Towards more effective adaptive planning: Measuring and reporting social resilience in vulnerable coastal communities facing climate change in tropical Queensland

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ABSTRACT: Settlements and communities in tropical Queensland are highly vulnerable to climate change and face an uncertain social, economic and environmental future. same time, these socially and economically vulnerable communities contain some of Australia's most significant biodiversity values, including existing and proposed World Heritage sites (Wet Tropics and Cape York) wetlands of international significance (Gulf of Carpentaria) and places of significant marine and terrestrial diversity (e.g. Torres Strait). Past approaches to environmental management have predominantly focused on the biophysical dimensions of the problem however an equally important focus on building regional-scale community resilience is required if some of the worst impacts of climate change are to be avoided or mitigated. Government and community stakeholders need to know which actions, policies and arrangements build and support social resilience compared with those This paper outlines an emerging framework, indicators and method for that do not. information gathering and analysis to: (a) benchmark social resilience; (b) target the priority interventions required; and (c) measure progress arising from these interventions.

Keywords: Social resilience, climate change adaptation, regional communities, frameworks and indicators, monitoring and evaluation

Introduction

Complex, multi-scale, integrated environmental and social dilemmas, such as climate change, require innovative governance approaches for adaptive ecosystem-based management (Berkes et al. 2003; Dietz et al. 203; Hughes et al. 2005; Armitage et al. 2009). For evidence-based policy to occur, indicators and the information they provide need to be properly interpreted and used by stakeholders in policy review and adaptation (Hezri and Dovers 2009). To build capacity and make structural changes to adapt in the face of climate change, research needs to meet the information needs of stakeholders, build trust relationships, and actively engage with stakeholders in knowledge co-production (Moser 2010).

The key questions of concern to stakeholders and policy makers concern the best instruments to apply, and how and when to employ them to enable desired, rather than undesired social and environmental outcomes. Stakeholders however are struggling to strengthen evidence-based policy because of a lack of good quality data, particularly social data to underpin an adaptive approach. The Productivity Commission's 2009 roundtable has identified this as a particular problem for climate policy which, because the complexity and uncertainty associated with this environmental problem, demands an adaptive policy approach in which monitoring and evaluation of novel regulatory frameworks and institutions must play a central role (Productivity Commission 2010).

Resilience and related concepts are conceptualized in a number of different ways according to the different disciplines, problem contexts, scale, and objectives (eg resisting change, bouncing back, or transforming in response to environmental or social perturbations). A shared view of what constitutes resilience in general and community/social resilience in particular is likely to remain elusive. Conversations about resilience within regional, sub-regional and local communities in the context of climate change and associated disasters can inform conversations about adaptation. The dynamic relationships that exist between vulnerability, resilience, hazard impact, hazard change, adaptive capacity and social change in the context of climate change and disasters can inform approaches to developing community based approaches to adaptation.

In the context of climate change, and in particularly assisting the adaptation of the management of natural resources and biodiversity, there is the potential for increased uncertainty about longer term and short-term weather impacts. This creates a need to be encouraging adaptive capacity at whatever level of the social scale might be under consideration. This study defines a resilient community as one that easily mitigates and adapts to the most severe impacts of climate change and extreme climatic events while maintaining or improving economic and social wellbeing and the health of the natural resource base over time (Dale et al. 2011). In the context of climate change issues and challenges facing tropical north Queensland, regional, sub-regional, regional council, community, and even property scales are appropriate. This effort at multiple scales is critical because social systems are not isolated from the biophysical or 'natural' systems; they are an

integral part of them (Klein et al. 2003). There is a variety of approaches to, and tools for, the development of capacity to cope with change at any scale eg. individual/ psychological scale (Kirmayer et al 2009, Barton 2005, Paton 2008), organisational/ individual institutional scale (Stephenson et al 2010 a and b, Dalziell and McManus 2004), the community/ social scale, (Flint and Luloff, 2005, Klein et al 2003, Handmer and Dovers 1996 and 2007) and at the social-ecological system scale (Powell 1999, Gunderson 1995, Geis 2000, Zhou et al 2010). It is essential that approaches taken, however, are context specific and developed in conjunction with those people who are to be affected. The key is to jointly identify the questions that need to be asked and responded to.

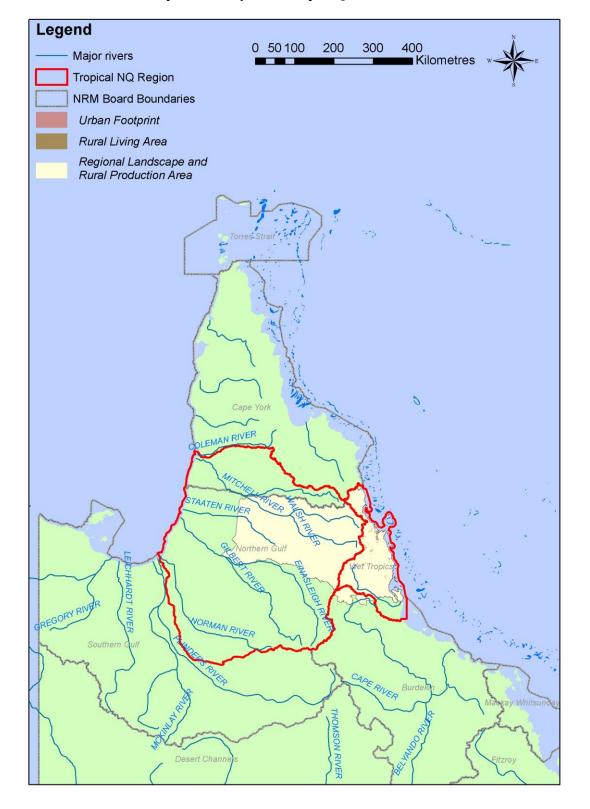
Regional and remote settlements and communities in tropical Queensland (see Map 1) are among Australia's most vulnerable in the face of climate change. The impacts of climate change in these locations include:

- more regular bleaching and mortality of corals in the Great Barrier Reef due to increased temperature;
- increased acidification of sea water and resultant decrease in coral growth and coral reef maintenance;
- Ecosystem changes and extinctions in the Wet Tropics Rainforests;
- Increased spread of disease (e.g. malaria, dengue) due to more favourable conditions and vectors;
- Flooding, erosion and damage to infrastructure associated with sea level rise/increased storm surge;
- Increased heat-related illness; and
- More intense storms and tropical cyclones (synthesised from CSIRO and BOM 2007).

The precise effects however of climate change on regional resources and resource condition, settlements, regional economies, and wellbeing are highly uncertain. At the same time, these regions contain some of Australia's most significant biodiversity, including existing and proposed World Heritage sites (Wet Tropics and Cape York) (Valentine 2006), wetlands of international significance (Gulf of Carpentaria) (Environment Australia 2001) and places of significant marine and terrestrial diversity (e.g. Torres Strait) (Great Barrier Reef Marine Park Authority 2009; Wet Tropics Management Authority 2009). Past approaches to terrestrial biodiversity management across Australia have predominantly focused on interventions using

biophysical knowledge. Some key features of regional and remote communities in tropical Queensland, however, suggest that policy and planning interventions should equally focus on building regional-scale community and social resilience in order to avoid or mitigate some of the worst biodiversity impacts of climate change (Wilson and Turton 2009; Gooch and Rigano 2010). It reflects global experience and trends towards integrated social ecological approaches to understanding and building resilience (Armitage 2005; Folke 2006).

This paper outlines an emerging framework and approach for information gathering and analysis to (a) benchmark social resilience, (b) target the priority interventions required, and (c) measure progress arising from these interventions. The next section describes the regional indicator framework and assessment method which was developed and applied to assess social resilience in the Cairns Region. We suggest that the broad approach has utility in other governance contexts to assess social resilience.



Map 1: Case Study location tropical Queensland

Methods

Our research sought to develop, in a collaborative manner, a pragmatic set of regional community resilience indicators that government agencies, NRM bodies and other community stakeholders could apply at sub-regional and community levels to support adaptation to climate change. Project members undertook the following seven steps:

- 1. Review recent social resilience research undertaken within the region. Content analysis of reports generated from a major four year project conducted at three nested scales was undertaken to identify key findings, problems and limitations with the approaches taken at each of the three scales (Krippendorf, 2004);
- Further identify and map the multidisciplinary knowledge on resilience. Reviewed bodies of literature were analysed according to the ways in which scholars use 'resilience', 'social resilience', 'community resilience' and adaptive capacity in different contexts and for different purposes;
- 3. Develop a regional indicator framework. This was constructed by synthesising information and insights gained through Steps 1 and 2;
- 4. End users review and refine the proposed pilot regional indicator framework. Several meetings were held with key end users including the Wet Tropics Management Agency (WTMA), the Great Barrier Reef Marine Park Authority (GBRMPA), Terrain NRM, Cape York Peninsula NRM, Northern Gulf NRM, Torres Strait Regional Authority, FNQ Regional Organisation of Councils, the Department of Infrastructure and Planning, Cairns Regional Council, ARUP; Association of Marine Park Tourism Operators (AMPTO); Tourism Tropical North Queensland (TTNQ); Cairns Marine; CAFNEC; and Regional Development Australia between October 2010 and March 2011 to stimulate discussions and refine specific components of the framework;
- 5. Trial the framework of indicators in state-of-the-region reporting in the Wet Tropics sub-region. The research team used the refined framework to compile relevant data. Small groups of community and research experts appraised the data in terms of social resilience and produced a Cairns Assessment Report. Decisions about the state of regional social resilience were made with the assistance of a 5-point vulnerability index developed in conjunction with the framework;
- 6. Build a collaborative alliance of management agencies within the region to consider the long-term strategy for adaptive management of community resilience; and

7. Map resilience in relation to biodiversity conservation.

Results and discussion

Step 1: Review previous social resilience research undertaken within the region.

Research conducted through the Commonwealth's Marine and Tropical Sciences Research Facility (MTSRF) Project 4.9.7 between 2006-2010 made progress to improve knowledge about social resilience, the relationships between social resilience and the environment, and frameworks and indicators to measure and monitor social resilience in tropical Queensland. This project was in actually a series of three sub-projects that investigated concepts of social resilience at three scales: community (Gooch et al. 2010), the region (Ross et al. 2010) and the meta-region (Lynam et al. 2010). Significant progress was made in theorizing and testing community and social resilience indicators at a regional scale however there were several important limitations of this work when considered in terms of meeting the needs for adaptive environmental management, namely that:

- It was not clear how the frameworks could be used for adaptive planning and management;
- 2. There was insufficient capture of contextual vulnerability in the frameworks to know where to prioritise efforts to build resilience within a social or community asset;
- 3. The frameworks required more resources than available to management agencies to perform assessments because of their scope and size and the number of proposed indicators:
- 4. The indicators lacked hierarchy and integration and some metrics and measures were particularly difficult to translate into an assessment of social resilience. Where assessments were made, data were poor and with limited application; and
- 5. Stakeholder engagement and the collaborative/co-research arrangements in this research were problematic despite an explicit desire to support natural resource planning/management by decision-making stakeholders and agencies (Table 1).

Table 1: A summary of the analysis of previous social resilience studies in tropical Queensland

Problem	Issues	Finding	Recommendation
Adaptive	Information from indicators	Indicators have	Embed the framework to
planning	needs to be interpreted in	value within an	define and monitor social

and management	the context of current arrangements for adaptive planning and management.	adaptive planning context.	resilience within an adaptive planning and policy approach to enable stakeholders to monitor the relationship between policy and outcomes (environmental and social).
Planning and policy to build resilience within the social asset	Social vulnerability must be included in the assessment framework to identify adaptation options and priorities.	Indicators of social resilience can underpin planning for the social asset.	Include contextual vulnerability factors related to economic viability and social vitality within the social resilience framework to support planning for the social asset.
Numbers of Indicators	Stakeholder and agency resources for monitoring and evaluation are limited, funding for research and development in general is <i>ad hoc</i> , and investment in social research in particular is not on parity with ecological research.	Modeling resilience for prediction and proactive planning requires integrated clusters of indicators.	Deliver a holistic social resilience framework, embedded within an adaptive planning and policy framework, and frugal synthesis into 3-6 integrated indicator sets.
Indicator hierarchy, metrics and measures	Indicators lack hierarchy and integration and some metrics and measures particularly difficult to translate into an assessment of social resilience. Where assessments were made, data is poor with limited application.	A 'lines of evidence' approach is more flexible than the pursuit of perfect indicators.	Expert and local stakeholder knowledge are brought together to support the overall assessment of social resilience.
Stakeholder engagement	The assessment framework must address the information needs of stakeholders, build trust relationships, and actively engage with stakeholders in knowledge co-production.	Adaptive planning and indicator development requires a collaborative and participatory approach.	Local stakeholders and researchers work together to refine the framework and approach.

(Ross et al. 2010; Lynam et al. 2010; Gooch et al. 2010)

An effective set of regional community resilience indicators that could be applied at sub-regional and community levels needs to overcome several problems. Resources for stakeholder and agency for monitoring and evaluation are limited, with funding for research and development in general *ad hoc*, and investment in social research in particular is not on parity with ecological research. Nevertheless, stakeholders require a basic framework and

indicators for immediate benchmarking to build information. There is increasing pressure for state of the environment reporting to present a more balanced view of environmental and social health and the intersections of the two. However without exception, stakeholders do not have the resources or sufficient capacity to collect information against lengthy lists of indicators or interpret them in a way that could provide useful information for decision making in the context of current arrangements. There is a need to develop a simple framework to underpin regular collection, analysis and use social information in the review and improvement of current arrangements.

Employing indicators as part of an overall assessment of community resilience also raises methodological questions about how to assess thresholds of resilience and non-resilience. At what point, for example, can communities and regions be considered socially resilient? The relative bearing of different indicators on actual community or social resilience and the interplay between different indicators and thresholds remains poorly defined. Research has struggled to find suitable ways to assess community resilience. The two dominant approaches are: (1) generalised measures that integrate data into composite indices; and (2) approaches that pursue multiple lines of evidence. Generalised measures use composite indices to reduce all variables to one number in order to provide data that is temporally and spatially comparable (Rygel et al. 2006). Four basic approaches to developing composite indices include: (1) constructing a single index by aggregating all relevant proxies; (2) a single index by defining area groupings; (3) separate indices representing different elements of vulnerability; and (4) vulnerability profiles for each area (Adger et al. 2004).

Advantages of composite indices include their standardised approach to assessment within and across regions and over time. Disadvantages lie in the dynamic nature of relationships between different aspects of resilience which can affect the overall status of a system. They can also reduce the importance of a single vulnerability factor by averaging variables or indices. In the latter case, a composite value could indicate that a region is not vulnerable when it may fact be extremely vulnerable because of a single critical factor (Rygel et al. 2006). They also require resources to identify relevant metrics and to collect data to conduct the assessment; a problem for resource constrained management agencies.

Information derived from the assessment also needs to be effectively integrated into the decision making process. Too often research generates information that stakeholders cannot interpret within the context of existing or proposed governance arrangements. Indicator based systems have been widely used to characterise and measure sustainable development both nationally and globally. Hezri and Dovers (2009:312), describe how the interest in indicator based systems "draws from the belief that research, statistics and indicators can lead to policies that will work better, on the assumption that 'scientific' information could guide social affairs" However, the lack of attention to consolidating multiple indicator systems restricts their use in policy and planning. Key issues include the fact that policy stakeholders have trouble translating sometimes copious amounts of information into something meaningful for decision making (Hezri and Dovers 2009). What is actually required is a hybrid of the two dominant approaches outlined above. Adaptive planning needs to draw on a multiple indicator approaches to generate information and use expert and stakeholder knowledge to synthesise this into a composite assessment of social resilience. Information needs to be generated using a line-of-evidence approach against a basic set (3-5) of fundamental attributes of community resilience (Dale et al. 2011). Each of these attributes needs to be defined by a limited number of Pressure, State, and Trend (PST) indicators.

Steps 2- 4: Developing, reviewing, refining and trailing a regional indicator framework in state-of-the-region reporting for the Wet Tropics sub-region

After reflecting on Step 1, we have developed a framework of attributes which we believe to be the basic elements necessary to track and measure social resilience. These include:

- 1. *Economic viability* -The economic health of a community, inclusive of for example, income levels and disparities, resource dependencies and economic vulnerability;
- 2. *Community vitality* -The social health of a community, inclusive of for example, physical health, community wellbeing and dissatisfaction, service access, incarceration rates, etc;
- 3. Aspirations and capacity The cohesion and diversity of people's aspirations for the future and the skills and capacities available to turn these aspirations into action; and
- 4. *Institutional governance systems* The effectiveness of decision-making systems including the connectivity between different parts of the system, the effective use of diverse knowledge in decision-making, and the capacity to deliver effective action.

These four attributes provide the basic substantive structure for resilience assessment and underpin an improved framework to design, implement and monitor community resilience. Other essential components of the community resilience framework, however, must include the integration of biophysical monitoring, climate risk assessment, and adaptive planning arrangements (Figure 1).

Monitoring Program Economic Community Viability Vitality Aspirations Resilience-Emerging Climate Change & Capacity Capacity focused Asset Plans and State of Risks and the Regional Potential Impacts Reporting Cycles Water Land Marine **Terrestrial**

Figure 1 Framework to design, implement and monitor community resilience (Dale et al. 2011)

Each of the four social attributes is further described by a limited set of PST indicators which are outlined in Table 2. We identified 3-6 critical indicators to assess the condition and trend of each attribute and tried to select the fewest number of indicators for each attribute that would still allow decision makers to monitor social resilience. These indicators were reviewed by the key end users, refined by the research team, and together the research team and end users complied relevant data against each indicator. The indicators and the data were reviewed by four small groups of community and research experts (one each for economic viability, aspirations and capacity, governance, and community vitality). Each expert group appraised the data collected, added additional expert knowledge to fill data gaps, recorded data gaps and limitations and assessed the resilience of current conditions for each attribute. Results were standardised using the 5-point index scale of community resilience, described below. The research team compiled these assessments to produce the Wet Tropics Pilot Assessment of Community Resilience.

Table 2: Pressure, State and Trend (PST) indicators and line of evidence for each community resilience attribute (source Dale et al. 2011)

Attribute	Possible Pressure, State and Tend	Possible Additional Lines of Evidence	Preferred Info Source or Proxy
	Indicators	Examples only, Assign jointly with	Examples only, Assign jointly with
		partners	partners
1. Economic Viability			
Diversity and quality of growth in economic activity.	Comparison of GRP and GVA by sector. Economic growth rates, with sectoral analysis.	Regional business size and turnover.	State and trend in Gross Regional Product (GRP) per industry - Australian Bureau of Statistics (ABS). State and trend in Real Gross Value Added (GVA) per industry (ABS).
Vulnerability of natural and energy resource base.	Comparative measure of natural resource dependency. Measure of energy security and diversity. Measure of food security and diversity.	Climate risk and vulnerability mapping. Expert (community and research) stakeholder appraisal of economic risks and vulnerabilities and growth/energy orientated dependencies in the economy.	Standardised expert group appraisal against social resilience index.
Inclusiveness and economic fairness/ equity.	Individual income (analysed by age, education level, industry and occupation). Household income analysed by (family composition, tenure type and low income households).	Disadvantaged communities' data.	ABS data sets.
Workforce participation and employment.	Regional employment participation rates and trends and employment by industry.	Office of the Employment Advocate statistics.	ABS data sets.
2. Community knowledge, aspirations and capacity			
Community awareness levels of climate change and natural resource sustainability.	State and trend in individual and sectoral understanding of NRM issues and current NRM behaviour (regular survey).	Reef and Rainforest Research Centre (RRRC) research concerning attitudes to climate change. Existing information for rural landholders + expert stakeholder appraisal of other sectors.	Standardised expert group appraisal against social resilience index.
Education levels and spread across the community.	Education distribution measures.		ABS data sets. Education Queensland datasets.
Skill levels and spread across the community.	Skills distribution measures.		ABS data sets. Education Queensland datasets.
Aspirations for sustainable	Detailed strategic perspectives analysis of	Expert appraisal (link information on	Facilitated expert group appraisal

natural resource management.	key natural resource managing sectors.	aspirations and governance).	standardised against social resilience index.
Leadership and complex problems solving.	Expert based indicator of regional leadership.	Expert appraisal (link information on aspirations and governance).	Facilitated expert group appraisal standardised against social resilience index.
Connectivity within and among key decision making institutions and sectors.	Expert based indicator of institutional connectivity.	Evidence of partnerships and collaborations between government and non-government organisations within the region and across policy scales assessed for each major sector.	Facilitated expert group appraisal of health of partnerships and collaborations for each sector within region and across policy scales and standardised using social
Adaptive management capacity of key decision making institutions and sectors	Expert based indicator of regional leadership and capacity.	Evidence of effectiveness of planning and arrangements for climate change (disaster management, land use change etc). Evidence of degree to which planning and IAs effectively resolve environmental, social and economic impacts, issues and needs.	resilience index. Facilitated expert group appraisal to gauge systemic decision making capacity and standardised using social resilience index.
Adaptive use and management of integrated knowledge sets.	Expert based indicator of regional leadership and capacity.	Key stakeholder opinions regarding adaptive management.	Facilitated expert group appraisal to gauge adaptive management and standardised using social resilience index.
4. Community Vitality			
Demographic stability	Basic demographic characteristics (e.g.: population, age structure, in- and out-migration rates, and population growth rates).	Other basic demographic information.	ABS data sets.
Wellbeing/ happiness within the general community.	Happiness, wellbeing or genuine progress indexes. Dissatisfaction ratings.	Community surveys regarding wellbeing.	Socio-Economic Index of Disadvantage.
General community health and disparities.	Specific general health indicators. Comparative indicators across key community sectors.	Specific regional or local research concerning identifiable health issues.	Department of Health indicators.
Community services, infrastructure, access, and disparities.	Generalisable and comparable service benchmarks. Comparative indicators across key community sectors.	Specific research concerning service and infrastructure issues.	Department of Community Service indicators.

Housing, accommodation and accessibility.	Levels of rental dependency. Levels of mortgage stress. Comparative indicators across key community sectors.	Specific research concerning accommodation and accessibility issues.	Department of Housing and Housing industry Indicators.
Community safety and risk.	Criminality/ reporting indicators. Spatially identified flood, cyclone, drought and other natural risk ratios.	Regionally identified safety and risk related research.	Council risk assessment studies.

Using this broad framework, the assessment method integrates a combination of existing monitoring information, specific studies, proxy information, stakeholder and expert knowledge to assess PST directions for key resilience attributes. Rygel et al. (2006) argue that "it is possible to determine the relative vulnerability of places without the difficult and problematic practice of weighting the various indicators" by using a Pareto ranking "that avoids the need to weight the vulnerability indicators" (Rygel et al. 2006:761). This project seeks to deliver such an integrated assessment outcome by using expert and stakeholder knowledge.

The advantage of this approach is in its flexibility in supporting adaptive planning and its ability to be developed within the extent of the resources available. It is particularly appealing in contexts where resources for social assessment are uncertain or limited. The approach allows assessments to be repeated and enhanced over time either as rapid regional assessments on negligible budgets or as comprehensive regional analyses based on detailed research, monitoring, and evaluation. The major disadvantage of this flexible approach occurs if the information base is inconsistent between consecutive assessments as it may be difficult to track or monitor issues.

Historically, the indicator literature and practical social assessment exercises in Australia and internationally have tended to apply a purist approach to defining indicators that best represent each attribute of community resilience (economic viability, aspirations and knowledge, governance, and community vitality). In other cases, extensive sets of indicators have been developed that represent only a small component of the clusters required (e.g. economic viability). In reality however, those supporting planning and impact assessment often face limited time frames and grave deficiencies in the type and value of data that can be secured to inform decisions. For this reason, an approach focused towards fully defining and populating perfect sets of indicators to for each attribute of community resilience does not meet the pragmatic needs of decision-makers. The production of copious amounts of information may also not significantly enhance the decisions being made. A far more flexible approach may be required, and could be achieved by:

- Evenly spreading potential information sets across the four attributes of social resilience. This will allow a more robust analysis. Focusing on only one or two clusters may present real limitations to decision making;
- Applying guidelines to illustrate the hierarchy of cluster, attributes, indicators and
 lines of evidence to ensure that a reasonable spread of information is identified. This
 will enable decision makers and researchers to identify the type of information that
 might be useful and to rapidly match the type of information that is actually available
 against the key indicators; and
- Applying lower order data sets and information (i.e. lines of evidence rather than perfect indicators) which may be more useful overall than striving for perfect indicator sets under impossible time, resource and data limitations. In constrained operational contexts, rough lines of evidence about the state and trend in key attributes is better in the shorter term than pursuing research into the perfect indicators for each attribute. In effect, this scanning-style approach means cutting your analysis cloth to the resources available, while noting the limitations.

In research relating to the use of indicators for building community resilience to date, there has been over-reach in the development of complex, detailed, perhaps "utopian" indicators at the expense of using easy to compile, multiple lines of evidence. We believe this has limited the uptake of community-based approaches to building community resilience. More community-based approaches might be the key needed to encourage people to start undertaking serious social analysis in the face of climate change or for starting to predict the likely response of communities. Once confidence can be built in such approaches, the communities concerned, governments and other key investors might be prepared to invest in more data rich approaches over time.

Index for assessing community resilience attributes

Long-term approaches to building community resilience require benchmarking and regular monitoring to help track the state and trend of key attributes and overall resilience over time. However, owing to resource and time limitations, consistent information and time-series data are not readily available to monitor state and trend clearly or in full detail at any one point in time. While the available data sets will

hopefully improve over time, decision-makers nevertheless require simple solutions to deliver targeted information immediately and within available resource and data limitations.

We therefore propose a method that brings together available indicators and other available lines of evidence into a generalisable, repeatable, index for each cluster of attributes, and again for measuring community resilience overall. We recommend a consistent approach to setting index values to enable reasonable comparisons between attribute clusters across time and between differing problem contexts where different attributes and indicators/ lines of evidence are used. We suggest that a way of conducting appraisals rapidly and consistently is to convene small expert groups, consisting of research and community expertise, to assess the resilience of each attribute as defined by the key indicators. After presenting such a group with available indicators or lines of evidence associated with the cluster, the experts could use a consistent rating system to come up with a relevant index value. Scholars and experts working together can achieve consistency over time by:

- Clearly recording a summary of the indicators and lines of evidence used to determine the index;
- Making data limitations explicit and recording these at the time of determining the index figure;
- Recording statements of clarification concerning the group's logic in setting the index value; and
- Attempting to keep the index measures consistent over time.

We have identified a simple set of decision rules associated with determining the index value (refer Table 3): Even in more data rich future scenarios, decision-makers will still require the targeted synthesis of multiple data and information, translated into findings relevant to understanding community resilience. Thus as information improves over time, we propose that the assessment approach outlined here provides a simple solution to build capacity and make structural changes to adapt in the face of climate change. It targets information to the needs of stakeholders, and engages researchers and stakeholders in trust relationships and knowledge co-production.

Table 3: Index scale of community resilience attributes (Dale et al. 2011).

Index Rating:	Decision Rule
5	The relevant community will easily mitigate and adapt to the most severe impacts of climate change and extreme climatic events, maintaining or improving their economic and social wellbeing and the health of their natural resource base over time.
4	The relevant community will make some progress on mitigation and accommodate the most severe impacts of climate change and extreme climatic events, maintaining their economic and social wellbeing and the health of their natural resource base over time.
3	The relevant community will suffer some shocks associated with the most severe impacts of climate change and extreme climatic events, taking considerable time and investment to adjust to secure their economic and social wellbeing and natural resource base.
2	The relevant community will be seriously impacted by the most significant impacts of climate change and extreme climatic events, resulting in declining social and economic wellbeing and natural resource health.
1	The relevant community will be irreversibly impacted by the most severe impacts of climate change and extreme climatic events, with both social and economic wellbeing and natural resource health unlikely to recover.

Conclusions

Stakeholders and institutions in tropical Queensland require much better information about the actions, policies, and arrangements that build and support community resilience and mobilise adaptive capacity in the face of climate change. As a research exercise alone, exploring community resilience holds little relevance to the real world. Equally, poorly informed by research expertise, planners and decision makers could find themselves not applying enough rigour to the selection and use of key attributes, indicators and other lines of evidence. In the development of appropriate index values, attributes and indicators, academic and experience-based knowledge have strong credence in facilitating adaptive approaches to climate change. The method outlined here ensures that the assessment of social resilience includes collective consideration by expert and local stakeholders to ensure information is used within planning and management processes.

Following targeted research with management stakeholders in tropical Queensland we have developed a fourfold framework of attributes that we believe to

be the basic elements necessary to track and measure social resilience trends within the context of climate change. Each attribute is further defined by a limited set of PST indicators and the method for building information integrates a combination of existing monitoring information, specific studies, proxy information, and stakeholder and expert local knowledge to assess PST directions for key resilience attributes. When linked to biophysical monitoring, climate risk assessment, and adaptive planning arrangements, the framework and approach has the capacity to support more comprehensive state of the environment reporting. This in turn can support stronger evaluation of the relationships between policy and outcomes (environmental and social) as well as underpin further research into the relationship between indicators and attributes, conditions and trends.

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