

Managing for Climate Variability in the Sydney Region – Issues, needs and new solutions for Local Government.

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Abstract

Coastal research and management often has an issue-specific focus, with little attention paid to the interdependencies between them. Climate variability is one such issue that is impacted by, and impacts on, several other areas (eg. coastal processes, infrastructure, health, and regional economies). These interdependencies create challenges for local councils 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 councils. In order to support local councils in the Sydney region to deal with the impacts of climate variability and change, the Sydney Coastal Councils Group and CSIRO have begun a project through the Australian Greenhouse Office National Climate Change Adaptation Program (“Systems Approach to Regional Climate Change Adaptation Strategies in Metropolises”), which will run over the next 2 years. The goal of this project is to work with local councils to determine key vulnerabilities and their capacity to adapt in order to manage these risks at a regional scale. The project approach will be tested to allow transfer to other regions throughout Australia.

Introduction

As part of the Australian Greenhouse Office (AGO) National Climate Change Adaptation Program, the Sydney Coastal Councils Group (SCCG) have partnered with two CSIRO Divisions (Sustainable Ecosystems, and Marine and Atmospheric Research) 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 AGO Adaptation Program; (ii) planned research activities; (iii) key concepts and issues to be addressed; (iv) potential benefits to local government; and (v) the next steps for the project.

Australian Greenhouse Office National Climate Change Adaptation Program

At the national level, Australia’s efforts to assess the implications of climate change and facilitate the implementation of adaptation strategies are largely initiated through the National Climate Change Adaptation Programme (NCCAP). This four year (2004-2008), \$14.2 million program is an initiative of the Australian Greenhouse Office within the Department of Environment and Heritage. The three expressed goals of the programme are,

- help Australians understand the likely impacts of climate change
- develop practical tools to support decision making on climate change adaptation
- assist in planning ahead to reduce the risks and capture opportunities.

To date, a range of projects and activities have been executed under the NCCAP including national scoping assessments of climate change vulnerability, which have been followed in some instances by more focused, sector-specific assessment projects. A number of guidance documents have also been generated to build understanding with regards to the costing of climate change impacts and the application of risk management approaches to ameliorate adverse consequences. The Sydney regional integrated assessment project is one of a portfolio of regional climate change assessment projects recently funded through the NCCAP. Other study areas include the Clarence City Council, TAS; Gold Coast, QLD; Western Port, VIC; and the ACT. Each of these studies is being developed and carried out independently, with each seeking to address a different suite of issues based upon the interests and concerns of local stakeholders.

Planned Activities

Over the course of almost two years, the Sydney integrated assessment project will seek to inform the region's coastal councils regarding the potential biophysical changes that climate change may cause in the region, 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: i) vulnerability mapping, ii) stakeholder consultation; iii) assessment of adaptive capacity; 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 mapping 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 regarding 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, analyse their 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 have identified 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 focused 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.

Key Concepts and Issues to be Addressed

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 non-quantitative aspects of the assessment on the other- by including expert judgement, 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, water catchments 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 focused on networking, coordination and strategic planning; however formal regional scale organisation and 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 government.

Adaptive Capacity

The Millennium 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 event, 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 recognized by both Australian Commonwealth and State governments. In addition to the \$14.2 allocated by the Commonwealth via the NCCAP, \$2.5 million has been allocated in 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 *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, creativity, and resilience.

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

- 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 aspects.

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. 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 politicized 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-averse 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 approach research in a participatory manner to achieve shared objectives.

Local government partnering with research organisations (eg. CSIRO)

Despite the complexity involved, taking a regional approach to adaptation to climate change is useful for a number of reasons. Some regions are more affected by climate change than others due to the negative synergies between climate change and other stressors; many practical adaptation strategies will be applied at a regional rather than sectoral scale; and 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, by treating 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, 8 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.

What's in it for Local Government?

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 both systematic issues associated with climate vulnerability; as well as, understanding barriers and opportunities to improving the adaptive capacity of those local councils.

Call for Input

Apart from the workshops being planned with Sydney councils, the project team are interested in documented case studies of local council initiatives to deal with climate vulnerability. If your council has relevant information please contact Geoff Withycombe at the Sydney Coastal Councils Group.

Conclusions

SCCG and CSIRO have begun a 2-year project through the AGO Adaptation Program. The project is focused on climate vulnerability in Sydney, and the adaptive capacity of local councils to scale-up to deal with regional issues. The project also explores key themes of systems approaches to climate vulnerability; 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 throughout Australia.

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References

- Abbs, D. J., S. Aryal, E. Campbell, M. Palmer, A.S. Rafter, and B. Bates, 2006: Impact of climate variability and climate change on rainfall extremes in Western Sydney and surrounding areas. Phase 1 report to the Upper Parramatta River Catchment Trust. 66 pp.
http://www.cmar.csiro.au:8000/e-print/open/abbsdj_2006a.pdf
- Adger, W. N., Brooks, N., Bentham, G., Agnew, M., and Eriksen, S. (2004). "New indicators of vulnerability and adaptive capacity." Technical report 7, Tyndall Centre for Climate Change Research, University of East Anglia, Norwich.
- Allen Consulting Group. (2005). "Climate Change: Risk and Vulnerability: Promoting an Efficient Adaptation Response in Australia." Report to the Australian Greenhouse Office, Department of Environment and Heritage, Canberra.
- AGO (Australian Greenhouse Office) (2005). National climate change adaptation program. Department of the Environment and Heritage, Canberra, Commonwealth of Australia, 6 pp.
<http://www.greenhouse.gov.au/impacts/publications/pubs/nccap.pdf>
- Bales, R. C., Liverman, D. M., and Morehouse, B. J. (2004). "Integrated assessment as a step toward reducing climate vulnerability in the Southwestern United States." *Bulletin of the American Meteorological Society*, 85(11), 1727-1734.
- Bellamy, J. A., McDonald, G. T., Syme, G. J., and Butterworth, J. E. (1999). "Evaluating Integrated Resource Management." *Society & Natural Resources*, 12(4), 337-353.
- Bradshaw, G. A., and Borchers, J. G. (2000). "Uncertainty as information: Narrowing the science-policy gap." *Conservation Ecology*, 4(1), 7.
- Burton, I., Huq, S., Lim, B., Pilifosova, O., and Schipper, E. L. (2002). "From impacts assessment to adaptation priorities: the shaping of adaptation policy." *Climate Policy*, 2(2-3), 145-159.
- Clark, R. N., Meidinger, E. E., Miller, G., Rayner, J., Layseca, M., Monreal, S., Fernandez, J., and Shannon, M. (1998). "Integrating science and policy in natural resource management: Lessons and opportunities from North America." Report no PNW-GTR-441, US Forestry Service, Pacific Northwest research station.
- Funtowicz, S. O. and Ravetz, J. R. (1991). "A new scientific methodology for global environmental issues", In Costanza, R. (ed.), *Ecological Economics: The Science and Management of Sustainability*, pp. 137-152. Columbia University Press, New York.
- Hennessy, K., Lucas, C., Nicholls, N., Bathols, J., Suppiah, R., and Ricketts, J. (2005). "Climate change impacts on fire-weather in south-east Australia." Climate Impacts Group, CSIRO Atmospheric Research and the Australian Government Bureau of Meteorology, Aspendale.
- Hennessy, K. J., Page, C. M., McInnes, K. L., Jones, R. N., Bathols, J. M., Collins, D., and Jones, D. (2004). Climate change in New South Wales. Part 1, Past climate variability and projected changes in average climate. Consultancy report for the New South Wales Greenhouse Office. Aspendale: CSIRO Atmospheric Research. 46 p. http://www.cmar.csiro.au/e-print/open/hennessy_2004b.pdf
- Hennessy, K., Whetton, P., Smith, I., Barthols, J., Hutchinson, M., and Sharples, J. (2003). "The impact of climate change on snow conditions in mainland Australia." CSIRO Atmospheric Research, Aspendale.
- Howden, M., Hughes, L., Dunlop, M., Zethoven, I., Hilbert, D. W., and Chilcott, C. (2003). "Climate change impacts on biodiversity in Australia. Outcomes of a

- workshop sponsored by the Biological Diversity Advisory Committee, 1-2 October, 2002." CSIRO Sustainable Ecosystems, Canberra.
- Howden, S. M., Reyenga, P. J., and Meinke, H. (1999). "Global Change Impacts on Australian Wheat Cropping." Report to the Australian Greenhouse Office. Working Paper series 99/04, CSIRO Resource Futures program, Canberra.
- IPCC. (1991). "The seven steps to the assessment of the vulnerability of coastal areas to sea level rise: A common methodology." Intergovernmental Panel on Climate Change Response Strategies Working Group, The Hague.
- Kates, R. W., Clark, W. C., Corell, R. J., Hgall, M., Jaeger, C. C., Lowe, I., McCarthy, J. J., Schellnhuber, H. J., Bolin, B., Dickson, N. M., Faucheux, S., Gallopin, G. C., Grubler, A., Huntley, B., Jager, J., Jodha, N. S., Kasperson, R. E., Mabogunje, A., Matson, P., Mooney, H. A., Moore, B., O'Riordan, T., and Svedin, U. (2001). "Sustainability science." *Science*, 292(5517), 641-642.
- Kay, R. C., Eliot, I., Katon, B., Morvell, G., and Waterman, P. (1996). "A review of the Intergovernmental Panel on Climate Change's common methodology for assessing the vulnerability of coastal areas to sea-level rise." *Coastal Management*, 24(2), 165-188.
- Klein, R. J. T., and Nicholls, R. J. (1999). "Assessment of coastal vulnerability to climate change." *Ambio*, 28(2), 182-187.
- McCarthy, J., Canziani, O. F., Leary, N. A., Dokken, D. J., and White, K. S. (2001). "Climate change 2001: Impacts, adaptation, and vulnerability." Third assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.
- Millennium Ecosystem Assessment (no date). "Strengthening Capacity to Manage Ecosystems Sustainably for Human Well-Being". www.millenniumassessment.org/en/index.aspx, last accessed 12th October 2006.
- Mills, T. J., and Clark, R. J. (2001). "Roles of research scientists in natural resource decision making." *Forest Ecology and Management*, 153(1-3), 189-198.
- NSW Greenhouse Office (2005) NSW Greenhouse Plan. The Cabinet Office of the Government of NSW, Sydney.
- Page, C. M., and R. N. Jones. (2001). "OzClim: the development of a climate scenario generator for Australia." Ghassemi, F., P. Whetton, R. Little, and M. Littleboy, eds., Integrating models for natural resources management across disciplines, issues and scales (Part 2). MODSIM 2001, International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, Canberra, Aust., 667-672.
- Ravetz, J. R. (1999). "What is post-normal science?", *Futures*, 31, pp. 647-653.
- Smith, T. F., Preston, B., McInnes, K. and Withycombe, G. (2005). "A Systems Approach to Coastal Research and Management." Proceedings of the 14th NSW Coastal Conference: Living on the Edge, 8-11 November, 2005, Narooma, NSW.
- Tansey, J., Carmichael, J., VanWynsberghe, R., and Robinson, J. (2002). "The future is not what it used to be: participatory integrated assessment in the Georgia Basin." *Global Environmental Change*, 12(2), 97-104.
- Walker, B. and Salt, D. (2006). *Resilience Thinking: Sustaining Ecosystems and People in a Changing World*. Island Press.
- Wilbanks, T. J. (2002). "Geographic scaling issues in Integrated Assessments of climate change." *Integrated Assessment*, 3(2-3), 100-114.
- Yamada, K., Nunn, P. D., Mimura, N., Machida, S., and Yamamoto, M. (1995). "Methodology for the assessment of vulnerability of South Pacific island countries to sea-level rise and climate change." *Journal of Global Environment Engineering*, 1, 101-125.