Ethnographic Perspectives on Resilience To Climate Variability in Pacific Island Countries

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Final Activity Report

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Table of contents

Summary

Climate variability and extreme events already have adverse effects on the Pacific Islands, and it is the possibility of increased frequency and/or intensity of these due to climate change that now most concerns policymakers.[1] In recent times the 1997-98 El Nino caused widespread drought and subsequent famine in the islands west of the international dateline, with agricultural losses in Fiji valued at US$65 million, and some 260,000 people in Papua New Guinea placed in a life threatening condition due to depleted food supply.[2] In the same period there was an increased frequency of tropical cyclones east of the international dateline. The Cook Islands experienced 17 tropical cyclones, the most recorded in a season.[3] Cyclones are particularly problematic and have caused massive financial losses; cyclone Ofa which struck Western Samoa in 1990 caused US$110 million worth of damage, as did cyclone Kina which struck Fiji in 1993.[4,5] As well as wind damage and damage from increased rainfall and flooding, cyclones induce storm surges which can reach up to six meters in height, far in excess of the maximum height of atolls. For example, in 1987 a cyclone and storm surge struck Tokelau, bringing waves that swept across the islands and flooding of up to a meter on the island of Fakaofo.[6] These surges will be greater if superimposed on elevated sea-levels, and greater still if cyclone intensity increases due to climate change.[7] Successful adaptation to climate change requires understanding and enhancement of people's strategies to prepare for, respond to, and recover from extreme events such as these.

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[1] McCarthy, J. Canziani, O. Leary, N. Dokken, D. White, K. (eds) 2001. *Climate Change 2001: Impacts, Adaptation & Vulnerability*. Cambridge University Press, Cambridge

[2] WMO (World Meteorological Organization). 1999. *The 1997-1998 El Nino Event: A Scientific and Technical Retrospective*. WMO, Geneva.

[3] WMO ibid

[4] Olsthoorn, A., Maunder, W. and Tol, R. 1999. Tropical Cyclones in the Southwest Pacific: Impacts on Pacific Island Countries With Particular Reference to Fiji, in Downing, T., Olsthoorn, A. and Tol, R. (eds.) *Climate, Change and Risk*. Routledge, London and New York: 221-244.

[5] Campbell, J. 1998. Consolidating Mutual Assistance in Disaster Management Within the Pacific: Principles and Application, in South Pacific Applied Geoscience Commission (ed.) *Seventh South Pacific Regional IDNDR Disaster Management Meeting*. South Pacific Applied Geoscience Commission, Suva: 61-71.

[6] Hooper, A. 1990. Tokelau, in New Zealand Ministry for Environment (ed*), Climate Change: Impacts on New Zealand*. Auckland: 210-214.

[7] Olsthoorn et al *op cit*.

The APN project ‘Ethnographic Perspectives on Resilience To Climate Variability in Pacific Island Countries’ sought to improve understanding of the ways in which local communities prepare for, manage, and recover from climatic perturbations. APN funding was used to bring together researchers and policymakers from across the Pacific to a workshop on the subject of local strategies and practices that support resilience to climate variability. The project capitalised on existing knowledge in the Pacific region rather than initiating further research. An outstanding feature of the project was the involvement of participants with long-term knowledge of places and people that have experienced climate variability in the past.

The workshop was held at the Paefika Inn in Apia, Samoa, on December 4-6 2001. Its aims were:

- To improve understanding and share awareness of the ways in which communities have prepared for, managed, and recovered from climate perturbations similar to those that are expected to occur with climate change.
- To bring together social science researchers and climate change policymakers from across the Pacific region to a workshop to enhance dialogue and share understanding of strategies for resilience to climate variability.
- To improve the quality of information feeding into policies for adaptation to climate change and climate variability.

In addition to discussing local strategies for managing climate variability, considerable discussion was given over to the meaning and practice of adaptation in Pacific Island Countries, the difficulties of adaptation policy, issues of migration and resttlement, the role and contribution of traditional knowledge, health, comprehensive government policy integration, and means of outreach to local communities.

The workshop has established a network of social scientists, climate change researchers, and climate change policy officers in the region. It also advanced understanding of the human dimensions of climate variability and climate change in the region, commenced regional discussions of human dimensions of climate change and variability; and attracted widespread media coverage thus raising the profile of climate change issues in the region (Appendix 5).

Background

Pacific Island Countries have been identified as being particularly vulnerable to climate change. This is recognised by both the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC). It is well established that island communities are extremely vulnerable to extreme events such as droughts, cyclones, floods and storm surges. Most analysts and modellers consider that these are increasing in intensity as a function of climate change, and droughts and floods are expected to increase in frequency as well.[8] Successful adaptation to climate change requires understanding and enhancement of people's strategies to prepare for, respond to, and recover from extreme events. This ability to cope with such sudden changes and still persist is termed 'resilience'. In short, the human dimensions of weather-related disasters in the Pacific are not well known, but are of increasing importance due to climate change.

The IPCC refers to the need for more information on local coping strategies under the ambit of 'traditional knowledge and skills', which are seen as 'vital resources' for adaptation.[9] In their review of the ten Pacific Island Countries' National Communications to the UNFCCC, Hay and Sem argue that to improve policy and decision making 'more needs to be known about the extreme events … and how natural and human systems will respond to changes in the magnitude and frequency of extreme events'.[10] Further support comes from the Alliance of Small Island States'1999 workshop on the Clean Development Mechanism and the Kyoto Protocol (Majuro 14-16 July 1999), which developed a list of capacity building needs which included the need for case studies of extreme weather events, and the identification and promotion of traditional knowledge, skills and practices which enhance adaptation. Finally, the most recent and comprehensive statement on capacity building and research needs in the South Pacific is the draft *Pacific Island's Framework for Action on Climate Change, Climate Variability and Sea Level Rise*, which identifies the following as a priority action:

[8] Cyclones are predicted to be more intense (if not more frequent) and a more El Niño-like mean-state is expected. See Jones, 1999, *An Analysis of the Effects of the Kyoto Protocol on Pacific Island Countries*. Apia: CSIRO and SPREP.

[9] See Nurse, McLean, et al, 1998, 'Small Island States', pp. 336-354 in *The Regional Impacts of Climate Change: An Assessment of Vulnerability*. Working Group II of the IPCC. Cambridge: Cambridge University Press.

[10] Hay and Sem, 1999, *Evaluation and Regional Synthesis of National Assessments of Vulnerability and Adaptation to Climate Change*, prepared for SPREP.

> Further research is required to link historical and anecdotal information as evidenced in many communities in the region to climate change, variability and sea-level rise … relevant local data is particularly critical for enhancing the understanding of impacts.

While adopting a broad, multidisciplinary social science approach—drawing on data gathered by geographers, archaeologists, and anthropologists—this project has utilised insights from ethnographic research to contribute both to understanding of social resilience to climate change and to the development of social policies related to adaptation to climate change. Ethnography, with its emphasis on long-term fieldwork and its privileging of local and indigenous perspectives, provides a high degree of social contextualisation and good data reliability which is critical for developing adaptation policies.

The project has thus helped bridge an identified gap in research by scoping, synthesising and communicating to policy makers existing knowledge about resilience to extreme events, as well as further investigating the meaning, practice, and challenges of adaptation in Pacific Island Countries. The project has drawn on knowledge that already exists rather than initiating new research.

Activities Conducted

The project began with the identification of contributors to the workshop. Contributors were given a background paper summarising and discussing the array of resilience strategies mentioned in the literature on disaster and hazards management, development studies, and ecological economics. This background paper was used as a prompt to participants. Contributors were then asked to produce extended abstracts/short papers for dissemination prior to the meeting. These were included in a book of abstracts (Appendix 6).

A three day workshop titled ‘APN Workshop on Local Perspectives on Climate Change and Variability in the Pacific Islands’ was held in Apia, Samoa on December 4-6. The workshop involved papers from researchers and policy makers followed by detailed discussions, including forums. The workshop featured social scientists with long-term experience in Pacific Island communities talking about social responses to climate extremes, and sharing with policy makers their observations on local strategies that provide resilience to climate variability. It also involved extensive participation from Pacific Islanders working in the field of climate change at the national and regional level sharing their experiences with climate change adaptation activities (see Appendix 2 for a list of participants). Another feature of the workshop was detailed discussion of the meaning and practice of adaptation, both at the local level and at the national policymaking level. A summary of the main findings of the workshop is available in Appendix 4, the programme is available in Appendix 1.

The formal opening of the workshop took place on Tuesday afternoon, December 4, and was followed by the first session of the workshop which consisted of papers on past, present and future changes in climate in the Pacific region. This was followed by small group discussions of social impacts of climate change, health issues, development issues, and governance and policy challenges. The aim of these small group discussions was to identify key issues and expectations for the remainder of the workshop. On Wednesday, December 5, there was a session discussing the concepts of resilience and adaptation and their application in practice. This was followed by a session on the experiences of climate change policy officers in three Pacific Islands countries. Wednesday afternoon was devoted to presentations and discussions of case studies of responses to extreme events in the region. Papers with case studies of responses to extreme events continued on Thursday, December 6. These were followed by two sessions on adaptation policy challenges, and a final plenary session to discuss the workshop's outcomes. In all sessions throughout the workshop there were vigorous discussions about issues raised in the papers.

At present the proceedings of the workshop are in review, having been edited by Jon Barnett and Mark Busse. The final phase of the project will involve some of the papers presented at the workshop to be published as an edited volume titled 'Ethnographic Perspectives on Resilience to Climate Change in the Pacific', intended for Cambridge University Press.

Outcomes

The workshop proved highly successful and enjoyable to all. It successfully established a network of social scientists, climate change researchers, and climate change policy officers in the region, and discussions among them are continuing. Climate change policy officers in the region were stimulated by the discussions and contributed actively to discussions of resilience and adaptation, and how strategies can be incorporated into policy. The workshop considerably advanced understanding of the human dimensions of climate variability and climate change in the region.

Pacific Island delegates were active in sharing the difficulties they face in making and implementing climate change adaptation policy. This was an unforeseen theme of the workshop, but was fortuitous given the presence of a number of people with experience in environment and development policymaking. Two key areas discussed were the need for better integration of climate change adaptation policies across other government departments, as well as for better outreach of adaptation information and planning to local communities. Pacific Island delegates reported that these discussions were extremely helpful, both for the opportunity to elaborate on their own challenges, as well as to hear of experiences in other Pacific Island and neighbouring countries. In addition to this, the papers on resilience and adaptation practices all helped to established future research and policy needs in the region.

Other issues explored—and understanding advanced—by the workshop which all participants found to be important concerned:

- the important role that migration and resettlement within and between countries is likely to play as a response to climate change;
- the problem of linking adaptation across the various scales at which adaptation will take place;
- the need to link adaptation targets and strategies with the aspirations of local people;
- the nature of thresholds of tolerance and the ways in which these may be established, and the ways in which these may be exceeded in the future;
- the health impacts of climate change, preparations to manage these, and the linkages between the health, development, and cultural sectors;

- the complex, interlinked nature of vulnerability to environmental change as well as other forms of change;
- the potential role that traditional knowledge can play in resilience and adaptation;
- the limitations of modelling approaches to social systems, and other ‘top down’ prescriptions and methods, and the challenges of finding appropriate methods to understand the local-level human dimensions of adaptation to climate change;

The workshop produced a book of abstracts and short papers, edited proceedings which are currently in review (forthcoming March 2002), and an edited volume of papers is planned (and underway). We expect to receive papers from contributors by May 2002 and to complete the editing process and submit the volume to Cambridge University Press before the end of the year.

Overall, the workshop was extremely successful in commencing regional discussions about the human dimensions of climate change and variability. It also raised the profile of climate change adaptation issues in the region through widespread media coverage of the event (Appendix 5).

On the final day of the workshop a short written survey was conducted, asking participants for their feedback on the survey and their hopes for future work on the human dimensions of adaptation to climate change in the region. The responses are summarised in Appendix 3. Their responses show that the workshop was highly successful, and that there is considerable demand for further activities.

Future Directions

An edited volume of selected papers from the workshop will be produced. Contributors have been asked to submit their papers by May 2002.

Discussions have begun on a number of future projects, including:

- research and workshops on adaptation policy issues, including appropriate scales at which adaptation activities should take place, integration of adaptation programmes across government departments, and means of outreach to local communities;
- research and workshops on migration and resettlement issues;
- training in social science vulnerability and adaptation assessment techniques;
- local level monitoring projects;
- research and workshops on the role and contribution of traditional knowledge;
- research and workshops on the health impacts of climate change;
- research and workshops on climate change adaptation and sustainable development;
- research and workshops on assessment of local level aspirations to establish targets and baselines of successful adaptation activities.

Apart from publication of the planned edited volume, the project leaders Barnett and Busse do not have plans to follow up in 2002 and 2003 as both are commencing new lecturing positions (at the University of Melbourne and the University of Auckland, respectively), and expect to be fully engaged for the coming year.

APPENDIX 1

WORKSHOP PROGRAMME

‘APN Workshop on Local Perspectives on Climate Change and Variability in the Pacific Islands’

Pasefika Inn

Apia, Samoa, December 4-6.

<u>Tuesday December 4</u>

11:00 – 11:30 Registration

1:00 – 2:00 PM—Welcome and introduction

- Welcome. Neva Wendt, South Pacific Regional Environment Programme
- Welcome. Dr Tu'u'u Ieti Taulealo, Director, Department of Lands, Survey and Environment, Samoa
- Jon Barnett and Mark Busse: The goals of the workshop
- Graham Sem: UNFCCC perspectives on adaptation
- Alistair Woodward: Preparing for climate change

2:30 – 3:45 PM—Climate change in the Pacific: past, present and future

- Jim Specht: Climate change and the settlement of the Pacific Islands
- Jim Salinger: Observed climate change and variability in the South Pacific
- Roger Jones: Climate change projections for the South Pacific
- Graham Sem: The IPCC Third Assessment Report

4:15 – 6:00 PM—Small group discussions

- Group on social impacts and responses – (lead by Nelson Rarua and John Campbell)
- Group on governance and policy challenges – (lead by Simon Saulei and Don Rubenstein)
- Group on health issues (lead by Jane Mogina and Alistair Woodward)
- Group on development issues (lead by Tim Bayliss Smith and Eva Lewenikuruwai)

Workshop Reception

Wednesday December 5

9:00 – 11:00 AM—Concepts of change

- Judith Littleton: Adaptation in climate change
- Roger Jones: The role of adaptive capacity in reducing vulnerability
- Jon Barnett: Resilience and adaptation
- John Campbell: Resilience and adaptation in practice

11:30 – 1:15 AM—Panel: The Pacific Islands Climate Change Assistance Programme (PICCAP) Experience

- David Poihega: Vulnerability and adaptation in Niue.
- Simon Saulei: Adaptation issues in PICCAP Papua New Guinea.
- Eva Lewenikuruwai: PICCAP – Fiji's experience and future plans.
- Small group discussion: the next phase of PICCAP?

2:30 – 5:00 PM—Case studies of responses to environmental change I

- Pene Lefale: Traditional methods for weather forecasting: the Samoa experience
- Seluka Seluka: Case studies on responses to climate change (cyclones, droughts and coastal erosion)in Tuvalu

Short break

- Rex Thomas: Case study of hurricane tsunami in Port Orly – Santo, Vanuatu in 1998
- Nelson Rarua: Rural community perspective on adaptation to climate change: a Vanuatu view point

Workshop dinner

Thursday December 6

9:00 – 10:40 Adaptation policy challenges

- Tim Bayliss-Smith: Development
- Don Rubinstein: Climate change, and relations between local communities and larger political structures in the Federated States of Micronesia
- Mark Busse: Effects of drought in the Middle Fly, Papua New Guinea
- Alistair Woodward: Health and climate change in the Pacific

11:10 – 12:40 Adaptation policy challenges

- J. Salinger, P. Lefale and G. Griffiths: The ‘Island Climate Update’ - a success story of collaboration
- Violet Wulf and Bismarck Crawley: Adaptation in Samoa
- Atu Kaloumaira: SOPAC’s Comprehensive Hazard And Risk Management (CHARM) programme

2:30 – 3:30 PM Adaptation and Policy

- Richard Moyle: Taku
- Tony Hooper: Tokelau perspective on climate variability
- Jane Mogina: Coping with droughts in Milne Bay, Papua New Guinea
- Stephen Dovers: Framing policy and building institutions for sustainability

4:00 - 4:15 PM Summary, research and policy recommendations plenary

APPENDIX 2

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APPENDIX 3
PARTICIPANT SURVEY SUMMARY

Workshop Questionnaire

At the end of the workshop, participants were asked to complete an anonymous questionnaire which asked for their assessment of the workshop in various areas. A total of 20 questionnaires were returned to the organisers.

Helpful for understanding. The first question on the questionnaire was "How helpful was this workshop in advancing your understanding of human dimensions of climate change?" Three possible responses were offered, and the vast majority of respondents indicated that the workshop was very helpful in this regard. The complete distribution of answers is as follows:

16	Very helpful
3	Moderately helpful
1	Not at all helpful

Helpful for networking. The second question asked participants "How helpful was this workshop in expanding your networks of people interested in the human dimensions of climate change?" Again, three responses were offered, and the overwhelming majority of respondents indicated that the workshop was very helpful in this regard. The full set of responses was as follows:

16	Very helpful
4	Moderately helpful
0	Not at all helpful

Workshop location. 11 of the 20 respondents made positive comments about the workshop location, rating it as excellent, very suitable, good, or fine. 3 respondents found the workshop location only okay or reasonable. 3 respondents suggested that Fiji would have been a better location because of its centrality and the easier flight connections to Fiji. The following is a detailed summary of the comments that were made concerning the location of the workshop:

6	Excellent
1	Very suitable
2	Good
1	Good idea though tricky
1	Fine
2	Okay
1	Reasonable
3	Fiji would be a better option
1	Suggestion to hold workshop in another place that never had a workshop before
1	Pragmatic and allows concentration
1	Definite problems with rain noise and mosquito bites

Flights. 11 of the 20 respondents rated their flights to and from the workshop as either okay, good, or fine. 2 respondents specifically commented that travel arrangements and flights were smoothly organised. 6 respondents were less satisfied with their travel arrangements and wrote comments ranging from “flight schedules a bit unfortunate” to “time of departing flight awful” to “exhausting”. 1 respondent generously acknowledged that the flight arrangements were “beyond organisers’ control, as good as could be”. The following is a detailed summary of the comments concerning flights:

6	Okay
2	Good
1	Good, but other less stressful arrangements could be good
2	Fine
1	Very smoothly and efficiently organised
1	Things went smoothly
1	Lousy time tabling
1	Time of departing flight awful
1	Exhausting
1	Beyond organisers’ control, as good as could be
1	Good carriers (airlines), flight schedules a bit unfortunate
1	Connections a problem this time of the year
1	Satisfied though hoped to get home earlier

Accommodation. 9 of 20 respondents rated the accommodation in Apia as excellent, good, or fine. 1 respondent commented that the accommodation was “smoothly and efficiently organised”. 10 respondents rated the accommodation as only okay, satisfactory, adequate, or moderate. The following is a detailed summary of the comments concerning accommodation:

2	Excellent
6	Good
1	Fine
1	Very smoothly and efficiently organised
4	Okay
1	Satisfactory
1	Satisfied, but would prefer a less expensive hotel
2	Adequate
1	Moderate
1	Mosquito screen had holes

Per diems. 13 out of 20 respondents made positive comments (more than adequate, good, okay, fine, adequate) about the per diems. 5 respondents indicated that they found the per diems too low. A detailed summary of comments concerning per diems is as follows:

1	More than adequate
2	Good
6	Okay
2	Fine
1	Adequate
1	Very smoothly and efficiently organised
1	Fair
1	Satisfactory, but could be raised
1	“Risible” (not enough)

1	Could be improved
1	Too low
1	Welcomed
1	Not applicable

Speakers and sessions. 11 of the 20 respondents found the speakers and sessions excellent, stimulating, fine, or good. 7 respondents commented, in one way or another, on the length of the sessions with 3 people attributing this to trying to accommodate too many papers and another 3 stating that the session chairs needed to exercise more control. The following is a detailed summary of comments:

2	Excellent
1	Excellent, good range of diverse experiences
1	A good range of expertise
1	Well organised, stimulating
2	Good
1	Good mix of speakers and valuable interactions from participants
1	Good but too cramped
1	Good, but problem of tightness of presentation and civil behaviour
1	Too cramped, but fine
1	Fair, although some papers inapplicable and too many speakers from one country
1	Variable, tighter chairing of sessions would help
1	Firmer control needed
1	Some longer than necessary, but all informative
1	Needed better time management but good mix and content
1	Suggestion to put practical experience first followed by theoretical presentations
1	Suggestion to have more discussion in small groups
1	Too many speakers on country and regional efforts
1	“People are different so accept how they present them”

Further activities. Considerable interest was shown in participating in further activities. 17 of 20 respondents indicated that they would be interested in participating in future workshops. 10 respondents were interested in training sessions, and 18 were interested in participating in local level research projects.

APPENDIX 4
SUMMARY OF FINDINGS

Summary

APN Workshop on Local Perspectives on Climate Change and Variability in the Pacific

4-6 December 2001, Apia, Samoa

Resilience to Climate Variability and Extreme Events

- The adverse effects of climate change will be experienced as a consequence of multiple and sequential stresses.
- Ecologically sustainable development can increase a community's resilience.
- Flexibility and diversity are integral for resilience, including in terms of
  - food resources
  - mobility
  - sources of materials
  - sources of income
  - sources of water
- Surpluses in social and ecological systems confer potential flexibility, and therefore resilience.
- Traditional knowledge and local experience are important for resilience and should be considered in policy and planning processes.

Human Dimensions of Adaptation to Climate Change

- Adaptation is a social response to stress, perceived stress, or anticipated stress. It is critical to keep in mind that it is people's perceptions of stress that lead to particular adaptations.
- Adaptation to climate change and variability are not new in the Pacific, but it is a new policy issue for Pacific Island countries.
- Adaptation always has costs. Adaptation in one area will have costs in other areas.
- Short-term adjustments can have long-term consequences, and some of these consequences may be unforeseen and uncertain.
- Health is a good indicator of capacity to adapt.
- Adaptations to extreme events such as cyclones, floods, and droughts, will continue to be important, but new adaptations to climate change will also be needed.
- Vulnerability is not just about climate change. Vulnerability to aspects of climate change and variability is symptomatic of vulnerabilities more generally.

Issues of Scale and Context

- Human adaptation to climate change and variability cannot wait for improved predictability from models.
- Different places in the Pacific (and more generally) are different. No single scheme will fit all places. Local contexts and situations are critical.
- There are significant discontinuities of scale—global, regional, national, and local—that must be considered in thinking about adaptation to climate change and variability.
- There is a need for channels for education and funding across these discontinuities of scale.
- There is more to the local context than environment. Environment cannot be separated from
  - social context
  - cultural context
  - historical context
  - political context
- History is critical in shaping particular contexts.
- Local contexts are constantly changing. There is no equilibrium state.
- Interventions will take place at a variety of scales and will be implemented by individuals, communities, other groups, and governments. Governments will have a key role in facilitating and co-ordinating these activities.

Adaptation Policy

- Climate change policy should not be made in isolation from
  - sustainable development
  - the local level
  - other Government departments
- Short-term payoffs are needed to meet long-term policy objectives.
- Principles that should guide policy development include
  - participation
  - integration
  - transparency
  - credibility
- A vital goal of adaptation policy should be to continue to meet peoples' expectations and aspirations for a good life.
- Policy needs to anticipate changes rather than simply respond to them as they transpire.
- Policy formulation and implementation should be an interactive process between research, diverse forms of knowledge (including local knowledge), local communities, and policy makers.

Adaptation Policy Implementation

- Outreach to the local level is required. This should be done through individuals and organisations with a demonstrated capacity to engage in outreach, including teachers, health workers, agricultural extension officers, Non-Governmental Organisations, and climate change project officers.
- Education and awareness at all levels is necessary.
- There is a need for more assistance and capacity building at the local level, as well as at other levels of society and the state.
- There is a need for well designed institutional structures to implement adaptation policy.
- There is a need for knowledge and information to be communicated in all directions throughout society, including the local level.
- There is a need for continuous dialogue among all stakeholders.
- There is a need to encourage and fund specialised climate change programmes, including an urgent need for continuation of funding for climate change country co-ordinators and country teams.
- There is a need to integrate adaptation activities with existing national and regional structures and programmes.

APPENDIX 5

MEDIA REPORT AND RELEASES

APN/Macmillan Brown Apia Workshop: Media Report

Five media releases were sent out during the workshop, to radio, print and television media in all Pacific island countries, and to print and radio media in New Zealand, Australia, Singapore and West Coast USA. They received extensive coverage.

Most directly, it seems that the workshop saved the Apia observatory. This daily rainfall and temperature record stretches back to 1902—probably the longest-term weather record in the world. The 6 December workshop media release quoting Dr Jim Salinger and Dr Roger Jones voicing concern at plans to shift the observatory was featured prominently by all the Samoan media—Televise Samoa, Radio 2AP, Radio 96FM, and in print, *The Samoa Observer*, *The Samoa Post*, *O Le Samoa*, *Samoana*, *Tautai*, *Newsline* and *Talamag* magazine. Last report from Faatoia Malele, the Samoa Meteorological Office director, was that new marina buildings would probably be sited further away from the observatory.

All five workshop media releases are attached. All were disseminated widely throughout the Pacific and Europe at least.

- Pacific Islands Report—which has a broad international audience and is used by most Pacific and Pacific Rim national media—ran each media release in full.
- SIDSnet, another widely read Pacific website, ran the 6 December preview media release on their homepage for three weeks.
- Radio New Zealand International ran interviews with Penehuro Lefale on traditional forecasting, Faatoia Malele on the Apia Observatory, and Nelson Rarua on climate change adaptation and community sustainability needs. Radio New Zealand News ran the preview media release and possibly others.
- Radio Australia's Pacific Beat programme interviewed Jane Mogina on drought in Papua New Guinea and the need to enhance rather than undermine community resilience; Penehuro Lefale on traditional forecasting, Bismarck Crawley and Viola Wulf on Samoa's coastal hazards mapping strategy, and Nelson Rarua on climate change adaptation.
- The Vanuatu media ran extensive interviews with Nelson on the same topic.
- The Samoan media did the same with Bismarck and Violet's 18 December coastal hazards media release.
- Televise Samoa made the workshop its lead item on the first night of the workshop, and

ran all other releases. Samoan print and radio media also ran all releases.

- New Zealand Press Association sent the preview media release to NZ newspapers
- In Europe, the Independent on Sunday (UK) ran the 7 December media release on traditional forecasting, and plans a further article based on the final 7 January release.

All workshop media releases received excellent coverage in Samoa, thus informing the Samoan public. All will have been disseminated far further than this brief post-workshop trawl has revealed. For example, post-workshop inquiries about the media releases came from the International Red Cross/International Red Crescent in both Geneva and New York, and from the Pacific Islands News Association in Suva asking for an exclusive on any further workshop media releases.

It seems therefore that it was a most sensible plan to include a science journalist in the workshop. The result was media-friendly releases, and a far wider dissemination of relevant and important issues than generally emerges from scientific or technical workshops.

Asia-Pacific Network for Global Change Research/Macmillan Brown Centre for Pacific Studies, University of Canterbury, New Zealand

Media Release
December 2, 2001

WORKSHOP ON LOCAL PERSPECTIVES ON CLIMATIC VARIABILITY
December 4-6, 2001
Apia, Samoa

PACIFIC EXPERTS STUDY PAST DISASTERS TO PLAN FOR FUTURE CLIMATE CHANGE

Officials, academics and community representatives from Pacific and Pacific Rim countries meet in Samoa this week to discuss how climate has changed in the past, how island communities coped then, and how that knowledge could help them deal with global climate change.

Canterbury University’s Dr. Jon Barnett, who is co-ordinating the Workshop on Loca1 Perspectives on Climate Variability, says knowing what worked in the past is critical for Pacific island communities, because climate extremes are expected to increase in intensity, if not frequency, due to global warming.

"Pacific people are likely to face disruptive changes because of global warming, but there hasn’t been much research into how they could deal with these changes," Dr. Barnett said.

This week’s workshop has been organised by Canterbury University’s Macmillan Brown Centre for Pacific Studies, with funding from one of its international counterparts, the Asia-Pacific Network for Global Change Research. The Pacific’s environment agency, the South Pacific Regional Environment Programme, is also heavily involved in the workshop.

Dr. Barnett says the focus is on local and indigenous perspectives, which have so far not been adequately considered in climate change research and policy in the Pacific.

"This includes how local communities help themselves, and the kinds of help they get from neighbouring communities, family members living elsewhere, governments, and aid agencies."

In the Pacific, locals have long complained that Western advice doesn’t take into account the fact that three thousand years of living in the same place have taught them a few things about their environment.

In a 1997 scientific paper, Nakibae Teuatabo, a former Kiribati Environment Minister, also formerly the Director of the Kiribati Meteorological Office, gave the example of one consultant who was clearly elated that simply by kicking some mud off a bank and pointing to it washing away, he had shown Kiribati officials how erosion silts up tidal lagoons.

"He did not know that people have traditionally piled stones on the reef platform to form fish traps that have lasted for a long time, and have also built groins to facilitate accretions of the beach," Mr. Teuatabo said.

His 1997 paper also detailed long-term Kiribati knowledge of the El Niño and La Niña weather patterns, and mentioned another underlying climate pattern, with what Kiribati people call the *Aumaiaki* and *Aumeang* phases. The strong westerlies of the *Aumeang*, which tended to blow down trees, but also replenished beaches with sand, haven’t been seen for some time.

Senior NIWA climate scientist Dr. Jim Salinger, who is also attending the workshop, said those bursts of stronger westerlies must have come from some underlying climate pattern. "The locals know about it but we don’t yet. If we did, and if we could identify what we needed to measure, we could give even better drought and storm warnings."

MACMILLAN BROWN CENTRE FOR PACIFIC STUDIES
University of Canterbury
New Zealand

MEDIA RELEASE
December 6, 2001

SAMOAN MARINA PLANS WOULD DESTROY GLOBAL METEOROLOGICAL TREASURE

A Chinese Government plan to build a US$ 4 million marina on the site of the Samoa meteorological office has dismayed climate scientists, who say moving the weather recording station would destroy one of the best climate records in the world.

Concern about the marina's impact on the integrity of weather records was raised during this week's Apia workshop on local perspectives on climate variability, organised by Canterbury University's Macmillan Brown Centre for Pacific Studies.

The Apia Observatory has measured daily temperature and rainfall since 1902. "That's the longest uninterrupted record in the Pacific, and one of the best in the world," Roger Jones said.

Dr. Jones, from Australia's Commonwealth Science and Industrial Research Organisation (CSIRO), said Samoa's uninterrupted weather record is the envy of virtually every country in the world. "If you build too close to the station, you distort the temperature readings, and if you move the station, you break the uninterrupted record," Dr. Jones said. "That would really harm our ability to monitor long-term changes in climate. The only way you can monitor trends in climate is to have a long-term record from the same site."

He said if the weather monitoring station did have to move, the record would only be preserved if there were parallel measurements at both old and new sites for at least five years.

Dr. Jim Salinger, a senior climate scientist with New Zealand's National Institute of Water and Atmospheric Research (NIWA), said the observatory's long record gives Samoa the best chance in the Pacific to monitor changes in climate.

"It's so important that last month Pacific island meteorologists attending an Asia-Pacific Network for Global Change Research workshop in Auckland recommended that it should be given World Heritage Site status," Dr. Salinger said. "For the sake of the Pacific's future ability to pick climate trends, I do hope the Governments of Samoa and China consider putting their fishing boat marina and buildings at least a hundred meters away from the Apia Observatory."

MACMILLAN BROWN CENTRE FOR PACIFIC STUDIES
University of Canterbury
New Zealand

MEDIA RELEASE
December 7, 2001

FORECASTING THE PACIFIC WEATHER BEFORE THERMOMETERS WERE INVENTED

The Pacific island voyagers who navigated the Pacific used their bodies' most sensitive parts to check the temperature of the surrounding waters, a workshop on local perspectives on climate variability has been told.

Climate researcher Penehuro Lefale told the workshop, being held in Apia this week, that Samoan fishermen in the open ocean would immerse their testicles in the seawater to test the temperature. "If the water was becoming colder, their testicles would shrink and they knew they were moving away from land," Mr. Lefale said. "If the water was warmer, they knew land was near."

He told the workshop, which has been organised by Canterbury University's Macmillan Brown Centre for Pacific Studies, that this was only one of a broad range of traditional forecasting techniques known to Samoans.

"On land, they could tell wind direction by the position of the piles of sand beside the hermit crab holes. The crabs pile the sand to shelter their holes from the wind, so the side of the hole where the sand was piled was the direction the wind was coming from."

Mr. Lefale said hermit crabs also signalled the approach of a tropical cyclone. "When they dig big holes, Samoans know a cyclone is coming, because the crabs are digging in deep so they'll survive the cyclone."

He said the behaviour of cockroaches also gave warning of a cyclone. "When they all fly into the open fales at night, you know a cyclone is coming." Mr. Lefale speculated that cockroaches could act as barometers, changing their behaviour when pressures dropped before a cyclone. Another workshop participant confirmed this theory, saying cockroaches had been found to be highly sensitive to changes in pressure.

Workshop participants from Tuvalu and Fiji said their people had similar forecasting techniques, and agreed that this knowledge should be recorded. They said there had been a lot of recent interest in traditional medicine and in plants with medicinal qualities, but so far there had been no research into traditional forecasting knowledge.

Media release from the Macmillan Brown Centre for Pacific Studies, University of Canterbury, New Zealand

18 December 2001

Samoa combines science with community in coastal risk planning

Samoa’s combination of the best scientific tools with community knowledge of the country’s coastline has put it ahead of most other Pacific countries in preparing for worsening damages from global warming. A detailed mapping exercise has identified every coastal risk along all coastlines, and local communities are now drawing up contingency plans.

Violet Wulf, from Samoa’s Department of Lands, Surveys and Environment, says villages are now discussing building new sea walls if appropriate, shifting some roads further inland to take them out of landslip, flooding and storm hazard zones, and improving their cyclone warning systems.

World Bank project component manager Mr Bismarck Crawley told a Macmillan Brown Centre/APN workshop on local perspectives on climate variability, held in Apia Dec 4 - 6, that the detailed aerial and land study of Samoa’s coastline shows that 76 per cent of Samoa’s 574 kilometres of coastline is highly vulnerable to coastal erosion.

As well, 93 per cent of Samoa’s coastal zone - virtually all the heavily populated areas - will be in the flood hazard zone within half a century. “On Manono Island, the whole island is vulnerable to coastal erosion and flooding, because all the land is so close to sea level,” Mr Crawley said.

The coastal hazards survey identified specific vulnerable assets like sea walls, bridges, roads, power lines and water pipes, and other resources that would be damaged by future cyclones, heavy flooding and landslips.

“Equally importantly, we’re working with the communities to work out the best solutions, to minimize these impacts. We set up 277 field stations, and that included gathering anecdotal data and conducting detailed interviews,” Mr Crawley said. The complex exercise of mapping Samoa’s coastal hazards involved every community in the country who will be affected. It was jointly organised by the World Bank’s Infrastructure Asset Management Project, AusAID and the Samoan Government.

Detailed hazard maps have recently been presented to the representatives of each village, and regular updates are planned. Mr Crawley said community discussions included the need to raise some houses, schools and churches where they would otherwise be destroyed or damaged by storms, floods and sea level rise.

Ms Wulf said Samoa had already used the mapping information to develop a national coastal hazard strategy, formalised in February 2001 and now being implemented locally.

Media release from the Macmillan Brown Centre for Pacific Studies, University of Canterbury, New Zealand

7 January 2002

Climate change already affecting Pacific island communities

Pacific island communities are already being forced to move their villages inland, as sea levels rise and storms become more savage. Participants from seven Pacific island countries attending the Macmillan Brown Centre for Pacific Studies workshop on local perspectives on climate variability, held in Apia Dec 4 - 6, confirmed meteorological observations that the Pacific climate is changing. They said the changes were so potentially dangerous that they could not afford to wait for any greater scientific certainty.

Nelson Rarua, from the Vanuatu Meteorological Office, said in some of his country's villages, especially on the smaller islands, rising seawater is now seeping under the island, and coming up underneath the villages. He said people living on those islands are resisting relocation. "Their chief has told them to move but the funny thing is, they haven't," Mr Rarua said. "But given the rate of sea intrusion, it's only a matter of time."

Simon Saulei, from the University of Papua New Guinea, said similar problems were arising in his country. He said people found it unthinkable to move off their family land, where they'd lived for thousands of years. "If they go to someone else's land, they lose their identity," Mr Saulei said. "You get all sorts of follow-on social and health problems."

He said however that changes in climate were forcing such considerations. "In the last 15 years we've had heavier rain and more erosion, and new roads built with overseas aid dollars are getting washed out."

Participants at the workshop said climate change brought two particular kinds of risks to Pacific island countries. Extremes like storms, droughts, floods and erosion would become more severe, and gradual increases in average temperature and sea level would cause accelerating problems when they passed certain critical thresholds. Past a certain temperature threshold, for example, Peruvian researchers have found that childhood diarrhoea hospital admissions rise eight per cent for every degree Celsius rise in temperature.

Workshop participants detailed the past resilience of Pacific island communities in the face of cyclone, storm surge and drought. However, they also spoke of how the resilience of people living on small islands only one to two metres high could be sapped by too many disasters piling up too close together.

Auckland University anthropologist Professor Antony Hooper presented one eyewitness account of the sheer terror of a storm surge that washed over Tokelau in 1987.

"At 7 in the evening, large waves began to come up at Fenuafala. The sight of them was terrifying . Nothing can stand and resist the path of a wave; wherever a wave goes it carries along with it standing trees - palms, pandanus and all, together with rocks, debris and sand. The lagoon was completely white and so rough that the islets on the other side could not be seen. People living at the lagoon side of Fenuafala could hear the roar and crash of the waves, and the smashing of the things they struck at the ocean-side. But more than that, they could see the huge breakers towering above the coconut palms. This means that the waves were 20 to 30 feet high, while the height of Fenuafala above sea level is only four to six feet."

Atu Kaloumaira from the Disaster Management Unit of SOPAC, the South Pacific Applied Geoscience Commission, said while communities could recover from such terrifying events if they happened only once or twice in a generation more frequent devastation would inevitably gradually wear away people's natural ability to cope.

Increases in averages are also important, Professor Alistair Woodward from the Wellington School of Medicine and Health Sciences told the workshop. He said in Nanjing and in Tokyo, researchers found that hospitals experienced dramatic increases in heatstroke admissions when temperatures rose above the thresholds of 31 and 35 degrees Celsius respectively. Dr Woodward said closer to home, increases in the temperature of the tropical Pacific's sea surface were responsible for the recent rise in cases of ciguatera, the fish poisoning disease which can cause paralysis or death.

The Apia workshop, which was funded by the Asia-Pacific Network for Global Change Research, agreed that a community's ability to deal with climate change depends on how well it also copes with other pressures. Participants stressed that there was no 'one-size-fits-all' method of planning for climate change, and said it was critical to take into account local contexts and situations. The workshop's final conclusions note that local knowledge is critical to the development of climate change policy, and the process of developing such policy should involve both national policymakers and local communities.

Nelson Rarua said while the workshop discussions dealt with Pacific island climate change concerns, the problem is a global one. "Of course Pacific island countries are voicing their concerns now because they are going to be hit hard. But did you know also that 2001 is now the second warmest since records began? The earth is spinning into a very dangerous situation and I think even talk of adaptation should not becloud the fact that the whole world should stop using fossil fuels now or we all suffer adverse consequences. For the benefit of future generations, developed countries should really act now."

APPENDIX 5

WORKSHOP ABSTRACTS

TABLE OF CONTENTS

RESILIENCE AND ADAPTATION

Jon Barnett
Macmillan Brown Centre for Pacific Studies
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The concept of resilience is increasingly being used in research and policy discussions on the impacts of climate change. Resilience is the inverse of short-term vulnerability: a vulnerable system is not very resilient / a resilient system is not very vulnerable. Resilience, then, is the ability of a system to cope with sudden external shocks and still persist. For any given society, resilience means being able to withstand sudden changes like floods or cyclones or economic downturn without great loss and without substantial damage to its core values and positive attributes.

To give an example: if flooding causes lasting damage to houses in a village, destroys all its food supplies and creates hunger or dependency on international food aid, contaminates its water and so creates significant illness, causes major conflict within the village, and leads people to permanently out-migrate, then that village would not be considered to be resilient to floods. However, if the village was able to rebuild its houses, maintain food and water security, control post-flood disease and maintain co-operative behaviour and sustain people's livelihoods, then that village would be considered resilient.

The need for resilience

Climate extremes severely impact on the Pacific Islands, and it is the possibility of increased frequency and/or intensity of these due to climate change that now most concerns policymakers (McCarthy *et al*. 2001). In recent times the 1997-98 El Niño caused widespread drought and subsequent famine in the islands west of the international dateline, with agricultural losses in Fiji valued at US$65 million, and some 260,000 people in Papua New Guinea placed in a life threatening condition due to depleted food supply (WMO 1999). In the same period there was an increased frequency of tropical cyclones east of the international dateline. The Cook Islands experienced 17 tropical cyclones, the most recorded in a season (WMO 1999). Cyclones are particularly problematic and have caused massive financial losses; cyclone Ofa which struck Western Samoa in 1990 caused US$110 million worth of damage, as did cyclone Kina which struck Fiji in 1993 (Campbell 1990, Olsthoorn *et al*. 1999). As well as wind damage and damage from increased rainfall and flooding, cyclones induce storm surges which can reach up to six meters in height, far in excess of the maximum height of atolls. For example, in 1987 a cyclone and storm surge struck Tokelau, bringing waves that swept across the islands and flooding of up to a meter on the island of Fakaofo (Hooper 1990). These surges will be greater if superimposed on elevated sea-levels, and greater still if cyclone intensity increases due to climate change (Olsthoorn *et al*. 1999). Successful adaptation to climate change requires understanding and enhancement of people's strategies to prepare for, respond to, and recover from extreme events such as these.

What makes communities resilient?

A number of characteristics help make communities in developing countries resilient, notably: the size and mobility of the labour force (can people move to get cash-paying jobs at short notice?); the strength of kinship ties (can households in need get assistance from relatives living elsewhere?); reserves of food supplies (are there famine foods or food stores?); and the ability to attract effective relief from government and multinational organisations (can communities attract assistance from larger organisations and can that assistance be implemented in ways that do not undermine future resilience?) (Torry 1979).

The social-ecological systems of the Pacific Islands have historically been able to adapt to environmental change. Considerable resilience to (short-term) hazards has been documented (Campbell 1990, Lessa 1964, Marshall 1979, Rappaport 1963). Campbell argues that Pacific Island societies have historically had a range of practices that made them resilient to climate extremes, and that since colonisation these have been modified to suit changed political and economic circumstances (Campbell 1998).

Research into coping with hazards has identified a number of general strategies that enable societies to both absorb and recover from sudden environmental changes, including:

- Diversification of sources of food, water, material and income, and the diversification of the means by which these are delivered. The more diverse the resources and the more diverse the means of delivery, the less likely it is that the supply of vital items will falter. For example, as well as storage and preservation of food, food security in many places in the Pacific is maintained through planting a diverse array of plants in gardens, and through biodiversity in the immediate environs which provides ‘famine foods’ when gardens fail;
- Maintaining surplus, slackness or savings in systems that supply food, water, materials and income. A system which has a capacity in excess of its needs can draw on this extra capacity in times of need;
- Maintaining options to relocate temporarily and permanently. Because of migration of Pacific people away from their home islands, ‘transnational economic and social relationships’ have developed, and these are an important factor in the resilience of Pacific peoples to global forces like climate change. For example, considerable migration within home islands was observed in Samoa and Tokelau during cyclone Ofa;
- Decentralisation of decision-making. Overly hierarchical systems are less flexible and hence less able to cope with surprise and adjust behaviour;
- Mobilising social networks and systems of redistribution (the whole insures the parts). Complex sets of interactions among people across space (principally through kinship) enable a community under stress from a hazardous event to receive assistance from other communities, usually in the form of redistribution of food and money. For example after cyclones Ofa and Val struck Samoa significant sums of money were sent to villages from Samoans living in New Zealand. This requires good social relations with ‘neighbours’ and family members;
- Maintaining equity within communities in terms of individual’s and household’s social and political influence, and entitlements to resources. Studies have shown that the more equitable societies are the more adaptable they are and the less prone they are to internal conflict in times of stress (see Adger 1999, Baechler 1999, Barnett 2001, Blaikie *et al.* 1994, Handmer and Dovers 1996, Hooper 1990, Kates 2000, Mogina 1999, Torry 1979).

Resilience, adaptation and adaptive capacity

Climate research and policy has traditionally described responses to climate change as adaptation, understood to be adjustments in natural and social systems in response to climate change (see McCarthy *et al*. 2001). For the most part this refers to adjustments to changes in mean climate and sea-level conditions. The ability to adapt is called adaptive capacity, the determinants of which, according to the Intergovernmental Panel on Climate Change (IPCC), includes: economic resources, technology, information and skills, infrastructure, institutions, and equity (McCarthy *et al*. 2001).

Both resilience and adaptation involve responding to environmental change. The difference is that resilience refers to a successful response to sudden, short term changes, whereas adaptation refers to successful responses to longer-term changes in mean conditions (see Figure 1).

Seeking resilience can also deliver adaptability. An integral feature of resilient systems is an ability to learn from, and reorganise to meet, changed conditions – and this is also an essential quality of adaptable systems. Both resilience and adaptive capacity are about the properties of systems that enable them to change to meet new circumstances in a controlled way without any significant economic, social or cultural damage.

Responses to short-term events can enhance or degrade ability to respond to similar events in the future. For example the provision of food aid after cyclones can undermine longer-term food security. Experience has shown that if food aid is maintained for too long, or is distributed in ways that bypass local networks of exchange and distribution, then this may lead to people becoming dependent on external sources of food to the detriment of local food self-sufficiency. Increased dependency on external food can undermine local self-sufficiency, making communities more vulnerable to future extreme events (particularly given that further food aid cannot be guaranteed). Conversely, if in recovering from a cyclone communities seek to increase local food production and diversify cultivars and location of gardens, then they are likely to be more resilient to future extreme events.

Responses to short-term events can improve or degrade adaptive capacity. For example, if in times of drought and subsequent food and water stress communities share resources to ensure food distribution is equal, this reinforcing or strengthening of social cohesion (or social capital) will assist in adaptation to longer term changes in mean conditions. However, if in response to drought there is protracted conflict among a community, with some people having substantially more food and water, or indeed unfairly appropriating food and water from common property sources, then this may have a lasting negative impact on social cohesion and a detrimental effect on the community's ability to adapt to longer–term changes in mean condition.

Research and policy implications

A strategy of resilience involves building up institutional structures and human resources as these are the first and last requirements of a system able to absorb, learn from, and modify itself to changes. A tentative list of policy goals can be proposed. These broad policy goals can be summarised as focusing on information, communication, education, economic policy and institutional design.

A first order priority is to increase the availability of information necessary to understand the state of the biophysical and social environment. This is a task for research in both the biophysical sciences and social sciences. Baseline data sets and monitoring of key indicators are necessary to understand sensitivity to change. Equally important, however, is the capacity to distribute this and other forms of information in all directions throughout the society. This means developing the physical infrastructure for communications, but also utilising regular social practices of information exchange.

In that broadly educated societies seem to more resilient to environmental change, education policy is a key to resilience and adaptation. In the realm of technical capability, the answer need not lie exclusively in formal training: not all research work requires a university degree, and it is as important to have a large number of people capable of reading equipment as it is to have a few technical experts able to interpret the data. Further, one need not have a degree in sociology to monitor basic changes in social conditions. Developing these technical skills may be as much about giving opportunities and responsibility to people as it is about training.

The need for resilient and adaptable social-ecological systems also has implications for economic policy in Pacific Island Countries. There is a need for investment in transport infrastructure to enable rapid transfer of resources wherever and whenever necessary. In the case of extremes events, better infrastructure will also enable rapid movement of people away from disaster areas. Equally important is the need to diversify sources of supply from within and islands, including sources of information, of technology, of raw materials and of income. The buffering principle suggests a need for purposeful accumulation (savings) of various forms of capital such as financial resources, food, fuel, fibre, and genetic diversity.

In terms of development, the variable vulnerability of groups within Pacific Island Countries suggests targeting employment and sustainable development programmes at the most disadvantaged people in the most disaster-prone places (see Blaikie *et al.* 1994). The understanding of 'social vulnerability' therefore becomes essential to policies for resilient and adaptable Pacific Island societies (see Adger 1999, Handmer *et al.* 1999).

In terms of food security after extreme events, experience from elsewhere shows that local employment schemes very effectively avoid famine by providing households with income that can be used to purchase food (Sen 1999). Rapid provision of medical assistance is also a highly effective response since death from famine occurs largely through reduced resistance to disease.

The most important institutional need is to enhance the participation of all people in research, in monitoring, in decision making, and in policy implementation so that to the greatest extent possible everyone is involved in the management of the relevant community's future. Enhancing participation may require developing capacity in communication, translation, team-work facilitation and conflict resolution, again suggesting the importance of education and training.

At the broader regional scale there is a scope for designing and implementing a polycentric organisational structure (a Pacific Island climate change administrative system) with three not necessarily hierarchically related levels: 1) regional - 2) national - 3) local. The purpose of such a system would be to involve as many people as possible in various activities related to climate change and accelerated sea-level rise. This is not to argue for the centralisation of authority, as this has historically been part of the process that has undermined community resilience to climate extremes. This also involves more than simply shifting all authority downward to local communities (although more of this is essential), instead it involves locating authority with appropriate regional, national, local and non-governmental organisations in a co-ordinated and communication-rich system. In this schema regional and national organisations are brokers, facilitators and funders of local level climate change adaptation strategies. Such a scheme offers the possibility of re-establishing mutually supportive relationships among local communities as they liase on the common problem of climate change and sea-level rise.

The South Pacific Regional Environment Programme is the obvious candidate for the principal authority at the regional level. At the national level there are two principal options, either expand on the Pacific Islands Climate Change Assistance Programme (PICCAP) country teams, or expand on the Disaster Management Committees established as a result of the International Decade for Natural Disaster Reduction (IDNDR). At the local level governing bodies based on the suitable administrative unit (most likely the village) could be established. Designing such a system could take account of existing organisations and linkages, and could identify key people.

As well as being a prerequisite for resilience in its own right, the proposed administrative system could be invaluable for a number of specific tasks related to adaptation: it could provide official nodes for supporting and organising research in localities; it could provide clear lines of communication vertically; it could provide a framework for monitoring changes and communicating findings; it could provide channels and nodes for community education and awareness raising; it can bring a wide array of people into an integrated system, and so help foster the development of human resources. In sum, these broad policy goals aim to develop systems of purposeful exchange between informed social groups living in a social-ecological context characterised by a fair level of resource saving, a high degree of sensitivity to change, a capacity to learn, and a capacity to change. They have strong resonance with existing calls for capacity building, disaster planning, education, and human development, and it is important to stress the interdependence of these things as a requirement for coping with climate change.

A final though: there is a need for policy formulation to define what constitutes 'significant' loss, or to put it another way: what would count as 'successful' adaptation? This might be ascertained by asking: what is it about life that is 'good' and which must be protected (if not enhanced) from the effects of climate change? For example, if rates of employment decline due to the impacts of climate change then adaptation has not been successful, or if people starve due to drought then resilience strategies have not worked. Ultimately, then, adaptation policy needs to take account of people's aspirations for the future: that is what sorts of lives people would like to live and would like future generations to live. It is this vision of development that policies for resilience and adaptation could be seeking to protect.

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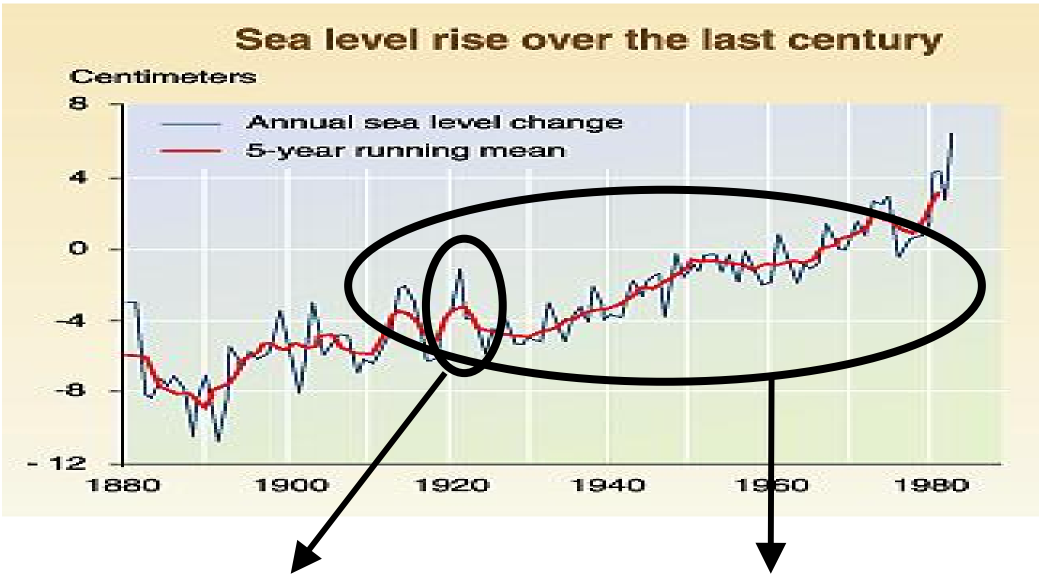

Resilience – response to short-term changes **Adaptation** – response to change in mean conditions

Figure 1: Conceptualising the difference between resilience and adaptation using the example of changes in sea-level.

EFFECTS OF DROUGHT IN THE MIDDLE FLY, PAPUA NEW GUINEA

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South of the central mountain ranges of New Guinea and straddling both sides of the political boundary that separates Papua New Guinea from the Indonesian province of West Papua is a vast lowland alluvial plain. From the air, this plain looks like a great green carpet stretching away in all directions to the horizon, uninterrupted except for the winding courses of muddy rivers and their flood plains consisting of shallow lakes and areas of periodically inundated grassland, marsh, and Melaleuca swamp savannah. The largest of these rivers is called the Fly by Europeans and Waimarha by the people who live along its middle reaches and who are the subject of this paper.

The Fly is one of the world's largest rivers, discharging 200 trillion tonnes of water and 100 million tonnes of soil and silt each year (Jackson 1982:104). This huge discharge is less the result of the Fly's catchment area, which is a relatively modest 75,000 square kilometres, than of the extremely high rainfall and erosion rates in the headwaters of the river where as much as 14 meters of rain has been recorded in a single year. For virtually all of its course, the Fly has an extremely low gradient. At the mouth of its main tributary, the Ok Tedi—a point 800 kilometres up river—the Fly is only 40 meters above sea level. This low gradient, combined with the high rates of erosion in the mountain catchment and the resulting high sediment load, has resulted in the formation of many back swamps, ox bow lakes, and blocked tributary lakes. These geographical features in the Fly's vast flood plain, which are critical to the livelihoods of the people who live along the river, have been formed by sediment deposited by the Fly as it loses speed and thus its capacity to carry sediment.

In terms of geography, climate, and vegetation, the Middle Fly area, which is the focus of my paper, is a transition zone between wetter, more dissected, and rainforest-covered areas to the north, and drier and flatter areas to the south which are covered with open forest, grassland, and savannah. The differences in vegetation are due in part to different rainfall regimes. The area between the Middle Fly and the south coast receives less than two meters of rain per year with two-thirds of that amount falling during the north west monsoon between December and March, while the lowland ridges to the north of the Middle Fly receive up to five meters of rain per year in a much less seasonal pattern.

The Middle Fly itself receives an average of 2.5 meters of rain per year, over half of which falls during the four months of the north west monsoon which lasts from late December to mid-April in the Middle Fly. The dominant geographical feature in the Middle Fly is the Fly River itself, with its 300 to 400 meter channel and 15 kilometre wide flood plain. In the midst of this flood plain are numerous lakes and extensive areas of swamp and marsh. Along the river and around the edges of the shallow lakes are large tracts of grassland and swamp which are periodically inundated when the Fly overflows its low banks. Away from the river are somewhat higher areas consisting of low ridges (in general only a meter or two high) covered with open forest or rainforest. In the marginally lower areas between these ridges are the vast sago swamps from which the people of the Middle Fly get most of their food. Despite these somewhat higher areas away from the river and its flood plain, the overwhelming impression one gets travelling through the Middle Fly is of extensive flatness and swamp. Paijman (1971:88) notes that such areas of the southern lowlands elevation differences of as little as half a meter can result in significant differences in the depth and duration of flooding when rivers are high and hence can be important in determining the height and composition of vegetation. This was certainly true in the Middle Fly.

The approximately 2,000 people who live in the Middle Fly Census Division are primarily hunters, fishermen, and sago makers, and they speak one or (more often) both of two closely related languages—Boazi and Zimakani. They have a loosely defined sexual division of labour in which the extended family is the maximum unit of production. The most important food item, both in terms of diet and ideology is sago, a starch extracted mainly through women's work from the pith of naturally-occurring sago palms (*Metroxylon sagu*) which grow abundantly along the edges of flood plain. In addition to sago, the Middle Fly is extraordinarily rich in wildlife. Pigs, wallabies, deer, cassowaries, and other birds such as ducks and geese are plentiful, and men hunt these animals using a variety of techniques and a combination of traps, bows and arrows, and shotguns. While ideologically less important than hunting, fishing (which is done by men, women, and children) probably provides more food. In contrast with hunting, fishing, and sago making, gardens play only a minor role in the production of food. Most people have a few stands of bananas along the banks of the Fly or around the edge of the village, but bananas are mainly thought of as supplementary food or as food for those times when there is nothing else to eat. In general, however, people in the Middle Fly disdain what they see as the hard work that gardens require, preferring to rely on wild sago, fish, and game—all of which are plentiful in the Middle Fly.

In addition to the yearly cycle of wet and dry seasons, there is a longer cycle of especially wet and especially dry years in the southern lowlands which are linked to the El Niño phenomenon. When I first arrived in the Middle Fly in June 1982, people identified 1965, 1972, and 1979 as having been particularly dry years, but 1982 (the year of the most extreme El Niño event up to that time) was the was the most severe drought in living memory in the Middle Fly. During the second half of that year, the Fly River dropped almost ten meters and shipping between Port Moresby and Kiunga, the port for the Ok Tedi copper mine at the headwaters of the Fly, was interrupted and several ships were stuck in the Fly between the middle and upper reaches of the river. The blocked tributary lakes some of which are usually three to four meters deep, were completely dry, the only time in living memory that was the case. The water level was so low that, during October and November 1982, it was impossible to make sago because there was no water with which to wash the starch from the pith, even though people dug deep holes in the then dry floors of their sago swamps. Also during the second half of 1982, people in the Middle Fly abandoned their villages in the midst of the river's flood plain and moved to camps along the banks of the Fly in order to be close to their stands of bananas and because the only drinking water was in the river channel itself. At the same time, as the swamps drained fishing and crocodile hunting, which is an important source of cash in the Middle Fly, became significantly easier.

Despite abundant natural resources, the Middle Fly has a population density of less than 0.5 persons per square kilometre. The primary reasons for this low population density appears to be malaria, which is endemic in the Middle Fly, exacerbated by the cycle of exceptionally dry years. Riley (1983) has argued that the present population distribution in New Guinea is largely the result of the regulation of population by malaria. He argues that malaria is a particularly good population regulator because it is efficiently transmitted through mosquitoes, it has a short incubation period, it causes high—but selective—mortality (mainly in individuals between six months and five years of age), it depresses fertility by causing abortion and premature labour, and in the long term it causes anemia and may reduce individuals' responses to other infections. While the relationship between droughts and population density in the Middle Fly is partly due to difficulties of obtain food and water during drought years, there is also a delayed effect related to sharp increases in malaria in the years immediately following particularly dry years. As the level of the Fly River drops, the lakes and swamps in its flood plain dry up. The exposed lake beds are quickly covered with high grass. When the river eventually rises and lakes are inundated, the grass remains, at least temporarily. The grass removes the oxygen from the water. The lack of oxygen, in turn, means that there are few or no fish in the lakes. Not only does this mean that fish are less readily available than when the lakes are clear, but it also means more mosquitoes since the fish eat the mosquito larvae.

This was the sequence of events following the extreme dry season of 1982. As already mentioned, during the second half of 1982, the lakes in the Middle Fly became completely dry and were covered with high grass. People burned this grass because they did not want it in the lake when the lake again flooded. Unfortunately, they burned it too early, and when the river rose in December 1982, the lakes were already again full of grass. It took over a year for the grass to die, and during that time there were few fish in the lake (removing an important source of daily protein) and the mosquitoes were much worse than they were after the grass died and the lakes were once again bodies of open water.

The effects of El Niño-induced drought in the Middle Fly are thus both immediate and long-term. The immediate effects include the difficulties of producing food and finding water, but the long-term effects include delayed increases in malaria and the regulation of population. Understanding drought in the Middle Fly thus provides a case study of the effects of large-scale climate events on people.

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RESILIENCE AND ADAPTATION IN PRACTICE

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The slow progress towards a meaningful international regime of greenhouse gas emission reductions means that Pacific Island Countries are likely to face considerable climate change impacts. Accordingly there has been growing attention on the need to develop capacity to adapt to, or resilience to withstand, the negative changes that might occur. In this paper I explore possibilities for effective adaptation in Pacific Island Countries drawing on existing and traditional practices.These include such things as maintaining crop diversity, food storage and preservation, inter-island exchange, building cyclone-resistant houses, and village (re)location. Many of the traditional practices have declined in the face of colonization and globalisation. Contemporary community expectations may also serve to make these options less attractive. Nevertheless, there are possibilities for learning from these traditional practices and adapting them to current settings. One example is the important role of outmigration and remittances as a response to natural disasters.

Consideration of traditional coping mechanism also enables us to reconsider some of the terminology used in climate change. The term resilience is one that is being commonly used in relation to climate change to connote ability of communities, or their assets, to withstand change. More specifically it means the ability to return to an original state after being disturbed. But, Pacific Island communities are dynamic and changing and an emphasis on this concept may serve to deny such processes. Much of the discussion on adaptation has focused on the identification of adaptation options. This implies that specific adaptations can be identified and implemented. However, when we consider traditional adaptive practices it is clear that they were parts of a larger socioeconomic and environmental system. They did not exist as single, unrelated, stand-alone activities but were integrated into everyday life. This created a state of adaptability in Pacific Island communities.

A case is made for the introduction of adaptability as a key concept in the climate change response lexicon. Adaptability connotes social (rather than technological) processes, flexibility, dynamism (as opposed to resilience) and a holistic rather than piecemeal approach. It also enables consideration of community led or bottom up approaches rather than the imposition of single or specific adaptation options that result from technological research and are usually imposed in a top down manner.

FRAMING POLICY AND BUILDING INSTITUTIONS FOR SUSTAINABILITY

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The following outlines some basic frameworks to help understand what is required for good environmental policy.

The task of framing policy processes and reforming institutions to have purchase on sustainability problems like climate change is recognised as being supremely difficult. This is especially the case where (long term) local or regional impacts result from international processes or the actions of other countries. In the case of climate change, policy responses are difficult because it involves crossing political, economic and ecological scales of time and space. Policy design must take account of two sources of perspective that will often be in tension:

- Existing understanding of other policy problems (like development) from fields such as public administration, law, institutional theory, international relations and political science; and
- An understanding of the *particular* nature of sustainability problems like climate change, and the ways in which they differ from traditional policy (and research) problems. That they do differ is evident from the difficulty encountered in handling these problems through existing, historically defined policy processes and institutions.

Sustainability problems like climate change differ in kind, and perhaps degree, from many other policy problems, due to their *problem attributes*, including:

- broad, deep and highly variable spatial and temporal scales;
- the possibility of absolute ecological limits to human activity;
- irreversible and/or cumulative impacts;
- pervasive risk and uncertainty, often not amenable to probabilistic analysis;
- new moral dimensions (other species, future generations);
- ‘systemic’ problem causes, embedded deeply in patterns of production, consumption, settlement and governance;
- complexity within and connectivity between affected systems;
- important resources and environmental assets are not traded through formal markets and not easily assigned a monetary value;
- difficulty in separating public and private costs and benefits;
- lack of available, uncontested research methods, policy instruments and management approaches;
- lack of defined policy, management and property rights, roles and responsibilities;
- demands and justification for increased community participation in policy and management; and
- sheer novelty as a suite of policy problems (Dovers 1997).

It is necessary to consider the underlying policy processes and institutional settings through which proposed policy responses will be mediated (or, in some cases, be aimed at changing). Three frameworks are presented below that seek to inform that dual focus. The first (Figure 1) is a checklist of the necessary elements of policy processes for sustainability. This is not a prescriptive model, but simply a broad framework identifying what comes before and after the specific ‘policy statement’ that often receives most attention (from Dovers 1995).

Figure 1: A Checklist of Elements for Good Sustainability Policy

Problem framing:

1. Discussion and identification of relevant social goals
2. Identification and monitoring of topicality (public concern)
3. Monitoring of natural and human systems and their interactions
4. Identification of problematic environmental change
5. Isolation of proximate and underlying causes of change
6. Assessment of risk, uncertainty and ignorance
7. Assessment of existing policy and institutional settings
8. Definition (framing and scaling) of policy problems

Policy framing:

9. Development of policy principles
10. Construction of policy statement
11. Definition of testable policy goals

Implementation:

12. Selection of policy instruments/options
13. Planning of implementation
14. Statutory, institutional and resourcing requirements
15. Establishment of enforcement/compliance mechanisms
16. Establishment of policy monitoring mechanisms

Monitoring and review:

17. Ongoing policy monitoring
18. Mandated evaluation and review
19. Extension, adaptation or cessation of policy/goals

20. Iterative description and explanation

Critical general elements, applicable at all stages:

- co-ordination and integration across/within policy fields
- public participation and stakeholder involvement
- transparency, accountability and openness
- adequate communication mechanisms

Each element within this framework (and within actual policy systems) is an important and complex matter in its own right. For example, policy instrument choice (element 12) demands the selection of a mix of coordinated instruments using of defined selection criteria. The next checklist indicates the complexity of such a task (Figure 2) (from Dovers 1995):

Figure 2: The Range of Possible Policy Instruments

Instrument class:	*Main instruments and approaches:*
1. R&D, Monitoring	Increase knowledge; develop technologies or practices; establish socio-economic implications; monitor environmental conditions or policy impact.
2. Communication and Information Flow	Directions: research findings to policy; policy imperatives to research; both to firms, agencies and individuals. Mechanisms: state of the environment reporting; natural resource accounting; community-based monitoring; environmental auditing; strategic impact assessment; fora for consultation or policy debate.
3. Education and Training	Public education (moral suasion); targeted education; formal education (schools, higher ed.); training (skills development); education regarding other instruments.
4. Consultative	Mediation; negotiation; dispute resolution; inclusive institutions and processes.
5. Agreements, Conventions	Intergovernmental agreements/policies (international or within federations); memoranda of understanding; conventions and treaties.
6. Statutory	New statutes or regulations under existing law to: create institutions; establish statutory objects and agency responsibilities; set aside land for particular uses; land use planning; development control; enforce standards; prohibit practices.
7. Common Law	Torts, nuisance, public trust.
8. Covenants	Conservation agreements tied to property title.
9. Assessment procedures	Review of effects; EIA; social impact assessment; cumulative impact assessment; risk assessment; life cycle assessment; statutory monitoring requirements.
10. Self-regulation	Codes of practice, codes of ethics, professional standards.
12. Community Involvement	Participation in policy formulation; community based monitoring; community implementation of programs; cooperative management; community management.
13. Market Mechanisms	Input/output taxes/charges; subsidies; rebates; penalties; tradeable emission permits/use quotas; tradeable property/resource rights; performance bonds; deposit-refunds.
14. Institutional Change	To enable other instruments or policy and management generally, esp. over time.
15. Change Other Policies	Distorting subsidies, conflicting policies or statutory objects.
16. Reasoned Inaction	(Where justified by due consideration.)

The following list (Figure 3) outlines the criteria that could be used to determine which of the possible instruments in Figure 2 would be most appropriate.

Figure 3: Criteria for Instrument Choice

Effectiveness criteria:

- information requirements;
- dependability (re. goals);
- corrective vs. antidotal focus;
- flexibility (across contexts, time);
- gross cost;
- efficiency (relative to achieving goal);
- cross-sectoral influence.

Implementation criteria:

– equity impacts;
– political/social feasibility;
– legal/constitutional feasibility;
– institutional feasibility; familiarity;
– monitoring requirements;
– enforcability/avoidability;
– communicability.

Policy responses are mediated through institutions – formal and informal, national and international, legal, social and economic. Institutional arrangements are crucial in defining what policy and management approaches are possible and what ones will be effective or lasting.[11]

The design and analysis of institutional arrangements for sustainability is a poorly-developed craft, but the ecological notion of 'adaptive management' is being found a useful general framework when extended to include institutional and societal learning dimensions. The following proposes a set of *attributes of adaptive institutions* for sustainability (Dovers 2001):

- sufficient longevity and continuity to experiment, adapt and learn;
- sufficient resources (human, financial, informational);
- a statutory (or other legal or customary) basis providing recognisable guiding principles;
- transparent and accountable processes, and a higher probability of persistence;
- integration of research and policy foci and/or roles;
- a degree of applied or grounded focus (region, sector, specific problem)
- cross-sectoral and cross-problem mandate, and thus;
- a mandate and capacity for comparative analysis (concurrent and/or sequential);
- a clear, predictable and maintained participatory structure and approach to investigation, policy formulation and/or management;

[11] Here I am conflating institutions—underlying rules, structures and patterns—with more ephemeral organisations. Given that an organisation is significant to sustainability and has sufficient longevity and recognition, it can be considered in institutional terms and the following considerations applied.

- mandate and ability to experiment with approaches, methodologies and instruments, and to move across professional and disciplinary boundaries; and
- a political context favouring establishment and continued operation.

These provide some basis for considering the adequacy of existing institutional arrangements, direction for their reform, or the shape of newly-created arrangements.

This brief set of perspectives is aimed at informing discussion, not prescribing ways of thinking about policy and institutional settings. The frameworks minimally sketched above have been developed and tested primarily in national and sub-national policy contexts, and may have less purchase on some of the issues being addressed at this meeting. That in itself may be a useful question to consider.

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TOKELAU PERSPECTIVES ON CLIMATE VARIABILITY

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The three atolls of Tokelau have a total land area of only about 12 square kms, and in 1996 had a population of some 1500. In UN terms the group is a “non self-governing territory”, for which New Zealand has administrative responsibility. Tokelauans are New Zealand citizens and about 5000 currently live in New Zealand. It is only in the last generation or so that the local economy has been transformed from a largely subsistence one (based on coconut, fish, pandanus and Cytosperma chammisonis) to one that is largely aid-driven, based on regular annual allocations of between NZ$4 million—6 million from New Zealand. Although Tokelau presently has a large degree of political autonomy, it has declared its intention of making an act of self determination at some time still to be specified, and has indicated a strong preference for some form of free association with New Zealand. Whatever form of government is finally decided upon, it is certain to include a large degree of village autonomy. This has a long tradition in Tokelau. On each atoll, the whole population is concentrated in a single village, under the tight control of a council of elders.

This tight centralised village control has an important bearing on the history of responses to climatic emergencies. The islands lie outside the region of frequent cyclones, but severe storms are not unknown and storm surges from quite distant hurricanes can cause severe infrastructural damage. In 1966, and again in 1987 and 1990, ocean waves washed right through the village areas, damaging both private and public buildings and destroying concrete sea walls—causing damage estimated at between NZ$500,000 and NZ$1 million. Yet no lives were lost in any of these events. Boats and canoes were brought up to high ground and secured and the entire populations were gathered in the village churches, where, although there was little they could do but pray, that was apparently sufficient at the time. The productivity of coconuts was diminished; breadfruit trees were broken and scorched, Cytosperma pits were flooded with seawater; but they all eventually recovered,

Droughts have historically been a problem in Tokelau, particularly on Atafu and Nukunonu which have limited groundwater. One of the most advantageous outcomes of the recent spate of building with imported materials has been vastly improved catchment and storage facilities. Water storage has been incorporated within the foundations of both private and public buildings, and these have survived the sea surges with little or no contamination.

Improved communications have also helped the task of coping with emergencies. The atolls now have modern telecommunications, and a small purpose-built vessel is based in the atolls, both for inter-island travel and also to Samoa. At least one of the atolls has now instituted restrictions on fishing within the lagoon, with the aim of conserving stocks of lagoon fish for immediate use in an emergency. Among the important areas for response to climatic emergencies, better (and earlier) warning systems and sea-wall construction (or control through plantings) would seem to be the most obvious.

THE ROLE OF ADAPTIVE CAPACITY IN REDUCING VULNERABILITY

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The key issue for adaptation is vulnerability, which requires the development of adaptive capacity to ameliorate negative impacts.

Adaptation is one of the two main ways to manage the risk of climate change (mitigation is the other). The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as an adjustment to actual or expected climatic stimuli or their effects (McCarthy *et al.*, 2001). Vulnerability to climate change is the degree to which a system is susceptible to, or unable to cope with, adverse affects of climate change. Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity. Adaptive capacity is the ability of a system to adjust to climate change to moderate potential damages, to take advantage of opportunities and to cope with the consequences. Therefore, the reduction of vulnerability requires an increase in adaptive capacity.

Adaptive capacity can be divided into generic and specific types. Generic adaptive capacity largely contributes to autonomous adaptation because it involves decision-making concerning ongoing development, sustainability and equity efforts. “Development” is not necessary a positive influence with regard to climate change, although it may be considered to improve general well being. The identification of maladaptive trends counter to the general expectations of development activity is important. Building specific adaptive capacity for climate change will focus largely on the need for planned adaptation and should allow the selection and prioritisation of the most beneficial measures. Adaptive capacity developed to manage climate change, where the risk of vulnerability is deemed sufficiently high should result in more sustainable development than generic capacity building.

Generic determinants of adaptive capacity include (Chapter 18.5.2, Smit and Pilifosova, 2001):

Economic resources—e.g. wealth/poverty levels, distribution and flow

Technology—access to a range of adaptation responses

Information and skills—knowledge, communication and education

Infrastructure—may be both a positive or negative influence

Institutions—governance, resource management, emergency response

Equity—access of individuals and communities to power and resources

It is generally agreed that there is a threshold of basic capacity required by a population before specific options can be assessed.

The interaction of adaptation to climate change with ongoing development has received little attention from researchers. However, it is also true to say that ongoing development projects and programs do not often properly consider climate or climate change. Both sides of this issue require further advancement, and nowhere is this more important than for Small Island States because of their need for short-term capacity building and the long-term risks they face under climate change.

Building adaptive capacity specifically for climate change requires development of the following themes:

- Adaptation is based on a response-behaviour mechanism in case of autonomous adaptation and information-behaviour mechanism in the case of planned adaptation. The role of behaviour in adaptation has largely been neglected to date but is critical.

- The understanding of adaptive behaviour begins with adaptation to current climate, and with gauging a broad range of responses to climate variability and extremes rather than the mean.
- Adaptation will need to be managed over appropriate time horizons, taking account of both climate change and policy needs. Because the development of adaptive capacity requires the investment of resources all long-term adaptations will require an accompanying short-term pay-off to justify these investments.
- The need for planned adaptation will be informed by an assessment of vulnerability requiring value judgements to be made. Metrics for assessing vulnerability include monetary, cultural, biophysical, social, legal and political factors. Constructing critical thresholds that mark an unacceptable degree of harm with stakeholders for the purpose of risk assessment is a particularly useful exercise.

Tools for linking climate change to the development of adaptive capacity that build on these themes will be introduced and described. These tools are developed for use with stakeholders and are intended to allow the development of adaptive capacity guided by local experience and concerns.

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CLIMATE CHANGE PROJECTIONS FOR THE SOUTH PACIFIC

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Projections and scenarios of regional climate change are needed to inform policymakers and the public in order to address the relevant articles of the United Nations Framework Convention on Climate Change (UNFCCC) and to provide in put for impact assessments. Regional climate change due to the enhanced greenhouse effect can be considered as a function of the magnitude of global climate change and how that change is expressed on a regional basis. The magnitude of global climate change is subject to uncertainties derived from multiple sources including future emission pathways, the radiative forcing of aerosols and the sensitivity of the global climate to radiative forcing. Projections of regional climate change are obtained from global and regional climate models (GCMs & RCMs). The range of uncertainties for any given region produced from several of these models is usually substantial.

Simulations from six climate models were analysed to provide ranges of regional change in mean temperature and seasonal rainfall for the South Pacific. The global warming ranges are provisional ranges derived from IPCC (2001) and are used to multiply the six climate patterns for each variable each averaged over four regions. The ranges of regional warming for 2050 and 2100 are shown in Tables 1 to 3. Regional warming is greatest near the equator, with temperatures projected to rise at global average rates or less. The warming rate decreases to the south (Table 1). Rainfall increases predominate in both the May to October and November to April seasons, especially in the eastern central Pacific (Tables 2 and 3). These increases range up to 50% per degree of global warming. Rainfall decreases are possible to the south of the equator in southern Polynesia and Melanesia during both seasons, though these occur in a minority of models. The warming and rainfall patterns resemble an El Niño-like mean state across the Pacific. Possible changes in the variability of the ENSO pattern around this mean state remains unknown. Decadal variability will continue to affect precipitation and therefore island hydrology. Rainfall intensity is likely to increase where mean rainfall increases (Table 4). Tropical cyclones show no systematic changes in number, or regions of formation and occurrence but an increase in intensity is indicated by some simulations and theoretical considerations. Scenarios based on these model analyses have been incorporated into the PACCLIM model constructed as part of the PICCAP Project.

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Table 1. Ranges of temperature change (°C) for regions defined by the PICCAP Project.

Region	Local warming per °C of global warming	Warming in 2050		Warming in 2100	
		Low	High	Low	High
Micronesia	0.7 to 1.0	0.6	2.3	1.0	5.7
Melanesia	0.7 to 0.9	0.6	2.1	1.0	5.1
Polynesia N	0.8 to 1.0	0.7	2.3	1.1	5.7
Polynesia S	0.7	0.6	1.8	1.0	4.5

Table 2. Ranges of rainfall change (%) for regions defined by the PICCAP Project for May to October, rounded to the nearest 5%, for 2050 and 2100.

Region	Response per °C of global warming			Change in 2050		Change in 2100	
	Driest	Median	Wettest	Driest	Wettest	Driest	Wettest
Micronesia	0	6	10	0	25	0	55
Melanesia	-4	2	6	-10	15	-25	35
Polynesia N	4	13	43	5	130	5	320
Polynesia S	-8	1	2	-20	10	-50	20

Table 3. Ranges of rainfall change (%) for regions defined by the PICCAP Project for November to April, rounded to the nearest 5%, for 2050 and 2100.

Region	Response per °C of global warming			Change in 2050		Change in 2100	
	driest	median	wettest	driest	wettest	driest	wettest
Micronesia	-2	1	4	-5	10	-10	30
Melanesia	-3	2	6	-5	15	-15	35
Polynesia N	6	14	20	5	50	5	130
Polynesia S	-6	1	3	-15	5	-40	15

Table 4. Projections of key elements of climate variability for the South Pacific under enhanced greenhouse conditions (Confidences derived by members of the CSIRO Atmospheric Research Climate Impact Group based on simulations and the recent literature).

System/variable	*Possible change*	*Notes and confidence levels*
ENSO		
Mean state	A number of coupled model simulations now show a more El Niño-like state over the Pacific.	Moderate confidence
El Niño / La Niña	The current phases of ENSO are likely to continue, although the exact form is unknown. In a more El Niño-like Pacific, La Niña may become the most anomalous phase.	Low confidence
Rainfall variability		
Daily	Daily extremes likely to increase in most regions (especially the central eastern Pacific), except where mean rainfall decreases of more than a few percent occur.	High confidence
Seasonal	Increases from most models are greater in May to October period, decreases in some regions possible.	Low confidence
Interannual	ENSO likely to continue, although its impact on year-to-year rainfall variability may change.	High confidence
Decadal	Decadal variability will continue to drive extremes of interannual variability and modulate ENSO.	Low confidence
Tropical Cyclones		
Intensities	0–20% increase in wind speed at $2xCO_2$	High confidence
Regions of formation	No change	Low confidence
Regions of occurrence	No change to further poleward	Low confidence
Numbers	No change	Widely conflicting results

TRADITIONAL METHODS OF WEATHER AND CLIMATE FORECASTING: THE SAMOA EXPERIENCE

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Even in the face of rapid advancement in scientific and technological understanding and knowledge of the climate system, many Samoans still tend to rely on Traditional Methods (SAT) of weather and climate observations and forecasts to forecast the on-set of extreme events like tropical cyclones, heavy rainfall and droughts. This paper briefly examines some of these SAT methods. The goal is to determine how useful they are in preparing for, and managing climate extremes in Samoa. The SAT methods are then compared to current scientific methods of forecasting (SCI) to assess their reliability and accuracy. It found both SAT and SCI compliment each other. The paper is based on the author's own experience growing up in Samoa. Most of the SAT described were verbally passed on to the author by his grandparents as well as by some village elders whom he visited during the course of his tenure as a weather observer and Head of the Climate Division of the Samoa Meteorological Service from 1983 to 1988. SCI methods and observations are mainly drawn from the report 'The Climate and weather of Western Samoa' by the former New Zealand Meteorological Services in 1988. The paper is non-scientific and should be treated as such.

ADAPTATION IN CLIMATE CHANGE

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Adaptation to climatic conditions is embedded in our relationship to and construction of the environment, from the use of umbrellas to agricultural cycles. In climate change research and policy, the concept of adaptation has been defined as all adjustments to climate change by individuals, institutions, and elements of the natural environment. Adaptation has been described variously as an inevitable outcome, as any response, as any beneficial response, or as any policy response. This shifting terminology does not add clarity.

In this paper, therefore, we need to address:

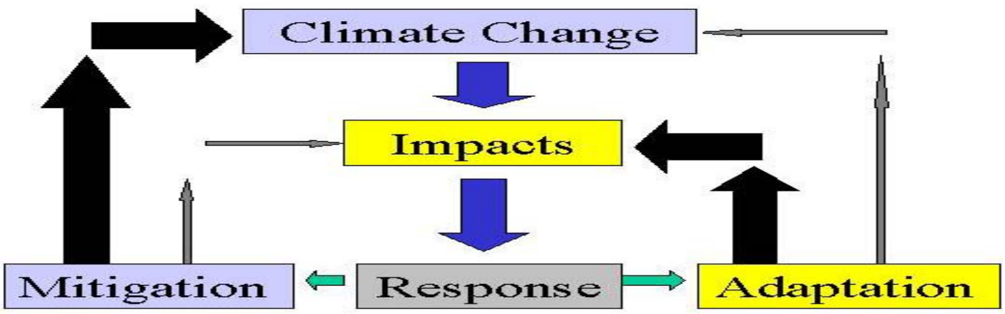
- what is adaptation?
- adaptation to what?
- who adapts?
- when and how does adaptation occur or not?

What is adaptation? In its simplest sense human adaptation is adjustment to the environment while maintaining function (Little 1995). This is a minimalist definition—it does not require that such responses be beneficial, simply that human actions involve at the minimum maintenance and at the maximum enhanced viability.

A fuller definition is that by Campbell and Wet (1999:v):

> *Adaptation refers to those actions or activities that people, individually or in groups, take in order to accommodate, cope with, or benefit from the effects of climate change.*

How is adaptation used? The baseline model of climate change and adaptation (Figure 1) identifies climate change, its impacts, and responses which are both mitigation and adaptation.



Based on Smithers & Smit 2000

Adaptation to what? It seems self-evident that, in terms of health, climate change will have a series of impacts on vector-borne disease, water-borne disease, temperature related mortality, etc. Certainly these impacts are not detailed in the model but these impacts or stressors have a series of characteristics:

- they relate differently to different aspects of climate,
- there is no single stressor, and
- the nature of adaptation depends on what is perceived as a stressor.

Who adapts? In the models of adaptation used it is often not clear who or what adapts. Often it is assumed that institutions (devoid of human decisions) will autonomously adapt. Adaptation is sensitive to scale: *a change at one level, particularly institutional, will not necessarily represent an adaptation for the individual.*

How does adaptation occur?

- Adaptation is ongoing and rarely linear, and again this means predictability of effect may be impossible to quantify.
- Adjustments to fluctuating or changed environmental circumstances involve time.
- Often there is a distinction made between "autonomous" adaptations and those that require or result from deliberate policy (planned).
- The adaptations that are adopted by individuals and communities are constrained by resources (personal, economic, social, natural and technological): not just their availability, but individual or community access and control.
- Adaptations also serve different purposes: to buffer, maintain the status quo, or to improve conditions.
- This leads to one of the problems of the current separation of adaptation from mitigation in climate change literature. Adaptation may serve to buffer or mitigate environmental impacts upon populations.

Costs and Goals. There is a tendency in the discussion of adaptation to list costs (if at all) in economic terms only. No adaptation is cost-free; and because there are numerous stressors, an adaptation to one situation can accrue a cost with another.

The final point is what are the goals of adaptation?

This complexity of perception, time, constraint, and goal means that not all adjustments to the environment either by individuals or by groups of individuals will be adaptive even if that is the goal. So this leaves us with a set of necessary questions about adaptation:

- **Adaptation to what?**
  - Interrelated stressors
  - Perceptions about impact
- **Who adapts?**
  - Individuals
  - Communities
  - People in institutions
  - Natural ecosystems
- **How does adaptation occur?**
  - Under which constraints?
  - Over what time?
  - With what costs?
- **Who benefits?**

COPING WITH DROUGHTS IN MILNE BAY, PAPUA NEW GUINEA

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Abstract

Within rural communities drought conditions generally disrupt food production. However, the consequences *of the disruption are felt in all aspects of village life. During drought the management of crops is not sufficient to sustain food availability, hence there is a change in both gardening practice and food procurement strategies. Experiences from Utalo village on Goodenough Island and Bogaboga village on Cape Vogel during the 1997 drought are used to illustrate change in food procurement behaviour and gardening strategies. Aspects of health and social conflict are also highlighted.*

Introduction

The 1997-1998 frost and drought in Papua New Guinea (PNG) was considered to be one of the worst on record for PNG (Allen *et al.* 1997, Allen and Bourke 1997). Food and water supply in most rural areas in PNG were seriously disrupted. Major relief programmes were initiated following national assessments of food production and water supply.

In Milne Bay, the assessment team categorised most areas as seriously under threat where people were living on famine foods and in some areas, water supply was seriously threatened. The north coast of the mainland area had run out of garden food and most of the people were living on famine foods. Many of the island areas were still small amounts of garden food, which was diminishing very quickly. Utalo village on Goodenough Island and Bogaboga village on Cape Vogel were two villages which faced serious shortages of food (Figure 1). This presentation is an account of my observations of how people in the two villages coped with the drought and their recovery process.

On Goodenough and Cape Vogel the rains stopped toward the end of March 1997 and the first rain came in late December 1997, though heavy rain did not arrived until late January 1998. Both areas were classified as category 4/5 in the assessment programme in November 1997, indicating that there was no food in the gardens and that they required assistance (Allen and Bourke, 1997).

Utalo—Goodenough Island

In Utalo, the rains stopped in March 1997. Within two months most of the taro plants had withered and died, but small amounts of the drought tolerant cultivar Kwadogana remained available for a short while (See Figure 2). The yam yield at harvest in April was reduced and little was stored. Up to June, yam was eaten as it was harvested from the gardens. The stored yam was available in small amounts until September. Cassava served as a major food source remaining available for a long period, particularly feral cultivars in abandoned hillside gardens. Wild yams and figs provided a further necessary source throughout the drought. These were harvested from the wild and formed the bulk of the evening meals. In early January 1998 breadfruit became readily available.

In September 1997 the community made copra, which they sold in Alotau and so enabled people to buy rice. Most households had about 20-30 kg of rice, which supplemented a diet of cassava, wild yams and figs. Utalo people received very little aid rice from the relief programme because of their isolation.

During the drought period people continued to plant yam gardens on the hill slopes. In addition, they cleared gardens closer to the river and low-lying wet areas where they planted taro, cassava, sweet potato and pumpkin. These gardens were producing food within two months of the rain arriving. All gardens recovered quickly when the rains arrived. First lot of food harvested came from the gardens made closer to the river and the low-lying areas. By the end of March 1998 food was plentiful in these gardens with people feeding sweet potato and pumpkins to pigs. Yam recovered and harvest appeared normal in April/May of 1998. Taro was slow in recovering. Planting material had to be taken from the river gardens to plant in the hill side gardens. By July 1998 taro harvest was back to normal.

Feasting was limited during the drought, however people were engaged in kweli which is a tradition of moving around from one village to the next singing. Singers received food as gifts. Rice that was bought with the money people raised and the small amount of aid rice often appeared as gift in these kweli events. Coastal people sang in inland villages to receive wild yams and wildfowl eggs while inland people received fish from coastal villages.

Bogaboga

In Bogaboga yams and bananas failed in most gardens as soon as the drought set in. Few gardens, which are further inland in and wetter areas, had yam and bananas till September. Most people ate sweet potato, which was available till June. From June to August wild yams were harvested from remnant forest, then sago from November (Figure 2).

Around October people were told of government assistance with food. They left their gardens and moved back to the main village on the coast. Many of the gardens were not planted for the following year. This was partly due to people eating their planting material and partly because they did not have food to feed other people who help with clearing and fencing of gardens. In the latter part of 1997 mangoes became plentiful and breadfruit was harvested in early part of 1998. Bogaboga people ate no cassava during the drought though they planted this and ate it during the recovery period from January 1998. Fish and shellfish were abundant and supplemented rice. Most families received money in remittances to rice and other foods from trade stores.

The first shipment of aid rice to Bogaboga arrived in early November. From November 1997 to April 1998 Bogaboga people received 5 shipments of aid rice which approximates to a total of 100-150 kg of rice per household for a period of 6 months. Even in early 1998 many people had not made new gardens, mainly because people had become confident that aid rice and remittance money would continue to flow in.

Post-drought observations

The gardens looked lush soon after the rains but food from the gardens was not available until March and April. Gardens that were planted during the drought recovered rapidly and food was harvested within 2-3 months, while gardens that were planted when the rains started took longer to produce food.

The effects of pests were evident following rains in 1998. Immediately after the rains started caterpillars destroyed all sweet potato gardens by eating the leaves. The recovery from the caterpillar damage was rapid and loss in yields was minimal. Much of the vegetation around the villages also lost their foliage from the caterpillar attack. In Bogaboga, feral pigs attacked abandoned gardens damaging planting material that was recovering after the rains. By June -July of 1998 rats and mice became problematic attacking garden crops before they were harvested as well as stored yam and sweet potato. Rats and mice remained a problem for over a year.

The increase in the numbers of sick people in the villages was also noticeable. The numbers of people with severe malaria and pneumonia reporting to the clinic were higher than previous records. During the peak of the drought period and the first four months of 1998, health centres nearest to Utalo and Bogaboga did not have some of the basic medicine, yet people continued to turn up for treatments.

In Utalo two elderly people died in 1998. Both were suffering from some respiratory infection complicated by malaria. In Bogaboga 18 people had died from various causes. While, the drought is not the direct cause of deaths in these two villages, clearly, the populations are vulnerable to disease because lower food intake and poor nutritional over a long period of time. There have been other records of increased deaths in PNG following the 1997 drought. Lemonnier (Lemonnier 2001) estimated a loss of seven percent of the population among the Ankave of the Gulf Province and 25 deaths per 1000 among the South Hewa of the Southern Highlands (Haley 2001). Among the Hewa the increased number of deaths lead to increased witch killings. In Bogaboga, while no sorcerers were killed, there was increased conflict between relatives of those who died and families associated with sorcery practice.

Government and agencies in the drought relief

The external agencies, and to some extent the national government played a major role in the 1997 drought event. The national assessment programme identified the most seriously affected areas and recommended assistance. The foreign governments and donor agencies were forth coming with assistance, some of which was delivered directly to the needy communities. The external governments and agencies did more for the drought relief than the national government of PNG. The government was slow in recognising the looming national disaster and only responded in a haphazard way when it was forced to. The high media profile of aid relief gave unrealistic expectations to the village people. For example in Bogaboga, people abandoned their gardens because they were told they would receive food aid. They receive more than what was necessary and for over a longer period then necessary.

Discussion

Drought events are not new to Goodenough Island and Cape Vogel. Over 100 years since European contact there were at least 5 drought years recorded, including the 1997 event. The 1946-47 event was thought to be of the same intensity as the 1997 drought. Thus people in these communities have some experience of coping with droughts and have traditional strategies in place for dealing with these drought conditions.

In Utalo, people recognised that drought had set in. They changed their garden behavior by moving to closer to low-lying wet areas to cultivated crops such as cassava and sweet potato that were likely to grow in dry conditions to provide food. At the same time they turned to food that in normal circumstances would be unpalatable. They foraged for wild foods. When they realised that their natural sources of food were not sufficient they turned towards bought food. However they did not become reliant on it. Instead they treated it as luxury food by giving it away as they would with yam and taro in normal conditions. While foraging and living on unpalatable foods they continued to plant yam and other gardens in anticipation of rain. This anticipation paid off in that gardens recovered within two months of the rains returning. The social practices for redistributing food continued even though it was under a different guise. At no point in time did they depend on the government for food. The people's perceptions was that government has no interest in their well being and hence have to be self reliant.

In Bogaboga, reaction to drought by villagers in 1997 was very different to other drought years. In traditional practice in Bogaboga, as soon as drought conditions were realised, people moved closer to water sources and swampy areas and planted banana, sweet potato, pumpkin. The yam planting material was stored away and planted as soon as the rains arrived. They foraged in the forest for wild yam and berries and in the grasslands they harvested Peuraria tubers. Their main source of food during drought period was the underground rhyzome of banana called bagana. These would have been harvested when the swamp gardens were being planted. The rhyzomes are cleaned, baked and stored above the fireplace. Bagana could be stored for six months. When needed, it was peeled, soaked, then sliced or grated and cooked again before being eaten. Diet of wild yam, Peuraria and bagana are always supplemented with fish and shellfish, which are always plentiful.

During 1997/98 drought only 12 households established swamp gardens and eventually returned to normal gardening practice when the rains arrived. For those who maintained their planting material and gardens, food returned by May 1998. Food was so plentiful that one clan from among this group challenged another clan in competitive food exchange. This is a guise for re-distributing excess food, which would otherwise spoil.

Rice replaced the need for bagana and Peuraria tubers. Prolonged availability of rice removed the need to establish grassland and floodplain gardens. Recovery of gardens was difficult because people lost planting material. Most of the people started returning to grassland and floodplain gardens around mid 1998. They had to wait another year to establish yam gardens when yam-planting material became readily available.

Recovery should have been much quicker. Unfortunately at Bogaboga, people had not only lost a lot of planting materials but they had also stopped making their gardens, particularly the most important ones of yams and banana. Bogaboga people had relied on greater government assistance. This had resulted in dependence on the cash economy for food, hence hindering their recovery.

Self-sufficient communities

In Utalo and Bogaboga, yam has been the important crop, with people managing over 30 cultivars in their gardens. They also manage a combination of other crops such as taro and banana with some drought tolerant cultivars. Crops such as yam can be stored and thus they may be available to people during periods of food shortages where they supplement famine foods. Concurrent management of several major staple crops and numerous cultivars are the people's assurance of food availability against climatic variability. In the previous drought episodes, communities survived by exploiting knowledge of crops, particularly drought tolerant crops and cultivars. These are strategies developed by communities from experience of many drought events.

Many of the traditional cropping systems in PNG have changed as communities change their subsistence activities. There has been a substantial shift to a widespread adoption of sweet potato and cassava cultivation and away from more poly-culture of traditional crops such as taro, banana and yam. Cassava and sweet potato are productive in areas of intense cultivation and are fast growing, thus essential in periods of drought recovery. However, dependence on two crops alone makes communities more vulnerable to conditions such as droughts. For example, in the highland areas where sweet potato is grown as a mono-crop for subsistence, the frost destroyed most of the crop in 1997. Utalo and Bogaboga have also adopted sweet potato and cassava, but as additions to the collection of existing crops they are cultivating. However as population pressure increase, land use intensification becomes attractive. In areas where there is high intensity of land use, sweet potato and cassava are the most suitable subsistence food crops.

The use of cash to buy processed food such as flour and rice improves food security as long as cash is forthcoming. Both Bogaboga and Utalo raised money to buy rice in 1997. In Bogaboga rice became the staple, while in Utalo it was treated as a food item of high status being given away during festivals. Thus while rice and flour are ideal food substitutes in short term, availability of money is restrictive.

The forests are important reservoirs of famine foods. Wild yams, roots and berries are important sources of food when garden crops fail or are in short supply. Fruit trees are not always affected by drought conditions. Their long and extensive root systems reach the water table and thus they remain productive when garden crops fail. Observations from Utalo and Bogaboga indicate that, fruit trees overproduce in drought conditions. Mangoes, breadfruit and Polynesian chestnut were abundant in 1997. Mangoes and breadfruit flesh was eaten as they came into season, Polynesian chestnut and breadfruit nuts were stashed for periods when food was scarce or sold to raise cash. Utalo people foraged in the forests for fruits and berries. Bogaboga people did not do much foraging and remained in area where they could receive food aid.

Experience of survival such as foraging for fruits and berries reinforces the knowledge required for survival during drought conditions. Similarly knowledge of drought tolerant crops is reinforced and transmitted with experience of drought conditions. Droughts are infrequent, and a severe one may occur only once in an individuals lifetime. Thus the lessons learnt from one event remain a lifetime lesson. The drought tolerant cultivars are planted every cultivation cycle even if the crops are not used as food. For example the drought tolerant cultivar of taro Kwadogana is terribly bitter most times (name means irritable to the mouth), however during severe dry conditions it is palatable. In the Utalo taro gardens, Kwadogana accounts for 10 % of taro plants. Many adults tasted Kwadogana for the first time in 1997, yet they plant it every year as an insurance against drought.

Conclusion

The effects of the 1997 drought were severe in most rural communities. While some communities such as Utalo coped well and recovered quickly, other communities such as Bogaboga took much longer to recover. Hence, many communities could not rely on foraging alone. According to many villagers in Utalo and Bogaboga, the length of the drought period was unexpectedly long and forests were unusually dry. Fires in the 1997 drought destroyed many of the forest food sources.

The village people found the climate changes leading up to the 1997 drought unusual. While they recognised drought conditions, they could not predict the severity and length of the drought period. This is partly due to the breakdown of specialist traditional knowledge and partly due to the fact that some aspects of climate variability is new phenomena to the village people. The role of the government and relevant agencies is crucial in keeping the communities informed of climate changes and encouraging communities to develop strategies, which are realistic and sustainable.

I have argued elsewhere that maintenance of crop and cultivar diversity is essential for coping with drought conditions (Mogina 1999). Similarly, I have noted the disruption long term food aid has on the sustainability of food production (Mogina 2001). While food aid is necessary under certain conditions, long term strategies for coping with drought are essential for community sustainability. Communities need to be empowered to protect their interests and their well being. As the experiences of 1997 drought indicate, traditional knowledge alone is not sufficient, and technical scientific knowledge and expertise is essential for long term planning. The collaboration of both traditional and scientific knowledge system in research and policy would be a step in the right direction in formulating strategies to cope with climatic variability.

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TAKÜ

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In common with several atolls in the Pacific in the last decade, Takü (Mortlock Island) in Papua New Guinea has witnessed land erosion, loss of shoreline vegetation and saltwater contamination of vegetable gardens. But the rate of damage appears far greater than that caused by a milimetric rise in sea levels alone, and residents are convinced that vertical encroachment exceeds 150 mm annually.

Several elements in the community's reactions to these phenomena are noteworthy: It is expatriate Takü throughout Papua New Guinea rather than island residents who are actively seeking solutions; these expatriates have created a formal, registered association as the means of channeling their efforts; and the initial impetus for that creation came from a non-Takü researcher on the island, namely, the presenter of this paper.

Among the activities to date of the Association branches are seeking an improvement to existing delivery of services to the island, political assistance, consideration of the construction of a seawall and reclamation of areas already lost to the sea, the creation of an awareness campaign and a variety of fundraising initiatives, and consideration of the possibility of relocation to Bougainville island

VULNERABILITY AND ADAPTATION IN NIUE

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Niue is an isolated upraised coral atoll with little fringing reef surrounding it. It has completed and presented its first National Communication to the UNFCCC in October 2001. The National Communication highlights some key areas that are highly vulnerable to the extreme effects of climate change. These are: coastal zones and reefs, agriculture, land use change and forestry, water resources, health, biodiversity and socio-economic factors. Niue does not have many natural resources and what there is has been severely affected by the elements. With the advent of even more severe weather events predicted for the future by scientists, Niue will also be a country that will be severely impacted by climate change due to its small size, isolation, lack of resources in terms of equipment, finance, capacity, medication, food crops, and protection. With its lack of resources to develop appropriate response measures, it can only adapt like it has been doing for past centuries. That is either through retreating further inland, migration, and adopting expensive alternatives like imports.

This presentation aims to highlight those vulnerable areas and what has been done and what needs to be done to alleviate some of the concerns that have arisen due to climate change and its impact on vulnerable small island states.

RURAL COMMUNITY PERSPECTIVE ON ADAPTATION TO CLIMATE CHANGE: A VANUATU VIEW POINT

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Adaptation to climate change is not an easy process, particularly in the rural communities where life is a continuous struggle to meet demands and pressures of every day living.

Mostly rural communities are the producers and depend entirely on natural resources to meet their subsistence and financial needs. The pressure they exert on the environment, therefore, depends on internal as well as external influences. Being a part of that respective environment, the communities continuously adapt to changes that affect them and thus they are continually evolving and changing accordingly.

Market pressures play a significant role in inducing changes to the community and their environment. The magnitude of the changes and pressures are dependent on the internal influences such as the community population, and the accessibility to urban markets.

So nurturing adaptation in the rural community must be approached in an integrative manner and taking into account the seriousness of the vulnerability of the exposure unit.

Immediate concerns need to be addressed directly. Mostly these concerns include: Accessibility to drinking water, flood protection infra-structure, soil erosion and coastal area and coastal infra-structure protection.

Longer-term community level adaptation process need to be nurtured in light of the pressures that exist within the community system. The basis for which the adaptation process is pursued is that rural communities will continue to use their environment in such a way that does not increase their vulnerability. For effective adaptive capacity building activities, awareness must be backed by on the ground action.

Policy reforms are required where there needs to be changes to mitigate unsustainable environmental practices. However, the adaptation policies must not be prescriptive. They should really come out in the form of Environment Business Plans or Climate Change Business Plans, where the communities are provided with environmentally friendly options to develop and meet their subsistence and financial needs. This will require a new arrangement, which SPREP and the Vanuatu Government should engage in to facilitate such an approach. This should be the new idea for adaptation in Vanuatu that local authorities and the national Governments must pursue, to minimize environmental abuse and increase in Vulnerabilities of rural communities.

CLIMATE CHANGE, AND RELATIONS BETWEEN LOCAL COMMUNITIES AND LARGER POLITICAL STRUCTURES IN THE FEDERATED STATES OF MICRONESIA

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In the Federated States of Micronesia (FSM), climate change and natural disasters such as droughts and typhoons have impacted islands differently, and these differences relate mainly to the differential vulnerability of the high volcanic islands and the low coral atolls. The volcanic islands, with their greater underground water reserves, and their larger and higher land masses, provide more secure sources of fresh water, and they afford considerably more protection from destructive winds and waves, than do the coral atolls. This contrast is evident throughout the islands of the Federated States of Micronesia, and is perhaps most dramatic in Yap State, which lies along the main corridor of frequent typhoon movements. Typhoons in the western Pacific Ocean typically consolidate in the vicinity of Pohnpei or Chuuk, and then intensify as they move westward. Hence Yap, the westernmost of the four FSM states, generally suffers the greatest impact of the storms at their most destructive force.

In earlier times, Micronesian island communities accommodated to climate extremes and natural disasters through the development of social and political linkages between the more vulnerable coral atolls and the neighboring high islands. These linkages allowed for mutual support between communities, and especially for the post-disaster assistance of coral islanders by their neighbors on volcanic islands. In Yap, these linkages were institutionalized into the *sawei* system—the so-called Yapese Empire—which involved formal relations of tribute and aid between Gagil in Yap, and the Western Carolines archipelago of outer islands from Ulithi Atoll near Yap to the Namonuito group near Chuuk Atoll. Elsewhere in Micronesia, similar linkages developed, although less formalized, allowing coral islanders to seek assistance from kinsmen, political leaders, and trade partners on nearby volcanic islands, in times of need.

During colonial times, these systems of social and political linkage intensified, and throughout Micronesia, permanent or semi-permanent resettlement colonies of coral islanders grew up on the volcanic island centers. Mid-19th century Carolinian refugees from typhoons began immigrant communities in Guam and Saipan, then under Spanish rule, while in the early 20th century Mortlockese and Kapingan immigrant communities formed in Pohnpei, then under German rule. Later, during the mid-20th century American administration, a resettlement community of Yapese Outer Islanders grew up in Colonia on the main island of Yap. These outer islander immigrant communities have enjoyed varying degrees of status, security and permanence in their respective locations on the main islands.

In the three FSM states with both high island and low island communities—Yap, Chuuk, and Pohnpei—as well as in the Republic of Palau, high islanders traditionally have enjoyed greater political status, and presumed cultural superiority, over the low islanders. During colonial and postcolonial times, the outlying coral islander communities have become increasingly disadvantaged politically and economically in relation to the high island communities. Government centers and services, political elites, and infrastructure development such as roads, schools, and hospitals are concentrated largely around the port towns and state capital areas on the high islands. This growing disparity between the economies of the outlying atolls and the urbanizing high island centers has deepened the dependence of the atoll communities on the high island centers and has led to a growing influx of coral islanders taking up residence in the urbanizing areas of the high islands in such places as Colonia in Yap, Weno in Chuuk, and Kolonia and Sokehs in Pohnpei.

The possibilities of global climate change and sea level rise have raised the stakes, especially for the coral islanders, who are most vulnerable, and these threats have prompted new attempts at strengthening linkages to high islands and securing the use of land there. In Yap, Outer Islanders have pursued three separate efforts in recent years, to either purchase land outright or to obtain land through traditional means. These efforts most recently have involved the FSM national government, which earlier this year (2001) provided a grant of U$250,000 to allow Yap Outer Islanders to purchase land at Gargey in Yap for their exclusive use. Now that the Congress of Micronesia has acted on behalf of the Yap Outer Islanders, other resettled coral islander communities in the Federated States of Micronesia, such as the Mortlockese in Pohnpei, are voicing demands for similar land grants to allow them to secure residential land in their high island state center. Some national planners in Micronesia have expressed the viewpoint that if outer islanders find life increasingly unsustainable because of climate change, then they should abandon their home islands and move to the state center. Planners argue that this is a preferable solution to having to sustain outer island communities if they can no longer provide for their basic necessities such as food and water.

At higher levels of political structure, the FSM government nationally has pursued a continuing association with the United States that will allow for free emigration of FSM citizens to the US and its territories, and will provide Micronesia with US federal assistance grants, including the Federal Emergency Management Assistance (FEMA) grants for disaster assistance and mitigation. At present the Compact of Free Association between the FSM and the US is under renegotiation, and islander concerns over vulnerability to global climate change will likely influence the perceived need for continuing free emigration privileges into the US, and disaster assistance benefits from the US.

Any evaluation of the Micronesian responses and resilience to climate change will have to take into consideration all of these political aspects and relationships.

OBSERVED CLIMATE CHANGE AND VARIABILITY IN THE SOUTH PACIFIC

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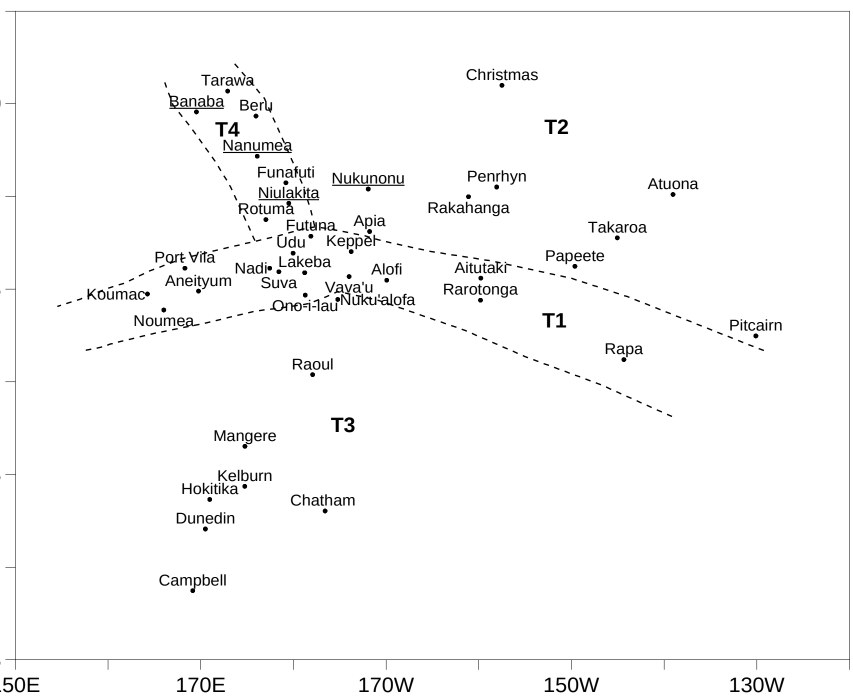
Observed trends and variability in climate and sea level for the South Pacific have been derived from high quality, long-term climate data, which commenced in the late 19th century. Beyond the long-term trends in climate, interannual climate variability over the Pacific is dominated by the El Niño/Southern Oscillation (ENSO) phenomenon. This has the strongest sea surface temperature (SST) signals of one sign along the equator over the central and eastern Pacific and a boomerang-shaped pattern of weaker SST signals of opposite sign extending over the middle latitudes of both hemispheres in the North and South Pacific. Recently, 'ENSO-like' features in the climate system that operate on time scales of one to three decades have been identified. These have been termed the "Interdecadal Pacific Oscillation" (IPO) and cause shifts in climate. Climate change and variability are well known to have a significant impact on human societies and on economic activities. The small island states of the Pacific are particularly vulnerable to extremes of climate (cyclone-induced storm surges, sea-level rise, etc.). Although these countries are in an oceanic environment, rainfall variability can be quite extreme because of ENSO and IPO. Global warming is also causing long-term change.

This paper reviews longer-term climate trends in the south west Pacific, then identifies decadal patterns of climate variation throughout the region responsible for climate shifts on decade time scales.

Equatorial and South Pacific Islands and associated four Zones



Climate Change

In the South-east Trades Zone (T1), a substantial increase in island temperature of 0.8^{o} C has occurred since 1910. Sea surface temperatures (SST) and night marine air temperature (NMAT) have increased by 0.4^{o} C since 1920. Temperatures have a steady small upward trend throughout the 20^{th}

century, with a hiatus of low trend from 1930 to 1970. Since 1920 annual rainfall shows a decrease over the period of record, especially since the late 1970s, with the 1980s decade being 10 percent less than the 1951-80 average. The Central Pacific Zone (T2) shows a decrease in island temperature of about 0.2^{o} C as seen from the late 1930s to the mid 1960s, followed by a sharp increase of 0.5^{o} C commencing in the 1970s. Marine temperatures (SST and NMAT) show a similar pattern, with an increase of 0.4^{o} C since 1970. Annual rainfall records in this region span back to 1940. These show that the period 1940 to the mid 1970s was drier, with a subsequent increase in annual rainfall of 15 percent or more.

For the New Zealand Zone (T3), island surface temperatures over the instrumental records have increased by 0.8^{o} C since 1900, and this is paralleled by increases in SST of 0.8^{o} C, and of 0.7^{o} C in NMAT. Because of New Zealand's complex orography, the local changes in annual rainfall have responded to the increased westerly circulation recently, with the south and west of the country becoming wetter since the mid 1970s, and the north and east drier. Annual rainfall for islands in this zone has decreased in this period. The Convergence Zones (T4) for the period of record from the 1930s, shows a small decrease in annual marine and island surface temperature from 1950 to 1970, followed by a small rise of about 0.2^{o} C to the 1990s. Although annual rainfall variability is large, long-term average rainfall was 10 percent less up to 1970. Since the mid-1970s annual rainfall has increased 15-20 percent.

Climate Variability

Recently shifts in climate have been detected in the Pacific basin, driven by a newly described feature of the atmospheric feature, the Interdecadal Pacific Oscillation (IPO), which modulates climate on time scales of one to three decades. The IPO causes significant shifts in climate which result in changes in average climate. The results show that the recently described IPO is a major source of climate variability in the south Pacific. The IPO, a coupled atmosphere/ocean process operates on time scales of several decades. In the positive phase sea level pressure (SLP) is lower in north Pacific and east Pacific, and higher in the south west Pacific. This is coupled with a trend of cooler than normal SSTs in the north Pacific, and the south west Pacific centred on the Cook Islands, and warmer than normal SSTs in the tropical south east Pacific. More southerly airflow is prevalent in the south west Pacific, and south westerly flow over the New Zealand area. In the negative phase the described anomalies are reversed. Climate shifts occur in the south Pacific when the IPO changes its phase. Between the most recent negative and positive phases little warming is seen in western parts of Kiribati and Banaba, where southerly airflow changes are greatest, and temperature increases are in excess of 0.6^{o} C in northern French Polynesia, where airflow changes are smallest. Annual rainfall increases by 50 percent or more in the north east of the south west Pacific region, whilst small decreases (~5 percent) occur in New Caledonia, Vanuatu, much of Fiji, Tonga, Nuie and in the southern Cooks. The IPO also alters teleconnections with the SOI. The climate shifts in the south Pacific caused by the IPO operate on a background of global warming.

The IPO also appears to influence the position of the South Pacific Convergence Zone (SPCZ), a major climate discontinuity which has cloud, convection and higher rainfall, in the south west Pacific. The position of the SPCZ shows a striking movement eastwards for the period during the positive phase of the IPO, compared with the negative phase. The IPO then modulates climate variability and trends in the south Pacific on timescales of several decades, against the background of global warming trends. The most recent phase of the IPO has generally intensified climate relationships with the Southern Oscillation, the source of climate variability in the Pacific on annual time scales.

Interannual variability in the Pacific is dominated by the El Niño/Southern Oscillation (ENSO) phenomenon. ENSO is driven out of the Pacific Basin. It has the strongest sea surface temperature (SST) signals of one sign along the equator over the central and eastern Pacific and a boomerang-shaped pattern of weaker SST signals of opposite sign extending over the middle latitudes of both hemispheres in the North and South Pacific. At the same time there is an exchange of atmospheric mass between the western and eastern equatorial Pacific, with mean sea level pressure anomalies of one sign over the Indo-Australian region, and of the opposite sign over the central and eastern tropical Pacific. Major climatic anomalies occur both globally and regionally during El Niño and La Niña events. During an El Niño, the trade winds weaken, and heavy rainfall and flooding occur over Peru and drought over Indonesia, Australia and southern Africa. Above average global temperatures also occur. In the tropical South Pacific the pattern of occurrence of tropical cyclones shifts eastward, so there are more cyclones than normal in areas such as the Cook Islands and French Polynesia. The south west Pacific becomes drier, whilst the central and eastern Pacific wetter. La Niña events tend to bring opposite climate anomalies to the Pacific and some regions of the globe.

THE 'ISLAND CLIMATE UPDATE'—A SUCCESS STORY OF COLLABORATION

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In 1996, a feasibility study commissioned by SPREP identified that there was an urgent need to disseminate climate information and seasonal climate forecasts to the South Pacific Region. This information was considered vital to the management and sustainable development of climate-sensitive resources in the South Pacific, such as water.

At that time, there was no mechanism available to the region to produce seasonal climate guidance. A project was therefore developed, to disseminate South Pacific climate information, including seasonal climate predictions.

The Island Climate Update (ICU) was first produced by NIWA (The National Institute for Water and Atmospheric Research Ltd.) in October 2000, funded by the Italian Government, through the Italian Ministry for the Environment, and the United States Department of Energy, through SPREP.

NIWA has received high praise from the users in the region, who typically use the guidance for planning purposes and to formulate response measures to impending climate related disasters such as droughts, floods and tropical cyclones.

The Island Climate Update is a success story of multi-national collaboration. Important contributions are made by most meteorological and development organisations in the area.

The ICU can be found at the NIWA website http://www.niwa.cri.nz/NCC/ICU/

CASE STUDIES ON RESPONSES TO CLIMATE CHANGE (CYCLONES, DROUGHTS AND COASTAL EROSION) IN TUVALU

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PICCAP Coordinator
Tuvalu

This case study on response to climate change was carried out last year and early this year on three islands, namely Nanumea, Nukufetau and Nui. In this study, I was looking at the responses from three different group levels that are most common on the islands, e.g. family, community and national. These groups' responses to climate change events referred to three time phases, e.g. before disaster, during and after.

From the study carried out, it was clear that at island and national level, there are climate change responses available within the communities but which remain dormant for most of the time. It is only when the climate change events are approached that these responses are visible and the rest of the community members participate. It is good to see that family and community groups are the immediate groups to react first to any disaster occurring on the islands. It was also found out during the study that individuals comprising these groups are very closely related, most of them are members of several extended families. The assistance provided by these small groups during climate change events are voluntary, timely, effective and labour free. It is interesting to note here the importance of local customs where all members of the community on each island is willing to contribute during adverse climate change events.

National assistance on the one hand is available most of the time but takes some time before it is forthcoming and involves some costs. It is always a practice by government to carry out certain formalities before any climate change assistance is endorsed and given out. From interviews, it has been disclosed that national responses are quite effective but sometimes dubious as they are governed by political masters.

In conclusion, the writer noted the importance of local customs on the islands in bringing together members of the community to address climate change issues at the community level, which is very effective in the case of Tuvalu.

CLIMATE CHANGE AND THE SETTLEMENT OF THE PACIFIC ISLANDS

Jim Specht
Australian Museum

The impact of climate change on people living in the Pacific Islands is generally regarded in a negative light. In historical terms, however, this is incorrect. Climate change has had both beneficial and deleterious effects on people's ability to colonise successfully all kinds of islands within the region. The paper will examine some of these beneficial and deleterious effects within a broad sweep of time, and will discuss some of the problems facing archaeologists and others who seek to write histories of the settlement of the many islands. In particular, it will look at some issues of scale and resolution that make it extremely difficult to unravel the various causes that have contributed to the landscapes within which people have colonised the islands and the adjustments that the people have made to ensure successful colonisation.

There are several fundamental points that must be accepted before we can embark on any consideration of the impacts of climate change. The first, and most crucial, is that climate change is a process, not an event. It is not something new, but because of the short time-scale of human life spans, we are not always aware of this. Many authors acknowledge that the glacial periods ('ice ages') of the Pleistocene geological period (about 1.8 million to 10,000 years ago) had enormous impacts on the region in terms of lower sea levels and locally cooler climates, with related changes to weather patterns and vegetation. But for some reason these authors frequently treat the last 10,000 years or so (the Holocene geological period) as if climate change has come to an end. In fact, we are most likely in a warm phase before another glacial episode.

Archaeologists, like earth scientists, tend to think in terms of much longer periods of time than those remembered in oral and written histories. This allows a different kind of perspective on human history in the region, one that deals with thousands of years rather than decades or centuries. For example, in the glacial period between about 30,000 and 10,000 years ago, sea level fell to about 120 metres below its present position, locally exposing 'new' land around many islands, and in many cases linking what are today islands into larger landmasses. By 10,000 years ago, sea level had risen again but was still about 50 metres lower than today. By about 5,000 years ago it was actually about 1-2 metres higher than at present, and it only settled at its present level after that, but at different times in each island group. It is worth noting that this higher sea stand was much more severe than that expected by the end of this century.

These changes in sea level were obviously important for people. Lower sea levels exposed more land and made it easier in some cases for people to move over long distances—for example, Australia and New Guinea were linked by a land bridge for much longer than they have been separated by Torres Strait, allowing people to move freely across the landscape. But with rising sea levels, many land bridges were flooded and the island world as we know it today started to form. In many regions, as in Papua New Guinea, where people arrived probably 45,000 years ago, the fluctuation in sea levels probably occurred at such a slow rate that in most situations people may not have been very aware of it taking place. On the other hand, around some parts of Australia, rising or falling sea levels on the gently sloping continental shelf could have been obvious in only a few years. People would have literally seen their world changing from year to year.

Changes in sea levels are often reflected in the distribution of former settlement sites. On some islands in the western Pacific, the sites now stand several metres above sea level, clearly positioned on old beach lines. In contrast, some sites of the Lapita pottery period (about 3300 to 2700 years ago) are now under water, as on the south coast of New Britain, in the Mussau group to the north of New Ireland, and around Buka and New Georgia in the Solomon Islands chain. These old settlements do not necessarily reflect rising sea level, but probably they represent settlements built out over the reefs as is still done in some parts of the western Pacific. On the other hand, the underwater Lapita pottery site at the Mulifanua Ferry berth, at the western end of Upolu in Samoa, is probably the result of the island subsiding, though the rate of subsidence is extremely slow.

As the sea level rose in the post-glacial period, it flooded vast areas, such as the Sepik-Ramu floodplain of Papua New Guinea. Studies in that region have shown that it was once a sea stretching inland hundreds of kilometres to the foothills that are now land-locked. With the fall of the sea back to its present level, and the filling in of the basin with sediments over the last 2-4,000 years, a vast new land was created for human settlement. Similar changes probably occurred, but on a much smaller scale, on many other parts of New Guinea and other islands. In many cases, these were probably assisted by the deposition of ash and other materials from volcanoes.

Many of the low coral islands and atolls that presently provide home for tens of thousands of people (indeed, for whole nations) may not have been formed until the sea level fell back to its present position, exposing coral reefs that had grown as a result of the higher sea levels. Some islands in Micronesia did not emerge from the sea until about 2,500-2,000 years ago; before that, they were simply not available for human settlement. It took a long time for these newly exposed reefs to become habitable, and then often only because people literally helped to create the environments that would support them. Classic examples of these are the islands where people grow the giant swamp taro, *Cyrtosperma chamissonis*, in specially made pits that require regular mulching to ensure their fertility.

The human modification of the newly formed islands to make them habitable raises more general issues about human impacts on island ecosystems. It has become popular to credit any landscape change on islands to the effects of people clearing forest and cultivating soils on steep slopes. One of the major proponents of this view is Patrick Kirch, who published a paper in 1997 comparing the landscape and human histories of Mangaia in the Cook Islands, and the tiny island of Tikopia in the extreme southeast of Solomon Islands. Kirch sketches very different stories of how the people on each island coped with the enormous changes that occurred there. On the other hand, Patrick Nunn has maintained a position that allows for the continuation of natural processes to form the landscape, rather than human intervention. Nowhere in his most recent book that reviews the many lines of evidence for the history of human colonisation of the Pacific, does Kirch seriously address this issue. Some authors invoke climatic fluctuations known elsewhere as the ‘Little Climatic Optimum’ (LCO), dated about 1200 to 650 years ago, and the ‘Little Ice Age’ (LIA), dated about 650 to 50 years ago. These periods saw variations in climate that were much less extreme than during the last glacial period or in the post-glacial climatic improvement, but for some authors these minor fluctuations were still sufficient to effect human populations and the islands on which they lived.

This raises an important question that constantly confronts archaeologists and others who seek to describe and explain human history: the evidence for climate change is almost always indirect, through various kinds of proxy records. Yet the degree of resolution of the archaeological record is rarely, if ever, sufficiently good for us to be able to state with certainty that X caused Y. Where we have human activities impacting on the environment at the same time as climatic changes, how can we attribute the changes that we see in the archaeological record, pollen cores, geomorphology and sedimentation to one cause rather than to another? Worse still, for most of the Pacific Islands, the records are patchy (if existent at all), and generally not well dated. It is not much help to know that there was a major influx of hill slope sediments into valleys at some time between 1200 and 1500 years ago, when the time envelope bridges the LCO and the LIA. Just because two ‘events’ appear to have happened at about the same time does not mean that one caused the other. A case in point relates to the loss of some species of land snails in Hawaii. Whereas one interpretation places responsibility on human activity, another suggests that the indirect effect of climate change through changing sea level may have been the culprit. Moreover, irrespective of whether it was climate or human activity that caused slope erosion on many islands, the outcomes often had a beneficial aspect. On Mo’orea, for example, the extensive slope erosion that occurred during human occupation infilled a swampy valley floor and made it available for human use.

A very simple conclusion arises from the above. While we know that there are cases where climate change, and its effects on sea levels and so on, must have had immense impacts on humans, there are far more cases where we simply do not have the evidence, both in terms of its quality and its fineness of resolution, to lay the cause at its door. For many Pacific Islanders, archaeology may seem to be an esoteric field of study, yet it will only be by combining archaeological studies with those of landscape and climate change that we will be able to gain a balanced understanding of the various impacts—both negative and positive—that both humans and climate have had on the insular environments that support the people of the Pacific. This is not to say that we should wait until we can be fairly certain that the picture is more complete and balanced, but we should be aware that the evidence currently available is not necessarily conclusive, one way or the other.

CASE STUDY ESSAY ON HURRICANE TSUMAN IN PORT OLRY—SANTO.VANUATU, IN 1998

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In correspondence with the Ethnographic Perspective on Resilience to climate change in the Pacific rim, may I wish to present my Case Study Essay about hurricane Tsuman which devastated and demolished Port Olry village on the 1st of April 1998 which is on April Fools Day.

It is purely a case study that which manifest the significance of how hurricane Tsuman shocked the whole village of Port Olry without having any indications of warning and affected so much. This paper describes how the local community victims prepared for, managed, coped with, endured through and recovered from the environmental shocks.

This paper briefly highlights the background of Vanuatu then leads to the background of port Olry itself. It precisely explains the compounds of the village structure.

Then it leads into the actual findings of what had happened before and after the hurricane Tsuman in Port Olry in 1998.

The major findings were:

- the local community acknowledged the experiences of changes in weather patterns, unpredictable climate change, experienced droughts, etc.
- the local community had second-hand news of natural disaster prevailing within regional countries.

The causes of vulnerability to natural disasters were:

- not receiving adequate information on global warning and it's impact,
- lack of global warning educational awareness,
- no preventative measurements taken in advance, and
- no conviction on local community the importance of advance preventative measurement.

The impacts on the lives of the people by the hurricane Tsuman in 1998.

- Both concrete cement and thatch houses were demolished
- The villagers were helpless and did not know what to do. They took it as a misery and as a sign of the "last days".
- Their economy—including coconut plantations, cattle farm, and fishing—was deeply affected.
- Their gardens were devastated.
- The local community faced difficulties in paying students' school fees and meeting their basic daily needs.

The short term-responses included:

- checking and monitoring the lives of the local community,
- community clean up,
- build temporary houses for homeless families, and
- clean their gardens, etc.

The long-term responses included:

- The community sought assistance from their Member of Parliament to pay for iron roofs.
- The community negotiated with donors to renovate the school classrooms.

My recommendations are the following:

- There is a need for more advanced dissemination of information about the validity of global warning at the village level.
- There is a need to encourage more capacity building workshops on environmental issues.
- There is a need for advocacy concerning logging practices which devastate the ecosystem.
- There is a need to promote-ecotourism for income generation.
- There is a need to promote adaptation for vulnerable off-shores villages.
- There is a need to enhance educational awareness.
- There is a need to provide funds to CBO, NGO, and individuals who take initiatives to coordinate workshops.
- There is a need to provide training to individuals who are involved in environmental issues.

VULNERABILITY OF KIRIBATI TO CLIMATE CHANGE AND SEA-LEVEL RISE: SCIENTIFIC INFORMATION NEEDS TO BE COMPREHENSIVE, AND UNFETTERED OF ADVOCACY

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Introduction

The purpose in providing this fact sheet on climate change is to put together the various views and opinions held locally that we consider to be constraints to gaining a fuller public support that is desired for effective planning and implementing adaptation measures in Kiribati.

1. Kiribati is not vulnerable because in the past sea level has risen to a level 2.4m above the present level.

That is one of the notions one obtains from studies on Kiribati by some scientists. The sea level rose to 2.4 above the present level by about between 4000 and 3000 BP and further that it was also during that period when the reef was forming.

Now the reef is the basis of the atolls. Moreover, Kiribati atolls were not inhabited until a later period. This implies that whilst the sea level was at its higher level than its present level, there were no atolls, and people on what might have been an elevation just above the sea surface.

The opinion captioned in Heading 1 above can therefore be dismissed.

2. During El Niño sea level normally changes by 40cm.

In the Country Report for the UNCED it was noted that sea level changes by 40cm during ENSO. An inference can be drawn that with a 40cm increase, Kiribati still exists. Sea-level rise scenarios under the climate change scenarios are between 9cm and 88cm by 2100, and for the year 2080 it would be 40cm. This means, however, that when El Niño occurs in the year 2080 sea level could rise to 80cm. Associated storms and storm surges would have serious implications for the atolls.

Any such opinion about being not vulnerable to a 40 cm rise in sea level can be dismissed.

3. Conglomerate outcrops as broad ramps, beach rocks perpendicular or parallel to the beach act as natural protection.

Some studies stressed that these physical features which are present along some beaches provide natural protection to the islands against erosion and sea-level rise (Woodroffe and McLean 1992 cited in Abete,1993). Furthermore, some of the conglomerate outcrops form the bases of islands that seem to be forming (accrediting), e.g. Nanimamai at Buota village in North Tarawa. Based in part on the presence of these rock formations along the beach of an island, the studies assessed different degrees of vulnerability to specific parts of the island.

All the studies concluded that atolls are young, formed about 4000-3000 BP. The studies moreover concluded that dynamic processes of accretion and erosion are ongoing with the normal weather and extreme weather events playing important roles in the processes. Old ridges are also observed in the middle of South Tarawa (Gilmore, et.al.1990), indicating that South Tarawa has increased in width since a time in the past when the old ridges marked off the shoreline. Lines of pumice are discovered also further inland from the existing shoreline at some islands. They also marked the position of the shoreline in the past.

All this information has led to the conclusion that dynamic coastal processes are complex but play a dominant role in determining the geomorphology of the atolls, thus their vulnerability to climate change and sea-level rise.

Knowledge of sediment production and their movements are needed to assist with more complete characterisation of the vulnerability of the atolls. This information is lacking.

The view captioned in Heading 3 above appear valid insofar as research for sediment sources and movements are important to enable a more realistic vulnerability assessment.

4. The sea-level around Kiribati is not rising; more recently it is falling.

As IPCC publishes its scenarios on sea-level rise, there are monitoring tide gauges installed around the Pacific. These tide gauges are the most accurate and therefore data from them are the most reliable. Recent readings in Kiribati show that the sea level is falling; they were rising in an earlier period.

That situation of the sea level needs to be understood within the proper context. What is meant by “falling” and “rising” is that asymptotic trends are falling and rising, that is, they were negative, then positive. This reflects the situation of the sea level, which of course “fall” and “rise” relative to its zero mark referenced to bench marks on Betio. Asymptotic trends are statistics derived from the actual relative heights of the sea level to the tide gauge zero mark. These heights are continuously taken, and a plotting of these heights over time depict fluctuating curves. Nonetheless, a best fit line can be calculated for the set of these heights. Starting from the time the first tide gauge reading was obtained and up to a length of time, it would be possible to calculate the best fit line. This line has a gradient. Take, for example, the first twelve months and plot the monthly mean sea level, then one can calculate the trend. Extend by a month, therefore the time period is now thirteen months and calculate the trend, and so on. The gradients of the trend lines form therefore a time series derived from the sea level readings off the tide gauge. A plot of these gradients is theoretically expected to fluctuate initially but will converge to a number, and such a number would reflect the real situation of the sea level. That number is not expected to emerge until after say 20 years, 18.6 years is said to be a period of a long tidal wave.

Apart from the theoretical analysis of the tide gauge readings, there are technical procedures that may from the start erroneously give unrealistic tide readings.

Until recently, we had thought that a procedure—a correct one—had been as follows. First is the stability of the tide gauge zero mark. They were referenced to benchmarks on Betio, which we understand to be stable, and to have been referenced to a datum in some map drawn up in the past. It is worrying to have recently heard from the Land Commissioner that it was the other way round. (Present during that conversation were Koin, Makin, Jim, and Teikarawa.) That is, the TGZ (tide gauge zero) mark functioned as a datum and the benchmarks were referenced to this zero mark. Moreover, when surveyors check the accuracy of the tide gauge, they would appear to assume the zero is stable, but that the benchmark on land was not. This is a very serious source of error if indeed our understanding of the Land Commissioner’s explanation of the procedure was accurate.

Let us elaborate on the last point. It is easy to see with the aid of diagram to follow this exposition. Consider the initial situation as follows. Let B be a bench mark on the land. Let O be the zero mark of the tide gauge. Let the distance between them be D. The sea level at that initial situation is say L above O. A time later survey check came. A first case, assume no change in L, and that silts has raised O a distance o from the original position at O in the original reading. Sea level drops now by a distance O. But survey assume that O is more stable than B, so they could adjust on their map by making B gaining extra height of O. Two explanations would then be possible. Whilst in reality the sea level has not changed, it now would appear that it has been falling, or that the land has been uplifted.

A variation of the first case is for B to sink by an extra depth of –o. The readings of the tide gauge would then indicate a rise in sea level when in fact it has remained constant. Survey adjustment would assume L has been stable but B changed by –o. The conclusions would be that either the sea has risen or that the land has subsided.

The deductions above are sufficient to demonstrate erroneous conclusions from the tide gauge, if it is true that surveyors now regard the tide gauge as being stable, in other words the zero mark is a reference point for the benchmark. Comments from the Lands Surveyor and NTF are really required to clarify our understanding.

We make a special plea that we (laymen as far surveying is concerned) should not be kept ignorant of the logic and rationales behind what the surveyors do with regard to the tide gauge at Betio. The question we ask is this: in checking the precision of level measurements, do we understand correctly that the end points (zero mark of the tide gauge) is taken as fixed and stable, whilst the level of the benchmarks on land are being considered as unstable?

The issue summarised in the heading of this section is one that we cannot as yet resolve from the NTF tide gauge instrument. We must also be guided against any misinformation. One incident of misinformation of the general public by scientists was when NTF scientists denied Tuvalu or Kiribati claims, based on their respective ranges of experience and knowledge outside the knowledge about the NTF tide gauge and reading, that sea level has been rising. The basis for which the scientists denied the claim was a limited data that the NTF tide gauge has accumulated.

5. A range of experience and knowledge of Kiribati.

Not counting institutional memory, this range is limited to a lifetime of individuals. More realistic would be the memories of those of older people. They do not understand climate change or global warming arising from CO_2, but talk to them about changes to the shoreline, in the pattern of the weather even of air temperature, change in the pattern of accretion and erosion, change in the reef platform, in fisheries, in agricultural productivity and tree crops resilience, changes to the water lens, and they will have something to say.

Local experience should be given more credence in scientific assessment of the vulnerability of Kiribati. For example, conglomerate platforms fronting some beaches are now exposed as the edge of the land receded through erosion, and this experience is disturbing and would not be eased by knowing the scientific information that conglomerates protect the land against sea-level rise.

6. Erosion and disappearance of few islets are due to coastal structural changes, such as seawalls, causeways, and removal of sand and aggregates.

Kiribati people would readily subscribe to the statement above. But to hold that the statement completely describes the observed situation, to deny in effect other explanations such as the disappearance of few islets could be due to causes that incorporate changes in weather conditions and in the sea level subsuming rising trends in the sea level would be contrary to the spirit of scientific reasoning. Yet some scientists who do not themselves think now that the sea-level has been rising often advance such a perception in explaining the problem of serious erosion experienced in Kiribati.

7. Kiribati people, and foreigners who live in Kiribati, complacently presume the land is solidly and safely outside the reach of the forces of the sea.

Extreme weather events such as storms and wave surges suddenly shake off that complacent viewpoint. The reality is brought home, but soon forgotten though impacts still remain. If these storms are to become more frequent, and would be exacerbated by sea-level rise, then the sooner the people would acutely sense the real vulnerability of their islands to the sea. Already some people are actually forced to build seawalls to protect extensive erosion, or to have moved further away from the shoreline.

Lack of documentation on activities that are essentially placed on the people due to climate change and sea level changes need to be remedied. This also applies to Section 6 above. Research in these areas will help in planning adaptation strategies.

8. The Creator created the I Kiribati people and unto them He gave them their homeland. Surely He would look after them and their homeland. He also gave a promise not to cause a flood again as was suffered by Noah's generations.

The Pacific Islands Council of Churches are not sharing the above view but it is view that some people in Kiribati have expressed. And this view is likely to be more palatable to some scientists in the Pacific Forum area than the view that there is climate change and sea-level rise. A "faithful" view in this particular situation is fatal. The view indicates a need for more efforts at public awareness raising, but this task would be more difficult if those scientists have designs to encourage some Kiribati people to hold on to their "faithful" view.

At workshops we carried out, the very faithful view was expressed. Once we responded by pointing out that the Pacific Islands Council of Churches have expressed concern about climate change. We also said that sea-level rise is not flooding from rain. In another occasion that the same view cropped up, we said that we could not assume any plan the Creator has for Kiribati because theologically no one is supposed to reason out things with Him. It would be wrong to anticipate what the Creator might or might not do.

This view can be dismissed.

9. Sea level rise can increase the water lens, provided rainfall does not decrease and the land width remain the same.

Even if rainfall and land width remain constant, storm surges will cause over wash of the land, making water in wells brackish. Water galleries for supplying water in the South Tarawa may not be adversely affected, provided also effective management is maintained. But other processes in the water cycle in the atoll environment may be more affected by climate change, for example, evapotranspiration. Impacts of climate change on such processes need also to be understood.

The view above appears consoling, but there is a need to integrate coastal area, agricultural vulnerability into the consideration of the vulnerability of the water lenses. Furthermore, we need to develop a most likely scenario of rainfall.

10. Scientific information on sea-level rise is viewed as threatening.

Sea-level rise scenarios published by IPCC are in the range of 9cm to 88cm by the year 2100. The talk of sea-level rise even without reference to the range is threatening to most I Kiribati. Consequently it has clouded objective planning for adaptation thereby becoming a constraint in planning. I Kiribati generally equate sea-level rise with a fatal demise. Yet in disseminating the scientific information, the intention by the Ministry Environment and Social Development is simply to inform the public and to obtain support for planning for adaptation measures.

This is a crucial constraint on the effectiveness of planning for adaptation. Careful planning for methods to convey the information is needed.

11. Lack of confidence in climate change scenarios and impacts on Kiribati atolls.

At the global level, there is good confidence in IPCC published scenarios on climate change and sea-level rise. On the other hand, scenarios at the local level are generally ill defined and not clearly understood. Global scenarios have therefore been used in vulnerability studies that were carried out.

In general, people readily accept global scenarios for what could happen in Kiribati. Nonetheless, some people think that scenarios at finer resolutions are required if more support and confidence are to come forth for any plans for adaptation.

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HEALTH, CLIMATE AND CLIMATE CHANGE IN THE PACIFIC

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Abstract

The prospect of a rapid change in the global climate has re-kindled interest in the links between climate and human health. These connections are diverse and far-reaching. Sometimes the effects are obvious, such as the injuries and illnesses related directly to droughts, floods and storms. Other, indirect consequences may be equally serious but less visible. Whether or not changes in climate have an effect on health depends not only on the nature of the change, and the rate at which it occurs, but also the vulnerability of the population affected. Adaptation (reducing vulnerability) is attracting attention as researchers and policy-makers come to appreciate that there are more opportunities to intervene to reduce susceptibility to harm than there are to prevent environmental change occurring. In some respects the countries in the Pacific are particularly at risk from climate stresses, because of their physical characteristics. But on a year-by-year basis the Pacific currently experiences greater variability in climate than any other region, and consequently natural and human systems have developed to cope with limited alterations in climate. A better understanding of these systems may shed light on both the effects of climate variability and mechanisms of adaptation, and in this way identify means of protecting public health across the Pacific.

How does climate affect health?

Table 1 provides one, commonly-cited division of effects of climate.

Categories of health effects due to climate

• Direct
effects of thermal extremes
illness and injury resulting from floods and storms

• Indirect
changes in vector-borne infections
other infectious diseases
exacerbate effects of pollutants in air and water
impaired nutrition resulting from agricultural disruption
effects of forced population movements

Far and away the most severe effects on health result from droughts, floods and storms: the numbers of people affected by these natural disasters, world-wide, runs into the millions. (Bouma *et al*. 1997).

Over the last thirty years the impact of such disasters world-wide has increased, largely due to much larger numbers of people living in disaster-prone areas (and possibly partly as a result of better reporting). But this trend has not been entirely regular—there has been a marked year by year variation in the number of people requiring assistance, reflecting the major global influence of the ENSO phenomenon. Overall, the impact of natural disasters has been much greater during El Niño years and in the year following than at other times. The pattern varies from one region to another—for example, cyclone activity in some parts of the Pacific increases under El Niño conditions (e.g. the Marshalls), while elsewhere storms occur more frequently at other times in the ENSO cycle.

Storms and cyclones can have very serious effects across the Pacific. For example, in Fiji in 1993 tropical cyclone Kina caused 23 deaths and massive economic damage to the country (which would have been even more serious if the major tourist areas had been affected). Following the cyclone, 15% of the national population (total 750,000 people) relied on food aid for up to 3 months.

Heatwaves are another example of climatic extremes that may have important health effects, although on a lesser scale than storms and cyclones. The largest study in the Pacific of the effects of heat was carried out by Charles Guest and collaborators in Australia. (Guest *et al*,. 2000) Daily death rates in the five major Australian cities were examined to see whether greater than expected numbers of deaths occurred during heat waves. The study suggests that between 1979 and 1990 elevations in temperature over 36 degrees C resulted in approximately 60 additional deaths a year. The effect varied considerably between the cities (most marked in Sydney and Brisbane), and was strongest amongst persons aged over 65. There was also an association between raised mortality and low temperatures, as has been noted in other studies.

Current numbers of climate-related deaths were then compared with those that might be expected under different climate change scenarios for the year 2030. The projected increase in deaths is small, and the effect varies between cities.

Storms and extremes of heat and cold are obvious examples of how climate can directly affect health. But other effects may result from indirect mechanisms. For example, climatic factors influence the range and behaviour of many important disease vectors. Mosquito-borne infections have been better studied than others; the relations between climate variations and dengue and Ross river fever will be reported elsewhere in this conference. Ciguatera or fish poisoning is caused by toxins produced by dinoflagellates that are carried on the surface of marine macro-algae.

In many Pacific islands with a high consumption of local fish, there is a positive correlation between sea surface temperature and notifications of ciguatera. (Hales *et al*. 1999) This is biologically plausible, as growth of organisms producing toxins, and of the fish that eat the algae and accumulate the toxins are promoted by warmer temperatures. However, as with all health effects of climate that are mediated by ecological mechanisms, the relation is complex. In this instance, the association of sea surface temperature and ciguatera is apparent only in those islands that experience warmer conditions during El Niño events. In the south-west corner of the Pacific, where the sea warms during the La Nina phase, there is no effect seen on rates of fish poisoning. Possible explanations include patterns of fish migration, and regional differences in amounts of fish consumed (the islands that warm during El Niño tend to eat much larger quantities of locally caught fish).

What determines the severity of the effects?

Severity of effect depends on the rate of change, and also nature of the change (humans are better equipped to adapt to cold, for example, than they are to deal with heat). The size of the impact depends as well on susceptibility to change, or "vulnerability".

The simplest description of vulnerability that I know of is "capacity for loss". Other definitions include "the extent to which a natural or social system is susceptible to sustaining damage" (Watson *et al*. 1998), "the sensitivity of a system to multiple exposures, taking into account the ability to adapt" (Woodward *et al*. 1998) and "communities or individuals that inhabit areas of environmental disturbance and are unlikely to adapt to change" (Jones and Robertson 1990).

Vulnerability may be individual or collective. It applies both to resistance to change, and to the ability to recover once changes have occurred. Vulnerability may have biological and physical causes, or it may result from features of social organisation.

The clearing of native forests is one example of biological and physical vulnerability. Such clearances modify the micro-climate, but they also increase susceptibility to flooding for a given rainfall. Studies of run-off after heavy rain in New Zealand, for instance, show much lower flows from areas that have retained native forest than those planted in exotics.

On the other hand, the falling casualty rate in Japan and Korea following cyclones (figure) is chiefly a consequence of reduced social vulnerability. Improvements have been made in the physical environment (for example, in the standard of housing), but the major cause of the reduced vulnerability of the population to extreme weather events is socio-economic: including factors such as better disaster planning and civil defence, information systems, and public education.

What is special about the effects of climate in the Pacific?

The most striking feature of the Pacific is the mis-match between regional contributions to greenhouse emissions (which is no more than 1-2% of the global total) and vulnerability to harm as a result of climate change (which is very high).

To some extent the fragility of the region is inherent. For example, geography dictates, to a large extent, vulnerability to the effects of sea level rise. Many populations in the Pacific are on the physical margins of sustainable settlement. The combined effects of coastal erosion, rising salinity, reduced rainfall and inundation are serious threats to a number of island states.

The ecological landscape is also unusually susceptible to harm. The longstanding isolation of many Pacific countries from the main continental land masses has meant that ecological systems have evolved in unique ways. These island ecosystems have been called “eccentric corners of the evolutionary process” (Leakey & Lewin 1996). A consequence of this isolation is susceptibility to introduced species, which face little competition for food and space.

New Zealand provides many good examples – from pests that are costly but have little direct impact on human health (eg tussock moth) to species that may carry serious diseases (eg A. camptorhynchus). Climatic factors may have an important influence on distribution and efficacy of mosquitoes and other disease vectors.

However vulnerability is not entirely determined by geography or history. The care with which coastal areas are managed will make a difference to the consequences of sea level rise; the frequency of vector-borne disease outbreaks depends on, among other factors, the competence of border control measures. In this sense the most important causes of vulnerability are those that are socially determined, because these are the ones that can be most readily modified.

As examples, consider two social phenomena that may strongly affect the “capacity for loss”: urbanisation, and the increasingly unequal distribution of resources within and between countries in our region.

The large-scale move of populations to cities is not unique to the Pacific, but it is now very prominent in this region, even in places such as Micronesia and Papua New Guinea which until very recently had no urban areas at all. Although the definition of “urban” living may vary from one collection to another, it is clear that the growth of urban populations outstrips national population growth in almost all countries.

There are many potential benefits of city living, such as opportunities for economic advancement and education. However the way in which cities grow can be to the detriment of the health and well-being of new settlers. Two examples that are particularly relevant to vulnerability to climate are the tendency for densely built cities to act as “heat islands” and the very poor condition of housing in many city squatter settlements, which may be prone to flooding, storm damage and vector-borne diseases.

Few would disagree with the notion that lack of income and other resources makes it more difficult to deal with environmental hardship. More contentious is the proposal that an unequal distribution of resources may also be a cause of vulnerability. However there is evidence from several countries (the US in particular) that once levels of income are controlled, the distribution of income is a determinant of population health status. Infant mortality, for example, is related both to national GDP, and to distribution of income, as measured by the GINI coefficient. For a given level of GDP, infant mortality rates increase with increasing inequality, and this effect is most marked when GDP is low. (Hales et al, 2000)

The mechanism for such an effect is not known, but it has been proposed that wide inequalities in wealth may erode the trust, cohesion and “social capital” that are required for the smooth running of any group. I know of no work relating income inequalities to the impacts of climate variation, but would speculate that such a relation does apply. Social cohesion and “interconnectedness” are very important factors determining the occurrence of famine, which is often climate-related. (Sen,1980) Work in other parts of the world has shown that people living in communities with wide inequalities in income are less likely to support “public good” initiatives (Kawachi 2001), which may well include aspects of civil defence and other adaptations to climatic extremes.

There is good evidence that inequalities are increasing in the Pacific, at a number of levels. The rapid shift to cash economies across the Pacific has resulted in wealth inequalities that were not experienced previously. One particularly striking example is Bougainville, where development of the Panguna mine caused large differentials in wealth in people of the region. At a national level, in many countries income differentials are opening up as the result of deliberate economic policies. In New Zealand, for example, the only growth in disposable incomes over the last decade has occurred amongst the most wealthy households (those in the top decile). There is very little information available from most Pacific countries on income distributions, but it is clear that economic differences between countries in our region are large and growing.

Moving from climate to climate change—how can we capture the full range of impacts on health?

Two problems confront us. First, many of the variables that are important for health are not captured very well in current climate change models. These variables include wind, humidity and rainfall density. Second, health impacts result from complex interactions of climate variables with the characteristics of local ecosystems. The example of fish poisoning and sea surface warming is a good example; another is the combined effects of sea level rise, land degradation and drought on agriculture and food security. But scenarios are most effective if they can be applied to the local scale, even if output from the climate models applies to relatively large areas; and knowledge of resistance and resilience of local environment is key to understanding potential impacts.

On a year-by-year basis, the Pacific currently experiences stronger fluctuations in climate than any other region, as a consequence of the El Niño Southern Oscillation. This means it may be difficult to pick up any climate change signals against the background of strong ENSO fluctuations. It means also that any effect of climate change on the timing and/or strength of ENSO will be particularly relevant to the Pacific. The IPCC concludes that such a relation is “not determined”, although one recent modelling study concluded that increased greenhouse gas concentrations are likely to lead to more frequent El Niño conditions and stronger cold events in the tropical Pacific. (Timmermann *et al.* 1999)

Where are the major gaps in knowledge about adaptation?

The most important causes of vulnerability and adaptation are social – because these are the causes that can be most readily modified. In the Pacific, this raises questions of economic resources, information and technology. The highest priorities for adaptation will of course vary from country to country. The greatest needs in Australia and New Zealand include strengthening public health infrastructure, developing emergency systems for storm and flood damage, preparations for the care of displaced populations and bio-security procedures (to prevent the introduction or extension of vector-borne disease). In other parts of the Pacific, the needs are likely to be different, and major issues may be food security, protection of fresh water supplies and primary health care.

How can we best use ENSO as an analogue for climate change?

ENSO is an attractive analogue for climate change in studies of impacts, since the Oscillation is the strongest year-by-year climate signal available for observation. However, ENSO may also serve as an analogue for adaptation. The Pacific has a unique experience of climate variability. Natural and human systems have developed over centuries to cope with variations that have occurred from year to year, in rainfall, temperature and storm activity. These measures have enabled communities to live with, and indeed to profit from the changes in the ENSO cycle. We should be cautious in extrapolating to human-induced climate change, where the rate of change will be much greater than historically, and the combination of climatic factors may be unfamiliar. Nevertheless, there may be important lessons from the past that can be applied to minimise future losses.

PREPARING FOR CLIMATE CHANGE

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It is eleven years since the IPCC produced its first technical report on climate change. In that time a mountain of scientific literature has been published, drawing on the efforts of thousands of people around the world. (Working Group II of the Third Assessment Report alone involved 183 Lead Authors, 243 Contributing Authors, and 440 reviewers.) There have been interesting changes along the way. The First Assessment Report (1990) concentrated on the physical processes driving the world's climate. The Second (1995) included a detailed review of the potential impacts of climate change. The major change in the Third Report (2001) was the emphasis on vulnerability and adaptation: the best part of the thousand page contribution from Working Group II is concerned with these subjects.

The way in which the IPCC reports has evolved reflects what has been happening in the climate change field generally. Adaptation - reducing the harm caused by environmental disturbance - has become a respectable topic for researchers and policy analysts. Mitigation is still the key to prevention in the long term, but I think there are few who would claim that reducing emissions and increasing carbon uptake will be sufficient on their own to deal with climate change.

Why has "preparing for climate change" risen towards the top of the list on the political and research agendas? One reason is likely to be committed climate change: the world will warm and the seas will rise, regardless of cuts made in future greenhouse emissions, because of the long-term effects of past emissions. Another explanation may be the surprise factor. Greater understanding of climate systems does not necessarily reduce uncertainty. In some instances more knowledge seems to make the future more mysterious and potentially threatening. Drawing on new evidence, the Third Assessment Report underlines the possibility of future scale-shifts (such as major alterations of ocean currents). Faced with possible, serious discontinuities of this kind, it makes a great deal of sense to gear up adaptive capacity.

Another consideration is the co-benefits of reducing vulnerability. Climate change might be seen as a vehicle for promoting social development generally. The changes that one would want to make to reduce the harm caused by climate change are likely to bring many other benefits. (And in some instances, these benefits will be apparent long before the impacts of climate change are felt.) Examples of "win-win" adaptations that are relevant in the Pacific include soil and water conservation, protection of coastal ecosystems, diversification in agriculture, improved bio-security arrangements and strengthened primary health care.

A sceptic might say: one would want to make changes like this anyway - what difference does climate change make? Apart from political considerations such as greenhouse credits and compensation, climate change provides a new framework for thinking about development. For instance, climate change puts teeth into the concept of sustainability. Nothing else has demonstrated so clearly that the planet is, in physical and biological terms, a closed system. Climate change is a sign that we have pushed the system to its limits, and the present generation's consumption of natural resources has reached a level that threatens the basic living conditions of future generations. In practical terms, climate change is a challenging reminder of what is needed to ensure long-term well-being and prosperity. It certainly puts a new slant on time scales for development and planning (even if greenhouse emissions were stabilized within the next century, sea levels would continue to rise until the year 3000).

Climate change also signals the need for action on a broad front, and for good connections between sectors. Health, which serves as an integrated measure of all the social impacts of climate change, is a good example. Preparing for the threats resulting from rapid changes in climate needs more than medical technology and old-fashioned health education. It means doctors working with urban planners, economists and water engineers (to name just a few). Such a focus on "up stream" causes of disease and injury is not new, but is timely: climate safety and health for all are two sides of the same coin.