

Managing for Climate Variability in the Sydney Region

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ABSTRACT

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Coastal research and management often has an issue-specific focus, with little attention paid to the interdependencies between those issues. Climate variability is one such issue that is impacted by, and impacts on, several other areas (e.g. coastal processes, infrastructure, health and regional economies). These interdependencies create challenges for local governments to scale-up so as to tackle these issues at a regional scale. Critical to this process of scaling-up is the adaptive capacity of local governments. A method to assist local governments deal with climate variability in the Sydney region is being developed by CSIRO and the Sydney Coastal Councils Group through the Australian Greenhouse Office National Climate Change Adaptation Program. The method consists of: (i) creating vulnerability mapping templates; (ii) working with local governments to determine collective and local vulnerabilities; (iii) analysis of local government priorities and capacity for adaptation; and (iv) assessment of transferability of the method to other regions.

ADDITIONAL INDEX WORDS: *Climate vulnerability, Resilience, Adaptation, Systems approaches*

INTRODUCTION

As part of the Australian Greenhouse Office (AGO) National Climate Change Adaptation Program (NCCAP), CSIRO have partnered with the Sydney Coastal Councils Group (SCCG) to undertake research on regional approaches to managing climate vulnerability in the Sydney region. The project was scoped over the last 18 months following interest in systems approaches to the management of climate variability in the Sydney region by local governments, which was documented in a paper presented at the 2005 NSW Coastal Conference (SMITH *et al.*, 2005). The project has recently commenced and will be completed over the next 2 years. This paper discusses: (i) the principles underpinning a new approach to climate vulnerability assessments; (ii) the implications for decision makers; and (iii) the application of a new approach to managing climate vulnerability.

UNDERPINNING PRINCIPLES OF A NEW APPROACH TO CLIMATE VULNERABILITY ASSESSMENTS

Climate impact assessments and associated interpretations of vulnerability have been restricted by modelling and data limitations and more importantly by the limited commitment and ability of stakeholders to respond to those assessments. Hence, a new approach to determine climate vulnerability using participatory approaches is needed. Key concepts that need to be addressed include: (i) integration; (ii) regional approaches; (iii)

adaptive capacity; (iv) the changing role of science; and (v) partnering between researchers and decision makers.

Integration

“Integration” has become a guiding principle across a number of natural resource management spheres, including Integrated Coastal Zone Management. Integrated resource management is an evolving concept. Elements of its underlying philosophy are that there are no simple or short-term solutions; that no single perspective is adequate to deal with complex resource use issues; that problems are beyond the scope of purely technical solutions; and that managing change in natural resource use is a long-term process involving the continuing integration of community action and statutory, policy and institutional adjustments (BELLAMY *et al.* 1999).

The move towards integration has also been apparent in climate change assessments. This has significantly increased the potential analytical power of studies but has consequences in terms of size, cost and complexity. Large climate change research programmes in the US have found that integrative research on complex sustainability issues is best carried out in a place-based context because the local scale facilitates assessment as a social process and promotes exchanges of information and understanding between investigators and stakeholders (WILBANKS 2002).

Two defining features of Integrated Assessments are that they reach beyond the bounds of a single discipline and address more than one sector or aspect of the problem and that their purpose is to inform policy and decision-making (TANSEY *et al.* 2002).

Integration can refer to disciplines, sectors, scales or methodological approaches. One of the frontiers of integrated assessment is transcending the boundary between quantitative analysis on the one hand and qualitative aspects of the assessment on the other – by including expert judgment, narrative stories, scenarios and stakeholder knowledge (WILBANKS 2002).

Regions

In Australia, regions have emerged as a key scale at which to address natural resource and ecosystem management problems. Regions have imprecise geographic boundaries defined by factors such as clusters of local government areas, watersheds and historically identified regions. It is a scale at which new issues often emerge and at which a range of institutions can begin to coordinate to address complex issues that cut across existing institutional responsibilities. Regional scale governance is often focussed on networking, coordination and strategic planning; however, formal regional scale organisations and other institutions are also emerging. As such regions are a key focus for societies' adaptive capacity and are important in dealing with cross scale effects and linking local issues with state and federal governments.

Adaptive Capacity

The Millennium Ecosystem Assessment defined adaptive capacity as “The general ability of institutions, systems and individuals to adjust to potential damage, to take advantage of opportunities or to cope with the consequences.” Adaptive capacity is important in dealing with complex human ecological systems where limited foresight is possible and their behaviour is characterised by abrupt changes of unknown nature. Given the uncertainty involved, assessing and improving adaptive capacity is obviously an inexact exercise. For a region, adaptive capacity will have many elements including the ability to identify and articulate the issues, values and groups affected by novel events, the capacity to effectively research and understand new issues and the ability to adapt the organisation of society to effectively address them. All of these elements can involve long lag times and therefore limit adaptive capacity. A broad systemic assessment of capacity is therefore required. Improved frameworks for characterising the behaviour of complex adaptive systems and developing improved management strategies such as “resilience thinking” (WALKER and SALT 2006) are also important in improving our capacity to manage these systems.

The importance of adaptation to climate change has been recognised by both Australian Commonwealth and State governments. In addition to the \$14.2 million allocated by the Commonwealth via the NCCAP, \$2.5 million has been allocated in New South Wales (NSW) towards an impacts and adaptation research programme, with a further \$2 million planned for capacity building for climate change (NSW Greenhouse Office 2005).

The coastal zone has historically been the focus of many climate change studies because early climate change projections highlighted the possibility of sea level rise and its associated physical and economic impacts. One of the earliest methodologies for assessing the implications of climate change was the Intergovernmental Panel on Climate Change (IPCC) Common Methodology for the assessment of the vulnerability of coastal areas to sea level rise (IPCC 1991). Reviews of the many studies that followed this framework uncovered several important weaknesses. These included the need to reflect local differences, to consider the wider socio-economic, traditional, aesthetic and cultural aspects of a study area and to integrate the results of the

analysis into local environmental planning processes (YAMADA *et al.* 1995; KAY *et al.* 1996; KLEIN and NICHOLLS 1999).

Whereas in the past many climate change studies took a simplistic approach to adaptation, generating a list of possible adaptation measures with little or no consideration of the process by which communities could implement them, current adaptation research falls within the domain of ‘sustainability science’ (KATES *et al.* 2001). This new direction, or second generation of adaptation studies (BURTON *et al.* 2002), considers the localised social and economic conditions that contribute to vulnerability, together with the extent to which a society copes with its current climate. Adaptive capacity refers to the ability of a system to adjust to climate change and variability to moderate potential damages, to take advantage of opportunities or to cope with the consequences (MCCARTHY *et al.* 2001). It is, however, a complex concept, involving many elements such as social capital, institutional memory, innovation and resilience.

In practical terms, adaptive capacity is a function of a number of factors, including:

- Recognition of the need for adaptation;
- Belief that adaptation is possible and desirable;
- Willingness to undertake adaptation;
- Availability of resources necessary for implementation of adaptation strategies;
- Ability to deploy resources in an appropriate manner; and
- External constraints on, or obstacles to, the implementation of adaptation strategies. (ADGER *et al.* 2004)

The current project will investigate adaptive capacity in the Sydney Coastal Councils region by looking closely at a number of these factors.

Changing Role of Science

Adaptation to climate change is an area in which scientists are required to focus on problem-solving in regional and local contexts. Historically, the need for close interaction between scientists and the public has not been central to climate change science but has been a common theme in other areas such as forestry and integrated catchment management. Experience within these fields, particularly with forestry debates in the US, shows that working within the science-policy interface is a highly politicised exercise, where issues are often about different ends rather than means (CLARK *et al.* 1998; MILLS AND CLARK 2001). A closer interaction between scientists and the public can be both positive and negative. Participatory processes can lead to greater demands for certainty, making scientists more risk-adverse and challenging the freedom to engage in the self-examination that is the essence of scientific enquiry (BRADSHAW and BORCHERS 2000). In contrast, public perceptions of the value and credibility of science may be higher if it is regionally specific and provided by local experts in the context of sustained interaction, good communication and trust (BALES *et al.* 2004). The term ‘post-normal science’ (FUNTOWICZ and RAVETZ, 1991; RAVETZ, 1999) has been used to describe scientific approaches that acknowledge uncertainty; recognise the value-laden nature of research; and approaches research in a participatory manner to achieve shared objectives.

Local government partnering with research organisations

Despite the complexity involved, taking a regional approach to adaptation to climate change is useful for a number of reasons, including: (i) some regions are more affected by climate change than others due to the negative synergies between climate change

and other stressors; (ii) many practical adaptation strategies will be applied at a regional rather than sectoral scale; and (iii) two or more vulnerable sectors may be important to a particular region, with the risks and vulnerabilities of the region depending on the cumulative effect of climate change on a number of sectors (ALLEN CONSULTING GROUP 2005).

Although many past climate change impact studies have focussed on particular sectors (e.g. HOWDEN *et al.* 1999; HENNESSY *et al.* 2003; HOWDEN *et al.* 2003; HENNESSY *et al.* 2005), CSIRO has recently undertaken a number of projects that aim to facilitate adaptation at a regional scale and build capacity among local government stakeholders. In conjunction with the Victorian Department of Sustainability and Environment, CSIRO is undertaking a series of pilot studies in three Victorian regions: Gippsland, Western Port and North Central Victoria. These studies are aiming to more fully integrate adaptation to climate change into the operations of local government, by treating climate adaptation as a component of regional sustainability. They are seen as pilot studies because there is no established methodological approach to understanding and building adaptive capacity at a regional scale.

In the Western Port study, stakeholders assessed their own respective vulnerabilities and priorities for adaptation. Whereas in the past, such assessments were the result of a top-down analysis that showed where the biophysical impacts of climate change were greatest, this study recognised that vulnerability was a function of the sensitivity to various aspects of climate and also of the localised capacity to adapt to it. Although scientific information on climate change impacts was presented to the workshop participants, they assessed the climate sensitivity of their areas of interest based on their local knowledge. They also considered how capable they were of adapting to future climate change in these areas. Based on the output of a number of workshops and sub-groups, eight high-priority cross-sectoral issues were identified. Two of these issues are due to be investigated further in a larger integrated assessment of the Western Port region, funded by the Australian Greenhouse Office.

IMPLICATIONS FOR DECISION MAKERS

Understanding issues such as climate vulnerability through a systems approach can highlight both the direct and indirect drivers of change, as well as the direct and indirect consequences of those changes. This understanding can uncover key management interventions that may have far reaching positive impacts and at the same time, highlight unintended negative consequences of current or alternative management actions. However, while a systems approach to understanding where to make management interventions is critical, an understanding of the adaptive capacity of local government to effectively implement and monitor those interventions is also needed. This project seeks to actively work with local councils to gain a better understanding of the systematic issues associated with climate vulnerability, as well as understanding barriers and opportunities to improving the adaptive capacity of those local councils.

APPLYING A NEW APPROACH TO MANAGING VULNERABILITY TO CLIMATE CHANGE

Over the course of almost two years, the Sydney integrated assessment project will help the region's coastal councils assess the potential biophysical effects of climate change, with subsequent emphasis on examining local capacities to adapt to potential climate change impacts. These activities will be carried

out in a series of stages, namely: (i) vulnerability mapping; (ii) stakeholder engagement; (iii) assessment of adaptive capacity; and (iv) project assessment. Each of these activities is discussed further below.

Vulnerability Mapping

In order to provide an initial basis for awareness raising and discussion, a vulnerability mapping exercise will be conducted for the Sydney region. This vulnerability analysis will utilise existing and emerging modelling outputs from CSIRO and other relevant projects (e.g. UPRCT project) and present them as simple spatial overlays that can be integrated with local contextual knowledge regarding infrastructure, networks and systems that are likely to be exposed and adversely affected by climate change.

Sound planning and management of the coastal zone in a future that is affected by a changing climate requires knowledge on how relevant geophysical parameters are likely to vary. For the coastal zone, such parameters include sea levels, severe weather conditions, rainfall, wind and wave climate and their subsequent impacts on erosion and flooding. HENNESSY *et al.* (2004a,b) undertook a comprehensive general assessment of how the climate of NSW may change in the future based on the analysis of a range of climate model simulations. The overall findings were for a future that would be warmer, drier and for which extreme weather conditions may increase. As part of the present study, a set of projections that are particularly relevant to the coastal zone will be developed in support of the broader project.

An investigation of the key weather systems responsible for extreme winds, rainfall and storm surges on the NSW coast in high resolution climate model simulations under present and future greenhouse gas forcing will be undertaken using a synoptic map-typing procedure to characterise the weather systems and examine how they may change in the future. Previous studies of wind changes over the southern NSW coastal region indicated that winds would increase in summer and winter whereas the central and north coast tended towards decrease in summer and winter under enhanced greenhouse conditions. In the present study, there will be a greater focus on wind directional changes to determine if there are systematic changes to the wind climate as a result of climate change.

These data on the potential implications of climate change on the physical climate system of the Sydney coastal region will subsequently be integrated within a geographic information system with data that convey the spatial diversity in vulnerability to climate change. Such data include the region's topography, land use and the locations of critical infrastructure and high-value assets (e.g., property, ecosystems and heritage sites) as well as socioeconomic indicators. The integrated vulnerability maps will subsequently serve as a risk communication tool for engaging stakeholders about climate change impacts and adaptation.

Stakeholder Engagement

As the goal of this integrated assessment project is to assess and facilitate adaptive capacity within local governments, a series of workshops will be conducted to bring climate change experts together with local governments to explore local vulnerabilities to climate change and to analyse the capacity to adapt to climate change and the factors determining or influencing that capacity. In order to focus stakeholder interactions on local concerns and vulnerabilities, separate workshops will be conducted in each of the 15 councils within the Sydney Coastal Council Group.

Analysis of Adaptive Capacity

Following the stakeholder workshops, three local councils will be chosen as case studies of local council adaptation to key issues that emerged from the regional and local workshops (e.g. water, infrastructure/asset protection, public health). The three case studies will include councils that meet criteria showing that they are either: (i) doing well in terms of implementing adaptation strategies; (ii) doing average in terms of implementing adaptation strategies; or (iii) doing poorly in terms of implementing adaptation strategies. The analysis of adaptive capacity will highlight potential barriers to adaptation and allow recommendations to be made to councils on how to improve their adaptation processes.

Project Assessment

Though focussed on the Sydney coastal region, it is hoped that the lessons learned regarding climate change adaptation in local government will be readily transferable to other areas within Australia. Therefore, a central component of the project is to evaluate the overall process of communicating climate risk and interacting with stakeholders to develop some generalisable principles. In particular, the project seeks to better understand the communication and decision-making networks within local governments through which adaptation decisions must travel and the endogenous and exogenous barriers to effective adaptation.

CONCLUSION

Climate change impact assessments and associated assessments of vulnerability require a participatory approach to incorporate stakeholder knowledge and to gain stakeholder commitment to enacting adaptation strategies. The project being undertaken by CSIRO in partnership with the SCCG and through the Australian Greenhouse Office NCCAP, is focussed on trialing a novel method for participatory assessments of regional climate vulnerability. Furthermore, the project will assess the adaptive capacity of local councils to scale-up to deal with regional issues. The project also explores key themes of systems approaches to managing climate vulnerability such as integration and partnering for science impact. The project will be rolled out through a series of workshops with local councils to determine climate vulnerability and barriers and opportunities to adaptive capacity. The project will have substantial benefits to understanding the direct and indirect consequences of management actions and the barriers and opportunities to successfully implementing those actions for local governments in the Sydney region and beyond.

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