



Climate Change Adaptation: Mapping the Context

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“Adapt or perish, now as ever, is nature’s inexorable imperative.”

HG Wells (1866-1946) Novelist, Journalist, Sociologist and Historian

Executive Summary

The IPCC First Assessment Report, completed in 1990, was updated in 1992 to provide the scientific foundation for negotiation of the United Nations Framework Convention on Climate Change. A primary finding was that mitigation and adaptation strategies should be considered as an integrated package and should complement each other to minimize net costs. But by the early 1990's, debate over climate change focused on the political positions for and against the reduction of greenhouse gas emissions and support of adaptation implied neglect of mitigation.

Now, it is understood that reductions in vulnerability to the impacts of anthropogenic climate change cannot be achieved through reducing emissions alone. We are already committed to a climate change beyond that already observed. Further, it is inevitable that damaging and even catastrophic events will occur regardless of current efforts to mitigate emissions. However, as our understanding of climate change and its potential impacts has become clearer, practical guidance on adaptation to climate change has been lacking. It is worth being explicit in defining the goal: to secure the common interest in the face of climate change. A good approximation to the common interest is to reduce the vulnerability of things valued in the world's many and diverse communities. Both mitigation and adaptation are means to this end.

One possible pragmatic response is to reframe the climate change problem in part for people directly impacted by climate change or by disasters popularly associated, rightly or wrongly, by climate change. The pain of loss is immediate and tangible, not remote or hypothetical. Each damaging drought, heat wave, flood or other disaster identified with climate change tends to motivate action, providing a window of opportunity to field-test promising policies to reduce vulnerability in the community impacted.

Such field testing of policies has important pragmatic attributes. First, they act to reduce vulnerability to loss that are already occurring in the system. Second, they are robust to failure – a series of modest policy responses, which evolve through a learning-by-doing approach, do not risk a single large investment and a concomitant requirement to get it right the first time. Third, they do not conflate impacts assessment with adaptation response as sometimes occurs in a risk management framework. Finally, they do not predicate the reduction of vulnerability in any particular context upon the detection of climate change, the attribution that the observed change is caused by humans, or the identification that climate change is the only problem of importance (or indeed a threat at all).

In this approach, a comprehensive national framework is not necessary to reduce vulnerability, even if there were sufficient knowledge to devise it and sufficient political will to impose it. Rather, a regional approach engaging all levels of government, using for example the US RISA model, is suggested.

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Introduction: the International Context

Scientific interest in global warming solidified in the late 1950s with direct measurements of atmospheric CO₂ at Mauna Loa in Hawaii, confirming the Revelle-Suess hypothesis that concentrations were on the rise. In 1959, Swedish atmospheric scientists Bert Bolin and Erik Eriksson identified a bottleneck in the transfer of carbon dioxide from atmosphere to ocean, and suggested that the burning of fossil fuels would lead to an accumulation of carbon dioxide in the atmosphere. They linked the accumulation with the energy balance of the earth and global warming (Bolin and Eriksson 1959; Bolin 1959). Scientific developments throughout the next three decades included improvements in climate records, recognition that gases in addition to CO₂ contribute to the greenhouse effect, and improvements in global circulation models of the atmosphere that increased confidence in predictions of global warming. Scientists and their allies took the lead in policy initiatives, while a number of scientists and non-governmental organizations actively started to promote the problem of climate change.

Perhaps “the high-water mark of policy declarations on global warming” (p 50, Bodansky 1994) came from the World Conference on the Changing Atmosphere: Implications for Global Security, held in Toronto in June 1988. The Toronto Conference Statement called for a 20% reduction in CO₂ emissions, a provocative demand which “caused considerable unease among governments and industry” (p 157, Boehmer-Christensen 1994). Also in June 1988, NASA scientist James Hansen testified before a U.S. Senate committee that he was 99% certain that global warming was underway (Hansen 1998).

In 1988, the United States and allied governments requested that the World Meteorological Organization (WMO) and the United Nations Environment Programme establish an organization that became the Intergovernmental Panel on Climate Change (IPCC). The Executive Council of the WMO, which had taken the lead, endorsed the IPCC and its brief in June 1988. The formal mandate of the IPCC was, and remains, to

- “(i) assess available scientific information on climate change,
- (ii) assess the environmental and socio-economic impacts of climate change, and
- (iii) *formulate response strategies*” (preface, IPCC 1995, emphasis added).

The IPCC First Assessment Report, completed in 1990, was updated in 1992 to provide the scientific foundation for negotiation of the United Nations Framework Convention on Climate Change by an International Negotiating Committee. Working Group III, also called the Response Strategies Working Group (RSWG), was chaired by Frederick Bernthal of the U.S. Department of State. The contribution of the RSWG to the assessment report stated that “Any responses will have to take into account the great diversity of different countries’ situations and responsibilities and the negative impacts on different countries, which consequently would require a wide variety of

responses.” (p xxv, Bernthal 1991). To accommodate a wide variety of responses and related considerations, the RSWG outlined “Possible Elements for a Framework Convention on Climate Change.” The sixth of eight main findings of the group stated “Limitation and adaptation strategies must be considered as an integrated package and should complement each other to minimize net costs. Strategies that limit greenhouse gas emissions also make it easier to adapt to climate change.” (p xlvi, Bernthal 1991).

The focus shifts to mitigation

By the early 1990’s, debate over climate change focused on the political positions for and against the reduction of greenhouse gas emissions, with the justification that such emissions reductions would lead to a reduction in the future impacts of climate on society (Sarewitz and Pielke 2000; Pielke and Sarewitz 2005). Adaptation had come to be considered, by both sides, a distraction from the primary debate on whether anthropogenic climate change was a real phenomenon. On one side, opposition to adaptation as a means to reduce vulnerability to the impacts of climate change was exemplified by former US vice-president Al Gore when he suggested that a focus on adaptation was a “kind of laziness, an arrogant faith in our ability to react in time to save our skins,” (p 240, Gore 1992). On the other side, action on adaptation to climate change required accepting that it was a real phenomenon, and perhaps underway. As Congressman George E. Brown, Jr. said, “Scientific uncertainty has become an operational synonym for inaction on global environmental issues, and the debate over global change has thus become an impediment to action on a wide range of issues critical to our survival” (p 21, Brown 1992).

Within the scientific community, there was a further sense, in the context of limited resources, that a choice needed to be made between mitigation and adaptation, and that of the two, mitigation was more important for the long term common interest, even if lack of support for adaptation had severe consequences in the short term. This view was reflected in the Second Assessment Report, in which Working Group III’s contribution on the economic and social dimensions of climate change allocated thirteen paragraphs to mitigation and only one to adaptation in its *Summary for Policymakers*. Working Group III also commented that mitigation and adaptation approaches might be incompatible: “possible tradeoffs between implementation of mitigation and adaptation measures are important to consider in future research.” Support of adaptation implied neglect of mitigation at that time.

Support for adaptation re-emerges

Scientific research throughout the 1990’s resulted in an understanding that the climate system has a large degree of inertia. This means that the climate system will take time to respond to actions that reduce the concentration of greenhouse gases in the atmosphere. The consequence of this inertia is that the earth is already committed to a certain degree of climate change beyond that already observed, even if

atmospheric greenhouse gas concentrations were stabilized today (Wigley 2005). This has been termed the “climate change commitment”. Thus, it is now understood that reductions in vulnerability to the impacts of anthropogenic climate change cannot be achieved through reducing emissions alone.

Further, as Pielke et al. (2007) point out “...vulnerability to climate-related impacts on society are increasing for reasons that have nothing to do with greenhouse-gas emissions, such as rapid population growth along coasts and in areas with limited water supplies. As Hurricane Katrina made devastatingly clear, climate vulnerability is caused by unsustainable patterns of development combined with socio-economic inequity. Post Katrina debate focused on whether or not the event bore the signature of global warming, despite the fact that scientists have known for decades the inevitability of a Katrina-like disaster in New Orleans” (p 597). It is inevitable that damaging and even catastrophic events will occur regardless of efforts to mitigate emissions.

For these two reasons – that some climate change is already locked in and that vulnerability to the climate is growing regardless of the extent of change – adaptation has re-emerged as a priority for the early 21st century.

The Marrakesh Accords and the Nairobi Work Programme

By the turn of the century, studies of significant climate change impacts and adaptation practices were becoming more specific and empirical, and support for adaptation became politically acceptable. There was an upsurge in interest about adaptation linked to current vulnerabilities (e.g. Parson et al., 2003; Brunner et al. 2004; Lynch et al. 2004; Holman et al., 2005) and the context broadened to include both other environmental stressors and changes in socio-economic conditions. Burton and van Asselt (2004) noted “a growing momentum for adaptation” with a “diversity of sources of funding and a diversity of approaches and rules adopted by different agencies and governments” (p 37).

The expanding role of adaptation was supported in international negotiations, particularly Decision 5 on National Adaptation Programmes of Action (NAPAs) made at the seventh Conference of the Parties in Marrakesh, Morocco in early November 2001 (UNFCCC 2001). The “Marrakesh Accords” intended NAPAs to focus on immediate vulnerabilities in those countries with limited adaptive capacity, and to mandate a “participatory assessment of vulnerability to current climate variability and extreme events.” (UNFCCC 2002a). In 2002, developing countries negotiated the “Delhi Declaration”, calling for greater attention to adaptation in international climate-change policy negotiations (UNFCCC 2002b). Subsequent Conferences of the Parties have further recognized the importance of local benefits of adaptation activities. By 2006, the Stern Review explained that adaptation “is the only way to deal with the unavoidable impacts of climate change to which the world is already committed” (p 405, Stern 2006).

Attempts first to consider adaptation and later to fund adaptation activities have directed attention to multiple sources of vulnerability, including many things from poverty to weather extremes (Burton and van Asselt 2004). Adaptation to climate change is now most usefully considered part of the broader issue of sustainable development.

IPCC Fourth Assessment Report (AR4)

Reflecting these changes, the IPCC AR4 was more specific and empirical with regard to adaptation as a means to reduce vulnerability to climate change, but true success stories and models for change are difficult to identify even here. Working Group II's *Summary for Policy Makers* noted that it "sets out the key policy-relevant findings" (p 8, IPCC 2007) of its assessment of impacts and adaptation, but these findings remain general in nature. These general conclusions are reminiscent of the First Assessment Report, despite the wealth of detailed knowledge accumulated in the intervening years. For example, context matters: "Costs and benefits of climate change for industry, settlement, and society will vary widely by location and scale. The most vulnerable industries, settlements and societies are generally those in coastal and river flood plains, those whose economies are closely linked with climate-sensitive resources, and those in areas prone to extreme weather events, especially where rapid urbanisation is occurring. Poor communities can be especially vulnerable..." (p 12). Moreover, "It is virtually certain that aggregate estimates of costs mask significant differences in impacts across sectors, regions, countries and populations" (p 17).

The implications of such differences were not formulated as response strategies contingent on the goals of policy makers in the Conference of the Parties, or as active recommendations. Instead, the Working Group II review of current knowledge about responding to climate change simply noted, for example, that "The array of potential adaptive responses available to human societies is very large, ranging from purely technological (e. g., sea defences), through behavioural (e. g., altered food and recreational choices), to managerial (e. g., altered farm practices) and to policy (e. g., planning regulations)" (p 19, IPCC 2007). It acknowledged "formidable environmental, economic, informational, social, attitudinal and behavioural barriers to the implementation of adaptation" (p 19) without proposing how they might be overcome. It also raised unanswered questions about decision making: "Adaptation measures are seldom undertaken in response to climate change alone but can be integrated within, for example, water resource management, coastal defence and risk-reduction strategies" (p 19). But who can and should do the integration, where, and how? The conclusion recommended that Working Group II's "judgements about priorities for further observation and research" in the technical summary "should be considered seriously...." (p 20).

Hence, as our understanding of climate change and potential impacts has become

clearer, practical guidance on adaptation to climate change has been lacking. New methods, frameworks, and guidelines are gradually being developed to facilitate second order studies, examples include: the United Nations Development Programme (UNDP) Adaptation Policy Framework (Burton et al., 2004), the NAPA Guidelines themselves (UNFCCC, 2002a), the Assessments of Impacts and Adaptations to Climate Change (AIACC) project (AIACC, 2004), and the Nairobi Work Programme (UNFCCC, 2006). But the focus has been primarily on developing countries, and as yet, rigorous assessment of the quality of these frameworks in field testing has been lacking.

Identifying the common interest

In this atmosphere of uncertainty, then, it is worth being explicit in defining the goal: to secure the common interest in the face of climate change. A good approximation to the common interest in response to climate change is to reduce the vulnerability of things valued in the world's many and diverse communities, and *not* in the stabilization of concentrations of greenhouse gases in the atmosphere *per se*. Stabilization of concentrations is one, but only one, means for reducing vulnerability, and reducing vulnerability is a somewhat different problem in each community. The many specific values and interests vary greatly across communities at each scale and are subject to change. But typically the values include people, property, other tangible and intangible cultural artefacts, and the animate and inanimate natural environment – in addition to minimizing the costs of protecting such things. The common interest can be served in the near term through adaptation to the impacts of any environmental or social stressors that in composite have damaged or threaten things of value, and in the longer run through mitigation of climate change by reducing greenhouse gas emissions. As strategies for reducing vulnerability, adaptation and mitigation are means, not ends in themselves. Hence, policy-relevant climate change adaptation research, programs, and treaties are means, not ends in themselves. They are properly evaluated according to their contributions to reducing vulnerability to loss under the influence of composite stressors.

From a common interest standpoint it is not reasonable in view of disappointing outcomes to defend business as usual in the climate change regime. We have the opportunity to focus or refocus on the common interest, coordinate our activities accordingly, and consider what we might do differently and better.

Pragmatic arguments for adaptation

Unresolved difficulties in serving the common interest were diagnosed as early as 1989 by William Ruckelshaus, former Administrator of the U.S. EPA: “The difficulty of converting scientific findings into political action is a function of the uncertainty of the science and the pain generated by the action.... It is hard for people – hard even

for the groups of people who constitute governments – to change in response to dangers that may not arise for a long time or that just might not happen at all” (p 1666, Ruckelshaus 1989). If this is so, then one possible pragmatic response is to reframe the climate change problem *in part* for people directly impacted by extreme weather events: the pain of loss from their perspectives is immediate and tangible, not remote or hypothetical. Each damaging drought, heat wave, flood or other disaster identified with climate change tends to motivate action, providing a window of opportunity to field-test promising policies to reduce vulnerability in the community impacted. In effect nature penalizes with severe sanctions past policies, including inaction, that have allowed significant losses from an extreme weather event to occur.

Such field testing of policies in response to extreme events has important pragmatic attributes. First, they act to reduce vulnerability to loss that are already occurring in the system. Hence this represents a *no regrets strategy*. Second, they are robust to failure – a series of modest policy responses, which evolve through a learning-by-doing approach, do not risk a single large investment and a concomitant requirement to get it right the first time. Hence it is also a *don't bet the farm strategy*. Importantly, it does not predicate the reduction of vulnerability in any particular context upon the detection of climate change, the attribution that the observed change is caused by humans, or the identification that climate change is the only risk of importance (or indeed a risk at all). In consequence, a comprehensive plan for “Managing Planet Earth”, or even Australia, is not necessary to reduce vulnerability, even if there were sufficient knowledge to devise it and sufficient political will to impose it.

A near-term emphasis on disaster-related adaptations can contribute to mitigation of climate change in the longer term. For example, during the recent prolonged drought in Victoria, a Melbourne newspaper observed that “Water saving has emerged as the most palpable sign that ... we finally get it – the climate is changing and we have to adapt.” (p 16, *Sunday Age*, January 28, 2007). While meteorologists and climate scientists continue to debate the physical and statistical linkages between weather and climate, growing numbers of people have already made the connection and are prepared to act on it. Major disasters can bring home to ordinary citizens the need for mitigation of climate change, and might do more in this regard than two decades of scientific assessments or promotional politics have done so far. People experience weather, not climate; and they experience it in the local places where they live and work. Rayner and Malone (1998) anticipated that “Accumulating some experience with adaptation could provide a complementary, even perhaps an alternative, model for pursuing emission reductions” (p 113).

Action on Adaptation – some success stories

Initiatives consistent with the principles described here have emerged in recent years. Here I provide a brief and selective consideration of some examples of adaptation research and implementation.

Research on Adaptation: RISA

Regionally and locally focused studies in support of policy decisions are an integral part of the intensive research that contributes to developing robust appraisals of field-tested alternatives. In the United States, the Office of Global Programs (OGP) in the National Oceanic and Atmospheric Administration (NOAA) took a step in that direction by initiating the Regional Integrated Sciences and Assessments Program (RISA). Beginning in 1995, RISA launched regional pilot programs to support “integrated research across a range of disciplines to expand decision-makers’ options at the regional level. It does this in a manner cognizant of the context in which decision-makers function and the constraints they face in managing their climate-sensitive resources” (Moser 2004). RISA has “been called a step in the right direction by some ... while others view it as a model that could guide larger efforts within USGCRP” (p 5, Hearings before the Committee on Science, House of Representatives, 107th Congress, 2nd Session, April 17, 2002, Washington, D.C: Government Printing Office.) In November 2005, RISA had eight regional pilot programs underway, but the political climate in the U.S. has led to a decreasing budget over time. Nonetheless, RISA appears to be a small but potentially important work in progress, and may provide a model for support of climate adaptation research in Australia.

An important driver for the design of the RISA program was an appraisal of the National Assessment experience to improve future assessments (Morgan et al. 2005). The appraisal team found that stakeholders should participate in defining an assessment at the outset: “Many believe that, in scoping out a policy-relevant assessment, one should begin by defining the bottom line from the target audience’s (stakeholder) perspective.... [Workshop participants] suggested that more success could have been achieved through using a stakeholder definition of the scope and providing a consistent approach/framework for incorporation of these bottom lines” (p 9031, Morgan et al. 2005) They also found “a difference between the perspectives and information sources of global/national-scale analysts and regional/local-scale analysts” that did *not* reflect a difference in expertise. Both sets of differently informed viewpoints were considered valid: “It would be a mistake if [top-down] guidance material were to force regional people to ignore information that they have a valid reason to believe is better than what is being supplied” (p 9028).

The RISA program took this appraisal of the value of decision-maker engagement, and indeed decision-maker driven, research as a core precept in the design of

programs to be supported. The RISA program requires what it terms “usable climate sciences” (p 2, RISA 2007) – that is, knowledge, products and services that are developed with specific applications or decisions in mind, and refined over time through field testing. Because climate information is only one of many types of knowledge needed for effective decisions, the RISA program requires the building of sustainable decision support by establishing long-term trust, open dialogue, and close partnerships. Finally, the RISA program has a focus on place-based integrated climate research, where complex problems are simplified not by dividing programs disciplinarily, but rather by dividing them geographically. Once it was recognized that research of relevance to the climate change threat is sufficiently complex that some simplification is necessary, it was possible to replace the privileged position of discipline with that of place. With these precepts, RISA has led to demonstrated payoffs in agriculture, bushfire, water resources, public health, drought, energy demand, fisheries and extreme weather.

Research and Action on Adaptation: the Pacific ENSO Applications Center

In connection with the 1997-1998 El Niño – so intense that scientists have since labelled it “The El Niño of the Twentieth Century” – the Pacific ENSO Applications Center (PEAC) showed how researchers can move beyond scientific assessments to support action on adaptation. In doing so PEAC field-tested certain practices that have applicability in the Australian context.

PEAC was established in August 1994 to test the feasibility of integrating climate variability research, forecasts, and application services “end-to-end” on an operational basis. PEAC was a joint venture of the University of Guam, the University of Hawaii, the Pacific Regional Office of the U.S. National Weather Service, OGP in NOAA, and the Pacific Basin Development Council. It focused on providing seasonal to interannual forecasts of the El Niño-Southern Oscillation (ENSO) and related information products for U.S.-affiliated Pacific Islands. It was initially assumed that large-scale coupled ocean-atmosphere models could produce forecasts that could be turned into useful information products for Pacific islanders. “However, the spatial resolution of large-scale models...did not meet the needs of the people the Center was intended to serve.” (p 1, Hamnett et al. 2000). PEAC shifted its research focus to link these models to empirically-based statistical models, adapting research to the different interests of different island communities. It produced “simple guides that describe rainfall and tropical cyclone activities expected under ‘normal,’ El Niño, and La Niña conditions” (p 1-2). Meanwhile, on the applications side, PEAC “conducted workshops, focus group meetings, and local briefings about ENSO in all of the client jurisdictions during 1995 and 1996.... From these briefings PEAC identified the concerns of participants on potential impacts of El Niño and La Niña events, and elicited information about the specific kinds of ENSO forecast information needed” (p 2). Research and applications came together in the *Pacific ENSO Update*, a quarterly newsletter distributed in hard copy and by website beginning in August 1996.

Importantly, these resources were in place in February and March 1997 when PEAC found indications of a developing El Niño warm event in several coupled atmosphere-ocean models it consulted regularly.

PEAC began alerting clients through the newsletter and informing government officials. The Water and Energy Research Institute (WERI) at the University of Guam produced seasonal forecasts of the percent of normal rainfall for Guam, Micronesia and Palau, at the request of officials in those places. WERI researchers began travelling across the affiliated Pacific Islands to brief government officials on the forecasts and to suggest immediate preparations for impacts to come. “The personal briefings were later identified as a key component of issuing the forecasts, gaining an understanding of the situation, and motivating people to action” (p 4, Hamnett et al. 2000).

PEAC succeeded in catalyzing action in response to its forecasts. The Marshall Islands, state and national governments in Micronesia, Palau, and Guam developed task forces and response plans similar to those already in place on Yap in Micronesia. The task forces “mounted public information campaigns to inform the public about what to expect from the El Niño, to explain measures that could be taken to conserve water and prevent outbreaks of diseases, and to warn of the increased wildfire risk and actions to reduce risks” (Hamnett 2000). An example of a few specific actions taken in advance included an acceleration of a repairs program for a water distribution system before the onset of the drought, and advance supply of new household catchment tanks. The Government of Guam decided that fresh water from their main reservoir should be conserved, and used brackish water to fight fires. All the islands imposed restrictions on water consumption during drought, but their policy responses also differed according to their circumstances.

PEAC was the critical organization pulling together participants and resources scattered through a distributed decision making structure. PEAC put the scattered task forces in contact with each other and provided useful information before and during the drought. PEAC sought external resources to help the affiliated Pacific Islands cope with the drought. It seems clear that PEAC effectively helped islanders reduce losses from the 1997-1998 El Niño. In doing so PEAC demonstrated the value of adapting research to the different needs of decision makers on the ground, engaging them directly in their own policy processes, and mobilizing external resources in support of their local policy decisions where needed. Note that PEAC accomplished all this in an advisory capacity; it was policy-relevant, not policy-prescriptive: local governments made and implemented the decisions, not PEAC, and agencies of national governments decided to support them.

Research and Action on Adaptation: Melbourne Water Consumption

Two of the most severe dry events in the instrumented record have occurred in the last two decades, in 2002 and 1994, both with average annual rainfall deficits across

the Australian continent of about 130 mm compared to the 1961-1990 average. The 2002 drought ranked in severity and areal extent with the most extreme droughts of 1902 and 1982-83 (both El Niño periods), and exacerbated the effects of eight years of ongoing rainfall deficits. The drought also coincided with exceptionally warm conditions: maximum temperatures established by a wide margin new autumn, winter, and spring records for the period since 1950. With severe bushfires in eastern Victoria and widespread water shortages, people began to recognize that this drought was unusual. Another rather dry year in 2003 corroborated the view that present conditions were an exception to the historical cycle.

Just prior to the drought of 1994, practitioners in Melbourne Water, the state authority responsible for water services in Melbourne, were exploring innovative approaches to water management. This included “Water Sensitive Urban Design” (WSUD). However, “At this time State government agencies were principally focused on downsizing and outsourcing... In particular, Melbourne Water was subject to a process of disaggregation into a wholesale water, drainage and waterway authority and three new retail water supply and sewage businesses” (p 23, Brown and Clarke 2007). Following the 1994 drought, however, WSUD started to become accepted in Melbourne water management professional circles. For example, the Melbourne Water executive started to encourage their staff to actively exercise their existing authority to place conditions on developments relating to drainage and water quality. Further, land developers started to be influenced by consumer demands for robust waterways.

By 2003, following the second intense drought, the reality of the long term and perhaps permanent nature of rainfall deficits had been accepted by the public. The Victorian state government prepared a deliberate strategy. The first step commenced with research, summarized in a report entitled “Water Smart City” (Mills 2002). Unfortunately this report underestimated the rainfall deficits to come, and would have benefited from a more iterative, adaptive approach as exemplified in the PEAC case. Nevertheless, it contained “good solid policy” (J. Thwaites, pers. comm.) that led to a supply and demand document “*Securing Our Water Future*”, released as a white paper in 2004. This was the first time in Victoria that policy included a legislative right for the environment to receive a water allocation (J. Thwaites, pers. comm.). The policy also included:

- a major reform in irrigation – secure irrigation rights in return for giving up some water for environmental flows;
- requirements for the government to make a new sustainable water plan every 5 years;
- requirements for an adjustment of water rights at regular intervals (every 15 years) based on climate change scientific evidence and environmental flow requirements;
- reformed water pricing with block tariffs.

An important element of the process was the extensive consultation - over 600 submissions were recorded, as well as meetings with the urban public, farming community, business groups, and environmental groups. Former deputy premier John Thwaites said “We saved 100 Gl a year at minimal cost. Compare that to the desalination plant which will supply 150 Gl with a capital cost of \$2 Billion and operating costs of \$70-100 Mill per year” (J. Thwaites, pers. comm.) On a per capita basis, the reduction is from about 380 litres per person per day in 1996 to about 290 litres in 2007.

The success of the program has been attributed to many factors, including the drought and a managed culture change around water. These two factors supported each other and meant that a well-designed policy could be enacted with strong public and political support. Brown and Clarke (2007) also suggest that a network of practitioners was key to Melbourne’s success in a series of decisions over the years: “An important driver of Melbourne’s transition was the legacy of a committed and innovative group of associated champions working across multiple sectors to advance change. ...Sharing common qualities, the characteristics of these champions included strong environmental values, a public good philosophy, active promotion of best practice ideology, having a ‘learning by doing’ approach to their work, as well as being opportunistic, innovative and adaptive” (p IV, Brown and Clarke 2007). Melbourne’s series of demand-management policies are procedurally rational, informed by technical and practical considerations, in a decentralized structure of decision making.

The National Climate Change Adaptation Framework

The drought of 2002 was the first extreme event in Australia to be associated directly with human-caused climate change. By November 2002, almost 62% of Australia had serious or severe rainfall deficiencies (Bureau of Meteorology 2003). Australian researchers concluded that the impact of the drought was made more severe than past droughts due to the high temperatures and concomitant enhanced evaporation associated with the warming of the climate (Károly et al. 2003; Nicholls 2003). Analysis by university researchers and by the Australian Bureau of Agricultural and Resource Economics found that the drought was estimated to have cost more than 40,000 jobs (and perhaps as many as 70,000), decreased agricultural output by 30%, decreased economic growth from 3.8% to 3.1%, and created a 50% increase in the trade deficit (Horridge et al. 2005, Abareconomics, 2002a, b). A government drought relief package totalling \$728 million over three years was committed to farmers and businesses in affected areas.

This dramatic evidence that climate change was leading to measurable impacts made manifest the “climate change commitment” that had emerged from the science of climate change, particularly in impacts assessments commissioned by the

Australian Greenhouse Office (AGO) around the same time, such as *Living with Climate Change*, published in December 2002 and other more specialized reports addressing impacts on salinity, alpine biodiversity, the Great Barrier Reef and economic issues through 2003 and 2004. Thus, the drought did as much or more to contribute to national momentum on climate change adaptation strategies as the international developments described earlier.

In 2004, the AGO tasked the Allen Consulting Group to write a report on climate change risk and vulnerability, in preparation for the development of a national framework for climate change adaptation. Representatives of ACG held consultative meetings across Australia with a range of stakeholders, decision-makers and researchers to inform the report. The resulting report identified five key issues: greater Australian Government facilitation, targeted information from trusted sources, better information on expected changes, more detailed regional analysis, and enhanced understanding of environmental threats and response options (ACG 2005). The focus of these key issues, also reflected in earlier AGO reports, is primarily on the impacts of climate change rather than adaptation research per se. This is a perspective that typically arises from the risk approach, which addresses the problem from the standpoint of what is changing in the climate system, rather than what values are vulnerable or what strategies and resources are available to respond.

The ACG climate change risk and vulnerability report was submitted in February 2005 and included as a recommendation listing the development of a National Climate Adaptation Framework for Council of Australian Governments (COAG) consideration. COAG then engaged the Allen Consulting Group in a second report to examine options for organizing Australia's climate change research resources so that they effectively support climate change decision-making at the national, regional and local levels. A further round of consultation was held in August and September 2006. Using these reports and other resources, the AGO was subsequently asked to develop an implementation plan in concert with decision-makers. An expert group of university researchers was convened in Canberra and were able to provide input to the implementation plan in November 2006 before it went to senior AGO staff.

On 13th April 2007, COAG agreed to a National Climate Change Adaptation Framework as the basis for jurisdictional actions for the near future. At the same meeting, the government committed \$26 million to establish and manage an Australian Centre for Climate Change Adaptation as part of the AGO (and currently part of the new Department of Climate Change) and \$100 million in program funding for the Centre over five years. In addition, a separate announcement was made for a new CSIRO Adaptation Flagship with funding of \$44 million (a result, reportedly, of intense lobbying at the highest levels.) The Australian Centre for Climate Change Adaptation has commissioned scientific work, including from the new Adaptation Flagship, with the intent to develop tangible responses to climate change.

An important strategy of the National Climate Change Adaptation Framework was to reduce both sectoral and regional vulnerability, but the appropriate section of the framework lists only sectors and not regions in the contextual sense (p 10, National Climate Change Adaptation Framework 2007). The sectors identified were water resources; coastal regions (too generic to be a true regional perspective); biodiversity; agriculture, fisheries and forestry; human health; tourism; settlements, infrastructure and planning; and natural disaster management. The COAG agreement set in motion the process that ultimately awarded a National Climate Change Adaptation Research Facility with \$10 million in funding to Griffith University on the eve of the election in October 2007. The remaining funds designated under the COAG process described above have not yet been allocated, but at present proposals are being invited from the research facility to host a number of adaptation research networks, with funding of an additional \$10 million available.

The expert group that met to discuss the National Climate Change Adaptation Framework in 2006 raised several issues in a subsequent position paper that was provided to the AGO. Chief among them was that the common good of the Australian people is influenced by many causal factors, including but not limited to climate, land use, ecosystem health, the by-products of resource use, and access to functioning democratic processes. It was stated that “Multiple stresses in composite lead to qualitatively different outcomes from single influences, and thus research that seeks to better understand the vulnerability and adaptive capacity of Australian society requires thinking that is *different from that used in traditional, sectoral or single problem approaches*” (p 1, Lynch et al. 2007, emphasis added.) This point was also emphasized in a report from the US National Academy of Sciences that was released at around the same time (BASC 2007).

Second, the distinction between climate change impacts assessment and climate change adaptation research was highlighted by the expert group. Impacts assessment is a crucial precursor to adaptation research and implementation but not a substitute for it. It was noted in discussion that impacts assessment could be appropriately sectoral.

The expert group noted the rising profile of research that addresses vulnerability and adaptive capacity in the face of climate change but noted that there is also a danger that experience accrued by current active researchers in the field would not be appropriately communicated. Since the sectoral approach had already demonstrated limitations, five broad areas of high priority research were highlighted, as summarized below:

1. Economic dimensions of adaptation that consider human health and wellbeing, indigenous issues, food security, demography and population
2. Extremes and disasters – learning from natural hazards experience
3. Methodologies of problem-oriented inquiry
4. Thresholds (also known as catastrophes)

5. Regional impacts in the Asia-Pacific, including environmental refugees, geopolitical tensions, and trade (Lynch et al. 2007).

The group also highlighted training both for building capacity in future researchers and in stakeholders as an important ongoing priority.

Closing Remarks

The three examples reviewed in the section on Action on Adaptation bring into focus the complex realities discounted or overlooked in the development of the national framework as currently envisioned. Those complexities include the diversity of contexts and multiplicity of interests relevant to reducing our vulnerability to climate change and other threats to our well-being and prosperity. Given human cognitive constraints, those complexities imply decentralization of adaptation science, policy, and decision making: Because no one can understand the national problem completely or completely objectively, or control local responses to it, it is prudent to bring practitioners in state governments, local governments, and communities into the process of evolving better solutions. Such a process engages the federal government in creating:

- a regulatory environment that promotes reductions in vulnerability;
- opportunities for the support of capacity building at lower levels of government; and
- support for appropriate field testing of new alternatives (for example, using the RISA model.)

Second, a continuous process with ongoing communication promotes an adaptive governance approach (Brunner and Lynch 2008); specifically, it allows for mid-course corrections in response to the evolving context. In the Melbourne Water case it was acknowledged that placing all scientific analysis at the beginning of the policy process, and not updating the science-based information as the situation evolved, led to outcomes that were less robust than might have been hoped for.

Finally, all of these examples were situations in which decision-makers acted to reduce vulnerabilities to loss that were already occurring in the system. This supported public engagement in the solutions and permanent culture change. This common interest motivation meant that there was no need for anthropogenic climate change to be invoked, and hence avoided the development of political opposition.

Some introspection suggests that we in the aggregate may have contributed unwittingly to disappointing outcomes to date by substituting such means as scientific assessments, national frameworks, and treaties as satisfactory outcomes. The recommendation is to refocus efforts on the common interest and evaluate our efforts accordingly.

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