CLIMATE CHANGE VULNERABILITY MAPPING AS A STAKEHOLDER ENGAGEMENT TOOL: CASE STUDY FROM SYDNEY, AUSTRALIA

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1. Summary

Local government is increasingly playing a leadership role in enhancing community preparedness and resilience with respect to climate change. However, given the complexity of the interactions between climate and society, a broad range of pathways exist by which community vulnerability can be increased or reduced. Engagement tools that can assist in communicating this complexity to stakeholders are therefore useful for expanding the portfolio of management options available to local government and insuring against adverse externalities in decision-making.

A vulnerability mapping exercise was undertaken in the metropolitan Sydney region to facilitate engagement with fifteen coastal local government areas regarding potential vulnerability to climate change and the barriers and opportunities associated with climate adaptation. Vulnerability was assessed across five impact areas: sea-level rise and coastal hazards, heat-related health effects, extreme rainfall and stormwater management, bushfire, and degradation of natural ecosystems and assets. Spatial estimates of relative vulnerability were determined through the integration of multiple vulnerability indicators within a geographic information system. Results reflected the high degree of spatial heterogeneity that exists with respect to climate vulnerability as well as the importance of demographic and socio-economic conditions.

2. Background

Australia has been described as one of the most vulnerable developed nations with respect to climate change (Garnaut Review, 2008), with this vulnerability arising from a number of factors (Allen Consulting, 2005; Hennessy et al., 2007). Australia experiences a high degree of climate variability including exposure to a range of climate extremes – extreme rainfall, winds, tropical cyclones and drought. The aridity of the continent creates challenges for securing reliable water resources for a diverse and growing economy (Marsden and Pickering, 2006). Meanwhile the continent's population is largely concentrated in dense communities in the coastal zone, exposing significant populations, and infrastructure to coastal hazards. Despite its relative affluence, there are sizable populations living in poverty with a high degree of social vulnerability to stress, particularly the nation's indigenous communities (Hennessy et al., 2007). In response to such vulnerability, the nation is rapidly attempting to develop strategies and institutional arrangements across a range of geopolitical scales to reduce risk. These strategies include mitigation efforts to address Australia's contribution to global greenhouse gas emissions (Garnaut, 2008), as well adaptation measures to reduce vulnerability to current climate variability and future climate change (Allen Consulting, 2005; AGO, 2007; COAG, 2007).

Local governments are likely to be one of the key governance scales for responding to climate change. This is particularly relevant in the context of climate adaptation, as the risks of unmitigated climate change to societal and ecological outcomes often will be borne at the local level (Handmer et al., 1999; Kelly and Adger, 2000; AGO, 2007). While a range of institutional arrangements and policy measures for mitigation exist within Australian local governments, the exploration of local adaptation has a more recent history. For example, risk assessments and strategic plans for adaptation only began to emerge from some local governments in 2007 (e.g., NATCLIM, 2007;

COM, 2008), followed in 2008 by a suite local government risk assessment pilot projects sponsored through the International Council for Local Environmental Initiatives (ICLEI) and Local Assessment Projects funded by the Australian Department of Climate Change across 50 local government areas (LGAs) in Australia.

Figure 1. Member councils of the Sydney Coastal Councils Group.

In order to maximise the effectiveness of stakeholder engagement on climate change, three critical issues need to be addressed (Justus et al., 2007). First, the engagement must assist in enhancing understanding within local governments about the benefits of initiating strategic responses to climate change. If climate change is not elevated sufficiently high on the policy agenda, councils are unlikely to allocate investments of capital resources in climate adaptation. Second, councils need to be provided with data and information about the implications of climate change that are deemed useful and relevant to local governments. Generic statements regarding projected changes in climate or potential climate impacts or data that are judged to be ambiguous or lack credibility are insufficient and/or ineffective for informing actors at the local scale about the need for or nature of a response. Third, adaptation initiatives need to gain support from a wide variety of institutional actors, meaning perceptions of climate change simply being an issue for environment officers or risk managers must be discarded in favour of 'whole-of-government' approaches (Allen Consulting, 2005). Accomplishing these tasks in the engagement process necessitates tools that capture the attention of stakeholders, stimulate critical thought, and encourage a holistic view of the local system in which climate change will manifest (Glicken et al., 2000). Spatial vulnerability assessment is one potential tool for stakeholder engagement that can satisfy these needs.

Here we report the use of a vulnerability assessment for the Sydney coastal metropolitan region to facilitate stakeholder engagement as part of a larger project to inform local government about climate change, vulnerability and the limits and barriers to adaptation at this critical level of governance (Hulme et al., 2007). We present the methods by which the vulnerability assessment was conducted and how that information was subsequently utilised in stakeholder engagement on climate change. We also discuss the lessons learned with respect to using spatial vulnerability assessment with stakeholders.

3. Project Overview

In 2006, the Australian Government's Department of Climate Change's (DCC), National Climate Change Impacts and Adaptation Program funded a series of five integrated assessment projects to explore different approaches to the regional assessment of climate change impacts and adaptation. In one such project, the Sydney Coastal Councils Group, Inc. (SCCG) partnered with the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Climate Adaptation Flagship and researchers from the University of the Sunshine Coast to examine limits and barriers to climate adaptation by local governments in the Sydney region (Figure 1). The SCCG is a regional organisation of fifteen local governments, established in 1987 to facilitate collaboration on coastal issues of interest to the member councils. The SCCG region represents approximately 1.3 million residents of the Sydney metropolitan area and includes diverse landscapes such as the central

business district of Sydney as well as more rural settings comprised of extensive national parks and conservation areas.

The project was conducted over a period of approximately two years with the goal of helping the region's local governments enhance their understanding of the potential biophysical and socioeconomic effects of climate change, with a particular focus on examining local capacities to adapt to potential climate change impacts and the limits, barriers and opportunities associated with the implementation of adaptation policies and measures. The project was designed around an approach to vulnerability assessment suggested by O'Brien et al., (2004), who argue that the implementation of actions to reduce vulnerability is first dependent upon building understanding regarding the biophysical and socio-economic drivers that contribute to that vulnerability. Hence, vulnerability is not simply the 'end point' of an analytical process, as is traditionally implied in biophysically-oriented assessments of natural hazards, but rather a characteristic of human populations, settlements and ecosystems. To assist in the analysis of vulnerability, adaptive capacity and the identification of interventions to address vulnerability factors, O'Brien et al (2004; pg. 2) suggest that *"vulnerability mapping can be used to identify 'hot spots' of vulnerability to climate change and other stressors, while case studies then provide an understanding of the underlying causes and structures that shape vulnerability".*

This general framework was operationalised within the SCCG project through a four stage methodology. As a starting point, a spatial vulnerability assessment was conducted to visualise the general pattern of regional vulnerability to different climate change impacts, identify 'hot spots', and explore a range of different components of vulnerability as well as specific indicators (Preston et al., 2008a,b). Second, the vulnerability assessment was utilised as a gateway to engaging with stakeholders in a series of fifteen workshops (one with each SCCG member council), where assessment results were used to elicit stakeholder discussion and feedback regarding vulnerability and adaptive capacity at the local scale. Third, these workshops led to a series of in-depth case studies where capacity issues common to the various councils were explored in more detail. Fourth, an ongoing process of project assessment and evaluation was conducted, with particular emphasis on the impact of the project with respect to stimulating adaptive responses in Sydney as well as the utility of the various methods and tools for use with other local government areas and municipalities in Australia. This paper focuses on the first two phases of the project and the lessons learned.

4. Methods for Vulnerability Assessment and Mapping

The first phase of the project was to undertake a vulnerability mapping exercise, the results of which could be used to engage with stakeholders in subsequent project phases (Preston et al., 2008a). The vulnerability mapping and its communication to stakeholders was designed to accomplish a variety of goals:

- Provide an introduction to the concept of vulnerability in the context of climate change;
- Identify some of the key climate change vulnerabilities of the SCCG region and some of the prior work that has been undertaken in their assessment;
- Identify some of the key determinants of vulnerability;
- Present spatial representations of relative vulnerability to some key impacts throughout the SCCG region;
- Provide some key conclusions and lessons gleaned from the assessment that may be useful in future research efforts;
- Provide stakeholders with an opportunity to review and comment on the assessment and suggest options for improvement and/or revision; and

- Stimulate thinking about climate change drivers, impacts and management responses.

In addition to providing information to the stakeholders, the project team was also interested in eliciting feedback from stakeholders regarding their perceptions of vulnerability and the utility of vulnerability assessment as a tool for building understanding about the implications of climate change.

4.1. Defining vulnerability

In defining the concept of vulnerability, the assessment and mapping exercise utilised the definition developed by the Intergovernmental Panel on Climate Change (IPCC) as part of its Third Assessment Report (IPCC, 2001): "Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes" (IPCC, 2001). As such, vulnerability reflects the degree of potential harm or susceptibility – not explicitly a prediction of future outcomes, such as is commonly generated through impact models and assessments. Rather, it is an analysis of risk factors that contribute to such susceptibility. While this may in fact be informed through the use of various modelling tools that indicate the relative susceptibility of different regions, communities or sectors to climate change, a broad array of other tools also may be employed. These may include stakeholder self-reported perceptions of vulnerability or the identification of relevant indicators that are commonly associated with susceptibility to harm or adverse outcomes.

Objective assessments commonly deconstruct climate change vulnerability into three constituent components: exposure, sensitivity and adaptive capacity (Allen Consulting, 2005; Smit and Wandel, 2006):

- **Exposure** refers to the exposure of a system of interest to stimuli that act on that system. This can be readily conceptualised as climate variability and/or the various changes in the climate system that are often of concern to stakeholders: temperature increases, rainfall variability and change (including extremes), or changes in the frequency or intensity of tropical cyclones.
- **Sensitivity** refers to the responsiveness of a system to climate hazards. This is often represented conceptually as a dose-response model – the more sensitive a system, the larger the rate or magnitude of an adverse response to a given hazard. Sensitivity may vary considerably from one system, sector or population to another.
- **Adaptive capacity** refers to the ability of a system to change in a way that makes it better equipped to manage its exposure and/or sensitivity to climatic influences.

The first two components, exposure and sensitivity, dictate the gross vulnerability of a system or process, and thereby provide an indication of potential susceptibility to adverse impacts. Meanwhile, the third, adaptive capacity, reflects the ability of the system to manage, and thereby reduce, gross vulnerability. For this project, adaptive capacity was conceptualised broadly, with emphasis placed on the fact that successful adaptation is a function not only of capacity in the form of the availability of resources to address vulnerability, but also the institutional barriers or constraints on the application of that capacity (Hulme et al., 2007).

Given the inherent complexities and uncertainties associated with complex environmental and social systems, direct quantitative modelling approaches are often inadequate for capturing the concept of vulnerability in a comprehensive manner. Therefore, attempts to assess vulnerability have often relied upon suites of relevant indicators that are assumed to be significantly correlated with different components of vulnerability (e.g., Adger et al., 2004). For example, a suite of indicators may be developed that represent the exposure of a system to a given natural hazard, while another set of indicators may be developed that represents the capacity of the system to cope or adapt to

such hazards. Although this approach prevents one from predicting outcomes (e.g., the number of lives lost or estimates of damages in dollars), it enables an assessment to draw from multiple sources of information to develop 'weight-of-evidence' estimates of vulnerability. Nevertheless, such estimates must still be cautiously interpreted and, where possible, they should be evaluated to ensure they are consistent with understanding of the system of interest.

4.2. Scope of assessment

The landscape of the SCCG region varies significantly, from highly urbanised and densely populated communities, to more regional areas that are less intensively utilised, as well as areas primarily valued for their role in nature conservation. As a result, the vulnerability of people, assets, and ecosystems within the SCCG region is spatially heterogeneous. Furthermore, the management of the potential risks of climate change may vary significantly, with responsibility for risk being borne in some instances by an individual, and in others by local, state/territory or national governments or other private institutions. To capture this diversity in potential climate change consequences and adaptation challenges, five areas of potential climate damages were selected for vulnerability assessment and mapping, all of which have relevance to the Sydney region (Preston et al., 2008a):

- Extreme heat and human health effects
- Sea-level rise and coastal hazards
- Extreme rainfall and stormwater management
- Bushfire
- Natural ecosystems and assets

The assessment and mapping of vulnerability to these different impacts was designed to emphasise the diversity of factors that can conspire to create vulnerability and the complexity of their interactions, consistent with the 'systems approach' advocated by the project as a whole. In fact, Smit and Wandel (2006) state that the goal of vulnerability assessment "*is not to produce a score or rating of a particular community's current or future vulnerability. Rather, the aim is to attain information on the nature of vulnerability and its components and determinates*". In recognition of this, the SCCG project utilised the output of this vulnerability assessment as a starting point for a more intensive, bottom-up assessment of vulnerability and adaptive capacity of local government through participatory workshops and interviews with stakeholders as well as evaluation of existing management plans.

4.3. Selecting and combining indicators

To identify relevant indicators of exposure, sensitivity and adaptive capacity to the five climate change impacts under consideration, a series of conceptual models was developed (Figure 3). These models were informed by published literature on climate change impacts and provided simple representations of the drivers of adverse consequences and the interactions among those drivers. A search of various data sources was then conducted to identify geographic data that were relevant indicators of the various drivers within the conceptual model. A large number of indicators were ultimately selected for each of the different climate impacts of interest. However, to ensure comparability in vulnerability estimates derived from indicators, indicators had to provide complete coverage over the entire SCCG region. This excluded a number of potential indicators including some data sets maintained by individual SCCG member councils.

Once data layers were converted to a common spatial reference, data were assigned a qualitative ranking from 1 to 5, with 1 representing low exposure, low sensitivity or high adaptive capacity and 5 representing high exposure, high sensitivity or low adaptive capacity. The spatial extent of indicators was restricted for the assessment of sea-level rise and coastal hazards, due to

the fact that exposure to coastal processes is a precondition for vulnerability. As such, an arbitrary elevation limit was selected and the extent of all indicators was restricted to this area. For each climate impact, vulnerability was assessed through the aggregation of three maps representing the different components of vulnerability (i.e., exposure, sensitivity and adaptive capacity). Due to differences in the number of indicators available for each component of vulnerability for each impact area, data had to first be integrated for each component to prevent any one component from biasing the results. Integration of indicators for each component of vulnerability was achieved simply by calculating the sum of all indicators. Individual indicators were given equal weight due to a lack of knowledge about their relative importance or the quantitative relationships among variables. Sums were then rescored to a scale from 1 to 9 based upon quintiles, with 1 representing low exposure, low sensitivity or high adaptive capacity and 9 representing high exposure, high sensitivity or low adaptive capacity. Integration of the three component layers was then accomplished by summing the scores from the three vulnerability layers, with the result again being rescored to a scale from 1 to 9. Different components were weighted in the calculation of vulnerability due to expert judgment regarding their relative importance (see Preston et al., 2008a). Where possible, vulnerability maps for individual impacts were compared to independent data sources as a validation test (Preston et al., 2008b).

The five vulnerability maps were subsequently integrated to generate a map of overall climate change relative vulnerability across the different impact areas. This sum was then rescored to a scale from 1 to 9 based upon quantiles, with 1 representing low vulnerability and 9 high. This view certainly does not consider all aspects of climate change vulnerability, as it is limited to the vulnerability layers and associated impacts upon which it is based. Furthermore, it must be treated cautiously as it assumes that the different vulnerability scores are comparable and can be meaningfully combined, which is arguable. Nevertheless, it provides a quick snapshot of where the SCCG region's hotspots for vulnerability lie.

5. Assessment Results

5.1. Extreme Heat and Human Health Effects

The net vulnerability of the SCCG region to extreme heat events was largely attributed to the interaction between exposure and adaptive capacity (i.e., vulnerable areas were often associated with both high exposure and low adaptive capacity) (Figure 2). As such, much of Hornsby Council and almost all of Rockdale Council were associated with high vulnerability, although the former's vulnerability was also attributed to an area of significant sensitivity. A number of additional councils had more spatially variable hotspots of vulnerability, including eastern Pittwater Council, the councils of central Sydney north and south of the harbour, as well as northern Sutherland Shire Council. Meanwhile, much of western Pittwater Council, northern Warringah Council as well as eastern and southern Sutherland Shire Council were associated with relatively low vulnerability.

5.2. Sea-Level Rise and Coastal Hazards

The net vulnerability of the SCCG region's coastal zone to climate change was concentrated around the east coast from Manly to Pittwater councils' coastlines and, particularly, Botany Bay and Rockdale councils (Figure 2). For these latter councils, their high vulnerability was function of multiple challenges including topography, high levels of development and low adaptive capacity. As a consequence, assets, infrastructure, and coastal amenities (e.g., beaches) in vulnerable areas must be carefully managed in the future to protect both development and amenity. To this end, local governments' adaptive capacities and their ability to partner with each other and state government to achieve management goals may be particularly important.

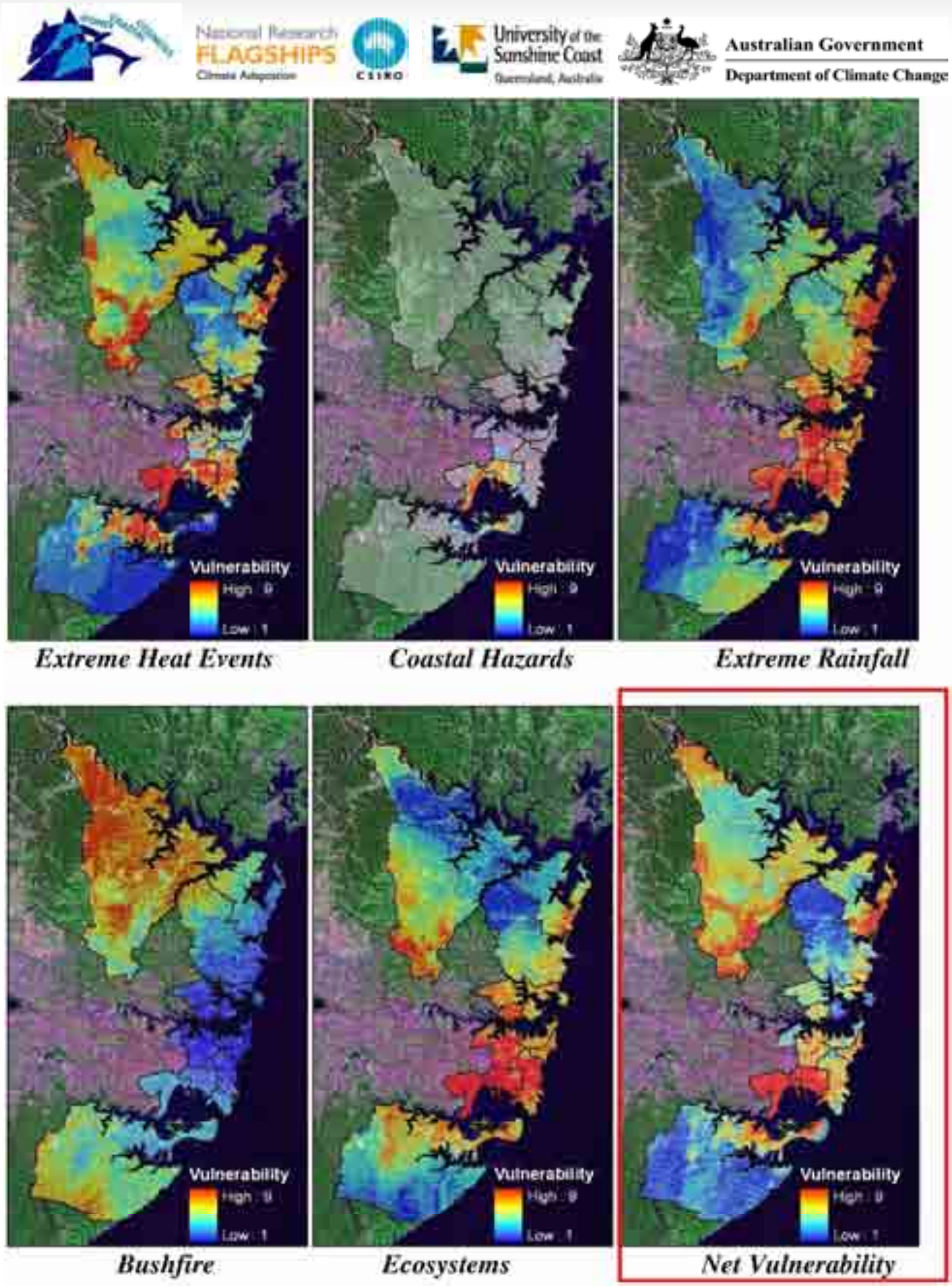

Figure 2. Results of vulnerability assessments for the five areas of potential impact and net regional vulnerability (red box) based upon weighted aggregation of the five areas of potential impact (see Preston et al., 2008a).

5.3. Extreme Rainfall and Stormwater Management

The vulnerability of the SCCG region to extreme rainfall and the resulting runoff was closely correlated with development patterns that contribute to impervious surface and high runoff rates (Figure 2). For example, councils associated with central Sydney generally had high levels of vulnerability. Nevertheless, a number of less urbanised areas were also judged to be vulnerable including areas of eastern Hornsby and northeast Sutherland Shire Council. These hotspots were largely the product of high levels of exposure and/or topographies and development patterns that enhance the sensitivity of the landscape. Low vulnerability was largely restricted to far northern Hornsby, northern Warringah, and western Pittwater Councils along with western Sutherland Shire Council, although some areas of vulnerability were identified along the northern edge of Hornsby Council along the Hawkesbury River.

5.4. Bushfire

Bushfire vulnerability for the SCCG region was closely correlated with available vegetation and fuel loads as well as areas where climate conditions are projected to become more favourable for fire weather conditions (Figure 2). Hence, much of Hornsby Council was identified as being of considerably high vulnerability, with some moderate to high vulnerability in neighbouring Warringah and Pittwater Councils as well. The only other areas of significant vulnerability occurred in the south of the SCCG region in Sutherland Shire Council. Here, as with Hornsby, significant bushlands create a fire hazard, which is exacerbated by low adaptive capacity. However, changes in the climate are projected to be less severe, as is the case in the north. Comparison of the vulnerability map with independent data sources regarding the distribution of bushfire risk in the region revealed a relatively high level of agreement (Figure 3), indicating that it is possible to validate relatively simple vulnerability assessments against real world data.

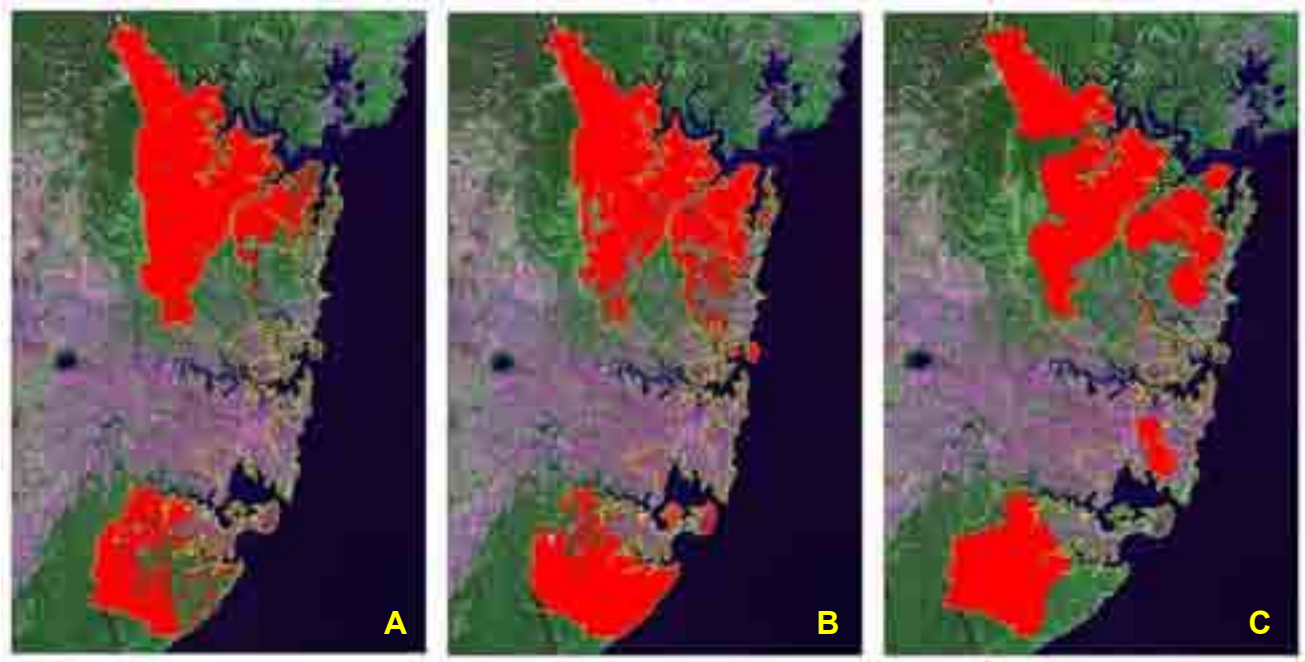

Figure 3. Comparison of assessment of bushfire vulnerability with other indicators of bushfire hazard (Preston et al., 2008b). Map A) areas with moderate to high vulnerability as assessed in the current study. Map B) Bushfire hazard areas identified by local government planning overlays, vegetation mapping or land use. Map C) Pattern of bushfires (2000-2007) as detected by satellite.

5.5. Ecosystems and Natural Assets

The vulnerability for the SCCG region's ecosystems and natural resources was closely correlated with the sensitivity component of vulnerability (Figure 2). The most vulnerable areas were southern Hornsby and southeast Pittwater councils, councils associated with central Sydney north and south of the harbour, and northern Sutherland Shire Council. Vulnerability within the region's peri-urban areas may be more critical as these represent transitional areas, where some natural amenity persists, but is under significant pressure. The high conservation value areas found throughout most of northern Hornsby and southeast Sutherland appear to be potential ecological refugia that may be most resilient to the effects of climate change. This suggests a potential strong need to continue to maintain the environmental health of these regions in the future.

5.6. Net Climate Change Vulnerability Map

The combination of the five areas of potential impact vulnerability maps into a net climate change relative vulnerability map resulted in a pattern that largely reflected the development patterns of metropolitan Sydney. The greatest regions of vulnerability are associated with population centres and dense development: southern Hornsby Shire Council, eastern Pittwater Shire Council, Sydney Harbour to Botany Bay (particularly Rockdale and Botany Bay City councils), and northern Sutherland Shire Council. The region-wide maps of vulnerability for the SCCG were averaged over the 15 SCCG member councils to generate internally consistent, but council-specific aggregate estimates of vulnerability for each of the five impact areas.

5.7. Stakeholder Responses to Vulnerability Mapping

During the second phase of the SCCG project, vulnerability maps were presented to stakeholders in 15 workshops conducted with each of the SCCG member councils. During the workshops, stakeholders were given a 45-minute presentation to council stakeholders, which provided an overview of the concepts of vulnerability, methods utilised in the current vulnerability assessment, and regional as well as council-specific results. These presentations focused on the diversity of drivers that may contribute to vulnerability rather than the resulting scores generated by the analysis. Stakeholders were encouraged to provide feedback during and after the presentation, and were presented with the opportunity to provide follow-up comments at any point after the workshops. Such feedback was used to identify perceived inconsistencies in the estimates of vulnerability. This led to the review of the various indicators utilised and in some instances revisions of the analysis (see Preston et al., 2008b). Through this process, a number of strengths and challenges of the assessment stood out as being particularly relevant to future assessment applications and their use in conjunction with stakeholders (Table 1).

6. Conclusions

In light of the results of the vulnerability mapping and mindful of the notes above regarding the interpretation of vulnerability, the following conclusions emerge as robust outcomes of the mapping exercise that may prove to be useful messages for the SCCG member councils:

- There is significant spatial variability throughout the SCCG region with respect to climate change vulnerability. Not only does vulnerability vary from council to council, it also varies from city block to city block and, realistically, from household to household.

- Despite accounting for the significant changes in the climate system projected for the region in the decades ahead, urban drivers that may exacerbate climate impacts such as population growth and associated infrastructure, as well as adaptive capacity within the SCCG region emerge as key factors affecting future vulnerability.

- A number of qualities of the vulnerability assessment and mapping lend themselves well to communicating with stakeholders. However, care must be exercised in the presentation of vulnerability and stakeholders must be guided in the interpretation of results. Furthermore, challenges will invariably arise due to real or perceived inconsistencies between assessed vulnerability and stakeholder beliefs. Transparency in addressing such challenges and providing stakeholders the opportunity to suggest potential revisions is essential to securing stakeholder buy-in of the assessment process.

Arguably, the true value of vulnerability mapping is the insight that is gained through the process of conducting the assessment and gathering feedback from affected parties. Hence, vulnerability assessment alone, without a 'learning-by-doing' ethos and/or a concerted effort to work with stakeholders in the communication and decomposition of vulnerability, is likely of limited utility in developing a rigorous understanding of adaptive capacity or the pursuance of adaptive decision-making.

Table 1. Lessons learned from Sydney regarding the strengths and challenges associated with vulnerability mapping as a stakeholder engagement tool (Smith et al., 2008).

Strengths
• The concept of mapping vulnerability created significant interest among stakeholders, with some citing this as a principle motivation for attending workshops.
• Mapping enabled stakeholders to readily compare analysis results with their own subjective perceptions of vulnerability given local knowledge of the landscape and how it responds to natural hazards.
• Some stakeholders noted that the vulnerability-based approach offered the opportunity to think about vulnerability and risk in a novel manner. In particular, there was interest in the assessment of adaptive capacity and its incorporation as an integral part of vulnerability, as this was a novel framework for thinking about vulnerability and risk for stakeholders.
• Stakeholders appreciated the complexity of the vulnerability assessment in its incorporation of a diverse array of indicators and drivers. Though challenging to comprehend and perhaps overwhelming without more detailed guidance, it proved effective in communicating the diversity of factors that could potentially influence vulnerability.
• There was obvious interest in thinking more about how vulnerability assessments could be expanded. For example, it was proposed that the vulnerability maps could be used to expand existing geographic data sets and mapping tools within Councils, further examine assets and resources falling within different vulnerability categories, communicate with Council stakeholders, and undertaken additional analyses focused exclusively on individual Councils.
Challenges
• The spatially explicit nature of vulnerability maps invariably led to stakeholder focus on areas identified as high or low vulnerability and associated semi-quantitative scores. This created the potential for stakeholders to deviate into thinking about the assessment as a final product or output, as opposed to an introduction into thinking about complex systems.
• Stakeholders sometimes struggled with the concept of relative vulnerability, assuming that significant differences in relative vulnerability necessarily translate into significant differences in absolute risk. This often contributed to disparities in stakeholder and investigator perceptions of risk (above).
• As evidenced by the survey of stakeholder perceptions of vulnerabilities (Box 1), there often appeared to be differences in perceptions of vulnerability between stakeholders and the vulnerability assessment. This appeared to stem from differences in how vulnerability was framed.
• Stakeholders were able to identify a number of variables or potential indicators that were not reflected in the analysis (e.g., non-resident populations or small-scale policy or management decisions) due to lack of readily available data or ignorance among investigators regarding its importance.
• A number of stakeholders raised the issue of weights associated with individual indicators or components of vulnerability (exposure, sensitivity, and adaptive capacity). Although stakeholders did not object to the weights that were utilised, they were quick to recognise the potential importance of differential weighting of individual indicators.
• The attempt to conduct a top-down objective assessment of vulnerability invariably overlooked institutional cultures and local contextual knowledge that can have a profound influence on perceptions of vulnerability and adaptive capacity as well as the effectiveness with which management decisions can be implemented. Therefore, objective measures of adaptive capacity may have little relationship with subjective perceptions.
• Some stakeholders retreated to a position of expecting 'experts' to provide 'solutions'. With such an expectation, vulnerability assessment was judged inadequate as its emphasis on expansionist views of complexity and diversity of drivers was inconsistent with the desired outcome of reductionist identification of explicit impacts and management solutions delivered by external experts. This suggests the need for assessments that can feed directly into decision-making.

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