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ABSTRACTS

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CONTENTS

RECENT CLIMATE CHANGE STUDIES IN FIJI, TONGA AND SAMOA

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Recent work has concentrated on adapting the Common Methodology for Assessing Vulnerability to Sea-Level Rise to a Pacific island situation. This has meant substituting an emphasis on quantitative measures of value with qualitative measures intended to manifest the generally non-monetized Pacific Island societies.

This methodology has been tested in a variety of situations and by a variety of operators in order to determine the optimal format for its use by minimally trained persons in the future in the region.

Results of the tests were used to develop vulnerability analyses for various islands. Sectoral analyses of tourism and agriculture were undertaken for Fiji.

Based on the studies of vulnerability and resilience, and the sectoral agricultural analysis, some preliminary conclusions can be made about the possible effects of climate change/sea-level rise on biodiversity in the region.

ISLAND MORPHODYNAMICS AND THEIR SIGNIFICANCE IN ASSESSING THE IMPACTS AND RESPONSES TO SEA LEVEL RISE.

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Low-lying coral reef islands are distinct in their characteristics, dynamics and continuance to other islands. The reef is by far, the primary provider of the material to perpetuate and maintain the island, in accordance with the prevailing environmental conditions. Any changes to these conditions, naturally or otherwise, impacts the islands significantly. However, it is frequently not appreciated that within the coral reef islands, there is considerable morphological and dynamic variability. Such differences are crucial to understand the actual impacts on the islands and their responses.

Morphological aspects such as the topography, shape, size and relation with the reef, influence the responses of the islands to the environmental changes induced on them. In addition, the natural dynamics such as the cyclic adjustments and long term developments of islands, together with human impacts, affect the decisive response of the islands to such changes. A close examination of the morphodynamic variability can delineate the enormous differences that exist between and within islands too. This is clearly illustrated with reference to the changes in wind-wave swell conditions, that induce 'seasonal' accretion and erosion patterns prevalent on the islands of the Maldives. The magnitude of morphodynamic variability of the islands in the Maldives is considerably high, despite been located in a cyclone-free belt and where the tidal range is small. Such differences have to a great extent been neglected so far, in assessing the vulnerability of coral reef islands to the impacts of accelerated sea level rise and in the formulation of adaptive and management strategies.

A more realistic vulnerability assessment of low-lying coral reef islands to sea level rise is a significant political, socio-economic, cultural and scientific issue, particularly in the face of the recently generated high level publicity about the fate of small islands. Such an assessment has considerable global implications, particularly on the many inhabitants of the low-lying islands, who have to survive the impacts, protect their livelihood and adjust to the responses of climate change and consequent sea level rise.

ADAPTATION/MITIGATION RESPONSE OPTIONS - INTEGRATED COASTAL MANAGEMENT PLANS

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The coast is an integral part of the livelihood of Pacific Island peoples. However, these areas continue to be modified through human intervention and natural disturbances such as climatic change and sea level rise. If these disturbances persist unabated, coastal resource managers may be forced into a largely experimental and reactive role in responding to them. It is now recognised that efforts are required to prepare for adaptation and mitigation.

Adaptation is a process of adjusting practises, processes and structures to reduce the adverse effects of global and regional climate change and to take advantage of potential benefits. Mitigation is focused on reducing green house gas (GHG) emissions or increasing GHG sequestration by sinks. In some cases, adaptation measures may conflict with mitigation measures. For SPREP and the Small Island Developing States (SIDS), it would thus be beneficial to address both mitigation and adaptation options as an adaptation option, regardless of the rate and severity of climate change.

Integrated Coastal Management (ICM) is accepted world-wide as a comprehensive, multi sectoral integrated approach to the planning and management of coastal areas. ICM is also recognised as an appropriate process for dealing with climate change related issues. The principles of ICM relate to the public nature of the ocean and to the use of coastal/ocean resources and space found in the Rio Declaration of Principles and in other international agreements.

ICM is particularly suited to the small Pacific Island countries because of their size and the interconnectedness of the coast and terrestrial areas. However, there has been a reluctance by funding agencies and Pacific island governments to develop plans of management using an ICM approach. This paper outlines the constraints and ingredients for piloting and implementing ICM for the Pacific islands. A phased, two pronged funding proposal which addresses short-term site-specific or sectoral climate change issues and lays the foundation for long-term coastal planning is suggested. The end result may not be a single solution or methodology but rather a set of principles that can be applied either on a national or regional level.

A BRIEF HIGHLIGHT ON INFORMATION AND TRAINING PROGRAMME THE SOUTH PACIFIC SEA LEVEL AND CLIMATE MONITORING PROJECT]

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The net result of modern technology and development in the Pacific Island Countries [PICs] has been that we have lost a lot of the traditional knowledge on which our daily lives depended in the past. We have allowed ourselves to act irresponsibly towards the marine environment, and made some of the same mistakes that have taken place in so-called developed countries. This is happening in a technological context that makes the potential to damage our home quite appalling.

Now we are becoming increasingly aware of the critical effects that humans are having on the oceans, atmosphere and hence our future survival, world-wide. The PICs raised concerns about changing sea levels due to global warming at the South Pacific Forum meeting in 1988. In particular, the people of low-lying coral atolls were concerned about the possible threat of sea level rise and climate change. In 1989, the Prime Minister of Australia committed the Australian Government to help Forum member countries address their concerns. The South Pacific Sea Level and Climate Monitoring Project developed as an Australian response to concerns raised by members of the South Pacific Forum countries. The National Tidal Facility, based at the Flinders University of South Australia, was contracted to manage, develop and implement the Project in 1991.

Under the project, eleven monitoring stations were planned to provide a wide coverage across the Pacific basin. All stations were operational by October 1994 and are continuously monitoring the sea level, wind speed and direction, wind gust, air and water temperatures and atmospheric pressure. Participating countries are : Cook Islands, Fiji, Kiribati, Marshall Islands, Nauru, Papua New Guinea, Solomon Islands, Tonga, Tuvalu, Vanuatu and Western Samoa. The Project aims to help PICs and their governments understand the scale and implications of changing sea level and climate. In the Pacific, the task is difficult since climate is only 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.

Among other regional scientific projects, the South Pacific Sea Level and Climate Monitoring Project in its second phase is gaining more momentum in the region and more and more people are aware of the importance of the sea level and climate change issue. Based upon the experiences gained during Phase I, the Information and Training Component of the Project is in top gear to disseminate the information and to train the local personnel in this respect. The awareness raising workshops that played a dominant role in Phase I, have been replaced with intensive training of technicians and scientific personnel from the PICs through Short-Term Attachment Training Courses in which 14 different short courses are included. So far, 3-week training courses are conducted twice a year and 13 participants from PICs are invited at a time. Regular Monthly Data Reports and Quarterly Newsletters of the Project have been widely distributed in the region since Phase II began. In addition, an 8-module School Curriculum on climate change and sea level issues is almost ready to be released for the Pacific region. Major activities of the Information and Training Component of the Project will be briefly outlined.

DEVELOPING PUBLIC AWARENESS FOR CLIMATE CHANGE : SUPPORT FROM INTERNATIONAL RESEARCH PROGRAMS

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Developing regional and local public awareness and interest in global climate change has been mandated as an important step for increasing the ability for setting policy and managing the effects of climate change. In order to increase public awareness, the informal flow of information (through journalism, public meetings, and public relations efforts) as well as formal education in environmental issues and basic science has to become a top priority at international, regional and local scales. Both educational goals and the flow of public information can be supported by a careful strategy of requesting assistance from international and regional research programs that are targeting the key environmental concerns of the Pacific region. Research programs frequently have resources, that could help reach regional goals. To obtain these resources, research programs and investigators need clear statements of national and regional strategies or priorities as a guide.

One such program, the Atmospheric Radiation Measurement (ARM) Program, has a requirement to develop local or regional education enrichment programs at their observational sites in the central USA, the tropical western Pacific (TWP), and on the north slope of Alaska. ARM's scientific goals will result in a flow of technical data and as well as technical expertise that can assist with regional needs to increase the technical resources needed to address climate change issues. The education program of ARM is designed to enrich the curricula of these local and regional areas. Details of the ARM education program in the Pacific will be presented. We suggest that giving strategic guidance to research programs can facilitate improved public awareness of climate change and its effects. This may also lead to local increased enthusiasm for careers in scientific, technical, and governmental policy arenas.

TROPICAL CYCLONES IN THE SOUTH PACIFIC REGION

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A survey will be made of the climatological characteristics of South West Pacific tropical cyclones. No two tropical cyclones are the same, but overall, some general patterns of behaviour may be distinguished. A brief summary of these patterns (the climatology) of tropical cyclones in the South

Pacific will be given, in respect to season, location, typical tracks, changes from year to year, and long term trends. The major shifts in patterns of cyclones that occur as a result of the El Nino Southern Oscillation phenomenon will be described.

The impacts of climate change on tropical cyclone occurrence and intensity remained uncertain at the time of the recent IPCC Second Assessment Report. However, some changes are likely since climate models are predicting changes in the key factors in cyclone initiation and maintenance, such as atmopheric stability and ocean temperature, and recent Australian work suggests they may be 10-20% stronger under 2 x CO2 conditions.

OVERVIEW OF METEOROLOGICAL INFORMATION AVAILABLE IN THE PACIFIC REGION

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High quality, long term meteorological data will underpin understanding of climate, climate change and climate variability. Neither of these qualities are easy to achieve, and in the Pacific region there are special circumstances which are unique and need to be addressed if appropriate data sets are to be maintained. The main agencies responsible for collecting the data are national meteorological services. The standards and procedures used by these services are universally defined by the World Meteorological Organization, and so theoretically it can be assumed that appropriate mechanisms are, and have been in place to ensure such data is available.

This paper will look at the infrastructure, the issues, the current situation and the expectations for the future on meteorological data in the Pacific region. There are a number of significant problems to be addressed but it is vital that we continue to work to ensure the production of the data. In particular individual nations need to ensure that they maintain meteorological observing infrastructure in such a way as to protect their ability to obtain the data which are vital to both current and future generations.

THE ARM PROGRAM IN THE TROPICAL WESTERN PACIFIC

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The Department of Energy's Atmospheric Radiation Measurement (ARM) Program was created in 1989 as part of the U.S. Global Change Research Program to improve the treatment of atmospheric radiative and cloud processes in computer models used to predict climate change. The overall goal of the ARM Program is to develop and test parameterizations of important atmospheric processes, particularly cloud and radiative processes, for use in atmospheric models. This goal is being achieved through a combination of field measurements and modeling studies.

Three primary locales were chosen for the implementation of extensive field measurement facilities. These are the Southern Great Plains (SGP) of the United States, the Tropical Western Pacific (TWP), and the North Slope of Alaska and Adjacent Arctic Ocean (NSA/AAO). The SGP covers approximately 55,000 square miles in north-central Oklahoma and south-central Kansas in the central United States. Implementation of the SGP began in 1992 and it is now in full operation. The TWP began phased operations in 1996 and is planned to be fully operational by 2001. The NSA/AAO is scheduled to begin operating in 1998. Each of these sites is planned to operate for at least 10 years. In addition to these three primary sites ARM may establish several supplementary sites to obtain data at other locales for shorter periods of time. Each locale has an education program associated with its measurement program.

The Tropical Western Pacific CART locale is a large expanse of tropical ocean and maritime continent lying roughly between 10o S and 10oN latitude and from 135oE to 150oW longitude. Climatologically, the locale is characterized by warm sea surface temperatures, deep and frequent atmospheric convection, high rain rates, strong coupling between the atmosphere and ocean, and substantial variability associated with the El Nino - Southern Oscillation (ENSO) phenomenon. The relationship between climatic variability in this region and variability in other areas of the planet is well known.

ARM is establishing five observation sites in the Tropical Western Pacific locale to provide data to better understand the effects of clouds and water vapor on the earth's radiation budget and to improve parameterizations in climate models. Each site will be equipped with an Atmospheric Radiation and Cloud Station (ARCS). An ARCS is a self contained semi-autonomously operating set of meteorological instruments, data acquisition systems, monitoring and control systems, communications systems, and support equipment.

The first site in the TWP began operating in Manus Province, Papua New Guinea, in October, 1996. The second site is scheduled to be installed on Nauru in the Spring of 1998. Subsequent sites are planned for a location near the equator in the eastern portion of the locale and at locations north and south of the equator in the central portion. It is hoped to have all five sites operational by 2002. Educational program activities have begun at established sites and within the Pacific Basin.

ON SEA LEVEL CHANGES IN THE TROPICAL PACIFIC DURING EL NINO SOUTHERN OSCILLATION EVENTS

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The tropical Pacific ocean encompasses about half the circumference of the earth at the equator, and it is subject to dramatic climate variability on an inter annual time scale : the El Niño Southern Oscillation (ENSO) phenomenon. ENSO is concerned, in particular, with notable large-scale sea level changes that will be documented for the whole tropical Pacific during the 1979-1996 period covering numerous El Niño and La Niña events. The sea level changes are derived from 0/450 dbar dynamic height anomaly issued from an objective analysis of XBT temperature data.

The ENSO-related sea level changes are schematically concerned with two types of movements appearing somewhat like zonal and meridional "seesaws". The zonal "seesaw", in near-equilibrium with the zonal wind stress, concerns chiefly the equatorial band : it is characterized by anomalously low (high) sea level in the west lagging by about half a year behind anomalously high (low) sea level in the east during El Niño (La Niña). Interestingly, the sea level changes extend off the equator in the west reflecting the role of ENSO-related changes in the curl of the wind stress. The meridional "seesaw", which lags by about one year behind the Southern Oscillation Index, consists of out-of-phase variations between the regions situated north and south of about 5°N, with the main changes happening in the western-central equatorial basin. The double "seesaws" result in a longitudinal mean sea level rise (drop) within about 5°N-20°S up to the mature phase, and not just till the beginning, of El Niño (La Niña), partly compensated by a longitudinal mean sea level drop (rise) within about 5°N-20°N. Our sea level analysis offers an observational basis for testing theoretical ideas dealing with the possibility of ENSO precondition and predictability.

PILOT PHASE JOINT IMPLEMENTATION PROJECTS IN THE PACIFIC ISLANDS

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Joint implementation provides a potentially cost-effective way of reducing global emissions, while also offering benefits to the host nation the form of additional technology and infrastructure development. With funding from the Australian Department of the Environment Sport and Territories (DEST), the South Pacific Forum Secretariat is implementing a Pilot Phase Joint Implementation (JI) program comprising two projects involving demand-side management and renewable energy. the Program reflects the Australian Government's interest to develop understanding and acceptance of the concept of JI.

The benefits of the JI program are seen as an opportunity to develop and to test prospective criteria for joint implementation, to inform Australia's views on the form and nature of an international JI scheme and to contribute to the development of internationa criteria for joint implementation.

DEST invited project proposals from Australian industry and the following two projects were selected : an air-conditioner efficiency project being undertaken by SRC International in the Solomon islands and a grid-connected photovoltaic project being undertaken by BP Solar in Fiji. the projects commenced in the first quarter of 1997 and are being carried out with the cooperation on the energy departments and the power utilities in each of the countries. The resulting savings in diesel fuel and the associated reduction in CO2 emissions will be monitored. Although the projects implementation and official monitoring are scheduled to conclude in mid 1998, it is anticipated that the project benefits and savings will continue to accrue into the future.

Key words : Joint implementation, demand-side management, air conditioners, renewable energy, grid connected photovoltaic, CO2 emission.

ANALYSIS OF CLIMATE CHANGE AND SEA-LEVEL VULNERABILITY : SUVA, VITI LEVU, FIJI

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Viti Levu is the largest of the Fiji Islands and the Suva Peninsula is the most populous urbanised area on Viti Levu. Suva is the capital of Fiji and the transportation hub for much of the South Pacific region. It is therefore a prime candidate for vulnerability assessment in the context of anticipated climate change and rising sea level.

To investigate the effects of water-level changes due to storms, tides and geenhouse-induced sea-level rise, a geographic information system (GIS) was used to incorporate coastal mapping, nearshore and onshore attributes and water-level information. Coastal mapping along this highly developed stretch of coast was aimed at establishing nearshore and foreshore slope, backshore elevation, beach and reef-flat condition, mangrove extent, and types and status of human-built structures.

Most of the downtown core and sections of associated residential areas are located on reclaimed land within a few metres above present mean sea level. The natural shoreline has been largely supplanted by sea walls and revetments. This project has documented the elevation, construction, and state of repair of these structures, and their relation to other foreshore features. Substantial sections of existing shore protection are degraded. Much of the shoreline (especially on the eastern side of the peninsula) shows evidence of erosion.

Tidal records were used to establish short-term sea-level trends and to evaluate the water levels associated with storm surges generated by tropical cyclones. The water-level record is highly variable because of seasonal, annual and interannual changes. These reflect both astronomical effects and climatic influences such as El Niño and the Southern Oscillation [ENSO]. Sea-level scenarios were chosen based on the trend of tidal records, coupled with the most recent estimates of global sea-level rise as provided by the IPCC. The following four sea-level scenarios for the year 2100 were evaluated : +0.00 m, +0.25 m, +0.50 m, and +1.00 m. Storm surge return intervals were calculated based on existing water-level data.

A spreadsheet-based storm-surge model was used to produce estimates of water-level elevations at the shoreline. A database structure was devised to permit geographically-based queries about inundation potential around the coast. A vulnerability index was tabulated based on the conditions under which the existing shore zones would be overtopped by a range of storm-surge heights and sea levels. In general, physical vulnerability increases from the downtown core to the east (toward the Rewa Delta) and, to a lesser extent, to the west (toward Lami). This is a function of the degree of protection from locally generated waves, the water depth in the harbour, and the height of the shore protection. Moving east from the downtown area, more wave setup over the reef and increasing wind setup increase the storm-surge height, while shore-protection elevations decrease and the state of disrepair increases.

The elevation of the backshore plays a role in the vulnerability as well. While we lack sufficiently detailed topography to estimate inundation limits, the presence of extensive low land (mangroves and other land surfaces <2 m above present mean sea level) is considered to increase

the vulnerability of an area. Limitations of this approach, common in Pacific Island nations, involve the lack of digital data on existing environmental conditions, population distribution, property values, infrastructure, and other key parameters and the scarcity of topographic maps and bathymetric charts at appropriate scales.

In order to address the question of vulnerability to sea-level rise, it is essential first to address vulnerability to extreme events under present conditions. While adequate levels of understanding and disaster preparedness are in place in some developed countries, this is often not the case for developing nations like Fiji and other Pacific Island states. It is therefore critically important that nations in the region develop an integrated plan for coastal management and for risk assessment and mitigation of coastal hazards under present conditions. Once these issues are addressed, the vulnerability to future environmental scenarios, whether artificially induced or natural, can be investigated more thoroughly.

EUROGOOS : POUR UNE CONTRIBUTION EUROPÉENNE AU SYSTÈME MONDIAL D'OBSERVATION DES OCÉANS

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Dans la stratégie de mise en oeuvre du GOOS il est recommandé d'utiliser les structures existantes notamment au niveau régional (IOC-WMO-UNEP/I-GOOS-III/12 Paris 13 juin 1997). La création de l'association EuroGOOS est un exemple d'initiative prise à titre privé pour répondre à cette recommandation. Les fondations d'EuroGOOS reposent à la fois sur la tradition historique des pays européens en océanographie et sur les acquis récents de la politique de l'Union Européenne en matière de recherche et de développement. Les membres d'EuroGOOS coopèrent pour :

-identifier les priorités de l'Europe en matière d'océanographie opérationnelle et évaluer les bénéfices potentiels de son développement, en termes économiques et sociaux,

-développer les bases scientifiques et techniques nécessaires à la réalisation de systèmes opérationnels d'observation des océans,

-contribuer à la réalisation et au fonctionnement de système opérationnels d'observation au niveau régional en Europe et dans les autres régions du monde.

L'Océan Pacifique joue un rôle important dans les échanges de matière et d'énergie qui régissent les grands équilibres de notre écosystémes terrestre ; ceci à l'échelle globale mais aussi, et plus intensément, à l'échelle des écosystémes insulaires spéciques de la région. L'océan est aussi un élément fondateur important des cultures et des économies pour tous les petits Etats et Territoires Océaniens. Pour ces deux raisons il apparaît que leur participation à la réalisation du GOOS est indispensable tant pour ce qu'il apporteront à sa réalisation que pour les bénéfices qu'ils pourront tirer de ses résultats. Dans la région du Pacifique Sud, ces Etats et Territoires ont des relations historiques ou récentes, établies bilatéralement ou multilatéralement avec l'Europe. La volonté exprimée d'EuroGOOS de contribuer à la réalisation et au fonctionnement de systèmes opérationnels d'observation au niveau régional non seulement en Europe mais aussi dans les autres régions du monde devrait donc s'exprimer de façon particulièrement forte dans la région.

CENTURY TO ANNUAL SCALE SEA-LEVEL CONTRIBUTIONS FROM ANTARCTICA

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Over the last few decades there has been great debate over the present mass balance of the Antarctic ice sheet, and whether Antarctica is contributing excess meltwater to the global oceans. In addition it has also been postulated that the potential exists for a rapid collapse of the West Antarctic ice sheet which would lead to an additional ~1-2 m of global sea-level. There has been considerable research conducted over the last 20 years to attempt to resolve these issues, and determine whether the state of Antarctic mass balance is a serious threat to the future of the Pacific Islands and other low-lying regions on Earth. This research has been fostered by an initiative through the SCAR Global Change Programme (GLOCHANT). This paper will attempt to provide an update on knowledge of the present Antarctic mass balance from : ground measurements, atmospheric modelling and analyses, and satellite remote sensing, and ; comment on whether Antarctica is contributing to a contemporaneous sea-level rise or fall component. The mass balance of Antarctica is principally controlled by the rate at which snow accumulates on the ice sheet surface, since the ice sheet responds slowly to changes in snow accumulation and temperature. Long reaction times (15 to 40 ka) of the ice velocities in central East and West Antarctica to climatic warming and increased snow accumulation, have resulted in ice thickening of 100-200 m during the Holocene. It is suggested that Antarctic ice volumes may have increased by 0.7 m of equivalent sea-level during the last 4,000 years. This increase in the ice volume would have contributed a simultaneous relative lowering effect on global sea-level. Atmospheric modelling and analyses, together with repeat satellite altimetry measurements of the ice sheet surface indicate that this trend is probably continuing today with ~0.2 to 0.6 mm/a of sea-level being removed from the global oceans and stored in the Antarctic ice sheet over the last century. Interannual climate variability associated with the Antarctic Circumpolar Wave may superimpose on this trend a variable global sea-level contribution of ±1.2-1.5 mm/a. Therefore it is probable that Antarctica is currently and will be for the next century, a net sink for sea-level rather than source of sea-level rise.

MONITORING SEA LEVEL IN THE TROPICAL PACIFIC FROM OBSERVATIONS AND MODELS

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Numerical models are now able to produce a reasonably faithful representation of the time evolution of the three-dimensional evolution of the ocean circulation at relevant dynamical scales. This is particularly true for sea-level which integrates a large part of the ocean dynamical properties over the whole water column.

Observations from the French/US Topex/Poseidon and the European ERS satellites provide basin-scale sea level measurements in near real-time. In-situ sea level measurements are also available in various locations, including tide gauges station and open ocean TAO moorings.

A specific research is conducted at ORSTOM, Nouméa, in order to combine all the complementary sea level information to construct a high resolution picture of sea level changes. Sophisticated mathematical techniques, known as data assimilation, are used to optimally derive real-time ocean evolution.

A new approach of assimilation based on the Kalman filtering technique has been implemented to blend data and model informations. First results will be shown based on the use of Topex/Poseidon data assimilated in a primitive equation model of the Pacific equatorial region between 30° N and 30°S.

NATIONAL CLIMATE CHANGE POLICY AND PROGRAMME

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In 1990 the Intergovernmental Panel on Climate Change (IPCC) recommended that nations having low lying areas vulnerable to the effects of predicted sea level rise should develop and implement national coastal zone management plans by the year 2000. This recommendation was adapted by the United Nations General Assembly and the 2nd World Climate Conference on Climate Change (UNFCCC).

In 1992 Fiji signed and ratified the agreement under Agenda 21, Article 4 of the UNFCCC. As part of the obligation under this agreement the following subtasks were carried out on Suva and mainly on the island of Ovalau off the Eastern coast of the main island of Viti Levu.

Subtasks :

(i) Vulnerability and Adaptation Assessment of Suva Peninsula Area aimed at collecting data that should reveal shore response and it's vulnerability to predicted sea level rise.

(ii) Study of coastal structures in Fiji by Mineral Resources Department to assess coastal structures and predict impact of any sea level rise and the extent of foreshore reclamation.

(iii) Survey of elderly people in coastal villages of Ovalau, by Department of Environment and University of the South Pacific to collect baseline information on changes and coastal forms in the absence of qualitative scientific data.

(iv) Survey of coral reefs around Ovalau by a private biological consultant company to assess present states in terms of species composition and support of other life forms within the coral reef ecosystem.

(v) Study of the Land Capability of Ovalau by Department of Agriculture Landuse Section to look at potential agricultural land in a systematic arrangement of different type and section that will determined their capacity for permanent sustainable production.

(vi) Integrated Resource Coastal Zone Management Workshop showed that due to Fiji's intricate land tenure system many problems arise in this development model based on a "top down approach". Department of Environment aim was to focus on "bottom-up approach" as a mechanism for more integrated approach by all partics involved whether government, non-government, private or rural community in facilitating development process and its implementation.

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There are identified policies, strategies, law and regulations at both the Federal and State level that are used and can be used to support planning for the future climate change. In addition, there are identified gaps, problems, and blockages to Climate Change adaptation and mitigation planning in the laws and regulations as well as in the structural and functioning of the government. Islands nations such as the FSM will be particularly vulnerable to global warming and accelerated sea level rise. Climatic Changes are expected to impact many resources within the FSM, including agriculture, forests, and water resources which will also affect the overall economy of the Federal as well as the States. However, the greatest impact will likely be felt in the coastal areas, as a result of increased inundation, erosion, and flooding due to higher sea levels. The capacity of the States and National Governments to plan for future impacts of sea level rise has to be recognized and prepared ways to minimize these climate change impacts.

MONITORING THE TROPICAL PACIFIC OCEAN FOR CLIMATE ISSUES

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The inter-tropical Pacific is particularly contrasted : the western part happens to be the oceanic area of the planet where rainfall is most abundant which result in a marked lowering of surface salinity (the "Fresh Pool"). It is also the place where the warmest waters in the upper layer are found usually refferred to as the "Warm Pool". The eastern part is characterized by strong easterly winds driving an intense equatorial upwelling cooling the surface layers.

Description and analysis of temperature, salinity and currents and of their seasonal and inter-annual variations are essentail for understanding the influence of oceans on global climate.

In 1969 ORSTOM started observational networks based on commercial vessels. They provided surface observation of temperature and salinity from bucket samples. Since 1979 the 0-700m upper layer temperature distribution XBT profiles allowed subsurface temperature survey. Automated measurement of surface temperature and salinity was developped in 1990 on commercial vessels and at coastal stations.

The development of these ORSTOM networks and the main results such as the ENSO related distribution of water masses like zonal displacement of Warm and Fresh pools are presented.

EMERGING PROGRAMS FOR APPLICATIONS OF EL NINO-SOUTHERN OSCILLATION (ENSO) PREDICTION AND MONITORING, FOR THE BENEFIT OF AFFECTED SECTORS IN THE PACIFIC ISLANDS REGION

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The El Nino-Southern Oscillation (ENSO) climate cycle has come to be recognized as a major source of seasonal to inter-annual variability in oceanic and atmospheric conditions, often leading to weather-related disasters and other ecological and economic impacts in many areas of the globe. ENSO-related variability is especially high in the tropical Pacific islands, where this climactic phenomenon is effectively "centered". International investment over the past 10-20 years in scientific programs aimed at greater understanding of the ENSO cycle has resulted in enhanced observing systems for real-time oceanic and atmospheric data, and improved capacities for climate monitoring and more skillful predictions of ENSO-related natural variability in climate. Such advances provide an opportunity to apply this information for the benefit of affected economic and environmental sectors in several regions of the globe, including the tropical Pacific islands. This presentation will discuss the emerging international and regional programs aiming to develop routinely available information resources, including monitoring and advance prediction of ENSO events, in support of applications of this information to affected sectors of the Pacific islands.

THE NEW ZEALAND CLIMPACTS MODEL AND ITS APPLICATION FOR IDENTIFYING CRITICAL THRESHOLDS

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Climatic variability plays a large role in the year-to-year variations of agricultural production in New Zealand. In the future, changes in climate could have far-reaching implications for the spatial patterns of agricultural land use and for yields and production levels. In order to examine the sensitivity of both managed and unmanaged environmental systems to climate variability and change, an integrated assessment model (IAM) has been developed for New Zealand. The CLIMPACTS system includes a global climate model, a regional module for generating climate scenarios, and a set of linked horticultural, arable crop and grassland models for impact analyses. The CLIMPACTS system presently allows nation-wide, spatio-temporal analyses of potential effects, taking into account a baseline climatology and land-use capability, as well as site-specific analyses. In this presentation, the model system and the results of an application aimed at examining critical thresholds of climate change and impacts are presented and discussed.

CARBON FLUXES AND CLIMATE IN THE EQUATORIAL PACIFIC

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In the tropical Pacific, carbon fluxes within the ocean and between the sea and the atmosphere, are closely linked to the geographical extension of the equatorial upwelling. This oceanographic phenomenon is due to the divergence of equatorial surface currents which generates vertical transport of deep and cold waters, with rather high carbon dioxide (CO_2) and nutrients (e.g. nitrate, phosphate, silicate,...) concentrations, to the surface. It yields a double effect on the superficial and lighted surface layer : (1) export of CO_2 from the sea to the atmosphere because of differences in partial pressures between the two, the ocean being considered as a "source" ; (2) increase of CO_2 uptake by oceanic primary production (i.e. plant photosynthesis), thanks to the presence of nutrients in the lighted layer, a process known as the "biological pump" and the ocean being considered as a carbon "sink". From present carbon budget estimates, it appears the equatorial upwelling is a "source" of CO_2, in spite of its enhanced primary production.

On a global scale, the Pacific equatorial upwelling covers most of the total "source" area on Earth, but it varies interannually in association with the El Nino-Southern Oscillation (ENSO) events. Thus, during El Nino periods, geographical extension of the upwelling is minimum ; so is CO_2 export from the ocean. This case has been observed during the 1991-1995 period on atmospheric records. On the contrary, during La Nina periods (e.g. the 1996 year), extension of the upwelling is maximum, leading to a greater CO_2 export flux to the atmosphere.

An important international research effort has been made in the 1990-1996 period in the frame of JGOFS (Joint Global Ocean Flux Study). Its purpose was to determine the main processes taking place in the biological pump and air-sea exchanges. However, the geographical extension of the upwelling, which can be tracked by pigment concentrations, has been poorly surveyed, mainly because of the lack of satellite devoted to oceanic primary production. NASA SeaWifs satellite, which is just about to be launched, should fill this gap.

CLIMATE INFORMATION AND PREDICTION SERVICES - CLIPS

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The Twelfth World Meteorological Congress in June 1995 recognized that important advances had been occurring in science and climate services. Of particular interest were the capability to exchange this information in near-real-time through modern communication technologies, and new capabilities and opportunities for climate forecasting for selected periods and regions. Congress asserted that the provision of current climate information and predictions would improve economic and social decision making and that this would support sustainable development. Therefore, Congress decided to advance the development of the concept and action plans for Climate Information and Prediction Services (CLIPS) as a major project in the World Meteorological Organisation (WMO) Long-term Plan for 1996-2005.

The primary objective of the CLIPS project is to develop the capacity of the National Meteorological and Hydrological Services (NMHSs) to take advantage of the recent advances in the science of climate and in the processing and delivery of climate information, and to pass on the benefits of the improved climate services to the user community. Following the planning phase, which included formulating the CLIPS concept and conducting expert missions, the project moved into the implementation phase with the launching of activities within the project's four components : training, demonstration/pilot projects, liaison with research programmes, and networking. This paper focuses on the implementation activities that are particularly relevant to the South Pacific Regional Environment Programme (SPREP).

IMPACTS DE L'OSCILLATION DU CLIMAT SUR LES PÊCHERIES DE THON DANS L'OCÉAN PACIFIQUE

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Les thons de surface, principalement la bonite ou listao (Katsuwonus pelamis) constituent l'essentiel des captures de thonidés dans l'océan Pacifique qui fournit annuellement près de 70% des prises mondiales. Bien que cette espèce soit présente de l'équateur aux zones subtropicales, le gros des captures provient du Pacifique équatorial ouest (la warm pool), région qui constitue le plus grand réservoir de chaleur de la planète et qui joue un rôle majeur dans les phénomènes climatiques, notamment l'oscillation El Niño (ENSO). Cette région est également caractérisée par une faible production primaire apparemment difficilement conciliable avec la présence du plus important stock mondial de thons. La mise en évidence d'une relation étroite entre les mouvements du maximum d'abondance des bonites et les déplacements, associés au phénomène ENSO, d'une zone de convergence sur le bord Est de la warm pool (Picaut et al. 1997) semble constituer un mécanisme essentiel au maintient du stock de thons de surface dans la warm pool (Lehodey et al. submitted). Un modèle numérique est développé pour étudier l'influence de la circulation océanique sur la distribution de la nourriture potentielle des bonites (Lehodey, submitted). Le modèle simule la redistribution de la production primaire (concentration de pigment du phytoplancton mesurée par satellite) par les courants océaniques de surface. En dépit de la simplicité du modèle et des limitations inhérentes aux données, l'indice de nourriture potentielle des thons de surface fournit une explication plausible de la distribution générale des captures dans le Pacifique. En accord avec les observations précédentes, il permet de proposer un mécanisme d'enrichissement secondaire de la warm pool susceptible d'expliquer le maintien d'une biomasse élevée de thonidés dans des eaux de faible productivité primaire. Ce type de modélisation devrait s'avérer très utiles à l'avenir dans les études d'impacts de changements climatiques sur les distributions et mouvements des populations de thonidés.

THE IMPACT OF PALAEOCLIMATE CHANGE ON GROUNDWATER QUALITY ALONG THE KENYA COAST

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The impact of palaeoclimate change on groundwater quality along the Kenyan coast has been investigated with particular reference to the south coast. The area under investigation lies between Mombasa Island to the north and Kenya Tanzania border to the south. It is bounded by latitudes 4° 45° south and longitudes 39° 00 and 39° 45' east. The area has experienced a number of palaeoclimate changes which have influenced sea level fluctuations between Triassic and Quaternary Periods. The fluctuations have occasioned deposition of various sedimentary rocks which have significant influence on groundwater quality. The results of data analysis of water samples from boreholes, wells and springs in the investigated area have indicated that unconsolidated Kilindini Sands of Quaternary Period have the best water quality and the Maji ya Chumvi Shales of Permo-Triassisc Period have the poorest water quality. Water of intermediate quality is associated with consolidated Mariakani and Mazeras Sandstone Series of Triassic Period and Coral Reef of Quaternary Period. On the basis of the aforesaid findings, a number of recommendations have made. These include detailed analysis of aquifer characteristics of Kilindini Sands which are a potential sustainable source of groundwater along the coast, sea water intrusion into the Lagoonal Sands and possible measures to avert it, mode of occurrence of springs along the beach at the low tide and sand dune aquifer along the coastline.

IMPACTS, ADAPTATIONS AND MITIGATION OF CLIMATE CHANGE : IPCC WORKING GROUP II REPORT AND CONCLUSIONS

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In December 1995 the Intergovernmental Panel on Climate Change (PICC) completed its Second Assessment Report. The largest contribution of the three working groups was that from Working Group II (WGII) whose charge was to review the state of knowledge and socio-economic sectors, as well as reviewing available information and the technical and economic feasibility of potential adaptation and mitigtion strategies. The WG II report is 829 pages long and consists of introductory "primers" on ecological systems and energy production and use ; 25 chapters on impacts, adaptations and mitigation options to a wide range of ecological systems and socio-economic sectors and activities ; and, in the appendices two sets of guidelines or methodologies for assessing the potential efficacy of adaptation and mitigation strategies, and an inventoty or technology data bases and information.

The report addresses the potential sensitivity, adaptability and vulnerability of ecological and socio-economic systems - including hydrology and water resources management, human infrastructure and human health - to changes in climate and sea level. With respect to vulnerability the report concludes that :

- Human-induced climate change adds an important new stress to the many ecological and social-economic systems already affected by pollution, increasing resource demands and non-sustainable management practices ;
- Most systems are sensitive to the magnitude and rate of climate change ;
- Impacts are difficult to quantify and existing studies are limited in scope, mainly to an arbitrary doubling of CO_2
- Successful adaptation depends upon technological advances, institutional arrangements, availability of financing and information exchange ;
- Vulnerability increases as adaptive capacity increases, which implies that some systems including low-lying coastal areas and small islands are more vulnerable to climate change (and often other natural hazards) ; and that,
- Unambiguous detection of climate-induced changes in most ecological and social systems will prove extremely difficult in the coming decades, and that the actual outcomes will include surprises and unanticipated rapid changes.

The report deals with : terrestrial and aquatic ecosystems including forests, range lands, deserts, cryosphere, mountain regions, lakes, streams and wetlands, coastal systems and oceans as well as with hydrology and water resources management, food and fibre, human infrastructure and human health. Specific topics of relevance to the Pacific islands are identified and discussed as are references to studies undertaken in the region that are cited in the report.

COP3 PREPARATION

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The Government of Japan (GOJ) has been promoting the preparation for the Third Meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), together with the UNFCCC Secretariat. COP3 will be held from 1 through 10 December 1997 at Kyoto International Conference Hall, Kyoto, Japan. Ministerial segment is scheduled to be held on the last three days, i.e., 8-10 December. Several thousand participants, observers and media people are expected to attend COP3, and various relevant events, such as technology exhibitions, workshops/meetings by business communities, local governments and environmental NGO's, are planned just prior to and during COP3, in Kyoto and in some citics near to Kyoto. Detailed information on the progress of preparation will be presented at the Meeting.

VULNERABILITY OF ISLAND COUNTRIES IN THE SOUTH PACIFIC TO SEA LEVEL RISE AND CLIMATE CHANGE AN OVERVIEW OF JAPAN/SPREP VULNERABILITY AND RESILIENCE STUDIES

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A series of studies to assess the vulnerability of the island countries in the South Pacific have been carried out under the collaboration of Japan and SPREP for the past six years. The case study countries were Tonga, Fiji, Western Samoa, and Tuvalu. During the studies, vulnerability and resilience of the coastal systems and socio-economic conditions were identified for each country. Villages in low-lying coastal areas are already sensitive to the erosion of land, storm surges, and, sometimes, tsunamis. In addition, new methodologies were developed to evaluate overall vulnerability using GIS or semi-empirical criteria. An overview of these studies will be presented to show the characteristics of the vulnerability and resilience of the region.

SOUTH PACIFIC SEA LEVEL AND CLIMATE MONITORING PROJECT IMPLEMENTATION OF TOPEX/POSEIDON ALTIMETRY TECHNOLOGY AT THE NTF IN 1997

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NTF has implemented the TOPEX/POSEIDON technology to complement observations from an array of eleven SEFRAME (SEA Level Fine Resolution Acoustic Measuring Equipment) tide gauge stations to investigate sea level variations.The T/P altimetry programme at the NTF runs under the umbrella of the South Pacific Sea Level and Climate Monitoring Project which is a long term programme sponsored by the Australian Agency for International Development (AusAID) for a precise monitoring of the secular sea level change at elevenSouth Pacific Forum member countries. The confirmed excellent operation of T/P and a decision to go ahead with the Jason mission in 1999 make the altimetry operational. At the end of the nominal mission in 1995, the Science Working Team (SWT) agreed on a number of improvements and to reprocess data (GDR-M version C). It can be envisaged that it would be possible to derive sea level variations to within 2mm a year. These encouraging results in accuracy and the Jason mission in the near future confirm that the NTF must keep the altimetry programme going. The firstfour years (1992-1996) of T/P mission provided the NTF Pacific Project with the opportunity to reliably quantify some of the features of the South Pacific sea surface dynamics. Implementation and routine processing of altimetry technology pose a challenge because of a considerable amount of data. Also, the increasing need to visualise varying sea surface topography and to investigate sea level variations demanded software which could facilitate the reprocessing of the current release of the new generation AVISO GDR-Ms version C datasets. To facilitate the potential applications of the new data the NTF has evaluated available software, both commercial and research-oriented and concluded that Generic Mapping Tools (GMT) will provide sufficient capabilities to support processing and visualisation.By implementing GMT the NTF has benefited in the field of rapid data manipulation and visualisation. GMT software is used to create, read, filter and perform mathematical operations on files. The resulting files can then be used to produce plots, including 2-dimensional surface plots of T/P altimetry data. Modern methods of producing, analysing and visualising T/P altimetry data place significant demands on an effective output format.In general, the following objectives must be met to efficiently manipulate, analyse and display T/P altimetry data :

- Ability to extract small subsets of data without reading an entire file.
- Algebraic operations on NetCDF grid files.
- Filtering of spatial data and computing gradients.
- Visualisation of the results using high quality colour graphics.

This presentation will highlight a number of applications of GMT for T/P data processing and visualisation. We suggest the use of GMT to facilitate the processing of T/P data and to rationalise the usage of computer resources.

THE SOUTH PACIFIC SEA LEVEL AND CLIMATE MONITORING PROJECT

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The South Pacific Sea Level and Climate Monitoring Project was established in 1990 in response to concerns raised by members of the South Pacific Forum. It was to address the potential impact of global warming on sea level and climate of the region. The project is supported by AusAID under the multicountry program and is managed by the National Tidal Facility at the Flinders University of South Australia.

To date there are major achievements including that eleven SEAFRAME stations are now in operation, a calibration, maintenance and survey routine has been established ; data acquisition systems run efficiently, data processing is now routine and several information and training workshops have been held. There are also ten locations where real-time displays are installedwith the last one planned for October.

Results from the project will be presented, including assessments of the trends in sea level compared to the regional and global averages and some comparisons to satellite altimeter data will be made. The trends from the gauges are generally higher than expected and the reasons for this will be examined. Interannual variability will be seen to be the major contributor to this rise, and the altimeter results reflect the gauge results.

SKILL AND REPRODUCIBILITY OF THE INTERANNUAL VARIABILITY IN THE SOUTHERN

PACIFIC USING GCMS

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The skill and reproducibility of the interannual variability of the precipitation is analyzed in various regions using covariance analysis techniques of numerical simulations. The results are based on an ensemble of three experiments for the period 1961-1994 perfomed with the a T30 spectral resolution version of the ECHAM4 general circulation model developed at the Max-Planck-Institut currently utilized at IMGA in Italy. The simulations are forced by prescribed monthly means SST distribution compiled at the Hadley Center, the GISST 2.1 data set.

The analysis is performed to assess the skill of the model in terms of validation of spatial variability patterns between observations and model and interms of correlation of time series of cavarying modes. The skill of the simulations can be estimated by performing an SVD analysis between the time series of observations fields and simulated fields, to extract the component of the model variability that is captured by the model. The reproducibilty can be assessed bt performing an SVD among the member of the ensmeble themselves to assess the amount of variability that is covarying.

Results indicate that the area of potential predictabilty include the tropics and the Caribbean, with local intensification of skill over the Pacific, South AMerica and the Gulf of Guinea.

IMPACTS A ATTENDRE D'UNE ELEVATION DU NIVEAU DE LA MER SUR LES COTES DE LA FRANCE METROPOLITAINE ET DES DOM-TOM

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Les conséquences probables de l'élévation du niveau de la mer que l'on prévoit pour le siecle prochain sont les suivantes : aggravation des submersions sur les cotes basses, accélération des érosions, renforcement des phénomenes de salinisation.

Les espaces deltaiques, les littoraux à lagune, les marais maritimes, les récifs coralliens apparaissent particulièrement menacés par la submersion. La vulnérabilité de la camargue tient en particulier à sa subsidence qui n'est plus compensée depuis que la charge solide grossiere du Rhone a été considérablement réduite par la multiplication des barrages et que les débordements du fleuve sont empêchés par son endiguement. On peut donc prévoir une extension des plans d'eau salée au sud de l'étang de Vaccares ainsi qu'en arrière des pointes de l'Espiguette et de Beauduc. Sur le littoral du Languedoc, il faut s'attendre à l'ouverture de nouvelles passes mettant en communication avec la mer des lagunes dont la maritimisation sera alors accrue. En revanche, tout indique que, sur les marais maritimes de la cote de la Manche et de celle de l'Atlantique, la sédimentation vaseuse verticale et latérale dont ils sont l'objet devrait largement compenser l'élévation attendue du niveau dela mer. Les projets d'extension urbaine ou industrialo-portuaire menacent davantage leur existence. Il en va de même pour la plupart de mangroves des DOM-TOM. La vase abonde sur le rivage de la Guyane et, ailleurs, l'érosion des sols favorise l'envasement des rivages, comme à Mayotte ou la vie corallienne régresse en faveur des palétuviers. Quant aux récifs coralliens, la croissance verticale des coraux devrait éviter leur submersion, sauf là ou des actions anthropiques (pollution et turbidite des eaux) pourraient la ralentir. Il convient aussi de prendre en compte l'accroissement de la température des eaux, lui-même lié à une accentuation de l'effet de serre, pouvant conduire au blanchissement des coraux et à une plus forte cyclogenèse à l'origine d'un amoindrissement par érosion des iles sableuses des atolls.

Les phénomènes d'érosion seront logiquement accélérés sur les falaises à recul rapide, comme celles du pays de Caux, puisque l'augmentation de l'épaisseur de la tranche d'eau diminuera le freinage des vagues par réfracion à proximité du littoral. De même, le démaigrissement des plages, déjà très généralisé et dû pour l'essentiel à un déficit en sédiments, sera accentué, en particulier sur la longue côte sableuse d'Aquitaine.

Les phénomènes de salinisation seront renforcés das les estuaires. le recours à un modèle numérique a fait apparaître que, dans le cas de la Loire, par une marée de vive-eau et un débit d'étiage du fleuve de 150 m3/s, une élévation du niveau de la mer de 0,60 m entrainerait une migration vers l'amont du front de salinité de 1 km.

Les dégradations constatées sur les rivages marins sont à mettre avant tout au compte de leur mauvaise gestion par l'homme et on a eu sans doute tendance à exagérer l'ampleur des effets négatifs sur les littoraux de l'élévation attendue du niveau de la mer. Cela dit, on ne peut pour autant les négliger aujourd'hui dans l'élaboration des schémas d'aménagement des littoraux.

THE AUSTRALIAN OZCLIM MODEL AND ITS DEVELOPMENT FOR HYDROLOGICAL IMPACT ANALYSES

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The OzClim model is in its formative stages of development. Rapid progress has been made in development of a climate change scenario generator, and attention is now being turned to the development of sectoral models for impact analysis. Since water is crucial to land use in Australia, one of the first efforts will be the incorporation of hydrological models for watershed analyses into OzClim, building on models developed and tested by DAR and collaborators for the regions of Australia. The purpose of these integrated modules will be to examine both the effects of climate variability and change on water resources, including extreme events, as they relate to the land and water management. In this presentation, the OzClim model is briefly presented, along with relevant hydrological models and their applications.

POLICY RESPONSE TO CLIMATE CHANGE IN NEW ZEALAND

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The New Zealand Government recognises the risks posed by global climate change, and is developing a comprehensive strategy on climate change to address emissions of all greenhouse gases and to protect and enhance greenhouse gas sinks and reservoirs. As part of its reporting requirements under the Framework Convention on Climate Change (FCCC), New Zealand produces a national greenhouse gas inventory annually.

Policy measures have concentrated on reducing the growth rate of carbon dioxide emissions, and include voluntary agreements with industry, and energy efficiency measures. Carbon dioxide removal by planted forests is a central part of New Zealand's approach to mitigating carbon dioxide emissions. New Zealand's policy approach also recognises the importance in its own emissions profile of other greenhouse gases, in particular, from the agricultural sector.

New Zealand recognises that commitments under the FCCC relate not just to addressing greenhouse gases, but to a range of other matters including contributions to the financial mechanism of the FCCC (the Global Environment Facility), actions taken to prepare for the impacts of climate change, and contributing to the scientific understanding of climate change. Climate change impacts on New Zealand have been assessed using a scenario approach, and some initial actions taken to adapt to the likely impacts of climate change.

START AND APN ACTIVITIES RELATING TO THE PACIFIC REGION

N. QUINN

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Australia

START – the SysTem for Analysis, Research and Training – provides a framework of regional networks for training and research on global environmental change and its human causes and effects. It has been established by the three global change research programmes – the International Geosphere-Biosphere Programme (IGBP), the World Climate Research Programme (WCRP) and the International Human Dimensions of Global Change Programme (IHDP). It has a secretariat in Washington, and established regional networks in the Mediterranean, north Africa, southern Africa, south Asia, east Asia and south east Asia. A parallel inter-governmental effort, the InterAmerican Institute, performs similar networking functions in the Americas.

There has been interest in establishing a START Oceania regional arrangement for some time, with some preliminary studies arranged by people from New Zealand and Australia a few years ago.

Consultation recently in Fiji involving interested parties from several countries and organisations supported further development of the idea, with a likely further consultation meeting in Australia in January 1998.

START is a research community driven arrangement. To facilitate links with governments and to ensure a broader regional perspective it works closely with the APN – Asia-Pacific Network for Global Change Research.

The APN was established as an inter-governmental organisation to foster increased developing country capacity and involvement in global change research, following the White House Conference on Science and Economics Research Related to Global Change. The APN Secretariat is in Tokyo, Japan. Most countries in Asia and Australia and New Zealand participate in APN activities.

APN operates through scientific planning and inter-governmental decision making processes to develop a region wide program of scientific activity.

The APN provides a basis for support for global program activity at the regional level, fosters improved communication and networks in the region, and limited funds for workshops, project support and attendance at major international events.

Involvement in APN and START activities is one way to participate in the global programs and retain a regional focus.

As well as climate issues START and APN are concerned with global change generally – biodiversity, land use, land cover and land form changes, toxification of ecosystems by pollution and other atmospheric changes.

The APNN is interested in exploring how Pacific countries might participate in, and benefit from, its activities.

COLD ANOMALIES IN RECENT AND HOLOCENE SEA SURFACE TEMPERATURE DERIVED FROM CORALS RECORDS IN THE SOUTH WEST-PACIFIC

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Corals have been shown to be reliable indicators of past sea surface temperature (SST). The chemical composition of their aragonitic skeleton (trace elements such as Sr/Ca, or stable isotopes such as dO18) allows the quantification of seawater temperature with a precision better than 1°C and a monthly or sometimes weekly resolution.

Recent data on past SST derived from corals indicate that during the last glacial maximum, 20 000 years ago, the tropical ocean was cooler by 5 to 6°C. In Vanuatu, 10 000 years ago, SST were 6.5°C cooler than the present mean of 27.5°C. In the following 1500 years, SST rose abruptly by 4°C. We also know that SST was similar to present some 4200 years ago. This record from Vanuatu appears to be offset when compared to a SST record from Barbados, in the tropical North Atlantic. There, the deglacial warming of surface water which amounts to 6°C started some 14 000 years ago.

In Vanuatu, the SST reconstruction over several years dated around 4166 ±15 BP indicate an intriguing 4°C cold spell which probably only lasted for a year. What exactly caused this pronounced cold episode is not known, but it could be linked to ENSO like climatic fluctuations. However, during the last 40 years of instrumental records, the temperature anomaly linked to ENSO around Vanuatu never reached 4°C. Much more extreme ENSO situations would have to be invoked to explain such a large SST drop.

It is therefore crucial to better document the amplitude and frequency of regional climatic instability in the Pacific Ocean over the last 6000 years, which is a period considered to be globally stable and similar to the present day.

GCOS, GOOS AND GTOS - INTERNATIONAL COOPERATION FOR MONITORING GLOBAL CHANGE

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(To be presented at 3rd SPREP Climate Change and Sea Level Rise Conference, August 1997)

To detect and predict global climate change requires international cooperation in monitoring the earth's climate and the many processes that govern it. In 1990, the Second World Climate Conference recognised that observations and information about the climate system adequate to address the issue of climate change or its possible impacts were not available. It recommended the establishment of the Global Climate Observing System (GCOS), based on existing weather and ocean observing networks. In 1992 the United Nations Environment Programme (UNEP), the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) and International Council of Scientific Unions (ICSU) formally established GCOS to address the observational requirements for climate system monitoring and prediciton.

GCOS and the related Global Ocean Observing System (GOOS) and Global Terrestrial Observing System (GTOS), established for similar reasons, are together planning a "global observing system" to address the needs for data arising from concern over possible climate changes, and also the growing recognition that industrial development needs to be sustainable. The international planning process is well under way for GCOS and GOOS, with GTOS at an earlier stage, having been formally established only in 1996. Although planned and coordinated internationally, these systems require cooperative action by individual nations if they are to be successful.

Australia is planning its contribution to GCOS and GOOS through a Joint Working Group sponsored by Australian bodies corresponding to the international sponsors. The Joint Working Group is supported by two Expert Sub-Groups providing scientific advice. Scientific plans for an Australian contribution to GCOS and GOOS are well advanced, and means of their implementation are being considered. The approach being adopted is to build on Australia's existing capabilities in climate monitoring, enhancing them in ways which will better meet the goals of GCOS.

Regional initiatives, particularly in ocean monitoring, promise to provide more effective observing programs. An example is the North East Asian Region GOOS (NEAR-GOOS) program of China, Japan, the Republic of Korea and the Russian Federation. Opportunities for and advantages of such regional programs in the South Pacific will be discussed.

OBSERVED CLIMATE CHANGE AND VARIABILITY IN YHE SOUTH PACIFIC

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Instrumental records began in the region in the mid-nineteenth century. Only recently, however, has temperature and precipitation been brought together and rigorously analysed. The data quality is best in New Zealand because of the recording methods. Here air temperatures have risen by 1.1°C since the mid 1890s and sea temperatures over the surrounding oceans by 0.6°C. Over the South Pacific, north east of the South Pacific Convergence Zone (SPCZ) only began warming since the late 1970s, at the same time this region became wetter. In the region southwest of the SPCZ, the islands show similar trends to the marine regions around New Zealand. These trends are confirmed byanalyses of sea temperatures from the surrounding oceans. Over New Zealand the warming has been greater at night. In the South Pacific, the areas that have become cloudier, northeast of the SPCZ, show greater warming at night. Conversely, the region that has become less cloudy, southwest of the SPCZ, shows equal
warming between day and night.

The Southern Oscillation accounts for considerable interannual variability of climate. To the southwest of the SPCZ, El Nino (EL) episodes cause below decadal average temperatures and La Nina (LN) episodes above decadal average temperatures. To the northeast of the SPCZ EL events cause above above, and LN events below decadal average temperatures. EL events cause above average rainfall northeast of the SPCZ and below average rainfall southwest of the SPCZ. The more frequent EL events since the mid 1970s have influenced decadal rainfall trends, but have not influenced decadal temperature trends.

The trends have been caused by increasing atmospheric pressure in the western part of the South Pacific during the last four decades, and a movement eastwards of the average position of the SPCZ.

TROPICAL CYCLONES IN THE SOUTH PACIFIC REGION

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A survey will be made of the climatological characteristics of South West Pacific tropical cyclones. No two tropical cyclones are the same, but overall, some general patterns of behaviour may be distinguished. A brief summary of these patterns (the climatology) of tropical cyclones in the South Pacific will be given, in respect to season, location, typical tracks, changes from year to year, and long term trends. The major shifts in patterns of cyclones that occur as a result of the El Nino Southern Oscillation phenomenon will be described.

The impacts of climate change on tropical cyclone occurrence and intensity remained uncertain at the time of the recent IPCC Second Assessment Report. However, some changes are likely since climate models are predicting changes in the key factors in cyclone initiation and maintenance, such as atmopheric stability and ocean temperature, and recent Australian work suggests they may be 10-20% stronger under 2 x CO2 conditions.

CARBON OFFSET : AN OPTION FOR CARBON DIOXIDE MITIGATION AND ALSO AS AN ECONOMIC INCENTIVE FOR FORESTRY MANAGEMENT AND BIODIVERSITY CONSERVATION IN PAPUA NEW GUINEA

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Current approaches to implementing protected area systems and forest management in papua New Guinea appeared not to be progressing well as expected due to a number of reasons. The most obvious of these are the types of land tenure systems inherent in the country and the dilemma of satisfying the immediate Financial and material needs of the landowners.

Land of resource owners throughout the country have been led into believing that development means infrastructure development (roads and bridges), employment and money and as such consider conservation as being unrealistic in addresing these immediate needs. Further, the benefits from conservation are seen as rather too remote (global) and thus have no immediate impacts to them. How then can we foster the notion about conservation and sustainable forest development through appropriate management strategies in light of this dilemma ? We need to address "developmental " needs in all our conservation and forest management approaches.

One possible means that we can integrate development with conservation and forest management with the necessary funding would be through these innovative "carbon offset" projects being advocated for addressing the issue of "Global Climate Change". Thus, in this paper the concept of carbon offset and how this concept can be applied in PNG to assist in the efforts of forest conservationand management strategies, and in tum, conserve the country's biodiversity and sustain the forest resources are being discussed.

DEALING WITH CLIMATE CHANGE AND SEA LEVEL RISE IN THE PACIFIC : VULNERABILITY AND RESILIENCE IN TUVALU

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Pacific island countries (PICs) are highly vulnerable to potential impacts of climate change and sea level rise. They will be significantly affected by adaptations and response strategies they choose to pursue in reducing their vulnerability in the next fifty years. In recognition of the importance of climate change as an environmental issue and of the need to integrate climate change into environmental and economic development objectives, Tuvalu ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1993. Since then several studies have been undertaken to assess the potential impacts of climate change and sea level rise and to identify response strategies for coping with such changes in the future.

One such study was undertaken in Tuvalu during the period November 1995-September 1996, as a collaborative effort between SPREP and Japanese teams of researchers with expertise in climatology, coastal engineering and management, socio-economic development and geographic information systems applications. A number of methodologies employed reflects a wide-ranging but complementary expertise that was available for the study. The methodologies included, semi-empirical assessment, review of previous studies, open-ended interviews, assessment of physical conditions and potential damage assessments by GIS applications and use of engineering approach, cost-benefit analysis of socio-economic data sought through interviews with both government employees and the general population and several focus group meetings with Maneapas from the outer Islands based on Funafuti.

Climate change vulnerability and adaptation assessment of Tuvalu and a recent review of literature on the potential impacts of climate change and sea level rise in the South Pacific, suggests that the most significant impacts identified are grouped into four exposure units - coastal zone, water resources, agriculture and human health. These four exposure units are likely to remain a focus of major concern in Tuvalu in the future. Despite a strong commitment by national, regional and international organisations in identifying these impacts and proposing plans of action to mitigate these changes little has been achieved so far to enable Tuvalu to deal directly with its future environmental problems. National, regional and international efforts need to be directed towards the integration of global environmental issues into local management priorities. The problems and, or, constraints associated with such integration involve the political will, lack of country-specific information, ownership of climate-related issues, national development priorities (as opposed to international obligations) and the cost of adaptation burden. Finally, some attention is focused on future areas for research and assistance in enhancing the capabilities of Tuvalu in responding to climate change and sea level rise.

KIRIBATI CHANGING COASTAL PROCESSES

N. TEUATABO

Government of Kiribati
Ministry of Environment and Social Development

Indigenous knowledge and understanding of any aspect of the atoll coastal environment, ought not to be overlooked or dismissed as erroneous simply because they are not documented or if they do it is in a format and language not as precise as technical and scientific reporting. And, when indigenous knowledge of the local situation conflicts with a technical and scientific explanation, there ought to be an effort made to understand both and to come up with explanation of the differences between the two streams of opinions, based on different modes of knowledge acquisition. This is because if genuinely we believe that scientific knowledge as is being presented by creditable scientists is the nearest one can get to understand the real world, then should we not also try to hear what the local community know of their small part of the same world that we try to understand, often within the scientific paradigm and the theories and must have accumulated knowledge of the particulars of their place. What actually happens? In my experience in Kiribati, expatriate scientists and technical consultants who came to Kiribati to advice on physical processes had not sufficiently talked with elderly members of the community.

In this paper, I submit that indigenous knowledge of any coastal areas can provide invaluable source of data for any scientific research that seeks to understand the coastal dynamics of that particular part of the coastal area. Changes in coastal areas based on long term experience of having lived in Kiribati are described. Effects of these changes on the structural arrangements of the village and life of the peoples is explained, and I will then try to suggest that these changes are not fully explained by locally induced perturbations to the dynamics of the coastal areas but that they additionally result from the climate change and sea-level rise that has taken place.

COASTAL CHANGES IN KIRIBATI INDIVIDUAL'S OBSERVATIONS...

(N. TEUATABO

Government of Kiribati
Ministry of Environment and Social Development

Let me first acknowledge my gratitude to you all, especially to the organisers, the SPREP and also to Kiribati Ministry of Environment and Social Development for making this presentation possible.

Speaking as a lone NGO, I feel exceedingly privileged and sense real responsibility that I am to relate to you, distinguished audience, observations about the coastal areas in Kiribati by some of the old and young people from the local communities. The toic is "Coastal Changes in Kiribati - Individuals Observations".

The observations are very important and must be brought out into an open forum such as this. I really therefore appreciate your being understanding on this point and for permitting a somewhat unconventional presentation at this type of seminars.

There are suggested explanations and rationales for these observations and for traditional knowledge that the local communities possess. The aim is to show that they are additional relevant data for the scientific assessment of coastal erosion and process. The range of data for studying and assessing coastal erosion in Kiribati must be expanded, even to cover the knowledge, legend, belief held by, and of the local communities.

It is also expected that a gap exist between the scientists perspective of the world and that of the local communities. This gap should be bridged. In a way this paper is an effort also towards this aim. It is explaining the local communities views about coastal erosion to the scientists.

There is a need to involve local communities in any research designed to understand their immediate environment. In this way, and as the process of investigation and explanation of the local environment goes on, one may finally hope to arrive at a more realistic and understandable assessment from the viewpoint also of the local communities.

Geographical Setting

Kiribati are three groups of atoll islands, rising to less than a metre above high water marks in most parts of the atoll islands. They lie between 150° W to 170° E longitudes and between 5°N to 11°S latitudes (Wilson, 1994) in the middle of the Pacific Basin. From west to east they are : the Gilbert Group, the Phoenix Group, and the Line Group.

Kiribati lies to the south of the Marshall islands, whilst it also shares common ocean borders with Nauru to the west, with Tuvalu and the Cook islands to the south and, with the United States who owns a few islands near the Phoenix and the Line Island Groups.

PROGRESS AND ACHIEVEMENTS OF THE PACIFIC METEOROLOGICAL SERVICES PROJECT

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The Pacific Meteorological Services Project (PMSP), funded by AusAID, arose out of a concern on the part of the governments of the Pacific about the impact of enhanced greenhouse effect. A report undertaken by WMO, in close cooperation with SPREP, resulted in the publication of "The Changing Climate in Paradise" report, which recommended a number of projects in support of strengthening activities to ensure collection of quality climate data throughout the Pacific.

The PMSP was one such project taken up and funded by the Australian Government, with its implementation contracted to the Bureau of Meteorology. The scope of the project and a brief description will be circulated and addressed briefly, before moving onto the progress to date, major achievements and what remains to be done in the future.

The ten countries participating in the Project are : Niue, Fiji, Western Samoa, Cook Islands, Kiribati, Tuvalu, Papua New Guinea, Tonga, Solomon Islands and Vanuatu. Initially the aim was to inspect as many meteorological climate and synoptic stations as possible and to provide new and upgraded equipment where necessary. This was to be followed and supported by training in methods of observation and equipment maintenance to ensure meteorological parameters were being measured and recorded accurately.

Early in the implementation phase of the Project it was realised that each of the National Meteorological Services involved has individual features and administration and individual difficulties to face and consequently individual problems to be addressed in improving collection and archival of data for the climate record. The project attempted to address this issue by assessing these individual needs and shaping the program to best suit each situation. In many cases this meant addressing matters that were to some extent outside the defined scope of the Project, but which were essential to a successful outcome.

While the Project initially aimed to replace only meteorological instrumentation, in several cases it was necessary to upgrade communication links which were essential for the reliable and timely transmission of meteorological messages. In other cases power supply and/or reliability was a problem and uninterruptible power supplies were supplied to some of the more remote stations. Personal computers were supplied in some cases to enable the use of the CLICOM database to archive and analyse climate data. In a few cases filing cabinets and photocopy machines were bought and installed to facilitate data recording and collection. Other issues arose throughout the project to do with safety and where possible equipment and training was supplied to address these.

To implement the three components of the Project, the Bureau employed the expertise of three inhouse technical specialists. The assessment of observing sites and the supply of new and upgraded equipment was carried out over the first 30 months of the project by Peter Dawson. Towards the end of the period a technical engineering specialist, Kim Nitschke, undertook a mission to assess the maintenance requirements of more sophisticated equipment in the region such as Automatic Weather Stations, radars and satellite reception facilities and he produced and published a fully costed feasibility study on his findings which is being distributed to you. The remaining component, the training component of the Project being implemented by Max Walsh has

been running since July, 1994 and is still active, and while training has been largely been conducted in-country, several valuable training exercises have been conducted in Australia with Pacific People being brought to Australia for specific training exercises.

The project was originally approved and funded by AusAID for a period of three years duration from Nov. 93 to Nov 96. However the training component was extended for a further year as it was seen to be vital to the success of the venture that training be followed up and supported for as long as possible to ensure the success of the Project in the establishment and security of the climate record throughout the participating countries.

IMPACTS OF SEA-LEVEL RISE ON COASTAL ZONE THE MAURITIUS CASE

R. R. VAGHJEE

USCSP

Mauritius is located near 20° S and 57°E at about 800 km east of Madagascar. Its land area is about 1860 sq km and has a population of 1.1 million inhabitants. Its coastline is 200 km long and is almost completely surrounded by fringing coral reefs. The main foreign currency earners are manufacturing Industries, Sugar exportation and Tourism.

This study was conducted within the US Country Studies Program. Coastal geomorphology maps were initially prepared describing in details the different types of beaches around Mauritius. The aerial video mapping technique was used for the purpose and the whole coastal region was filmed from an helicopter which flew at an altitude between 30-50m.

Two specific sites where coastal erosion was very acute were selected for detailed studies. Contour maps at intervals of 50 cm and profiles of the beaches at various transects were prepared following intense surveying of these two sites. The area which would be inundated using various sea-level rise scenario was estimated and coastal erosion was calculated at these sites using the Brunn rule for a sea-level rise of Im. The socio-economic impacts on the various infrastructures were also estimated.

Some adaptation measures are provided.

NATIONAL-SCALE INTERGRATED IMPACT MODELS FOR ASSESSING VULNERABILITY TO CLIMATE CHANGE

R. A. WARRICK

University of Waikato - NZ

Needs and Recent Developments in the Asia-Pacific Region, by R.A.Warrick

There has been expressed concern that the trend toward large, highly-aggregated, economically orientated, global-scale integrated models is ignoring the unique physical and socio-economic characteristics of individual countries, particularly in the developing world. Within the Asia-Pacific region, however, a national-scale approach to integrated impact modelling has recently been developed which addresses some of these concerns. The approach began with the development of the CLIMPACTS model for New Zealand, and now includes : OzClim (for Australia) : BDCLIM (for Australia) ; BDCLIM (for Bangladesh) ; and VANDACLIM (a training tool for an imaginary country). The purpose of this brief presentation is to introduce the basic structure common to each of these models, and to point out the advantages and disadvantages of the overall approach.

VANDACLIM : A TRAINING TOOL FOR CLIMATE CHANGE VULNERABILITY AND ADAPTATION ASSESSMENT

R.A. WARRICK, G.C. SIMS, G.J. KENNY, W. YE AND G. SEM

University of Waikato - NZ

Fashioned after the CLIMPACTS model structure, VANDACLIM is an integrated impacts model for an imaginary country called Vanda. Vanda, and thus VANDACLIM, was developed as a training tool as part of the CC : Train (UNITAR) training package for vulnerability and adaptation assessment. During the two-week training course, participants carry out a mini-assessment for Vanda, using VANDACLIM for baseline climate description, methods testing, climate scenario generation and impact analyses. In this presentation, the Vanda simulation is described and the use of the VANDACLIM model for training purposes is presented and discussed.

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SPREP

South Pacific Regional Environment Programme

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