`

SOUTH PACIFIC SEA LEVEL AND CLIMATE MONITORING PROJECT: PHASE IV

STRATEGIC REVIEW REPORT
September 2007

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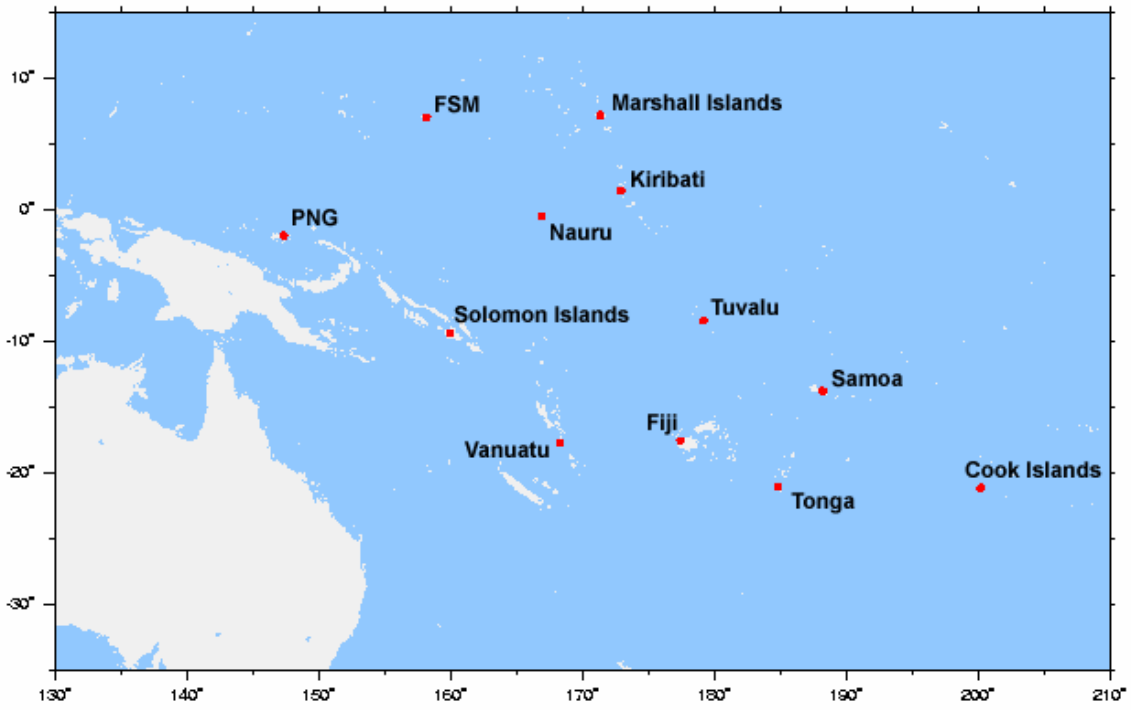
ACRONYMS

ABSLMA	Australian Baseline Sea Level Monitoring Array
ACE CRC	Antarctic Climate & Ecosystems Cooperative Research Centre
AMSAT	Australian Marine Science and Technology Office
ARGN	Australian Regional GPS Network
ASLOS	ATWS Sea Level Observation System
ATWS	Australian Tsunami Warning System
AusAID	Australian Agency for International Development
BoMET	Australian Bureau of Meteorology
CGPS	Continuous Global Positioning System
CROP	Council of Regional Organisations in the Pacific
ENSO	El Niño-Southern Oscillation
FSM	Federated States of Micronesia
GA	Geoscience Australia, Department of Industry, Tourism and Resources
GCM	Global Climate Model
GLOSS	Global Sea Level Observing System (International Oceanographic Commission)
GMS	Geostationary Meteorological Satellite (Japan)
GOOS	Global Ocean Observing System
GPS	Global Positioning System
GTS	Global Telecommunications System (WMO)
IOC	Intergovernmental Oceanographic Commission
IGS	International GPS Service
IPCC	Intergovernmental Panel on Climate Change
IPO	Interdecadal Pacific Oscillation
IUCN	The World Conservation Union
Monthly Data Report	Report containing technical calibration and quality control data for the SEAFRAME network
MOU	Memorandum of Understanding
NGO	Non-governmental Organisation
NIWA	National Institute of Water and Atmospheric Science, NZ
NMS	National Meteorological Service
NOAA	National Oceanic & Atmospheric Administration, USA
NTC	National Tidal Centre
NTFA	National Tidal Facility Australia (Flinders University)
NZAID	New Zealand Agency for International Development
NZMet	New Zealand Meteorological Service
PCC	SPSLCMP Project Coordinating Committee
PDO	Pacific Decadal Oscillation
PDD	Project Design Document, SPSLCMP: Phase IV
Phase IV	Phase IV of the SPSLCMP
PI GCOS	Pacific Islands Global Climate Observing System
PIC	Pacific Island Country
PICs	Pacific Island Countries
PI-CPP	Pacific Islands Climate Prediction Project
PIFS	Pacific Island Forum Secretariat
PI-GOOS	Pacific Island Global Ocean Observing System
PGs	Partner Governments
Project	The SPSLCMP and all its Phases
PTWC	Pacific Tsunami Warning Centre
QA	Quality Assurance
RCCA	Regional Communications & Coordination Adviser, SPSLCMP: Phase IV

Region	South Pacific Region
RTO	Regional Technical Organisation
SEAFRAME	Sea Level by Fine Resolution Acoustic Measurements
SOPAC	South Pacific Applied Geosciences Commission
SPC	Secretariat of the Pacific Community
SPREP	South Pacific Regional Environment Programme
SPSLCMP	South Pacific Sea Level and Climate Monitoring Project
SRT	Strategic Review Team
TAG	Technical Advisory Group
TOR	Terms of Reference, SPSLCMP: Phase IV
UHSLC	University of Hawaii Sea Level Center
UNFCCC	United Nations Framework Convention on Climate Change
USP	University of the South Pacific
WMO	World Meteorological Organisation
WWF	World Wide Fund for Nature

MAP: Current SEAFRAME and CGPS sites



EXECUTIVE SUMMARY

The Strategic Review of the South Pacific Sea Level and Climate Monitoring Project (SPSLCMP): Phase IV was carried out in April-May 2007. The aims of the Review were to investigate and advise on: (1) The long-term sustainability of the SPSLCMP network and its provision of data from the South Pacific region to PICs and international stakeholders; (2) the need for infrastructure upgrades of the SEAFRAME and CGPS components; (3) a structure and process for improved alignment with other regional climate monitoring activities in the Pacific region; (4) options for ensuring the long-term provision of utilities (communications and power) to the sites in the network; (5) options for the future funding and management of project activities; and (6) to assess and advise on end-user needs and a possible restructuring and optimisation of the network.

The independent members of the Strategic Review Team SPSLCMP were: Dr. Rosemary Sandford (Team Leader, Antarctic Climate & Ecosystems Cooperative Research Centre (ACE CRC), Hobart) and Dr. John Hunter (Science Lead, ACE CRC, Hobart). Drs Sandford and Hunter were joined by Mr. Philip Hall (former Project Manager, SPSLCMP: Phase IV, Canberra) and Ms. Roberta Thorburn, (Manager, Pacific Environment Team, AusAID, Canberra), who contributed advice and logistics support

In Australia, the Strategic Review Team (SRT) consulted with BoMET, AusAID and GA. The SRT also visited New Zealand, the Cook Islands, Samoa and Fiji and consulted as widely as possible in the time available. Teleconferences were subsequently conducted with, and email responses were sought from, a range of stakeholders in the South Pacific Region.

A number of issues emerged from the Review. These are:

- There is unanimous support for the continuation of the SPSLCMP, beyond Phase IV;

- Support for BoMET as the Australian managing contractor and for GA and SOPAC as sub-contractors in Phase IV, remains strong;

- Transfer of SPSLCMP network management and operations funding from project-based funding to BoMET earmarked recurrent funding is strongly recommended as being more appropriate to the long-term and scientific nature of the project and its contribution to global data archives. This may require a New Policy Proposal (NPP) to Government, sponsored by AusAID and supported by BoMET and GA to provide for a recurrent budget for the SPSLCMP, to be included in the appropriations for either BoMET or AusAID;

- Infrastructure refurbishment and upgrade by the end of Phase IV is supported and requires additional funding, as was recognised in the PDD (2006);

- The Palau gauge, operated by the University of Hawaii Sea Level Center (UHSLC), should be upgraded in 2008-2009 in collaboration with UHSLC to make it more compatible with the SEAFRAME system, and connected to a permanent survey mark (or marks) on the island. This will require additional funding, as was recognised in the PDD (2006);

- A SEAFRAME gauge or a multifunction gauge (i.e. one that also serves as a tsunami warning system) should be installed at Niue. This also will require additional funding.

- Uncoupling training and capacity building from the project in Phase IV has diminished the SPSLCMP's profile among stakeholders in the region;

- As a matter of urgency, BoMET and the SPSLCMP need to review and collaboratively reconfigure SPSLCMP data and information product development and delivery to meet PIC and regional needs and priorities;

- In-country training of NMS personnel and climate change professionals attached to NMSs and government agencies remains a high priority in Phase IV;

- BoMET and SPSLCMP in consultation with AusAID, need to develop and direct the project's communication and training products so that they may be readily used by other initiatives (for example, those supported by AusAID) that address PIC and regional vulnerabilities to the impacts of climate change;

- BoMET, GA and AusAID should pay particular attention to gender equity in SPSLCMP management and operations. Working with partner governments and regional organisations, they should actively encourage the direct participation of women in the development and delivery of all SPSLCMP initiatives. This includes: policy development and decision making; project scoping, design, implementation and monitoring; training and capacity building; and the development, production and distribution of communication and training products.

- AusAID and GA should consider the development of capacity building initiatives aimed at developing the skills of the younger generation of both male and female surveyors and technicians now coming through the Land Management and Survey departments of PICs, in order to help PICs realise and exploit the secondary benefits of the CGPS stations.

- The SRT recognises the PICs' preference that greater responsibility for a number of SPSLCMP activities be transferred to a Regional Technical Organisation (RTO) by Phase VI, providing the RTO is willing and able to assume these responsibilities.

The SRT agrees with the findings of the SPSLCMP: Phase III Project Review Report (2003): that it is important that the core data collection activities of the project are continued; that protection of data quality is a priority; and that data and information should be widely available and in forms that meet end-user needs. The continued involvement of AusAID in all aspects of communication, training and capacity building is highly valued, and AusAID's ongoing participation in the SPSLCMP beyond Phase IV is strongly supported.

1 INTRODUCTION

1.1 South Pacific Sea Level and Climate Monitoring Project

The South Pacific Sea Level and Climate Monitoring Project (SPSLCMP) was developed in 1991 as an Australian Government response to concerns raised by member countries of the South Pacific Forum over the potential impacts of human-induced global warming on climate and sea levels in the Pacific region.

The primary goal of the SPSLCMP is to generate an accurate record of variance in long-term sea level for the South Pacific and to establish methods to make these data readily available and usable by Pacific Island countries. The Project has been running for over 15 years and is now in its fourth phase, which commenced on 1 January 2006 and is due to end on 31 December 2010.

Since 1991, the Project has established a network of 12 high-resolution sea level monitoring SEAFRAME (Sea Level Fine Resolution Acoustic Measuring Equipment) stations throughout the Pacific. These stations have been established at the Cook Islands, Federated States of Micronesia (FSM), Fiji, Kiribati, Marshall Islands, Nauru, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. All are located on wharves. A system for transmitting the data via satellites and telephone links is in place, and computer databases have been established at the National Tidal Centre (NTC) (formerly the National Tidal Facility Australia (NTFA)), for processing, analysing, archiving and making the data available to the international community.

See Map: Current SEAFRAME and CGPC sites (p. 6), Annex 2, and <www.bom.gov.au/pacificsealevel/project_info.shtml>.

Each SEAFRAME station is supported by a Continuous Global Positioning System (CGPS) station (except in the Solomon Islands, where installation is scheduled for late 2007). CGPS measurements are being made to determine the vertical movement of the land with respect to the International Terrestrial Reference frame, and this is the primary reason for the installation of the CGPS stations near the SEAFRAME stations. The CGPS network has been progressively installed since 2001.

The project is managed by the Australian Bureau of Meteorology (BoMET) on behalf of the Australian Agency for International Development (AusAID). BoMET sub-contracts Geoscience Australia (GA) and the South Pacific Applied Geoscience Commission (SOPAC) to assist in the project. The roles of each agency are described in the SPSLCMP: Phase IV Project Design Document (PDD), dated April 2006. National Meteorological Services (NMSs) are the key counterpart agencies in the PICs. The project has a Regional Communications and Coordination Advisor (RCCA) based in, and formally attached to, SOPAC.

1.2 Background of SPSLCMP: Phase IV

SPSLCMP: Phase IV builds on the achievements of Phases I, II and III. The goal of Phase IV is to continue to provide for partner countries an accurate long-term record of sea level variability and change in the South Pacific that enables them: (1) to respond to and manage related impacts; (2) to manage their near-shore and coastal resources sustainably; and (3) to develop policies and strategies for responding to long-term trends. The current phase of the

project began in January 2006 and runs for five years, as indicated above. It is expected to cost $9 million, plus GST.
In delivering the project goal, key objectives of Phase IV are to:

- Maintain the investment in existing and new monitoring infrastructure;
- Continue the core process of collecting, analysing, storing and disseminating high quality sea level data from the SPSLCMP stations;
- Increase regional and local level participation in project activities;
- Enhance institutional capacity through training and technology transfer; and
- Improve information and data exchange between partners and stakeholders.

Processed and analysed data is made available to partner countries and the international scientific community, and information products and training have been provided to targeted groups in the Pacific Island countries.

SPSLCMP Phase IV has a technical focus. The primary objectives of its design are to ensure the continued operation and maintenance of the existing network, and the continued collection, analysis, storage and dissemination of high quality sea level data across the Pacific region.

2 SCOPE OF REVIEW

2.1 Terms of Reference

The Terms of Reference (TOR) for the Strategic Review of SPSLCMP: Phase IV was developed by AusAID in consultation with members of the Technical Coordinating Committee. The TOR states that the Review will assess and make recommendations in accordance with the Objectives of the Strategic Review (see Section 1.3). *Note*: The complete TOR, May 2007, is attached at Annex 1.

2.2 Objectives of Strategic Review

As stated in the PDD (2006) and the Terms of Reference (Annex 1), AusAID will undertake a strategic review of the Project by no later than October 2007 to investigate and advise on:

1. The long-term sustainability of the network and its provision of data from the South Pacific region to PICs and international stakeholders;
2. The need for infrastructure upgrades of the SEAFRAME and CGPS components to ensure the long-term viability of the network;
3. A structure and process for improved alignment with other regional climate monitoring activities in the Pacific region which will maximise synergies;
4. Options for ensuring the long-term provision of utilities (communications and power) to the sites in the network; and
5. Options for the future funding and management of project activities including consideration of the possible transfer of management of future phases of the Project to another Australian Government or Pacific regional agency or agencies.

In addition, it is agreed that it is important for the Review to assess and advise on:

6. The applications and value of the existing project data set to end users, as well as long-term requirements for sea level data from a network in the South Pacific;
7. Opportunities to advance gender equity within and through the work of the activity; and
8. A possible restructuring and optimization of the network.

The Review is not tasked to assess the progress of the Project's implementation. This will be assessed through a mid-term project governance review in 2008.

2.3 Members of the Strategic Review Team, SPSLCMP: Phase IV

The independent members of the Strategic Review Team, SPSLCMP: Phase IV were:

- Dr. Rosemary Sandford (Team Leader, Antarctic Climate & Ecosystems Cooperative Research Centre (ACE CRC), Hobart);
- Dr. John Hunter (Science Lead, ACE CRC, Hobart);

The independent members were supported by Mr. Philip Hall (former Project Manager, SPSLCMP: Phase IV, Canberra); and Ms. Roberta Thorburn (Manager, Pacific Environment Team, AusAID, Canberra), who contributed advice and logistics support.

2.4 Consultations

In undertaking the Review the SRT consulted as widely as possible in the time available. This consultation included Australian government agencies and sea level experts, and a range of government agencies, community organisations, CROP member organisations, academic and NGO stakeholders in the PICs. The SRT visited the Cook Islands, Samoa, Fiji and New Zealand. In addition, SRT members conducted teleconferences with CROP member organisations and experts and received written comments from other PICs. (See Annex 3 for details of those consulted.)

3 CURRENT USES AND VALUE OF THE DATA SET FROM THE EXISTING NETWORK

All those consulted agreed that the SPSLCMP network was a valuable scientific and information resource, that the value of the data increased with its duration and that sea level and climate monitoring should continue indefinitely.

At the international level, the most important scientific use of SPSLCMP sea level data is as input to the global climate data set (e.g. used in scientific publications referred to by the IPCC). The sea level data from any one station will not yield a useful estimation of the long-term trend until about 2050 (see Annex 2). The true value of this data is only realised when it is combined with other data such as sea level observations from neighbouring gauges and satellite altimetry data (e.g. Church et al., 2006a). Projections of sea level for, say, 2050 require the use of global climate models (GCMs) and cannot be accomplished through a simple extrapolation of the present trend, because the acceleration in sea level (which is detectable during the 19th and 20th century) will very likely continue during the coming decades. The validity of GCMs is, however, improved by the existence of high-quality sea level data sets such as those provided by SPSLCMP. Similarly, the validity of satellite altimetry (the other important sea level observing system) depends on accurate measurements of sea level, accompanied by associated CGPS observations.

Data from SPSLCMP is also provided to the international scientific community. Through the Project's technical partners, sea level change information contributes to the expertise and outcomes of the Intergovernmental Panel on Climate Change (IPCC) Working Group I "The Physical Basis of Climate Change", as well as Working Group II "Climate Change Impacts, Adaptation and Vulnerability". The relationship of the regional movements in sea level change to the global trend (and their impacts) is highlighted through these forums.

3.1 Data and Information Needs of Pacific Island Countries (PICs)

The PICs use SPSLCMP data for international, regional, and in-country policy and decision making purposes. At an international level, data is used to inform global and regional negotiations, for example, to inform PIC and Pacific Region negotiating positions in the United Nations Framework Convention on Climate Change (UNFCCC) regarding the Kyoto Protocol, the development of the Pacific Plan, and the development and implementation of the Pacific Islands Framework for Action on Climate Change 2006-2015. At a national level, PICs use SPSLCMP data and data analysis to develop national adaptation strategies and action plans, for example, Samoa's National Adaptation Programme of Action 2005.

Sea level rise and climate change will directly affect women as they have a high degree of dependency on the natural environment to perform their daily household maintenance tasks. How women might benefit from the data and information collected by SPSLCMP is not adequately understood. Further exploration of women's end user needs is encouraged (AusAID 2007).

Several PICs advise that the regional sea level and climate data such as that produced by SPSLCMP may be, and is, used to inform planning, policy development and decision making, for example in water management, forestry, agriculture, fisheries, health, education, infrastructure development and tourism. Tourism is a major source of national revenue for PICs. Many tourism developments (and their impacts) are concentrated in fragile coastal areas; areas which are also particularly vulnerable to sea level and climatic change.

An important in-country use of the SPSLCMP sea level data is in the production of tide calendars which have proved very popular among the PICs. Produced as one page per month, they are downloadable from the web and also as A4 and A3 hardcopy for distribution to the PICs. PICs expressed interest in having tide calendars produced for other islands where there is currently no tide gauge. If there is real local value in this, then it could be progressed by the installation of temporary tide gauges for a period of at least a year in these locations. This would require that BoMET and AusAID evaluate, cost and identify a source of funding for any increase in costs.

In earlier phases of SPSLCMP, real-time tidal displays were provided to the local port authority in some PICS to support shipping operations. This was valued by the users but for a variety of reasons has been largely discontinued. *It is recommended that options for reinstating these displays be investigated, probably using a web- or GTS-based system. Again, this would require additional funding and BoMET should identify a source of funding for any increase in costs.*

A number of interviewees indicated that useful products could be generated by combining tidal predictions with information about any present surge (which may last for a few days) and knowledge of the sea level associated with present El Nino-Southern Oscillation (ENSO) conditions. These would provide a better estimate of sea level for the subsequent days than is provided by tidal predictions alone.

One use of the sea level data that should be discouraged is to view the data as a "real-time" indicator of the long-term sea level trend. As already noted, the month-to-month and year-to-year variations in the apparent long-term trend have little statistical significance. It is evident that this needs further careful and consistent explanation across the Region. (See Annex 4).

There currently seems to be a lack of understanding of the regional and local wave climate, and a lack of appreciation of the importance of ocean waves in providing a strong influence on sediment transport processes and shoreline motion. *It is recommended that, in consultation with the regional organisations, the need for wave monitoring, analysis and modelling be assessed by BoMET, and appropriate action taken to meet such need.*

Finally, a number of PICs commented on the desirability of combining modern scientific research with traditional, anecdotal knowledge gained over generations of life on the islands. From careful and sustained observation of the natural environment, islanders have learned how changes in the natural environment such as extra mango crops in a season, can 'forecast' major changes in the weather, like more frequent and severe cyclones. There is a keen interest among both older and younger generations of islanders, to record this traditional knowledge and to integrate it with scientific approaches. *It is recommended that in Phase V, BoMET and AusAID, in consultation with USP, investigate strategies to achieve this.*

Recommendations

1. *It is recommended that options for reinstating real-time tidal displays be investigated, probably using a web- or GTS-based system. This would require additional funding and BoMET should identify a source of funding for any increase in costs.*

2. *It is recommended that, in consultation with the regional organisations, the need for wave monitoring, analysis and modelling be assessed by BoMET, and appropriate action taken to meet such need.*

3. *It is recommended that in Phase V, BoMET and AusAID, in consultation with USP, investigate strategies to achieve the integration of scientific and local knowledge.*

3.2 Unexpected/Secondary Benefits of Data

The PICs, SOPAC, SPREP and USP identified a number of unexpected or secondary uses of data that are of both immediate and future benefit to end-users. It was noted by SOPAC that SPSLCMP data has important applications quite apart from its key role in collecting data on sea-level rise. Such applications include the use of SPSLCMP data in coastal mapping, hydrography, hydrodynamic modelling and coastal zone management application.

SOPAC also emphasised the importance of having sea level measurements that are local to each PIC. NMSs commented that they could use meteorological data from the SEAFRAME stations in much the same way as they use data from an automatic weather to support local area weather monitoring and forecasting. The meteorological data collected at the SEAFRAME stations, while not uniformly to World Meteorological Organisation (WMO) standard, has also proved useful in relation to activities which occur near the SEAFRAME location (such as port operations and infrastructure development), which may be distant from the site of the National Meteorological Service observations. Since the meteorological data is broadcast over the GTS, BoMET believes this data is being used as input to global weather forecasting models.

Tide chart data is used to make decisions about when to fish in-shore and lagoon fisheries. Tide charts are also consulted in the scheduling of major national and local community cultural and social events such as the Samoan offshore national canoe race which attracts large numbers of tourists.

Finally, since the raw CGPS data is stored by GA, it may be used to provide accurate base station data for the location of survey control points around the islands. This was carried out in Samoa in 2005 and will be carried out in Fiji in the near future. As GPS surveying becomes more commonplace in the PICs, the CGPS stations should prove useful in other GPS applications.

3.3 Data Issues

There are a number of data-related issues that are of concern to the SRT and immediate action should be taken by BOMET to rectify these. They include ensuring: (1) that data end-users have a clear understanding of appropriate uses of SPSLCMP data – locally, regionally and internationally; (2) that they understand the need for long-term (i.e. multidecadal) sea level data for policy and decision making purposes; (3) that the SPSLCMP products are easy and inexpensive to access and interpret; and (4) that the PICs are aware of the usefulness, availability and locations of the large body of international climate and sea level data, and the ways in which it may be used to solve local and regional problems.

BOMET should encourage equal participation of women and men in any fora. This may require actively seeking out women's groups and holding workshops in community meeting places at times that suit women's workloads.

3.3.1 Duration of Data Sets

The estimation of the long-term trend in sea level is confounded by the presence of variations at a range of time scales. These variations are the reason why long records are required for the detection of significant sea level trends. Tide-gauge records contain a wide range of motions such as tides and surges, and multi-year oscillations related to climate variations (e.g. the El Nino-Southern Oscillation). On the other hand, Continuous Global Positioning System (CGPS) records show considerable variability which is unrelated to the actual motion of the station and which is not yet fully understood. While analysis techniques are being steadily improved, different CGPS analyses centres produce significantly different results (see also Annex 4). *It is therefore recommended that regular comparisons be made between the CGPS analyses provided by GA and those provided by other international centres. This may require requesting these centres to include the SPSLCMP CGPS data (available from the GA website) in their analyses.*

Analyses of sea level records from the region suggest that around 60 years of sea level data are required in order to determine the long-term trend in relative sea level at a single tide-gauge with any significance (see Annex 4 for an explanation of 'relative sea level'). The present data from the SPSLCMP SEAFRAME gauges is therefore far too short to yield any useful estimate of long-term trend. A consequence of this is that caution should be taken when interpreting the first table of the SPSLCMP Monthly Reports. At the present time neither the estimate of the long-term trend nor its change since the previous month has statistical significance and it would be unwise to base policy decisions on such data.

Consequently, the SRT believes that the presentation of data in the various (e.g. monthly) SPSLCMP reports has created a misleading impression of the usefulness of certain data products such as estimates of long-term trend. *It is therefore recommended that a review be*

carried out of the data provided in SPSLCMP reports and the way in which it is presented. Appropriate changes should then be made.

Similarly, analysis of CGPS data from SPSLCMP and of other global sources of GPS data suggest that about 7 years of data is required to estimate vertical land motion, in relation to studies of sea level. This has the important implication that, in order to obtain useful estimates of the trend in absolute sea level (see Annex 4 for an explanation of 'absolute sea level') the required length of a tide-gauge record is about eight times that required for a CGPS record. This means that there is a greater urgency to install sea level gauges than CGPS stations. Therefore (as will be noted later) it may be worth ensuring that a tsunami gauge is bought up to the specification of a sea level gauge and related to a "solid-ground" benchmark, even if during the initial phase of its operation there is no accompanying CGPS station. The delayed installation of such a station would not be overly detrimental, so long as a decade or so of CGPS data were obtained at some later time.

The above discussion relates to data from a single station. In order to obtain useful information on the long-term sea level trend at a given place, it is necessary to use data from a number of sites, combined with information from other instrumentation. Such an analysis yields what is called a 'reconstruction', which provides useful estimates of long-term regional trend (e.g. Church et al., 2006). *It is recommended that sea level reconstructions should be used by the Pacific countries to understand the long-term change in sea level, and its past and present impacts on their islands.*

SPSLCMP data may also be used to gain an understanding of the extremes of sea level, which is necessary for both planning and policy. For this purpose, at least 25 years of data are necessary. (This is discussed more fully in Annex 4.)

Recommendations

4. *It is recommended that regular comparisons be made between the CGPS analyses provided by GA and those provided by other international centres. This may require requesting these centres to include the SPSLCMP CGPS data (available from the GA website) in their analyses.*

5. *It is recommended that a review be carried out of the data provided in SPSLCMP reports and the way in which it is presented. Appropriate changes should then be made.*

6. *It is recommended that sea level reconstructions should be used by the Pacific countries to understand the long-term change in sea level, and its past and present impacts on their islands.*

3.3.2 Location of SPSLCMP Data and its Availability

Sea level, meteorological and CGPS data from SPSLCMP is quite widely distributed and easy to access, once the user knows where to look and what to do. However, there is a widespread perception among end-users (including NMS officers and regional and community organisations in all the PICs visited by the SRT) that the data is difficult to access on the web. Part of the difficulty is that access to the SEAFRAME data from the BoMET website requires registration, which leads to the following problems: (1) the registration requires the applicant to send an email, and this requirement is not immediately obvious, (2) there is no clear statement of what should be provided in that email, and (3) it is not clear to the applicant whether there will be a charge levied for provision of the data.

While the SRT accepts that some registration process is necessary in order for BoMET to keep account of the usage of SPSLCMP data, *it is recommended that an easier and more transparent registration process should be implemented, involving the completion of a standard online form rather than the sending of an email.*

Another problem is that there is little available information on the location of SPSLCMP data or its derived products (e.g. annual mean sea level) on the web. It took some effort by the SRT, even with prior knowledge of the major global sea level databases, to understand the distribution network for SPSLCMP data, including what products are available and where they may be found. *It is recommended that information describing the web locations of SPSLCMP data be widely distributed to potential users.* This information should be included on the SPSLCMP website, on BoMET's and AusAID's websites, on appropriate regional (e.g. SPREP and SOPAC) websites, on the data CDs supplied by the project and in email and hardcopy project newsletters. This information should include the list of relevant databases (which is attached here as Annex 5).

There are still significant problems with Internet access in the PICs. While it may be relatively easy to send an email, downloading significant quantities of data may pose a problem. Although CDs containing the SPSLCMP data are distributed regularly and quite widely among the PICs, these CDs are apparently not available on request from the BoMET website. *It is recommended that additional CDs of SPSLCMP data are produced and made available on request. The availability of these CDs and the method of requesting them should be prominently indicated on the SPSLCMP website.*

Finally, the websites are all in English which is the second language of most PICs. Those in remote areas of PICs often have lower education levels, fewer English language skills and are less likely to have access or time to use a computer. It would be advantageous for alternative means of information dissemination to be explored. Translation of any material into local languages will not only ensure wider comprehension but will also assist PICs to feel a greater sense of involvement in the project.

Recommendations

7. *It is recommended that an easier and more transparent registration process should be implemented, involving the completion of a standard online form rather than the sending of an email.*

8. *It is recommended that information describing the web locations of SPSLCMP data be widely distributed to potential users.*

9. *It is recommended that additional CDs of SPSLCMP data are produced and made available on request. The availability of these CDs and the method of requesting them should be prominently indicated on the SPSLCMP website.*

3.3.3 PICs Data 'Ownership' and Intellectual Property

A number of PICs expressed concern about data ownership and control, intellectual property and access regarding locally and regionally obtained data. It is important that the SPSLCMP is explained not as a means whereby the "rest of the world" would take data from the region, but rather as the important contribution the region makes to the global database and to the vast number of activities which can be labelled "IPCC science" (e.g. IPCC, 2007). The products

which flow back to the region are therefore not just dependent on individual records from tide-gauge and CGPS stations, but on the wealth of accumulated global climate science.

The SPSLCMP management should therefore concentrate not only on building the capacity of the PICs to appropriately use the data from their individual tide gauges, but also on showing them how to access and use the vast sources of data available globally to meet regional and local needs. *It is recommended that additional in-country training and capacity building, particularly for personnel employed in the climate offices/sections attached to NMSs, be developed and implemented to address regional and PIC needs in relation to data use and application.* The RCCA can play a role here, working with BoMET and GA stakeholders, in particular NMSs and surveyors, to assist the PICs to match up what the PICs need with what the SPSLCMP can provide. The PI-CPP has held similar workshops which appear to have been received very positively by the PICs.

Recommendations

10. *It is recommended that additional in-country training and capacity building, particularly for personnel employed in the climate offices/sections attached to NMSs, be developed and implemented to address regional and PIC needs in relation to data use and application.*

3.3.4 SPSLCMP and Gender Issues

The SRT were only able to visit three PICs during the 15 days available for field work in Australia, NZ and the South Pacific. During this time, the SRT met with both women and men in their capacity as representatives of partner governments, regional organisations and non-government organisations. The SRT was unable to specifically consult women's organisations or women's representatives in partner governments. It is therefore recommended that these groups be specifically contacted for their input as part of future consultations on this project.

The independent members of the SRT are reluctant to draw conclusions about gender equity issues in the PICs based on this small sample. In this context, the aim of comments made in this section and elsewhere in the report is to draw to the attention of BoMET, GA and AusAID the need to actively consider gender equity in all aspects of SPSLCMP management and operations. It is considered that, to further advance gender equity awareness and the delivery of gender appropriate products, training and capacity building, the proposed Joint Taskforce and the Project Coordinating Committee are probably the most appropriate mechanisms to take these issues forward in the first instance (see Sections 7 and 9).

Despite international acknowledgment of the need to involve both women and men in environmental management, women remain largely absent at all levels of policy formulation and decision making in natural resource and environmental management, conservation and rehabilitation programs. Women and men should be involved equally in the management and protection of natural resources as women's access to and use of natural resources is likely to differ from that of men (AusAID 2007).

The SRT met with both women and men from CROP member organisations, government departments, community organisations and NGOs in the Cook Islands, Samoa, Fiji, BOMET and AusAID. Of the people interviewed by the SRT outside the Pacific Region, 77% were male and 23% were women, while of those interviewed within the PICs, 62% were male and 38% were women. (See Annex 3 for consultation details.) The SRT noted that both women and men occupy positions of influence within all the PICs visited and that several of the PICs have strong matriarchal traditions. A number of the women consulted play key roles in management

and in policy and decision making in government departments, in information production and distribution among communities, and in CROP member organisations. Women are also directly involved in data collection, data management and data analysis, as well as in applying SPSLCMP data to local issues in order to assist their governments and communities to understand the impacts of sea-level rise and climate change.

However, a gender imbalance was apparent in the NMS forecasting areas and in the lands and survey departments. There is some indication that this may be an outcome of education systems in which girls are not encouraged to study maths and physics which are traditionally male dominated subjects, but which are also prerequisites for qualifications in forecasting and survey work. *It is recommended that SPSLCMP communication materials be produced for schools to raise awareness of career opportunities for both women and men in NMS forecasting and climate change. The SRT recommends that BoMET, together with USP, could investigate the possibility of creating scholarships to encourage women to study for, and consider career opportunities in, non-traditional fields.* BoMET and the RCCA should also work with Partner Governments to encourage them to support career opportunities for women in non-traditional fields such as climate change, meteorology and surveying; to increase counterpart capacity for women's participation in the development and delivery of climate change strategies and action plans; and to develop affirmative action plans to support and resource female staff.

There are already many women in the PICs working to address community issues related to the anticipated impacts of and adaptation to, sea-level rise and climate variability and change. For example, women are working with vulnerable coastal communities on issues of coastal erosion and the availability of fresh water. Women are also actively engaged in addressing issues such as the protection of sustainable fresh water resources against saline intrusion, health, education and agriculture. Vulnerability assessment and the development and implementation of adaptation strategies are priority issues for the PICs and end-user consultations need to ensure they capture the perspectives and priorities of both women and men. The SPSLCMP should encourage the professional development of women already working on coastal erosion and water resource projects.

Given that women generally have less access to the decision making processes that govern their lives, it is imperative that the SPSLCMP: actively seeks to understand women's end-user needs; acknowledges the different needs of women and men; and builds upon the existing skills and knowledge of both women and men in environmental management. The SPSLCMP should also aim to strengthen the capacity of women's groups to analyse the data and information generated by this project.

The SRT recommends that the SPSLCMP should work with partner governments, agencies and regional organisations to actively encourage the direct participation of women in the development and delivery of all SPSLCMP initiatives. This includes: policy development and decision making; project scoping, design, implementation and monitoring; training and capacity building; and the development, production and distribution of communication and training products. Any consultation process needs to effectively ensure that women can participate. This may involve separate consultations for women at times appropriate to their workloads. It will also be imperative for organisations representing women to be consulted early and effectively. AusAID suggests that these processes will need to be documented and measured ahead of the next review.

Recommendations.

11. *It is recommended that SPSLCMP communication materials be produced for schools to raise awareness of career opportunities for both women and men in NMS forecasting and climate change.*

12. *The SRT recommends that BoMET, together with USP, could investigate the possibility of creating scholarships to encourage women to study for, and consider career opportunities in, non-traditional fields.*

13. *The SRT recommends that the SPSLCMP should work with partner governments, agencies and regional organisations to actively encourage the direct participation of women in the development and delivery of all SPSLCMP initiatives. This includes: policy development and decision making; project scoping, design, implementation and monitoring; training and capacity building; and the development, production and distribution of communication and training products. Any consultation process needs to effectively ensure that women can participate. This may involve separate consultations for women at times appropriate to their workloads. It will also be imperative for organisations representing women to be consulted early and effectively.*

3.3.5 Retention of Sea Level and Climate Change Expertise in the Region

There are a number of tertiary-educated younger scientists and professionals in NMSs, climatology offices and lands and survey departments and also occupying positions as climate change advisers/educators in the Cook Islands, Samoa and Fiji. Unfortunately, time did not permit the SRT to visit other PICs.

A major difficulty faced by all PICs, is the loss of these (and other) talented and experienced people to better paying positions in regional and international positions both outside their home countries but still within the region, and outside the region entirely. The challenge is how to retain, support, mentor and provide career opportunities for these people. Most expressed a strong desire to remain in the region and aspired to leadership positions eventually. In addition to their qualifications, many have international experience in the United Nations (UN) system, for example in the Office of Small Island States, and they contribute directly to PIC international negotiations in the UNFCCC regarding the Kyoto Protocol through briefings and participation on national delegations.

Recommendations.

14. *During the balance of Phase IV and into Phase V, it is recommended that BOMET, supported by AusAID, should take steps to encourage additional training, educational and career opportunities for young scientists and professionals in the PICs and care should be taken to ensure that 50% of these opportunities are given to women. This can be coordinated via the SPSLCMP/PI-CPP Taskforce (hereinafter, Joint Taskforce; see Section 7). It is recognised that additional financial support will be required and that the Joint Taskforce and AusAID should investigate the provision of same in the context of regional capacity building (see Section 9).*

3.4 Sea Encroachment Mapping

The term “sea-encroachment” is interpreted here as meaning the permanent alteration of the shoreline at some specified tidal state (e.g. mean sea level or mean high water), on the assumption that the topography remains fixed (i.e. that no erosion or deposition occurs). Using

this interpretation, mapping of a new shoreline simply involves selecting the surface contour corresponding to the higher sea level. An alternative interpretation of "sea encroachment", which is discussed at the end of this section, is the temporary inundation which occurs under extreme sea level conditions (e.g. a surge associated with a tropical cyclone).

The SRT found very little support for sea-encroachment mapping from the PICs. The following issues were raised in relation to the value, or otherwise, of sea encroachment mapping in SPSLCMP Phase IV:

a) it ignores the processes of erosion and deposition, which dominate shoreline motion over much of the region;
b) presently available survey data (which has a vertical resolution in the order of metres) is inadequate to provide the resolution required (typically centimetres) for addressing projected sea-level rise during the coming century;
c) the cost of surveying the coastal strips of the islands at a vertical resolution sufficient for useful mapping would be very high; and
d) there is presently no requirement to survey all of the shorelines at once – resources would be better spent on key sites of coastal vulnerability.

There is clearly a requirement for integrated coastal vulnerability assessments to be carried out that involve a full range of physical science issues (e.g. sea-level rise, impacts of surges and tsunamis, and coastal erosion), coupled with analyses of social and cultural impacts. Sea-encroachment mapping could form one small part of this, although the cost of the required survey work would probably limit such mapping to key areas where such analysis is deemed directly relevant.

The PICs commented in particular on the need for PICs to be directly involved in any project scoping, design, implementation and monitoring so that (1) any sea encroachment mapping project would have direct relevance and application to those priority issues determined by the PICs, rather than by external scientists and other experts; and (2) that any physical mapping of coastal impacts of sea-level rise and sea encroachment should be coupled directly with an assessment of the social and cultural impacts.

A particularly useful early component of vulnerability assessment may be a geomorphologically-based vulnerability analysis of the entire shoreline of the major islands, of a similar form to that recently produced for Tasmania (Sharples 2006). (It is noted that the coastal processes of Pacific islands are quite different from, and in many ways more complicated than, those of Australia.) Another feasible option is the use of historical aerial photography and recently-available high-resolution satellite imagery to determine past shoreline movement. This has already been done in Samoa, where aerial photography right back to the 1950s apparently exists.

As mentioned in Section 3.1, there currently seems to be lack of understanding of the regional and local wave climate, and a lack of appreciation of the importance of ocean waves in providing a strong influence on sediment transport processes and shoreline motion.

A separate issue is the analysis of the effects of extremes of sea level, as a result of high tides, surges and/or tsunamis. The maximum sea level recorded during the approximately 14 years of SPSLCMP is typically 1 metre above mean sea level (the highest recorded at any station is 1.7 m relative to mean sea level, at Nauru in December 2001). The projected global sea-level rise from 1990 to 2095 is estimated to be between 0.18 m and 0.79 m (IPCC, 2007), which

would therefore have a significant effect on the frequency, severity and impact of extreme sea level events. Studies of the effects of climate change on extreme sea levels (for example, Church et al., 2006b, for Australia) often use hydrodynamic modelling to simulate the inundation caused by extreme events. The SRT does not believe that these types of studies are what is meant by "sea-encroachment mapping" in the context of this Review. However, the analysis and modelling of extreme sea level events and their impacts (e.g. temporary flooding) is a capability which should be developed for the region (for example, by a Regional Technical Organisation (RTO)), and one which would depend, to a certain extent, on data from SPSLCMP.

There is an apparent lack of demand for sea encroachment mapping from the PICs consulted in this review. These PICs expressed more urgent needs for targeted and integrated coastal vulnerability assessments, and action on more immediate priorities such as the protection of fresh water sources, agriculture, fisheries, health and education. *The SRT cannot therefore recommend that sea encroachment mapping be supported as a PIC priority in Phase IV. Rather, attention should be given to broader issues of coastal vulnerability.* The significant costs associated with sea encroachment mapping further mitigate against it being a priority issue in the near future.

Recommendations.

15. *The SRT cannot recommend that sea encroachment mapping be supported as a PIC priority in Phase IV. Rather, attention should be given to broader issues of coastal vulnerability.*

4 LONG-TERM CONTINUATION OF NETWORK

4.1 PICs perspective

The SRT found unanimous support for the long-term continuation of the SPSLCMP network. The PICs acknowledge the necessity for long-term climate data sets and understand that the SEAFRAME stations do not only measure tides but are part of a significant network monitoring sea level change at seasonal, annual, interannual and longer time scales. The need to ensure the consistency and reliability of data collection and management, and the protection of data integrity into the future was well understood by the PICs, NMSs and by the Pacific Forum Secretariat (PIFS), SOPAC, SPREP and USP.

However, the SRT found significant misunderstanding about the present value of SPSLCMP sea level data and its derived products e.g. present estimates of the long-term trend and its variation from month to month (see Annex 4). These misconceptions can only be addressed by awareness-raising and capacity-building activities that not only provide information on the SPSLCMP products, their uses and limitations, but also on the much wider "climate" context in which they sit. Therefore a clear need exists for targeted training programs and information products that are relevant to PIC and regional needs (see Sections 7 and 9).

4.2 Australian perspective

The South Pacific and Australian regions are intimately linked and it is impossible to consider the implications of climate change in one region without considering the other. In addition, reconstructions of sea level using data from tide gauges and other instruments (e.g. satellite altimeters) are often global in extent (e.g. Church et al., 2006a, 2006b, Jevrejeva et al., 2006)

and therefore data from all regions of the world are required. The Bureau of Meteorology, GA and the Australian sea level community see a clear need for continuing data collection by SPSLCMP.

4.3 International Stakeholders' perspective

As noted previously, many climate analyses require global data sets. SPSLCMP provides a network of high-quality sea level monitoring stations, which ensure that the western Pacific maintains a station density significantly higher than most other oceanic regions. This is entirely appropriate scientifically, given the importance of this region to global climate, for example, it is the site of the West Pacific Warm Pool and is critically involved in the El Nino-Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO) and the Interdecadal Pacific Oscillation (IPO).

The high-quality data collected by SPSLCMP, which is incorporated into the major global sea level databases, is used in reconstructions of global and regional sea level change and in global analyses of sea level extremes (e.g. Wodworth and Blackman, 2004). It is also believed that the meteorological data collected at the SEAFRAME stations, while not uniformly to World Meteorological Organisation (WMO) standard, is being incorporated into the data that is then assimilated into global meteorological models.

While it is difficult to quantify exactly what would be lost, from a global and regional perspective removing future SPSLCMP contributions would be a significant loss to the international scientific community and to the international donor community.

5 NEED FOR MODIFICATION AND/OR OPTIMISATION OF EXISTING NETWORK STRUCTURE AND DESIGN

5.1 Palau and Niue: SEAFRAME and CGPS stations

In 2002 the National Tidal Facility Australia (NTFA) conducted a pre-feasibility study of SEAFRAME stations at Palau and Niue (see Annex 6). They found that, from a scientific perspective, the existing system at Palau (or Belau; see below) should be supported, and that a SEAFRAME be installed at Niue.

Palau (Belau): This now has a dual Aquatrak system (installed in 1999) with a closely-coupled CGPS, run by the University of Hawaii Sea Level Center (UHSLC). This has also been a Global Sea Level Observing System (GLOSS) station since 1974, which indicates its scientific importance. The SRT recommends (and NTC has recommended) that this system be upgraded in collaboration with UHSLC to make it compatible with the SEAFRAME systems, by the addition of some sensors and possibly some changes to instrument calibration methodology.

There is significant debate about the appropriate siting of a CGPS relative to a tide gauge. Some recommend that it is placed on "solid" ground within a few kilometres of the tide gauge (as with SPSLCMP), while others recommend that it is placed within close proximity of the gauge (which generally means on the actual wharf, as in the case of the present Palau system). The debate is, however, rather more philosophical than practical. In order to estimate the *relative* sea-level rise for an island and the *absolute* sea-level rise, knowledge of both the vertical motion of the tide gauge (which may be sited on a wharf of poor vertical stability) *and* the vertical motion of the land if required. This is generally accomplished using conventional (optical) surveying techniques to assess the relative motion of the tide gauge and the land, and a single CGPS station situated somewhere within the surveying network; the exact location is

relatively unimportant. It is important that a permanent survey mark (or marks) be installed on the land mass of the islands, and that this (these) be connected to the tide gauges and present CGPS installation by conventional surveying.

Niue: NTFA (2002, see Annex 6), found the addition of a new station at Niue would add significantly to the spatial coverage within the "South Pacific Convergence Zone" (a key component of the regional climate system). NFTA recommended that a new gauge at Niue would be of substantial benefit to the local people through its contribution to environmental planning and development. BoMET (2007) further stated that a gauge at Nuie would provide a basis for studies of local environmental phenomena, such as extreme events, as required for planning and coastal development.

There has been a question concerning the presence or otherwise of a tide gauge or tsunami warning gauge at Niue. IOC (1998) reported that "without a tide gauge there is no measurement of current, swell movement, sea level and other data" and NTC (2004) noted that "a tsunami warning gauge (similar to a tide gauge) was installed at one time, but is no longer operative". However, ITIC (2005) reported that the "tsunami/tide system damaged by Cyclone Emani" was reestablished at Alofi Wharf, Niue, in October 2004. Curiously, this is the only reference that could be found to "Cyclone Emani"; it is most probable that this actually refers to Cyclone Heta, which affected Niue on 5 January 2004. A tide gauge was operational at Niue on 3 May 2006 when a tsunami was observed (ICG/PTWS, 2007). ASLOS (see Annex 7) reported that, in January 2007, there was "an existing PTWC pressure sensor at Sir Robert's Wharf" (the PTWC is the Pacific Tsunami Warning Centre, one of NOAA's two tsunami warning systems). NTC, however, believes informally that "the PTWC may be seeking to offload operation of the gauge to another entity".

In summary, it appears that a tsunami warning gauge was installed some time prior to 2004, but was damaged by a cyclone in early 2004. It was then re-established by PTWC (using a pressure sensor) in October 2004 and has been operational at least until early 2007. There is, however, no reason to suppose that it is not still working.

Regarding CGPS facilities, the South West Pacific GPS Project established a CGPS station at Niue in 1996 (PCGIAP, 1999). This was named "NIUC" and was operational until it was destroyed by Cyclone Heta in 2004. GeoNet (a New Zealand science program; see http://www.geonet.org.nz/) installed a CGPS station (named "NIUM") in the Niue Meteorological Service Building Compound in September 2005. This is to the same International GNSS Service standards that SPSLCMP has adopted. The data from NIUM is available from GeoNet and should be sufficient for the needs of SPSLCMP.

A SEAFRAME gauge at Niue would marginally improve the network from the point of view of data density (Niue falls roughly midway between Tonga, Samoa and the Southern Cook Islands) and would provide Niue with a means of estimating the statistics of extreme water levels. If the existing tsunami warning system is withdrawn and this leaves a weakness in tsunami warning capability, there are two options: (1) a modified SEAFRAME system could be installed to satisfy tsunami-warning and sea level monitoring requirements or (2) a combined SEAFRAME /ATWS (Australian Tsunami Warning System) warning system could be installed, sharing some common elements. Siting a gauge on Niue is problematic due to the rugged nature of the coastline and extreme sea conditions which have caused significant infrastructure damage in the past. An earlier report for the ATWS Sea Level Observing System (ASLOS, see Annex 7), recommended Sir Robert's Wharf at Alofi as the only possible site for an ASLOS system, noting that it would still not be ideal for tsunami monitoring and that it would be highly vulnerable to damage. This is also probably the only site for a SEAFRAME system.

There is, therefore, some scientific merit in installing a SEAFRAME system at Niue. It is also difficult to envisage how Niue could proceed with sustainable development, and plan for future extreme events, without having a tide-gauge installation of the type currently employed by SPSLCMP. It would be particularly cost-effective given the existence of the GeoNet CGPS station and the demand for some form of sea-level gauge would also be increased if the existing tsunami warning gauge were withdrawn. However, it should be born in mind that the SEAFRAME would be vulnerable to damage.

In conclusion, *the SRT recommends* that:

(1) *The Palau system be upgraded in collaboration with UHSLC to make it compatible with the SEAFRAME system, and connected to a permanent survey mark (or marks) on the island;.*

(2) If the existing PTWC tsunami gauge at Niue continues to operate, or if it is withdrawn and is not replaced by an ASLOS gauge, then a SEAFRAME gauge should be installed; and if the existing PTWC tsunami gauge at Niue is withdrawn, and it is replaced by an ASLOS gauge, then SPSLCMP should contribute funds to make it a multifunctional installation.

Recommendations.

The SRT recommends:

16. *The Palau system be upgraded in collaboration with UHSLC to make it compatible with the SEAFRAME system, and connected to a permanent survey mark (or marks) on the island.*

17. *If the existing PTWC tsunami gauge at Niue continues to operate, or if it is withdrawn and is not replaced by an ASLOS gauge, then a SEAFRAME gauge should be installed. If the existing PTWC tsunami gauge at Niue is withdrawn, and it is replaced by an ASLOS gauge, then SPSLCMP should contribute funds to make it a multifunctional installation.*

5.2 Multifunction Gauges: Tsunami Warning System, SEAFRAME and CGPS

There are significant differences in the requirements for sea level gauges of the type used for SPSLCMP and for tsunami monitoring. (These are discussed in Annex 8.) There are three options for multifunction tide/tsunami gauge installations:

1. Co-locating a standard SEAFRAME and a standard tsunami gauge. There are some clear gains in a joint installation, such as a degree of redundancy and possible cost-saving (e.g. the weatherproof enclosure, power supply, data logging and telemetry). The only real compromise would be in the choice of siting; SEAFRAME and tsunami gauges generally require sheltered and exposed environments respectively.
2. Upgrading a SEAFRAME to act as a tsunami gauge. This has been implemented for the SPSLCMP gauges, which now record at 1-minute sampling, the resultant data being broadcast over the GTS for tsunami warning purposes. A disadvantage of this solution is that the siting of the SEAFRAME gauge is unlikely to be optimal for tsunami monitoring.

3. Upgrading a tsunami gauge to act as a tide gauge. A tsunami gauge may be upgraded by the addition of vertical referencing, which may be considered in two phases. Firstly, a stable survey mark (or marks) should be installed on "solid" ground and connected to the tide gauge by conventional surveying techniques. Secondly a CGPS should be installed and also connected to this network. The surveying network should be checked on a roughly annual basis, in order to determine any vertical movement. However, as noted in Section 3, in order to estimate a trend in sea level, the duration required for GPS data is significantly less than that required for sea level data. It is therefore not necessary to install the CGPS at the same time as the instrumentation and survey mark(s) – however, as a priority, the survey mark(s) should be installed and connected to the tsunami gauge before the gauge becomes operational.

   Some measures may be necessary to ensure long-term stability (especially in the vertical) of the installation. In addition, since the technology used in the gauge may be relatively new, *it is recommended that a visual tide pole be incorporated into the installation to provide a regular check on the operation and stability of the gauge.*

There was significant interest among the PICs for tide gauges to be installed in other locations. Additional gauges would also strengthen the present network. Upgraded tsunami gauges, fulfilling this role, would provide a cost-effective solution.

BoMET advises that as part of the ATWS, all of the SPSLCMP stations will be upgraded to report in real-time. Several new tsunami sea level stations, where applicable, will be co-located with the existing SPSLCMP stations, with others being located for the optimum identification of tsunami. Due to differing observational requirements, it is not envisaged that the SPSLCMP stations will be significantly upgraded within the lifetime of the ATWS project. However where synergies exist, there will be potential for future alignment with both projects. Data obtained from the sea level stations will provide important data for tsunami models and warnings which will benefit the region and Australia. All data obtained from the sea level monitoring equipment will be shared with host governments in near real-time.

Recommendations.

18. Multifunction gauges would represent cost-effective solutions in some situations. In cases where a tsunami warning gauge (which uses relatively new technology) is upgraded to a multifunction system, it is recommended that a visual tide pole be incorporated to provide a regular check on the operation and stability of the gauge.

6 INFRASTRUCTURE UPGRADE OF SEAFRAME AND CGPS COMPONENTS

6.1 Equipment replacement and upgrading

The need for infrastructure upgrade of the SPSLCMP technical components relates more to the SEAFRAME network than the CGPS network. All of the SEAFRAME stations (with the exception for Pohnpei (FSM), which was established in December 2001), have been operational since October 1994, whereas the existing stations in the CGPS network have all been installed since 2000 (i.e. during Phase III). BoMET has confirmed that the age of the core technology used in the SEAFRAME stations is now approaching 25 years, it being approximately 10 years old at the time the first SPSLCMP SEAFRAME installation was commissioned at Lautoka, Fiji, in October 1992. While SEAFRAME operation and

maintenance issues have so far been minimal, largely due to the robustness of the existing equipment, their obsolescence means that the current spare parts and support arrangements are now at risk. Therefore any future upgrade of the SEAFRAME infrastructure will need to include new data loggers, new sensors, new communications equipment and replacement of worn, damaged and corroded fittings and housings.

There have since been significant advances in the relevant recording, computing and telecommunications technologies, delivering greater data storage and faster processing capabilities, not to mention the rapid development of internet communications and their application to data transmission and dissemination. BoMET intends to introduce these technologies into the Australian Baseline Sea Level Monitoring Array (ABSLMA), which it operates. BoMET advises that planning for close integration of the management and operation of SEAFRAME and ABSLMA networks is already well underway. For example, a major technical evaluation of the platforms and sensors (including radar devices and the next generation of BoMET's automatic weather station) to be used for the ABSLMA is currently underway, and the outcome of this evaluation will have a major bearing on the direction BoMET will take the SPSLCMP SEAFRAME network.

While BoMET is working towards a unified approach to operating its sea level observing networks, to ensure economies of scale, standardised application of technology, optimisation of maintenance and technical support activities, etc., there is a risk that the new technology may not be as accurate nor as robust as the existing equipment. To mitigate this risk, BoMET proposes to participate in international comparison testing programs while maintaining the extant technology in parallel with the new technology as long as possible. *It is therefore recommended that future planning for the SPSLCMP SEAFRAME network be coupled to BoMET's development plans for the ABSLMA.*

BoMET also recognises that, depending on decisions yet to be made, opportunities may exist to more strongly couple the capital activities of the Australian Tsunami Warning System (ATWS) with the SPSLCMP by exploiting potential synergies that may generate some cost savings. BoMET research into that concept is at an early stage, and hence BoMET was not able to quantify those opportunities for the purposes of the SRT.

In relation to the CGPS network, GA has been conducting an ongoing station upgrade program in conjunction with its periodic survey and maintenance field visit program. Upgrade requirements for the CGPS network are therefore limited to standardising computing and communications equipment, replacement of the older air conditioning units and upgrading site security measures, rather than major refurbishment of the physical infrastructure.

Should AusAID decide to proceed with the inclusion of Palau and Niue into the SPSLCMP, both BoMET and GA will need to conduct site surveys at each location to gather the information necessary to provide an accurate estimate of infrastructure and installation costs.

Similarly, should AusAID decide to broaden the scope of the Project to identify PIC needs and facilitate local access to SEAFRAME and CGPS station data by NMSs and Lands & Survey Departments, both BoMET and GA will need to assess the cost of providing that capability within the context of the agreed change of scope.

In summary, BoMET's position is that there are a number of significant planning and organisational considerations which need to be addressed and/or clarified before capital estimates for upgrade of the SEAFRAME and CGPS networks can be adequately determined. BoMET, therefore, was not in a position to provide the SRT with any further updates to the

estimates provided in Annex J to the Phase IV PDD (see Table below), but expects that those estimates will remain indicative within the decision timeframe of the Review.

Recommendations.

19. It is recommended that future planning for the SPSLCMP SEAFRAME network be coupled to BoMET's development plans for the ABSLMA.

6.2 Budget estimates for network infrastructure upgrade

The SRT requested that BoMET revise its estimated capital costs for an infrastructure upgrade of the SPSLCMP network (see Annex J, Phase IV PDD, April 2006 below), to take account of an infrastructure cost upgrade, excluding the siting of new gauges at Palau and Niue during Phase IV.

Monitoring Network Infrastructure & Equipment Upgrade					
FY	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**Total**
Reimbursables	20,000	125,000	143,400	64,200	$352,600
Capital Equipment		900,000	686,400	243,200	$1,829,600
TOTAL	**$20,000**	**$1,025,000**	**$829,800**	**$307,400**	**$2,182,200**
Consisting of:					
Reimbursables	20,000	60,000	40,000		$120,000
Capital Equipment		900,000	200,000		$1,100,000
Total BoMET	**$20,000**	**$960,000**	**$240,000**		**$1,220,000**
Reimbursables		40,000	78,400	39,200	$157,600
Capital Equipment			486,400	243,200	$729,600
Total GA		**$40,000**	**$564,800**	**$282,400**	**$887,200**
Reimbursables		25,000	25,000	25,000	$75,000
Capital Equipment					
Total SOPAC		**$25,000**	**$25,000**	**$25,000**	**$75,000**

Notes:
- Estimates do NOT include an allowance for contingencies.
- Estimates do NOT include salary. These are already included in full-time staff estimates for Phase IV.
- Estimates do not include Palau and Niue.

Table A: Estimated capital costs for infrastructure upgrade of the SPSLCMP network (from Annex J, Phase IV PDD, April 2006)

BoMET has decided that planning for the SPSLCMP network should be coupled to development of plans for the ABSLMA, an evaluation of which is currently underway, plus decisions may be taken to more strongly couple the capital activities of the ATWS with the SPSLCMP (see also section 6.1). BoMET advised the SRT that the values from the original

expenditure (Table A) should be taken as given and that no major change was expected in relation to the direction of the scope, configuration or the technology of the network (BoMET's Response to the Questions from the SRT, 3 May 2007). DFAT also suggests that an update of costs for infrastructure upgrades might take into account the potential for costs to be shared by the ATWS and SPSLCMP projects.

Given these provisos, the SRT is not able to make further comment on BoMET's budget estimates for infrastructure upgrade, except *to recommend that the Australian Government should make every effort to ensure the long-term continuation and maintenance of the SPSLCMP network at a level and in a condition that will ensure the continued collection, management, analysis and delivery of quality data to current and future global databases, the international scientific community, the Pacific Region, the PICs and Australian end-users.*

Recommendations.

20. It is recommended that the Australian Government should make every effort to ensure the long-term continuation and maintenance of the SPSLCMP network at a level and in a condition that will ensure the continued collection, management, analysis and delivery of quality data to current and future global databases, the international scientific community, the Pacific Region, the PICs and Australian end-users.

7 ALIGNMENT WITH PACIFIC REGION CLIMATE MONITORING ACTIVITIES

7.1 Current and expected information products in the Region

There are so many sea level and climate change information strategies, information products, communication and action plans in the Region that it can be confusing for stakeholders. There is a distinct risk of information overload so that stakeholders become 'immune' to the messages about sea-level rise and climate variability and change. Another risk is that the lack of clear delineation and even competition among organisations working in the information delivery and capacity building fields, may be counterproductive to the need for achieving coordinated on-ground action.

Australia participates in a number of other international scientific activities focusing on sea level change and climate impacts, including the Pacific Islands Global Ocean Observing System (PI-GOOS: http://ioc.unesco.org/GOOS/Pacific/pacgoos.htm), the Pacific Islands Global Climate Observing System (PI-GCOS: http://www.pi-gcos.org) and the Global Sea Level Observing System (GLOSS: http://www.gloss-sealevel.org). It is envisaged that during SPSLCMP Phase IV the sea level network will be more widely promoted as a joint undertaking with PICs and regional agencies as a core observing component of PI-GOOS, PI-GCOS and GLOSS.

SPREP coordinates the Pacific Islands Framework for Action on Climate Change and is responsible for the development of an Action Plan to implement this framework. SPREP is also organising a Climate Change Roundtable later in 2007 <www.sprep.org>. (See also Section 7.)

SOPAC helps member countries to sustainably manage natural resources and minimise risks from natural hazards (SOPAC 2006). The development and use of innovative mapping and modelling tools to assist planners and resource managers has been a cornerstone of SOPAC's communications and information delivery. <www.sopac.org>

The SPSLCMP Draft Communications Strategy and Plan is currently being developed by the RCCA in SOPAC in consultation with the implementation partners BoMET and GA (and AusAID). The major focus of the Communications Strategy and Plan is to raise awareness of the SPSLCMP in the Pacific Region, in particular key national policy- and decision-makers responsible for resource management and allocation, planning and development, health and education and other national policy priorities.

The draft SPSLCMP Communications Strategy contains a number of proposals for getting the SPSLCMP message across. This includes a dialogue/outreach plan, including workshops with PICs to identify PIC needs; the development of PIC-appropriate information products, data applications and other capacity building tools; and strategies for product delivery. The draft Communications Strategy has yet to be finalised and implemented. This will be the primary responsibility of the RCCA working collaboratively with regional stakeholders including the PICs, SOPAC, SPREP, NGOs and the USP.

It is strongly recommended that the SPSLCMP Communications Strategy should be developed and implemented as a matter of urgency in Phase IV and it should take account of the recommendations of this review. It is clear that the absence of a communications strategy and action plan has diminished the SPSLCMP's profile among stakeholders in the Region and contributed to a lack of understanding about how the SPSLCMP data might best be applied to address local issues. The development and implementation of the Communications Strategy has been budgeted for in the current phase.

A number of creative, PIC-targeted initiatives have been developed and implemented by BoMET's Pacific Island Climate Predictions Project (PI-CPP). The PI-CPP is the outcome of another AusAID/BoMET collaboration. (See Section 7.2.)

Recommendations.

21. It is strongly recommended that the SPSLCMP Communications Strategy should be developed and implemented as a matter of urgency in Phase IV and it should take account of the recommendations of this review.

7.2 Pacific Island Climate Predictions Project (PI-CPP)

In 2001, a needs-analysis funded by the Australian Agency for International Development (AusAID) for strengthening meteorological services in Pacific Island Countries (PICs) found that the majority of National Meteorological Services (NMSs) in the region were encountering difficulties in providing basic meteorological services for the citizens and industries of their countries. In response AusAID, in collaboration with the Australian Bureau of Meteorology (BoMET), developed a project plan – the Pacific Island Climate Predictions Project (PI-CPP), to assist the participating PICs to generate and make use of seasonal predictions. Seasonal to inter-annual climate variability has important practical, planning and policy implications for PICs. See <www.bom.gov.au/climate/pi-cpp>.

The project has four parts:

- Develop and install PC-based climate prediction software, SCOPIC.
- Train NMS personnel in the use of the climate prediction software and the establishment of a climate prediction service.

- Facilitate linkages between NMS staff and those clients making climate sensitive decisions.
- Train clients in the effective use of prediction information.

Targeted and comprehensive training are required in order that both the benefits and limitations of the prediction information are clearly understood. Prediction services are tailored to the specific needs of user sectors in each country to help ensure the optimum use of the predictions. Virtually all training activities are carried out in-country.

PI-CPP Project Objectives

At the end of the project implementation, the NMS of each participating country will have software tailored for use in its location, and a thorough understanding of how seasonal climate prediction services can support climate-sensitive decision making in industry and government. Key representatives of climate-sensitive activities (e.g. agriculture, water management, disaster mitigation) will have received training in the effective use of climate predictions in a risk management context. In turn, the growth in productivity and efficiency that will follow in climate-sensitive industries will naturally flow through to better food security, improved public health, better managed water resources and more robust national economies.

Both AusAID and the Bureau of Meteorology are keen to coordinate PI-CPP activities with those of other countries and organisations with expertise and interest in climate-related capacity-building in the South Pacific Region and with the SPSLCMP: Phase IV.

Feedback from the PICs to the SRT indicates that PI-CPP training initiatives, regular consultations with key sectors and individuals within the PICs and in-country visits are appreciated by the PICs. PICs mentioned that they found SCOPIC very user-friendly. (SCOPIC was developed specifically to meet PIC needs.) The efforts by PI-CPP personnel to understand PIC needs, to establish ongoing relationships with NMS staff and other end-users, and to appreciate and take into account cultural differences in product development and delivery were also appreciated.

7.2.1 PI-CPP: Phase II and SPSLCMP: Phase IV: Information Products and Collaboration

The expanding community of climate experts in Pacific Island and Pacific Rim countries will guarantee a long-term flow of data and supporting information throughout and into the Region. The building of indigenous capacity in climate science, its application to practical problems and the creation of a framework through which countries can learn from and support each other will make an enormous contribution to sustainable development throughout the region.

A number of PICs commented on the multitude of scientific research projects in the Region and noted that the majority appeared externally driven and were not always appropriate to the needs of the Region or individual PICs. Representatives of PIC government departments and community organisations, SOPAC and SPREP, indicated a preference for scientific research and outputs to be tailored to meet Regional and PIC in-country needs, rather than being driven by the research priorities of external scientists and donors. Local and community level ownership is imperative to the success of the project.

There are potential synergies between PI-CPP and SPSLCMP: Phase IV in relation to product development and delivery mechanisms/processes to meet PIC needs for training, skills development and capacity building. The PI-CPP appears to have strong relationships with PIC end-users and PI-CPP data and information products (including SCOPIC) have been well

accepted by the PICS. Unfortunately, Internet access in the Region is often unreliable, slow and costly. As mentioned, lengthy delays in downloading key data sets and information products are frequently experienced across the Region. A number of PIC government agencies, NGOs, the USP and community workers confirm that the availability of the modern hardware and up-to-date versions of software required to access international and Australian databases is limited.

The SRT received a number of comments about the type of data and information products available from BoMET and the SPSLCMP. Computer literacy and access vary across the region and within individual PICs, as do literacy levels generally. As an organisation, BoMET needs to review its data and information products to ensure they meet PIC (as well as departmental) needs.

Hard copies, the use of pictures, colour and culturally appropriate materials including the telling of stories, are vital in getting the sea level and climate change message across. Many communities have a rich oral tradition and get great value and depth of understanding by the oral transmission of information, particularly by radio and story telling. Written material can be re-read and passed along to others in the community (especially when written in the local language) and can be posted on notice boards. Favourable comments were made about "The Island Climate Update" (ICU) sponsored by NIWA, SOPAC, SPREP and NZAID. An article about SPSLCMP appeared in a recent issue of ICU. It may well be worth the SPSLCMP collaborating with NIWA, NZAID and others in the region about options for disseminating SPSLCMP information in this way. WWF's "Climate Witness Toolkit" received similarly favourable comments from the PICs.

The fundamental message to the SRT was that the SPSLCMP should deliver PIC-relevant data and information products for use by professionals and scientists as well as for use as tools in training and capacity building. The products themselves must be culturally appropriate and gender aware and they must resonate with end-users at regional, national and local levels. This will require some changes in the SPSLCMP's web-based product emphasis and the ways in which the SPSLCMP designs, develops and delivers its data and information products. It would also be useful to record by sex and location those who have received training as this will assist in understanding the demographics of beneficiaries, and will assist in evaluating changes and monitoring gender balance.

It is worth noting that the Pacific Island components of both the Global Ocean Observing System and the Global Climate Observing System (PI-GOOS and PI-GCOS respectively), provide regional mechanisms for both assessing regional requirements for a large range of ocean and climate data and products and determining appropriate delivery mechanisms. They also provide fora that group countries and organisations both inside and outside the regions, while their Secretariats are closely linked with regional organisations such as SOPAC. PI-GOOS and PI- GCOS should therefore be used, to the extent possible, by the SPSLCMP in further developing information products and collaboration among the PICs. The Regional Communications and Coordination Adviser (RCCA) at SOPAC should continue to play a pivotal role in ensuring regional coordination in this regard and should be a member of the Joint Taskforce.

It is strongly recommended that BoMET (including the NTC and the NCC) establish a Joint Taskforce in collaboration with, for example, AusAID, SOPAC, the Secretariats for PI-GOOS and PI-GCOS, SPREP, the PICs and USP to prepare an Action Plan to: (1) develop an organisational mechanism for collaboration and synergy between the regional projects for which the BoMET is the Managing Contractor (SPSLCMP and the PI-CPP), and PI-GOOS and PI-GCOS; (2) work with the PICs to identify needs and solutions for the delivery of

culturally and gender appropriate sea level and climate change data and information products; (3) identify PIC needs for training courses for NMS, climate change and technical personnel and recommend on their implementation; and (4) ensure that data and information products produced by the SPSLCMP and the PI-CPP can be used as tools in training courses and capacity building in the PICs and the Region. It is recommended that the collaboration should integrate, to the extent possible, input from other relevant BoMET projects, for example, ATWS, Pacific Data Rescue and Tropical Cyclones.

In addition, it is recommended that the Joint Taskforce should investigate synergies between SPSLCMP and NZ counterparts in relation to the activities, products and programs undertaken by NIWA and NZAID.

Finally, as the specific needs of women do not appear to be well understood by the project and given the historically male-dominated nature of the field, *the SRT further recommends that the Joint Taskforce should include members with gender and cross-cultural expertise.* AusAID can advise on the components and requirements of an engagement strategy for women. (See also AusAID's gender policy, 2007)

While both the PI-CPP: Phase II and SPSLCMP: Phase IV maintain productive relationships with SOPAC, the SRT considers there is a need for both projects to strengthen their interactions with other key regional organisations including the USP, SPREP, the Pacific Islands Forum Secretariat (PIFS) and the Secretariat of the Pacific Community (SPC). This would be achieved as a direct outcome of the activities of the proposed Joint Taskforce. (See above and Section 9.)

Recommendations.

22. *It is strongly recommended that BoMET (including the NTC and the NCC) establish a Joint Taskforce in collaboration with, for example, AusAID, SOPAC, the Secretariats for PI-GOOS and PI-GCOS, SPREP, the PICs and USP, to prepare an Action Plan to: (1) develop an organisational mechanism for collaboration and synergy between the regional projects for which the BoMET is the Managing Contractor (SPSLCMP and the PI-CPP), and PI-GOOS and PI-GCOS; (2) work with the PICs to identify needs and solutions for the delivery of culturally and gender appropriate sea level and climate change data and information products; (3) identify PIC needs for training courses for NMS, climate change and technical personnel and recommend on their implementation; and (4) ensure that data and information products produced by the SPSLCMP and the PI-CPP can be used as tools in training courses and capacity building in the PICs and the Region. It is recommended that the collaboration should integrate, to the extent possible, input from other relevant BoMET projects, for example, ATWS, Pacific Data Rescue and Tropical Cyclones.*

    In addition, it is recommended that the Joint Taskforce should investigate synergies between SPSLCMP and NZ counterparts in relation to the activities, products and programs undertaken by NIWA and NZAID.

    The SRT further recommends that the Joint Taskforce should include members with gender and cross-cultural expertise.

7.3 Regional Communications and Coordination Adviser: Roles and Responsibilities

The appointment in late 2006 of the RCCA, based at SOPAC, helps to address a significant gap in BoMET-PIC relations. The RCCA will facilitate easier access for PICs to the SPSLCMP data and the information they need to inform issues-based, policy and decision making. In addition, the RCCA plays a pivotal role in ensuring that SPSLCMP data and information products are designed and delivered to meet PIC and regional needs.

It is imperative that the RCCA role is valued for the unique expertise and perspective that it brings to the SPSLCMP and that it: (1) not be encumbered by excessive bureaucratic demands; (2) has the flexibility to liaise directly with all stakeholders as required; (3) can recommend, with authority and organisational recognition, changes to SPSLCMP data and information strategies and delivery mechanisms that might be required to meet the social, cultural, gender and policy needs of the PICs and the Region; and (4) has equal standing with the Project Manager, PI-CPP, on the Joint Taskforce as recommended in Section 7.2.1.

The SRT noted that the RCCA position is also responsible for the management of the power, telecommunication and internet accounts for the SEAFRAME and CGPS stations, including tackling issues such as the loss of power and communications to SPSLCMP sites which have resulted from payment problems. The SRT was advised by the RCCA and SOPAC that the situation regarding the timely payment of accounts has improved since the appointment of the RCCA. However, the SRT considers that this administrative function could more appropriately be performed by a suitably skilled person under the joint supervision of the RCCA and SOPAC's Finance Manager. Without this administrative support, there is a risk that the RCCA will be diverted from its primary roles and responsibilities and from the new task of working with the PI-CPP Project Team Leader on the Joint Taskforce.

The SRT recommends that an administrative officer be appointed to assist the RCCA with the management of the power, telecommunication and internet accounts at SOPAC. The SRT recommends that AusAID examines the situation to see if additional funding is required. If so, additional funding should be provided in the Project from 2007-2008 to fund an administrative officer in SOPAC who would be responsible to the RCCA for ensuring the accounts are managed in a timely and proactive manner, and would be accountable to the SOPAC Finance Manager for performing this function in accordance with SOPAC's financial procedures and audit provisions. The SRT recognises that management of the utility accounts is not a full-time function; however, there are additional benefits to be gained if the person performing this function could also provide wider administrative support to the RCCA in relation to primary roles and responsibilities.

The SRT appreciates that the RCCA is already establishing constructive relations with stakeholders and with other CROP member organisations, including SPREP. SPREP has a mandate to coordinate the regional framework for climate change and related roundtable processes including the Pacific Region Climate Change Roundtable scheduled for later in 2007. SPREP, through its Pacific Futures Programme, also assists with mainstreaming climate change development processes and capacity building activities <www.sprep.org/programme/pacific_futu.htm>. Together with SOPAC, SPREP is a major intergovernmental organisation and stakeholder in the region. Each organisation brings significant and differing expertise to bear on the key PIC concerns of vulnerability assessment and the development of adaptation strategies and action plans.

The SRT acknowledges that the development of the Regional Communications Strategy for Climate Change in the Pacific Region resides with SPREP. *The SRT therefore recommends as*

essential that the RCCA continues to work directly with SPREP, PI-GOOS and PI-GCOS to assist in the development of a regional climate change communications Strategy that: (1) meets the needs of all stakeholders, including male and female end-users, at the community and village level; (2) involves government, industry, NGO, USP and community input; (3) aims to present and disseminate information equally to male and female end-users; and (4) effectively harnesses the sea level and climate change expertise, skills and synergies resident in both SOPAC and SPREP. The RCCA should continue to liaise with SPREP in relation to the development of the SPSLCMP Regional Communications Strategy because it contributes to the implementation of the overarching Regional Climate Change Strategy.

Recommendations.

23. *The SRT recommends that an administrative officer be appointed to assist the RCCA with the management of the power, telecommunication and internet accounts at SOPAC. The SRT recommends that AusAID examines the situation to see if additional funding is required. If so, additional funding should be provided in the Project from 2007-2008 to fund an administrative officer in SOPAC who would be responsible to the RCCA for ensuring the accounts are managed in a timely and proactive manner, and would be accountable to the SOPAC Finance Manager for performing this function in accordance with SOPAC's financial procedures and audit provisions.*

24. *The SRT recommends as essential that the RCCA continues to work directly with SPREP, PI-GOOS and PI-GCOS to assist in the development of a regional climate change communications strategy that: (1) meets the needs of all stakeholders, including male and female end-users, at the community and village level; (2) involves government, industry, NGO, USP and community input; (3) aims to present and disseminate information equally to male and female end-users; and (4) effectively harnesses the sea level and climate change expertise, skills and synergies resident in both SOPAC and SPREP*.

8 LONG-TERM PROVISION OF UTILITIES TO NETWORK SITES

8.1 Risk Assessment

The level of risk to SPSLCMP network sites, should Partner Governments (PGs) be unwilling or unable to maintain utility infrastructure to the SEAFRAME and CGPS sites, is assessed as low. There is no history in the life of the Project to date of any PG being unwilling or unable to provide power and communication utility infrastructure to their resident SEAFRAME or CGPS site. That situation is unlikely to change given the apparent level of commitment that PGs have to the Project, as evidenced by the SRT visits to the Cook Islands, Samoa and Fiji.

During Phase IV, the Project has experienced a number of periods of political change and/or unrest of varying durations, both in the PICs and in Australia, without major disruption to station or network operations. The main problems to date with maintaining infrastructure and supply have been primarily due to a lack of communication between the utility service providers and the Project through the local points of contact on infrastructure works programs. That has caused temporary outages, or issues with timely payment of service accounts. Nauru stands out as continuing to be an ongoing challenge for the Project, with frequent and long outages of both power and telephone services regularly having a negative impact on station operations. These can be considered symptoms of a struggling economy rather than any unwillingness on the part of the Government of Nauru to support the objectives and operations

of the Project. Fortunately, the effectiveness of backup systems and manual recovery processes means that data loss has so far been kept to a minimum.

It is anticipated that the risk will be mitigated further with NMSs and lands and survey departments having better access to station data on a daily basis. This will encourage them to foster stronger relationships with the local utility service providers.

8.2 Options for supply of communications and power to network sites

In addition to the early resolution of problems relating to account payment processes, the risk could be further reduced by the establishment of stronger links between the NMSs, lands and survey departments, utility service providers and the Regional Communications and Coordination Adviser (RCCA). Since the appointment of the RCCA and availability of some limited administrative support in SOPAC to assist the RCCA with account payment processes, this situation appears to be improving. SOPAC is setting up a system of advance payments which should minimise the risk of cut-offs due to non-payment. The provision of designated, ongoing administrative support to assist the RCCA in managing the accounts (see Section 7.3) should further assist in ensuring continuity of supply.

It is recommended that the RCCA will take a lead role in encouraging regular communications among all stakeholders (including utility service providers). This will foster awareness of the SPSLCMP and its contributions to understanding regional and local sea-level rise and other climate change-related issues in the Region. *It is further recommended that utility service providers should be treated as key stakeholders in the SPSLCMP*. This should enhance their understanding of the value of the SPSLCMP to the PICs and to the Region and thus their commitment to the success of its ongoing operations.

Finally, the SRT considers that the issue of public liability in the event of potentially negative consequences of a power and/or communications failure, is presumably one to which BoMET, GA and SOPAC have given thought, especially as some SEAFRAME stations are already – or will soon become – part of the Australian Tsunami Warning System, or provide data and information that will be relied upon by third parties in a near real-time situation.

Recommendations.

25. It is recommended that the RCCA will take a lead role in encouraging regular communications among all stakeholders (including utility service providers).

It is further recommended that utility service providers should be treated as key stakeholders in the SPSLCMP.

9 SPSLCMP: FUTURE OPTIONS

The SPSLCMP's contribution to global, regional and national science is universally understood and valued by the international sea level and climate change scientific community (including the IPCC), NZ, the PICs, CROP member organisations, NGOs and the USP. The Australian sea level and climate change scientific community, Australian government agencies and academic institutions similarly expressed complete support for the Project. *The SRT therefore strongly recommends the continuation of SPSLCMP beyond Phase IV and the continuation of BoMET as the Australian Managing Contractor and GA and SOPAC as sub-contractors in Phase IV.*

There appears to be general agreement from within Australia and the South Pacific Region, that for the duration of Phase IV and Phase V, and possibly longer: (1) BoMET is the most scientifically and technically qualified and capable organisation to host the continuation of the BoMET/SPSLCMP Core Program (network, data management and QA, operational and maintenance services; (2) the CGPS network should remain sub-contracted to GA; and (3) SOPAC should continue to provide regional technical support and liaison with the PICs. There is, however, concern in the Region that SPSLCMP data and information products, delivery strategies and mechanisms do not take sufficient account of PIC's social and cultural needs and differences, local issues and policy priorities (such as coastal and infrastructure development and management, land use and planning issues, health and education).

BoMET's focus on the scientific and technical aspects of the network is understandable, given its mission as a scientific research, data monitoring and delivery organisation. However, in order to continue to meet its public interest obligations, *the SRT recommends that SPSLCMP needs to give more attention to the needs and priorities of its end-users in the scoping, design, development and delivery of SPSLCMP products and the training of male and female end-users in how to analyse, use and apply the data.* There is also a clear need for improved communication between the NTC and the National Climate Centre (NCC) in order to better coordinate sea level and climate change messages and product delivery.

The SRT strongly recommends that capacity building be reinstated as a matter of urgency in the SPSLCMP in Phase IV and that capacity building remain as an essential component of the SPLCMP in both Phase V and Phase VI. Capacity building was not included in Phase IV as it was considered that a strategic review of the project was required to first determine the future of the SPSLCMP beyond the completion of Phase IV. It should be noted that BoMET did not take over from AMSAT as the Australian managing contractor of the SPSLCMP until 1 January 2006, at the commencement of Phase IV. The SPSLCMP: Phase III Progress Report (2003) recommended strongly that well-organised and ongoing training and capacity building was required. Similarly, the independent Communications Evaluation Report (December 2004), which was commissioned by AMSAT, drew attention to the urgent need for appropriate information products to keep stakeholders informed about the project's short- and long-term outputs and for training and capacity building as an integral part of the SPSLCMP. Finally, AMSAT's Phase III Completion Report (December 2005) commented on flaws in project design and delivery including negative comments on the costs of information dissemination and the risk of assumptions about the capacity of the PICs as equal partners in terms of their human and financial resources.

The release of the IPCC Working Group II Report (April 2007) which highlights the severity and extent of anticipated sea level and climate change impacts on the Region, emphasises the urgency of assisting communities to build their resilience to sea-level rise and climate change.

There is also a need to review SPSLCMP governance arrangements to take account of changes in PIC needs, SPSLCMP product delivery and capacity building initiatives, funding arrangements among Australian Government agencies, and proposed changes in the regional institutional framework. For these reasons, *the SRT recommends the establishment of a SPSLCMP Project Coordinating Committee (PCC) to provide strategic advice, guidance and leadership of the transition process from Phase IV to Phase VI. The PCC would act in a capacity comparable to a Board of Management or equivalent body. In this respect its role would not duplicate, and would be broader than, the role of the SPSLCMP's existing Technical Coordinating Committee (TCC). In the first instance, it is envisaged that the PCC should evaluate the management, funding, governance options and the transition scenarios proposed by the SRT (see Section 9.2.4 for detail).*

Note: The SRT cannot recommend an exact continuation of the status quo as it is clear that *inter alia,* capacity building needs to be reinstated in the SPSLCMP from Phase IV. Instead the SRT proposes two fundamentally different options for the PCC to consider in deciding how the SPSLCMP might best be implemented into the future in order to fulfil both its scientific and technical objectives and address PIC and Regional end-user needs and priorities. The SRT thus identifies two options – Option 1 and Option 2 – for consideration by the PCC, BoMET and AusAID (see "SPSLCMP: Future Options", Section 9). The SRT believes that there may also be a number of variations of each of these options that could be considered by BoMET and AusAID (in consultation with partner governments, regional organisations and other stakeholders), in planning for the future of the SPSLCMP.

Option 2 is a fundamentally different model of SPSLCMP management, funding and governance from that put forward in Option 1. Option 2 encapsulates the SRT's efforts to reflect the desires of many PICs to work towards greater regional responsibility for managing, analysing and applying sea level and climate change data locally and regionally, while being aware that a critical mass of expertise and resources first needs to be developed and consolidated in the South Pacific Region.

Finally, a sole option is deliberately not recommended as significant institutional changes are currently underway in the Region and the outcomes remain uncertain. In the opinion of the independent members of the SRT, it would be presumptuous to recommend only one strategy or option. Others living and working in the South Pacific Region are better placed to consider which option might be the more appropriate. There may, of course, be other options not readily apparent to the SRT given the brevity of its field trip and the resulting and inevitable limitations of its consultations.

Recommendations.

26. *The SRT strongly recommends the continuation of SPSLCMP beyond Phase IV and the continuation of BoMET as the Australian Managing Contractor and GA and SOPAC as sub-contractors in Phase IV.*

27. *The SRT recommends that SPSLCMP needs to give more attention to the needs and priorities of its end-users in the scoping, design, development and delivery of SPSLCMP products and the training of male and female end-users in how to analyse, use and apply the data.*

28. *The SRT strongly recommends that capacity building be reinstated as a matter of urgency in the SPSLCMP in Phase IV and that capacity building remain as an essential component of the SPLCMP in both Phase V and Phase VI. ,*

29. *The SRT recommends the establishment of a SPSLCMP Project Coordinating Committee (PCC) to provide strategic advice, guidance and leadership of the transition process from Phase IV to Phase VI. The PCC would act in a capacity comparable to a Board of Management or equivalent body. In this respect its role would not duplicate, and would be broader, than that of the SPSLCMP's existing Technical Coordinating Committee (TCC). In the first instance, it is envisaged that the PCC should evaluate the management, funding, governance options and the transition scenarios proposed by the SRT (see Section 9.2.4 for detail).*

9.1 Option 1

Year	Jan 2006-Dec 2010: Phase IV	Jan 2011-Dec 2015: Phase V	Jan 2016-Dec 2020: Phase VI
Network management & operation, data QA, technical maintenance. (BoMET/SPSCMP Core Program)	BoMET Core Program. - BoMET manages SEAFRAME network. - BoMET subcontracts CGPS network to GA. - BoMET subcontracts SOPAC for regional technical support.	BoMET Core Program. - BoMET manages SEAFRAME network. - BoMET subcontracts CGPS network to GA. - BoMET subcontracts SOPAC for regional technical support.	BoMET Core Program. - BoMET manages SEAFRAME network. - BoMET subcontracts CGPS network to GA. - BoMET subcontracts SOPAC for regional technical support.
Communications / Training	1. SPSLCMP Phase IV Coms. Strategy implemented by BoMET/SOPAC. 2. Joint Taskforce established to identify information and training needs, providing advice to 1 (above) and Capacity Building (below).	1. SPSLCMP Coms. Strategy incorporated into the regional climate change communications strategy for which SPREP has the mandate (as at 2007). 2. Joint Taskforce in operation.	1. SPSLCMP Coms. Strategy incorporated into the regional climate change communications strategy for which SPREP has the mandate (as at 2007). 2. Joint Taskforce disbanded-(fulfilled purpose).
Capacity Building	AusAID/BoMET reinstate capacity building related to SPSLCMP (e.g. data analysis & applications), as advised by Taskforce (above).	AusAID/BoMET responsible for regional capacity building.	AusAid/BoMET responsible for regional capacity building.
Project Governance	SPSLCMP Project Coordinating Committee (PCC) established to evaluate SRT options & provide leadership of transition processes from Phase IV.	PCC provides oversight of transition processes and provides strategic advice.	PCC provides oversight and ongoing strategic advice.
Funding	AusAID.	- AusAID-capacity building. - BoMET-recurrent funding (core program).	- AusAID-capacity building. - BoMET-recurrent funding (core program).

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9.2 Explanation of Option 1

9.2.1 BoMET/SPSLCMP Core Program.

The BoMET/SPSLCMP Core Program comprises network management and operation, data management and Quality Assurance (QA), and technical maintenance.

The SRT recommends that the BoMET/SPSLCMP Core Program remain the responsibility of BoMET and its subcontractors GA and SOPAC, from Phase IV-Phase VI.

9.2.2 Communications & Training

Training is understood to be activities that relate closely to the collection and analysis of SPSLCMP data.

The uncoupling of communications, training and capacity building from the Core Program in Phase IV has resulted in a reduction of the SPSLCMP profile in the Pacific. This is partly because development and implementation of the SPSLCMP Communications Strategy is lagging, and partly because BoMET needs to build and sustain better ongoing relationships with colleagues and counterparts in the PICs. A number of improvements are recommended to SPSLCMP communication and training products and processes (including the immediate establishment of a Joint Taskforce in Phase IV), to assist BoMET improve communications both within the organisation and between BoMET and its end-users (in particular, the PICs).

A number of improvements are recommended to SPSLCMP communication and training processes and products. *It is recommended that all SPSLCMP communication and training initiatives be more inclusive of women and other PIC stakeholders.*

The establishment of a Joint Taskforce in Phase IV is also recommended to oversee and redress the communication, information and training deficiencies identified previously and to encourage synergies among BoMET's projects, PI-GCOS, PI-GOOS, and other regional initiatives including those undertaken by NZ and other Australian agencies such as AusAID, (see Section 7.2.1 for details).

It is envisaged that the Joint Taskforce continues until its purpose has been fulfilled, and that it is chaired by AusAID for the remainder of Phase IV and for Phase V. This will ensure that the current weaknesses in SPSLCMP communications and training are addressed, and that a smooth transition beyond Phase IV into the regional climate change communications strategy is achieved. (SPREP currently has the mandate for developing a regional climate change communications strategy).

9.2.3 Capacity Building

Capacity building is understood to be activities that relate to the application of SPSLCMP products to address climate related needs in the PICs, for example vulnerability assessments and adaptation strategies.

The SRT strongly recommends that capacity building be an integral part of the SPSLCMP. It should be reinstated immediately in Phase IV and continue into Phase VI. Guidance on specific capacity building initiatives and PIC priorities should be sought from the Joint Taskforce and the PCC. In the first instance, data analysis and applications relevant to PIC priorities should be developed. AusAID and BoMET should assume joint responsibility for the implementation of capacity building for the duration of the project, in close collaboration with SOPAC and SPREP. Given the need for greater PIC ownership and the apparent current lack of understanding of women's end-user needs, it is recommended that cultural and gender awareness training be a component of future capacity building training. SPSLCMP capacity building should be funded by AusAID and linked to AusAID's other sea level and climate change strategies and action plans in the Region.

9.2.4 Project Governance

The SRT recommends that a SPSLCMP Project Coordinating Committee (PCC) be established as soon as possible to: (1) consider and evaluate the management, funding and governance options and the transition scenarios proposed by the SRT; (2) provide strategic advice and leadership in the transition processes from Phase IV to Phase VI; and (3) provide strategic scientific and end-user guidance to the project generally. The PCC would act in a capacity comparable to a Board of Management or equivalent body.

It might be appropriate for AusAID to chair the PCC to ensure continuity and retention of project and institutional memory through the transition process. It is important that the PCC not be dominated by the managing contractor as this would run the risk of it being perceived as self-serving. *It is recommended that the PCC should consist of representatives from BoMET, AusAID, the Joint Taskforce (which includes SOPAC), the PICS, USP, SPREP and independent scientific, policy and community development expertise from the Region as appropriate to the tasks at hand.* PCC membership should also draw on cultural, gender and technical expertise. Details of membership, roles and the frequency and location of meetings will be determined among project partners.

The Regional Meteorological Services Directors' Meeting is another forum that should be consulted.

It would be appropriate for the PCC to take into consideration the outcomes of the Pacific Island Forum Leaders meeting later this year. It is understood that *inter alia,* this meeting will decide on the PPAC (2006) recommendations for changes in the regional institutional framework. The PPAC report recommends the Secretariat of the Pacific Community (SPC) as the RTO as it is "a non-political, technically-focused organisation, having the widest membership of all the CROPS and one that provides for equal participation by independent states and territories" (PPAC 2006). Should an RTO such as the SPC be appointed as the overarching technical organisation in the South Pacific, adjustments in PCC membership might be required.

9.2.5 Funding

The SRT recommends that in Option 1, AusAID continues as the primary funding source for the remainder of Phase IV. From Phase V it is recommended that the SPSLCMP's Core Program be funded through an appropriate increase, covering all related costs, in BoMET's recurrent funding. Option 1 further recommends that AusAID would then fund the SPSLCMP's

capacity building initiatives identified by the Joint Taskforce and the PCC. For example, one activity could involve collaboration with USP to deliver data analysis tools and products appropriate to the Region. This scenario recognises that AusAID is moving away from funding long-term projects which involve scientific research and data collection (such as the SPSLCMP). BoMET's recurrent funding allocation will need to be increased accordingly to fund both the SPSLCMP Core Program and the communications and training initiatives identified by the SRT. *It is recommended that any such increase in funding would have to be effected through a New Policy Proposal (NPP) to Government, sponsored by AusAID and supported by BoMET and GA, to provide for a recurrent budget for the SPSLCMP to be included in the appropriations for either BoMET or AusAID.*

New funding will be required in Phase IV for network upgrade and the extension of the network to Palau and Niue (see Executive Summary and Section 5.1). Additional funding will also be required to implement new capacity building activities identified by the Joint Taskforce and the PCC.

9.2.6 Transition from Phase IV to Phase VI: Option 1

The SRT recommends that for the balance of Phase IV, the Core Program should focus on project consolidation, infrastructure refurbishment and upgrade as identified by BoMET and the extension of the network to Palau and Niue. This should be coupled with the completion and implementation of the SLSLCMP Communications Strategy and the reinvigoration of training initiatives as recommended by the Joint Taskforce.

By Phase VI, BoMET will be still responsible for delivery and maintenance of its Core Program. However, the SPSLCMP Communications Strategy will have been incorporated into a regional climate change communications strategy, currently being developed by SPREP. *It is recommended that in Option 1, the SPSLCMP and its Communications Strategy be monitored and evaluated against both achievement of project and strategy objectives and against changing end-user needs in each Phase. By the end of Phase VI, is anticipated that the Joint Taskforce should have achieved its objectives (see Section 7) and been disbanded.*

The SRT recommends that AusAID and BoMET should reinstate capacity building related to the SPSLCMP as a priority in Phase IV, for example, the development and delivery of data analysis and applications to meet PIC needs and priorities. As capacity building will be an 'add-on' to the current project in Phase IV, additional funding may be required. The Joint Taskforce may be a vehicle for developing a proposal for such activities and submitting the proposal to AusAID for consideration (see Section 9.2.5). Throughout the transition process, AusAID and BoMET will retain joint responsibility for regional capacity building which will continue to be funded by AusAID.

Finally, it is recommended that the PCC or equivalent body will continue to provide leadership, oversight and ongoing strategic advice to the SPSLCMP.

Recommendations: Option 1.

30. *The SRT recommends that the BoMET/SPSLCMP Core Program remains the responsibility of BoMET and its subcontractors GA and SOPAC, from Phase IV-Phase VI.*

31. *The establishment of a Joint Taskforce in Phase IV is recommended to oversee and redress the communication, information and training deficiencies identified in the*

SPSLCMP and to encourage synergies among BoMET's projects, PI-GCOS, PI-GOOS, and other regional initiatives including those undertaken by NZ and other Australia agencies such as AusAID, (see Section 7.2.1 for details).

It is recommended that all SPSLCMP communication and training initiatives be more inclusive of women and other PIC stakeholders.

32. *The SRT strongly recommends that capacity building should be an integral part of the SPSLCMP. Capacity building should be reinstated immediately in Phase IV and continue into Phase VI.*

33. *The SRT recommends that a SPSLCMP Project Coordinating Committee (PCC) be established as soon as possible to inter alia: (1) consider and evaluate the management, funding and governance options and the transition scenarios proposed by the SRT; (2) provide strategic advice and leadership in the transition processes from Phase IV to Phase VI; and (3) provide strategic scientific and end-user guidance to the project generally.*

    It is recommended that the PCC should consist of representatives from BoMET, AusAID, the Joint Taskforce (which includes SOPAC), the PICS, USP, SPREP and independent scientific, policy and community development expertise from the Region as appropriate to the tasks in hand.

34. *The SRT recommends that in Option 1, AusAID continues as the primary funding source for the remainder of Phase IV. From Phase V it is recommended that the SPSLCMP's Core Program be funded through an appropriate increase, covering all related costs, in BoMET's recurrent funding. Option 1 further recommends that AusAID would then fund the SPSLCMP's capacity building initiatives identified by the Joint Taskforce and the PCC.*

    It is recommended that any increase in funding would have to be effected through a New Policy Proposal (NPP) to Government, sponsored by AusAID and supported by BoMET and GA, to provide for a recurrent budget for the SPSLCMP to be included in the appropriations for either BoMET or AusAID.

35. *The SRT recommends that for the balance of Phase IV, the Core Program should focus on project consolidation, infrastructure refurbishment and upgrade as identified by BoMET and the extension of the network to Palau and Niue.*

    It is further recommended that in Option 1: (1) the SPSLCMP and its Communications Strategy be completed, implemented and evaluated against both achievement of project and strategy objectives and against changing end-user needs in each Phase; (2) AusAID and BoMET should reinstate capacity building related to SPSLCMP as a priority from Phase IV; (3) by the end of Phase VI the Joint Taskforce should have achieved its objectives and been disbanded; and (4) the PCC (or equivalent body) will continue to provide leadership, oversight and ongoing strategic advice to the SPSLCMP.

9.3 Option 2

Year	Jan 2006-Dec 2010: Phase IV	Jan 2011-Dec 2015: Phase V	Jan 2016-Dec 2020: Phase VI
Network management & operation; data QA; technical maintenance. (BoMET/SPSCMP Core Program)	BoMET Core Program. - BoMET managers SEAFRAME network. - BoMET subcontracts CGPS network to GA. - BoMET subcontracts SOPAC for regional technical support.	BoMET Core Program. - BoMET managers SEAFRAME network. - BoMET subcontracts CGPS network to GA. - SOPAC/RTO provide regional technical support.	BoMET in partnership with RTO. - RTO to oversee regional partnership involving BoMET, GA, SOPAC, SPREP.
Communications / Training	1. SPSLCMP Phase IV Coms. Strategy implemented by BoMET/SOPAC. 2. Joint Taskforce established to identify information and training needs, providing advice to 1 (above) and Capacity Building (below).	1. SPSLCMP Coms. Strategy incorporated into the RTO's regional climate change communications strategy. 2. Joint Taskforce operational and collaborating with RTO.	1. SPSLCMP Coms. Strategy incorporated into the RTO's regional climate change communications strategy. 2. Joint Taskforce disbanded (fulfilled purpose).
Capacity Building	AusAID/BoMET reinstate capacity building related to SPSLCMP (e.g. data analysis & applications), as advised by Taskforce (above).	AusAID & Joint Taskforce negotiate transfer of capacity building to RTO.	RTO takes over responsibility for regional capacity building. - AusAID may continue advising & funding specific projects.
Project Governance	SPSLCMP Project Coordinating Committee (PCC) established to evaluate SRT options and provide leadership of transition processes from Phase IV.	PCC provides strategic advice and collaborates with RTO on oversight of transition process.	SLSLCMP under the governance of RTO. PCC continues advisory role to RTO.
Funding Options	(i) AusAID. (ii) AusAID.	(i) AusAID-capacity building, BoMET-recurrent funding (core program). (ii) BoMET-recurrent and RTO funding.	(i) AusAID-capacity building, BoMET-recurrent funding(core program). (ii) BoMET-recurrent and RTO funding.

9.4 Explanation of Option 2

9.4.1 BoMET/SPSLCMP Core Program.

The BoMET/SPSLCMP Core Program comprises network management and operation, data management and Quality Assurance (QA), and technical maintenance.

The SRT recommends that: (1) BoMET's Core Program remains the responsibility of BoMET during Phase IV; (2) In Phase V, SOPAC in collaboration with the PIF-designated RTO, assumes a greater share of responsibility for aspects of the Core Program, e.g. data analysis in preparation for (3) a potential shift in network and data management responsibilities to a BoMET/RTO partnership from Phase VI – providing the RTO is willing and has the expertise and capacity to take on an expanded technical and data collection role.

9.4.2 Communications & Training

Training is understood to be activities that relate closely to the collection and analysis of SPSLCMP data.

It is recommended that the SPSLCMP Communications and Training initiatives in Phase IV of Option 2 remain the same as those outlined in Option 1. This includes the immediate establishment of a Joint Taskforce in Phase IV. A key aim of the Joint Taskforce is to assist BoMET to improve communications both within the organisation and between the BoMET and the PICs. The Joint Taskforce will assist in identifying information, communication and training needs. The main differences between Option 1 and Option 2 in relation to communications and training are in Option 2 from Phase V onwards. *From Phase V, it is recommended that the Joint Taskforce works collaboratively with the designated RTO, so that by Phase VI, the SPSLCMP Communications Strategy is incorporated into the RTO's Regional Climate Change Communication Strategy.*

9.4.3 Capacity Building

Capacity building is understood to be activities that relate to the application of SPSLCMP products to address climate-related needs in the PICs, for example vulnerability assessments and adaptation strategies.

The SRT strongly recommends that in Option 2, capacity building related to the SPSLCMP be reinstated in Phase IV as in Option 1, with the Joint Taskforce providing guidance on priorities and specific initiatives (see Capacity Building, Option 1). *It is further recommended that in Phase V, the Joint Taskforce in consultation with AusAID, negotiates transfer of capacity building from BoMET to the RTO to take full effect from Phase VI.* AusAID may continue to provide advice and to fund specific capacity building projects as agreed with BoMET and the RTO.

9.4.4 Project Governance

As in Option 1, the SRT recommends that an SPSLCMP Project Coordinating Committee (PCC) be established in Phase IV (see Project Governance, Option 1). In Phase V, the PCC continues to provide strategic advice and commences discussions with the RTO to develop a process or processes for transferring project governance to the Region by the end of Phase VI. It is envisaged that the RTO would assume governance of the SPSLCMP by the end of Phase VI and that the PCC would continue in an advisory role to the RTO for a period thereafter.

Note: There may, however, be caveats on the speed and extent to which this transfer might occur, for example, regarding the willingness of the RTO to take over full responsibility for the SPSLCMP and the capability of the organisation to do so.

9.4.5 Funding

The SRT recommends two possible funding scenarios for Option 2 that need to be considered by Australian and partner government. They are:

(1) AusAID will cease to fund the SPSLCMP Core Program from the end of Phase IV at which time project costs (including those for Communications and Training) will be absorbed by BoMET subject to an appropriate increase, covering all related costs, in BoMET's recurrent funding allocation. AusAID will continue to support specific capacity building projects into Phase VI.

(2) AusAID will cease to fund SPSLCMP from the end of Phase IV. In Phase V, the SPSLCMP will be funded by an appropriate increase in BoMET's recurrent funding and by the RTO. Under this scenario, BoMET would continue to fund the Core Program, Communications and Training, while the RTO funded the regional capacity building related to the SPSLCMP. AusAID might also provide some funding (via the RTO), for capacity building initiatives related to the SPSLCMP. The increase in BoMET's recurrent funding would again have to be effected through a New Policy Proposal (NPP) to Government, sponsored by AusAID and supported by BoMET and GA, to provide for a recurrent budget for the SPSLCMP to be included in the appropriations for either BoMET or AusAID.

9.4.6 Transition from Phase IV to Phase VI: Option 2

In Option 2, the SRT recommendations for the remainder of Phase IV remain the same as for Option 1. They are that: (1) the Core Program should focus on project consolidation, infrastructure refurbishment and upgrade as identified by BoMET and the extension of the network to Palau and Niue; (2) the SLSLCMP Communications Strategy should be completed and implemented; (3) training initiatives as recommended by the proposed Joint Taskforce should be implemented; and (4) AusAID and BoMET should reinstate capacity building related to the SPSLCMP.

By Phase VI, it is recommended that:(1) BoMET, in partnership with the RTO, will be responsible for delivery and maintenance of the Core Program (providing the RTO is willing and has developed the capability and resources to do so); (2) the SPSLCMP Communications Strategy will have been incorporated into the RTO's Regional Climate Change Communications Strategy, and (3) the RTO will have assumed responsibility for regional

capacity building related to the SPSLCMP. Finally, by the end of Phase VI, the Joint Taskforce will have fulfilled its purpose and PCC will continue in an advisory role to the RTO as required.

Option 2 is a fundamentally different model of SPSLCMP management, funding and governance from that put forward in Option 1. Option 2 encapsulates the SRT's efforts to reflect the desires of many PICs to work towards greater regional responsibility for managing, analysing and applying sea level and climate change data locally and regionally, while being aware that a critical mass of expertise and resources first needs to be developed and consolidated in the South Pacific Region.

Recommendations: Option 2.

36. *The SRT recommends that: (1) BoMET's Core Program remains the responsibility of BoMET during Phase IV; (2) In Phase V, SOPAC in collaboration with the PIF-designated RTO assumes a greater share of responsibility for aspects of the Core Program e.g. data analysis in preparation for (3) a potential shift in network and data management responsibilities to a BoMET/RTO partnership from Phase VI – providing the RTO is willing and has the expertise and capacity to take on an expanded technical and data collection role.*

37. *It is recommended that the SPSLCMP Communications and Training initiatives in Phase IV of Option 2, remain the same as those outlined in Option 1. This includes the immediate establishment of a Joint Taskforce in Phase IV.*

    From Phase V, it is recommended that the Joint Taskforce works collaboratively with the designated RTO, so that by Phase VI, the SPSLCMP Communications Strategy is incorporated into the RTO's Regional Climate Change Communication Strategy.

38. *The SRT strongly recommends that in Option 2, capacity building related to the SPSLCMP be reinstated in Phase IV as in Option 1, with the Joint Taskforce providing guidance on priorities and specific initiatives (see Capacity Building, Option 1). It is further recommended that in Phase V, the Joint Taskforce in consultation with AusAID, negotiates transfer of capacity building from BoMET to the RTO to take full effect from Phase VI.*

39. *As in Option 1, the SRT recommends that an SPSLCMP Project Coordinating Committee (PCC) be established in Phase IV (see Project Governance, Option 1). In Phase V, the PCC continues to provide strategic advice and commences discussions with the RTO to develop a process or processes for transferring project governance to the Region by the end of Phase VI – depending on the willingness of the RTO to take over full responsibility for the SPSLCMP and the capability of the organisation to do so. In Option 2, the PCC would continue in an advisory role to the RTO for a period thereafter.*

40. *In Option 2, the SRT recommends two possible funding scenarios for consideration by the Australian government. In both cases any increase in BoMET's recurrent funding would again have to be effected through a New Policy Proposal (NPP) to Government, sponsored by AusAID and supported by BoMET and GA, to provide for a recurrent budget for the SPSLCMP to be included in the appropriations for either BoMET or AusAID. The funding options are:*

    (1) AusAID will cease to fund the SPSLCMP Core Program from the end of Phase IV,

at which time project costs (including those for Communications and Training) will be absorbed by BoMET subject to an appropriate increase, covering all related costs, in BoMET's recurrent funding allocation. AusAID will continue to support specific capacity building projects into Phase VI.

(2) AusAID will cease to fund SPSLCMP from the end of Phase IV. In Phase V, the SPSLCMP will be funded by an appropriate increase in BoMET's recurrent funding and by the RTO. Under this scenario, BOMET could continue to fund the Core Program, Communications and Training, while the RTO funded regional capacity building related to the SPSLCMP. AusAID might provide some funding (via the RTO), for capacity building initiatives related to the SPSLCMP.

41. *Transition from Phase IV to Phase VI.*

The SRT recommendations for the remainder of Phase IV remain the same as for Option 1. They are that: (1) the Core Program should focus on project consolidation, infrastructure refurbishment and upgrade as identified by BoMET and the extension of the network to Palau and Niue; (2) the SLSLCMP Communications Strategy should be completed and implemented; (3) training initiatives as recommended by the Joint Taskforce should be implemented; (4) AusAID and BoMET should reinstate capacity building related to the SPSLCMP; and (5) a Project Coordinating Committee should be established.

By Phase VI, it is recommended that BoMET, in partnership with the RTO, will be responsible for delivery and maintenance of the Core Program (providing the RTO is willing and has developed the critical mass and resources to do so). The SPSLCMP Communications Strategy will have been incorporated into the RTO's Regional Climate Change Communications Strategy, and the RTO will have assumed responsibility for regional capacity building related to the SPSLCMP. By the end of Phase VI, the Joint Taskforce will have fulfilled its purpose and been disbanded, and PCC will continue in an advisory role to the RTO as required.

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

The SRT acknowledges the value of the SPSLCMP network operation and outputs to global science, Australia, the South Pacific Region and the PICS. To ensure the ongoing collection of the long-term, quality data sets essential for input to global databases and scientific analyses of sea level and climate change, SPSLCMP infrastructure needs to be refurbished and upgraded by the end of Phase IV as indicated by BoMET. In addition, the extension of the network to Palau and Niue should be progressed in 2008-09. As flagged in PDD (2006), additional new funding from the Australian Government is required for the network upgrade and the Palau-Niue design and installation. BoMET needs to undertake further work to estimate the additional costs with a greater degree of certainty.

Training and capacity building need to be reinstated in the SPSLCMP as a priority. Data and information products and delivery, and the training for PIC NMSs and climate scientists must be reconfigured to meet PIC and regional needs by the end of 2008-09. BoMET should make every effort to involve the PICs directly in the development of these products and training initiatives. The proposed Joint Taskforce must be established immediately to coordinate this process.

Establishment and operation of the new Joint Taskforce could be funded by AusAID, should additional funds be required. The proposed activities of the Taskforce are consistent with AusAID's mandate to assist with vulnerability assessment and the development of adaptation strategies and capacity building in the South Pacific, and with AusAID's proposed *'An Environmental Strategy for Australian Aid'* (2007) and AusAID's *Gender equality in Australia's aid program – why and how* (2007).

The SRT proposes that a SPSLSCMP Project Coordinating Committee (PCC) be established to evaluate the management and funding options and the transition scenarios recommended by the SRT for Phase IV and beyond. Additional staff and resources may be required for this task. The PCC should provide strategic oversight and advice to BoMET as the managing contractor, in relation to both the scientific research and data management aspects of the network, and the PIC science-policy interface. The objective is to ensure that the project takes full account of SPSLCMP end-user needs and that SPSLCMP products are developed and implemented to address these needs.

Funding for the SPSLCMP's Core Program should be sourced from the Australian Government's recurrent funding allocation for BoMET, rather than continue as project-based funding. Additional new funding is required and is recommended here – for the infrastructure upgrade, and investigation and installation of tide gauges at Palau and Niue. BoMET will provide updated costings to AusAID for this purpose.

Finally, the SRT recognises that scientific projects such as the SPSLCMP cannot be considered in isolation from social, environmental, economic, policy and institutional factors as identified in the Pacific Plan 2005, the Pacific Islands' Framework for Action on Climate Change 2006-2015, National Vulnerability Assessments, Adaptation Strategies and Action Plans, and the Pacific Plan Action Committee (PPAC) Report (2006).

The SPSLCMP: Phase IV Strategic Review Team's recommendations for the future management, funding and governance of the SPSLCMP are made in the context of all of the above.

10.2 Recommendations

CURRENT USES AND VALUE OF THE DATA SET FROM THE EXISTING NETWORK

Recommendation 1: Real-time tidal displays

It is recommended that options for reinstating real-time tidal displays be investigated, probably using a web- or GTS-based system. This would require additional funding and BoMET should identify a source of funding for any increase in costs.

Recommendation 2: Regional and local wave climate

It is recommended that, in consultation with the regional organisations, the need for wave monitoring, analysis and modelling be assessed by BoMET and appropriate action taken to meet such need.

Recommendation 3: Integrating scientific and local knowledge

It is recommended that in Phase V, BoMET and AusAID in consultation with USP, investigate strategies to achieve the integration of scientific and local knowledge.

Recommendation 4: CGPS records and analysis

It is recommended that regular comparisons be made between the CGPS analyses provided by GA and those provided by other international centres. This may require requesting these centres to include the SPSLCMP CGPS data (available from the GA website) in their analyses.

Recommendation 5: SPSLCMP data presentation

It is recommended that a review be carried out of the data provided in the SPSLCMP reports and the way in which it is presented. Appropriate changes should then be made.

Recommendation 6: Sea Level Reconstructions

It is recommended that these sea level reconstructions should be used by the Pacific countries to understand the long-term change in sea level, and its past and present impacts on their islands.

Recommendation 7: Location of SPSLCMP data and its availability

It is recommended that an easier and more transparent registration process be implemented, involving the completion of a standard online form rather than the sending of an email.

Recommendation 8: Electronic Access to SPSLCMP data and products

It is recommended that information describing the web locations of SPSLCMP data be widely distributed to potential users.

Recommendation 9: SPSLCMP CDs

It is recommended that additional CDs of SPSLCMP data are produced to be made available on request. The availability of these CDs and the method of requesting them should be prominently indicated on the SPSLCMP website.

Recommendation 10: In-country training and capacity building in data use and application

It is recommended that in-country training and capacity building, particularly for personnel employed in climate offices/sections attached to NMSs, be developed and implemented to address regional and PIC needs in relation to data use and applications.

Recommendation 11: SPSLCMP communications and gender equity

It is recommended that SPSLCMP communication materials be produced for schools to raise awareness of career opportunities for both women and men in NMS forecasting and climate change.

Recommendation 12: SPSLCMP and scholarships for women

The SRT recommends that BoMET, together with USP, could investigate the possibility of creating scholarships to encourage women to study for, and consider career opportunities in, non-traditional fields.

Recommendation 13: SPSLCMP and consultation with women

The SRT recommends that the SPSLCMP should work with partner governments, agencies and regional organisations to actively encourage the direct participation of women in the development and delivery of all SPSLCMP initiatives. This includes: policy development and decision making; project scoping, design, implementation and monitoring; training and capacity building; and the development, production and distribution of communication and training products. Any consultation process needs to effectively ensure that women can participate. This may involve separate consultations for women at times appropriate to their workloads. It will also be imperative for organisations representing women to be consulted early and effectively.

Recommendation 14: Retention of Sea Level and Climate Change Expertise in the Region

It is recommended that BOMET, supported by AusAID, should take steps to encourage additional training, educational and career opportunities for young scientists and professionals in the PICs and care should be taken to ensure that 50% of these opportunities are given to women. This can be coordinated via the SPSLCMP/PI-CPP Taskforce (Joint Taskforce; see Section 7). It is recognised that additional financial support will be required and that the Joint Taskforce and AusAID should investigate the provision of same in the context of regional capacity building.

Recommendation 15: Sea Encroachment Mapping

The SRT cannot recommend that sea encroachment mapping be supported as a PIC priority in Phase IV. Rather, attention should be given to broader issues of coastal vulnerability.

NEED FOR MODIFICATION AND/OR OPTIMISATION OF EXISTING NETWORK STRUCTURE AND DESIGN

Recommendation 16: SEAFRAME and CGPS stations – Palau

The SRT recommends that the Palau system be upgraded in collaboration with UHSLC to make it compatible with the SEAFRAME system, and connected to a permanent survey mark (or marks) on the island.

Recommendation 17: SEAFRAME and CGPS stations – Niue

The SRT recommends that if the existing PTWC tsunami gauge at Niue continues to operate, or if it is withdrawn and is not replaced by an ASLOS gauge, then a SEAFRAME gauge should be installed. If the existing PTWC tsunami gauge at Niue is withdrawn, and it is replaced by an ASLOS gauge, then SPSLCMP should contribute funds to make it a multifunctional installation.

Recommendation 18: Mulitfunction Gauges: Tsunami Warning System, SEAFRAME and CGPS.

Multifunction gauges would represent cost-effective solutions in some situations. In cases where a tsunami warning gauge (which uses relatively new technology) is upgraded to a multifunction system, it is recommended that a visual tide pole be incorporated to provide a regular check on the operation and stability of the gauge.

INFRASTRUCTURE UPGRADE OF SEAFRAME AND CGPS COMPONENTS

Recommendation 19: *Equipment replacement and upgrading*

It is recommended that future planning for the SPSLCMP SEAFRAME network be coupled to BoMET's development plans for the ABSLMA.

Recommendation 20: Budget estimates for network infrastructure upgrade

It is recommended that the Australian Government should make every effort to ensure the long-term continuation and maintenance of the SPSLCMP network at a level and in a condition that will ensure the continued collection, management, analysis and delivery of quality data to current and future global databases, the international scientific community, the Pacific Region, the PICs and Australian end-users.

ALIGNMENT WITH PACIFIC REGION CLIMATE MONITORING ACTIVITIES

Recommendation 21: SPSLCMP Communications Strategy

It is strongly recommended that SPSLCMP Communications Strategy should be developed and implemented as a matter of urgency in Phase IV and it should take account of the recommendations of this review.

Recommendation 22: PI-CPP: Phase II and SPSLCMP: Phase IV: Information Products and Collaboration and – Joint Taskforce

It is strongly recommended that BoMET (including the NTC and the NCC) establish a **Joint Taskforce** in collaboration with, for example, SOPAC, the Secretariats for PI-GOOS and

PI-GCOS, SPREP, the PICs and USP, to prepare an Action Plan to: (1) develop an organisational mechanism for collaboration and synergy between the regional projects for which the BoMET is the Managing Contractor (SPSLCMP and the PI-CPP), and PI-GOOS and PI-GCOS; (2) work with the PICs to identify needs and solutions for the delivery of culturally and gender-appropriate sea level and climate change data and information products; (3) identify PIC needs for training courses for NMS, climate change and technical male and female personnel and recommend on their implementation; and (4) ensure that data and information products produced by the SPSLCMP and the PI-CPP can be used as tools in training courses and capacity building in the PICs and the Region. It is recommended that the collaboration should integrate, to the extent possible, input from other relevant BoMET projects, for example, ATWS, Pacific Data Rescue and Tropical Cyclones.

In addition it is recommended that the Joint Taskforce should investigate the synergies between SPSLCMP and NZ counterparts in relation to the activities, products and programs undertaken by NIWA and NZAID.

The SRT further recommends that the Joint Taskforce should include members with gender and cross-cultural expertise.

Recommendation 23: Additional Administrative Officer for RCCA/SOPAC.

The SRT recommends that an administrative officer be appointed to assist the RCCA with the management of the power, telecommunication and internet accounts at SOPAC. The SRT recommends that AusAID examines the situation to see if additional funding is required. If so, additional funding should be provided in the Project from 2007-2008 to fund an administrative officer in SOPAC who would be responsible to the RCCA for ensuring the accounts are managed in a timely and proactive manner, and would be accountable to the SOPAC Finance Manager for performing this function in accordance with SOPAC's financial procedures and audit provisions.

Recommendation 24: RCCA and Regional Communications Strategy for Climate Change in the Pacific Region.

The SRT recommends as essential that the RCCA continues to work directly with SPREP, PI-GOOS and PI-GCOS to assist in the development of a regional climate change communications strategy that: (1) meets the needs of all stakeholders, including male and female end-users, at the community and village level; (2) involves government, industry, NGO, USP and community input; (3) aims to present and disseminate information equally to male and female end-users; and (4) effectively harnesses the sea level and climate change expertise, skills and synergies resident in both SOPAC and SPREP.

LONG-TERM PROVISION OF UTILITIES TO NETWORK SITES

Recommendation 25: Options for supply of communications and power to network sites

It is recommended that the RCCA take a lead role in encouraging regular communications among all stakeholders (including utility service providers); and

It is further recommended that utility providers be treated as key stakeholders in the SPSLCMP.

SPSLCMP: FUTURE OPTIONS

Recommendation 26: SPSLCMP Continuation

The SRT strongly recommends the continuation of SPSLCMP beyond Phase IV and the continuation of BoMET as the Australian Managing Contractor and GA and SOPAC as sub-contractors in Phase IV.

Recommendation 27: SPSLCMP End-user needs and priorities

It is recommended that SPSLCMP needs to give more attention to the needs and priorities of its end-users in the scoping, design, development and delivery of SPSLCMP products and the training of male and female end-users in how to analyse and use the data.

Recommendation 28: SPSLCMP: Phase IV-Phase VI and capacity building

The SRT strongly recommends that capacity building be reinstated as a matter of urgency in the SPSLCMP in Phase IV and that capacity building remain as an essential component of the SPLCMP in both Phase V and Phase VI.

Recommendation 29: SPSLCMP Project Coordinating Committee (PCC)

The SRT recommends the establishment of a **SPSLCMP Project Coordinating Committee** (PCC) to provide strategic advice, guidance and leadership of the transition process from Phase IV to Phase VI. The PCC would act in a capacity comparable to that of a Board of Management or equivalent body. In this respect its role would not duplicate, and would be broader than, that of the SPSLCMP's existing Technical Coordinating Committee (TCC). In the first instance, it is envisaged that the PCC should evaluate the management, funding, governance options and the transition scenarios proposed by the SRT.

OPTION 1: RECOMMENDATIONS

Recommendation 30: BoMET/SPSLCMP Core Program

The SRT recommends that BoMET/SPSLCMP Core Program will remain the responsibility of BoMET and its subcontractors GA and SOPAC, from Phase IV-Phase VI.

Recommendation 31: Communications & Training

The establishment of a Joint Taskforce in Phase IV is also recommended to oversee and redress the communication, information and training deficiencies identified previously and to encourage synergies among BoMET's projects, PI-GCOS, PI-GOOS, and other regional initiatives, including those undertaken by NZ and other Australian agencies such as AusAID.

It is recommended that all SPSLCMP communication and training initiatives be more inclusive of women and other PIC stakeholders.

Recommendation 32: Capacity Building

The SRT strongly recommends that capacity building should be an integral part of the SPSLCMP. Capacity building should be reinstated immediately in Phase IV and should continue into Phase VI.

Recommendation 33: Project Governance

The SRT recommends that a SPSLCMP Project Coordinating Committee (PCC) be established as soon as possible to inter alia:
(1) consider and evaluate the management, funding and governance options and the transition scenarios proposed by the SRT;
(2) provide strategic advice and leadership in the transition processes from Phase IV to Phase VI; and
(3) provide strategic scientific and end-user guidance to the project generally.

It is further recommended that the PCC should consist of representatives from BoMET, AusAID, the Joint Taskforce (which includes SOPAC), the PICS, USP, SPREP and independent scientific, policy and community development expertise from the Region as appropriate to the tasks in hand.

Recommendation 34: Funding

The SRT recommends that, in Option 1, AusAID continues as the primary funding source for the remainder of Phase IV. From Phase V it is recommended that the SPSLCMP's Core Program be funded through an appropriate increase, covering all related costs, in BoMET's recurrent funding. Aus AID would then fund the SPSLCMP's capacity building initiatives identified by the Joint Taskforce and the PCC.

It is recommended that any such increase in funding would have to be effected through a New Policy Proposal (NPP) to Government, sponsored by AusAID and supported by BoMET and GA, to provide for a recurrent budget for the SPSLCMP, included in the appropriations for either BoMET or AusAID.

Recommendation 35: Option 1 – Transition from Phase IV to Phase VI

The SRT recommends that for the balance of Phase IV, the Core Program should focus on project consolidation, infrastructure refurbishment and upgrade as identified by BoMET and the extension of the network to Palau and Niue; (2) the SLSLCMP Communications Strategy should be completed, implemented and evaluated against both achievement of project and strategy objectives and against changing end-user needs in each Phase; (3) training initiatives as recommended by the Joint Taskforce should be implemented; (4) AusAID and BoMET should reinstate capacity building related to SPSLCMP as a priority from Phase IV; and (5) a Project Coordinating Committee (PCC) should be established.

By the end of Phase VI, the Joint Taskforce should have achieved its objectives and been disbanded and the PCC will continue to provide leadership, oversight and ongoing strategic advice to the SPSLCMP.

OPTION 2: RECOMMENDATIONS

Recommendation 36: BoMET/SPSLCMP Core program

It is recommended that: (1) BoMET's Core Program will remain the responsibility of BoMET during Phase IV. (2) In Phase V, SOPAC, in collaboration with the PIF-designated RTO, assumes a greater share of responsibility for aspects of the Core Program e.g. data analysis in preparation for (3) a potential shift in network and data management responsibilities to a BoMET/RTO partnership from Phase VI – providing the RTO is willing and has the expertise and capacity to take on an expanded technical and data collection role.

Recommendation 37: Communications & Training

It is recommended that communications and training initiatives in Phase IV of Option 2, remain the same as outlined in Option 1. This includes the immediate establishment of a Joint Taskforce in Phase IV. From Phase V, it is recommended that the Joint Taskforce works collaboratively with the designated RTO, so that by Phase VI, the SPSLCMP Communications Strategy is incorporated into the RTO's Regional Climate Change Communication Strategy.

Recommendation 38: Capacity Building

It is strongly recommended that in Option 2 capacity building related to the SPSLCMP be reinstated from Phase IV (as in Option 1), with the Joint Taskforce providing guidance on priorities and specific initiatives (see Capacity Building, Option 1). It is further recommended that in Phase V, the Joint Taskforce in consultation with AusAID, negotiates transfer of capacity building from BoMET to the RTO to take full effect from Phase VI.

Recommendation 39: Project Governance

As in Option 1, the SRT recommends that a SPSLCMP Project Coordinating Committee (PCC) be established in Phase IV (see Project Governance Option 1). In Phase V, the PCC continues to provide strategic advice and commences discussions with the RTO develop a process or processes for transferring project governance to the Region by the end of Phase VI – depending on the willingness of the RTO to take over full responsibility for the SPSLCMP and the capability of the organisation to do so. In Option 2, the PCC would continue in an advisory role to the RTO for a period thereafter.

Recommendation 40: Funding

The SRT recommends two possible funding scenarios for Option 2:

(1) AusAID will cease to fund the SPSLCMP Core Program from the end of Phase IV at which time project costs (including those for Communications and Training) will be absorbed by BoMET, subject to an appropriate increase covering all related costs in BoMET's recurrent funding allocation. AusAID will continue to support specific capacity building projects into Phase VI.

(2) AusAID will cease to fund the SPSLCMP from the end of Phase IV. In Phase V, the SPSLCMP will be funded by an appropriate increase in BoMET's recurrent funding and by the RTO. Under this scenario, BoMET could continue to fund the Core Program, Communications and Training, while the RTO funded regional capacity building related to the SPSLCMP. AusAID might provide some funding (via the RTO), for capacity building initiatives related to the SPSLCMP.

Note: The increase in BoMET's recurrent funding would again have to be effected through a New Policy Proposal (NPP) to Government, sponsored by AusAID and supported by BoMET and GA, to provide for a recurrent budget for the SPSLCMP, to be included in the appropriations for either BoMET or AusAID.

Recommendation 41: Option 2 – Transition from Phase IV to Phase VI

The SRT recommends that for the balance of Phase IV, the Core Program should focus on project consolidation, infrastructure refurbishment and upgrade as identified by BoMET and the extension of the network to Palau and Niue; (2) the SPSLCMP Communications Strategy should be completed, implemented, and evaluated against both achievement of project and

strategy objectives and against changing end-user needs in each Phase; (3) training initiatives as recommended by the Joint Taskforce should be implemented; (4) AusAID and BoMET should reinstate capacity building related to SPSLCMP as a priority from Phase IV; and (5) a Project Coordinating Committee (PCC) should be established.

By Phase VI, it is recommended that: (1) BoMET, in partnership with the RTO, will be responsible for delivery and maintenance of the Core Program (providing the RTO is willing and has developed the critical mass and resources to do so); (2) the SPSLCMP Communications Strategy will have been incorporated into the RTO's Regional Climate Change Communications Strategy; and (3) the RTO will have assumed responsibility for regional capacity building related to the SPSLCMP. By the end of Phase VI the Joint Taskforce will have fulfilled its purpose and been disbanded, and PCC will continue in an advisory role to the RTO as required.

Annex 1: Terms of Reference

SOUTH PACIFIC SEA LEVEL AND CLIMATE MONITORING PROJECT PHASE IV

TERMS OF REFERENCE
STRATEGIC REVIEW
March 2007

Background

This Terms of Reference document has been prepared for carrying out a strategic review of the South Pacific Sea Level and Climate Monitoring Project (SPSLCMP), assessing the need for collection and use of high quality sea level data and options for operating and maintaining the network beyond the completion of Phase IV (i.e. beyond 31 December 2010).

Phase IV builds on the achievements of Phases I, II and III. The goal of Phase IV is to continue to provide an accurate long-term record of sea levels in the South Pacific for partner countries that enables them to respond to, and manage, related impacts.

Australia participates in a number of other activities focusing on sea level change and climate impacts, including the Pacific Islands Global Ocean Observing System (PI-GOOS: http://ioc.unesco.org/GOOS/Pacific/pacgoos.htm), the Pacific Islands Global Climate Observing System (PI-GCOS: http://www.pi-gcos.org) and the Global Sea Level Observing System (GLOSS: http://www.gloss-sealevel.org). It is envisaged during Phase IV that the sea level network will be more widely promoted as a joint undertaking with Pacific Island Countries (PICs) and regional agencies as a core-observing component of PI-GOOS, PI-GCOS and GLOSS.

Project data is also provided to the international scientific community. Through the Project's technical partners, sea level change information contributes to the expertise and outcomes of the Intergovernmental Panel on Climate Change (IPCC) Working Group I on "The Physical Basis of Climate Change", as well as Working Group II on "Climate Change Impacts, Adaptation and Vulnerability". The relationship of the regional movements in sea level change (and their impacts) to the global trend is highlighted through these forums.

The *project purpose* is to assemble an archive of sea level and related climate data that provides partner countries with the information about sea level variability and change they need to manage their near-shore and coastal resources sustainably, and to develop policies and strategies for responding to long-term trends. The current phase of the project began in January 2006 and will run for five years. It is expected to cost $9 million, plus GST.
Phase IV has a technical focus rather than a capacity building one and the primary objectives of its design are to ensure:

1. The continued operation and maintenance of the existing network of high-resolution sea level monitoring stations established under the earlier phases of the Project; and
2. Continued collection, analysis, storage and dissemination of high quality sea level data from the SEAFRAME and continuous global positioning system (CGPS) monitoring stations across the Pacific region.

The project is managed on behalf of the Australian Agency for International Development (AusAID) by the Australian Bureau of Meteorology (BoMET). BoMET sub-contracts Geoscience Australia (GA) and the South Pacific Applied Geoscience Commission (SOPAC) to assist in the project. The roles of each agency are described in the Project Design Document (PDD) dated April 2006. National Meteorological Services (NMSs) are the key counterpart agencies in the PICs. The project has a Regional Communications and Coordination Advisor based in and formally attached to SOPAC.

Strategic Review Objectives

The PDD states that AusAID will undertake a strategic review of the Project after about 12 months' implementation of Phase IV to investigate and advise on:

1. The long-term sustainability of the network and its provision of data from the South Pacific region to PICs and international stakeholders;
2. The need for infrastructure upgrades of the SEAFRAME and CGPS components to ensure the long-term viability of the network;
3. A structure and process for improved alignment with other regional climate monitoring activities in the Pacific region which will maximise synergies;
4. Options for ensuring the long-term provision of utilities (communications and power) to the sites in the network; and
5. Options for the future funding and management of project activities including consideration of the possible transfer of management of future phases of the Project to another Australian Government or Pacific regional agency or agencies.

In addition, it is agreed that it is important for the Review to assess and advise on:

6. The applications and value of the existing project data set to end users, as well as long-term requirements for sea level data from a network in the South Pacific;
7. Opportunities to advance gender equity within and through the work of the activity; and
8. A possible restructuring and optimization of the network.

The Review is not tasked to assess the progress of the Project's implementation. This will be assessed through a mid-term project governance review in 2008.

Scope

In undertaking this Review the team will consult with:

- BoMET officers working on Phase IV and on the Pacific Islands Climate Prediction Project Phase II (PI-CPP II) in Melbourne
- GA and CSIRO officers in Canberra and Hobart
- SOPAC officers in Fiji
- Secretariat of the Pacific Regional Environmental Programme (SPREP) in Samoa;
- Regional WMO Office in Samoa
- President of WMO RA-V in the Cook Islands
- PI GCOS and PI GOOS officers in Fiji and Samoa
- IPCC users of SPSLCMP data (by phone)
- NMS officers and AusAID posted officers in Pacific island countries as agreed with AusAID
- NIWA, NZMet and NZAID in Auckland and Wellington.

The Review will assess and make recommendations on:

1. The current uses and value of the data set derived from the existing network since the commencement of the project, both to the PICs and also to climate science in general;

   a. The team should consult with users of the data in the Pacific and internationally to establish its value in the forms currently available. In PICs, care should be taken to determine whether unmet needs for information exist in PIC populations, particularly by women and recommend ways of meeting those needs;

   b. Unanticipated benefits and uses of project data should be noted;.

   c. The team will be provided with an independent assessment of the BoMET proposal for developing sea encroachment maps for PICs, including an assessment of the level of demand or need for such maps. Based on this assessment the team should advise on the potential inclusion of the proposal as a component of SPSLCMP Phase IV or post Phase IV.

2. The need for long-term maintenance of the network and the on-going need for sea level data from the South Pacific region by PICs, Australia and international stakeholders,
3. The need for a possible modification and/or optimization of the current network structure and design, with options if necessary;

   a. Assess the need for additional SEAFRAME and CGPS stations, specifically in Palau and Niue and estimate the cost of providing, installing and maintaining them.

   b. Advise on the viability of multifunction gauges serving both the Australian Tsunami Warning System and SPSLCMP at current SEAFRAME sites.

4. The need for infrastructure upgrade of the SEAFRAME and CGPS components to ensure the long-term viability of the network;

   a. Some components will be 15 or more years old by the time of this review. On the understanding that the Government of Australia may wish to continue supporting the collection of data beyond Phase IV of the Project, assess the need for equipment replacement and upgrading, with an estimated budget.

5. A structure and process for improved alignment with other regional climate monitoring activities in the Pacific region which will maximise synergies, recognising the limited capacity and resources available to PICs;

   a. Assess the current and expected information products of other regional climate monitoring and related activities and their potential to duplicate, reinforce or complement SPSCLMP Phase IV activities and information products.

   b. Specifically assess PI-CPP Phase II as a potential vehicle for capacity building in NMSs on manipulation and presentation of data to target audiences.

   c. Suggest a collaborative structure through which SPSLCMP Phase IV, PI-CPP Phase II or another activity or agency could maximise the efficiency of provision and the accessibility of all climate change information products to target audiences.

d. Make recommendations on how the Regional Communications and Coordination Advisor might enhance PIC ownership of the Project by improving NMS ability to convey information to national target audiences, taking into consideration the different information needs of women and men.

6. Options for ensuring the long-term provision of utilities (communications and power) to the sites in the network;

   a. Phase IV includes a budget for in-country utilities costs. MOUs will be negotiated with individual partner governments (PGs) requiring them to maintain utility infrastructure to the SEAFRAME and CGPS sites, but not to cover the cost of supply. Assess the level of risk that PGs will be unwilling or unable to comply and suggest means of reducing that risk.

7. Options for the future funding and management of project activities including consideration of the possible transfer of management of future phases of the Project to another Australian Government or Pacific regional agency or agencies. Previous phases of the Project included capacity building for PIC NMSs and anticipated the eventual transfer of responsibility for Project inputs to partner governments. Phase IV recognises that this is unlikely to be practicable in the short or medium term. Without this developmental component, the Project is a technically demanding activity and unsuitable for management by individual PICs.

   a. Consider and make recommendations on options for management by an appropriate technical agency (or consortium of agencies) in Australia or the Pacific region, such as BoMET, GA or SOPAC.

   b. Consider and make recommendations on options for the additional funding required to support the project on a long-term sustainable basis, under the management of a technical agency as recommended under 7(a) above.

   c. Consider and make recommendations on options for the future governance of project activities, including the composition of a project coordinating committee.

   d. Outline steps in preparation for a potential transfer to another agency, aiming at a smooth transition at the end of Phase IV.

Duration and Phasing

- Selection of Review Team: March 2007.
- Review Team preparation in Australia: 5 days (Team Leader and Scientific Leader). (Briefing and documentation review a week before departure on field review.)
- Review Team briefing in Canberra and visit to GA: 1.5 day (whole team).
- In-Australia Field Review: April 2007: Visiting Melbourne (BoMET): 2 days (whole team).
- Overseas Field Review: 18 April–3 May 2007. Visiting Fiji (SOPAC, Fiji Meteorological Service, other relevant government counterparts); Cook Islands (Meteorological Service and other relevant government counterparts); Samoa (SPREP, Regional WMO Office, Meteorological Service and other relevant government counterparts); and New Zealand (NIWA, NZMET and NZAID): 15 days (whole team).
- Draft report submitted to AusAID: within 2 weeks of completion of Overseas Field Review: 5 days (TL), 3 days (SL).

- Presentation of report to Peer Review Group: 1 day (whole team).
- Peer Review Group's Comments passed to Review Team within 2 weeks of meeting.
- Draft Final Report, submitted to AusAID within 2 weeks of receipt of comments: 3 days (TL), 1 day (SL).
- Examination by AusAID within 2 weeks of receipt of Draft Final Report..
- Final Report Submitted to AusAID within 1 week of receipt of final comments: 2 days (TL).
- Final Report presented to TCC in September 2007.

Specification of the Review Team

The review team will be assessing scientific, technical, and institutional and project management issues relating to assembling an archive of sea level and related climate data that provides to partner countries information about sea level variability and change, enabling them to respond to and manage related impacts. Organisational management issues resulting from any changes to the project will also be considered. The Review Team members will therefore require a mix of expertise, including expertise in understanding sea level variability and rise and its application to climate change studies and coastal inundation and flooding.

Team leader

The Team Leader should have relevant scientific expertise and will:

- be responsible for the implementation of the mission, including preparation of the report to AusAID standard in accordance with AusGuide;
- be responsible for the allocation and scheduling of tasks to team members;
- represent AusAID and take the lead in all discussion, presentations and briefings; and
- ensure AusAID Posts are briefed on mission purpose.

Scientific leader

The scientific leader should be a climate scientist unconnected with the project and will be allocated responsibility for leading on technical areas of the review as appropriate by the team leader.

Phase IV Project Manager

The Phase IV Project Manager will participate as a member of the review team in accordance with Section 4.5 of the PDD. Although the Project Manager's salary component is covered by the approved project budget, all travel and per diem costs associated with the Project Manager's participation on the Strategic Review Team will be an additional cost to the Project.

AusAID observer

The AusAID observer will be a member of the Pacific Environment Team and will:

- participate in review team debriefs and discussions
- read and provide comments on draft and final reports
- bring an AusAID policy perspective to program review considerations

Reporting Requirements

The Review Team will produce the following outputs (in accordance with the time frame specified in Duration and Phasing above), all of which will be agreed with AusAID:

- An aide memoire or exit report, for presentation to AusAID Post in Suva before departure from Fiji and to AusAID on return for discussion.
- A draft report in MS Word/Excel format (late versions) with working papers as directed by the team leader (only if necessary). The review report format should follow AusGuide guidelines. Where re-design is recommended, the format for PDD implementation, resource and cost schedules should be used.
- A draft final report by email.
- A Final Report in MS Word/Excel format (late versions) with working papers as directed by the team leader. The Report should not exceed 30pp, with annexes if necessary.
- Reports should be technical and written in a concise clear manner.

Annex 2: SPSLCMP Project Development

SOUTH PACIFIC SEA LEVEL AND CLIMATE MONITORING PROJECT (SPSLCMP)
PROJECT DEVELOPMENT

BoMET identifies four phases of SPSLCMP development. They are:

Establishment, Phase I: July 1991 to June 1995

11 SEAFRAME (Sea Level Fine Resolution Acoustic Measuring Equipment) monitoring stations were established at Cook Islands, Fiji, Kiribati, Marshall Islands, Nauru, Papua New Guinea, Solomon Islands, Tonga, Tuvalu, Vanuatu and Samoa. All are located on wharves. A system for transmitting the data via satellites and telephone links was put in place, and computer databases were established at the then National Tidal Facility Australia (NTFA) at Flinders University in Adelaide, for processing, analysing, archiving and making the data available to the international community

Monitoring, Quality Assurance and Developing the Record, Phase II: July 1995 to December 2000

The NTFA provided tidal charts and sea level data to regional partners which were used in navigation, planning for coastal development and forecasting of weather hazards. Between eight and nine years of data at various sites had been collected by the end of Phase II.

Precision Recording and Capacity Building, Phase III: January 2001 to December 2005

The 11 SEAFRAME stations continued to record sea level and climate data. A new SEAFRAME station was established at Pohnpei, in the Federated States of Micronesia (FSM), bringing the number of stations in the network to 12. Feasibility and design studies into two more possible stations in Palau and Niue were undertaken but these did not proceed to implementation. Regional technical involvement through the South Pacific Applied Geoscience Commission (SOPAC) was introduced, and information products and scientific studies were expanded. A major new initiative in this Phase was the installation of a Continuous Global Positioning System (CGPS) network linked to the SEAFRAME sites and managed by Geoscience Australia (GA). The CGPS network is designed to monitor vertical movement of the gauges and help determine absolute sea level. Ten of the 12 CGPS stations planned were installed. During this Phase the NTFA became a part of the Australian Bureau of Meteorology (BoMET) and was renamed the National Tidal Centre (NTC), with its offices co-located with the Bureau's South Australian Regional Office in Adelaide.

Monitoring, Reporting and Review, Phase IV: January 2006 to December 2010

This Phase is being managed and operated by BoMET in partnership with AusAID, SOPAC, GA and the National Meteorological Services (NMSs) within the Pacific Island countries. The 12 SEAFRAME stations are continuing to record and the data is continuing to be processed by the NTC. The remaining two CGPS stations of the CGPS network will be installed in the Marshall Islands and the Solomon Islands.

<www.bom.gov.au/pacificsealevel/project-info.shtml>

Annex 3: Consultation List

Country	Organisation	Name	Position	Email Address	Contact Details
Australia	Australian Bureau of Meteorology PO Box1289K, Melbourne, Vic 3001 Street Address: 700 Collins St, Docklands, 3008	Ray Canterford	R. P. Canterford (ADS) Branch Head, Weather and Ocean Services Policy Services and Systems Division	r.canterford@bom.gov.au	Phone (+613) 9669 4087 mobile 0413 244 305 Fax (+613) 9669 4695 Bureau Web address http//www.bom.gov.au/ Bureau Marine Services http//www.bom.gov.au/marine Bureau Oceanographic Services http//www.bom.gov.au/oceanography
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Cook Islands	Cook Islands Meteorological Service	Arona Ngari	Director		
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Annex 4: Required Durations of Sea Level Data Sets

One of the prime motivations for the SPSLCMP was to ascertain the long-term trend of sea level at each location, relative to the land (relative sea level) and also relative to the centre of the Earth (*absolute* sea level). The former is derived directly from the tide-gauge record (with any allowance for local movement, for example due to sinkage of the wharf) while the latter is derived from taking the sum of the elevation measured by the tide-gauge and the height measured by a Continuous Global Positioning System (CGPS) station located on `solid' ground within a few kilometres of the gauge. Unfortunately, neither tide-gauge records nor CGPS observations show just a simple trend.

Tide-gauge records are "contaminated" by motions such as the tides, surges (driven both by wind and by atmospheric pressure), seasonal effects (e.g. due to changes in water density) and longer-term variations such as those caused by the El Nino-Southern Oscillation (ENSO). However, it should be noted that, with modern instrumentation, most of the variability of a tide-gauge record represents real motions of the water surface; variations due to instrumental error are probably less than 1 cm in magnitude.

CGPS records also show real variations, such as Earth tides, which should be removed prior to any trend estimation. However, even after removal of such "real" motions, CGPS records show considerable variability which is unrelated to the actual motion of the station. The sources of this variability, and methods of removing it, are not yet fully understood, even though the accuracy of analyses techniques is being steadily improved. The analysis of data from a CGPS station is not done in isolation – it is done as part of a global analysis by organisations which belong to the International GNSS (Global Navigation Satellite System) Service (IGS). Unfortunately, due to the rapid developments in analysis technology, these organisations do not perform identical analyses, with the result that the published motion for any one station depends on which analysis produced it. For example, for Hobart, Tasmania, the vertical land velocity is presently estimated to be 3.6 and 5.9 mm/year by the Jet Propulsion Laboratory and the European Centre for Orbit Determination, respectively (see http://www-gpsg.mit.edu); these, although based on the same six years of data, differ significantly and are probably at least an order of magnitude too large. Care should therefore be taken when considering data from a single analysis centre. *It is therefore recommended that regular comparisons be made between the CGPS analyses provided by GA and those provided by other international centres. This may require requesting these centres to include the SPSLCMP CGPS data (available from the GA website) in their analyses.*

Church et al. (2006a) found that the long-term trend of sea-level rise in this region is typically 1-2 mm/year. A simple analysis of the way in which variability (either natural or real) contaminates the apparent trend indicates that the uncertainty in a trend estimate varies inversely as the record length to the power of 1.5 (Iz, 2006). Twenty seven years of tide-gauge data from Tuvalu (based on a combination of observations from a tide gauge run by the University of Hawaii Sea Level Centre (UHSLC) and data from the SPSLCMP gauge) yielded a trend estimate with an uncertainty (standard deviation) of ±1.6 mm/year (Church et al., 2006a). From this it may be estimated that, for an uncertainty of ±1.0 mm/year (which would yield a barely significant result for a trend of 1-2 mm/year), we require a tide-gauge record which is about 37 years long (which would mean waiting until 2030, using SPSLCMP data). For a *useful* estimate of long-term trend we need an uncertainty of less than about 0.5 mm/year, which would require a record length of about 58 years (which would mean waiting until about 2050). This finding is consistent with the claim of Douglas (2001) that tide-gauge records should be 60-70 years in length if they are to yield valid estimates of long-term trend. The

uncertainty of a trend based on the present SPSLCMP data (of about 14 years' duration) is about ±4 mm/year, which means that *the present SPLCMP data is incapable of estimating the expected trend of 1-2 mm/year with any significance at all.* This is a most important conclusion and one which must be continually emphasised. A consequence of this is that caution should be taken when interpreting the first table of the SPSLCMP Monthly Reports and it would be most unwise to base policy decisions on this data alone.

We can similarly estimate the uncertainty of a trend in a CGPS record of any length. Using data up until 2005 (of about three years duration) from the SPLCMP CGPS stations (on the Geoscience Australia website) and global GPS data of rather longer (typically six years) duration (Woppelmann et al., 2007), it is estimated that only about 5 years of data is required to yield a trend uncertainty of 1 mm/year. For a trend uncertainty of 0.5 mm/year, a record length of about 7 years is required.

An important implication of the above estimates is that, for a given uncertainty in the trend, the required length of a tide-gauge record is about eight times the required length of the CGPS record. This means that there is generally a greater urgency to install sea level gauges than CGPS stations. Therefore it may be worth ensuring that a tsunami gauge is bought up to the specification of a sea level gauge and related to a "solid-ground" benchmark, even if during the initial phase of its operation there is no accompanying CGPS station – the delayed installation of such a station would not be overly detrimental, so long as a decade or so of CGPS data were obtained at some later time. These conclusions, of course, depend on the (often reasonable) assumption that the vertical location of the land changes reasonably steadily over time. While the Pacific is often considered to be a tectonically active region, six of the SPSLCMP sites are well away from plate boundaries and, of the remainder that are closer, it is by no means certain that they will all experience erratic vertical motion. It is therefore important that any potential SPSLCMP site is evaluated carefully for any possible tectonic motion.

The above should not be taken as an assertion that there is no usefulness in the SPSLCMP sea level data until about 2050. The estimate of trend uncertainties given above relate to *data from a single station.* The appropriate way in which to estimate the trend at a given place is to use data from a number of sites, combined with information from other instrumentation. Such analyses yield what is called a *reconstruction,* which provides useful estimates of long-term regional trend (e.g. Church et al., 2006a). It is these reconstructions which should be used by the Pacific countries to understand the long-term change in sea level, and its past and present impacts on their islands.

In addition to information relating to the long-term trend in sea level, an understanding of the extremes of sea level is also required. One useful measure is the *average recurrence interval* (ARI), which is the average time between occurrences of a given extreme level. This also requires long data sets. Pugh (1987) indicated that a given data set can only be used to estimate extremes with ARIs up to about four times the data length. It is common for engineers and planners to design for extremes which have an ARI of 100 years, which would therefore require at least 25 years of data. This puts an approximate minimum on the length of sea level data sets for any useful analysis of extremes.

Annex 5: Location and availability of SPSLCMP Data

One-minute data from the SEAFRAME gauges (including meteorological variables) is broadcast over the Global Telecommunications System (GTS) of the World Meteorological Organisation (WMO) every three minutes, for use by the global community for tsunami monitoring purposes. There are also hourly transmissions of all data from the previous hour via the GTS.

The 6-minute and hourly-averaged sea level data from the SEAFRAME gauges is distributed quarterly on CDs to the PICs. It also resides, in various forms at four global databases:

1. **The National Tidal Centre (NTC) web site**

   http://www.bom.gov.au/oceanography/projects/spslcmp/data/index.shtml

   Hourly-averaged data is stored up until the end of the previous month. The data is composed of sea level, air and water temperature, barometric pressure, the sea level residual (with and without adjustment for the inverse barometer effect) and wind observations (direction, gust and speed). Access to this data is subject to registration by sending an email to NTC (although the instructions for doing this are not particularly clear on the NTC web site).

2. **The University of Hawaii Sea Level Centre (UHSLC) web site**

   http://ilikai.soest.hawaii.edu/uhslc/datai.html

   Monthly, daily and hourly-averaged data are stored. At the time of writing (May, 2007) only data to the end of 2004 was available. The data is freely available without registration. In addition, UHSLC holds some "fast delivery" products which have not been subject to final quality control.

3. **The database of the Global Sea Level Observing System (GLOSS) at the British Oceanographic Data Centre**

   http://www.bodc.ac.uk/data/information_and_inventories/gloss_handbook/stations>

   All SPSLCMP stations except Vanuatu, Tonga and Samoa are part of the GLOSS network. It is intended that the remaining three stations should become part of the GLOSS network in the near future. Hourly data are stored. At the time of writing (May, 2007) only data to the end of 2001 was available. The data is freely available without registration.

4. **The Permanent Service For Mean Sea level (PSMSL)**

   http://www.pol.ac.uk/psmsl/psmsl_individual_stations.html>

   Annual and monthly-averaged sea level data are stored. At the time of writing (May, 2007) only data to the end of 2004 was available. The data is freely available without registration.

The CGPS data is stored at the Geoscience Australia (GA) website at http://www.ga.gov.au/geodesy/slm/spslcmp/. Annual reports are produced showing plots of the processed results, the latest being at http://www.ga.gov.au/geodesy/slm/spslcmp/timeseries.jsp. The raw data is at http://www.ga.gov.au/geodesy/slm/spslcmp/network.jsp

Annex 6: Study of SEAFRAME stations for Palau and Niue

Pre-Feasibility Study of SEAFRAME stations for Palau and Niue: The Scientific Perspective

National Tidal Facility Australia

May 2002

Summary

Two new stations, Palau and Niue, have been proposed for addition to the Pacific Array. The cost and effort involved must be justified in terms of scientific, as well as other benefits. This study reviews the scientific basis for inclusion.

The Palau region is relatively under-sampled and lies in an area critical to the formation of El Niño, making it invaluable for monitoring of both decadal and inter-annual variability. The University of Hawaii recently upgraded their Palau gauge and is now to the standard required to meet the goals of the Pacific Array, with the proposed addition of meteorological sensors and satellite communications.

The addition of a new station at Niue would add significantly to the spatial coverage within the "South Pacific Convergence Zone" (a key component of the regional climate system). It also would provide a basis for studies of local environmental phenomena such as extreme events as required for planning and coastal development.

Introduction

The South Pacific Sea Level and Climate Monitoring Project ("Pacific Project") aims to help Pacific Island Countries and their governments understand the scale and implications of changing sea levels, climate and climate variability. In the Pacific, the task is difficult since climate is only one part of the problem of changing sea levels. Others include the movement of the earth's crust due to movements of continental plates, active volcanoes, and earthquakes which all occur in the region.

The Pacific Project was established to set up high resolution monitoring stations in eleven island countries for measuring the relative motions of sea level at each station. In addition, the project also carries out a supplementary survey and geodetic programme for measuring relative movements of the crust at other strategic sites in each country with respect to the reference station. These measurements can be used to differentiate localised problems from changes to sea level and movements of the earth. They can help identify changes to sea levels with reference to a similar network of stations in Australia and elsewhere in the world, whether these changes are due to thermal expansion of the ocean, contributions from land ice, or changing properties of water from different ocean zones. The project also collaborates with on-going international geodetic programmes, which may be incorporating satellite altimetry and radio astronomy, to provide a measure of regional vertical control, with exchanges of

information and data with national, regional and international Climate Change centres. This will help the understanding of the complex problem of measuring changes in sea levels.

There are presently twelve stations monitoring sea level and climate. Eleven stations were commissioned over two years, starting in October, 1992, with the addition of Pohnpei, FSM in December 2001. The eleven stations are in the Cook Islands, Tonga, Samoa, Fiji, Vanuatu, Solomon Islands, Tuvalu, Kiribati, Nauru, Marshall Islands and PNG.

These stations use the SEAFRAME (Sea level Fine Resolution Acoustic Measuring Equipment) system which has also been installed around Australia. The equipment has built-in sensors that measure water level, using a very sensitive acoustic sensor (with a pressure sensor as a backup), wind speed and direction, maximum wind gust, air and water temperatures, and atmospheric pressure. The equipment has the capacity to measure sea level changes within one millimetre precision, every six minutes. Other measurements are recorded once every hour.

It should be remembered that the current average rate of global sea-level rise is just over one millimetre per year, so there must be stringent specifications for equipment and engineering. Sea level and climate data are now regularly recorded and automatically transmitted via the Japanese Geo-stationary Meteorological Satellite and the telephone lines to NTF Australia, located in Adelaide, South Australia.

Project objectives

The Project goal is:

To provide an accurate long-term record of sea levels in the South Pacific for Project partner countries and the international scientific community, that enables them to respond to and manage any impacts.

The overall purposes of the Project in the Phase III Request for Tender are defined as:

1. Data and information provision. To assemble an archive of sea level and related meteorological data that provides to partner countries the information about sea level variability and change that they require to manage their near-shore and coastal resources sustainably, and to develop policies and strategies for responding to long-term trends.

2. National counterpart agency capability in acquisition and use of sea level information. To develop the capability within the national counterpart agencies of the partner countries to acquire, manage, and disseminate data and information about sea level variability and change.

3. Regional organisation capability in management of sea level information. To develop the capability within selected Pacific regional organisations to provide the support needed to generate (or assist in generating), preserve and interpret an accurate record of absolute sea level variation in the region.

The National Tidal Facility Australia critiqued the goals and purposes as follows:
The proposed goal and purposes given at *Request for Tender* are deficient in that they neither define the accuracy of measurement or length of record required for a scientifically conclusive result. In particular, the level of accuracy determined must govern the resolution of the instruments. Phases I and II were established on the premise that 20 years of observations require accuracy to the sub-millimetre per year level. Observations from these Phases have

verified this need, as has the PIC demand for short-term results. Stilling wells and bubblers suggested by the RFT can not produce this accuracy.

Terms of Reference for the Pre-Feasibility Study

Terms of Reference (TOR) were written for a "Feasibility Study" in 2001. As a result of various circumstances and discussions, the Feasibility Study did not go forward, but instead this Pre-Feasibility Study was initiated. However, much of the original TOR are still relevant and form the basis for the pre-feasibility study.

Background

SEAFRAMES for collecting data on sea-level rise have been established under Phase I & II of the Sea Level and Climate Monitoring Project in 12 Pacific Island Countries. Niue and Palau are not among these countries, but have requested that SEAFRAMES be installed on several occasions.

Niue and Palau have not been considered for SEAFRAMES in the past as it was believed that sufficient data to meet project needs was available from SEAFRAMES located in other geographically close countries. Niue and Palau claim that the data available from these other countries is not sufficient to assist in coastal management within their countries and SEAFRAMES directly installed on their territory would greatly enhance their environmental management capacity.

The cost of one SEAFRAME is considerable - around $200 000 and once installed will require ongoing maintenance. Justification for new SEAFRAMES therefore needs to be convincing.

AusAID has agreed to conduct a feasibility study during Phase III of the project to determine the merits of installation in Niue and Palau. Output 1.2 of the project contract outlines a 'technical assessment completed on the Niue and Palau requests for a SEAFRAME'.

Objectives

A frank assessment of the need for and the merits of a SEAFRAME in Niue and Palau.

Scope of Services

The Consultant will travel to Niue and Palau and analyse local conditions to determine:

- Whether the project can meet its stated objectives without SEAFRAMES in Niue and Palau.
- What specific benefits for local coastal management would be provided by a SEAFRAME in each country.
- What level of commitment and capacity to contribute to the ongoing resourcing and maintenance of a SEAFRAME is available, should it be deemed unnecessary for the project itself.
- What specific benefits to the project's overall objectives would be derived from SEAFRAMEs in Niue and/or Palau.
- The cost of installation and maintenance of each SEAFRAME.
- Provide preliminary information of results to AusAID Canberra staff before departure.
- Subsequent to AusAID notification, provide debriefing at Ministerial level in each country to communicate the findings of the study.

- Provide a written report within ----- days of departure to AusAID communicating the findings of the feasibility study on the above points.

Physical settings

The main island of Palau, Babelthuap, is a relatively high, mountainous volcanic island located southeast of the Philippines at 7° 30’ N, 134° 30’ E. Its primary port is at the capital, Koror.

Niue is a single, isolated, raised coralline platform at 19° S, 170°W.

The locations of Palau and Niue are shown in **Figure 1** on a background of sea surface temperature. The temperatures were obtained as averages over weekly values for a one year period (the year 2000). A broad “warm pool” can be seen northeast of Papua New Guinea. Tongues of warm water extend eastward and southeastward from the warm pool. These two tongues follow along special lines known to meteorologists as the Inter-Tropical Convergence Zone (ITCZ) and Sub-Tropical Convergence Zone (SPCZ), respectively. Palau is located on the northern edge of the warm pool and also within the ITCZ, while Niue is located at the southern boundary of the SPCZ.

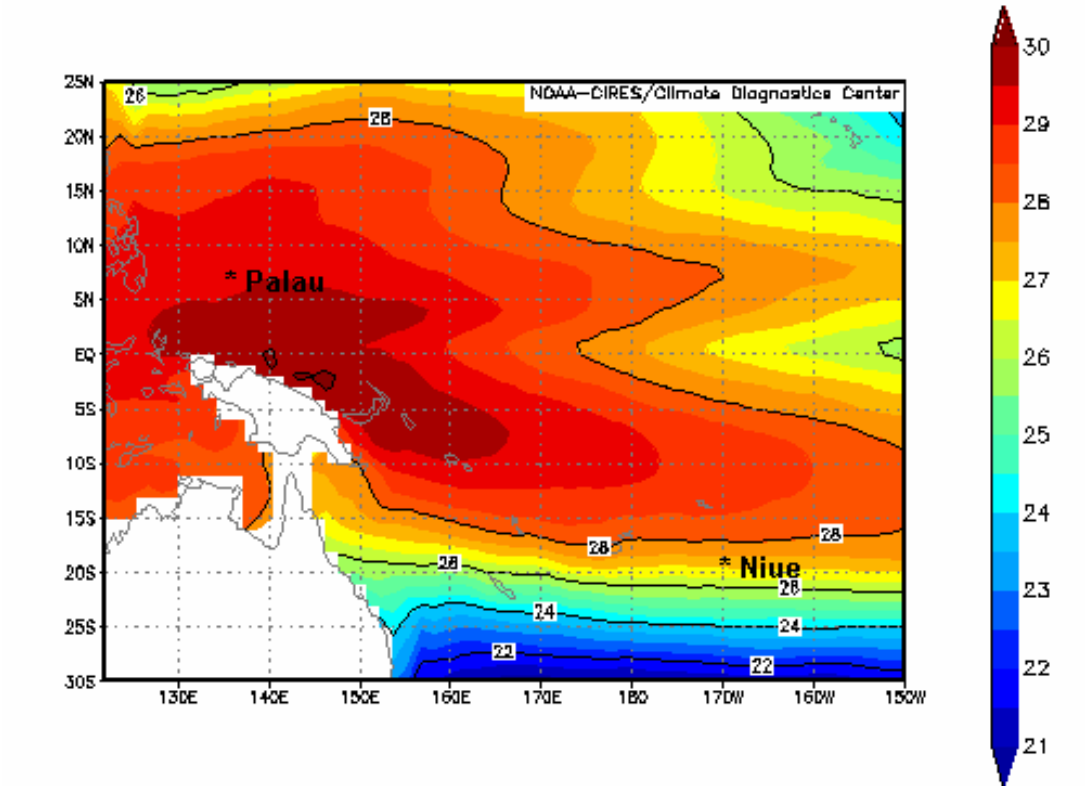

Figure 1. Map of sea surface temperature showing sites. Courtesy: NOAA-CIRES.

The convergence zones are so-named because the near-surface winds tend to converge along these lines. Where convergence occurs, the air rises, carrying with it water vapour that condenses to form cloud bands. Thus, the ITCZ and SPCZ are visible as regions of relatively high cloudiness. Their positions shift somewhat with the seasons, but an even greater shift occurs during El Niño events[1]. This shift, which results in a redistribution of rainfall across the western and central Pacific, can be seen in **Figure 2**.

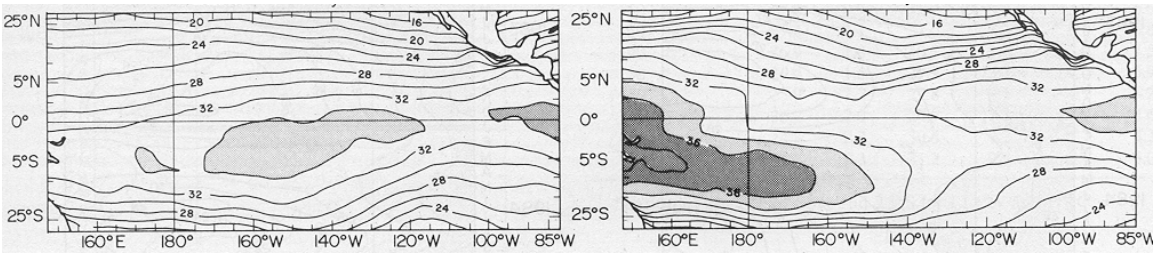

Figure 2. Maps of low level precipitable water, during El Niño (left) and immediately after (right).

Much of the variability that occurs in the upper ocean is carried from east to west in the form of large-scale waves. For example, when an El Niño event occurs, the normal currents off the coasts of the Americas undergo massive changes to their characteristic directions, temperatures, etc. This sets off a chain reaction that causes a westward moving large-scale wave just off the equator. This wave is important to the study of El Niño because it is forms a key part of the "coupled oscillator" system comprised of the ocean and atmosphere[2], and as it moves along it displaces warm equatorial water. It plays a particularly important part in the mature and later stages of the El Niño. These waves were originally detected in tide gauges fortuitously located in the western tropical Pacific[3] and the gauges continue to play an important role in tracking the large-scale sea level variability in the region. The sea level signature of the waves is apparent in **Figure 3**. Over the 3.5 month period separating the images (as the wave passed), the sea level at Palau fell by more than 10 cm.

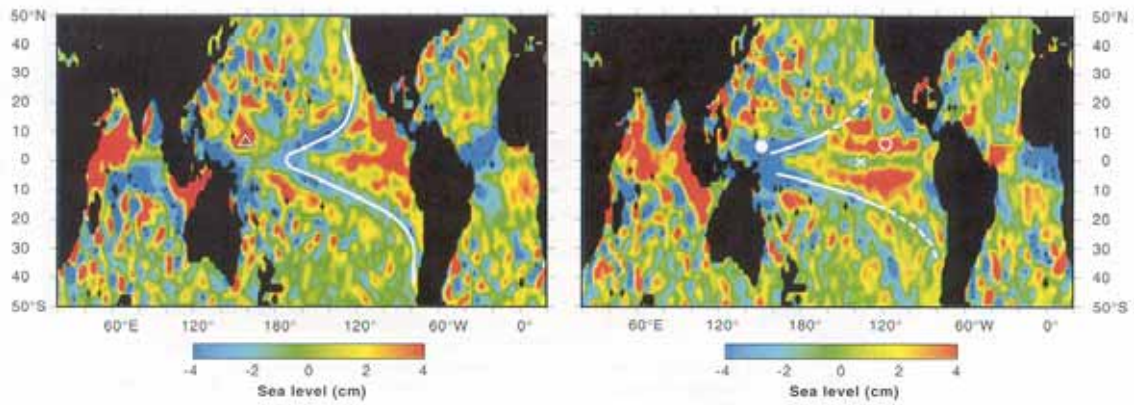

Figure 3. Maps of sea level taken 3.5 months apart during normal conditions. White lines are drawn along the troughs of a westward-moving large-scale wave, showing how the wave has moved over the interval. Courtesy: Chelton and Schlax[4].

The location of Palau has added oceanographic significance due to its proximity to both the equator, and the western boundary of the ocean. During the early stages of El Niño, a complex series of inter-related atmospheric and oceanic processes simultaneously occur in the area previously referred to as the "warm pool"[5]. It is an invaluable site for monitoring these processes, which have a distinctive sea level signal.

Monitoring long-term sea level changes

It is well accepted that the detection of long-term sea level changes requires precise datum control, long time series, and a level of accuracy beyond that provided by normal port tide gauges. The many islands of the western tropical Pacific offer the best opportunity anywhere, from the standpoint of spatial sampling frequency[6]. The network of gauges established by organisations such as the University of Hawaii (UH) since World War II have been of paramount importance in enriching our knowledge of the currents and year to year variations of

the regional currents. They are mostly inadequate for the rigorous requirements of long-term trend monitoring.

Figure 4. University of Hawaii tide gauge at Palau showing twin Aquatrak acoustic gauges, CGPS receiver, and instrument hut.

From an argument of spatial sampling alone, the island of Palau is clearly well situated for the establishment of a SEAFRAME station. The nearest sites within the Pacific array are Manus Island and Pohnpei, both more than 2,200 km distant. A UH site (with a conventional tide gauge) was operative at Palau from 1969-1999, and then replaced by an acoustic gauge (**Figure 4**). The gauge was also complemented by a CGPS instrument, which, over time, will enable precise datum control and the measurement of absolute sea level. UH scientists have expressed a desire to cooperate with the operators of the Pacific array in surveying, maintaining and exchanging of both sea level and CGPS data to the mutual benefit of both parties. A plot of recent data is shown in **Figure 5**.

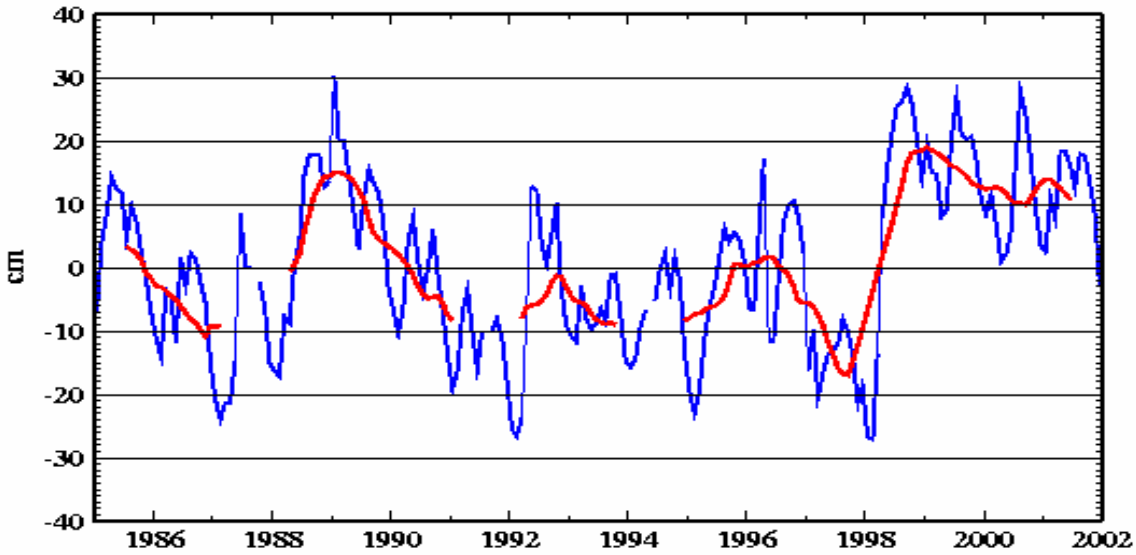

Figure 5. Time series of sea level at Palau (Courtesy: University of Hawaii). A thick red line shows the "El Niño time scale" variability, with seasonal, tidal, and other relatively high frequency fluctuations filtered out. Note the low sea levels in the El Niño years of 1987, 1992 and 1997/98.

Niue is located in the middle of a diamond-shaped area enclosed by the Cook Islands, Tonga, Fiji, and Samoa (current SEAFRAME sites), about 640 km from both Nuku'alofa and Apia. In the context of long-term monitoring, the increase in coverage presents a less-compelling case than Palau's. On the other hand, adding a station at Niue would help discriminate between absolute and relative changes in the area as a whole, would add significance to a joint trend computation that included all five sites, and provide a potentially important element of redundancy to the array.

Short-term ocean variability

As we have seen, the islands of Palau and Niue are located in very different oceanographic regimes. Palau is in the western source region for the North Equatorial Counter Current, which flows from west to east between the latitudes of 5° and 10° north of the equator. It is a region of particular significance to the genesis of El Niño, and subject to energetic large-scale waves.

Tide gauges at Palau, Yap, and elsewhere in the vicinity have given useful evidence in a number of studies of the dynamics of the tropical Pacific Ocean not directly related to El Niño, and will doubtless continue to do so[7]. This is because it is located near the confluence of several important oceanographic currents. It can be thought of as the source of the North Equatorial Counter Current; it is just east of the Halmahera Eddy, and also receives water from the extension of the South Equatorial Current, part of which flows north across the equator offshore of Papua New Guinea. Some of the southern water re-circulates into the eastward-flowing North Equatorial Current, some enters the Halmahera Eddy, and a substantial proportion enters the Indonesian Archipelago, through which it flows to the Indian Ocean. As such, the Palau region also plays an important part in the global oceanic overturning process known as the "global conveyor belt".

Niue is near the centre of the South Pacific Gyre, the general counter-clockwise rotating circulation pattern of the South Pacific basin. This is not to say that a gauge at Niue could not be useful to studies of seasonal variability. Its position, along with Tonga and the Cook Islands at the southern side of the SPCZ, and at the heart of the Southeast Trade Winds, could in future make it well placed for studies involving the coupled atmosphere-ocean system. The spatial gradients of wind known to occur there (known as "wind stress curl" to oceanographers) imply

simultaneous fluctuations to the depth of the upper ocean, which in turn affect sea level[8]. As the ocean relaxes back to its normal state, the energy generated by the wind gradients propagates westward in the form of large-scale waves, eventually depositing their energy in the western boundary current system[9]. The spatial scale of the waves at these latitudes, and their generating mechanism, is such that to effectively study them requires data sampling at a resolution of less than 1000 km, a resolution that would be achieved were data from Niue to become available.

As far as could be determined by this study, the only pre-existent climate monitoring based at Niue is the data collection from the local meteorological office. For nearshore development to occur, normally a time history of the local wave climate and occurrence of extreme events is used to establish such factors as the required height above High Water, and the rate at which discharge into the ocean is dissipated. The SEAFRAME instrument not only records six-minute averages of sea level, it also records a parameter which can be related to significant wave height, and in the event of cyclones and tsunamis, the sampling frequency can be increased to provide data at one-minute intervals (the average over 60 one-second samples). It therefore contributes to both local environmental monitoring and to the tsunami network.

Recommendations

This study finds that, from the scientific perspective, compelling reasons exist for supporting the Palau gauge and installing a new SEAFRAME gauge at Niue. The two sites differ in terms of both climate and oceanography, and the grounds for feasibility also vary. Palau presents a superb opportunity to add value and significance to the long-term sea level trend calculation for the Pacific Array, and is also central to studies of El Niño. A new gauge at Niue would be of substantial benefit to the local people, through its contribution to environmental planning and development. It would also enable scientists to monitor the extent and variability of an important climate phenomenon (the South Pacific Convergence Zone).

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Annex 7: ASLOS Site Selection Report - Alofi

EXTRACT:
AUSTRALIAN SEA LEVEL OBSERVING SYSTEM (ASLOS)
SITE SELECTION REPORT – ALOFI
SITE SELECTION SUMMARY REPORT – ASLOS NETWORK LOCATION 9

Assessment Trip Overview

This report summarizes a site selection visit by Matt Gould and Bryan Hodge from the 19th to 26th January 2007 to Niue. Niue is an atoll 18km by 23km that has relatively steep cliffs and bathymetry. It has few safe access points to the water and most of these are man made.
In general Niue is subject to cyclones and extreme sea that frequently wipe out coastal infrastructure.

It is a stable independent country with official ties to New Zealand and recently an MOU with Australia regarding the ATWS and SPSLCMN projects. A previous assessment in 2001 by NTC was used to guide this assessment.

Site Details

- Early Warning site for Tonga and Kermadec Zones
- Monitoring site for Chilli Zone
- Verification site for South Solomon and New Hebrides Zones

Site	Name	Station No.	Position	Status
1	Sir Robert's Wharf - Alofi	None	19° 3'14.75"S 169°55'17.74"W	Conditional
2	Avatele Boat Ramp	None	19° 7'33.91"S 169°54'47.42"W	Unsuitable (Lack of Infrastructure, logistics and water depth)
3	Nanukulu Landing	None	18°58'36.44"S 169°53'50.63"W	Unsuitable (Lack of Infrastructure, logistics and water depth)
4	Matapa Chasm	None	18°57'43.65"S 169°52'55.99"W	Unsuitable (Lack of Infrastructure, logistics and water depth)

Assessment summary of preferred site

Site 1 – Sir Robert's Wharf – Alofi

This is the main wharf for Niue and handles all freight on and off the island and number of local fishing and tourist activities. It is a concrete structure built on natural limestone and appears to be structurally sound. Local knowledge indicates that the wharf is inundated approximately 10 times per year.

The wharf is on the leeward side of the island for swell, but faces the major tsunami sources. The water around the wharf exhibits swirling currents and has variations in the water depth over small distances. Water depth varies from 2m to a typical value of 7m with a tidal range 1m.

The wharf being a solid construction will interfere with the sea level signal and is likely to make interpretation of the data difficult. There is an existing PTWC pressure sensor at Sir Robert's Wharf which may assist in determining the extent of this problem.

- Power – Mains power exists but is turned off during cyclones
- Communications - Satellite coverage or line of site RF to the Met Office at Learmonth.
- Ownership – The Wharf is owned by the Niue Government and administered by the Department of Public Works. There is already a MOU with the Government of Niue.

Overall Recommendation

It is recommended that Sir Robert's Wharf Alofi not be accepted for inclusion in the ASLOS network but held in reserve noting that:

- While this is the best of the options on the island it is less than adequate scientifically and highly vulnerable to damage due to accidental damage or cyclone damage.
- That the above recommendation be reassessed after assessments of Apia (Samoa), Nuku'alofa (Tonga) and Vava'u (Tonga) have been completed.
- The above recommendation be reassessed after obtaining data from the PTWC gauge at the site.

Annex 8: Multifunction Gauges: Tsunami Warning System, SEAFRAME, CGPS

The sea level monitoring instrument used for SPSLCMP (commonly, and here, called a "tide gauge") is designed to measure tides, surges, and longer-term variations in mean sea level. The sensor is installed in a stilling well, which effectively removes wind and swell waves (typically of period 5 to 10 seconds), while allowing tides and surges (typically of period greater than a few hours) to be measured with virtually no attenuation (ie the instrument records the exact height of the tide or surge). In order that they are able to detect gradual changes in mean sea level, they are nowadays vertically located to an accuracy of order a millimetre. SPSLCMP uses an Aquatrak acoustic sensor which is vertically referenced using a combination of CGPS and conventional surveying techniques. Tide gauges are generally sited within harbours, embayments or lagoon, often to afford protection from ocean waves.

The observational requirements for a tsunami warning system are somewhat different. The primary reasons for monitoring tsunami waves are both to provide an early warning and quantitative assessment of an approaching wave, and to supply data to support the computer modelling of tsunami waves. It is necessary that the instrument measures accurately the sea-surface displacement relative to the "pre-tsunami" water level, at a temporal resolution which captures the true shape of the wave as it propagates across the ocean. There is a significant debate about the required temporal resolution and there are suggestions that it may need to be shorter than one minute. However, two things should be borne in mind:

1. the temporal resolution of tsunami models is limited by the size of the spatial computational grid (for present models, this indicates a maximum temporal resolution of rather less than one minute); and
2. waves which have periods approaching one minute, are no longer "deep water" waves and are subject to dispersion, which smooths out the higher frequencies as the wave propagates; the wave from a distant tsunami therefore contains little variability at periods of less than about one minute.

For the present discussion it is assumed that one-minute resolution is adequate for tsunami monitoring. This high sampling rate is accompanied by a requirement that variations at this time scale are not distorted or attenuated by either the instrument itself (which may be mounted in a stilling well) or the location (e.g. a harbour). For the stilling well used in a SEAFRAME installation, there is probably negligible attenuation for waves of period one minute. However the resonant periods of harbours, embayments and lagoons are generally one minute and upwards, so that tsunami waves may well be distorted on entering these systems. Tsunami gauges should therefore ideally be located away from such resonant systems.

The primary differences between the requirements for "tide gauges" and tsunami gauges are:

- A tide gauge requires accurate vertical referencing, and continuing monitoring of any vertical motion of the gauge; tsunami gauges do not.
- A tide gauge should be able to adequately resolve tidal motions, and motions of meteorological origin except for wind waves and swell. Modern tide gauges typically sample every 6 minutes.
- A tsunami gauge should have a sampling period as short as one minute and should be sited outside harbours, embayments or lagoons in order to minimise distortion of the wave.
- It is important that a tide gauge record for a considerable period of time (many decades) with as little disturbance as possible (especially in the vertical). It is therefore generally best to locate a tide gauge in a sheltered environment so that it may not be damaged by ocean waves.

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