Rural and Remote Health
MEDLINE listed
Impact factor 0.878
The International Electronic Journal of Rural and Remote Health Research, Education, Practice and Policy
ISSN 1445-6354

ORIGINAL RESEARCH

Developing rural community health risk assessments for climate change: a Tasmanian pilot study

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Submitted: *20 June 2014;* ***Revised:*** *24 April 2015;* ***Accepted:*** *7 May 2015;* ***Published:*** *22 September 2015*

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Rural and Remote Health **15: 3174. (Online) 2015**

Available: http://www.rrh.org.au

ABSTRACT

Introduction: This article examines the development and pilot implementation of an approach to support local community decision-makers to plan health adaptation responses to climate change. The approach involves health and wellbeing risk assessment supported through the use of an electronic tool. While climate change is a major foreseeable public health threat, the extent to which health services are prepared for, or able to adequately respond to, climate change impact-related risks remains unclear. Building health decision-support mechanisms in order to involve and empower local stakeholders to help create the basis for agreement on these adaptive actions is an important first step. The primary research question was 'What can be learned from pilot implementation of a community health and well-being risk assessment (CHWRA) information technology-based tool designed to support understanding of, and decision-making on, local community challenges and opportunities associated with health risks posed by climate change?'

Methods: The article examines the complexity of climate change science to adaptation translational processes, with reference to existing research literature on community development. This is done in the context of addressing human health risks for rural and remote communities in Tasmania, Australia. This process is further examined through the pilot implementation of an electronic tool designed to support the translation of physically based climate change impact information into community-level assessments of health risks and adaptation priorities. The procedural and technical nature of the CHWRA tool is described, and the implications of the data gathered from stakeholder workshops held at three rural Tasmanian local government sites are considered and discussed.

Results: Bushfire, depression and waterborne diseases were identified by community stakeholders as being potentially 'catastrophic' health effects 'likely' to 'almost certain' to occur at one or more Tasmanian rural sites – based on an Intergovernmental Panel on Climate Change style of assessment. Consensus statements from stakeholders also suggested concern with health sector adaptation capacity and community resilience, and what community stakeholders defined as 'last straw' climate effects in already stressed communities. Preventative action and community engagement were also seen as important, especially

with regard to managing the ways that climate change can multiply socioeconomic and health outcome inequality. Above all, stakeholder responses emphasised the importance of an applied, complexity-oriented understanding of how climate and climate change impacts affect local communities and local services to compromise the overall quality of human health in these communities.

Conclusions: Complex community-level assessments about climate change and related health risks and responses can be captured electronically in ways that offer potentially actionable information about priorities for health sector adaptation, as a first step in planning. What is valuable about these community judgements is the creation of shared values and commitments. Future iteration of the IT tool could include decision-support modules to support best practice health sector adaptation scenarios, providing participants with opportunities to develop their know-how about health sector adaptation to climate change. If managed carefully, such tools could work within a balanced portfolio of measures to help reduce the rising health burden from climate change.

Key words: climate risk assessment, health sector adaptation, rural community health, Tasmania.

Introduction

Overview

Climate change is widely acknowledged as one of the largest foreseeable threats to community health and wellbeing in the 21st century[1]. The extent to which health services are prepared for, or able to adequately respond to, climate change impact-related risks remains unclear[2,3]. The fifth assessment report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) concluded that action to adapt health services is the key unknown in estimating the future health burden of climate change[4]. Additionally, the IPCC's special report on managing extreme events (SREX) concluded that adaptive actions will be necessarily 'framed by trade-offs between competing prioritized values and objectives'[2]. Building health decision-support mechanisms in order to involve and empower local stakeholders to help create the basis for agreement on these adaptive actions is an important first-step aid for informing health sector adaptation actions.

This article examines the development and pilot implementation of an approach to support local community decision-makers to plan health adaptation responses to climate change. The approach involves health and wellbeing risk assessment supported through the use of an electronic tool based on an IPCC style of assessment. First, the article examines the complexity of the climate change science to adaptation translational process – with reference to existing research literature on community development – in the context of addressing human health risks for rural and remote communities in Tasmania, Australia. Second, this process is further examined through the pilot implementation of an electronic tool designed to support the translation of physically based climate change impact information into community-level assessments of health risks and adaptation priorities. It is argued that, if managed carefully within a balanced portfolio of efforts[2], such integrative tools are likely to provide valuable support for decision-making that will assist reducing human health vulnerability to climate change in rural communities.

The urgency of building risk management capital

More than 80 000 journal papers on climate change have been published. More than 7300 of these describe the health effects of climate change, and of those more than 6800 were published after 2000. The leading health journal *The Lancet*, summarising the findings of the IPCC fourth assessment report (AR4)[5], described climate change as likely to be the biggest human health threat of the 21st century without appropriate health sector adaptation[1]. Estimates produced by the UN suggest an escalating human toll globally from climate change of >300 000 mortalities, >300 million seriously affected annually, half a billion at extreme risk, and several

billion people being vulnerable[6]. Developing countries and rural communities are most at risk as climate change works to multiply health inequalities arising from socioeconomic disadvantage[2,7,8]. Australia, the country where this pilot tool was developed, is one of the world's most at-risk developed countries[9-13] .

Climate vulnerability of rural communities is a function not simply of geographical location, socioeconomic disadvantage and more limited access to community infrastructure, but also of the lower levels of climate change risk management capital held by these communities and about them. 'Climate change risk management capital' for the health sector can be described as access to adaptive mechanisms for managing the health and wellbeing effects of climate change, from adaptation know-how and motivation to material assets for making those adaptations[14]. Climate adaptation is often defined as an 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities'[5] – in contrast to 'mitigation' or reduction of carbon emissions. Adaptation activities are wide-ranging and can include preventative or avoidance actions, as well as sharing or bearing risk and loss[15,16].

Yet communities are heterogeneous. As working group II of AR5 concluded, 'the precise causes of vulnerability, and therefore the most relevant adaptation capacities, vary greatly from one setting to another'[4] such that 'choices and outcomes for adaptive actions to climate events must reflect divergent capacities and resources and multiple interacting processes'[2]. While adaptation more generally at the local community level can confer health benefits[4] and health stakeholders are diverse, health adaptation requires specialised health sector knowledge and action. Health adaptation involves understandings of the culture and nature of the health professions, the biomedical dynamics of health, and the operational contexts of health services[2]. This heterogeneity of communities and specialist requirements of health adaptation presents particular obstacles to achieving community-level health adaptation, notwithstanding the extensive literature on adaptation documented in SREX[2]. As working group II of AR5 suggests, the focus of adaptation has been on public health surveillance, disaster planning and coordination measures, vulnerability mapping and early warning systems[4]. However, while the volume of quantitative studies relevant to adaptation is growing and the importance of epidemiological approaches has been asserted[17], relatively little practical *health* sector adaptation at the local, whole-of-community governance level is occurring[16,18-23].

It is important to observe that just because an event can be researched, is foreseeable and/or detected through early warning systems, it does not mean that communities have 'actionable knowledge'[24]. Scientific knowledge must be integrated into local contextual knowledge in meaningful ways for it to be actionable. As the policies of the global UN and WHO suggest, climate change adaptation must involve applied, decision-support approaches that build on, and learn from, local community knowledge, particularly for already disadvantaged groups[25,26].

Under-utilisation of health risk assessments

One response to these shared challenges globally has been to conduct climate change impact and risk management exercises at the local community level, including through local climate witnessing programs[27]. Climate change risk management exercises are often led by local government, building on their strong foundations in impact and risk assessments for local planning. A 2013 review of climate change adaptation tools by Australia's National Climate Change Adaptation Research Facility (NCCARF) estimated that about a third of local government associations in Australia have completed some kind of climate change risk assessment exercise, even if only of an awareness-raising kind[3]. However, most of these exercises are broadly focused paper-based questionnaires that do not target climate change-related risks to health specifically. While the NCCARF review identified more than 300 international products that could be variously described as supporting processes, data collection, or providing integrated knowledge portals, few online whole-of-community *health* risk assessment and adaptation tools were identified[3].

This is not to deny the richness of potential adaptation options in the literature summarised by SREX[2]. Nor is it to deny the accumulating efforts of leading agencies to develop early warning systems[28-37], as opposed to products for community health adaptation decision support.

In this context, this article argues that the lessons from climate change research and from the findings of government-funded state and national health impact and risk assessments[38,39] have not been well translated into local community health impact and risk assessments. Furthermore, the health sector has not been well supported to translate the findings of localised climate change impact and risk assessment exercises into provincial or national health planning.

Community health sector adaptation tools

Many countries are developing fine-grained local-level climate change projections for local community use. However, the need remains for more integrated mechanisms with greater utility for stepping local communities through what is required to turn climate change projections into local health sector adaptation priorities leveraging local knowledge[2].

Accordingly, the present study was informed by principles consistent with the experience of effective local-level disaster risk assessment summarised by IPCC[2] and SREX[2]. The study is also consistent with the literature on community climate change risk perceptions that has recommended climate change adaptation tools should involve (1) use of local municipality-level climate change projections to target local contexts; (2) re-framing and re-examination of risk perceptions[40-42] using a structured process of scrutiny of the evidence; (3) building a sense of self-efficacy[43] in using climate change projections, together with other information, to make decisions; and (4) consensus-making among community stakeholders about the risks and adaptive actions needed, in the light of practical barriers, to create the impetus for collective action.

The Tasmanian context

Tasmania is an Australian island state with a population of approximately 500 000 people. More than half of this population lives in the greater city area of the capital Hobart, located in the south of the island. While the overall population density is low, the average age of the population is amongst the oldest in Australia, which is also contributing to increased pressure on health services.

Tasmania has a cool temperate climate, with current projections predicting average annual temperatures across the island will increase by between 1.6°C and 2.9°C by 2100. With eastern and north-eastern coast waters warming rapidly, it is increasingly recognised as a global warming hotspot[13].

Significantly, it has been noted that in the area of climate change impact on health services a number of important gaps exist, including in relation to 'regionally-focussed vulnerability and risk assessment and monitoring; and techniques for improving the responsiveness and management of health impacts or events as they arise, as well as preparing communities for longer term adjustment to changing environmental and health conditions'[13].

Methods

In responding to these challenges, the authors developed and piloted an electronic tool to help support the translation of physically based climate change impact information into community-level assessments of health risks and adaptation priorities. The development of this tool was intended for use primarily by local government or similar community governance agencies. The primary research question driving its development was 'What can be learned from pilot implementation of a community health and well-being risk assessment (CHWRA) IT-based tool designed to support understanding of, and decision-making on, local community challenges and opportunities associated with health risks posed by climate change?'

Approach

Stakeholder participants in the project attended three face-to-face workshops hosted by local government agencies in Tasmania (southern rural inland, rural north coast, and remote north-western highlands). Local government authorities administered invitations to local community members identified with particular expertise, or the need to develop expertise, in climate change and health risk management. Municipal authorities were advised to keep the workshops to a manageable size of about eight people. There were eight participants on the north coast and six at each of the southern and north-western highlands workshops. Some IT support and equipment were provided to participants, building on available local resources. Each workshop was about 5 hours in duration and involved the following steps.

Create understanding: A climate scientist presented local area climate projections using a PowerPoint presentation via Skype conference. The facilitator then described the evidence on climate–health dynamics, using both the international epidemiology literature as well as pre-workshop research into local general practitioners' conceptualisations of observed local climate–health dynamics.

Profiling: Data were collected from workshop participants about the length of time they had resided in the region, their community role and their opportunities to observe health or health-related effects of climate in their local government area.

Climate health effects: Working individually, participants provided broad observations identifying health impacts already felt in their local area, in ways useful to conceptualising a wide range of possible local climate–health dynamics, both positive and negative.

Climate health risks and opportunities: Working individually, participants provided detailed, structured estimates of health risks and opportunities, which involved identifying the nature, extent and likelihood of these risks and opportunities.

Supplementary questions: Working as a group, participants added and answered any additional questions about climate health issues not covered previously but that they considered important to their region.

Identify priorities: Working individually, participants developed priorities for adaptation under five domains for health service development (service governance and culture, service delivery, workforce development, material infrastructure and finance) described in the pre-pilot publication on these health adaptation domains, particularly for more climate-vulnerable groups.

Consensual summary statements: The facilitator shared the data provided by individual respondents with the group (ie showed group responses on a screen using the inbuilt tool capabilities for data integration and display); the group considered these data to reach consensus on the key impacts, risks and opportunities, and adaptations needed, taking into account practical implementation issues such as costs, and key strategies needed for particular vulnerable groups.

Details of the CHWRA decision-support tool

The CHWRA information technology-based climate change adaptation decision-support tool was designed to help support resource-poor rural communities through all aspects of the interactive face-to-face workshop. Primarily this involved the collection and collation of responses from workshop participants that the tool could then be used to easily display graphically to facilitate further discussion around emerging priorities and perspectives. The tool was designed to provide secure web-based data access, data integration and data discovery services designed to optimise data availability, useability, security and interoperability. Development of the tool involved investigating ways of integrating open-source features and functions suitable for the workshop. Detailed weather and climate data are available for Tasmania and may be obtained from the Australian Bureau of Meteorology databases. To make the tool usable in locations where these detailed data are not available, the authors adapted free open-source mapping tools to support

interpolation of less granular data to support workshop activities. The tool offers a number of specific functions and features that include:

- a simple user interface supporting ease of data collection, collation, analysis and display of data generated by workshop participants
- localised geospatial mapping of key features and community services within any local community/region
- dynamic visualisation of climate time-series data (historic and projected) overlaid on maps of the local community region
- integration and visualisation of other locally available data – demographics, community service facilities and capacities – mapped at the local government region level.

It should be emphasised that the tool continually evolved through the life of the pilot and post-pilot period. Figure 1 is a screenshot of the initial form of the integrative tool used in the pilot, from a section used to obtain data for step 6: participant identification of priorities for adaptation under five domains for health service development.

Figure 2 is a screenshot showing one of the functions of the tool available post-pilot. It illustrates what could be described as the interactive 'tagging function' of the tool, which enables stakeholder perceptions and knowledge about services to be incorporated into existing maps (ie maps that were not developed by the researchers and do not presently include that local knowledge). The local knowledge could be some aspect of a health service or some other feature of the local area relevant to understanding a community's infrastructure and adaptive capacity. To the right of the figure can be seen a box including the local area climate change projections or profile. While technically this tagging feature is straightforward, the task of ensuring its ease of use and integration into the flow of the workshop in a manner that optimised data capture from stakeholders, with data discovery and visualisation relevant to health-climate risks, proved to be complex. Ultimately this function aims to capture such features of local services easily added by participants, to map and run time-series data based on climate model projections over the tagged maps, aiding visualisation of likely impacts and risks faced into the future. While data-poor communities present specific challenges, for regions where good-quality health services data are not available at a sufficiently fine detail or granularity, the tagging function can aid incorporation of local knowledge with climate change projections.

Local climate profiles

Workshop participants received a local climate profile for their municipality prepared by a climate scientist from the University of Tasmania's Antarctic Climate and Ecosystems Cooperative Research Centre, drawing on their technical reports series from the Climate Futures for Tasmania project[44]. This was a point of departure for the first step of the workshop where the climate scientist gave an oral presentation by Skype summarising the local climate change projections and the science behind these projections, and was available to answer questions. The local climate change profiles for each of the three municipalities included assessments and/or estimates of the past, current and future climate information. The future climate information was based on fine-scale (~10 km) dynamically downscaled regional climate model projections corresponding to two plausible scenarios of carbon emissions in the 21st century: high emissions continuing (the A2 scenario), as well as emissions plateauing and then falling (the B1 scenario)[45]. These two emissions scenarios were chosen from the suite of scenarios presented in the special report on emissions scenarios (SRES)[46]; future iterations of the tool could easily accommodate later emissions scenarios. For example, in the pilot tool workshop, under the higher emissions scenario (A2), the rise in average temperatures over the 21st century for the southern inland municipality was projected to be 2.6–3.3°C compared with the lower emissions scenario (B1) projected change of 1.3–1.6°C. Changes in the frequency, intensity and duration of extreme temperatures were included for the two different scenarios for each municipality in the study. Further changes in rainfall, runoff, river flows and flooding, as well as projections for extreme sea level

events, were described for different areas of the municipality. This information was nuanced for the local context; for example, specific local municipality river flooding projections were based on climate model outputs as well as flood hydraulic models. This allowed estimates of high flood levels for catchments with a critical duration of less than a specific number of hours in a specific area given by the climate profile for a specific region. Some example agricultural impacts and opportunities were also given based on standard agricultural indices, such as specific decreases in chill hours relevant to vineyards, and increases in suitable agricultural land currently undeveloped due to temperature-linked altitude limitations. These climate profiles also noted where conditions would stay the same, for example the proportion of time in severe drought.

Climate and health information

Workshop participants were also informed by a 30-minute presentation on national and international research on climate and health, consistent with the summary paper of the field[3], as well as available Tasmanian research from the published pre-pilot study. The Tasmanian-based research described a wide range of clinical and non-clinical effects of climate change on communities from a qualitative interview-based study of how general practitioners conceptualised observed health effects of climate change: mental health effects such as depression from drought and dispossession; insect-borne diseases such as Ross river virus in communities where this virus had not previously been observed; asthmatic conditions linked to shifts in the seasonality of pollens; water (quality and supply) issues linked to extreme weather; anxiety and stress linked to interactions between climate change, the global financial crisis and changes in global markets affecting farm viability and food costs. This juxtaposition between the international literature and pre-pilot work for the tool provided a point of departure for conceptualising (not establishing) possible climate health effects in the local community.

Ethics approval

Ethics approval for the study was obtained from the Human Research Ethics Committee at the University of Tasmania, REF #H0012002.

Results

Respondent profiles

In all three municipalities, respondents indicated they had spent a range of time in their region, from 1–5 years through to 35–45 years. Their responses indicated they had diverse occupational roles: local government environment officers, emergency services staff, medical and allied health professionals, and representatives of health consumer organisations. A rural general practitioner from each region was in attendance at each workshop. Most respondents across the three regions indicated they had spent 25% or less of their time 'observing the health or health-related effects of climate change': four out of the six attending in the south, all eight in the north, and three in the north-west. As intended, the stakeholders were not primarily health practitioners, but community leaders with a wide range of roles important to whole-of-community responses to the health effects of climate change.

Community participants' risk assessments and adaptation priorities

Table 1 describes the health risks identified by participants in the site working individually, as part of step 4 of the workshop asking them to identify 'what might happen in the near or distant future' for their local government region. The results in the table suggest that community members identified perceived catastrophic effects that are 'likely' to 'almost certain' to occur, as well as myriad other health effects with lesser expected impacts, likelihood and immediacy.

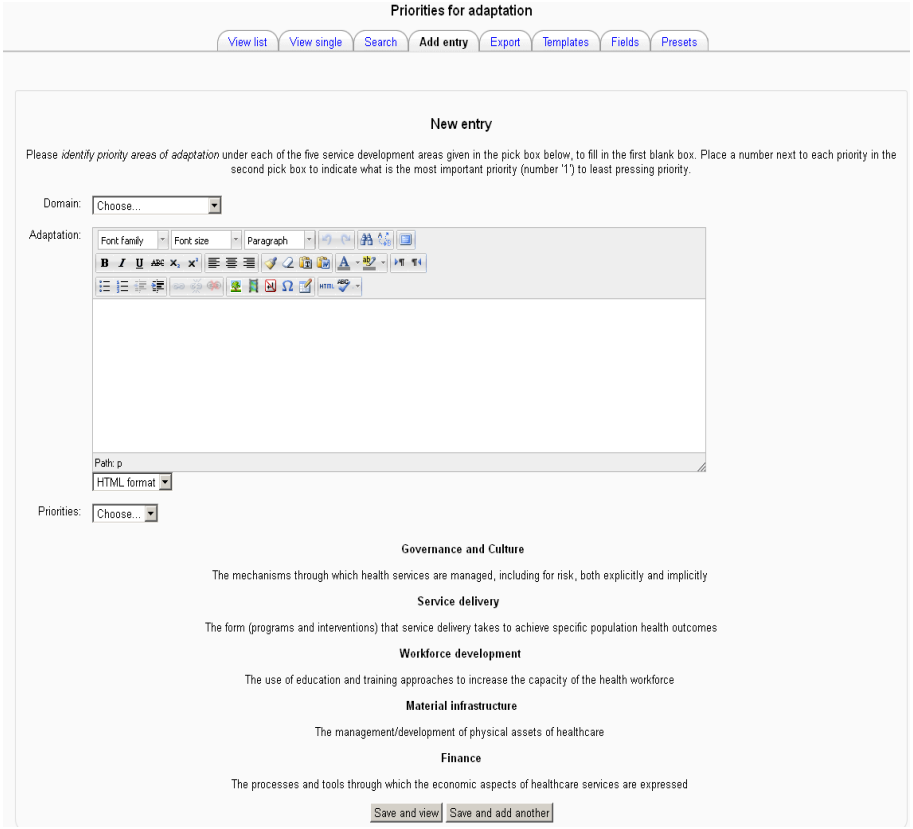

Figure 1: Screenshot of the community health and well-being risk assessment tool at pilot stage.

Table 2 provides an example community consensus statement from the integrative tool, suggesting the 'free form' of these statements of key impacts, risks, priorities for adaptation, cost considerations and other practical issues. As such, it offers a snapshot of the kind of observations captured from each of the three pilot sites. The themes that connected the three consensus statements collected were a concern with adaptation capacity and community resilience, and what they described as 'last straw' climate effects for stressed communities. There was an emphasis also on limited health infrastructure and its implications for adaptive capacity. Statements also focused on preventative action and community engagement, including for groups with lower health literacy.

A key theme was managing the socioeconomic multipliers of the effects of climate change. Food security was cited as important, with adaptive capacity shaped by a community's disadvantaged location in the food supply chain, even where that community is a food-producing community. Another theme was declining community volunteerism (leading, for example, to a lack of trained voluntary firefighters) and community participation generally. Statements also referred to declining localism of policy and planning, and its implications for managing nuanced and locally informed rural responses to climate change. They included a concern about the absence of evidence-based supports for decision-making about health adaptation. Above all, responses emphasised the importance of an applied, complexity-oriented understanding of how climate interacts with local services and communities to create health effects. In relation to the CHWRA tool, the northern group in particular stated the need for more modelling of the kinds of information the tool was designed to elicit from local climate witnesses.

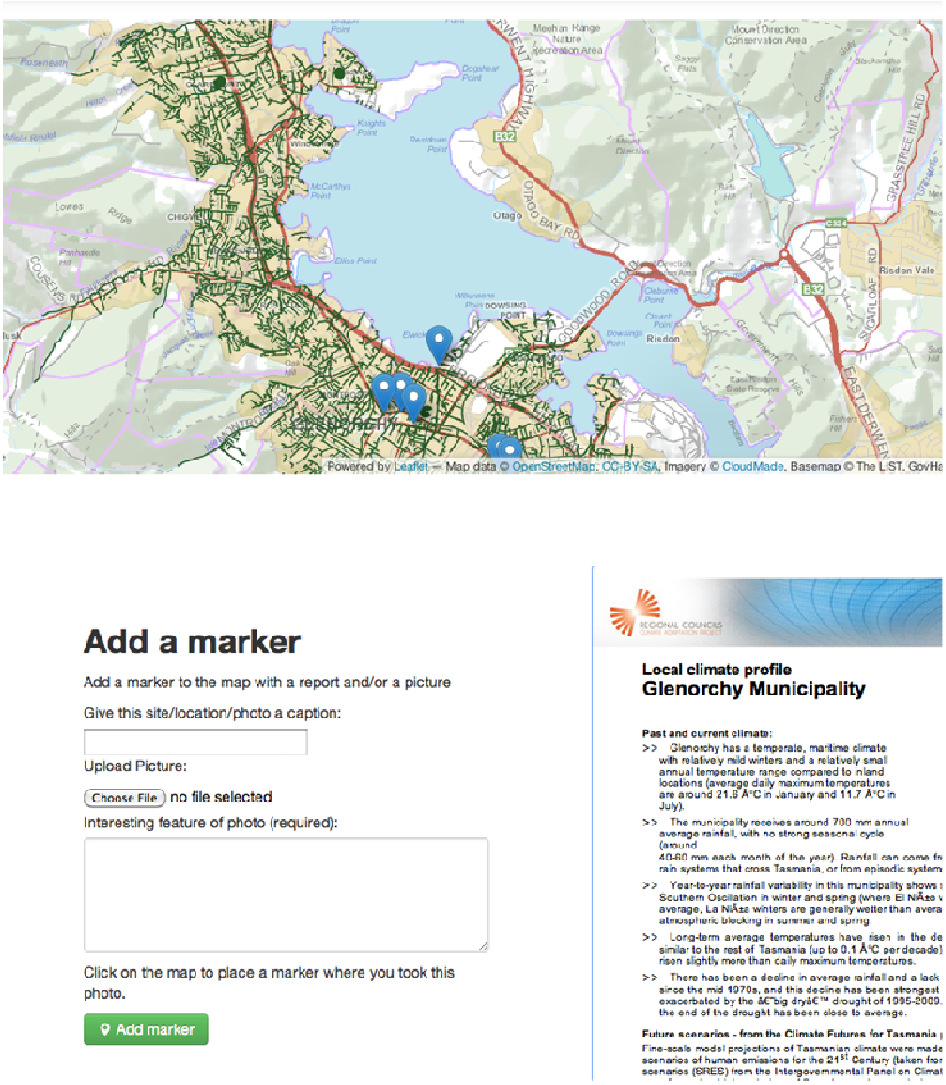

Figure 2: Screenshot of the tagging function of the community health and well-being risk assessment tool.

Discussion

This study presents a practical example of how complex community-level judgements about climate change, health risks and responses can be usefully captured electronically in ways that offer potentially actionable information about priorities for climate adaptation – a first step in planning. The authors found that community stakeholders were willing and able to provide information about their observations of health risks and offer suggestions for adaptive actions for their community. Such contextualised priority setting has the potential to shift debates away from contested beliefs about climate change towards much-needed action on the shared vulnerabilities facing a particular community.

Table 1: Community stakeholder-identified health risks during workshops at three rural Tasmanian local government sites

Name of health effect	Site(s)	Size of health effect (not significant, minor effects, moderate effects, major effects, catastrophic effects)	How likely the health effect is in your community (not likely, very unlikely, unlikely, quite possible, likely, almost certain)	When you think the health effect will take place (over the next year, within the next 1–5 years, within 6–20 years, more than 20 years from now)
Bushfire	S	catastrophic	almost certain	1–5 years
Depression	S, N	major to moderate; catastrophic	almost certain; possible	1–5 years to coming year; >20 years
Waterborne diseases	NW, S, N	catastrophic; moderate to minor; catastrophic to moderate	possible; likely; likely	6–20 years to 1–5 years; 1–5 years to coming year; 1–5 years to coming year
Sunburn	NW	major	almost certain	1–5 years
Heatstroke	NW	major	almost certain	1–5 years
Ross river virus	NW, N	major; major	likely; almost certain	6–20 years; 1–5 years
Reduced exercise due to inclement weather	S	major	almost certain	coming year
Chronic illnesses shaped by declining socioeconomic wellbeing	N	major	possible	6–20 years
Skin cancer	NW, N	major; minor	almost certain; likely	1–5 years to coming year; >20 years
Cataracts	S	moderate	likely	1–5 years
Food insecurity and related nutritional health issues	S, N	moderate	possible	1–5 years; >20 years
Air quality-related health issues (eg respiratory illnesses)	NW, N	moderate; moderate	possible; likely	1–5 years; 1–5 years
Viruses (other than Ross river virus)	S	moderate	possible	coming year
Allergies	S	minor	almost certain	coming year to 1–5 years
Psychosocial impacts of break-up of families due to distance commuting for jobs	S	minor	likely	1–5 years
Dengue fever	N	minor	possible	1–5 years

N, northern local government site. NW, north-west site. S, southern site.

However, the literature and the example in the present study also highlight the challenges associated with translating climate change projections into community-level assessments about health adaptation priorities. A translational tool will most likely not be used by local communities unless resources and commitment exist for that translation. The CHWRA tool needs to be facilitated by a local governance mechanism and supported by at least one climate scientist and climate and health researcher. Further, as the facilitator emphasised to the workshop participants, such judgements must be regarded as only one indicative source of information for health planning in a region, designed to supplement other information that a community has about itself. What is important about these community judgements is not their precision or reliability – as if it is this that should or does limit action – but the creation of shared values and commitments.

Table 2: Tasmanian north-west highlands consensus summary statement from the integrative tool

Key health impacts	• Severe weather effects, storms and floods, which will be differently experienced by different groups; severe financial hardship and mental health effects linked to these • Small effects might be 'the last straw' wind storms or high winds that also have impacts on the community; storm damage-related stress and mental health problems appear to be high but need to be monitored (and that is a complex task)
Key health risks	• Inability of local community to deal with the changing/increasing health risks; we have a very low socioeconomic base so anything that affects finances does affect stress • We can have quite sudden major effects arising from migration that bring significant stress on infrastructure, services, transport; we do get a lot of retirees • We can't in any simple and direct way attribute the risks of the future to climate; any such risks will be complex and arise from interacting factors; however, the change in the incidence and prevalence of some diseases may be attributed to climate
Key priorities for adaptation	• Some effects of climate will be good for Tasmania (eg people migrating to Tasmania) and for this region; but this migration can also be negative depending on how one views development • Greater diversity of farming enterprises is needed • Increased grants for capacity of medical centres are important • There is a need to decentralise energy generation and make it affordable • We need to build local knowledge about climate change effects for local planning and adaptation • Rural health should be decentralised not centralised, ie basic levels of care should be decentralised, primary healthcare must be delivered locally • We need some effort put into the monitoring of health, improving health information systems at the local level • A well-developed local health facility (in progress) puts us in a better position to deliver local responses
Cost considerations	• The council and community's capacity to plan for new events is shaped by financial capacity, which is reduced by the previous extreme weather events we have had here; reserves are depleted by the previous event at both the council and community level; there is a cumulative effect on resilience of a council and individuals in the community of flooding; thus repeated events 'draw down' on the response capability.
Other practical issues important to implementing these adaptation priorities	• Most supermarkets only have three days of supplies on hand and the diversity of food supply is critical too; because we are at the end of the supply chain for food we are more vulnerable; wherever the supply chain is broken we are vulnerable because we are at the end of that distribution line • We are also more vulnerable to food security issues because we are food producers but food produced here is still very expensive (what we produce here is not sold here); one must travel to Devonport to access the local produce as it is not available in the shops; thus people with low incomes here face much higher food prices than those in Victoria because the food supply chain does not distribute local food locally; accordingly we plan to have a kitchen in the new health centre but our local energy efficiency support group needs more financial and other support to implement options; let's change the law so that people can more easily sell food commercially

This pilot study encountered other key decision-support challenges that would benefit from further exploration. While community participants identified a wide range of broad adaptive priorities, they found it difficult to provide advice about more specific adaptation actions. Accordingly, while the integrative tool delivered a wide range of broad, potentially useful information for each region and was feasible given local community resources and time, its technical features (data visualisation, integration and analysis) are in ongoing development in light of these findings. The tool will eventually be fully web-based and adaptable to any geospatial location, regardless of the diversity in the granularity of data sources available for that location. A future inclusion will be the introduction of an expert-system module to support best-practice adaptation scenarios, providing participants with opportunities to develop their know-how about health adaptation. This adaptation modelling work is especially important as knowledge about adaptation strategies increases.

Currently, it involves examining known adaptation activities and strategies covering 'share loss or share risk; bear loss or bear risk; prevent effects or reduce effects; avoid risk or exploit changes in risk'[15], under each of the service adaptation domains in the tool (Fig1) in relation to specific known climate-vulnerable groups.

Conclusions

In the context of the wider community development literature, the present study supports theoretical frameworks emphasising the importance of accessing local creativity and innovation including through competence-building[44,45]. However, it also indicates the limitations of such frameworks. The consensus statements obtained reinforce that local government and community resources and capabilities are indeed finite. Consistent with the IPCC's conclusions[2], local adaptive processes need support from higher levels of government and often also from other local areas to be effective[47]. Future development of the tool should help achieve this integration through data sharing and presentation in different policy-relevant forums and formats. The data from the tool will need to be presented in a way that helps community participants explain the findings to other members of their community not at the workshop. There is a potential gulf between those who participate in such risk assessment exercises and the wider community: other residents may not necessarily agree with participant-held or even community-wide notions of, for example, bushfire risk[48]. Much more needs to be understood about whether and how identifying adaptation priorities in such risk assessment exercises leads to real action.

Notwithstanding the complexity of the challenges in providing communities with decision-support tools of this kind, interest in and demand for such support tools is high. The project has been widely disseminated across Australian local government industry forums as well as other national and international climate change research forums. Information about the project has been selected by the Southern Tasmanian Councils Authority for inclusion in their wider adaptation guidelines for local government authorities, an encouraging sign of horizontal or intermunicipal integration. The CEOs of environmental protection agencies or their equivalents in 11 African and central Asian countries have collaborated with the authors of this study to develop a funding application platform for trialling and adapting the tool in their countries, particularly in rural communities. Additional partnerships for trialling and adapting the tool for use in the South Pacific and mainland Australia are still under discussion. Such dissemination is proceeding with an awareness that, managed poorly, community health risk assessment could work as a liability, adding to the risks such communities already face from climate change. Yet, if managed carefully, such tools could work within a balanced portfolio of measures[2] to help reduce the rising health burden from climate change.

Acknowledgements

This article is dedicated to the memory of our dear colleague and friend Erica Bell – the primary author of this manuscript – who sadly passed away in late July 2014. Erica was the inspiration for this project and was an important figure in moving forward the area of public health issues and climate change in the state of Tasmania.

The content of this article was submitted as part of a consultant's report to the funder and has been presented at a wide range of national and international conferences. Prior to the project being conducted, the intentions of this study were described in a paper published in the 2011 conference proceedings of the Australian Centre for Excellence in Local Government Researchers Forum. This project has also had the support of key national and Tasmanian stakeholders: the Australian Centre for Excellence in Local Government, the Local Government Association of Tasmania and the Southern Tasmanian Councils Authority, as well as the three local government authorities who participated in the pilot. The authors thank the local community organisations that provided participants. Special thanks are also owed to the University of Tasmania's Antarctic Climate and Ecosystems

Cooperative Research Centre for providing the climate scientist for workshops and for allowing workshops to draw on their technical reports series from their Climate Futures for Tasmania project. The authors gratefully acknowledge OpenStreet Map as the provider of the open-source mapping tool used. Notwithstanding, all content in this article is the sole responsibility of the authors and this article does not purport to express the views of any of the individuals or organisations so acknowledged. This project was supported by the Tasmanian Government's Office of Climate Change, Department of Premier and Cabinet 'ClimateConnect' community grants program and a University of Tasmania Research Enhancement Grant.

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