Respondent 36867, Researcher).

Responses that represent a conflicted, uncertain image of the future include

> It shifts from pessimistic (when you think about how much we've already destroyed/damaged, our lack of understanding of many systems) to optimistic if I try to believe in the adaptive capacity of many systems, our potential as humans to be innovative and find solutions, and all the efforts and research going into sustainability of socio-ecological systems (Respondent 36733, Researcher).
>
> I'm optimistic about playing a role in causing change and that important change can occur. The extent of this change worries me. I'm pessimistic about how long it will take and what will be lost...people, ecosystems and species along the way (Respondent 36551, Both Researcher/Policy Maker).
>
> 100 years, I am very pessimistic. 500 years, I am much less. Humans do adapt over time, but how that adaptation manifests remains to be seen. We may yet pull our feet from the fire (Respondent 36576, Researcher).

Responses that represent an optimistic image of the future include

> Humans have always shown that when faced with a massive challenge, either created by their actions or through natural causes we have the ingenuity and creativity to 'fix the mess' (Respondent 36398, Policy/Decision maker).
>
> Things are constantly improving and have done so since humans evolved (Respondent 36625, Policy/Decision maker).
>
> If we believe in a positive future then we will create a positive socio-ecological future ... Life has shown it can adapt to any change and any environment. So can our mental spirit (Respondent 36772, Policy/Decision maker).

Leximancer content analysis of the explanatory comments shows that the main concept themes of respondents's feelings about our socio-ecological futures are (Appendix 4, Figure 14)

- Change (change, climate, systems) (100% connectivity with other concepts);
- Image (optimism, pessimism) (34% connectivity);
- People (people, world, countries) (30% connectivity);
- Future (future, capacity, economic) (26% connectivity);
- Adapt (adapt, environment) (22% connectivity); and
- Systems (13%).

The analysis shows a 70% likelihood of the co-occurrence of the concept of "optimism" with "pessimism". Where "optimism" is mentioned, there is a 25% likelihood of the concept of "capacity" being mentioned. Also, where "pessimism" is mentioned, there is a 60% probability of the co-occurrence of "political" and a 57% likelihood of the co-occurrence of "impacts". This means that those who had conflicted views of the future tended to be optimistic about people's capacity to adapt and their ingenuity, but were simultaneously pessimistic about the severity of the future socio-ecological system impacts of climate change or the inertia of global economic and political systems to take action.

A cross-tabulation of respondent's views about socio-ecological futures and resilience factors (in terms of levels of social prescription) upon which they depend indicates that most of those participants, who

are either pessimistic or optimistic, share the belief that socio-ecological systems resilience depends on a balance of personal rights and social sanctions and/or development of human consciousness and collective spirit (Figure 7).

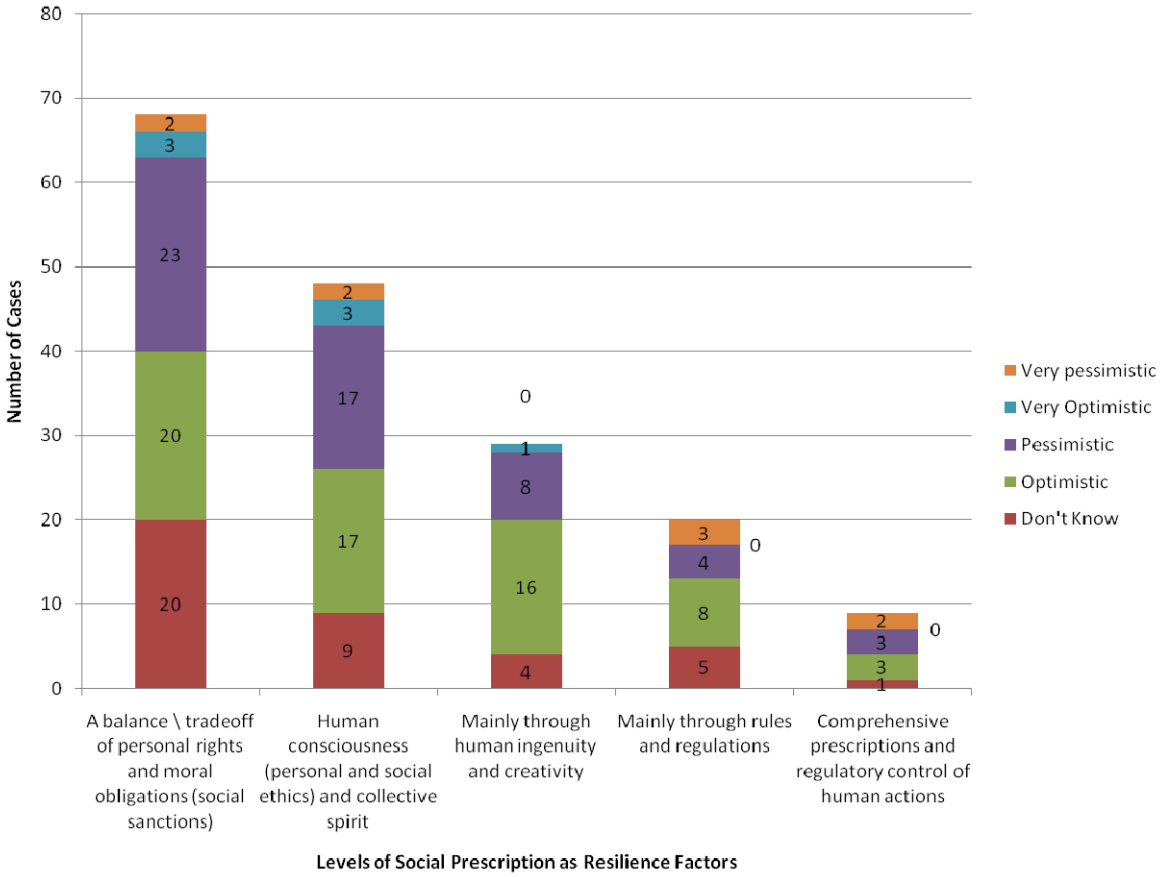

Figure 7 Cross tabulation of resilience factors and feelings about long-term socio-ecological futures

2.1.7 Spatial scales of research or application

In response to Question 21, respondents identified the spatial scales at which their research or policy work is targeted. Respondents could select more than one spatial scale. The most frequently identified spatial scale is the national level (106 respondents), followed by the State/provincial level (97 respondents) (Table 11).

Table 11 Spatial scales of work or research

Choices	*Absolute frequency*	*Relative frequency*
National	106	29.6%
State/Provincial	97	27.1%
Local	80	22.4%
International	75	20.9%
Total	**358**	**100%**

In response to Question 22, respondents identified the broad sectors in which they worked. In the sample, there is a similar representation between the non-government or non-profit sector and the government/corporate sector (Table 12).

Table 12 Respondents by sector

Choices	*Absolute frequency*	*Relative frequency*
Government or Corporate	82	51.9%
Non-government (includes academia) or non-profit	76	48.1%
Total	**158**	**100%**

In response to Question 23, respondents who identified they work in the non-government or non-profit sector, were asked to provide more information about their organisational context. The majority (72.4%) are based at universities (Table 13).

Table 13 Type of non-government or non-profit organisation

Choices	*Absolute frequency*	*Relative frequency*
University	55	72.4%
Other	11	14.5%
Community service	5	6.6%
Advocacy group	3	3.9%
Charity/Foundation	2	2.6%
Total	**76**	**100%**

In response to Question 25, respondents identified the size of the operational budget that they control or implement. The sample represents a diverse mix of financial responsibility regarding adaptation to climate change programs (Table 14); therefore, the data about adaptive capacity is drawn from a range of actors from government and non-government sectors.

Table 14 Size of annual operational budget controlled by respondents

Choices	*Absolute frequency*	*Relative frequency*
$0 (no budget)	37	22.7%
Less than $50,000	34	20.9%
$50,001-$100,00	17	10.4%
$100,001-$500,000	42	25.8%
$500,001-$1,000,000	14	8.6%
$1,000,001 - $5 mil	8	4.9%
Greater than $5 mil	11	6.8%
Total	**163**	**100%**

The cross-tabulation of respondent's work focus on spatial scale and systems context indicates the current concentration of effort in adaptive capacity to climate change. The main activity is addressing socio-ecological systems at the regional scale (state/provincial) (Figure 8). The least activity is addressing biophysical systems at the local scale (see Synthesis discussion).

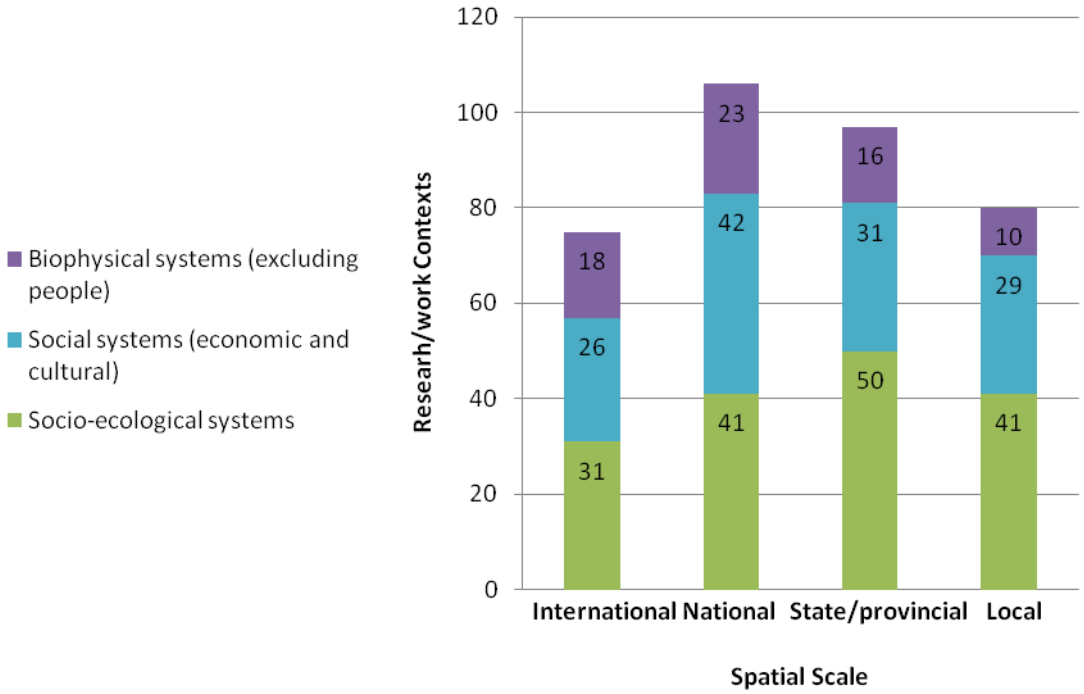

Figure 8 Comparison of effort between spatial scales and systems

2.1.8 Effectiveness of the concept of adaptive capacity related to climate change for decision makers

In response to Question 17, researchers rated the effectiveness of the application of adaptive capacity programs undertaken by communities, organisations and governments. Most researchers (nearly 40%) consider that adaptive capacity programs are partly effective, although a large proportion take a neutral position (Table 15). A small proportion of the sample (7.1%) consider adaptive capacity programs to be ineffective.

Table 15 Researchers' rating of the effectiveness of adaptive capacity programs

Choices	*Absolute frequency*	*Relative frequency*
Strongly effective	3	2.6%
Effective	10	8.9%
Partly effective	44	38.9%
Neutral	19	16.8%
Partly ineffective	9	8.0%
Ineffective	8	7.1%
Strongly ineffective	1	0.9%
Not applicable	19	16.8%
Total	**299**	**100%**

In response to Question 24, policy/decision makers provided information about the degree that responding/adapting to climate change impacts is now a part of their policy/decision-making. Over half considered that it to be core business (Table 16).

Table 16 Adaptation to climate change – degree of policy/decision makers' current business

Choices	*Absolute frequency*	*Relative frequency*
Core business	31	55.4%
Partial business	19	33.9%
Marginal/non-core business	6	10.7%
Total (policy makers only)	**56**	**100%**

In response to Questions 26 and 27, policy/decision makers rated the usefulness of the concept of adaptive capacity (related to climate change) to their policy/decision-making in directing programmes and actions. Of the subgroup of decision makers, 85.5% considered that the concept is useful (either very useful, useful, or somewhat useful) in directing their programs (Table 17).

Table 17 Rating by decision makers of the usefulness of the concept of adaptive capacity

Choices	*Absolute frequency*	*Relative frequency*
Very useful	19	34.5%
Useful	17	31.0%
Somewhat useful	11	20.0%
Neutral	4	7.3%
Somewhat not useful	2	3.6%
Not applicable	2	3.6%
Total (policy makers only)	**55**	**100%**

NVivo content analysis of the comments regarding the usefulness of the concept of adaptive capacity to decision makers found three main responses

- Adaptive capacity is a useful concept (10 references);
- The concept of adaptive capacity has limits (6 references); and
- There is a theory – practice divide (3 references).

Examples of the first type of response are

> Allows planning and action to move in parallel (Respondent 36673, Policy/Decision maker).
>
> Adaptive capacity is part of the qualitative assessment of the resilience capacity of communities of geography and/or of interest (Respondent 36727, Both Researcher and policy maker).

Examples of the second type of response are

> Either I have missed the point of adaptive capacity, have none or refer to my opening comment, is (sic) adaptive capacity just another non event (Respondent 36866, Policy/Decision maker).
>
> But we should remember the hammer principle 'If your only tool is a hammer, everything starts to look like a nail' (Respondent 36652, Both Researcher and policy maker).
>
> Adaptive capacity is a useful concept for system changes when the change is minor and over a long period. Unfortunately climate change is already measuring up as hard, fast and big (Respondent 36848, Policy/Decision maker).
>
> Climate Change adaptive capacity is not necessarily a useful way to conceive or frame organisational change - already much literature in this area (Respondent 37394, Both Researcher and policy maker).

Examples of the third type of response are

> It is difficult to link the theoretical discussion to practical decisions (Respondent 36621, Both Researcher and policy maker).
>
> Adaptive capacity can be misleadingly reassuring that we can adapt with minor changes. It may not mean that to the researchers but it does to many policy makers (Respondent 36848, Policy/Decision maker).

Leximancer content analysis of the comments regarding the usefulness of the concept of adaptive capacity to decision making, shows that the main concept themes are (Appendix 4, Figure 15)

- Change (100% connectivity to other concepts);
- Adaptive (60% connectivity;
- Decisions (36% connectivity); and
- Useful (23% connectivity).

Leximancer shows that in the comments there is a 20% likelihood that the concept of "useful" co-occurs where the concept of "adaptive capacity" is mentioned. The main issue is the perceived information divide between adaptive capacity researchers, policy makers and end users (e.g. farmers) who have to make decisions in response to climate change that affects their livelihood.

In response to Questions 28 and 29, decision makers indicated their level of agreement with the statement that more effective ways are needed for building their organisation's capacity to adapt and become more resilient to climate change impacts. Combining the strongly agree and agree data, 72.2% of decision makers indicated that their organisation needs more effective adaptive capacity building strategies (Table 18).

Table 18 Decision makers' perceptions of the need for more effective adaptive capacity building strategies

Choices	*Absolute frequency*	*Relative frequency*
Strongly agree	25	46.3%
Agree	14	25.9%
Somewhat agree	7	13.0%
Neutral	5	9.3%
Somewhat disagree	1	1.8%
Disagree	2	3.7%
Total (policy makers only)	**63**	**100%**

NVivo content analysis of the comments regarding improving the effectiveness of adaptive capacity building strategies found five main responses

- Poor adaptive capacity – lack of organisational awareness of climate change impacts and therefore perception of the organisation to adapt (9 references);
- More participation, inclusive dialogue (4 references);
- Good adaptive capacity – it is already well understood in the organisation (3 references);
- More understanding to overcome theory – practice divide (3 references); and
- Access to resources (2 references).

Examples of responses about poor adaptive capacity in their organisation are

> Most people in the organisation in which my project is located have little or no idea about climate change and the effects of it for the region (Respondent 36392, Policy/Decision maker).
>
> Local Government does not have the capacity to adapt to change of any sort (Respondent 36866, Policy/Decision maker).

Examples of responses about more participation, inclusive dialogue, needed to build their organisation's adaptive capacity are

> Building our capacity will depend on strong internal communication and collective understanding of what we are doing. Particularly important when corporate knowledge retention is considered (Respondent 36403, Policy/Decision maker).
>
> Importantly those who are currently researching and making policy are missing much important information by excluding participation. The ability to generate knowledge is greatly enhanced by inclusive dialogue (Respondent 36704, Both Researcher and Decision maker).

Examples of responses about good adaptive capacity in their organisation are

> We are have been building this stuff into our daily work for a while now and I am confident that the concept is well accepted (and accordingly the budget and resources are a priority) (Respondent 36566, Policy/Decision maker).
>
> Fisheries agencies in SE Australia are leading the way nationally with a four-year program examining adaptation of fishing and aquaculture sectors and fisheries management to climate change (Respondent 36824, Policy/Decision maker).

Examples of responses about more understanding to overcome the theory practice divide are

> We need to understand it (adaptive capacity) in order to manage our own public lands and explain it to farmers (Respondent 36722, Policy/Decision maker).
>
> Much governance and Climate Change literature is theoretical but not particularly useful in making changes (Respondent 37394, Both Researcher and policy maker).

Examples of responses about better access to resources to improve adaptive capacity are

> I think rural communities need access to resources of knowledge and some financial to be able to build some strategies for the future (Respondent 36727, Both Researcher and Policy Maker).
>
> Farmers are to have access to all the information they need (Respondent 36704, Both Researcher and Decision maker).

The comments support the quantitative results that participants believe that their organisation needs to improve their adaptive capacity and the main areas identified included better internal communication, participation, understanding and access to resources to overcome the theory-practice divide.

Leximancer content analysis of the explanatory comments regarding improving the effectiveness of adaptive capacity building strategies shows that the main concept themes are (Appendix 4, Figure 16)

- Change (100% connectivity with other concepts);
- Capacity (78% connectivity);
- Adapting (18% connectivity); and
- Building (10% connectivity).

The clear inference from analysing the comments is developing more effective ways of building capacity to adapt to climate change impacts is essential. Where the concept of "building" is mentioned, Leximancer shows the likelihood of co-occurrence with the following concepts

- 63% with "capacity";
- 33% with "essential"; and
- 7% with "impacts".

2.2 Key informant interview results

This section presents the findings of the key informant interviews and specific coding queries that were run to identify relationships. Feedback about the future conceptual development of adaptive capacity is given, followed by ideas for the improvement of adaptive capacity programs. Lastly, cross cutting issues affecting adaptive capacity research and its application by policy makers are outlined. Examples of responses for each 2nd tier theme code are given in Appendix 6. The sources of comments by participants are identified as researchers (R) or decision makers (DM).

2.2.1 Future conceptual development of adaptive capacity

Information on the response to the question, what further research is needed to improve the understanding of adaptive capacity, is presented as a commentary of the points raised by the key informants. Cross-referencing to example comments refers to numbered quotations in Appendix 6 (e.g. [1]). A Leximancer concept map of the combined responses to this question shows the major themes and concepts discussed (Appendix 4, Figure 13). The frequency of themed references by key informants shows the level of concurrency for each and graphically indicates where issues were raised (Figure 9).

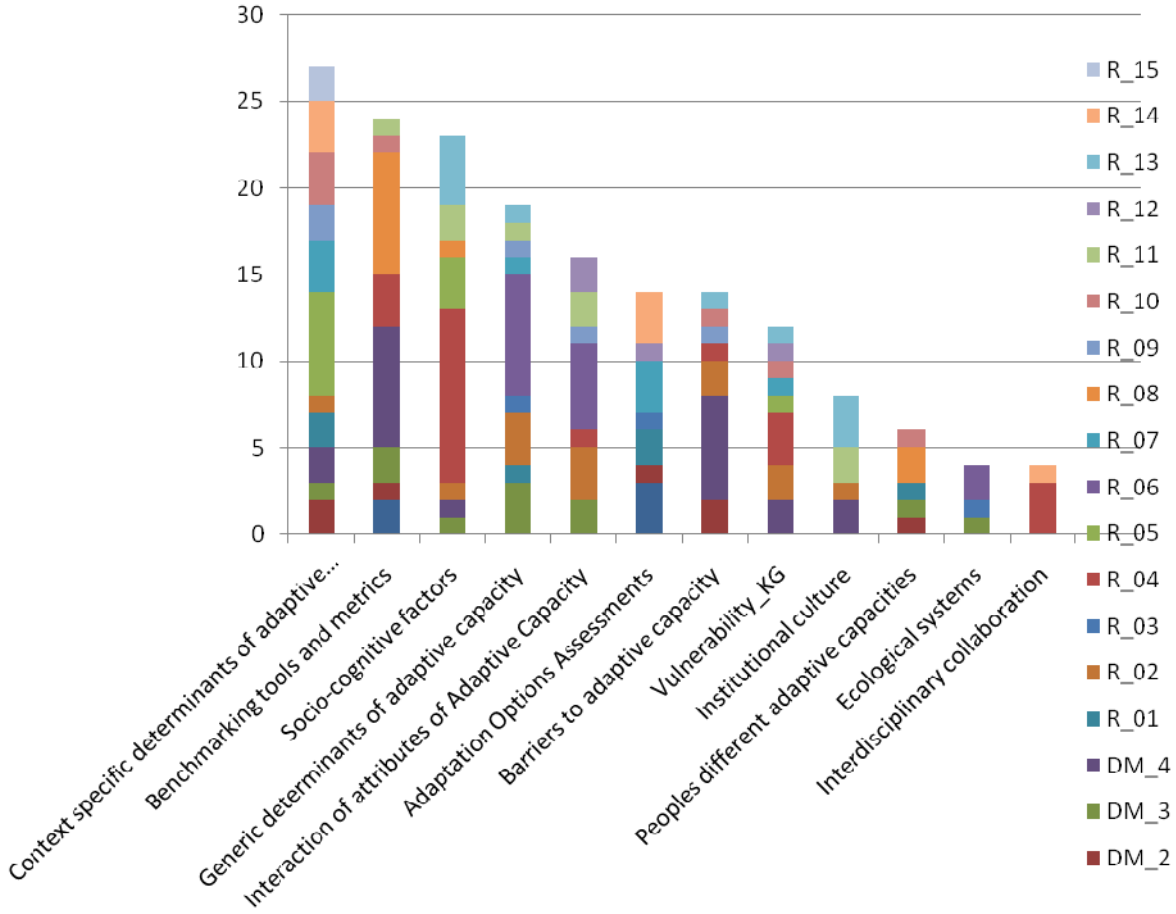

Figure 9 Frequency of themed references by key informants

Key informants (12 out of 19) raised the need to better understand the context-specific determinants of adaptive capacity. This affects methodology as more field work and context specific research is required [1, 2]. Due to the specificity of adaptive capacity, the research effort to develop meaningful benchmarking tools and metrics of adaptive capacity was also discussed (8 out of 19), and some believe that agreement is needed among the research community over the metrics of human adaptive capacity [3] and the degree of transferability across scales. On this basis, other research questions may be explored, such as the possibility of measuring the adaptive capacity of an organisation and benchmarking it with other organisations [4]. The development of performance monitoring of

adaptations over time would also improve [5] along with public confidence in the success of adaptation interventions.

A matrix query was run to examine whether informants who referred to the need for benchmarking tools or monitoring performance also spoke about this as a way to maintain confidence among decision makers and with the public. Two results were returned that suggest that effective performance monitoring of adaptations and benchmarking has a positive influence on keeping institutional and public confidence in the success of adaptation interventions. For example

> It's often very hard to get people on the political side to support particular actions if the benefit is difficult to grasp or if there's not a good indicator that they can use to measure long term or midterm how that particular action has contributed (DM_1).

Key informants (8 out of 19) discussed the current knowledge gap around the socio-cognitive factors of adaptive capacity. Here, they spoke about wanting more understanding about the socio-cognitive factors of individual perceptions of risk, empowerment, human capital, response and behaviour [6, 7, 8]. Key research questions are (i) what are the relationships of socio-cognitive factors to scale and cultural contexts (e.g. societal paradigms, social capital, development pathways and community advocacy); and (ii) what are the relationships of socio-cognitive factors to institutional norms and organisational culture?

A compound query was run to examine whether informants who spoke about the need for research about socio-cognitive factors of adaptive capacity, often talk about the individual scale. Five references were found that link these two issues; for example

> So I'd say that, in a way, much of the work that I think needs to be done is on actually understanding different individual's perceptions and understandings and different people's feelings of empowerment and self advocacy, in different cultural contexts. Then I suppose how those individual kind of social cognitive dimensions then link to collective sort of advocacy and collective action (R_4).

Linked closely to the socio-cognitive factors of adaptive capacity, key informants (4 out of 19) also discussed the need for further research in understanding the relationships between institutional cultures and adaptive capacity. At the micro-level, a better understanding of the drivers and socio-cognitive factors that influence the perception and behaviour of decision makers within an institution [23] is necessary. While at the meso-level, what makes an institution more adaptive or resilient than another [24]?

Key informants (9 out of 19) discussed the need for more research into the generic determinants of adaptive capacity. One informant spoke about the need for greater understanding of social system attributes that confer adaptive capacity and how to build it [9]; while another warned that generic adaptive capacity assessments are useful yet limited (tending to be pejorative statements) [10]. The common thread among comments was the focus on understanding the inter-relationship between adaptive capacity and individual agency [11, 12] and skill dependency [14].

To test this observation, a compound query was run to examine whether informants who spoke of the need for research about generic determinants of adaptive capacity, often focus on the individual scale. Of the 19 coded references from both sources, 5 references were found; one example is

> I think that further research needs to be focussed on looking at these generic determinants of adaptive capacity because there is a whole range of determinants that might lead an individual to be more or less adaptive to have that capacity. I think those determinants are at least to some extent based on experience and background. So, you know, a particular educational background, for example, might lead one to be more or less adaptive (DM_3).

In support of the claim that comments about generic determinants of adaptive capacity tended to focus on the individual, a Leximancer content analysis of the comments shows that there is a 92% likelihood of co-occurrence for the concept "individual" where the concept "capacity" is mentioned. Key informants (7 out of 19) also raised the need to research the system interaction of attributes of adaptive capacity. A structure or typology is desired comprising the combination of multi-dimensional influences or attributes of adaptive capacity in a system [13]. Others seek greater knowledge about the inter-relationship between adaptive capacity and resilience [14]. At the socio-economic dimension,

the issue was raised of more understanding about cross sectoral interactions and transferability of adaptations [15]. Some key informants (7 out of 19) sought more research about designing adaptation options assessments. Knowledge gaps include the development of capacity and better methods for the assessment of the costs and benefits of adaption options and actions to improve strategic planning/decision-making [16].

It was proposed that adaptation research is of a special form that requires multi-scalar (top-down and bottom-up) approaches, is iterative and collaboratively engages stakeholders [17]. A participatory, reflexive research methodology targeting the former gap, can therefore build a learning culture/organisation that seeks to continually improve adaptive capacity and the success of adaptations. Responding to global forces of change (including climate change), policy-makers need to be aware of the relationship of adaptation strategies to socio-economic development pathways and integrated policy development [18].

A compound query was run to examine whether informants who spoke of adaptation option assessments, also spoke about development pathways and policy development. Three references were found; for example

> So policy makers nationally need to be very aware of the potential pathway of adaptation strategies and make decisions about whether they're good or bad. If they're good, how they can be facilitated (R_14).

Key informants (7 out of 19) couched a number of knowledge gaps as barriers to adaptive capacity. The types of barriers mentioned are

- Quantitative data gaps that limit access to information (e.g. local climate change exposure, sensitivity, adaptive capacity);
- Institutional inertia or barriers to decision support systems and planning tools, lack of codes of conduct and guides, lack of social/cultural learning, institutional silos, lack of understanding of perceptions of risk, and lack of self-awareness;
- Absence of or poor planning legislation;
- Lack of funding arrangements for performance monitoring, lack of communication of demonstration projects, and absence of institutional change;
- Lack of understanding of the weak points in a system – the part that has the least adaptive capacity;
- Simplistic view of adaptive capacity and the assumption that one model of adaptive capacity can fit everywhere (research paradigm); and
- Lack of skill and cadre of adaptation decision makers/policy makers.

Based on the comments, the main issue for decision-makers is that overcoming barriers to adaptive capacity has a strong relationship to good governance and policy development [19]. A compound query was run to examine whether informants who spoke of the barriers to adaptive capacity, also relate this issue to governance, institutions and/or decision-making. Five references were found, 36% of the coded sample, from three informants. Some key informants (8 out of 19) discussed further research to identify vulnerability across scales. The two key issues were (i) identifying the most vulnerable populations for different contexts, which also relates to priority of response [20, 22]; and (ii) understanding the changing structure of vulnerability (exposure, sensitivity and adaptive capacity) that leads to effective adaptation [21]. A coding query was run to examine whether informants who spoke about vulnerability as a knowledge gap relate this issue to priority of response. Six references were found; for example

> My present thinking is that interventions should focus on the most vulnerable places and the most vulnerable communities within those places. I suppose that if you were going to begin to roll out a program to build adaptive capacity, the best investment would be to target the place – the people – in the geographic spaces who are most exposed and who will need to do something, to take some action to be prepared sooner and begin the conversation with those people (DM_3).

Related to the issues of priority of response and context specific research, some key informants (5 out of 19) also identified the need for more research to unpack people's (cohort's) different adaptive capacities [25]. The linking issues are that

- Understanding people's different adaptive capacities is related to vulnerability and priority of response; and
- Understanding cohort's adaptive capacities is dependent on context specific research and influences subsequent adaptations.

A few informants (3 out 19) raised the knowledge gap of ecological systems. More research is needed into the climate change impacts on ecological systems and the adaptive capacity of biota [26]. Furthermore, more knowledge is required on how to avoid ecological thresholds (tipping points) or change the sensitivity of the threshold in the system. This ability, it is suggested, is a factor of adaptive capacity [27].

Finally, a small number of key informants (2 out of 19) called for more research into interdisciplinary collaboration and sectoral transferability of adaptation lessons. Here, one issue is that due to the multi-dimensional nature of adaptive capacity, a better understanding of it can only come from interdisciplinary research [28]. Another issue is that knowledge transferability is related to particular forms of research engagement with stakeholders (e.g. action research and social learning) [29].

2.2.2 Improvement of adaptive capacity programs

The second question asked of key informants was how the effectiveness of adaptive capacity strategies might be improved for decision makers. A Leximancer concept map of the combined responses to this question shows the major themes and concepts of interest discussed by the key informants (Appendix 4, Figure 14). The frequency of themed references by key informants shows the level of concurrency for each and indicates where issues were raised by only a few key informants (Figure 10).

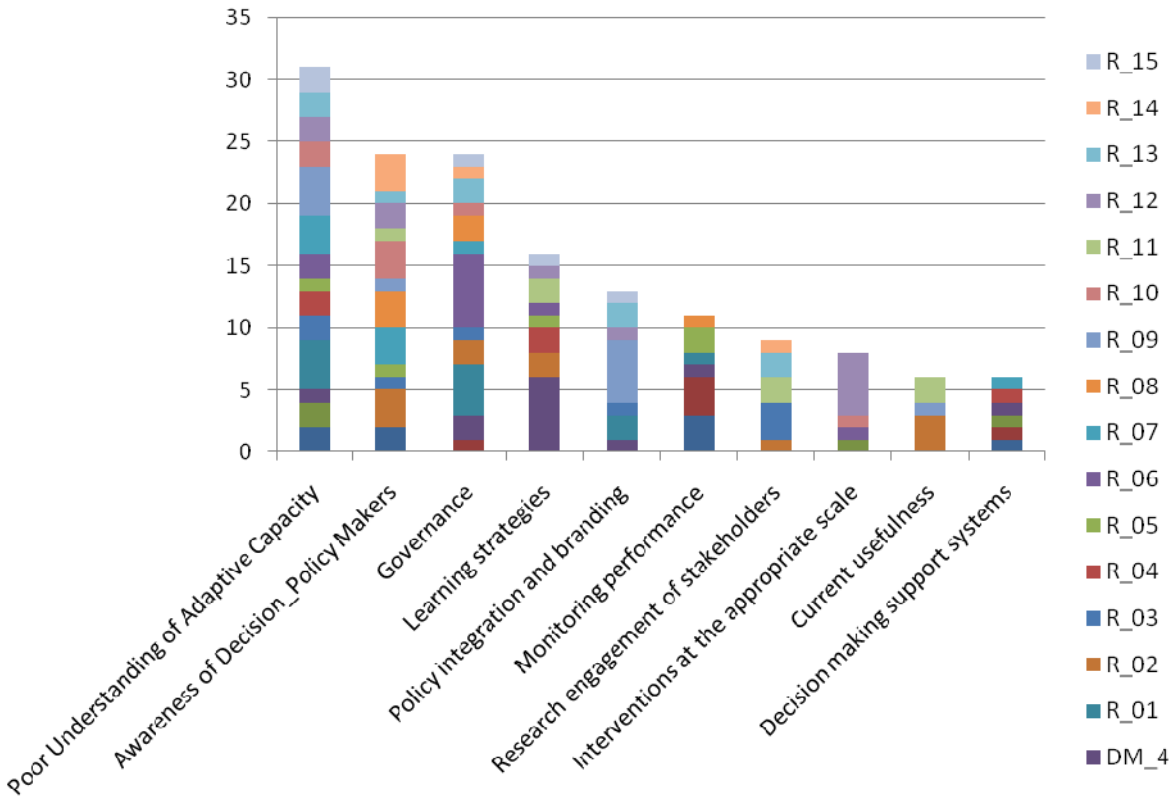

Figure 10 Frequency of themed references by key informant

Most key informants (14 out of 19) stated that currently there is poor understanding of adaptive capacity among decision makers before discussing ways of improving that understanding or the effectiveness of adaptive capacity programs. The first point raised is that different understandings or conceptualisations of adaptive capacity exist between researchers and decision makers [30]. The second is that the extent to which this human faculty needs to be better understood depends on the particular group and decision-making context [31].

Compound coding queries were run to identify how informants related poor understanding of adaptive capacity to different groups, such as researchers and decision/policy makers. Four specific references relate to the poor understanding among researchers; and ten references relate to the poor understanding among decision/policy makers.

Many key informants (12 out of 19) mentioned governance needs to be addressed to improve the effectiveness of adaptive capacity strategies. The issues discussed include (i) adaptation requires a whole of government or organisation approach (e.g. to avoid the 'beyond our portfolio authority' response) and governance arrangements can enhance adaptive capacity [32]; (ii) governance influences policy design, program development, and its performance monitoring; and (iii) the role of governments includes the provision of public goods (e.g. knowledge about impacts and risks of climate change) and the protection of the weak [33]. Strategy ideas suggested by informants include (i) the development of bridging organisations to deal with cross scale governance issues, since inter-governmental levels can cause incompatible program outcomes in response to adaptations [34]; and (ii) change communications from focusing on adaptive capacity to good governance in response to climate change impacts [35], or indeed the wider raft of global environmental mega-trends.

Many key informants (12 out of 19) also discussed the relationship between building adaptive capacity and raising awareness (self/organisational) of decision/policy makers' responsibilities in that endeavour [36, 37]. Issues include (i) questioning whether decision makers have the right methodological skills set for climate change adaptation [38]; and (ii) reduced potential for regret through investing in adaptive capacity building rather than infrastructure to reduce exposure and related impacts [39]. Strategy ideas suggested by key informants include (i) maintain or enhance decision/policy makers' confidence and support of adaptation science by improving communications; and (ii) mainstream a new mindset among policy makers that is future orientated amidst uncertainty [37]. Some key informants (8 out of 19) discussed how learning strategies are a means of improving the effectiveness of adaptive capacity building strategies. Adaptive capacity at larger scales is largely determined by institutional learning related to good governance [40]. As a result, a practical strategy idea is for decision makers to focus on action learning (learning by doing) [41]. A closely connected idea is that organisational learning is related to performance monitoring. Some key informants (6 out of 19) argued that monitoring performance of adaptive capacity strategies and adaptations is a means of improving their effectiveness [44]. Some comments related to the need for further research into metrics for adaptive capacity, while other comments related to adaptive learning. A compound coding query was run to examine whether informants who spoke of the need to monitor performance relate this issue to learning strategies. Three out of ten references were found that did [45].

Key informants (7 out of 19) identified policy integration and branding as a way to improve the effectiveness of adaptive capacity strategies. This goes beyond rhetoric and seeks greater adaptive capacity within an institution through the process of integrating policy outcomes across related programmes. For example, there is a relationship between adaptation and development pathways (community development, sustainable development, economic development) framed by policy programs [42]. Strategy ideas suggested by informants include (i) integrate adaptations and adaptive capacity strategies with existing policy development and performance measurement – link with whole of government approaches and use plainer English (e.g. talk about effective institutions or good governance [43]); and (ii) adaptive capacity to climate change needs to be reframed for decision makers as they need to respond to other social and technological forces of change affecting the their sphere of responsibility – a more holistic view is required in implementing adaptive capacity strategies [44]. Some key informants (5 out of 19) raised the importance of engagement of stakeholders in the research process to improve the effectiveness of their adaptive learning. One suggested idea relates to context specific assessments of adaptive capacity. Here research methodologies need to engage stakeholders in a relevant way to improve the effectiveness of adaptive capacity strategies (e.g. action research [47]). One informant argued that researchers need to be better listeners and 'park' theories, unfamiliar concepts (e.g. adaptive capacity), and jargon at the door to understand what stakeholders need if they are to adapt effectively [48].

The low concurrency of this issue among informants suggests that either appropriate research engagement is accepted by researchers, or that this result reflects researchers' blind sides. This is

discussed further in the synthesis section by comparing the findings here with the results of the online survey's Question 12 (research methodology) and Question 16 (knowledge type).

Some key informants (4 out of 19) spoke about the relationship between targeting interventions at the appropriate scale and building adaptive capacity effectively, and where it is needed [49]. This point also links to determining priority of response to target what or who is most vulnerable. A compound coding query was run to examine whether informants who raised the issue of interventions at the appropriate scale, also spoke about priority of response and/or vulnerability. Two references were found within the 8 key informants that raised both these issues. Interventions at the appropriate scale also depend on the most compatible level of governance being engaged and effective public agency partnerships [50]. Some key informants (6 out of 16) discussed how decision-making support systems are inter-related when adaptation is effective. They suggest that improved decision-making support systems relate to good governance and removal of institutional barriers, and these all influence the effectiveness of adaptive capacity strategies [51, 52]. A small number of informants (3 out of 19) stated how the concept of adaptive capacity is useful to decision makers. These include (i) it is a useful concept for facilitating self-reflection among decision-makers and, by extension, the learning organisation [53]; (ii) it is a useful concept as a communication tool across scales, sectors and research fields; and (iii) there is an acknowledgment that a lot of current government activity in the United Kingdom around building strategies for adaptive capacity [54].

2.2.3 Scale

Most key informants (15 out of 19) mentioned the challenge of understanding adaptive capacity across different scales (mentioned 66 times). The scale most talked about, in terms of frequency of coded response (mentioned 24 times) and the number of informants (9 out of 19), is the individual scale. Comments regarding individual scale refer to knowledge gaps and the need for research to understand the complexity of socio-cognitive determinants of adaptive capacity and aggregation from the individual scale to the range of collective scales (institution, community and nation) [55, 56]. Another issue raised is the complexity of adaptive capacity working at multiple scales underpinning different modes or nested responses to change management [57]. Key informants (15 out of 19) discussed the inter-relationship between fostering adaptive capacity and institutional issues and models (mentioned 40 times). Sub-themes that emerged include socio-cognitive factors (mentioned 11 times), funding (mentioned 10 times) and transferability (mentioned 9 times). For socio-cognitive factors, better understanding is needed about (i) the socio-cognitive dimensions of adaptive capacity and their relationship to institutional perceptions of risk and subsequent organisational responses [58]; and (ii) the influence of the dominant societal paradigm (e.g. development pathway) on the awareness and skill of decision makers (e.g. developing human capital), institutional behaviour (e.g. facilitating social capital) and the relationships between other determinants of adaptive capacity.

Some key informants (6 out of 19) discussed how annual operational funding arrangements need to change to improve the effectiveness of adaptations and adaptive capacity building strategies (e.g. longer-term financial plans) [59]. They also suggested that institutional models influence the priority of response and decisions about which adaptations to fund first. Some key informants (5 out of 19) also identified how to improve the transferability of lessons learned or successful adaptive capacity strategies between institutional contexts, sectors or scales through demonstration projects or bridging organisations [60].

2.2.4 Priority of response

Many key informants (12 out of 19) connected the issue of priority of response in adaptations to building adaptive capacity (mentioned 39 times). Sub-themes that emerged include priority of response based on vulnerability (mentioned 20 times), timeframe (temporal scale) (mentioned 8 times) and public confidence (mentioned 6 times). For the first sub-theme, some key informants (7 out of 19) argued that there is a need to prioritise adaptive capacity building efforts and adaptation investments on the most vulnerable [61]. This was the issue most often raised both in regard to frequency of coded responses and the number of informants who raised this as an issue.

Some key informants (6 out of 19) also stated that the priority for research response and policy development depends on the timeframe of the adaptation decisions under consideration [62]. Some adaptation responses may be prioritised, for better or worse, by considering their impact on the public's confidence or trust of climate change science or policy maker's actions/performance [63]. The issue of public or policy-maker confidence was raised by only two informants, but clearly poll-driven policy making (as seen in the Australian media) is a real threat to the acceptance and thus effectiveness of adaptation to climate change.

Appendix 3 Online Survey Text

NCCARF Adaptive Capacity Synthesis Project

Dear Colleague,
This survey is being conducted to assess the nature and utility of adaptive capacity research in relation to climate change. The survey takes less than 10 minutes to complete. Your identity will be kept anonymous. The results will be reported to the Australian National Climate Change Adaptation Research Facility (NCCARF) as well as published in the near future.

The survey is being conducted by the University of the Sunshine Coast and is funded by NCCARF as a Synthesis Project.

Your participation in the survey is greatly appreciated.

If you have any queries please contact Dr. Phillip Daffara at pdaffara@usc.edu.au

Start

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1. How do you define 'adaptive capacity' in relation to climate change?

2. Which of the following are you?

- ○ Researcher (studying the impacts of climate change or contributing to adaptation science)
- ○ Policy decision-maker (directing programmes and actions to respond to climate change)
- ○ Both

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3. Which of the following contexts do you research or make decisions?

- ○ Biophysical systems (excluding people)
- ○ Social systems (economic and cultural)
- ◉ Socio-ecological systems

4. In which of the following disciplinary fields were you primarily trained?

- ○ Mathematical Sciences
- ○ Physical Sciences
- ◉ Earth Sciences
- ○ Environmental Sciences
- ○ Biological Sciences
- ○ Agricultural and Veterinary Sciences
- ○ Information and Computing Sciences
- ○ Engineering
- ○ Technology
- ○ Medical and Health Sciences
- ○ Built Environment and Design
- ○ Education
- ○ Economics
- ○ Commerce, Management, Tourism and Services
- ○ Studies in Human Society
- ○ Psychology and Cognitive Sciences
- ○ Law and Legal Studies
- ○ Studies in Creative Arts and Writing
- ○ Language, Communication and Culture
- ○ History and Archaeology
- ○ Philosophy and Religious Studies
- ○ Other

5. In which of the following disciplinary fields are you primarily currently working?

- ○ Mathematical Sciences
- ○ Physical Sciences

- (•) Earth Sciences
- ( ) Environmental Sciences
- ( ) Biological Sciences
- ( ) Agricultural and Veterinary Sciences
- ( ) Information and Computing Sciences
- ( ) Engineering
- ( ) Technology
- ( ) Medical and Health Sciences
- ( ) Built Environment and Design
- ( ) Education
- ( ) Economics
- ( ) Commerce, Management, Tourism and Services
- ( ) Studies in Human Society
- ( ) Psychology and Cognitive Sciences
- ( ) Law and Legal Studies
- ( ) Studies in Creative Arts and Writing
- ( ) Language, Communication and Culture
- ( ) History and Archaeology
- ( ) Philosophy and Religious Studies
- ( ) Other [ ]

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Queensland, Australia

NCCARF Adaptive Capacity Synthesis Project

Worldviews and Orientations

6. In life, where do you believe the power/agency lies to create the future you want?

- ( ) All within me (strongly internal)
- ( ) Mostly within me (internal)
- (•) Both (internal and external)
- ( ) With others (external)
- ( ) Completely with others (strongly external)

7. If inclined, please explain your answer to the previous question.

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8. On which of the following do you believe the resilience of our socio-ecological systems depends?

- ( ) Comprehensive prescriptions and regulatory control of human actions
- ( ) Mainly through rules and regulations
- (•) A balance \ tradeoff of personal rights and moral obligations (social sanctions)
- ( ) Mainly through human ingenuity and creativity
- ( ) Human consciousness (personal and social ethics) and collective spirit

9. If inclined, please explain your answer to the previous question.

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10. Overall, how do you feel about our long-term socio-ecological futures?

- ( ) Very pessimistic
- ( ) Pessimistic
- ( ) Don't Know
- ( ) Optimistic
- (•) Very Optimistic

11. If inclined, please explain your answer to the previous question.

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12. Which methodological approach(es) do you use in your research? (please tick all relevant responses)

- [ ] Hypothesis driven research
- [ ] Interpretative enquiry (e.g. ethnography)
- [ ] Critical analysis (e.g. critical ethnography)
- [x] Action research (proactive social learning and action)
- [ ] Other (please explain)

13. Which type of research do you tend to do?

- (•) Interdisciplinary
- ( ) Disciplinary

14. How would you describe your orientation to knowledge generation?

- ( ) Quantitative knowledge
- ( ) Qualitative knowledge
- (•) Mixed knowledge

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15. Which outputs of research do you produce? (please tick all relevant choices)

- [ ] Journal Papers, Books Chapters and Books
- [ ] Conference Papers
- [ ] Technical Reports
- [ ] Policy or Position Papers for Government
- [x] Websites
- [ ] Digital Media (video, DVD, PowerPoint)
- [ ] Other (please explain)

16. Is the knowledge generated by your activities mostly fundamental or applied ?

- ( ) Fundamental (i.e. knowledge generation excluding case studies)
- (•) Applied (i.e. case studies)

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17. How would you rate the effectiveness of the application of adaptive capacity programs? (e.g. communities, organisations, non-research, etc.)?

- ( ) Strongly Effective
- ( ) Effective
- ( ) Partly Effective
- ( ) Neutral
- ( ) Partly Ineffective
- ( ) Ineffective
- ( ) Strongly Ineffective
- ( ) N/A

18. What main area of concern/activity do you work in? (you may select more than one)

- [ ] Emergency Management
- [ ] Human Health
- [ ] Marine Biodiversity and Resources
- [ ] Primary Industries
- [ ] Settlements and Infrastructure
- [ ] Social, Economical and Institutional Dimensions
- [ ] Terrestrial Biodiversity
- [ ] Water Resources and Fresh Water Biodiveristy

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18. What sector do you mainly work in?

- ( ) Private
- ( ) Public (including academia)
- (•) Both

19. Where do you sit in the knowledge chain of adaptive capacity research?

- (•) Generating applied knowledge or actionable science
- ( ) Using/implementing applied knowledge or actionable science
- ( ) N/A

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20. On which scale(s) does your work cover? (you may select more than one)

- [ ] International
- [x] National
- [x] State/Provincial
- [ ] Local

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21. Do you work in a non-government or non-profit organisation?

- (•) Yes (includes academia)
- ( ) No

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22. What type of non-government or not-for-profit organisation do you work in?

- ( ) Community Service
- ( ) Advocacy Group
- (•) Charity/Foundation
- ( ) University
- ( ) Other (please explain) [ ]

23. To what degree is responding/adapting to climate change impacts a part of your policy/decision making now?

- ( ) Core business
- (•) Partial business
- ( ) Marginal/non-core business

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24. What size operational annual budget do you control and implement?

- ( ) $0 (no budget)
- ( ) less than $50,000
- (•) $50,001 - $100,000
- ( ) $100,001 - $500,000
- ( ) $500,001 - $1,000,000
- ( ) $1,000,001 - $5 mil
- ( ) greater than $5 mil

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25. How useful is the concept of adaptive capacity related to climate change to your policy/decision making (i.e. in directing programmes and actions)?

- ( ) Very Useful
- ( ) Useful
- ( ) Somewhat Useful
- ( ) Neutral
- (•) Somewhat Not Useful
- ( ) Not Useful
- ( ) Not Very Useful
- ( ) N/A

26. If inclined, please explain your answer to the previous question.

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27. How strongly do you agree with the statement that more effective ways are needed of building your organisation's capacity to adapt and become more resilient to climate change impacts?

- ( ) Strongly Agree
- ( ) Agree
- ( ) Somewhat Agree
- ( ) Neutral
- (•) Somewhat Disagree
- ( ) Disagree
- ( ) N/A

28. If inclined, please explain your answer to the previous question.

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Queensland, Australia

NCCARF Adaptive Capacity Synthesis Project

We appreciate you taking time to complete our survey.
Thank you,

Sustainability Research Centre - ML28
University of the Sunshine Coast
MAROOCHYDORE DC QLD 4558
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Close preview

Appendix 4 Comments received about the survey

19 references were collected that commented some of the survey questions. Some examples follow.

In regard to Question 2

> "You would be better to leave options below. Nobody fits neatly into such categories." (respondent 36708)

In regard to Question 7

> "What sort of psychological nonsense is this?" (respondent 36298)
>
> "Loathe to be categorised on a locus of control scale." (respondent 36619)

In regard to Question 9

> "However, none of the options above really cover this." (respondent 36392)
>
> "I don't like the single choice options!" (respondent 36458)
>
> "This question is better answered by allowing multiple selections or including the likes of 'All above' or 'None above.'" (respondent 36497)
>
> "You're forcing false tradeoffs." (respondent 36632)
>
> "Meaningless question." (respondent 36655)
>
> "My choice is none of the above but your system forces me to produce an answer in order to continue." (respondent 36723)
>
> "Serious point missed by this survey" (respondent 36727)
>
> "I'm annoyed that I'm being forced to choose only 1 of the above, because all are relevant." (respondent 36806)
>
> "You should allow more than one option here" (respondent 36809)

In regard to Question 11

> "Again meaningless, given (i) the non-utility and diverse constructions of 'socio-ecological futures' and (ii) it depends what aspects. Therefore cannot answer." (respondent 36655)
>
> "Not don't know - but actually in the middle - why can't I choose this?" (respondent 36806)
>
> "Don't know is not a mid point between pessimistic and optimistic." (respondent 36874)
>
> "'long' - how long? 'our' - whose?" (respondent 36305)

Questions 19, 22 are not framed in a way that is appropriate for people working on the ground, at the grass roots of adaptive management of the environment and agriculture." (respondent 36704)

4.1 Concept Maps

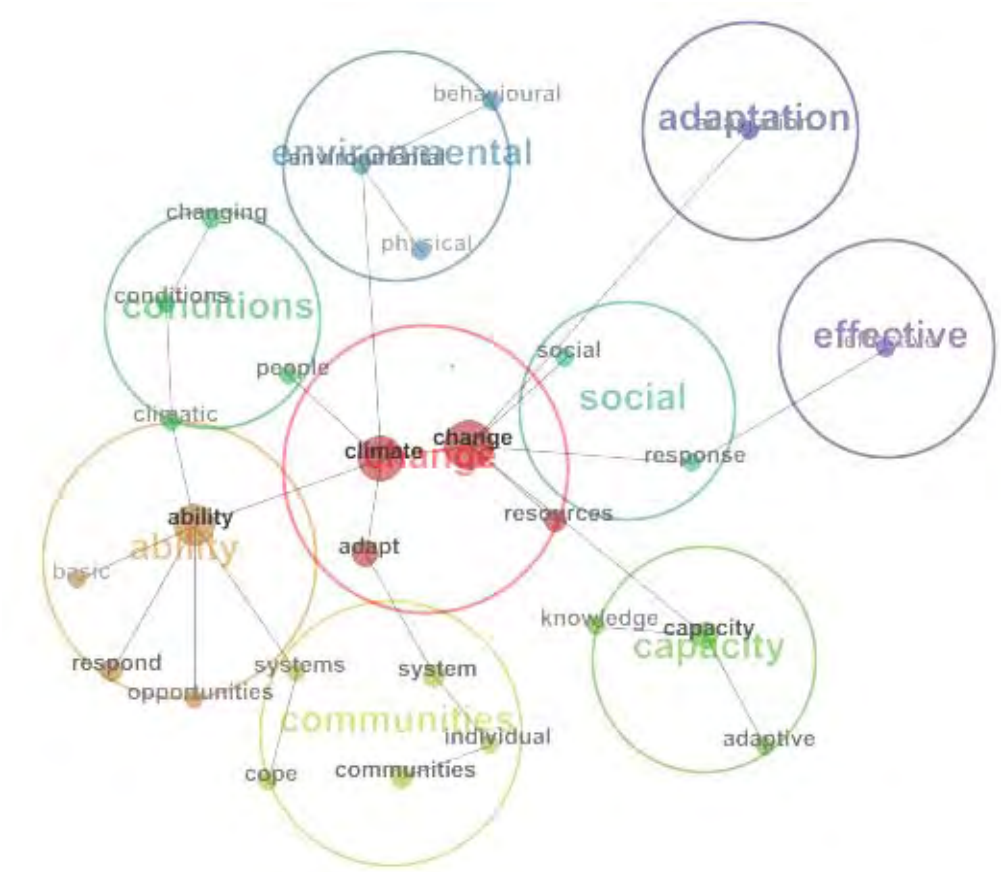

Figure 11 Concept map of survey participant's definition of adaptive capacity

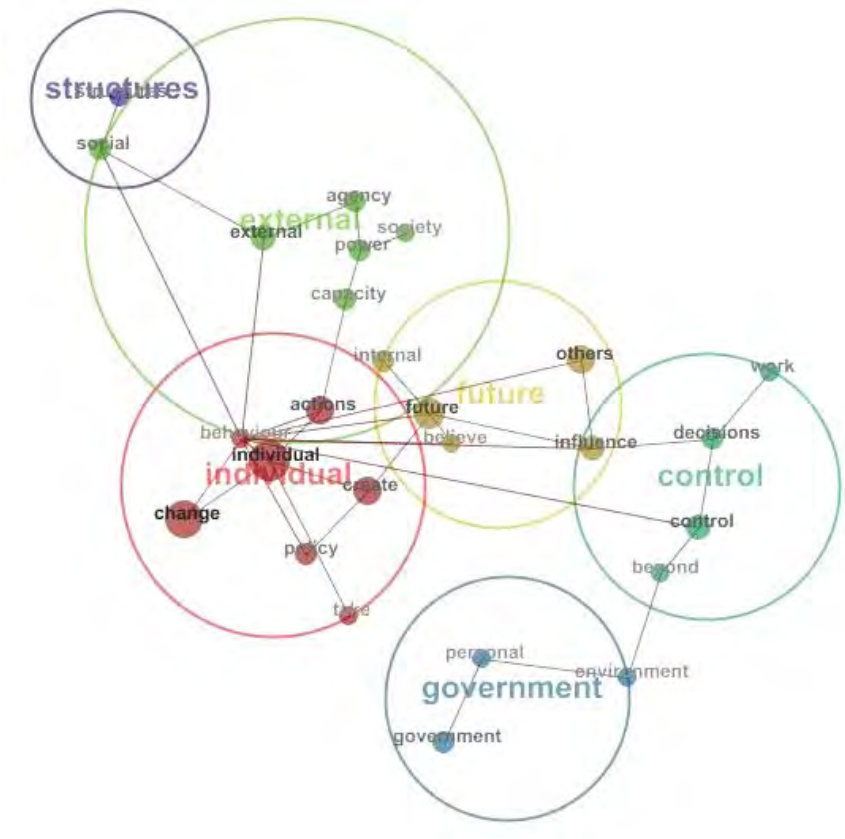

Figure 12 Concept map of participant's worldviews about agency in creating the future

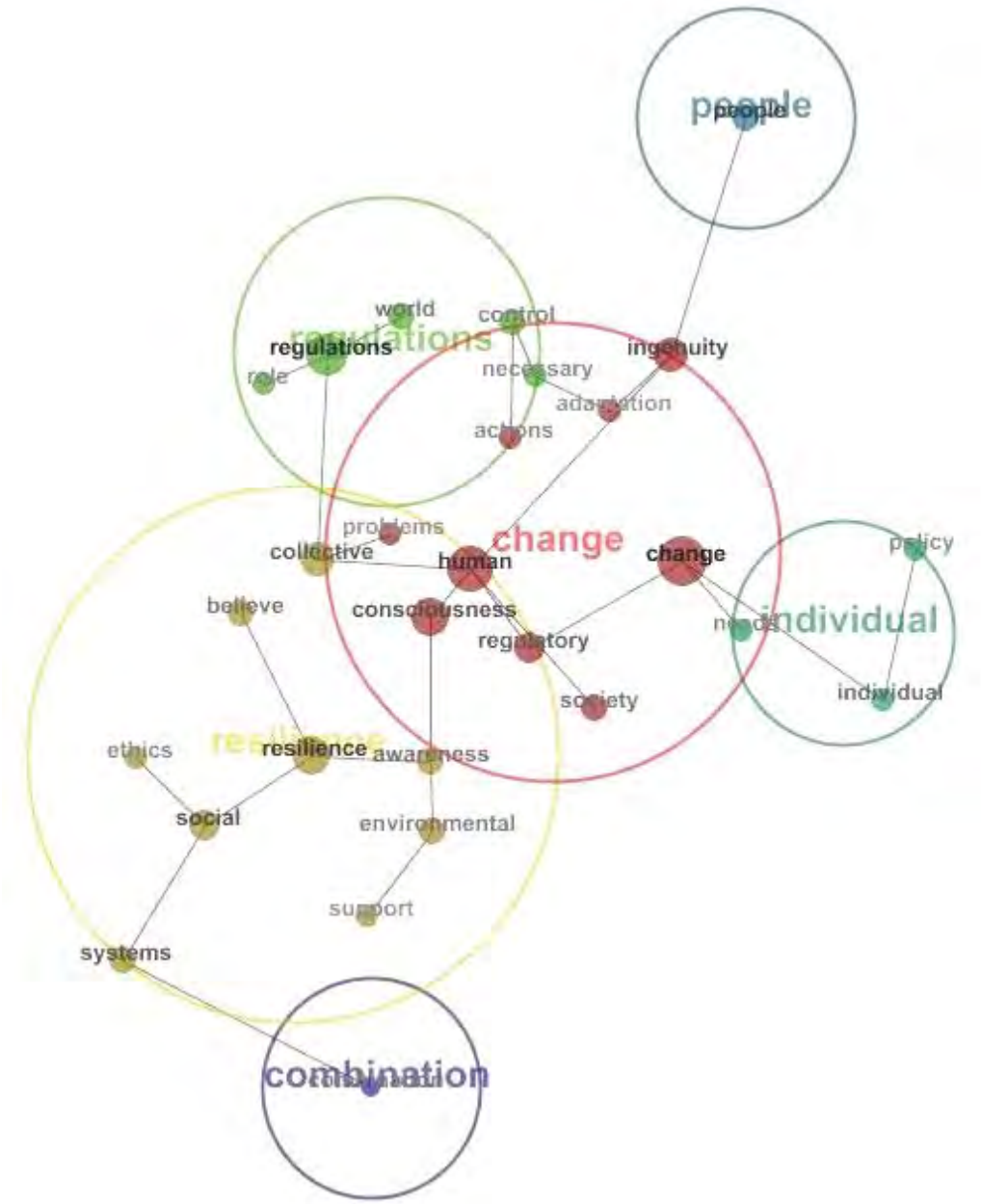

Figure 13 Concept Map of participant's socio-ecological resilience factors

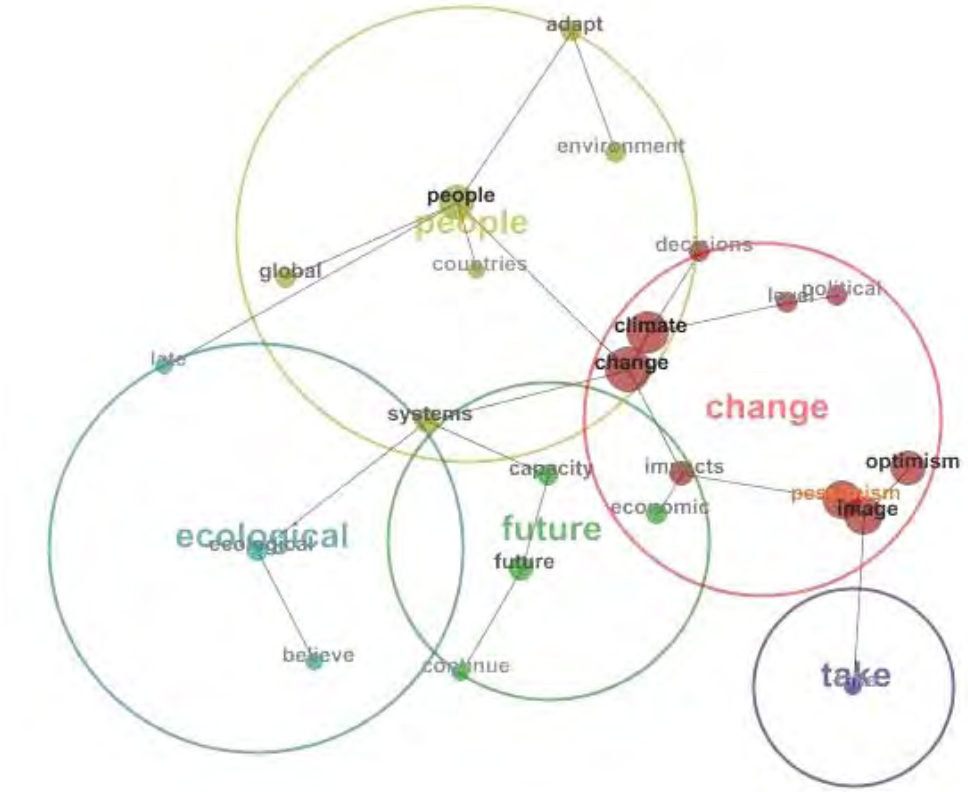

Figure 14 Concept map of participant's feelings/images about our socio-ecological futures

N.B. For the Leximancer content analysis of the text, the concept word "image" was manually created in the project's thesaurus and defined by combining the found concepts relating to feelings of "pessimism" and "optimism".

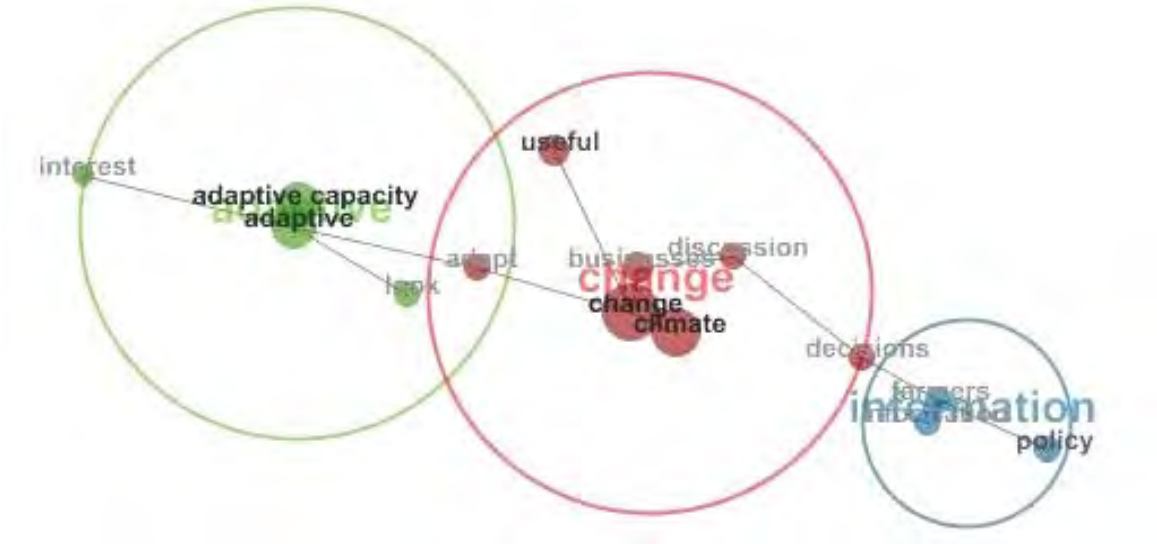

Figure 15 Concept map of decision makers' perceptions of the utility of adaptive capacity

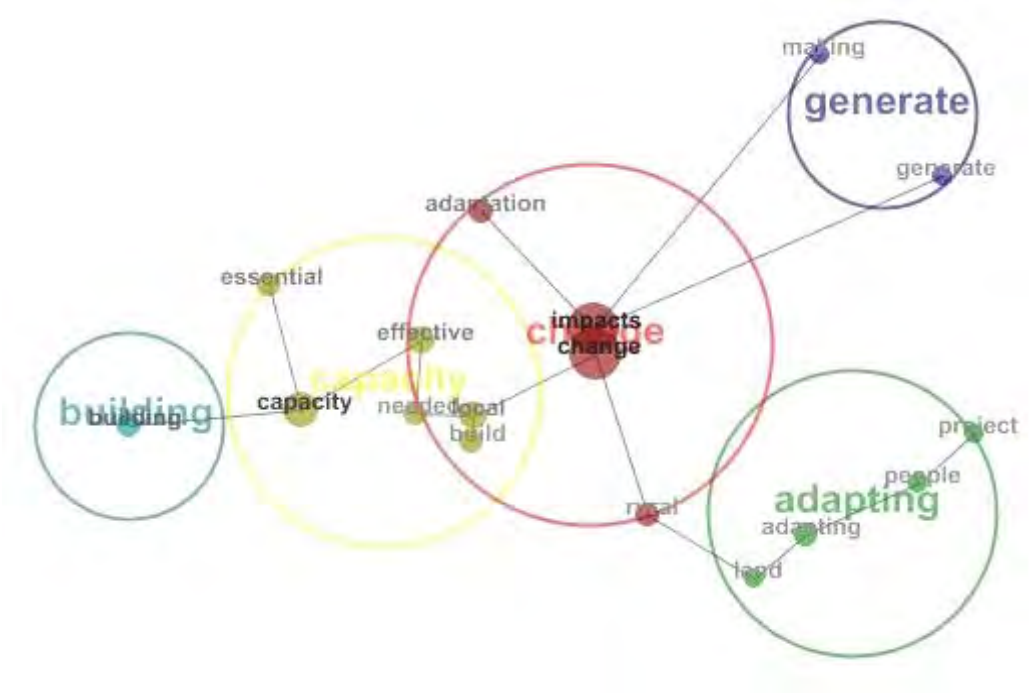

Figure 16 Concept map of decision maker's perceptions about the need for adaptive capacity building

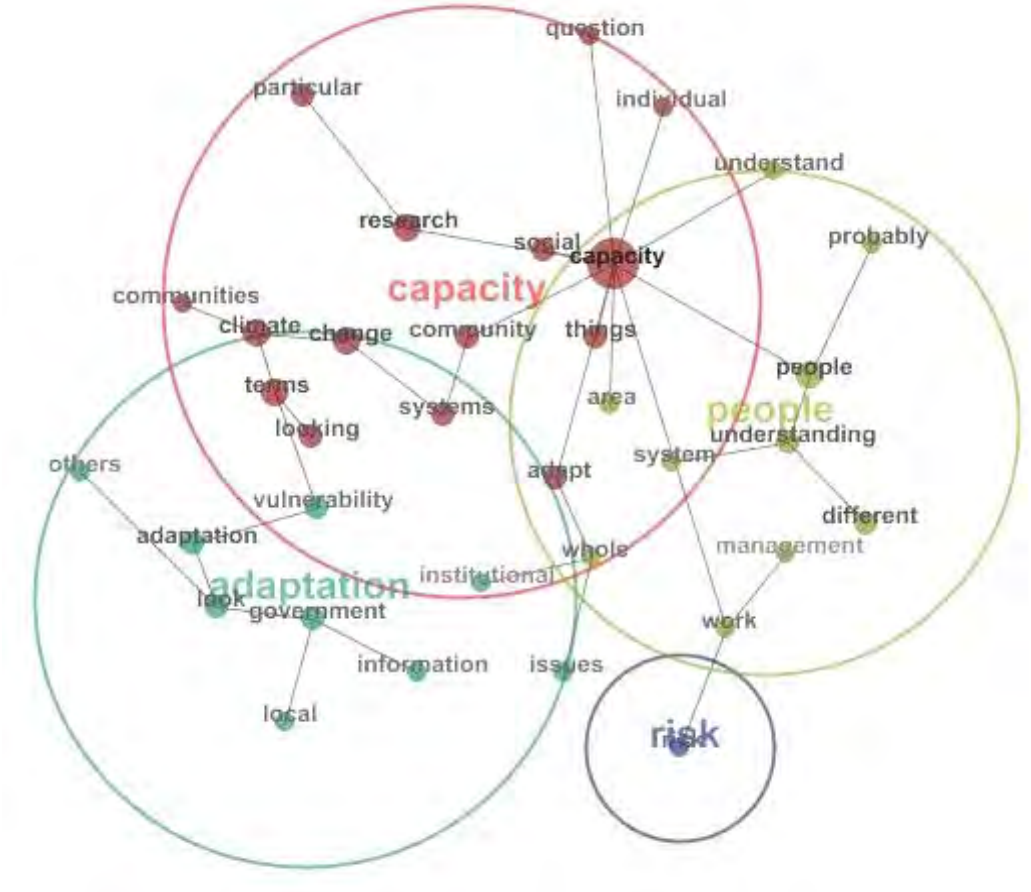

Figure 17 Concept map of key informants' responses to Question 1

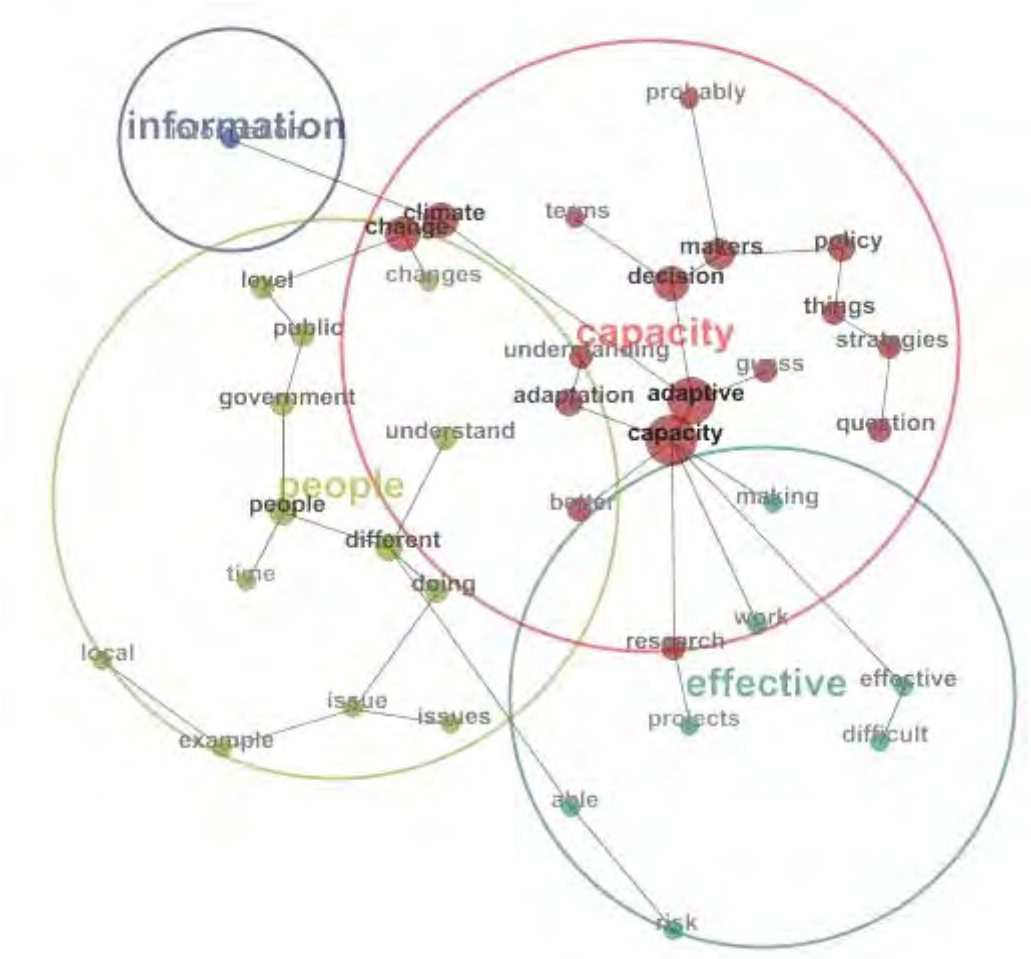

Figure 18 Concept map of key informants' responses to Question 2

Appendix 5 Key Informant Interviews - materials

EMAIL TEXT FOR KEY INFORMANT INVITATIONS

Dear [title, surname],

You have been identified as a leading researcher contributing to the field of adaptive capacity for climate change response.

A research team at the University of the Sunshine Coast has been funded through the Australian National Climate Change Adaptation Research Facility (NCCARF) to complete a 6-month study on the nature and utility of adaptive capacity research in relation to climate change. As a leading person at the cutting edge of the field, you are invited to participate in a key informant interview. Your insights will be highly valued and your participation would be greatly appreciated.

Interviews will take less than 10 minutes and focus on two main questions exploring (1) the conceptual development of adaptive capacity research; and (2) its application by decision makers.

We would like to schedule the interviews in the week beginning 23 November 2009. If you are interested in participating, please let us know a convenient time.

A research information sheet and a consent form have been attached for your consideration.

I look forward to your response.

Prof Tim Smith

University of the Sunshine Coast

RESEARCH PROJECT INFORMATION SHEET
An Assessment of the Nature and Utility of Adaptive Capacity Research

Principal Researcher:

Prof Tim Smith, University of the Sunshine Coast, Director Sustainable Research Centre (SRC), TSmith5@usc.edu.au

Associate Researchers:

Dr Phillip Daffara, University of the Sunshine Coast, SRC, PDaffara@usc.edu.au
Ms Noni Keys, University of the Sunshine Coast, SRC, NKeys@usc.edu.au

INFORMATION STATEMENT

What is this research project about?

The goal of the project is to assess the interpretation and approach to adaptive capacity research among a range of disciplines, and to assess the utility of the concept for decision-making, in order to make recommendations to improve synergies between climate change adaptation researchers and decision makers. The project is funded by the Australian National Climate Change Adaptation Research Facility (NCCARF).

Who is invited to participate in this research project?

Participation in this study is voluntary. Researchers of adaptive capacity to climate change and policy/decision makers across diverse contexts are invited to participate. They may discontinue participation at any time without penalty or the need to provide an explanation.

Why are you being asked to participate?

Your perceptions and understandings of the concept of adaptive capacity and its usefulness will help the research team make recommendations to improve synergies between climate change adaptation researchers and decision makers.

What are you being asked to do?

You are being asked to participate in a key informant interview. The interview takes less than 10 minutes and will be digitally recorded.

Will the information be confidential?

Key informant interviews will be conducted to ensure anonymity of the interviewee and transcripts of interviews will not have names recorded against them. The audio files will be securely stored for three years using numerical identifiers before being destroyed.

What will be done with the information?

The findings of the research will be reported to NCCARF in two reports, as well as being published in two journal articles.

Thank you for your interest and participation in this project

If you have any complaints about the conduct of this research raise them with the Principal Researcher or, for an independent person, contact the Chairperson of the Human Research Ethics Committee at the University: (c/- the Research Ethics Officer, University of the Sunshine Coast (ML26), Maroochydore DC 4558; tel (07) 5459 4574; email humanethics@usc.edu.au).

University of the Sunshine Coast

RESEARCH PROJECT

Project: National Climate Change Adaptation Research Facility Synthesis and Integrative Research Programme: Assessment of the Nature and Utility of Adaptive Capacity Research

Principal Researcher: Professor Tim Smith, Director Sustainability Research Centre, USC

Associate Researchers: Dr Phillip Daffara, Ms Noni Keys

INFORMED CONSENT

I agree to take part in the research project named above.

I have read and understood the information statement provided for this project and any questions I have asked have been answered to my satisfaction.

I have been advised that the audio recording of the interview will be destroyed after 3 years and I will be provided with a report of the research findings.

I agree that the information collected during an interview may be published in various forms including: the final report to the National Climate Change Adaptation Research Facility; journal articles; and conference papers. I understand that all published information will maintain my anonymity.

I understand that my participation is voluntary and I can withdraw at any time.

I understand that I can contact Professor Tim Smith at any time with questions or concerns regarding this project.

NAME OF PARTICIPANT .....

SIGNATURE ..... DATE .....

NAME OF PROJECT RESEARCHER: .....

SIGNATURE ..... DATE .....

Web www.usc.edu.au | Telephone +61 7 5430 1234 Facsimile +61 7 5430 1111 | Maroochydore DC Qld 4558 Australia | Sippy Downs Drive Sippy Downs Qld 4556 Australia

Appendix 6 Key Informant Example quotes for each 2nd tier theme code

Context specific determinants of adaptive capacity

1. "What makes them less vulnerable, more vulnerable? What puts them in a position to at least have the tools that they need in order to act? So I think that it's sort of field work to inform what we think with respect to the theory of adaptive capacity."(R_10)
2. "I think that the levels of exposure and sensitivity to external stresses, including climate, are certainly site specific, the degree to which there is an ability to respond and the capacity to respond, depends on where you are and a wide range of, [to me], underlying determinants that are really very path dependent as well" (R_5)

Benchmarking tools and metrics of adaptive capacity

3. "We certainly perhaps need to define a series of metrics, some measures that we might agree on. Now again, in the research side, just getting all the people together to try and agree on what metrics are used is probably a major research project in it's own right" (R_8)
4. "I think more research in to that, how do you assess adaptive capacity from an organisational point of view would be quite useful. But I see some of the problems [unclear] when it comes to quantification and benchmarking which is what a lot of them are after to see where they may be low and where they may be high." (DM_1)
5. "Are there measures or indicators or something that you can come up with that can be considered as a proxy for identifying adaptive capacity and then for measuring over time how that's changing, whether your policy interventions are being successful or not." (DM_2)

Socio-cognitive factors of adaptive capacity

6. "But I think there's this whole sort of black box that is actually to do with how people kind of process information about risk, how they process information about the different impacts and what their own appreciation/understanding of change and of the options that are open to them – their own feelings of empowerment and self advocacy." (R_4)
7. "So I'd say that, in a way, much of the work that I think needs to be done is on actually understanding different individual's perceptions and understandings and different people's feelings of empowerment and self advocacy, in different cultural contexts. Then I suppose how those individual kind of social cognitive dimensions then link to collective sort of advocacy and collective action." (R_4)
8. "In my opinion I think the big challenge with respect to adaptive capacity and understanding around adaptive capacities – there are two key areas. One is individual behaviour and how individuals make decisions and respond to perceptions of risk."(R_13)

Generic determinants of adaptive capacity

9. "what are the attributes of that social system that confer adaptive capacity." (R_6)
10. "Generic adaptive capacity assessments are useful but ultimately they end up typically being pejorative statements, not unlike other pejorative statements about rich and poor people, or wealthy people and people in risk countries and poor countries and so on." (R_7)
11. "I kind of see adaptive capacity containing a few components like the information and the skill set that is available in the system, the individual agency I suppose, so the ability of individuals to make those sort of decisions." (R_11)
12. "I think that further research needs to be focussed on looking at these generic determinants of adaptive capacity because there is a whole range of determinants that might lead an individual to be more or less adaptive to have that capacity. I think those determinants are at least to some extent based on experience and background. So, you know, a particular educational background, for example, might lead one to be more or less adaptive." (DM_3)

Interaction of attributes of adaptive capacity

13. "I believe that in terms of further research – it is interesting looking at the combination of influences. I mean, I think it is a multidimensional thing...it is going to be a matter of the combination of things that have led a person to the capacity that they as an individual have. The extent to which you can generalise that up into communities of interest or behaviours is something that I honestly haven't got an idea about." (DM_3)

14. "So the first thing I'm saying is its skill dependent. I think one thing that needs to be looked at quite carefully is the nature of that skill dependence...A second issue then is really the nature of still really sorting out these ideas of the relationship between adaptive capacity and resilience." (R_2)

15. "There's issues about cross sectoral interactions and the effectiveness of adaptation in one sector in relation to what's happening in other sectors as well as other scales" (R_12)

Adaptation options assessments

16. "That, I think is something where I feel at least, there is a bit of a gap when it comes to assessing the costs and benefits of particular adaptation actions. Of course that's not so much about their adaptive capacity it's more about what options do we have and how do we make a decision on it when we have different options at hand." (DM_1)

17. "But adaptation research too because, from the way we look at it here, it's a not unique, but a special sort of research that is required to allow industries and communities to adapt to new climates. That is a unique combination of top down sort of biophysical and economic modelling in a sense of what the options might be. But very much bottom up in industry and community engagement in terms of them working through in an iterative way with researchers about what their options really are." (R_14)

18. "So policy makers nationally need to be very aware of the potential pathway of adaptation strategies and make decisions about whether they're good or bad. If they're good, how they can be facilitated." (R_14)

Barriers to adaptive capacity

19. "This really speaks to the issue around what we talk about in terms of barriers to adaptation. So what we find is that quite often there are institutions such as a government that seem to have appropriate information, resources, and knowledge and awareness of an issue to respond 'appropriately' but often they fail to do so. That tends to be tied up in institutional culture, perceptions of risk, institutional silos." (R_13)

Identifying vulnerability across scales

20. "I think we do have to be able to understand who's actually the most vulnerable according to different impacts, different disturbances and be able to kind of target support to that." (R_4)

21. "There's a whole raft of issues around understanding the sort of underlying fundamental structure of vulnerability in a way that leads to adaptation rather than just to understanding the decline." (R_12)

22. "My present thinking is that interventions should focus on the most vulnerable places and the most vulnerable communities within those places. I suppose that if you were going to begin to roll out a program to build adaptive capacity, the best investment would be to target the place – the people – in the geographic spaces who are most exposed and who will need to do something, to take some action to be prepared sooner and begin the conversation with those people." (DM_3)

Understanding the relationships between institutional cultures and adaptive capacity

23. "So why do institutions behave the way they do and perceive risk in the way they do and respond to it in the way they do?" (R_13)

24. "So research around the inner workings of institutions and what makes one institution more adaptive or resilient than another institution, I think, would be useful and another key area of uncertainty." (R_13)

Peoples' (cohorts) different adaptive capacities

25. "we would begin to understand what this human adaptive capacity is all about and how different people have different capacities. How are we going to build that, so that people begin to be more self reliant?" (DM_3)

Ecological systems

26. "The level of the lack of knowledge across the environment described generally including the sort of biota is extreme and we haven't even begun to scratch that surface of adaptive capacity in the environment." (DM_3)

27. "One is you can learn to stay away from critical fish holes, or tipping points, or whatever you want to call them. Often, in social ecological systems, there're biophysical or ecological fish holes and you need to learn about those and the adaptive capacity is the ability to not cross that threshold. The second way of building adaptive capacity is to actually move the threshold and there are ways in which you can change attributes of a system, an ecological system for example, whereby you can make that system able to withstand a bigger shock before it goes across that threshold and changes to some other mode of functioning." (R_6)

Interdisciplinary collaboration and sectoral transferability

28. "But I think it's actually learning across disciplines. Because I think the only way that we're really going to be able to add to understanding adaptive capacity is through trying to create these multi-dimensional frameworks. So I don't think you can go that far down one particular discipline without having to really make strong links across to other disciplines. You know, I don't think one discipline can answer the questions that you now need to answer about adaptive capacity." (R_4)

29. "So the new part about this is how you form that dynamic interface between researchers and community leaders and opinion leaders about mapping new futures for whether it be industries or whether it be communities. So that, to me, is the evolving science in it." (R_14)

Poor understanding of adaptive capacity among decision makers

30. "I don't think that researchers or decision makers have a common understanding of what adaptive capacity is. I think that people use it to their convenience. I think a lot of people don't understand - don't use the concept at all, so it's a completely foreign concept to them." (R_1)

31. "I have found that the term adaptive capacity is not at all well understood in local government circles...But definitely, it seems to be one of those terms people throw around a bit but often, when you really talk about, what does this mean, they're very vague and have a very diverse range of understandings." (DM_1)

Governance

32. "So linking adaptive capacity with just much more mainstream policy processes, - there is such a tendency to fall into a jargon - but it highlights the need for a whole of government approach to those kinds of challenges." (R_1)

33. "What governments really do at all levels is provide things in the public good. Provide public good information about risks and disseminate that widely. You can say that that is building adaptive capacity. So that's one role of government which is to provide public goods that wouldn't normally be provided, like free information about the risks." (R_2)

34. "Bridging organisations turn out to be one of the things institutionally that are often most lacking. A bridging organisation is a non-threatening organisation, often without strong powers, but it links one level of government to another level of government, which links local actors and managers through to the next layer of governance above." (R_6)

35. "So I think trying to take this concept of adaptive capacity and improving adaptive capacity in organisations, I think one thing we could do is just jettison this whole jargon around adaptive capacity and just stick with terminology that people are more used to. So we can talk about good governance" (R_14)

Awareness (self/organisational) of decision/policy makers responsibilities

36. "So the first thing would be for policy makers to recognise that they themselves are subject to adaptation and adaptive capacity and that the government systems that they operate within may or may not be adaptive in their own right." (R_12)

37. "Well I think adaptive capacity needs to be mainstreamed to the extent that every decision that is made about long term investments and infrastructure and things like that, take into account the fact that they are going to put this in place into a dynamic climate that is going to change. The degree to which it accommodates the uncertainty and the risks associated with that, they absolutely have to do that." (R_5)

38. "I'm not sure that the decision makers that are dealing with climate change adaptation have the right methodological skill set for dealing with climate change adaptation." (R_14)

39. "So, one of the things that I think decision makers about adaptation need to understand is that it's probably cheaper, has less potential for regret and may also ultimately give you more effective outcomes to invest in increasing capacity rather than investing - particularly investing in efforts to reduce exposure." (R_7)

Learning strategies

40. "The adaptive capacity of a jurisdiction of a region or state or a province or even up to the level of a nation state, is actually more determined by other things like the competence of institutions and the way that institutions are able to act collectively. The way they're able to learn from each other from different parts of the system" (R_2)

41. "I think it's all about the monitoring, learning by doing" (DM_4)

Policy integration and branding

42. "I'd rather see the integration of adaptive capacity within sustainable development." (R_19)

43. "I think one thing we could do is just jettison this whole jargon around adaptive capacity and just stick with terminology that people are more used to. So we can talk about good governance; we can talk about best practice; we can talk about sustainability – things that are more familiar perhaps to decision makers." (R_13).

44. "So yes, we need to focus on climate change at this time, because it's urgent and because we are ready to do something collectively at the societal and global levels, but I think for decision makers, this won't be the only [ecosystem] change that they're dealing with and... there are other key social and technological changes that are happening at the same time and economic changes...So the key message that I would like to emphasise is that yes we need to have a good understanding of climate change adaptation but when it comes to communicating with decision makers and to them making decisions, it needs to be nested within an understanding of other changes that are happening. Otherwise it just becomes a little silo of its own." (R_9)

Monitoring performance

45. "And so being able to draw some sort of before and after assessment before the policy interventions and after and then to how effective it was, if we can do that then we can have a much stronger sense of which policy mix has been effective, which ones have been not effective and then what we need to consider into future policy interventions." (DM_2)

46. "I think it would be really helpful to go back and evaluate the degree to which these [adaptive capacity building] strategies have been successful, that's the only way we'll learn from our failures as well as our successes." (R_5)

Research engagement of stakeholders

47. "That stakeholders are engaged and in some ways may be taking ownership of any research that is going on and feel a part of it and feel engaged and are willing, interested and can see that you know that there are benefits to be gained" (R_3)

48. "But it's much more about what's the language that you use when working with stakeholders; are the questions that you're asking relevant to stakeholders in their particular context. So that's just sort of a translational exercise." (R_13)

Interventions at the appropriate scale

49. "The other thing relates to a question of how much adaptation is done locally as opposed to how much is more a societal activity. That applies to a series of scales again; an issue raised before. So understanding the level at which adaptive capacity particularly needs to be enhanced for different contexts" (R_12)

50. "In regard to Australia's different government levels and different scales and different contexts, how might we improve the partnerships among these different levels of government in building adaptive capacity and improving our adaptation responses" (R_10)

Decision-making support systems

51. "I think everyone, in almost all organisations would say they haven't got enough capacity, in either their own time, their own knowledge, or the tools and processes which they use or utilise to make good decisions." (DM_4)

52. "It's about thinking about the time scales of risks and the way they're going to unfold and the contribution of existing decision-making institutions to creating vulnerability in the first place and recognising that sometimes those institutions are a problem and not a solution." (R_7)

Current usefulness of the concept

53. "I think it's particularly useful for people in the head of organisations who can see there are some capacity problems within their organisation and understand it but want to make it more obvious for the entire team, so it sort of can increase the understanding of these sorts of issues across organisations." (R_11)

54. "I guess at present the majority of action (in U.K.) is actually in building adaptive capacity rather than necessarily in adaptive actions per say and that would seem appropriate." (R_6)

Adaptive capacity across different scales

55. "So if you had a collection of individuals who individually you would say had adaptive capacity, that doesn't necessarily mean that collectively all living in a particular area, they're going to have adaptive capacity at the same – judged to be – their adaptive capacity collectively is not simply the aggregation of their individual adaptive capacity." (R_2)

56. "So I'd say that, in a way, much of the work that I think needs to be done is on actually understanding different individual's perceptions and understandings and different people's feelings of empowerment and self advocacy, in different cultural contexts. Then I suppose how those individual kind of social cognitive dimensions then link to collective sort of advocacy and collective action." (R_4)

"So what's adaptive capacity to one scale is transformation on another scale and is probably just incremental amendments to day to day activities at a scale in the other direction. So there's a whole issue of nesting things there." (R_12)

Institutional issues and models

57. "So why do institutions behave the way they do and perceive risk in the way they do and respond to it in the way they do" (R_13)

58. "Then probably finally we need to look at a whole range of innovative tools and methods to look at funding arrangements. How we can actually more effectively fund those demonstration projects, institutional change, monitoring size et cetera across organisations" (DM_4)

59. "Bridging organisations turn out to be one of the things institutionally that are [sic] often most lacking. A bridging organisation is a non-threatening organisation, often without strong powers, but it links one level of government to another level of government, which links local actors and managers through to the next layer of governance above...So getting that kind of communication across scales is often one of the biggest stumbling blocks because it doesn't take place, so bridging organisations do that."(R_6)

Priority of response in adaptations and building adaptive capacity

60. "So you are going to invest first basically on the people who are in the most vulnerable geographic space, but second of all those within that space who are extremely, highly exposed, but who haven't begun to think about what to do next." (DM_3)

61. "It's not just about, well, here's the risk now; it's about thinking about the time scales of risks and the way they're going to unfold and the contribution of existing decision-making institutions to creating vulnerability in the first place and recognising that sometimes those institutions are a problem and not a solution."(R_7)

62. "We are now starting to see the cartoonists in the newspapers making fun of the differences of opinion on climate change. What that means is if they're doing that, the public is also starting to feel it's a bit of a joke." (R_8)

Appendix 7 Additional generic recommendations

7.1 Socio-ecological systems research meta-criteria for the development of adaptive capacity

The following meta-criteria are offered with the intent of developing the concept of adaptive capacity. They may be used by adaptive capacity researchers to formulate their research proposals. Not all the meta-criteria may be relevant for a project, so some judgement about applicability is needed.

1. How does the research/project progress the development of robust evaluation protocols and tools for adaptation action plans, policies and measures?

2. How does the research/project consider the socio-cognitive factors of adaptive capacity and their interaction across applicable spatial scales (from individual to collective)?

3. How does the research's/project's methodology engage stakeholders in the planning, design, implementation and monitoring of adaptation projects, for the purpose of maximising adaptive learning and transferability of knowledge to adaptors, thereby improving stakeholder capability to respond?

4. How does the research's/project's methodology employ systems thinking tools and approaches to examine the generic and contextual interdependencies of adaptive capacity?

5. How does the research's/project's methodology facilitate interdisciplinary collaboration to maximise the opportunity to understand the multi-dimensional nature of adaptive capacity?

6. How does the research/project seek to understand the indicators (generic or context specific) of adaptive capacity?

7. How does the research's/project's methodology recognise the values of cultural diversity and alternative ways of knowing? Does it design methods to integrate Indigenous knowledge (past and current adaptive practices) with contemporary adaptive science?

8. How does the research/project examine the barriers preventing the capacity of actors within the system to adapt?

9. How does the research/project assist adaptors to understand their multi-scalar vulnerabilities, sensitivities and build awareness of their own adaptive capacities?

10. How does the research/project explore and present in a legible, meaningful way the ecological and biophysical impacts of climate change relevant to the adaptors within the system?

7.2 Guiding principles for decision makers to navigate the peculiarities of adaptive capacity

The following operational guiding principles for decision makers are offered to improve the effectiveness of adaptive capacity strategies and actions. The relative significance of these principles will change depending on the decision-making context, so their application requires thoughtful consideration.

Monitor performance

Agree with your stakeholders (institutional or community) the easily measured indicators of adaptive capacity you will use to benchmark the agility of the organisation to respond to external forces of environmental change, including climate change impacts. How will you know if your institution is more adaptive or resilient compared to another?

Nurture self and collective awareness

Adaptive capacity is a useful concept for facilitating self awareness/reflection among decision makers and, by extension, the learning organisation. Develop awareness of the relationship between adaptation strategies and alternative societal paradigms or development pathways (e.g. continued economic growth or sustainable development) and organisational culture. At the larger institutional scale, the success of adaptations also relates to socio-cognitive factors that manifest at the smaller, individual scale, such as perceptions of risk, skill, empowerment to respond (hope) and behaviour of decision makers.

Learn by doing together

Adaptation research is a special form of research that requires multi-scalar (top-down and bottom-up) approaches, is iterative and collaboratively engages stakeholders. It assumes that there are diverse understandings or conceptualisations of adaptive capacity among researchers and decision makers. An organisational culture of learning is critical to effective adaptations.

Plan for complexity, not control

By focussing on good governance in response to climate change impacts (or any other ecological, social or technological external driver of change), adaptive capacity is inherently improved. Good governance drives performance monitoring, the redesign of decision-making support systems and seeks to overcome institutional barriers; all of which influences the capacity to respond to or adapt.

Adaptation requires a whole of government or organisation approach (e.g. to avoid the 'beyond our portfolio authority' response) to enable

- Effective communication – the role of governments includes the provision of public goods (e.g. knowledge about impacts and risks of climate change) and the protection of the vulnerable;
- Policy integration – integrate climate change adaptations and adaptive capacity strategies with other policy outcomes;
- Performance monitoring of adaptive capacity strategies and adaptations as a means of improving their effectiveness;
- Better capability and methods for the assessment of the costs and benefits of adaption options to improve strategic planning/decision-making over the long-term; and
- Participation by others – inter-governmental levels can cause incompatible program outcomes in response to adaptations, (bridging organisations are a means to deal with cross scale governance issues).

Foster futures orientated thinking

Due to increasing awareness of uncertainty and complexity in the world and the multi-dimensional nature of adaptive capacity, a better understanding of it can only come from fostering new or alternative thinking that questions the future. Conditions that can assist in forming new mindsets among policy makers include

- Action learning (learning by doing);
- Trusting stakeholder collaboration;
- Policy development that incorporates resilience systems thinking (e.g. that change is dynamic, surprises are inevitable, and adaptation is part of the human experience);
- An understanding that there is less potential for regret through investing in adaptive capacity building compared to investing in infrastructure to reduce exposure and related climate change impacts; and
- Continual improvement of human capital (skills).

Rethink, redesign, rebuild institutional models

Better understanding is needed about the socio-cognitive dimensions of adaptive capacity (human capital) and their relationship to institutional perceptions of risk and subsequent organisational responses (social capital). However, adaptations do not need to wait for this knowledge. Pragmatically, rethinking processes, redesigning models and rebuilding institutional trust can start by

- Fitting for purpose operational funding arrangements (e.g. longer term financial plans or intergenerational community plans) that improve the effectiveness of adaptations and adaptive capacity building strategies over different terms of government;
- Prioritise adaptive capacity building efforts and adaptation investments on the most vulnerable (geographically, demographically); and
- Improving the transferability of lessons learned or successful adaptive capacity strategies between institutional contexts, sectors or scales through demonstration projects or bridging organisations.

Promote diverse adaptation pathways, actions and participation from as many as possible

While adapting, value cultural diversity and alternative ways of knowing by

- Considering Indigenous knowledge (past and current adaptive practices) and how it might enhance contemporary adaptations;
- Engaging in action research with your stakeholders to improve the effectiveness of adaptive capacity strategies and transferability of knowledge; and
- Maintaining or enhancing decision/policy makers' confidence and support for adaptation science by partnering with the research community/ies.

Know your 'adaptive' limits and institutional barriers

Decision/policy makers are part of the socio-ecological system and need to build their own capacity to adapt as well as improve the adaptive capacity of the system. As such, overcoming barriers to adaptive capacity has a strong relationship to personal limitations (perceived or actual), personal development and agency. Be aware of the following types of barriers to adaptive capacity

- Knowledge gaps - access to context specific information about the changing nature of vulnerability, exposure, sensitivity, adaptation options and potential climate change impacts;
- Knowledge paralysis – in a world of dynamic change, complexity and uncertainty, we cannot predict the outcomes of adaptations - but do not get bogged down in this apparent conundrum by resolving to do nothing;
- Institutional barriers - decision support systems and planning tools, codes of conduct and guides, culture, silos, perceptions of risk, awareness, inertia;
- Planning legislation;
- Funding arrangements for performance monitoring, communication of demonstration projects, and institutional change;
- Weak points in a system - the part that has the least adaptive capacity;
- Simplistic views of adaptive capacity and the assumption that one model of adaptive capacity can fit everywhere;
- The skill and cadre of adaptation decision makers/policy makers; and
- The public's confidence or trust of climate change science (poll driven policy making) or policy maker's actions/performance.

Collect as much meaningful information as you can and communicate it

Designing effective, efficient, equitable and legitimate adaptations (and minimising mal-adaptations) requires an understanding of the socio-ecological impacts of climate change relevant to the adaptors within the system. Good communication skills are important to build awareness of the climate change impacts and risks as well as the opportunities.