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The Nippon Foundation

Proceedings of International Seminar on Islands and Oceans 2010

January 20-22, 2010

Ocean Policy Research Foundation

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the Nippon Foundation from the proceeds of motorboat racing.

Proceedings of International Seminar on Islands and Oceans 2010

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Foreword

Today, islands, which are dependent on the sea, are faced with various problems accompanying climate change, such as the increasing intensity of natural disasters, sea level rise and even land submersion. Problems concerned with urbanization and waste management have also been increasing.

United Nations Convention on the Law of the Sea (UNCLOS) recognizes the rights of coastal states over the marine resources in their EEZs, while also assigning to them responsibility for the protection and preservation of the marine environment. Therefore, the management of ocean areas surrounding islands should be conducted in an integrated way, including from the perspective of marine conservation.

Island life and the ocean are closely connected in many ways. Nonetheless, in terms of the responsibility to manage and conserve their surrounding ocean areas, island states have difficulty in fulfilling the task on their own. Coordination and cooperation by the international community towards solutions with island states are called for.

Based on this understanding, from 2009 OPRF has started a three-year research project entitled 'Management and Conservation of Islands and their Surrounding Ocean Areas'. As a part of this project, OPRF has decided to seek cooperation with the Australian National Centre for Ocean Resources and Security (ANCORS) and the Pacific Islands Applied Geoscience Commission (SOPAC), to host an international seminar to examine issues covering the conservation and management of islands and their surrounding oceans each year.

The purpose of this seminar is to guide and support our three-year research project 'Management and Conservation of Islands and their Surrounding Ocean Areas.' as it progresses and develops. The Seminar will be held to address the following three themes:

1) The management and conservation of islands
2) Adverse effects of climate change and variability on islands
3) Island-based management of ocean areas

In the first year, we will study the current issues facing island conservation and marine management in Pacific island states, i.e., carry out fact-findings. Then, in the second year, we will identify the most pressing of these issues. In the third year, based on the results of studies conducted in the previous two

years, we will discuss how to address those issues and make policy proposals accordingly. In this first seminar, therefore, we will focus on addressing our first year's research agenda, which is fact-finding.

On these themes, both Japanese and overseas experts, working on issues of Pacific island states, will exchange research outcomes and opinions and discuss related issues. It is our hope that the seminar will provide an ideal platform for cross-disciplinary exchange, encouraging participants to consider island and ocean issues from an integrated perspective, and share their understanding, knowledge, and expertise, as well as distill and consolidate the issues.

Ocean Policy Research Foundation

Acknowledgement

The International Seminar on Islands and Oceans 2010 was made possible by the generous support of The Nippon Foundation from the proceeds of motorboat racing. We would like to express our sincere gratitude for this support and also acknowledge the Foundation's concern for an understanding of marine and land environmental issues and the life of people living on islands.

Brief Overview

Seminar

International Seminar on Islands and Oceans 2010

Date

January 20-22, 2010

Venue

The Nippon Foundation Building (Akasaka, Tokyo, Japan)

Language

English-Japanese simultaneous interpretation

Theme

The 'International Seminar on Islands and Oceans 2010' will be held to discuss on 1) Management and conservation of islands, 2) Adverse effects of climate change and variability on islands, 3) Island-based Management of Ocean Areas.

Host

Ocean Policy Research Foundation (OPRF)

Co-Organizers

Australian National Centre for Ocean Resources and Security
(ANCORS, University of Wollongong)

Pacific Islands Applied Geoscience Commission (SOPAC)

Participants

Australia:

Mr. Quentin HANICH
(ANCORS)

Prof. Richard KENCHINGTON
(ANCORS)

Dr. David LEARY
(The University of New South Wales)

Dr. Clive SCHOFIELD
(ANCORS) (paper submission only)

Prof. Martin TSAMENYI
(ANCORS, Director)

Fiji:

Ms. Emily ARTACK
(SOPAC, Research Fellow)

Prof. Robin SOUTH
(The University of the South Pacific)

Dr. Joeli VEITAYAKI
(The University of the South Pacific)

Dr. Arthur WEBB
(SOPAC, Manager)

New Zealand:

Associate Prof. Paul KENCH
(The University of Auckland)

Japan:

Dr. Tomohiko FUKUSHIMA
(The University of Tokyo, Associate Professor)

Dr. Masahiko ISOBE
(The University of Tokyo, Professor)

Associate Prof. Yasuhiko KAGAMI
(Chubu University, Associate Professor)

Dr. Kei KAWAI
(Kagoshima University, Associate Professor)

Dr. Hajime KAYANNE
(The University of Tokyo, Professor)

Dr. Makoto OMORI
(Akajima Marine Science Laboratory.
Tokyo University of Fisheries, Prof. Emeritus)

Dr. Kensaku TAMAKI
(The University of Tokyo, Professor)

Dr. Toshio YAMAGATA
(The University of Tokyo, Professor)

Dr. Tetsuo YAMAZAKI
(Osaka Prefecture University, Professor)

Dr. Moritaka HAYASHI
(OPRF. Waseda University, Prof. Emeritus)

Dr. Tadao KURIBAYASHI
(OPRF. Keio University, Prof. Emeritus)

Mr. Masahiro AKIYAMA
(OPRF, Chairman)

Mr. Hiroshi TERASHIMA
(OPRF, Executive Director)

Mr. Takashi ICHIOKA
(OPRF, General Manager)

Mr. Yoshinori SUGAWARA
(OPRF, General Manager)

Dr. Kazuyuki MAIWA
(OPRF, Research Fellow)

Ms. Catherine Vivar ODA
(OPRF, Research Fellow)

Mr. Mitsuru OKAWA
(OPRF, General Manager)

Dr. Yoshitaka OTA
(OPRF, Research Fellow)

Ms. Hiroko SASAKI
(OPRF, Research Fellow)

Programme

January 20, 2010
Day 1

9:00	**Opening**
9:00-9:10	**Opening Address** Mr. Masahiro AKIYAMA (OPRF, Chairman)
9:10-9:55	**Keynote Speech** Mr. Hiroshi TERASHIMA (OPRF, Executive Director) **Remarks by Co-organizer** Prof. Martin TSAMENYI (ANCORS, Director) Dr. Arthur WEBB (SOPAC, Manager-Ocean and Islands Programme)
9:55-10:10	Coffee Break

Session I

Management and Conservation of Islands

Many Pacific island states are formed from low atolls, which are vulnerable to natural disasters such as cyclones, flood tides, and shoreline erosion. Also it is pointed out that recent changes in residential patterns in those islands have brought about rapid urbanization in certain coastal areas, which has had negative impacts on island environments as well as on the lives of the people. Having noted those social and environmental problems, this session considers both institutional and technical efforts to protect islands, which are exposed to harsh conditions from natural threats, as well as efforts to facilitate natural revitalization capacity. We hope to have discussions on various topics related to the management and conservation of islands, including the preservation and revitalization of coral reefs, an important base for island life, the state and risk of natural disasters, and other issues concerned with the social and natural environment.

Chair: Dr. Arthur WEBB (SOPAC)
Co-Chair: Dr. Hajime KAYANNE (The University of Tokyo)

Presentations

10:10-10:40 Prof. Paul KENCH (The University of Auckland)
'Pacific Island Landscapes'

10:40-11:10 Dr. Joeli VEITAYAKI (The University of the South Pacific)
'Drowning In Their Waste: Waste Management Issuees Threatening Sustainability of Pacific Island States'

11:10-11:40 Dr. David LEARY (The University of New South Wales)
'Ocean Energy Opportunities and Challenges in the Pacific Islands Region within the Context Climate Change'

11:40-12:10 Emily ARTACK (SOPAC)
'The Pacific Regional Strategy and Arrangements for Hyogo Framework for Action Implementation'

12:10-13:00 Lunch Break

13:00-13:30 Dr. Arthur WEBB (SOPAC)
'Atoll Shoreline Response to Sea Level Rise over the Last 50 Years – Pingelap & Mokil Atolls, FSM'

13:30-14:00 Dr. Makoto OMORI (Akajima Marine Science Laboratory)
'Rehabilitation of Coral Reefs by Artificial Efforts'

14:00-14:30 Discussion

14:30-14:50 Coffee Break

Session II

Adverse Effects of Climate Change and Variability on Islands

The issue of climate change and its impact on the marine environment was recognized in Agenda 21 and the international community has been discussing the importance of solving global environmental problems and the submersion of islands caused by sea level rise. However, to address the environmental change caused by climate change, typically sea level rise, further discussion and study is needed to understand the ways in which both island states and the international community should collaborate to adapt and mitigate the impact from climate change. This session reviews actual influences of climate change and variability on island states in the Pacific and discusses possible measures to deal with environmental phenomena such as sea level rise. Based on this review, after discussing the responses of island and other states towards the effects of climate change and variability on islands, including sea level rise the session will focus on international cooperation regarding islanders' habitation problems.

Chair: Prof. Martin TSAMENYI (ANCORS)

Co-Chair: Dr. Toshio YAMAGATA (The University of Tokyo)

Presentations

14:50-15:20 Dr. Toshio YAMAGATA (The University of Tokyo)
'Impacts of Climate Change and Variability on Pacific Islands and Their Surrounding Waters'

15:20-15:50 Prof. Robin SOUTH (The University of the South Pacific)
'Marine Biodiversity and Climate Change in the Pacific Islands'

15:50-16:20 Dr. Hajime KAYANNE (The University of Tokyo)
'Pacific Island States' Coral Reefs and Their Ecological Response to Changing Environments'

16:20-16:50 Prof. Richard KENCHINGTON (ANCORS)
'Managing Responses to Changing Ecosystems'

January 21, 2010
Day 2

Session II
Adverse Effects of Climate Change and Variability on Islands
(continued)

9:00-9:30 Dr. Kei KAWAI (Kagoshima University)
'Socio-Economic Effects on Island Society as Result of Climate Change and Climate Variability'

9:30-10:00 Dr. Moritaka HAYASHI (OPRF)
'The International Legal Implications of Climate Change/Variability for the Rights of Island States over Their Surrounding Waters'

10:00-10:30 Discussion

10:30-10:50 Coffee Break

Session III
Island-based Management of Ocean Areas

UNCLOS recognizes the rights of coastal states over the marine resources in their EEZs, while also assigning to them responsibility for the protection and preservation of the marine environment. Due to this recognition, islands scattered across vast, open waters are responsible for managing extensive ocean areas and therefore play important roles as operational stations for regional and international marine management. Based on this recognition, the session will address the state of socio-economic activities developing both on islands and in surrounding ocean areas and the actual state of marine management of those areas. It will also explore ocean management in general based on the relations between islands and their surrounding ocean.

Chair: Mr. Hiroshi TERASHIMA (OPRF)
Co-Chair: Prof. Richard KENCHINGTON (ANCORS)

Presentations

10:50-11:20 Dr. Kensaku TAMAKI (The University of Tokyo)
'Research on Implementation and its Problem of Marine Boundaries for Island States'

11:20-11:40 Dr. Tomohiko FUKUSHIMA (The University of Tokyo)

'Pacific Seafloor Mineral Resources: Development and Other Issues'

11:40-12:10 Dr. Clive SCHOFIELD (ANCORS) (paper submission only)
'The Delimitation of Maritime Boundaries of the Pacific Island States'

12:10-13:00 Lunch Break

13:00-13:30 Prof. Martin TSAMENYI (ANCORS)
'Pacific Islands States Regional Response to the Challenges and Constraints of EEZ Management'

13:30-13:50 Associate Prof. Yasuhiko KAGAMI (Chubu University)
'The Development of Remote Island Policy in Japan: with a Focus on Uninhabited Islands'

13:50-14:20 Mr. Quentin HANICH (ANCORS)
'The Western and Central Pacific Fisheries Commission: Fisheries Management in Ocean Areas Surrounding Pacific Island States'

14:20-14:40 Coffee Break

14:40-15:10 Dr. Tetsuo YAMAZAKI (Osaka Prefecture University)
'International Initiatives for Sustainable Deep-Sea Mining in Pacific'

15:10-15:40 Dr. Tadao KURIBAYASHI (OPRF)
'Some Preliminary Remarks on International Legal Implications of Islands and EEZ Management'

15:40-16:10 Discussion

18:00-20:00 Reception

January 22, 2010
Day 3

Chair: Prof. Tadao KURIBAYASHI (OPRF)

9:30-11:00 Discussion

11:00-11:30 Coffee Break

11:30-11:45 **Wrapping Up**
Mr. Hiroshi TERASHIMA (OPRF)

11:45-12:00 **Closing Remarks**
Mr. Hiroshi TERASHIMA (OPRF)
Prof. Martin TSAMENYI (ANCORS)
Dr. Arthur WEBB (SOPAC)

Adjourn

Contents

Session 3: Island-based Management of Ocean Areas

Administration and Editorial Office

Session I

Management and Conservation of Islands

Pacific Island Landscapes

Paul Kench
Associate Professor

School of Environment, The University of Auckland, New Zealand

The Pacific Ocean is host to thousands of small islands, most of which are located in, or close to the tropics. These islands represent a fraction of the ocean surface area and exhibit great diversity in physical and ecological characteristics. They also provide the only habitable land for Pacific Island nations. Due to their small size, isolation and less developed status Pacific Island countries are considered among the most vulnerable nations on earth. Future increases in sea level, climatic variability and anthropogenic impacts all pose significant threats to the natural environment that may promote significant changes in the physical and ecological condition of islands and pose major management challenges to Pacific Island countries. Understanding future changes in the physical environment of Pacific Islands and development of sound management strategies must be founded on a robust knowledge of the formation and environmental processes that govern the geomorphological and ecological condition of island environments.

The factors that control island formation and change operate across a range of temporal and spatial scales. At geological timescales (>10^5 years) the broad patterning (location and genesis) of Pacific Islands has been controlled by plate tectonic processes and associated volcanism. At plate boundaries islands formed either as a result of plate divergence (sea floor spreading) or more commonly 'island arcs' occur at zones of plate convergence: where the collision of oceanic plates and subduction promotes the formation of new volcanic islands; or through plate buckling uplifted limestone islands occur. At intraplate locations linear chains of seamounts, islands and guyots occur as the result of plate motion over a stationary (volcanic) hotspot beneath the oceanic crust. While most Pacific Islands began life as a volcano on the ocean floor the contemporary geomorphic condition of Pacific Islands reflects the influence of a range of other processes since the time of initial island formation. These factors include: tectonic processes, climate (temperature, precipitation, wind), and ocean processes (sea level change and wave regime). These processes which operate over short to medium timescales (10^0 – 10^4 years), and which exhibit regional variability, have oscillated throughout the Tertiary and Quaternary and transformed the initial volcanic form of islands.

Contemporary Pacific Islands are generally divided into three physical types: volcanic islands; high limestone islands, and atolls. In general this division reflects a reduction in island area and ecological complexity. Volcanic high islands are typically characterised by higher relief and larger island sizes. However, the combination of steep relief, high rates of precipitation, warm temperatures and surface water drainage induce some of the highest rates of land denudation in the world. Consequently, volcanic islands are characterised by highly weathered, fertile but unstable slopes that produce highly dissected landscapes and deliver vast quantities of sediment to the coastal margin to form depositional plains. Atolls form through the combination of slow subsidence of the volcanic core and coral reef growth around the volcanic basement. Atoll islands are typically low lying (<5 m above MSL), are small in area and composed entirely of carbonate materials derived from coral reefs. High limestone islands form through uplift of atolls and are characterised as table-top platforms generally > 50 m above sea level, and surrounded by cliffs and terraces as a consequence of reef flat development. Atoll and high limestone islands have little or no surface drainage and water limitations combined with poor soil development constrain development of complex ecological communities.

While significant physical differences exist between volcanic and atoll islands, human settlement and infrastructure are concentrated on the low-lying coastal margins in both island types. In general, the physical condition of the coastline relies on the interplay between: coral reef growth, sediment supply, accommodation space, sea-level change and climate (cyclones, wave regime). These factors vary spatially and temporally and have imparted unique geomorphological signatures (e.g. storm v non-storm coastlines). Near future changes in these environmental variables will drive geomorphic adjustment of the coast of Pacific Islands, although the rate, style and magnitude of change are poorly resolved.

PACIFIC ISLAND LANDSCAPES

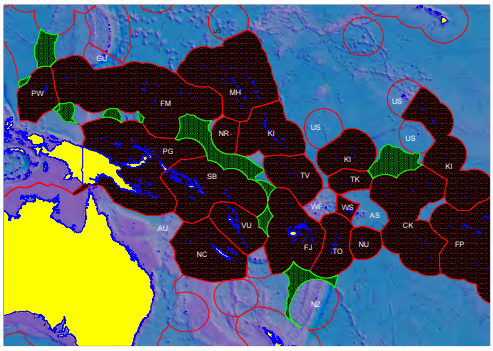
Paul Kench

School of Environment

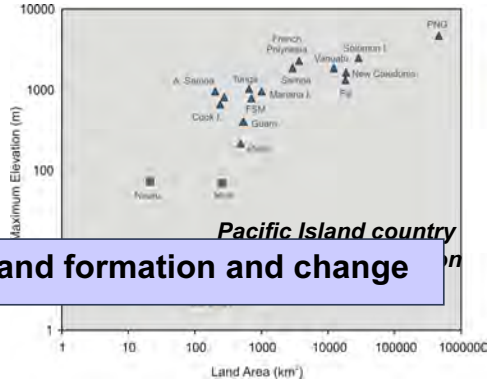
The University of Auckland, New Zealand

1. BACKGROUND
Pacific Context

- Pacific Ocean ~ 180 x 10^6 km^2
- > 25,000 islands ~ 0.75% of ocean area
- Concentration in tropics and SW Pacific



- Vulnerable
  - [size, isolation, governance, susceptibility to environmental change]
- Homogeneity vs Diversity
- Understanding controls on island landscape development and change is fundamental for effective management and to reduce vulnerability

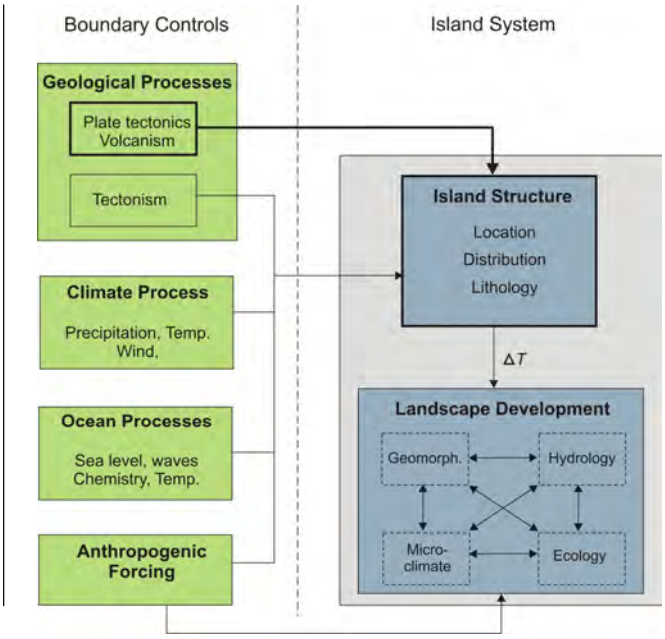


Pacific Island country

To examine the controls on Pacific Island formation and change

1. BACKGROUND
Controls on Pacific Island Formation and Change

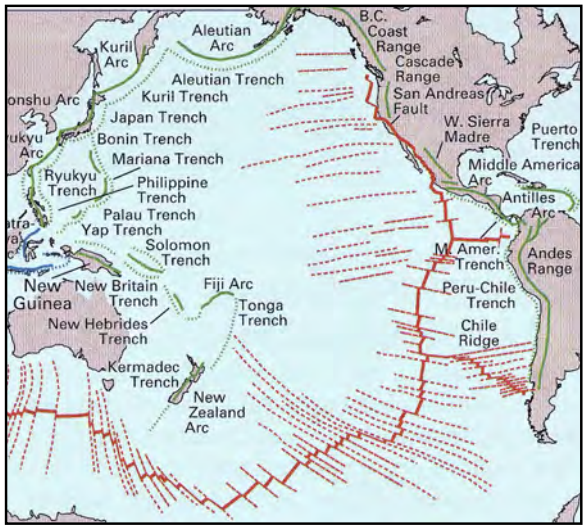
- Over geological time multiple boundary controls interact to form and transform Pacific Island landscapes
- The importance of these processes varies temporally and spatially



2. PACIFIC ISLAND FORMATION
Geological Processes (10^6 yrs)

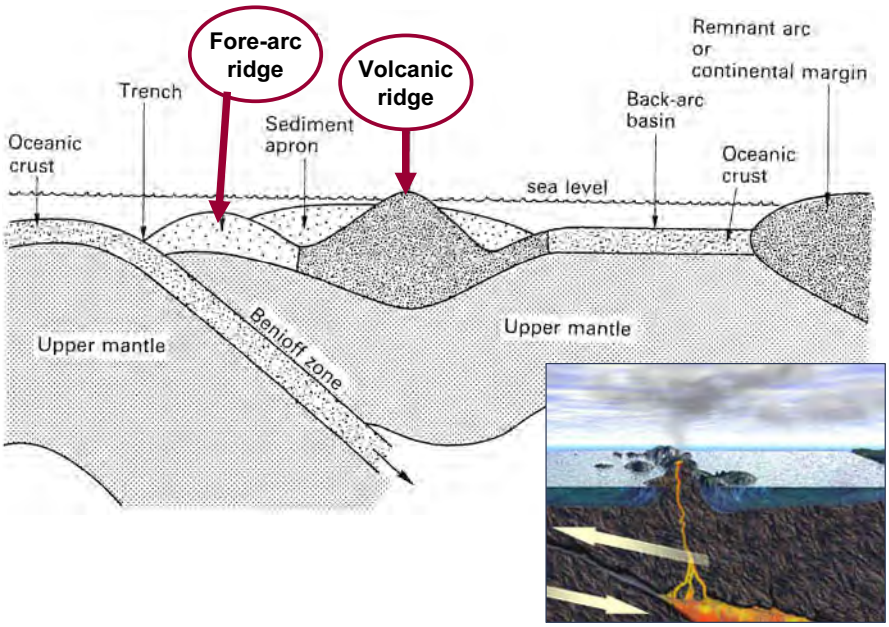
'*All islands started life as a volcano*'

- At long timescales (10^6 yrs) geological processes explain the formation and location of Pacific Islands
- **Plate Tectonics** and associated **volcanism** accounts for the distribution, initial form and lithology of PI's



2A. Island Formation at Plate Boundaries

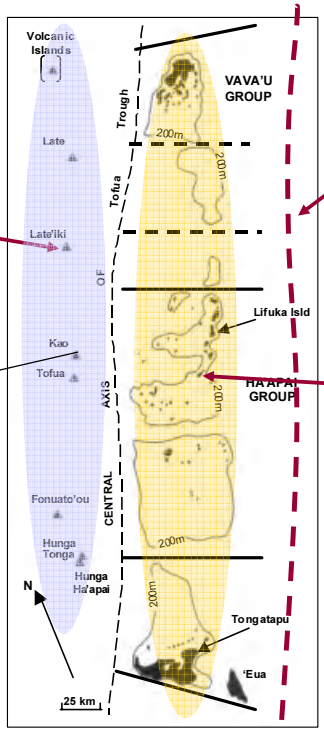
- Islands can form in a number of places at collision zones



2A. Island Formation at Plate Boundaries

- **Produces parallel chains of islands = Island Arcs**

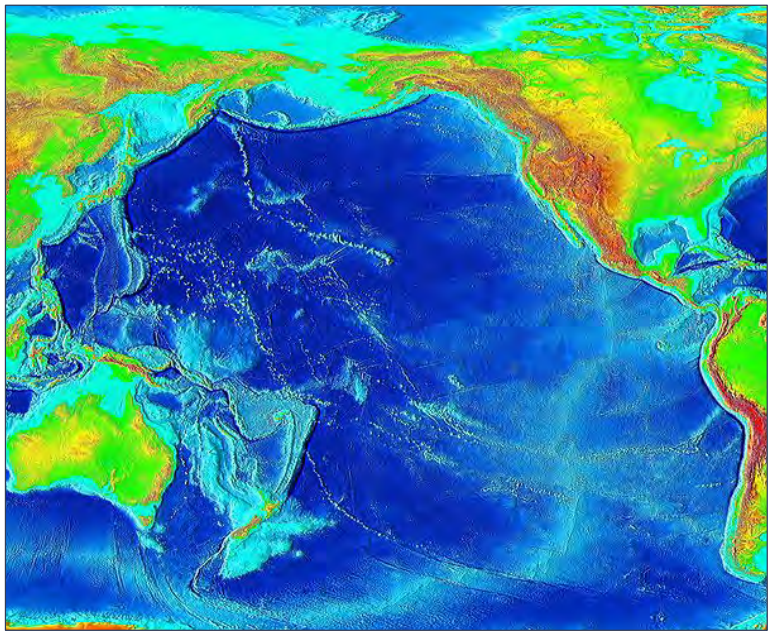
Tofua Ridge = Volcanic-arc volcanic islands



Trench: > 10km deep

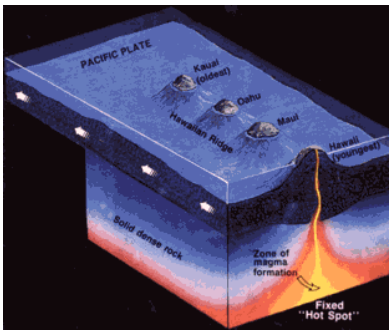
Tonga Ridge = Fore-arc ridge limestone islands

2A. Island Formation at Intraplate Locations



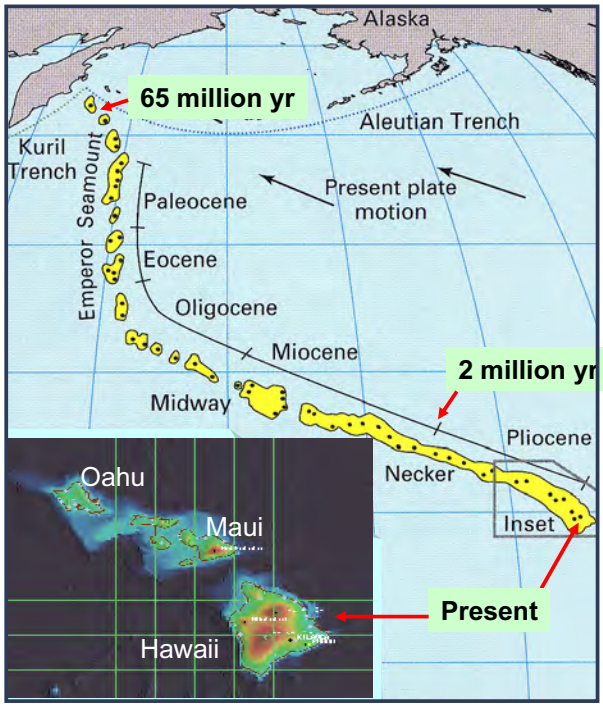
2A. Island Formation at Intraplate Locations

- **Hotspots:** localised thermal plumes exist in the earth's upper mantle which allow magma to rise forming volcanoes



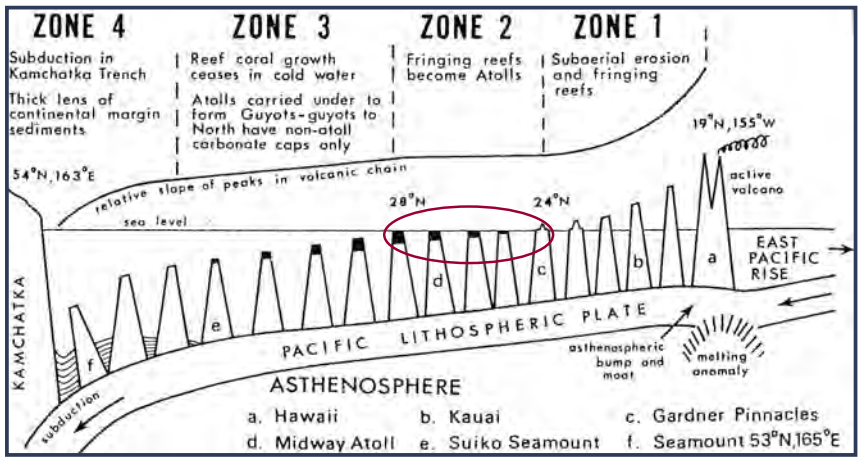
2A. Island Formation at Intraplate Locations

- Episodic volcanism and plate migration allows a sequence of volcanic islands to form in a linear chain
- Volcanoes are older with distance from the hotspot



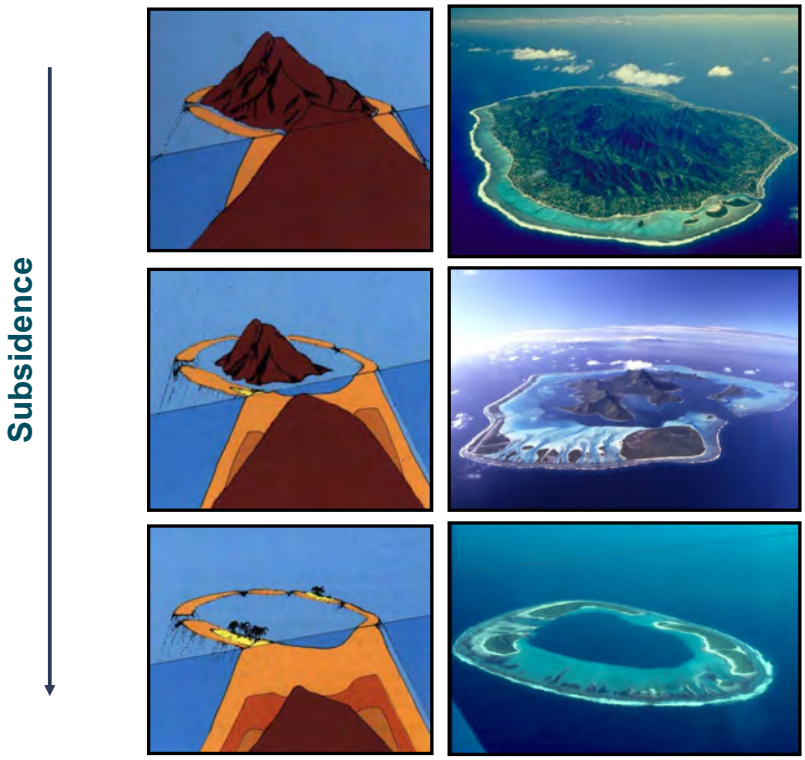
2A. Island Formation at Intraplate Locations

As Islands move along the plate they are altered from their initial form



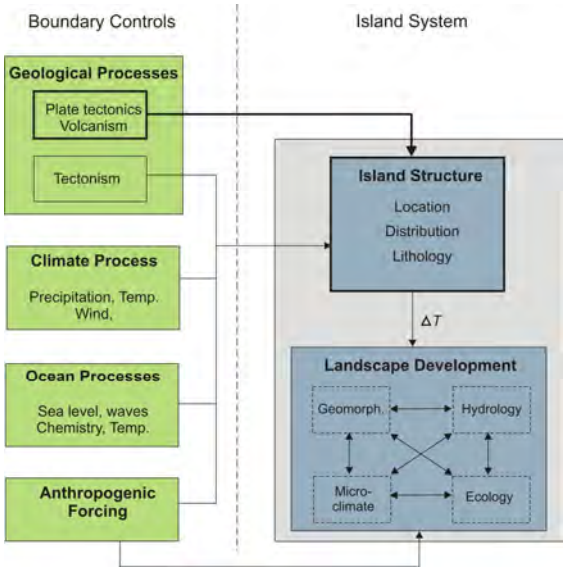
Long-term development over millions of years as plates migrate
Islands are ephemeral features on geological timescales

2A. Island Formation at Intraplate Locations



3. PACIFIC ISLAND LANDSCAPE DEVELOPMENT

- Overlying this geophysical template the geomorphic development of Pacific Islands reflects the ongoing interplay between controlling factors that:
  - Vary temporally (event to millennial scales)
  - Vary spatially (Pacific to island scales)
  - Transform primary landforms



3. PACIFIC ISLAND LANDSCAPE DEVELOPMENT
Examples of Spatial Variations in Climate

- Precipitation
- Temperature gradients
- Zones of cyclogenesis

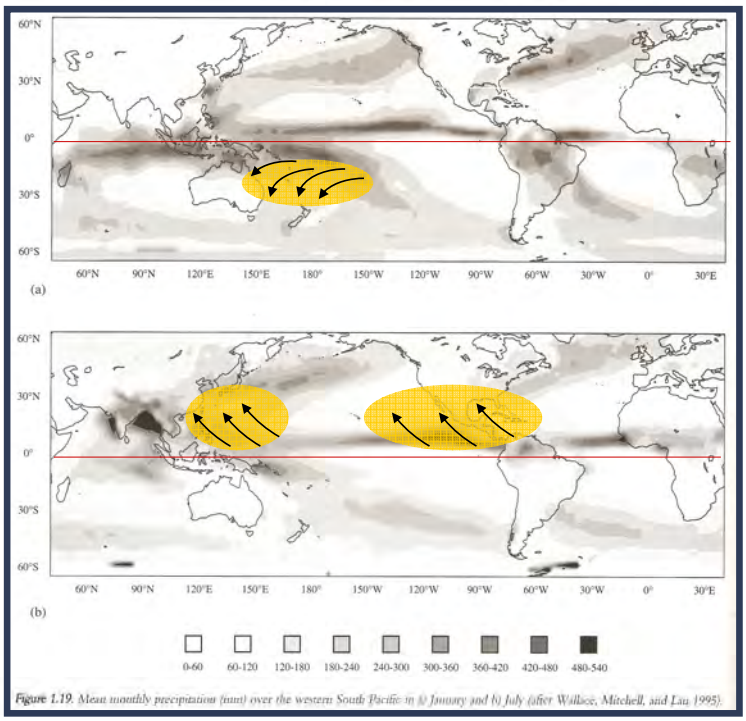
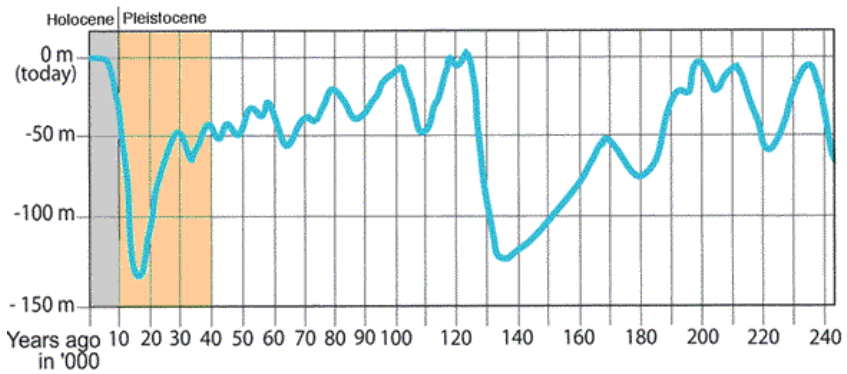
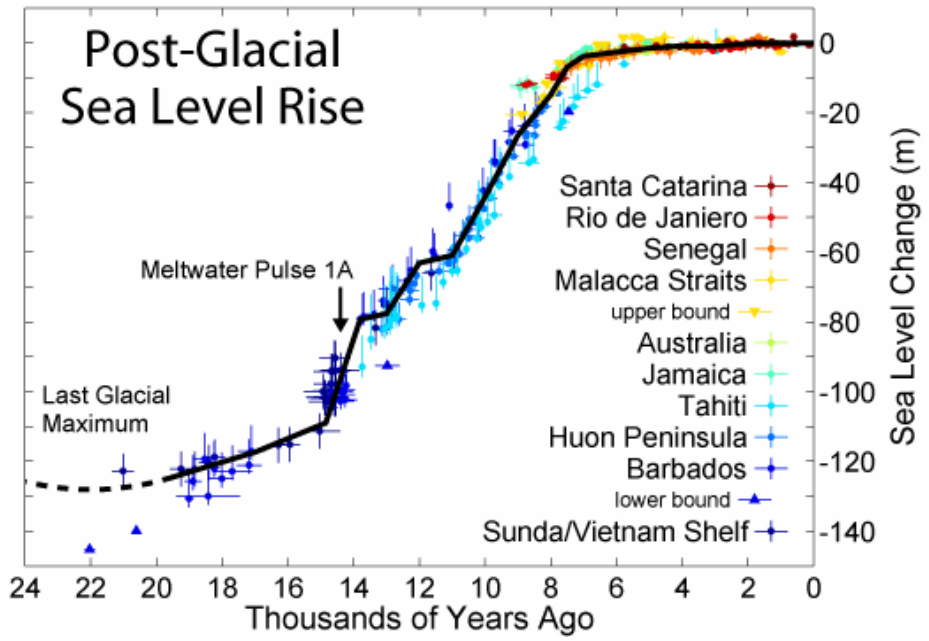


Figure 1.19. Mean monthly precipitation (mm) over the western South Pacific in (a) January and (b) July (after Wallace, Mitchell, and Liu 1995).

3. PACIFIC ISLAND LANDSCAPE FORMATION
Example of Temporal Variation in Sea Level



3. PACIFIC ISLAND LANDSCAPE FORMATION
Examples of Temporal Variation in Sea Level

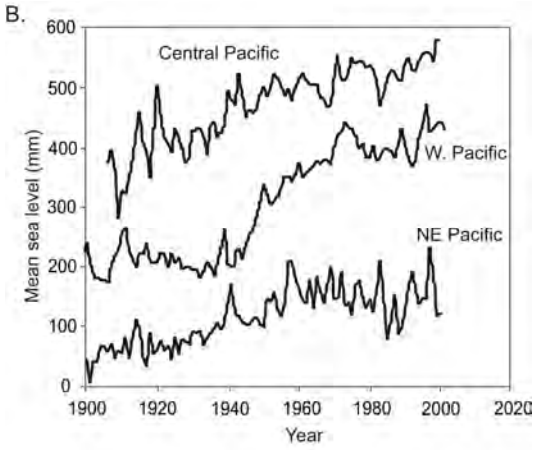


3. PACIFIC ISLAND LANDSCAPE FORMATION
Examples of Temporal Variation in Sea Level

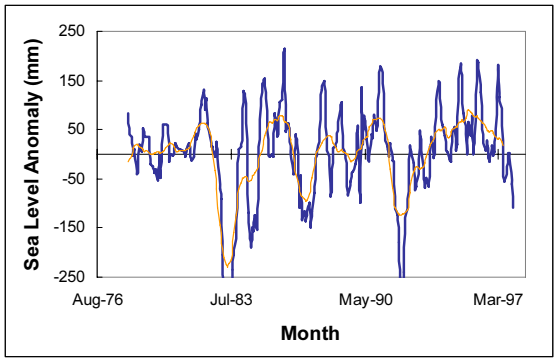
Change in New Zealand land area 18000 years ago (msl -130 m)

3. PACIFIC ISLAND LANDSCAPE FORMATION
Examples of Temporal Variation in Sea Level

Centennial-scale sea level change



Inter-annual sea level change



4. LANDSCAPE DEVELOPMENT
Example 1: Volcanic High Islands

Geomorphic factors:

- Lithology = volcanic
- Tropical temp
- Precipitation
- Time

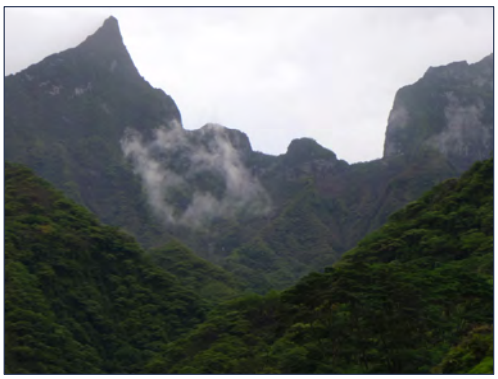
- Rapid weathering and landscape denudation

	Total (t x 10^{-6} a^{-1})	Ratio Sediment:Solute	Surface lowering (mm a^{-1})
Africa	**731**	**2.64**	**0.0093**
N. Amer.	**2220**	**1.93**	**0.0408**
S. Amer.	**2391**	**2.97**	**0.0504**
Asia	**8025**	**4.04**	**0.0718**
Europe	**655**	**0.54**	**0.0257**
Oceania	**3355**	**10.45**	**0.0627**

4. LANDSCAPE DEVELOPMENT
Example 1: Volcanic High Islands

Landscape Characteristics:

- Deeply weathered slopes
- Uplands unstable thin soils
- Heavily dissected hillslopes
- Surface drainage
- Delivery of sediment to coast
- Low-lying coastal plains



4. LANDSCAPE DEVELOPMENT
Example 2: High Limestone Islands

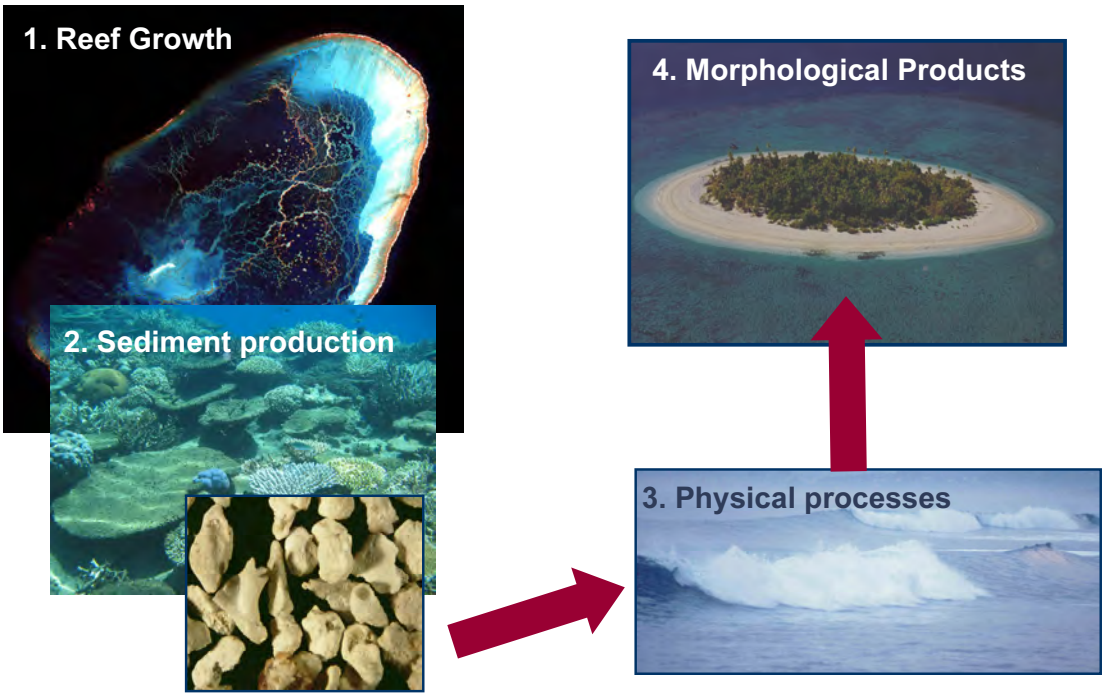
Geomorphic factors:

- Uplift & tilting
- Reef development
- Lithology limestone
- No surface drainage (karstic processes)

Landscape Characteristics:

- Terraced/cliffed
- Karstic features
- Subsurface caves
- Thin soils

4. LANDSCAPE DEVELOPMENT
Example 3: Low Atoll Islands



4. LANDSCAPE DEVELOPMENT
Example 3: Low Atoll Islands

Landscape Characteristics:

- Geologically young (< 3000 yr)
- Small in size
- Low elevation ~5 m above msl
- Unconsolidated sediments
- Poor soils
- No surface hydrology

4. LANDSCAPE DEVELOPMENT
Example 3B. Influence of Wave Energy on Reef Islands

High Energy (cyclones)

- Capacity to transport and deposit large material
- High surge runup limits in storms

Island Characteristics:

- Gravel/boulder composition
- Higher elevation (5-7 m amsl)
- Limited soil development
- Marginal groundwater resources

4. LANDSCAPE DEVELOPMENT
Example 3B. Influence of Wave Energy on Reef Islands

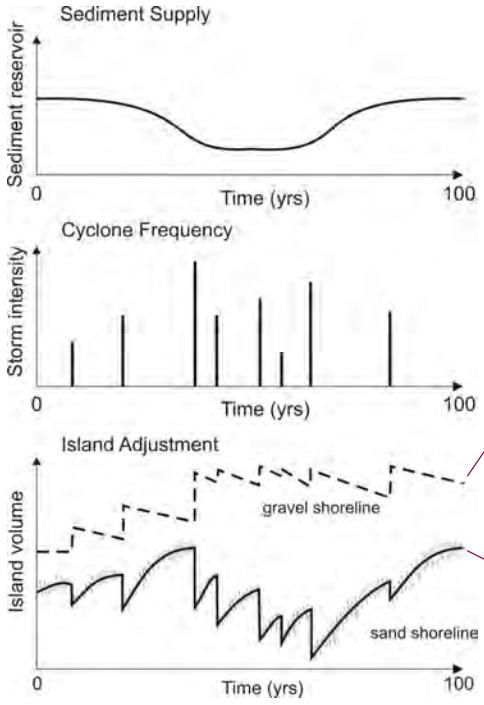
Low energy (non-storm)

- Capacity to transport and deposit only sand size material
- Lower surge runup limits

Island Characteristics:

- Sand composition
- Lower elevation (2-3 m)
- Potential for groundwater resource

4. LANDSCAPE DEVELOPMENT
Example 3B. Influence of Wave Energy on Reef Islands

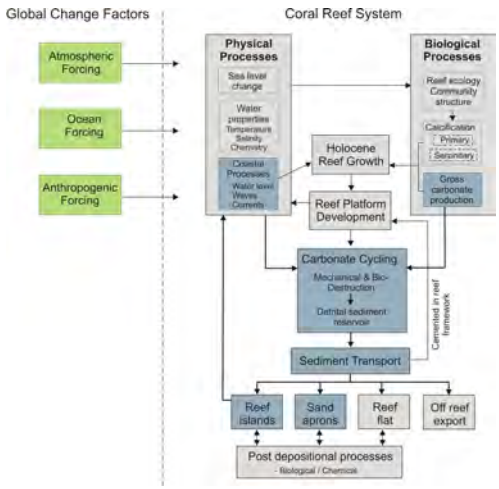


Kench, Perry and Spencer (2009), after Bayliss-Smith (1988)

4. LANDSCAPE DEVELOPMENT
Example 5: Coral Reefs and Associated Sedimentary Landforms

Coral Reefs

- Ubiquitous features
- Major landform unit that modulates the structure and morphology of the coastal zone



Sedimentary Landforms

- Accumulations of sediment deposited on or adjacent to the reef structure

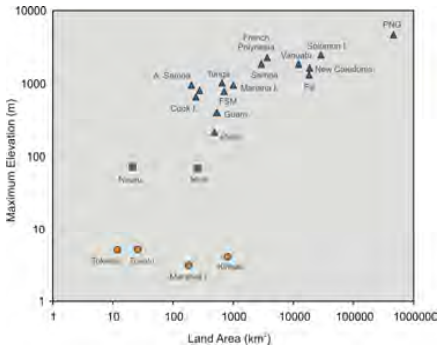
Coastal Landscapes are physically the most dynamic landscapes

SUMMARY
Diversity of Island Landscapes

- The formation and transformation of Pacific Island landscapes reflects the interplay of geological, climate and ocean processes over a range of **spatial** and **temporal** scales
- Theses interactions produce a diverse range of landscapes
- Landscape diversity patterns island scale resources: ecological processes, physical resource availability, water resources

SUMMARY
Diversity of Island Landscapes

- Implies large geographic variations in physical landscape sensitivity to change
- Current assertions of vulnerability are overly simplistic
  - High v low islands
  - Populations are located at the coast
  - We aggregate vulnerability at the national scale



SUMMARY

Dynamics of Pacific Island Landscapes

- Landforms are not static they are in continual adjustment to fluctuations in boundary controls at short to long timescales
  - Pacific coastlines are most dynamic
- Boundary controls on island formation and change are now perceived as threats with projected near future changes
- To support management need to:
  - better resolve magnitude and pace of change of island landscapes
  - Identify those factors that will have greatest impact on landforms at the management timescale

Pacific Islands Drowning in their Waste: waste management issues that threaten sustainability

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Abstract

PACNEWS on the 15th of July 2009, quoted the Mayor of Waitakere, Mr Bob Harvey referring to the Pacific Islands as a "waste disaster" with the neighbouring four island states of Tonga, Samoa, Cook Islands and Niue turning into environmental disasters 'amidst their own waste and pollution'(PACNEWS 2009). According to Harvey, the trip he had shared with the Prime Minister of New Zealand into four Pacific Island Countries 'left him fearing for the future of some of the Pacific's most pristine tourist destination' (PACNEWS 2009), which are threatened by pollution and poor waste management. According to Mr Harvey, the failure to meet basic requirements for sewerage, commercial and farm runoff and domestic waste were ruining paradise.

I agree with Mr Harvey and regard waste management today amongst the three main environmental problems faced in the Pacific Islands. Experience over the last few decades has shown that Pacific Islanders have used economic development as the excuse to pollute their homes because they have not seriously managed their waste or have cut corners to reduce their costs of production. Consequently, Pacific Islanders are disposing highly toxic, non biodegradable and persistent waste as they do their garden and household biodegradable and have not learned from the painful experiences in countries such as Japan, which at one time was ravaged by diseases such as the Minamata that were due to improper waste management practices.

Introduction

In the pursuit of economic development, Pacific Islands have ignored the need to look after their waste and have been hazardously discarded these and not given them the attention they deserve. The result is slow economic development and what Mr Harvey termed the "waste disaster" that Pacific Islands are sinking in. Many of the island nations are unable to effectively address the problem they allowed to happen and are now relying on external assistance because they are helpless. There is now more challenge due to the global campaign for sustainable development (CROP 2004).

There is higher demand for space and natural resources such as water and natural biodiversity because of ever increasing population numbers and the continued degradation of existing resources. Critical habitats such as rivers, wetlands, coasts, sea grass beds, mangrove forests, coral reefs and rocky shores have been altered irreversibly and hampered from providing the environmental services that they perform. In addition, younger generations are used to the wastes around them and accept these as normal part of their surrounding diminishing any likelihood of corrective action. The consequences of these ignorance and carelessness are polluted food sources and areas with restricted uses.

With their limited terrestrial resources and biodiversity, Pacific Islanders need to ensure that waste does not unnecessarily occupy land or compromise the use of their natural resources. They must adopt measures in all sectors and involve all stakeholders to guarantee that the wastes are minimised and properly managed so as not to unnecessarily occupy areas and consume resources that can be more profitably used.

The treatment of waste as a resource to reduce the ecological costs of development and increase the financial and economic opportunities in these resource-strapped islands provide particularly welcomed development potential for Pacific Islands. Waste must be better managed to reduce the degradation of picturesque spots that are important to people and for economic activities such as tourism and recycled materials and provide new items such as biogas, compost and grey water use while maintaining farmlands and clean water. Scientific methods and technology must be used to protect the environment from the damaging effects of poor waste management.

Unlike climate change and sea level rise that Pacific Islanders can do little to correct, waste management is all dependent on what the people practice. In this article, I examine the state of waste management in the Pacific Islands and the challenges to be addressed. I will also propose some approaches that can be adapted to improve the management of waste. Waste management is now severe but can be addressed if concerted effort is exerted at all levels by all stakeholders.

The paper has four other sections. The first provides some background information on the Pacific Islands followed by the discussion on the “waste disaster” in the Pacific Islands. The last two sections are on the approaches to be taken to address the “waste disaster”, followed by some reflections on the way forward.

Pacific Islands

Pacific Islands are large ocean states scattered the width and length of the world's biggest water body, where the ocean has social, spiritual, cultural and economic significance. Land accounts for only 2 percent (550,000 sq km) of the region's total area of approximately 30,000,000 square kilometres. The largest of the islands states is Papua New Guinea (PNG) with 84 percent of the region's land area. The remaining 21 states share 16 percent of the land area illustrating the land restriction in some of these countries. Eight islands states have land areas of around 700 square kilometres, four have areas of less then 30 square kilometres while 15 entities are either made up wholly or largely of atolls and coral islands. The scarcity of land-based resources in many Pacific Islands particularly in the atoll countries and territories make waste management critical.

The population of the Pacific Islands was around 8.6 million in 2004, representing an increase of approximately 1.7 million people over the previous 10 years (Haberkorn 2004). With an annual population growth rate of 2.2 percent per annum, there is a doubling time of 32 years. Population densities range from just over 8 persons per km^2 for Pitcairn Island to 505 persons per km^2 for Nauru. The figures are over 100 per km^2 for four countries, over 200 for 3 countries, and 421 for Koror in Palau, 757 for Funafuti in Tuvalu, 1179 for Majuro in the Marshall Islands, and 2190 for Tarawa in Kiribati. In Ebeye, one of some 90 islets comprising Kwajalein Atoll in the Marshall Islands, where people were relocated by the U.S. military to free the atoll's lagoon for intercontinental ballistic missile testing, the population density was over 25,000 per km^2 (South et al. 2004). For this reason, people must manage their waste and maintain their natural resources because they continually have to cater for more people in their small and vulnerable islands.

The annual urban growth rate is between 3 and 4 percent while the urban population doubling times in the Pacific Islands range from 17 to 23 years. In South Tarawa, with a current estimated growth rate of 5.2 percent per annum, the population doubles every 13 years. It is difficult to see how the South Tarawa's economy, society and environment will cope with an additional 36,700 people in nine years (Haberkorn 2004).

In many Pacific Islands, economic considerations have over ridden environmental concerns. However, the practice has not improved the economy, which remains weak and small as shown by the GDP, but has aided the destruction and modification of habitats in the Pacific Islands (Table 1). As explained in Easter (2010), 'In the space of just a few generations, the people of the Pacific have moved from subsistence living to a much more cash propelled economy and, while in some ways this is a positive progression, for many communities it also means having to deal with the demands and consequences of a consumer oriented culture'.

Modernisation has changed the waste types that are handled and the systems in place to manage these or protect limited natural resources from pollution or exploitation (Easter 2010). More durable and persistent wastes have become part of the predominantly green waste that Pacific Islanders are used to. In addition, the weak economies restricts the waste management options available in the region, which needs to understand that only proper waste management will ensure that the environment continually provides the ecological services they require and for which they do not have to heavily invest.

There is considerable difference in the state of the river estuaries, sand and mudflats, sea grass beds, mangrove forests, rocky shores and coral reefs throughout the Pacific Islands, with negative human influence most profound in areas of development. Marine resources in ports such as Suva, Lautoka, Port Moresby and Pago Pago are over exploited and polluted resulting from the destruction of natural habitats associated with the construction of coastal infrastructure, landuse, fishing, natural disasters and poor development planning. Many of the dumps in the Pacific Islands are in mangrove forests and coral reefs where the wastes seep into the marine environment.

Waste Management is a programme within the Pacific Regional Environment Programme (SPREP), the regional organization that oversees the environmental issue within the Pacific Islands. SPREP's vision is to minimise the adverse impacts of development on the people, economies and environment of the region in an efficient and cost-effective way (SPREP 2010:1). SPREP had declared 2005 the Pacific's "Year of Action Against Waste" to help Pacific Island countries improve the management of solid waste and is working with its member countries to develop a Regional Master Plan to improve the management of solid waste and to help countries to develop their own national waste management strategies. It also helps to build capacity in the public and private sectors to develop better policies, governance and implementation strategies as well as assist with advice and assistance on particular projects and proposals to cater for solid waste, hazardous waste and marine pollution.

Table 1. Geographic, Demographic and Economic Statistics for Large Ocean States.

Country	Land Area (Km^2)	Population (1994)	Pop. Density	Annual Growth Rate (%)	Total GDP ($US 000)	Per Capita GDP
American Samoa	200	54,600	273	3.7	203125.3	5194.8
Cook Islands	237	19,100	81	1.1	70095.5	4052.1
Federated States of Micronesia (FSM)	701	105,900	151	3.0	246011.2	2652
Fiji	18,272	777,700	43	2.0	1620707.4	2118.5
French Polynesia	3,521	218,000	62	2.5	3202764.2	15,305.20
Guam	541	146,700	271	2.3	1180427.8	9637.7
Kiribati	810	78,300	97	2.3	33875.4	468
Marshall Islands	181	54,069	299	4.0	74735.8	1556
Nauru	21	10,600	505	2.9	160875.0	17486
Niue	259	2,100	8	-2.4	6891.6	3077.8
Northern Mariana Is.	471	56,600	120	9.5	571297.0	10094
New Caledonia	18,585	182,200	10	2.0	2125919.6	12753
Palau	488	16,500	34	2.2	49367.1	3247.4
Papua New Guinea	462,243	3,951,500	9	2.3	5670260.7	1468
Pitcairn	5	60	12			
Samoa	2,935	174,140	59	0.5	165885.7	1017.9
Solomon Islands	28,370	367,400	13	3.4	262526.2	738.7
Tokelau	10	1,500	150	-1.3	624.0	372.8
Tonga	747	98,300	132	0.5	138035.0	1415.7
Tuvalu	26	10,114	389	1.7	64187.2	7053.5
Vanuatu	12,190	164,100	13	2.8	208878.5	1308.8
Wallis and Futuna	255	14,400	56	1.3		

Modified from Dalzell *et al.* (1996)

The Waste Disaster

The “waste disaster” now prevalent in the Pacific Islands is the result of years of ignorance and neglect and the pursuit of economic development policies that did not treat waste management as an environmental cost and a threat to sustainable development. The result is a region where the small islands are drowning in their waste, which include sewerage, industrial, commercial and domestic waste. Mr Harvey named Tonga and Cook Islands as countries that have failed to attend to their rapidly degrading environment. Unfortunately, the story is not dissimilar throughout the Pacific Islands. Takitumu Lagoon in Rarotonga, Cook Islands, a major destination for New Zealanders, is now severely polluted due to increasing human waste, inappropriate septic tank systems on the coastal sands and habitat damage caused by the local pig farms directing their effluents into the lagoon (PACNEWS 2009).

Mr Harvey also described the mountains of waste in the landfills in Tonga, where all disposables such as paper, glass, plastic, metal and wood are taken. The problem is compounded by the high cost of recycling, which makes the removal of waste costly and prohibitive (PACNEWS 2009). In rural villages such as Nukuhetulu, there is no household waste collection and disposal service. Wastes generated in these villages are traditionally burnt, buried in the backyard, or dumped in the mangroves on the edge of Fanga’uta Lagoon. Every household has its own dump in their backyard where the rubbish is burnt on a regular basis. Non biodegradable waste like tins, plastics, and iron, are accumulated before they are buried in the backyard, agricultural land, or thrown into the mangroves, with little thought about its impact on the environment (SPREP 2010g). The villagers in Nukuhetulu were unaware that dumping waste in the mangroves threatens the environment.

Only an estimated 10 percent of the population in the Pacific Islands has sewerage systems, which eventually end in the river and sea. Septic tanks and pit latrines in low-lying areas, atolls and sand and coral islands enhance the leaching of waste into waterways, which worsens during floods (Easter 2010). Diarrhea is common in Pacific Island communities and is a leading cause of death, particularly in children under five. Unfortunately, the people don’t see the relationship between illness and waste management (SPREP 2010j). In Kiritimati Island, the people only realised the connection between their flush toilets and polluted groundwater when a red vegetable dye was poured into one of the toilets’ and a pink solution appeared in one of their wells (Easter 2010, SPREP 2010e).

Although some urban areas of Pacific Island countries have sewerage systems, 90 percent of the region’s population relies on using on-site systems such as pit latrines, pour flush latrines or flush septic tanks. According to Dr Leonie Crennan, who has worked on sanitation issues in the Pacific region, these systems are acceptable when properly located away from sensitive waterways and coastlines; they are not advisable for atoll countries with vulnerable groundwater systems (SPREP 2010j).

Fiji with a population of just over 800,000 uses a minimum of 66-million plastic bags annually; meaning 83 plastic bags per person per year (Easter 2010, Nair 2010). For example, waste from the more than 50,000 people in squatter settlements in Suva and from people living in rural areas, without access to rubbish collection services, usually ends up in the nearest bushes, roadside, river or sea as it is too far and expensive to take their waste to the Naboro landfill (Nair 2010). An observer once reported that she visited a shantytown on the outskirts of Suva where Fijians and Indians live, side by side, in squalor and that the only sandy beach she visited was covered in rubbish – plastic and nappies (Easter 2010). People regard proper waste management as someone else's problem. Even those who pay for the removal of their garbage do not care where it goes and what is done to it – just as long as it is taken away (Easter 2010, Nair 2010).

The Suva City Council in Fiji spends F$2.8 million to collect around 24,500 tons of solid waste a year consisting of household, green/garden and other municipal waste for disposal at its Naboro landfill (Yao, Lao and Taoba no date). With such amount of waste to be handled from only one of the municipalities that use the landfill, it will be exciting to see if it is in operation for the 18-25 year period it was commissioned.

Waste management is acute in heavily populated atoll nations such as Kiribati where over 40,000 people live on South Tarawa and generate more than 6,500 tonnes of rubbish annually (Easter 2010, SPREP 2010a, 2010c, Takesy 2010). Over 80 percent of that waste can be recycled or composted but are simply swept into big piles in the middle of villages where they become breeding grounds for rats and diseases.

During the International Waters Project (IWP) 2000-2006, the largest number of nations tried to address waste management (SPREP 2010b, SPREP 2010h). Of the 14 IWP Pilot Communities that were involved in this US$12 million over 7 years project, eight were on waste reduction compared to the four for enhancing coastal fisheries and two for freshwater protection. Both the enhancement of coastal fisheries and the protection of freshwater protection are associated with poor waste management. The success of IWP will depend on whether the funded initiatives fizzled out at the end of the project.

With the total land area of a mere 181 square kilometres and a population nearing 60,000, the waste collection and disposal system has been expensive for the Government, which in five years constructed and closed four separate dumpsites on Majuro Atoll (Chutaro 2010). Majuro does not have a modern sanitary landfill and the current dumps are located right on the shoreline where much of the mixed (organic, hazardous, recyclable) waste simply overflows into the sea. Majuro households are encouraged to dispose all of their waste into large skip bins located on the main road. These bins are frequently overflowing creating an unsightly and unhealthy

environment; many people continue to put their garbage in pits or throw them in the sea even though there are bins located throughout Majuro Atoll.

A social and economic baseline survey of Jenrok, the IWP pilot community on Majuro Atoll found that many of the 2,000 people in this congested urban community lack even the most basic services, such as access to fresh water and housing. In endorsing the first survey-study detailing the root causes of poverty, waste management issues, governance and social difficulties in a community in the Marshall Islands, President Kessai Note explained that the report provided a snap shot of an urbanized population that has become inundated with waste and pollution (Chutaro 2010).

The village of Jenrok with its population of 1,814 generated two tons of trash per day - that's about 1.06 pounds per day per person (Chutaro 2010, Easter 2010). The population of Majuro is producing an average of nearly 30,000 pounds or 15 tons of trash per day, which equates to nearly 11 million pounds or 5,475 tons of trash being produced annually in the nation's capital alone. The waste analysis found that 50 percent of Jenrok's garbage (by weight) was green waste, 20 percent was recyclable aluminum, PET plastics, cardboard, and an astounding16 percent consisted of disposable diapers. If people in Jenrok composted and recycled all their current garbage and used cloth diapers it would reduce its waste by 86 percent - leaving only 14 percent to be collected and sent to landfill (Chutaro 2010).

In the Cook Islands, an economic valuation of water pollution by the Cook Islands IWP revealed that water pollution was costing Rarotonga NZ$7.6 million (US$5.4 million) every year. The study by Dr Stefan Hajkowicz of CSIRO, Australia, and Cook Islands consultant Mr Petero Okotai, suggested that the costs are potentially avoidable with sound watershed management practices. The most significant estimated costs are through lost tourism income of $3.5 million each year (47 percent), bottled water purchases (20 percent), and healthcare costs from water quality related illnesses (13 percent) (Menzies and Brown 2010).

There is currently no chemical water treatment in Rarotonga and the people are advised to boil their drinking water because the coarse gravel filters now used can remove the large objects from the water but not the bacteria. In spite of the more than $115,000 spent yearly on household water filters (Easter 2010, Marsh 2010), the quality of tap water is well below the international safety standards with faecal coliform exceeding acceptable levels at most intakes around Rarotonga (Marsh 2010, Menzies and Brown 2010). A challenge in the Cook Islands as elsewhere in the Pacific Islands is to achieve a balance between the need for the supply of clean drinking water to the community – and the attitude of many landowners who feel it is their 'right' to do as they wish on their land. In addition, many people in these communities do not consider water quality a problem because they have tough stomachs, but "those at risk include

the elderly, the children, the sick and the visitors to the island who expect a good, safe water supply" (Marsh 2010).

In Tuvalu, Mr Kelesoma Saloa, explained how "flush toilets and septic tank systems have been promoted in Funafuti as the most safe and hygienic way to dispose of human waste" (SPREP 2010e). Surveys have found the septic tanks to be inappropriate for an atoll environment. According to Mr Saloa, 'many of these septic tanks were not constructed properly to begin with. Even when these systems are well constructed, Tuvalu's high groundwater levels, and porous soils make this technology a potential health hazard. In the densely populated areas of Alapi and Senala many of these septic tanks are now discharging directly into the ground water. The septic tanks are located too close to each other, too close to wells, and to homes,' (SPREP 2010e). During high tide and heavy rain, the contaminated effluent from soakage pits overflows into low-lying residential areas, putting people at risk from illnesses such as hepatitis, typhoid, gastroenteritis and diarrhea (SPREP 2010h, 2010j).
In Tuvalu, rainwater is the only cheap and reliable source of potable water. Most ground water today is contaminated because of the extensive use of water sealed latrines, leakage from septic tanks, and from pigpens. The result according to Mr Saloa, is an algal scum along the lagoon shoreline adjacent to the pilot communities. A small number of wells is used for washing clothes, flushing toilets, bathing, and other daily uses (SPREP 2010e).

In PNG, according to Mr Madu, the people in Barakau have disposed of human and animal waste in the same way they have done for generations but the problem is the huge increase in the number of people in the village and the quantity of waste they discharge into the environment (SPREP 2010i). The mounting piles of plastic accumulating in the sheltered western end of Barakau beach adds to other household waste from the row of toilets on the beach along the high-tide water line. People do not understand the linkage between poor waste disposal and their health and wellbeing.

Waste Management Issues

A diverse and imaginative range of initiatives from local communities to governments to identify possible low-cost solutions that can improve waste management at the national and regional levels are now promoted by SPREP. The IWP is not about funding infrastructure, such as water treatment plants or landfills but helping communities to identify the root causes so they can develop low-cost solutions that they can apply. In turn, these community-based solutions and management approaches can then strengthen the effectiveness of environmental management at the national and regional levels. The IWP illustrates how SPREP aims to generate maximum value from limited resources as increased regional collaboration and the pooling of limited resources to address urgent environmental issues such as waste management that are common among all Pacific Island countries (Easter 2010, SPREP 2010b).

According to Mr Sione Faka'osi, the National Coordinator for the Tonga IWP, it is important for Tongans to know that careless littering or overflowing septic tanks impacts on their underground water system and that correct and simplified information to educate them in ways of improving waste management reach all Tongans. The project promotes household composting, sorting and re-using of organic rubbish, home gardening and plant nursery using compost soil and organic farming (SPREP 2010g).

Mr Saloa blames the waste disaster on the low awareness of the impacts of poor sanitation on groundwater, human health, and the surrounding environment. Moreover, the limited financial and technical support available to install and maintain environmentally sound wastewater treatment systems worsens the problem. The priority is to provide Cabinet in Tuvalu with clear recommendations detailing the costs and benefits of all the solutions currently available to address the problem. The recommendations will include clear guidelines about the sort of financial, human and institutional resources required to support the management of safe toilet systems in Tuvalu (SPREP 2010e).

Dr Crennan and Mr Saloa agree that one option for Tuvalu is to introduce dry sanitation systems, such as composting toilets, that don't use water and don't discharge contaminants into the ground. There are no costs to operate these toilets apart from the local materials such as leaves, coconut fibre and sticks that must be added after use to enhance the composting process (SPREP 2010e, 2010j). Compost needs to be emptied from the collection chamber every nine months to two years depending on the size of the chamber and usage but this task is less onerous than moving a pit toilet around the compound, and less difficult than de-sludging a septic tank (SPREP 2010j). However, getting people to change their toilet habits requires a great deal more effort. Ironically, while many people in the Pacific Islands treat flush toilets as a symbol of advancement, composting toilets are fast becoming the choice for luxury lodges in sensitive areas of Australia and New Zealand (SPREP 2010j).

The Prime Minister of Samoa, the Chair of the Pacific Islands Forum at the time, warned of the health and environmental hazards associated with waste management that threaten development potentials and opportunities in Pacific Island countries. According to the Prime Minister, increased regional collaboration and the pooling of limited resources will help address urgent environmental issues such as waste management that are prevalent in all Pacific Island countries (Jackson and Menzies 2010, SPREP 2010d). Samoa is promoting best practice in waste reduction as part of SPREP's "Year of Action Against Waste" campaign and is advertising the Tafaigata Semi-Aerobic Landfill and Recycling Facility as a model for other Pacific Island countries looking to improve their waste management systems (SPREP 2010d).

According to Ms Sandeep K Singh, the National Coordinator of the IWP in Fiji, people need to work towards an integrated waste management system that minimises the impact of waste on the environment and public health. For this, Government and the business sector need to find ways to make it easier to recycle their plastics and compost their green waste. Ms Singh also highlighted the lack of recycling system in Fiji in spite of the activities of recycling companies that export waste and the concentration of plastic collection activities around the urban areas (Nair 2010).

The overlap in existing environmental legislation and conflicting roles and responsibilities is cited by Ms Singh as reasons for the mixed messages about proper waste management received by the people. To address the problem IWP in Fiji, formulated a project to provide a dollar value to the problem of waste management because people understand the magnitude of a problem better when a dollar value is assigned compared to giving scientific information (Nair 2010). According to Dr Padma Lal, who led the study, the introduction of incentives is more effective than relying on penalties that are difficult to police and enforce.

Fiji Parliament in 2005 passed the Environment Management Act (EMA) which in parts deal with waste management and pollution control. The Department of Environment required $500,000 to fully enact the Environment Management Act which was expected in 2008. However, Fiji is not following Vanuatu and Papua New Guinea in their ban on plastic bags but has commissioned the Naboro Landfill to replace the Lami Dump, the eyesore that served Suva from its beginning. Naboro landfill is managed by HG Leach Company Limited of New Zealand, a private company (Nair 2010). The rehabilitation of Lami Dump will cost around $1-million and is part of the $10-million provided by the European Union.

Waste Management Policies, Strategies and Plans

Strategies are needed to identify and address the 'root causes' of the waste disaster in the Pacific Islands including the sectoral, societal and governance weaknesses that need to be improved. Education and awareness must be improved through relevant research that provides the

information necessary for new and innovative waste management approaches. People must be convinced of the health and environmental risks associated with waste so they can make informed decisions to improve their situation (Easter 2010, Takesy 2010b).

Good partnership between stakeholders including Governments, donors, institutions and local communities must be established to determine the sanitation systems that are environmentally, economically, and culturally appropriate. IWP has demonstrated a two-pronged approach that has benefited Governments as well as the pilot communities and provided cost-effective ways to improve the management of waste at different levels and areas. In Funafuti in Tuvalu, for instance, with only 4000 people many of whom living on daily incomes of less that $AUD4 per day it is unlikely that the construction, operation and maintenance of a centralized, fully-reticulated, wastewater treatment system can be a viable option (SPREP 2010e).

Focus at all levels and by all stakeholders must be on reduction, reuse, recycling and getting people involved in waste management. The huge quantity of organic waste transmitted in the Pacific Islands represents the savings that can be made with better waste management practices. In addition, valuation studies should reveal who suffers what as a result of waste problems and why and how much they costs them. The studies can allow planners to get a better feel for how much money ordinary people and the governments can save by better managing their waste (SPREP 2010g, 2010h).

In Tonga a 2002 report on Tonga's "Priority Environmental Concerns" identified pollution as the biggest environmental problem facing the country and recommended that measures be taken to minimise the impacts of waste (SPREP 2010g, 2010h). The first activity is to encourage the separation of waste at the household level through composting. The high percentage of organic material that can be composted and used to grow fruit and vegetables will allow only the inorganic rubbish to be taken to the landfill which will save the country money and extend the life of the landfill. Moreover, the Tonga Community Development Trust is promoting composting as an effective alternative to the intensive use of pesticides and other agricultural chemicals that are polluting the lagoon and water lens. Composting allow people to learn how to keep their water and sea clean by reusing their green waste, return nutrients to the soil, contribute to the protection of cultural trees, and protect the environment in the long term (SPREP 2010m).

The Way Ahead

The Pacific Islanders should be mobilized to find simple tools, services and incentives to change the way they treat their waste. Governments must empower communities to manage their waste effectively. Incentives are required to show people that waste management can provide them benefits (Easter 2010). Quantifying the cost of medicines to families, the cost of sick days to

businesses and lost tourism and other opportunities and convincing people that such costs can be saved will motivate them to change their ways. If we know how much money we're losing because of waste problems, we'll have a better idea about how much money we could actually save by getting involved in waste management activities. The same information can be used by all governments when making decisions about how much to invest in waste management compared to other social issues.

New technologies and approaches must be used and promoted through training, education, and public awareness. For example, composting toilet is appropriate in many Pacific Island communities particularly those on coral atolls where the soil is porous and in delta areas where the water levels are high as the villages are virtually below sea level. Composting toilet also is better because it is cheaper, has low maintenance costs and does not need to be moved around the house (Easter 2010). Development of new and better technologies and alternatives require good research programmes that many of the countries do not have. Research and capacity building must be addressed because a lot more benefit will accrue from good research programmes that are forward looking and innovative.

The articulation of sustainable development is a good start for the Pacific Islands. These financially weak island nations need to seriously pursue development that will enrich the majority of their people while jealously guarding the health and integrity of their environmental resources that support all of the people's development activities. Poverty alleviation, gender and equity must be emphasised together with strategic policies and plans, good governance and local action. Of course, political commitment and funding is important to ensure that economic development and healthy environment are simultaneously attained in the Pacific Islands.

SPREP's IWP provided practical lessons to develop a Master Plan to improve the management of solid waste in the region. The Regional Solid Waste Management Strategy adopted in 2005, is the blueprint for improving the management of solid waste throughout the region (Anonimous no date, SPREP 2010l, Yao,Lao and Taoba no date). It should be the basis of national strategies developed to put in place strategies and activities for the proper management of waste. The countries should now individually and collectively commit themselves to better manage their wastes which can provide opportunities that are non existent at present.

Pacific Islands are now at the cross road. The people today have the opportunity to take leadership and shape the future of life in these islands and they should do it properly while they have the time. One lesson that should now be clear to all is that what ever is done to the environment will be reflected in its services to humanity, which cannot be independent of the environment. Pacific Islanders must do all in their power to ensure that they live within the bounds and limits determined by the natural systems.

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OCEAN ENERGY OPPORTUNITIES AND CHALLENGES IN THE PACIFIC ISLANDS REGION WITHIN THE CONTEXT OF CLIMATE CHANGE.

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Abstract

Pacific Island Countries (PICs) have traditionally been heavily dependent on imported fossil fuel to meet their energy needs. Over recent years PICs have been exploring several sources of renewable energy. This paper focuses on the opportunities and challenges ocean energy offers PICs in the future carbon constrained world. While a number of different technologies have been proposed wave energy (where the energy of the surface wind waves is used to produce electricity by a variety of devices installed on the surface of the sea) and ocean thermal energy conversion or OTEC (which uses the temperature differential between cold water from the deep ocean and warm surface water) have been the main focus of research in PICs. Tidal energy has relatively less potential for development in PICs. This paper surveys some recent developments in the commercialisation of ocean energy primarily in Europe, North America, Australia and New Zealand. It is rarely noted though that research and development of ocean energy has also been undertaken in PICs for over four decades. The paper goes on to examine research and development in relation to ocean energy in PICs during this period. Despite this research and development it will be argued that the lack of credible peer reviewed scientific data on the nature and scale of this resource remains the major obstacle to its future development by PICs. The paper then considers a number of policy, legal and financial challenges that will need to be overcome if the potential of ocean energy as a source of renewable energy for PICs is ever to be realised.

Keywords: wave and tidal energy, OTEC, barriers to renewable energy in pacific island countries

Background and introduction

Pacific Island Countries (PICs) have traditionally been heavily dependent on imported fossil fuel to meet their energy needs (Woodruff 2007). Per capita consumption of energy in pacific island economies is closely linked to per capita gross domestic product (GDP) and the combined effect of low GDP, high energy prices, small population density and remoteness means PICs are extremely vulnerable to external economic and energy crisis (Jafar 2000). Several academic and policy studies over recent decades have highlighted that unless efforts are made to increase efficiency of energy use and move towards greater use of renewable energy sources, increases in demand for imported fossil fuels will place even greater burdens on PIC economies and their environments (Reddy 1998).

In response to the dual challenges of climate change and energy security PICs have been exploring several sources of renewable energy including small hydro-power, solar energy (both photovoltaic systems and solar hot water), wind energy, biofuels (such as coconut oil and bagasse) hybrid solar and diesel systems and various forms of ocean energy (Roper 2005). Accordingly over the last 20 years various national, regional and civil society policy initiatives and programs have sought to assist PICs in the development of their abundant renewable energy resources (for further details see for example Roper 2005; Yu and Tapling 1997; Pacific Islands Forum 2010; and SOPAC 2010a). These programs have included studies by the Energy Working Group (EWG) of the Council of Regional Organisations of the Pacific (CROP), the Secretariat of the Pacific Community (SPC),the South Pacific Regional Environment Programme (SPREP), the Pacific Islands Applied Geoscience Commission (SOPAC) and the Pacific Power Association (PPA) (Marconnet 2007). For example, a *Pacific Islands Energy Policy and Plan*, was developed by EWG, which contains both energy policy and planning components (Marconnet 2007). Similar projects include the Pacific Renewable Energy France Australia Common Endeavour programme which, with funds from France and Australia, implemented solar projects in the Marshall Islands, Tonga, and Vanuatu, as well as a wind project in the Cook Islands (Marconnet 2007). SOPAC has been involved in a wide range of renewable energy projects across a range of renewable energy sources including biomass, hydroelectricity and photovoltaics (Marconnet 2007). SOPAC has also implemented the Pacific Islands Energy Policies and Strategic Action Planning to develop and review energy policies in Pacific Islands, as well as supporting analysis on related matters such as studies of tariffs studies, rural electricity frameworks and wind energy development (Marconnet 2007).

This paper focuses on the renewable energy opportunity ocean energy offers PICs. For more than 100 years technologies that harness energy from the oceans have been under development. While a number of different technologies have been proposed the three main areas of research and development have been hydrokinetic energy (where the energy of ocean (or fluvial) currents and tides is captured by devices which are installed under the surface of the water); wave energy (where the energy of the surface wind waves is used to produce electricity by a variety of devices installed on the surface of the sea); and ocean thermal energy conversion

or OTEC (which uses the temperature differential between cold water from the deep ocean and warm surface water) (Soerensen and Weinstein 2008).

The first section of the paper begins by briefly surveying some recent key developments in the commercialisation of ocean energy primarily in Europe and North America. The paper then highlights research and development in relation to ocean energy in PICs over the past 30 years and considers which PICs appear to be best placed to take advantage of ocean energy. The paper then goes on to offer some comments on a number of policy, legal and financial challenges that will need to be overcome if the potential of ocean energy as a source of renewable energy for PICs is ever to be realised on a substantial scale and suggest some possible questions for future research in relation to ocean energy and PICs.

Recent progress in commercialisation of ocean energy

After many decades of research and development, in the last few years a number of new commercial scale ocean energy plants have been constructed or are currently under construction around the world especially in Europe and North America. In both Canada and France, for example, the commercial generation of electricity from tidal energy has been proved over many years (World Energy Council 2009). More recently a number of new tidal energy plants have been constructed, are under construction or are proposed including include tidal energy projects in Nova Scotia, Canada (Doelle 2009), the Sihwa tidal power plant in Gyeonggi Province South Korea, the proposed Kaipara Harbour tidal energy plant on New Zealand's North Island and more recently a proposed tidal energy plant in Clarence Strait north-east of Darwin, Australia (Leary and Esteban 2009a; Leary and Esteban 2009b). In the case of wave energy, projects either in operation, under construction or proposed include the Pelamis project (a commercial wave farm installed and now operational on a pilot scale in Portugal) the SeaGen project (recently installed in Stranford Lough in Northern Ireland) and prototype devices such as the Wave Dragon which has been connected to the Danish electricity grid at Nissum Bredning since 2003 (Leary and Esteban 2009a).

At least three companies operating in Australia are also involved in the testing of prototypes, and in the last few months at least one of those companies, Carnegie Wave Energy, has moved to full scale commercialisation of their proprietary technology (Leary and Esetban 2009a). In December 2009 Carnegie commenced construction of a 5MW wave energy project off the coast of Perth which is expected to be in operation by 2011 supplying electricity to some 3,500 homes or the equivalent of 500,000 tonnes of avoided CO_2 emissions over the life of the project (Carnegie Wave Energy 2010)

While there was much interest in the 1970s and 1980s in the potential of OTEC as a renewable energy technology, in more recent years the commercial interest and research and development in relation to OTEC has not kept pace with that of tidal and wave energy. A number of companies such as the US based Lockheed Martin and smaller companies such as Sea Solar Power, as well as Japanese companies like Xenesys Inc aim to commercialise OTEC

technology. But to date development of OTEC on a commercial scale has yet to be achieved. Most investment of any significance is directed towards tidal and wave energy.

Thirty years of research and development of ocean energy in the Pacific Region

While moves towards commercialisation of ocean energy has gained pace in Europe, North America, Australia and New Zealand it is rarely noted that research and development of ocean energy has also been undertaken in several PICs and that some of that research continues today.

As early as 1981 a trial of OTEC technology was undertaken in Nauru. From 1981 to 1982 the Tokyo Electric Power Company (TEPCO) and Toshiba installed and began technical trials of a mini-OTEC trial facility on the west coast of Nauru (Wade et. al 2004). This "was the first land based OTEC plant in the world to produce net power; it was [at that time] the highest power OTEC plant ever operational and the first to feed power to an operating commercial grid" (Wade et.al 2004). More recently in August 2008 Japanese company Xenesys Inc and the Pacific Petroleum Company Group established a joint venture based in Tahiti to conduct commercial and technical feasibility studies for OTEC in French Polynesia, New Caledonia and Vanuatu. In October 2008 Xenesys reportedly was looking at a number of possible sites for construction of an OTEC plant in Tahiti to supply electricity to facilities such as a hospital and an industrial site (Xenesys 2010). The current status of these projects is unknown.

Pre-dating early studies on OTEC, tidal energy was considered in a feasibility study in 1976 in the Cook Islands (Wade et. al 2004).The forerunner of SOPAC (the ESCAP Coordinating Committee for Offshore Processing) commissioned a feasibility study of flow through channels of the Cook Islands. But this study concluded that further development of the resource was not viable (Wade et. al 2004).

The potential of wave energy in PICs has also been subject to several detailed studies. Thus from 1987 to 1995 a wave energy resource assessment was performed for SOPAC by a Norwegian firm, OCEANOR, with funding from the Norwegian Agency for International Development (NORAD) (Scottish Enterprise 2005). The study was undertaken in Rarotonga in the Cook Islands, Kadavu in the Fiji Islands, Tongatapu in Tonga, Funafuti in Tuvalu, Efate in Vanuatu and Upolu in Samoa (SOPAC 2010b). In 2002 SOPAC and U.S. Wave Energy Inc entered into a memorandum of understanding agreeing to expand on this earlier work. Further review of data obtained in earlier studies identified promising sites for wave energy near Muani Village on the island of Kadavu in Fiji and subsequently conducted a feasibility study of this site (Mario 2003). Fiji's Department of Energy and Rural Electrification Departmental Strategic plan 2005-2007 proposed construction of a wave energy plant at Muani (subject to availability of funding) but it is not clear if that project ever proceeded (Johnston 2005). Full feasibility studies for sites in Samoa and Tonga were also proposed in 2002. Again it is also not clear if those studies were undertaken (Scottish Enterprise 2005).

Apart from these studies the only clear example of possible commercial interest in wave energy in the Pacific that I have been able to identify are sites on the islands of Lifou and Maré

islands in the Loyalty Islands, New Caledonia that have been investigated by Société de Recherche du Pacifique (SRP). SRP is the sole distributer of Pelamis wave energy technology in the South Pacific. SRP's web site suggests further feasability studies are underway (SRP 2010). But the current status of the project is unclear.

Challenges for future development of ocean energy

While clearly there has been some interest in ocean energy in the Pacific there are still a number of major barriers to further widespread development of ocean energy. The following discussion canvasses some of these and offers a few brief comments on how they may be overcome

Lack of scientific data on nature and scale of resource

A necessary pre-condition to the commercial and pilot scale ocean energy projects underway in Europe, North America, Australia and New Zealand etc was a comprehensive scientific understanding of the nature and scale of the energy resource to be exploited. One of the major barriers to exploitation of ocean energy in PICs is the lack of data on the nature and scale of the resource in individual PICs. Despite the interest shown in various forms of ocean energy in the Pacific (including the examples mentioned above) there is little easily accessible useful scientific data on the potential of these resources in the mainstream scientific literature. For example, a brief search of published peer reviewed scientific literature in the Science Direct database by the author conducted for the purposes of this paper failed to find any recent peer reviewed literature with useful information on the scale of ocean energy resources of the Pacific.

What information that is available is largely scattered in a few reports prepared for SOPAC and other agencies which are often difficult to source. In that respect it is worth noting work by both SOPAC and SPREP over the last decade which provides a starting point for future research and development. A number of such studies are worth noting. Firstly, a report published in 2001 by SOPAC (Mario 2001) suggests the Cook Islands, Fiji, Guam, Kiribati, New Caledonia, Samoa, the Solomon Islands and Vanuatu have the potential for OTEC plants and recommends further feasibility studies to look at possible options to build pilot demonstration plants at these sites (Mario 2003). Likewise a study of renewable energy in PICs by SOPAC (Fairbairn 1998) undertaken in 1998 noted potential for development of OTEC as "good" in five PICs (Cooks Islands, Fiji, Kiribati, Marshall Islands, and Nauru). The same report also noted that both Fiji and Tonga possessed good wave resources while 11 PICs (Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Niue, Palau, PNG, Samoa, Solomon Islands, Tuvalu and Vanuatu) were assessed as having definite potential but the extent of wave energy resources was noted as unknown. But the descriptive terms such as "good" used in these studies are vague and it is not clear on the face of these studies what the scientific basis was for these conclusions.

More recently in 2004 and 2005 the Pacific Islands Renewable Energy Project (a joint project of SPREP, the GEF, UNDP and Pacific Island countries) published a series of reports identifying opportunities for renewable energy in PICs. Table 1 below summarises the main conclusions of that project on the resource potential (and where relevant actual experience with such technology) of PIC wave energy, tidal energy and OTEC.

Again, while these later studies are much more detailed, the scientific basis for the resource assessments are unclear on the face of the reports. Clearly if PICs are ever to exploit their ocean energy resources in any meaningful way in the future, then further detailed scientific research is required to clearly identify which locations in which countries are best endowed with these resources, as well as the scale of such resources. These can then be followed by further studies of the economic and technical feasibility of the exploitation of such resources. Such research will be expensive and PIC countries do not have the financial resources and technical and scientific expertise to undertake such research without overseas assistance, a fact already acknowledged by SOPAC (SPOAC 2004).

Table 1: Ocean energy resource potential in Pacific Island Countries (Compiled from date extracted from Wade et. al 2004).

Country	Wave energy	Tidal energy	OTEC
Cook Islands	A 1987 joint Norwegian and SOPAC study suggests the wave resources of the Cook Islands are the best of any Pacific island country.[1]	A 1976 feasibility study of flow through reef channels for ESCAP concluded the resource was not suitable for development. No further data available since that study.	OTEC potential unknown although in 2003 Japanese company Xenesys Inc proposed carrying out a feasibility study, but due to lack of funding for the study it appears to never have been undertaken.
Fiji	Studies conducted in 1980 and the early 1990s suggest a substantial resource.	Tidal range and coastal conditions make development not economically feasible.	Studies conducted in 1991 by Japanese researchers suggest promising resources.
Kiribati	"Not great" and not considered practical. Unfortunate given absence of storms and typhoons that may pose a threat to wave energy converters in other countries.	Significant flow of tidal waters through lagoon channels during tidal flow periods but is intermittent in nature and therefore not considered suitable for development.	No specific surveys of the resource have been conducted but speculation is that resource is significant given local geomorphological conditions (i.e presence of atolls).
Marshall Islands	Proposed 300 kW wave energy project was proposed for Giugeegue island in 1990 but did	No data.	No data.

[1] The Cook Islands is a self governing democracy in free association with New Zealand.

	not proceed.		
Nauru	Low to modest wave resource not currently viewed as economically viable.	No data.	OTEC resource assessed as excellent. A technical trial of OTEC by Japanese companies took place in 1981 with construction of an experimental plant on the west coast of Nauru that produced a net power of 15kW. No further development in Nauru since then.
Niue	Good.	No data.	Good.
Palau	Modest but unlikely to be of sufficient size for commercial exploitation.	No data.	Good but regarded as uneconomic.
Papua New Guinea	Little data.	A number of possible locations for tidal energy plants have been studied. Buka Passage, Bougainville has been proposed as one possible viable site. But progress on this project unknown.	No data.
Samoa	Little data but assessments from Norwegian studies in early 1990s suggest moderate resource.	No data.	No data.
Solomon Islands	No assessment has been undertaken but extrapolating from data from Fiji and Vanuatu suggests significant potential to meet the Solomon Islands energy needs.	No data.	No data.
Tokelau	No measurements taken but speculation is the resource is moderate.	No data.	Resource considered to small for development. Power demand to small to warrant development.
Tonga	Significant. Proposed trials on Tongatapu's coastline in the 1980s did not proceed due to failure of proponent technology in other countries.	Possible potential noted in the late 1980s with at least one possible site considered. But the intermittent nature of the resource meant the proposed site was regarded as unviable.	Potential unknown.
Tuvalu	Moderate.	No data.	Large potential. But independent analysis considered the smallest economically attractive

			installation to be far larger than the power demand of Funafuti.
Vanuatu	Significant resource potential which in theory could provide much of Vanuatu's energy needs.	No data.	No data.

Challenges for renewable energy development shared with other PICs and developing countries

Quite apart from the lack of detailed scientific data on the scale of these resources all PICs to varying degrees face a number of common barriers to expanded renewable energy development that need to be considered and overcome. Although not intended as an exhaustive list some of these barriers include:

- lack of awareness and knowledge of existing renewable energy options (Weisser 2004);
- limited expertise in design, installation, operation, and maintenance of renewable energy systems in PICs (Johnston 2005);
- poor policy planning (Woodruff 2007);
- legal and regulatory barriers including inadequate legal frameworks for renewable energy power sources and the onerous requirements for small power producers set by utility entities (Urmee et. al 2009);
- high capital costs (Urmee et. al 2009);
- existing foreign debt burdens which raise problems in obtaining financing for renewable energy projects (Weisser 2004); and on a related theme a lack of access to capital to develop such projects with renewable energy project competing with other more pressing priorities (Yu and Tapling 1997);
- lack of subsidies for renewable energy (Urmee et. al 2009);
- inadequate institutional and human resource capacities (Weisser 2004);
- markets that are too small to attract foreign investment in renewable energy projects (Woodruff 2007);
- lack of economies of scale (Woodruff 2007) and small size of electricity generation utility companies (Roper 2005);
- limited access to technology appropriate for their needs; (Woodruff 2007);
- poor investor perceptions (Woodruff 2007);
- lack of co-ordination in aid donor projects and programs (Forum for Energy and Development 1999).

Challenges specific to ocean energy technology

A detailed study of each of these is outside the scope of a short paper such as this and by themselves warrant further detailed research. But a number of these are particularly relevant to ocean energy and arguably present represent major barriers to significant development of ocean energy in PICs.

One of the most significant of these is access to funding for possible ocean energy projects. Access to both public and private sector funding is critical for the successful development of ocean energy projects. There has been a significant growth in investment on ocean energy in the past few years. Between 2004-2008 world capital expenditure on wave energy was estimated at £72 million and £55 million on tidal energy projects respectively (Scottish Enterprise 2005). Government investment in research and development of ocean energy technology has been particularly important to the emerging industries recent growth. In the U.K. for example, since 2004 the Department of Energy and Climate Change has allocated some £50 million for research and development associated with wave and tidal energy in U.K. waters (U.K. Department of Energy and Climate Change 2010). Similarly, in Australia, one of the most advanced commercial research development programs in relation to wave energy conducted by Carnegie Wave Energy has benefited from significant government grants, including a AUD$12.5 million grant from the Western Australian governments Low Emissions Energy Development Fund in 2009 (Carnegie Wave Energy 2010).

Perhaps even more significant for the long term development of ocean energy globally is the emergence of the interest of mainstream investment markets in the potential of ocean energy. For example, Carnegie Wave Energy has recently raised capital through several share issues on the Australian stock exchange including a $AUD 5.75 million capital raising in 2008 and a more recent share placement in December 2009 of $AUD 8.865 million dollars which was over subscribed (Carnegie Wave Energy 2010). Further re-enforcing the conclusion that ocean energy is now beginning to enter the main stream investment market are a series of buy recommendations from stock brokers and investment analysts (See Carnegie Wave Energy 2010).

But PICS simply do not have access to resources on such a large scale and any future development of their resources will therefore be heavily dependent on funding from other sources. So far as the author is aware there have been few studies of how multi-lateral lending agencies and other funding sources such as aid programs might be utilised to source funding for ocean energy projects in PICs. In that respect earlier more generic studies such as that undertaken by SPREP as part of the Pacific Islands Renewable Energy Project in 2005 may serve as a useful starting point (Wade 2005). But the limited studies that have been undertaken so far suggest many of these existing mechanisms are not particularly responsive to the needs of PICs. Thus as Roper (2005) has observed even though many possible mechanisms do exist

> "No special arrangements have been made by the international community to help with the hard work of developing viable [renewable energy] projects and in having them

> submitted [under such mechanisms]. Moreover, it is likely that few SIDS [Small Island Developing States] will benefit from the Kyoto Protocol's Clean Development Mechanism (CDM); the approvals for CDM projects will concentrate on large schemes, not small ones such as those in SIDS"

A related issue which has been identified in developed countries is the need for feed-in tariffs to provide additional financial incentive for further industry investment in ocean energy (Leary and Esteban 2009a). But here again it is questionable if any PIC has either the financial capacity or the existing legislative basis for feed-in tariffs to encourage investment in ocean energy in their respective jurisdictions. The potential of import duties, taxes, licence and concession fees and other government charges to act as barriers to deployment of renewable energy technologies in PICs also stands out as another area ripe for potential further detailed research. There is very little data on the impact of these measures on the adoption of renewable energy in PICs in general, and as far as the author is aware no research has been undertaken on the impact of such measures on development of potential ocean energy projects in PICs.

Even in developed countries where the commercialisation of ocean energy is now quite advanced, the lack of clear regulatory frameworks for ocean energy is emerging as a crucial barrier to further commercialisation of ocean energy requiring urgent legislative intervention (Leary and Esteban 2009a). Key issues warranting law reform even in developed countries include inadequate and in some case quite cumbersome legislative frameworks for assessing the potential environmental impact of ocean energy projects (often such legislation is designed to regulate energy technology with far greater environmental impact- relative to other technologies the environmental impact of most ocean energy technology is benign); the complexity of existing licensing and regulatory frameworks when applied to ocean energy; and the limited application of existing legislative frameworks beyond the territorial sea.

Although there is little experience with actual pilot or commercial scale ocean energy projects in PICs, in the absence of specific legislative initiatives in individual PICs similar barriers might also be anticipated. The lack of both detailed energy legislation (and in particular renewable energy legislation) in many PICs might also arguably complicate things further for future proponents of ocean energy projects in PICs.

In terms of international law the jurisdiction of the coastal state to regulate ocean energy projects within its internal waters, territorial sea and exclusive economic zone is clearly recognised by the 1982 *United Nations Convention on the Law of the Sea* (LOSC) (Leary and Esteban 2009a). This is beyond doubt given the sovereignty over internal waters and the territorial waters recognised by the LOSC. The only qualification to this is the responsibility of the coastal state not to interfere with the right of innocent passage in the territorial sea (Leary and Esteban 2009a). Even where there is potential conflict between the rights of the coastal state in the territorial sea and the right of innocent passage existing mechanisms (such as the mechanisms by which the International Maritime Organisation (IMO) designated sea lanes and prescribes traffic separation schemes) appear to be robust enough to deal with such conflicts (Leary and Esteban 2009a). A similar situation applies within the EEZ where the provisions of

Article 56(1) of the LOSC provide a firm basis in international law for the exploitation and regulation of exploitation of ocean energy in the EEZ. But absent clear regulatory regimes within areas of national jurisdiction it's difficult to see how PICs will be able to effectively exercise the rights recognised by international law.

Conclusion

In this short paper I have sought to offer some insight into the opportunities and challenges for the development of ocean energy in PICs. While on the surface one might expect the oceans that surround these countries offer a valuable renewable energy resource, it appears the likelihood of commercial exploitation of ocean energy in PICs is still many years off. While there have been major advances in commercialisation of ocean technology in developed countries in the past few year (more so for wave and tidal energy than OTEC) major challenges still have to be overcome even by developed countries. For PICs the challenges are even greater. A lack of scientific data on the nature and scale of the resource as well as a range of unique economic and legal obstacles mean much more work still needs to be done by scientists, other academics, policy makers, civil society and legislators before PICs can ride the new wave of promising ocean energy technologies to a cleaner more secure clean energy future.

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The Pacific Regional Strategy and Arrangements for Hyogo Framework for Action Implementation

Emily Artack

on behalf of Mosese Sikivou
Manager Community Risk Programme
Pacific Islands Applied Geoscience Commission (SOPAC)

International Seminar on Islands and Oceans 2010
"Management and Conservation of Islands"
Pacific Disaster Management
Nippon Foundation Building, Akasaka, Tokyo, Japan
January 20-22nd 2010

Outline

- Disasters in the Pacific
- Pacific Islands Applied Geoscience Commission (SOPAC)
- Pacific DRR and DM Framework for Action 2005 – 2015
- Pacific DRM Partnership Network
- Pacific Disaster Net: www.pacificdisaster.net
- DRM National Action Plans
- Recent Highlights
- Key Priorities

SOPAC

Samoa Tsunami

29th September 2009

Total deaths: 143

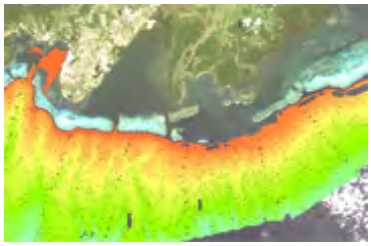
Estimated damage: US$104 million

Source: WB Policy Note: Not if but When, 2006

SOPAC

SOPAC

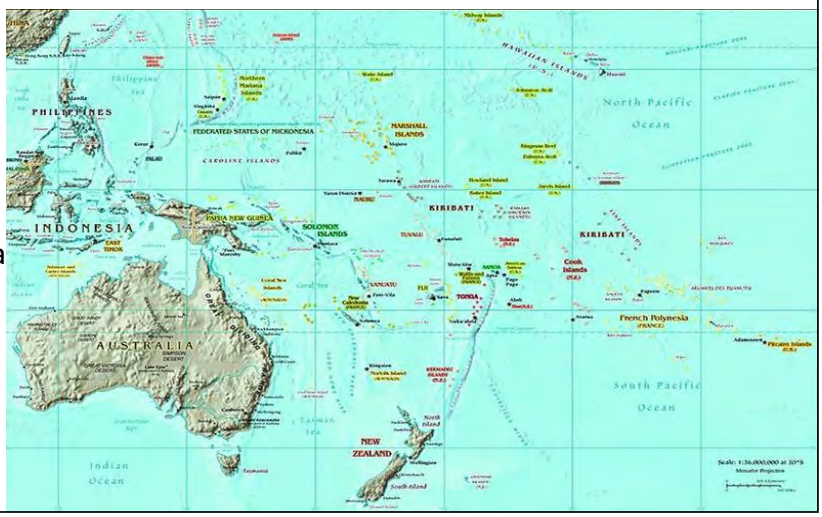
- Pacific Regional Intergovernmental Organisation
- Established 1972
- 21 members
  - 14 Island States; 5 Territories; Australia and New Zealand
- Member of Council of Regional Organisations in the Pacific
- Regional centre
  - Applied science & technical expertise and support
  - Coordinate DRM capacity building for PICs
  - Research, development and management of non-living resources in ocean and island systems
  - Addressing issues relating to seabed resources, energy, maritime boundary delimitation and monitoring of ocean processes.

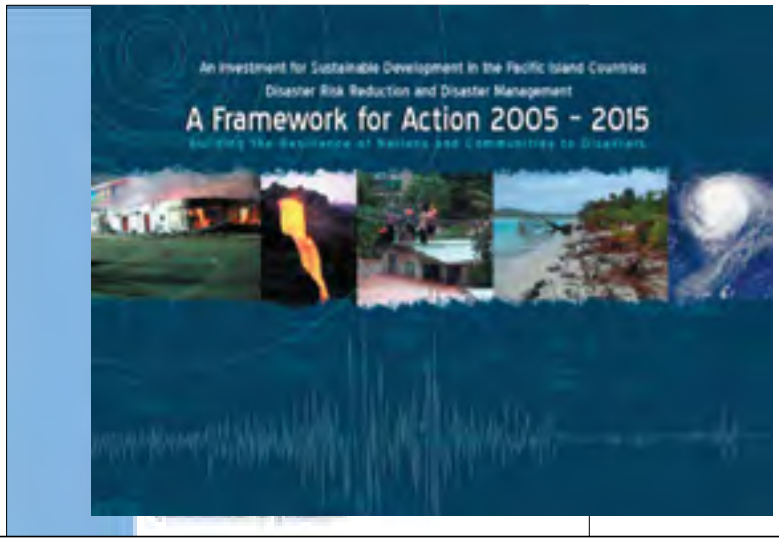


SOPAC Member Countries

- **MEMBER COUNTRIES**
- Australia
- Cook Islands
- Federated States of Micronesia
- Fiji Islands
- Guam
- Kiribati
- Marshall Islands
- Nauru
- New Zealand
- Niue
- Palau
- Papua New Guinea
- Samoa
- Solomon Islands
- Tonga
- Tuvalu
- Vanuatu

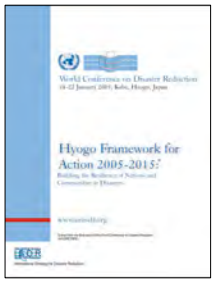
- **ASSOCIATE MEMBERS**
- American Samoa
- French Polynesia
- New Caledonia
- Tokelau





Pacific DRR & DM Framework for Action 2005 - 2015

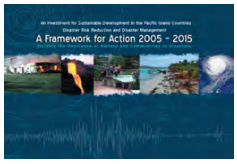
SOPAC



Hyogo Framework for Action, 2005

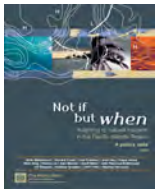
Pacific Islands Framework for Action on Climate Change, 2005

Pacific Plan, 2005



Pacific DRR & DM

Framework for Action 2005 - 2015



WB Policy Note

Not if But When, 2006

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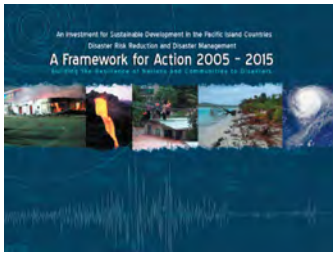

- Theme 1: Governance – organisational, institutional, policy and decision-making frameworks
- Theme 2: Knowledge, information, Public awareness and education
- Theme 3: Analysis and evaluation of hazards, vulnerabilities and elements at risk
- Theme 4: Planning for effective preparedness, response and recovery
- Theme 5: Effective, integrated and people-focused early warning systems
- Theme 6: Reduction of underlying risk factors

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Pacific Platform for Disaster Risk Management

- Annual Regional Disaster Managers Meeting
- Annual Meeting of the Pacific DRM Partnership Network
- Biennial Pacific Regional Meeting of Pacific CEOs for Finance/Planning and DRM

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Pacific Platform for DRM

- **Concept**
  - Bring together key DRM players: disaster managers, partners/donors, CEOs for Finance/Planning and DM
- **Benefits**
  - Demonstration of high level commitment to DRR and DM
  - Raise the profile of participation in DRR and DM
  - Highlights achievements at the global level
  - Strengthen the voice of civil society
  - Ensure that annual meetings of PICs and partners are mutually reinforcing

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Pacific Platform for DRM

- **Objectives**
  - Raise the Pacific profile extra-regionally and its influence with respect to the GPDRR
  - Consider outcomes of the GPDRR and implement as appropriate for the Pacific
  - Effectively implement and report on the progress of the Pacific DRR and DM Framework and HFA
  - Improve coordination amongst stakeholders including governments, donors, UN agencies, NGOs and also CC stakeholders

SOPAC

Background

- Formed in February 2006 to assist Pacific countries in developing and implementing disaster risk reduction and disaster management strategies to help ensure sustainable development.
- First meeting in February 2006
  - April 2007
  - July 2008
  - May 2009

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Priorities

1. Establishment of a regional **information database** to provide Pacific countries with an overview of existing Pacific Island Country DRR and DM capacities, needs, information sources, resources, policies, plans and regulations.
   - Pacific Disaster Net www.pacificdisaster.net

2. Development/implementation of **DRM National Action Plans** for Pacific countries in line with the Regional Framework.

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Pacific Disaster Net

SOPAC

www.pacificdisaster.net

Portal for DRM
in the Pacific Region,
launched September 2008

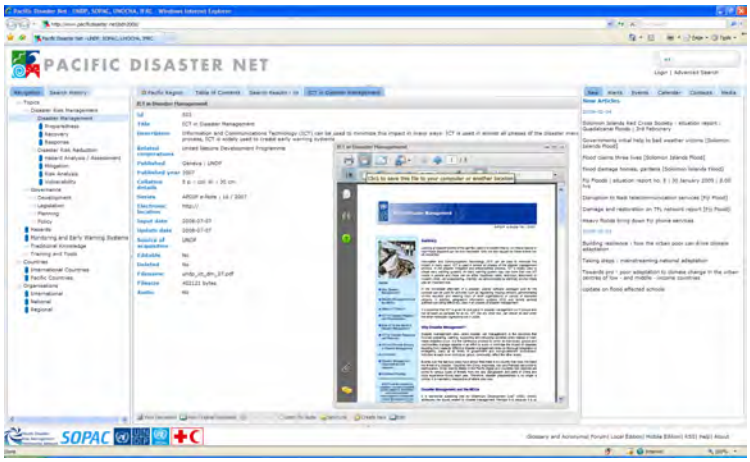
- Alerts (automatically updated)
- Documents (+3000)
- Events (+1200)
- Contacts (+470)
- Calendar (+190)
- Media (19 Videos)
- Country Pages
- Forum
- Wiki (Help / How to …)
- Weekly Newsletter

- Hosts up-to-date and live information - in a range of formats and from different sources
- Relating to Governance, Risk Assessment, Early Warning and Monitoring, Disaster Risk Management, Training and Tools
- Available online and offline (Local Edition) on DVDs - allowing a much wider outreach even into communities without Internet access
- Developed by SOPAC, IFRC, UNDP-PC and OCHA as initiative under the PDRMPN

SOPAC

Documents

More than 3000 Documents, enhanced and updated every day.
Information and data with multiple access points for experts and inexperienced users.



- Search
- Browse & Filter
- Advanced Search
- New Documents
- Display with different formats (to cover narrow bandwidth and even offline access)
- Share by email and link
- Print and download

SOPAC

Alerts & Events

- Alerts are automated and frequently imported from different sources, including CAP (Common Alert Protocol) as new standard.
- Google Maps and Google Earth (Plug-in) implemented.

More than 1100 Events are available

and will be enhanced in the future.

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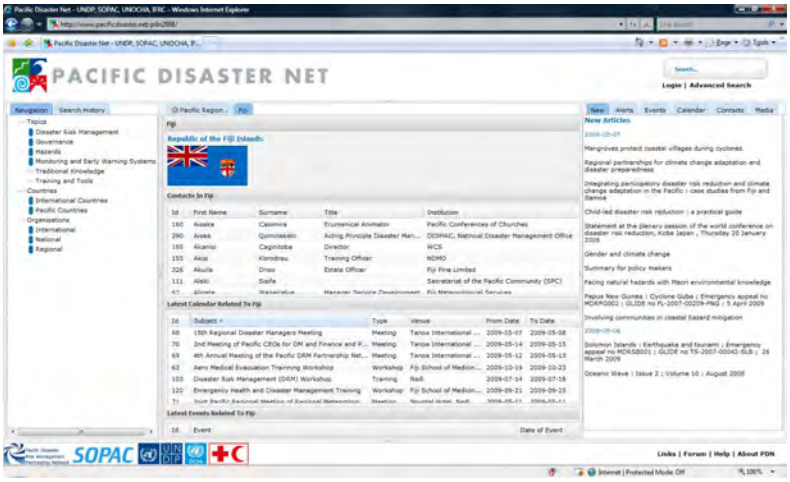
Contacts, Calendar & Country pages

•Currently 470 Contacts for DRM in the Pacific Region
•Calendar with Meetings, Trainings, Conferences etc. is available
•Country pages with filtered content from above, additional Links and Facts



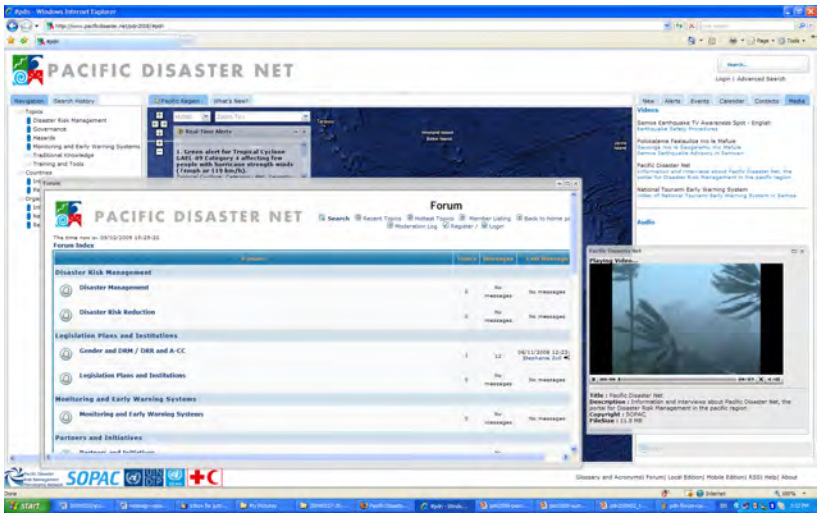
Registered users can contribute information.

New content is accessible via RSS feeds and in the future as Newsletter by email.

SOPAC

Videos, Forum, Interactive Handbook / Wiki, future Image Archive …

Videos, Help – 'How to use PDN' as interactive handbook and including Animations, Glossary, a future Image Archive, Audio files etc. add to the range of current and future content.



A Forum is available as
•public and interactive 'meeting place'
•for discussions online,
•for questions and answers,
•message transfer and
•posting information.

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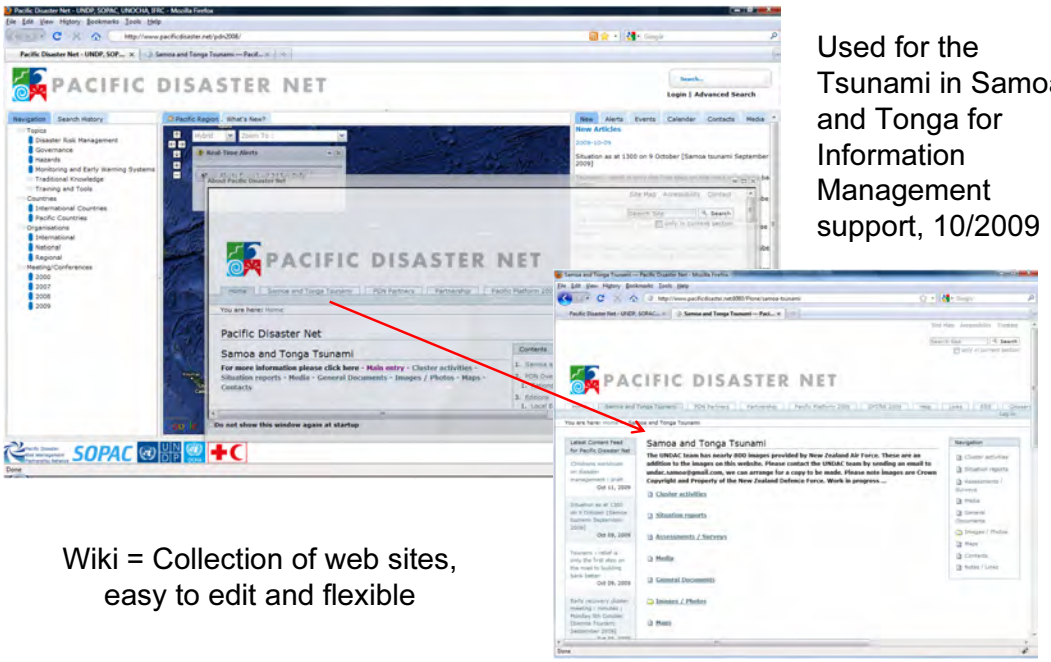
Wiki
Tsunami Samoa / Tonga IM support



Used for the Tsunami in Samoa and Tonga for Information Management support, 10/2009

Wiki = Collection of web sites, easy to edit and flexible

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Local Edition (Offline), Mobile Edition (PDA)

Pacific Disaster Net is available online – but also **offline** as 'Local Edition', on DVDs which will be frequently updated and distributed, allowing a much wider outreach even into communities without Internet access.
A 'Mobile Edition' for PDA's like BlackBerry etc. is in development and also including data subsets for download.

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Future Plans & Contact

Future plans

- IM for DRM in the Pacific region (Pacific DRM Partnership Network Portal, Baseline data, Assessments & National Observatories)
- NDMO Websites
- Search Engine
- Country missions with Introductions, Trainings and Content collection
- Newsletter
- Content feeding, Data population, Evaluation and Surveys
- Improve and enhance functionalities (Image Archive, Maps, ...)
- Educational / Awareness / Kids content (One *Pacific Disaster Net* Per Child)
- *and more …*

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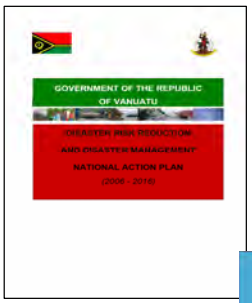
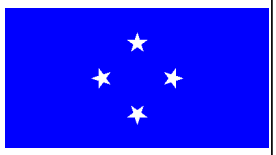
DRM National Action Plans



Vanuatu



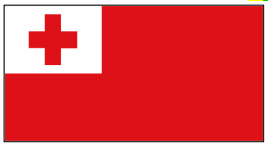
FSM

Fiji

Marshall Islands

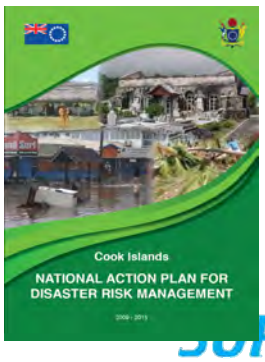
Palau

Tonga



Sol Islands

Cook Islands



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DRM National Action Plans - Stages

1. Pre-NAP Planning	2. Situation Analyses	3. NAP Development	4. Implementation Programme	5. Government Approval & Donor Consultation
•High level advocacy •Identification of in-country counterparts •Country engagement planning	•Information collection •Stakeholder consultation at different levels •Identification of key issues	•Validation and prioritisation of key issues •Development of actions	•Implementation structure •Costing •Financing strategy •Communication s strategy •M&E	•Presentation to Cabinet •Donor consultation •Implementation with Partnership support

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Key Priorities

- Continue **high-level political advocacy and leadership**, to seek genuine commitment for disaster risk management and climate change adaptation as key sustainable development imperatives at regional and national levels;
- Strengthen the collaborative **integration of DRM and CCA** at the regional and national levels and coordinated development and implementation of the national **DRM National Action Plan (NAP) and Climate Change National Adaptation Plan of Action (NAPA)**;
- Increase **community awareness and preparedness programmes**, and promote engagement and ownership of ground-level initiatives in DRM and CCA;
- **Harmonise terminology and concepts** in the area of DRM and
- **CCA agencies**;

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- Secure accurate and timely **baseline data and information** to support informed decisions
- **Broaden the Pacific DRM Partnership Network** to include relevant stakeholders, such as the private sector, utilities and services that are essential stakeholders for DRM and sustainable development to assist in the mobilisation of resources to support initiatives;
- Incorporate best practices and lessons learned from **traditional DRM practices** with applied scientific and technical methodologies and approaches;
- Strengthen **South-South** collaboration and coordination, specifically in sharing lessons learned and best practices,
- Mid-term **review of the Pacific DRM Framework** following on from mid-term review of the **HFA in 2010**.

SOPAC

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Thank you

Atoll Shoreline Response to Sealevel Rise over the Last 50 Years (Pacific Regional Island Shoreline Monitoring System - PRISMS)

Arthur Webb – Ocean & Islands Programme, SOPAC.

The International Panel on Climate Change (IPCC, 2007) indicates global mean sea levels have risen during the 20th centaury by approximately 170 mm and are estimated to be currently rising at a rate of about 3.1 ± 0.7mm yr^{-1}. Church *et al*. (2006) analysed sea level data for Funafuti, Tuvalu in the Central Pacific and derived a rate of 2 ± 1 mm yr^{-1} over the period 1950 to 2001, this is one of the few specific investigations of sea level available for the Pacific Islands region and indicates 100 mm ± 50 mm over the last 50 years. Mean measured Pacific Islands regional sea level rates derived from the South Pacific Sea Level and Climate Monitoring Project, 2007 suggests a regional mean rate of 4.87 ± 1.91 mm yr^{-1}, or around 100mm ± 40mm over the last 20 years, however this data record is acknowledge to be too short to yet be reliable.

Whilst significant uncertainty still exists with regards to regional sealevel variability and exact rates of rise there is sound evidence showing sealevel over the last half centaury has increased in the central western Pacific Islands region by mean annual rate of approximately 2mm yr^{-1} or approximately 0.1m over the last 50 years. This has prompted significant concern that sealevel rise has caused wide spread erosion in the Pacific Islands region yet few if any empirical studies testing the relationship of the present rates of sealevel rise and influence over erosion have been made. Given the heightened concern over the issue of climate change induced sealevel rise especially in atoll settings it is a matter of considerable concern that few empirical studies exist to guide our understanding and shoreline monitoring attracts little attention or funding from the international community.

The most anticipated physical impacts of sea-level rise on islands are shoreline erosion, inundation, flooding, salinity intrusion, and reduced resilience of coastal ecosystems (e.g. Leatherman, 1997; Mimura, 1999; Khan et al., 2002; Yamano et al., 2007). And it is commonly reported in non-scientific literature (e.g. Time Magazine. 20-27 August, 2001) that coastal erosion is already occurring due to climate change related sea level rise. Since the premise of shoreline erosion is not well supported by empirical data but rather appears to be based more commonly on non-expert opinion especially in the “popular media”. The Pacific Islands Applied Geoscience Commission (SOPAC) has as a matter of urgent priority worked to improve empirical understanding of shoreline response to sealevel rise and thus inform Pacific

Island member Governments and communities with empirical fact. It is also recognised that significant resources are being mobilised in the Pacific Islands region to support Climate Change Adaptation and these approaches frequently consider coastal vulnerability and shoreline defence measures in the face of sealevel rise. Within the context of climate change stress it is not possible to make informed decisions with regards to appropriate shoreline engineering or defence measures unless sealevel related shoreline dynamics are first understood. Without this we run the risk of mal-adaptation, wasting limited resources and possibly antagonising rather than ameliorating coastal vulnerability issues.

The SOPAC PRISMS (Pacific Regional Island Shoreline Monitoring System) initiative has studied shoreline position and overall island area over temporal scales of the last 20 to 60 years on 27 atoll islands in the Federated States of Micronesia, Kiribati and Tuvalu. Accurate comparisons of land area and shoreline position using historical aerial photographs with satellite imagery of the 27 islands show that 86% of islands have remained stable or have increased in overall area over the last 20 – 60 years. Thus within the islands studied the predominant trend is for stability and island area increase over the last 20 – 60 years – not a predominant trend of island area loss. The predominant trend of island stability and land area increase has occurred during the last 20 – 60 years a period during which sealevel is know to have risen approximately 0.1m.

To our knowledge SOPAC's PRISMS monitoring programme is the only system which has accurately measured shoreline response in atolls to current rates of sea level rise. Otherwise, much of what is purported to be understood with reference to atoll shoreline processes appears to be based on modelling and particularly the use of Bruun (1962). The Bruun Rule in its simplest form (as recommended by UNESCO http://www.unesco.org/csi/pub/info/info410.htm to determine shoreline vulnerability to sealevel rise) states that on soft shores for every incremental increase in sealevel a proportionate amount of erosion or land loss will occur. Since it is known that there has been an approximate 0.1m increase in sea level over the last 50 years we should, according to the Bruun Rule, expect a commensurate loss of land on soft shores of 10m. The results from PRISMS conclusively shows this has not occurred and the present common use of models based on the Bruun Rule to describe atoll shoreline response to sea level rise is inappropriate and fails to adequately explain the relationship between shorelines and present rates of sealevel rise. Given these facts we must also ask if the use of Bruun for future modelling scenarios has any relevance.

The results of PRISMS shows the crucial importance of developing adequate technical baselines and monitoring systems which provide empirical guidance with regards to how climate change

stress may manifest in Pacific Island environments. In this case PRISMS highlights how reliance on untested models and unwarranted credence given to non-scientific reporting has distorted current understanding of atoll shoreline processes and response to known rates of sealevel rise. However, it is important to note that many sectors pertinent to the Pacific Islands development and climate change adaptation aspirations (e.g. shoreline response, water supply and hydrology, oceanography, inundation, etc.) also critically lack investment in adequate baseline development and monitoring.

The irony is the huge emphasis and substantial resources being directed to climate change adaptation in the Pacific Islands, this unabashed enthusiasm is frequently unsupported by sound empirical understanding of the natural systems and environments in which these projects will be implemented (as highlighted by PRISMS) and thus may fail to achieve their desired results. Development partners must as a matter of urgency support sustained environmental baseline establishment and monitoring if we are to then implement effective climate change adaptation and development in the Pacific Islands.

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Rehabilitation of coral reefs by artificial efforts

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Akajima Marine Science Laboratory, Okinawa

Abstract

Rehabilitation of coral reefs by artificial effort means effort to replace equivalent lost habitats by actively measure such as the reconstruction of habitats and/or replanting of corals. It includes artificial improvement and/or creation of coral habitat through civil engineering and underwater silviculture and transplantation approaches.

Coral propagules for transplantation may be cultured using either asexual or sexual propagation of corals. The rehabilitation of coral reefs by means of asexual propagation is simple and less labour intensive compared to sexual propagation techniques. However, most of the transplanted pieces share the donor's limited DNA, giving the reef a smaller gene pool. On the other hand, sexual propagation may bring genetically more diverse corals, but is more expensive. Both techniques require device to protect the transplanted corals from predation by fish and coral-eating gastropods. Some 4-year old colonies of Acroporid coral *Acropora tenuis*, cultured from eggs and transplanted onto the seabed at Akajima, Okinawa, had grown to 20-25 cm in diameter and spawned for the first time in their life. Although the small scale of success so far may not be significant, given the wide range of degradation of coral reefs, our improved methods have proved promising to overcome the challenges for coral reef rehabilitation.

Keywords: Coral reefs, Rehabilitation, Cultivation, Restoration

Introduction

The decline of coral reefs worldwide leads an urgent measure for conservation and restoration. Climate change that causes coral bleaching and various local stresses from human activities such as red soil run-off, eutrophication, excessive fisheries, rampant over-development of land areas, and over use of coral reefs by tourism are driving reefs for functional collapse. Chronic outbreaks of crown-of-thorns starfish also cause degradation of coral reefs.

Coral reef conservation should be focused firstly on removing the chronic stresses and facilitating natural and long-term recovery. Without reduction of these stressors, artificial effort toward reef restoration and rehabilitation will not bring fruitful result. The present paper reviews some artificial approaches for restoration and rehabilitation of coral reefs with presentation of

recent technical development in Okinawa, Japan.

Rehabilitation of coral reefs by artificial effort

This strategy means efforts to replace equivalent lost habitats by active measure such as the reconstruction of habitats and/or replanting of corals. They include artificial improvement and/or creation of coral habitat through civil engineering (physical rehabilitation) and underwater silviculture and transplantation (biological rehabilitation) approaches. In places where the movement of sand and rubble of dead corals interfere with a natural process of recruitment, engineered stabilization of the seabed, creation of habitat and regulation of current with artificial reefs and natural rocks have been attempted. Competing ideas among scientists and engineers vary widely, from creating coral habitat with concrete reef such as “reef balls” (Sharman et al, 2002) and “Eco-Block” (Maekouchi et al. 2010) to the use of weak electric current on substrata (Schumacher 2002). The “Eco-Block” is a large wave-dissipating block with unevenly processed surfaces that enhanced settlement and growth of corals at Naha Port, Okinawa (Fig. 1). However, to date, neither artificial reef nor electric current has proven to be a very efficient restoration tool, when used for transplantation measures or natural recruitment.

Many hermatypic corals expand their distribution by sexual reproduction. Fertilized eggs and larvae disperse over wide areas, settle into polyps, and build up colonies by budding or division of polyps. Alternatively, when a part of the colony is broken by such as typhoon waves, fragments settle on the neighboring seabed and grow up asexually to form new colonies. Coral propagules for transplantation may be spread by human action, using either asexual or sexual propagation of corals.

At present the techniques using asexial propagation are to either 1) affix coral fragments, trimmed from donor colonies, directly to the substrate or 2) transplant nursery-grown coral pieces (propagules) after letting them grow to a certain size in a nursery.

Rinkevich (1995) and Shaish et al. (2008) proposed “gardening the coral reef concept” that is based on a two-step protocol: 1) rearing coral propagules in nurseries to plantable size, and 2) transplanting the nursery-grown coral colonies. They developed a rearing technique for small coral fragments in specially designed nurseries, and emphatically state that only the establishment of large-scale nurseries and transplantation action will be able to cope with extensive reef degradation on the global scale.

The culture technique using asexual propagation is simple and inexpensive. However, most of the transplanted fragments share the donor’s limited DNA, giving the reef a smaller gene pool and may reduce gene flow among restored coral reef populations. Excessive collection of the fragments may injure the donor colonies and coral reef communities. Also, collection of large numbers of coral fragments is only possible in waters where donor corals near the

transplantation site are plenty.

At Akajima Marine Science Laboratory (AMSL) at Akajima Island, Okinawa, we have developed culture technique from eggs by means of sexual propagation of corals. At present, production of coral propagules for reef restoration is concentrated on the genus *Acropora*, a few members of the family Faviidae and on brooders such as the genus *Pocillopora.* The sexual propagation technique may bring genetically more diverse corals, but is labour intensive and more expensive than that by asexual propagation. In order to obtain coral gemetes or fertilized eggs, accurate information on the timing of coral spawning is critical.

Mass spawning of *Acropora* corals starts in Okinawa near the full moon on early summer (May and June) nights. The colonies spawn countless egg/sperm bundles within 30 to 60 minutes. Fertilization between different colonies takes place immediately below the sea surface soon after the bundles come apart. Fertilized and unfertilized eggs aggregate and drift in a slick on the sea surface in the morning after spawning (Fig. 2). For coral mass culture, the eggs and embryos may be collected from the slicks. Alternatively, we collect the bundles underwater by net or keeping coral colonies in aquaria immediately before spawning and induce fertilization in the laboratory by means of gently mixing the bundles released from more than three donor colonies of the same species (Fig. 3). The embryos are then bred in large water tanks on land or floating ponds in the sea (Fig. 4). They grow into planula larvae. Five to six days after fertilization, the planulae swim down to the bottom to look for suitable places to settle.

Reared planulae may be directly released onto degraded reef or artificial reefs at very high densities and allow them to settle naturally, or they may be induced to settle onto artificial substrata and reared in aquaria or *in situ* nurseries until they are ready to be transplanted to seabed. Results of the direct seeding have shown that early recruitment can be significantly enhanced; however, the majority of these settled coral dead due to natural processes. At present, therefore this method is not recommended until positive evidence of a long term effect has been demonstrated.

When *Acropora* planulae are competent to settle, they follow special chemical signals emitted by crustose coralline algae and certain bacteria on substratum (Morse et al. 1996; Negri et al. 2001). The artificial substrate could be made of concrete, slate or unglazed potter's clay, but they must be preconditioned to allow luxuriance of crustose coralline algae on the surfaces. Larval settlement will be completed after two days with the settlement rate of about 60% (Fig. 5). On the substrata, the planulae metamorphose into polyps (juvenile corals) each measuring about one millimeter in diameter and the polyps multiply their clones to form colony. Juvenile corals are then cultured in cages together with algae-eating juvenile top-shell snails, and suspended at 1.5 to 3 m depth into the sea.

This mixed culture of *Acropora* corals and top-shell snails in same cage has dramatically increased the success of coral culture (Omori 2005). Coral propagules cultured from eggs in

June 2005 have grown to an average diameter of 6.0 cm one and half years later (Fig. 6). In December 2006, we have transplanted them onto nearby degraded seabed. Although we lost many colonies by unexpected typhoon waves, the remainder grew well (Fig. 7), and some of these 4-year old corals had spawned in June 2009 for the first time in their life (Iwao et al. 2010). Many butterflyfish and damselfish are swimming around the corals.

Discussion and consideration

It is humbling and somewhat depressing to compare the small scales of active restoration projects relative to the worldwide scale of reef degradation. However, if we could restore coral reefs in many places, then the function of coral reef ecosystems could be locally preserved, eggs and larvae of corals could be supplied to neighboring areas, and cascade benefits may become evident into the future. Saving coral reefs is not something that we can do in two or three years, but perhaps in a decade.

The cost of rehabilitation should be offset by the benefits gained. Estimates derived from nursery-grown fragments suggest that US$0.5 to 1.0 is needed per propagule (Shafir et al 2006). At a spacing of 1 m on a degraded reef this would suggest culture costs alone of US$ 5,000-10,000 per hectare (for the 10,000 propagules/ha that would be needed) and labour costs for underwater transplantation of about US$25,000 (5 persons x 100 hours). AMSL's method of culturing corals by sexual propagation is more expensive; the cost of one propagule (ca. 6 cm in diameter) would be about US$10.

The coral reef restoration and rehabilitation by artificial effort are still in an experimental stage. In order to proof the efficacy, there are a number of hurdles that we must overcome, particularly in the techniques for maintenance of the transplanted corals. For instance, physical factors such as current, light, and temperature that mainly affect survival and growth of transplanted corals have not been adequately studied. Nibbling and predation by fish and coral-eating gastropods on newly transplanted corals often cause serious problem.

Following the success of coral culture at AMSL, Fishery Agency of Japan established coral culture facility, the Akajima Coral Hatchery (ACH) at Akajima. The ACH successfully produced tens of thousands coral propagules in aquaria on land and transplanted 63,000 propagules at Okinotorishima, Japanese southernmost coral reef in the Pacific in April 2008. So far, humans have never tried to speed the natural island-building process by civil engineering and coral transplantation technique. As a research project, however, it is an exciting task to reinforce the coral reefs of small islands in the tropics that may be submerged due to rising sea levels.

Acknowledgement

I would like to appreciate the Nippon Foundation for a long-term financial support to AMSL for achievement of coral culture and transplantation technique.

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Figure 1: Corals covered on the wave-dissipating “Eco-Blocks” at Naha Port, Okinawa. The “Eco-Blocks” were placed 8 years ago. The photo was taken in August 2007. (Courtesy of Okinawa General Bureau).

Figure 2: Offshore aggregates of fertilized eggs (called “slicks”) of corals.

Figure 3: Fertilization and rearing of coral larvae in tank.

Figure. 4: Large-scale rearing of coral larvae using floating pond.

Figure. 5: Reseeding of planula larvae on pre-conditioned tiles. The planula larvae settle and metemorphose to polyps.

Figure. 6: Culture of coral propagules in cages suspended to 3m in the sea (Courtesy of H. Kobayashi, Asahi Shimbun)

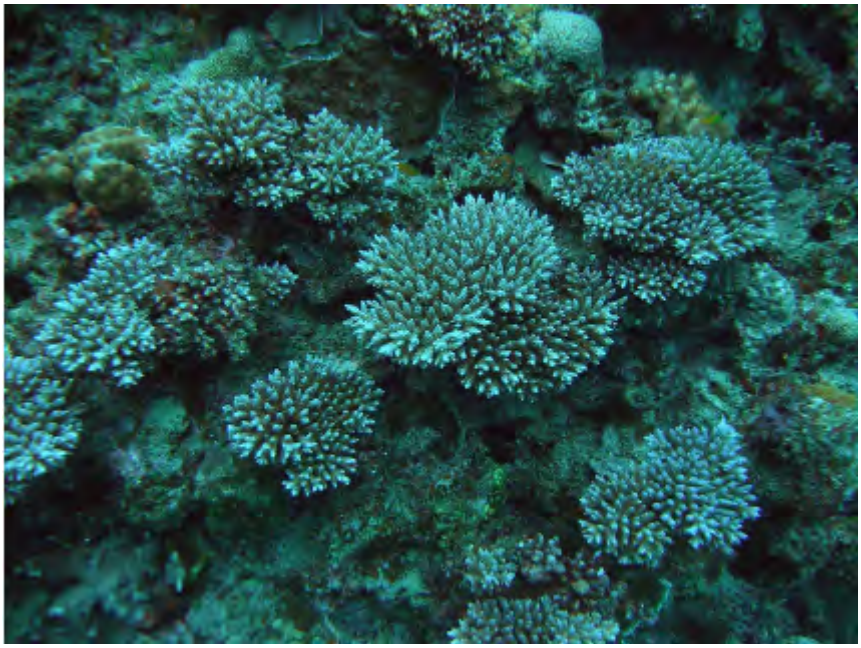

Figure. 7: Cultured *Acropora tenuis* colonies at Akajima, Okinawa. The coral propagules were cultured from eggs in June 2005 and transplanted with concrete plates. The photograph was taken on January 2009 (3.5-years old colonies, about 20cm in diameter).

Session II

Adverse Effects of Climate Change and Variability on Islands

Impacts of Climate Change and Variability on Pacific Islands and Their Surrounding Waters

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Abstract

Sea level change under the global warming stress has recently received much attention of the society. In order to be well prepared against the expected disaster, we need to understand how sea level variations occur regionally under the global change. It is often reported that the sea level rise due to global warming is encroaching on low-lying coastal regions and islands. Actually, two small islands of Kiribati have already been consumed by the encroaching Pacific Ocean. Tuvalu is believed to be one of the first nations to disappear. However, this view is too simplistic as we reported elsewhere.

An unusual state of the tropical Pacific is certainly observed in recent decades. In this state, a warm sea surface temperature (SST) anomaly is associated with high sea level and low atmospheric sea level pressure anomalies in the central tropical Pacific. The warm SST anomaly is sandwiched by cold SST anomalies in the eastern and western Pacific. This pattern shows a marked difference from the conventional El Niño and is now accepted as the El Niño Modoki based on our original research published in 2007. The El Niño Modoki event appears to occur more frequently and more persistently in recent warming decades. We believe that the consequence is the recent sea level rise around the Pacific Islands and their surrounding waters.

The second EOF mode derived from the satellite observed sea level anomalies confirms the above notion. The associated spatial pattern of the EOF mode captures higher sea level anomalies in the central Pacific, which are associated with warm SST anomalies defining the El Niño Modoki. The corresponding time series of the second EOF mode rightly capture the recent increase of El Niño Modoki events. This has serious consequences on islands of the central Pacific as those islands must suffer encroachment of the Pacific Ocean during the positive phase of ENSO Modoki, i.e. El Niño Modoki.

It is important to appreciate that impacts of the global climate change appear through changes in magnitude, frequency and phase of natural climate modes generating climate variability and even through evolution of a new climate mode such as El Niño Modoki. This new scientific outcome should be reflected in the next IPCC report.

Introduction

Estimates of sea-level change for the 20th century are dependent on only a few tide-gauge records. Recent addition of satellite altimeter data gave us the opportunity to explore the global scale sea-level changes including the patterns of regional changes. Estimates based on the Topex/Poseidon altimeter data suggest a rise of global sea level at the rate of about 3.1 mm/year (e.g. Cazenave and Nerem, 2004). Another recent analysis from merged TOPEX/Poseidon and Jason-1 data estimates a global rise of 2.8 ± 0.4 mm/yr (Nerem et al., 2006). Most importantly, these recent studies are able to show that the changes in the sea level are characterized by uneven spatial structures with positive trends in one region and negative in the other (e.g. Cazenave et al., 2004). The long-term variations of sea level are mainly caused by large-scale changes in advection and buoyancy fluxes caused by thermal expansion and fresh water variation. On shorter terms, from years to decades, climate variations in different ocean basins significantly influence the sea-level variations. The North Atlantic Oscillation, the El Niño/Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) are some of the known modes of climate variations that are linked to the regional sea-level variations. For example, Volkov and van Aken (2005) suggest that the interannual change of the sea level in the North Pacific is coherent with PDO, which possibly switched from a positive phase to a negative phase in 1998.

In recent decades, the tropical Pacific is in a strange state from a climate dynamicist's viewpoint; we often observe a warm sea surface temperature (SST) anomaly associated with high sea level and low atmospheric sea level pressure anomalies in the central tropical Pacific (Ashok et al., 2007; Weng et al., 2007; Ashok and Yamagata, 2009). Interestingly, this warm SST anomaly is sandwiched between two cold SST anomalies with low sea level in the eastern and western Pacific. This pattern shows a marked difference from the conventional El Niño and we called the anomalous ocean-atmosphere condition El Niño Modoki (Pseudo El Niño) in 2006. It appears that the world climate research community has now accepted the terminology (e.g. Chen and Tam, 2010). As we already mentioned in the workshop report of 2009, to have a correct scientific view of our planet must be the first step to consider policies for mitigating possible threats of the global change.

El Niño Modoki

It is written in a report of Working Group I of the Intergovernmental Panel on Climate Change that global sea level rose at an average rate of 1.8 [1.3 to 2.3] mm per year over 1961 to 2003. It is also written that the rate was faster over 1993 to 2003: about 3.1[2.4 to 3.8] mm per year. However, these values are too small compared to commonly accepted threats in the central Pacific islands.

In order to appreciate this apparent discrepancy, we must first appreciate the difference between climate variations and climate change. Climate change is due to external origins that influence our climate system and has time scales of centuries or even more. Because of such long time scales, it appears as a weak trend in time series with a shorter time span. One typical example is the occurrence of glacial/interglacial periods due to changes of the solar radiation. Another example is the recent global warming trend most probably due to anthropogenic increase in global warming gases. The change in the atmospheric composition may also occur owing to changes in land processes, volcano activities, etc. that are outside the ocean-atmosphere system. In contrast, climate variations, which have shorter time scales from years to decades, are characterized by internal origins in our ocean-atmosphere system and those are natural variations in both atmosphere and hydrosphere even if their occurrence frequency and magnitude could be influenced by the climate change. Those climate variations are generated by major natural climate modes that have clear spatial structures and life cycles, as typified by El Niño and Indian Ocean Dipole in the tropics.

Using various ocean/atmosphere datasets mainly for the period 1979-2005, we suggest the existence of a new climate mode that is different from conventional El Niño in the central tropical Pacific. The unique central Pacific warming is associated with a horse-shoe SST pattern, and is flanked by a colder anomaly on both sides along the equator (Fig. 1). Such a zonal SST distribution results in anomalous two-cell Walker circulations over the tropical Pacific (Fig. 2). Both ITCZ and SPCZ expand poleward, forming a wet region in the central tropical Pacific. Conventional EOF analysis of monthly tropical Pacific SSTA shows that the new mode is represented by the second mode that explains 12% of the variance.

Since the mode cannot be described as one phase of El Niño evolution, we suggest that the phenomenon should be called El Niño Modoki (Pseudo-El Niño). The El Niño Modoki involves ocean-atmosphere coupled processes, indicating the existence of a unique atmospheric component during the evolution, which is analogous to the Southern Oscillation in case of El Niño. Thus the total entity should be called ENSO Modoki.

The Modoki's impact on the world climate is very different from that of ENSO (and the Indian Ocean Dipole). Possible geographical regions for droughts and floods influenced by Modoki and ENSO are compared. Interestingly, the Modoki's influences over regions such as the Far East including Japan and the western coast of USA are almost opposite to those of the conventional ENSO (Fig. 3).

The difference maps between the two periods of 1979-2004 and 1958-1978 for various oceanic/atmospheric variables suggest that the recent weakening of equatorial easterlies related to weakened zonal sea surface temperature gradient led to more flattening of the thermocline. This appears to be a cause of more frequent and persistent occurrence of the Modoki event during recent warming decades; the ENSO Modoki has a large decadal background while

ENSO is predominated by interannual variability.

Appreciating the two different phenomena in the tropical Pacific will enhance our understanding of the coupled ocean-atmosphere dynamics and thus contribute to reducing the uncertainty in the climate prediction.

(This section is almost the same with that written for Proceedings of International Symposium on Islands and Oceans in 2009. Since El Niño Modoki is still a new terminology, I have decided to include it here.)

Sea level changes associated with ENSO and ENSO Modoki

In order to recognize the role of ENSO Modoki on the sea level variability of the tropical Pacific, modes of sea level anomalies are identified using EOF technique. The sea level anomalies are derived from Topex/Poseidon and Jason-1 altimeter data and the merged data extends from 1993 to 2009. The EOF analysis of the sea level anomalies reveals interesting modes of variability in the tropical Pacific. The EOF1 exhibits a dipole pattern with opposite loadings in eastern and western Pacific, which basically correspond to the ENSO variability. The time series of this EOF mode (PC1) corresponds to interannual variation of ENSO with El Niño events represented by positive peaks.

The EOF2 pattern is distinctly different from that of EOF1. With a positive loading in the central Pacific, the EOF2 pattern illustrates higher sea level anomalies associated with the El Niño Modoki event in that region. Most importantly, the corresponding time series of this EOF (PC2) shows clear decadal modulation with a distinct positive phase after 2001. During this recent time period tropical Pacific gave birth to frequent El Niño Modoki events apparently associated with changes in wind stress, which might indirectly be related to the global warming. This has serious consequences on islands of central Pacific as those regions will experience strong decadal changes in sea level associated with ENSO Modoki.

Summary

Sea level change has received much attention under the global warming stress. A report of Working Group I of the Intergovernmental Panel on Climate Change projects sea level rise of 0.18-0.59m in accord to global average surface warming of 1.8-4.0 °C at the end of the 21st century. As understood well, major processes to cause such sea level rise are i) thermal expansion of sea water and ii) loss of land ice. Since models used to obtain those estimates do not take into account full effects of changes of ice sheet flow, uncertainties may be larger. Those figures provide us with general indication of what we face globally in the expected global

warming trend. However, in order to be well prepared against the expected disaster, we need to understand how sea level variations occur regionally under the global change.

We observe an unusual state of the tropical Pacific in recent decades in which a warm SST anomaly is associated with high sea level and low atmospheric sea level pressure anomalies in the central tropical Pacific. Interestingly, this warm SST and high sea level anomalies are sandwiched between two cold SST anomalies with low sea level anomalies in the eastern and western Pacific. This pattern shows a marked difference from the conventional El Niño and we call the anomalous ocean-atmosphere condition El Niño Modoki (Pseudo El Niño). The frequent occurrence of El Niño Modoki is a true identity of the encroaching ocean in the central tropical Pacific. Predicting strength, frequency and period of this anomalous climate signal by use of a state-of-the art coupled ocean-atmosphere model is necessary to adapt to the expected sea level rise due to the global warming trend. Efforts in this direction are underway.

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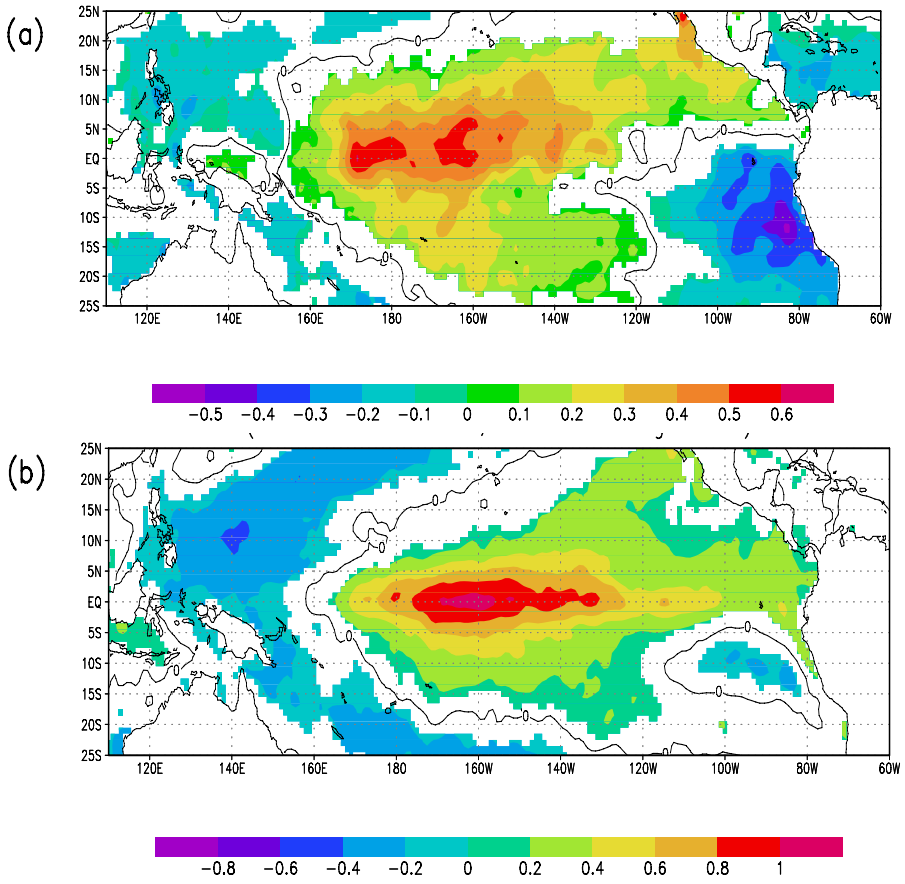

Figure 1: Composite SSTA in ºC during strong positive El Niño Modoki events averaged over (a) seven boreal summers, namely JJAS seasons of 1986,1990, 1991, 1992, 1994, 2002 and 2004 and (b) 8 boreal winters, namely DJF seasons of 1979-80, 1986-87,1990-91, 1991-92, 1992-93, 1994-95, 2002-2003 and 2004-05. Significant values above 95% confidence level from a two tailed Student's t-test are shaded.

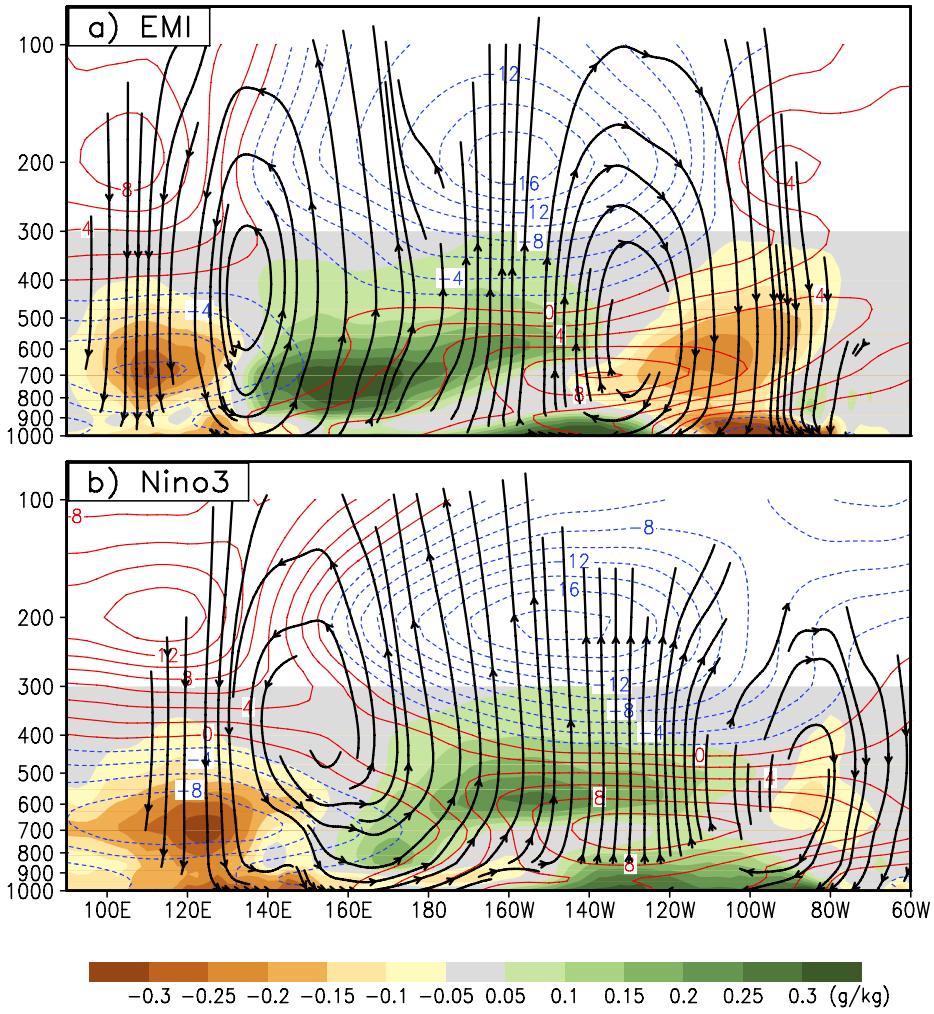

Figure 2: Anomalous Walker Circulations (10S -10N) between 90E and 60W based on partial regression for a) El Niño Modoki Index (EMI) introduced suitably using zonal SST differences and b) Niño3 Index. The vertical velocity at the pressure levels ismultiplied by a factor of -50 to give a better view. The regressed specific humidity is shaded. The contours are for the regressed velocity potential (unit: 10^5 m^2s^{-1}). The units labeled in the regression patterns are actually the units per standard deviation of the index being regressed. The standard deviations for EMI and Niño3 in JJA are 0.504˚C and 0.553˚C, respectively.

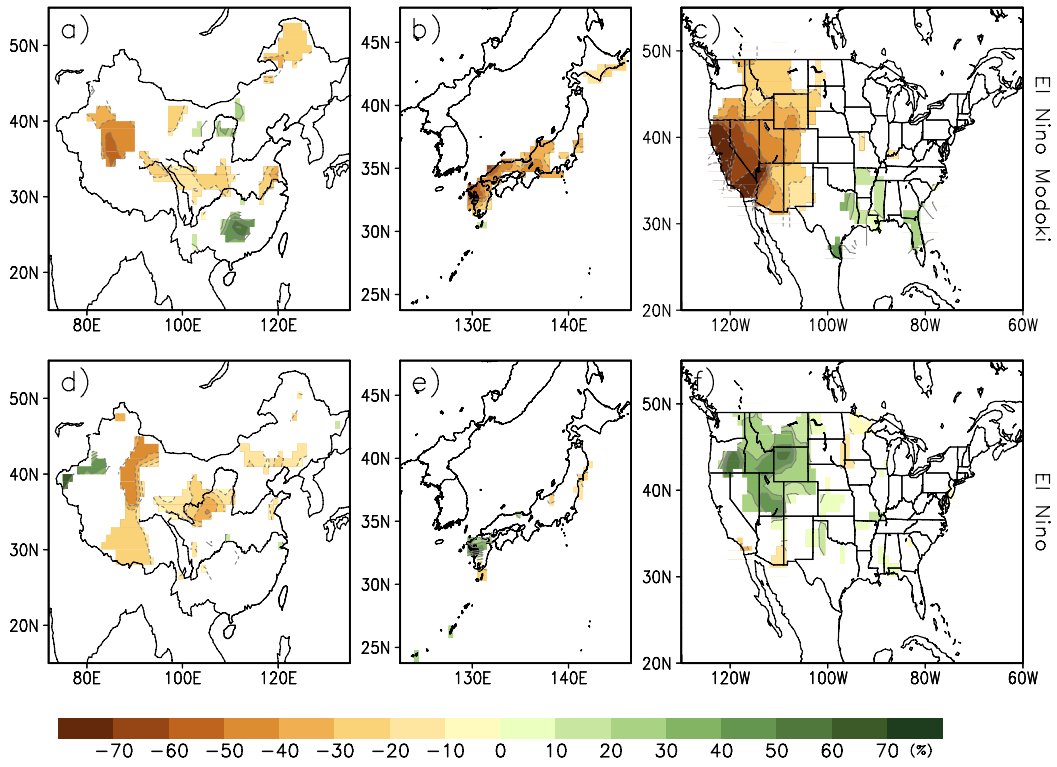

Figure 3: Composite JJA rainfall patterns (anomaly percent of normal: %) for the three largest El Niño Modoki events (1994, 2002, and 2004) in a) China, b) Japan, and c) the United States, and those for the three larges El Niño events (1982, 1987, and 1997) in d) China, e) Japan, and f) the United States. The values with significant levels less than 80% are omitted.

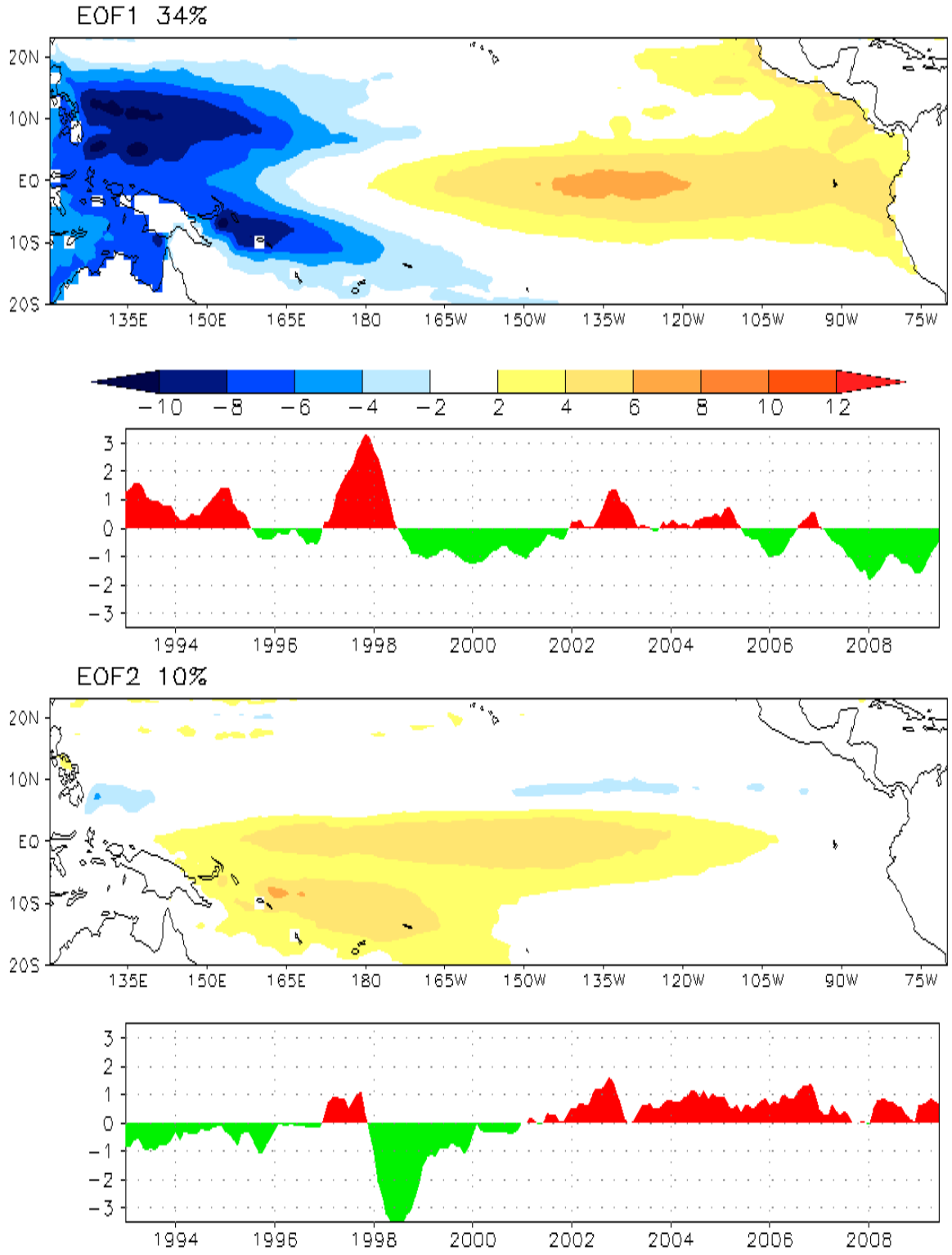

Figure 4: The EOF1 and EOF2 together with their respective PCs obtained from the merged sea level anomalies derived from Topex/Poseidon and Jason-1 altimeter data.

Marine Biodiversity and Climate Change in the Pacific Islands

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Introduction

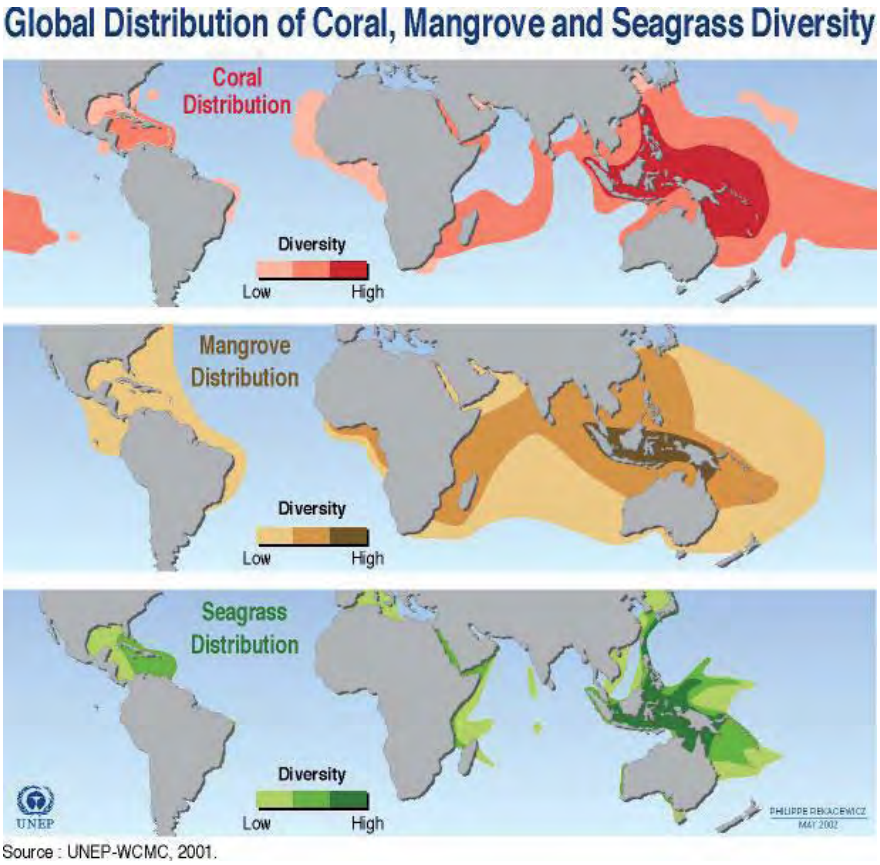

Figure 1 : Global distribution of coral, mangrove and seagrass diversity

The vast Pacific Islands region occupies some 33 million square kilometres, some 17% of the World's ocean, and it contains some of the richest marine biodiversity in the world (Fig. 1). The mostly coastal peoples of the region rely on the marine resources gathered from their reefs and lagoons for their food security and during the past 15 years have taken unprecedented actions to conserve their resources for themselves and future generations, through the establishment of community-based marine protected areas (MPAs). Climate change is predicted to be one of the

most important phenomena threatening livelihoods and food security in the region, with many low-lying atolls and islands highly vulnerable to sea level rise, their very existence under threat.

Measuring the impacts of climate change on marine biodiversity in the Pacific islands requires *a priori* knowledge of that biodiversity itself. The MPAs established in the region focus on fisheries, which are in fact a small proportion of the rich species biodiversity of the region. Our overall knowledge of biodiversity leaves much to be desired. Public knowledge of the importance of biodiversity and the consequences of its loss is variable throughout the region, and there is a severe lack of taxonomic capacity (the taxonomic impediment). This capacity is the key to understanding the region's marine biodiversity.

There are many threats to the region's biodiversity, and climate change is one of these. In order to better understand the nature of the threats, and how to mitigate against them, there is a need to raise the importance of biodiversity and the consequences of its loss much higher on the regional agenda.

2010 – The United Nations International Year of Biodiversity (IYB).

The United Nations has declared 2010 as the International Year of Biodiversity. Its purpose is to "...raise the importance of biodiversity and the consequences of its loss..." International IYB day is May 22nd. The Objectives of the IYB are shown in Box 1.

The 10th Conference of Parties of the Convention on Biodiversity (COP 10) will be held in Nagoya, Japan in October 2010; the incoming President of COP 10 is Mr Sakihito Ozawa, Japan's Minister of the Environment. During COP 10 Strategic issues for evaluating progress and supporting implementation of the convention will be considered and it is anticipated that the negotiations to conclude an international regime on access and benefit-sharing will result in the adoption of an instrument on Access and Benefits Sharing.

Box 1

Objectives of the IYB

To enhance public awareness on the importance of biodiversity and on the underlying threats to biodiversity, including climate change;

To raise awareness of the accomplishments to date that communities and governments have achieved in efforts to conserve and sustainably use biodiversity and its components, and to promote equitable sharing of benefits from the use of genetic resources as well as to raise awareness on the shortcomings in these efforts;

For all individuals, organisations and governments to take the immediate steps needed to halt the loss of biodiversity;

Mr Sakihito Ozama, in-coming President of COP10 and Minister of

The Global Taxonomy Initiative (GTI)

The GTI was established at COP VI of the CBD "..in order to provide necessary support to the Convention's other programmes of work on thematic areas and cross-cutting issues..." In Decision VIII/3 paragraph 9(b) the Conference of the Parties urged Parties and other Governments to undertake or complete or update, as a matter of priority, national, regional and global taxonomic needs assessments. The COP, at its 9th meeting, identified Outcome Oriented Deliverables as relevant outputs of the Programmes of Work of the GTI (Decisions VIII/3 paragraph 15).

GTI Needs Assessments

To date 46% of Parties have responded to national taxonomic needs assessments: none has been accomplished in the PICs. There is therefore a need for countries to develop lists of organisms, their geographic distribution, and information on their abundance and/or state of endangerment,

their socio-economic importance and other relevant contexts. In order to accomplish this, there is a need for projects to be developed in support of national taxonomic needs assessments.

Innovative approaches to facilitate the inventorying and monitoring of the component of biodiversity, such as DNA bar-coding, have made significant progress, although relatively little in the PICs. Progress was made on the Global Taxonomy Partnership and its special fund for the Global Taxonomy Initiative.

Global and Pacific Initiatives in support of the GTI

Global initiatives are shown in Box 2.

Box 2

Some of the global initiatives in support of the GTI

The Encyclopedia of Life: www.eol.org

Catalogue of Life: www.sp2000.org

The Barcode of Life Initiative: www.barcoding.si.edu

The Global Biodiversity Information Facility: www.gbif.org

Pacific initiatives in support of the GTI include:

- Establishment of the Pacific Islands Network for Taxonomy (PACINET), under the BioNET initiative.
- Project of the Secretariat for the Pacific Community (SPC): *Impact of climate change on fisheries in the Pacific.* In recognition of the importance of fisheries to the Pacific, SPC and AusAID have joined forces to assess the likely effects of climate change on fish habitats and the productivity of oceanic, coastal and inland fisheries and aquaculture. The broad aim of the project is to equip policy makers and managers in Pacific Island countries and territories with information on how climate change might affect their plans for the sustainable use of fish for food, employment and national revenue. The project will address important questions about the effects of climate change on fisheries, such as: Will the abundance and distribution of tuna change? Will

coastal fisheries be less productive? Are changes in weather patterns likely to increase the risks for small boat operators? Will future patterns of rainfall affect the potential for small-pond aquaculture? How well prepared is the region to adapt to any such changes? [www.spc.int]

- Project of the Bishop Museum and the Secretariat of the Pacific Regional Environment Programme (SPREP) "*...Climate Change and Biodiversity in Melanesia – Assessing vulnerability of marine, terrestrial ecosystems to projected climate change...*" This is an expert-led study to assess the vulnerability of biodiversity and island ecosystems in Melanesia to climate change. The areas considered in this study include the island of New Guinea (including the Indonesian provinces of Papua and West Papua and the nation of Papua New Guinea); Solomon Islands; Vanuatu; New Caledonia; and Fiji. [www2.bishopmuseum.org]
- Biodiversity inventory for Fiji: University of the South Pacific and PACINET. This preliminary biodiversity inventory is scheduled for completion during 2010.

GTI Outcomes

As a result of the slow progress in PICs on the 2010 objectives under the GTI, the measurement of the impact of climate change on marine biodiversity becomes that much more difficult.

Overall, the 2010 targets have not been met, and there is a need for more regional and national GTI-related project funding. PICs need to complete national species listings, including information on invasive and alien species, and endangered species. In addition, population data are generally lacking in most PICs, and GTI targets are not incorporated into national policies.

Threats to marine biodiversity

The CBD's Global Biodiversity Outlook (2006) indentified five threats to biodiversity, and these are (not ranged in any order of priority):

1. Invasive alien species
2. Climate change
3. Nutrient loading and pollution
4. Habitat change
5. Overexploitation

While the five major threats to marine biodiversity might have separate drivers, there is also a great deal of interaction amongst them: climate change is but one of these, but is probably one of the most important.

Specific threats to coral reefs in PICs, linked to climate change, include

- coral bleaching (caused by rising sea water temperature);
- mass die-offs (thus reducing biodiversity);
- increasing acidification (resulting in a reduced capacity of reef organisms to produce hard skeletons);
- population shifts resulting from increasing water temperature; and
- increase in numbers and impacts of invasive/alien species.

Of the identified threats, those that are global in nature (e.g. sea temperature rise, ocean acidification) are hard to mitigate through actions such as conservation. Other identified threats (e.g. pollution, habitat destruction, over-exploitation) can be mitigated through conservation and shifts in government policies.

Marine Reserves in the Pacific Island Countries

The oldest marine reserve in the PICs is the Palolo Deep National Marine Reserve of Samoa, established in 1972. During the past 15 years many reserves have been established in the PICs; by 2008 there were more than 500 communities with MPAs, in 15 independent countries in the region, the large majority of these being community-driven and focussed on conservation of dwindling inshore fisheries resources (Govan, 2008, 2009).

The establishment of marine reserves has been accelerated in response to the Johannesburg Implementation Plan, and by the Locally Managed Marine Areas Programme (LMMA). The reserves feature high biodiversity, and are dominated by community-based reserves of relatively small size. The LMMA programme has been strongly supported by international funding, and in general there is a low level of government funding.

As mentioned, the marine reserves in PICs are mostly geared towards fisheries conservation, and include no-take (*tabu* in Fiji) areas. Relatively few focus on large marine ecosystems, with a notable exception being the recently established MPA in the Phoenix Islands, Kiribati. There is relatively little information available about the overall biodiversity contained in the reserves, with the exception of fishery-related data. What is clear, however, is that MPAs do enhance resiliency to the impacts of climate change, although few quantitative data are available (Mumb y & Harborne, 2010).

Coral Reef Biodiversity

During the past decade the health of coral reefs has attracted global attention, following the mass coral bleaching event of 1998. The table below is derived from Wilkinson (2008).

International efforts in support of coral reefs include:

- International Coral Reef Initiative (ICRI)
- International Coral Reef Symposia (ICRS)
- Global Coral Reef Monitoring Network (GCRMN), including ReefCheck
- NOAA Reef Watch Program
- Pacific Islands GOOS Programme
- CORAL Reef Alliance

The *Status of Coral Reefs* Report (Wilkinson, 2008) summarises that state of the world's coral reefs (see table below). This indicates that 54% of the World's reefs are lost, or are at risk.

The status of reefs in the Pacific is generally good, and in the most remote areas climate change (and consequent bleaching) is the main factor impacting them. The major efforts in monitoring and conservation are having a positive effect on reef health, and are generating a wider public appreciation of the importance of coral reefs to Pacific peoples. A significant problem is that in most PICs, this increased awareness is not well reflected in national policies towards the sustainable use of reefs.

Table 1

Status	Percentage
Lost	19%
Critical	15%
Threatened	20%
Stable or recovering	46%

Knowledge of the biodiversity of Pacific Island reefs

Coral reefs are the marine counterparts of tropical rainforests in terms of their rich biodiversity. There are various estimates of the species biodiversity to be found on reefs, ranging from 100,000 to 600,000 species, even as high as 9 million species (www.eoearth.org). What is important is that the *vast majority* of these species remains undiscovered, and therefore unknown and undescribed. The reefs of the Indo-Pacific are much richer in biodiversity than anywhere else on earth, and there is a gradual drop-off in species numbers as one progresses from the centre of diversity to the farthest reaches of the Pacific Ocean.

Knowledge of some groups of organisms is relatively good, for example:

- More than 2,000 species of fishes
- More than 600 species of marine benthic macro-algae (seaweeds)
- Approximately 500 species of scleractinian corals
- 13 species of seagrass
- 11 species of mangroves
- 6 species of sea turtles (almost all endangered)
- 8 species of whales (almost all endangered)
- 8 species of dolphins
- 1 species of dugong

There are many groups, however, that are poorly known:

- Many mollusca and crustacean
- A large variety of other groups of invertebrates
- Deep water organisms (including fishes)
- Marine fungi, bacteria and other microorganisms
- Marine phytoplankton
- Marine zooplankton

Pacific Biodiversity Challenges and linkages to Climate Change

As stressed above, there is a need for professional taxonomic expertise in the region, or else we will continue to rely on a handful of regional specialists, with the majority of input coming from overseas. A Pacific Islands organisation comparable to the ASEAN Centre for Biodiversity (www.aseanbiodiversity.org) would go a long way to assisting in the building of taxonomic

capacity; the ASEAN Centre is already doing a great deal to raise awareness of the impacts of climate change on their region's outstanding biodiversity heritage. Proposals for such a Pacific Island centre have been on the drawing board for some time, but lack the necessary funding.

Regardless, there is an urgent need to catalogue national marine biodiversities, and for funding in support of this. There is also a need to record and incorporate vernacular taxonomic knowledge into the biodiversity equation. Then, countries will be able to include biodiversity information into climate change research.

The consequences of a lack of knowledge of biodiversity will include:

- Lack of information about a high percentage of the region's marine biodiversity;
- A continuing lack of regional taxonomic expertise;
- An uncertainty as to whether measured changes to biodiversity are due to climate change alone, or to a combination of factors; and
- A lack of biodiversity science in the climate change equation.

How to move forwards...

- The PICs should re-visit the GTI objectives during the coming decade (following COP10), and implement them as far as possible;
- Include more scientific information so as to better understand climate change;
- Carry out strategic planning and vulnerability assessment, and seek funding for priority adaptation measures.

If some of the suggestions are not met, the measuring of the impact of climate change on biodiversity will focus on a few "iconic" and highly valuable species. The loss of biodiversity will take place without our knowledge, as many species will disappear without ever having been discovered in the first place. Subtle changes in distributions and abundances will occur under our noses, but largely unrecorded.

The take-home message is that we need to arrest the rapid loss of our already known biodiversity, by protecting it as far as possible from human-induced factors, including climate change. By this strategy, it is hoped that the unknown biodiversity (which is greater than the known by several orders of magnitude) will also be protected so that it can await discovery for the benefit of future generations.

Acknowledgements:

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Pacific island states' coral reefs and their ecological response to changing environments

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Abstract

Pacific islands are mainly distributed in tropical and subtropical region and are fringed with, and in many cases, formed themselves by coral reefs. Formation of coral reefs and atoll islands in response to environmental changes is governed by ecological processes. Potential of vertical accumulation rate of coral reef crest is 2 to 4 m/1000 years (20 to 40 cm/100 years), almost equivalent to projected rise of sea level in this century. Therefore the coral reefs with healthy ecosystem have a potential to keep up with rising sea level. The body of atoll islands is made up of coral and foraminiferal sand. The foraminifers mainly live densely on the ocean-ward reef flat and are delivered inside the lagoon-side to form the islands.

However, these ecological processes are now being suffered by human activities. By now the major problem in the Pacific islands is local rather than global one. Local stresses have increased the island nation's vulnerability and harmed its natural resistance to the global environmental changes. To increase the resilience of the Pacific island nations' coast against sea level rise, not only conservation but also rehabilitation of ecosystem is necessary to enhance sand production and sedimentation processes. Countermeasure plans must be based on helping to promote natural island maintenance processes and must not conflict with natural resilience potential. Human activities and engineering countermeasures should be evaluated based on a habitat-sedimentation processes. From these evaluations, eco-technological countermeasure plans to enhance coral reef formation and sand production and sedimentation, including coral and foraminifera farming, should be developed and applied.

Keywords: coral reefs, Pacific islands, global environmental changes, local stresses

Introduction

Corals precipitate calcium carbonate underneath their tissues to form colony skeletons. The form of the colony varies as massive, branching, thick branches (corymbose), table-like, encrusting etc., which are determined not only by species of corals but also by environment surrounding them. Wave, light and siltation are the three major factors determining colony forms. The coral skeletons pile up to reach sea level (low water level) to form a body of carbonate rock called limestone. Many other calcifying organisms also take part in reef landform formation process. The surface of a coral reef forms a shallow flat just beneath the sea surface. Coral reefs as a landform are defined as a breakwater structure formed by corals and other calcifying organisms with its surface reaching sea level.

Coral reef landforms serve diversified creatures with a habitat. The biodiversity of coral reef community is the highest among marine ecosystems, and coral reefs by themselves are formed by organisms. A reef flat formed just beneath the sea surface effectively receives sunlight for photosynthesis of the symbiotic algae inside host corals and other primary producers. Coral reefs also act as a natural breakwater to protect coasts and islands behind them.

Most of the Pacific islands in the tropical and subtropical regions are fringed with, and in the case of atolls, formed themselves by coral reefs. Figure 1 shows distribution of coral reefs in the world, which clearly shows that the area of coral reef distribution overlaps with the Pacific island states. In the tropical Pacific, many atolls are distributed shown by blue dots.

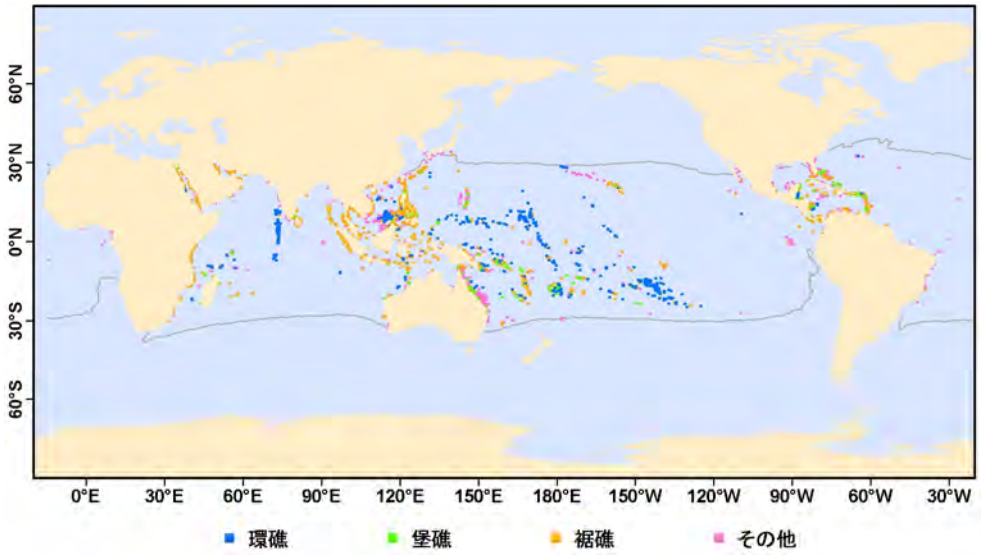

Figure 1: World distribution of coral reefs classified by their reef types. Blue: atolls; green: barrier reefs; orange: fringing reefs; pink: others (from ReefBase: http://www.reefbase.org/).

With increasing magnitude of human activities, coral reefs are now under threats of both local and global environmental stresses. Increasing human stress in coastal zone has degraded coral reefs (Fig. 2). Not only direct destruction of coral reefs by landfill, dredge, and artificial construction but also increase in terrigenous input of silt and eutrophic water has degraded coral reefs. The human stress in coastal zone is particularly increasing in Asia-Pacific regions, where increase in human population in coastal zone is rapid and urbanization is in progress. Effective management plan must be established based on understanding of coral reef landforms and their zonation.

Global warming will induce more frequent and severe bleaching of corals. In 1997-1998, anomalous high sea surface temperature induced world-wide coral bleaching (Fig. 3). As the sea surface temperature increases by 2 to 3°C in this century, severe bleaching would occur every two years in the middle and every year in the late 21th century (Hoegh-Guldberg, 1999).

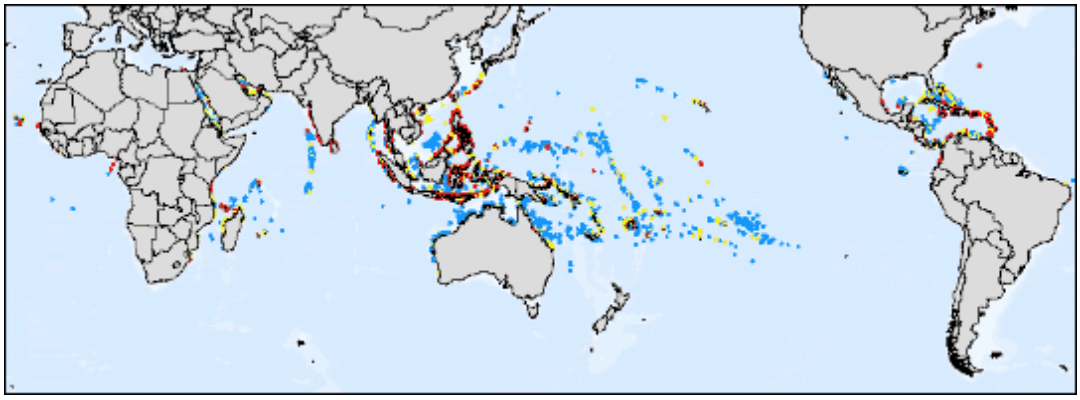

Figure 2: Coral reefs of the world classified by potential threats from local human activities. Estimated threat to coral reefs is high (red), medium (yellow) and low (blue). (from World Resources Institute: http://www.wri.org/).

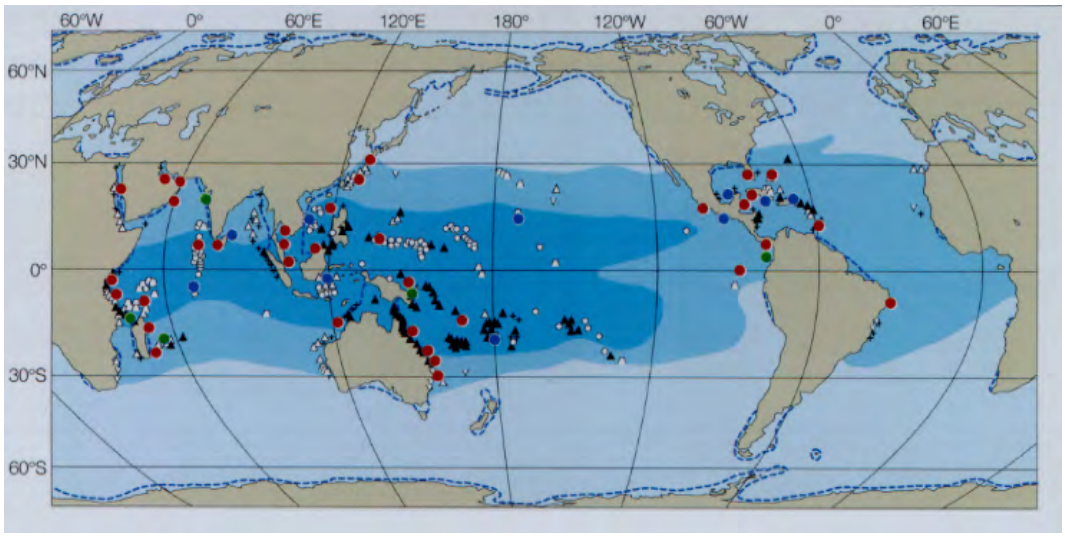

Figure 3: Coral reef bleaching in 1997 to 1998. Red dots show the coral reefs suffered from sever bleaching in 1997 to 1998 (from Japanese Coral Reef Society: http://wwwsoc.nii.ac.jp/jcrs/).

Response of coral reefs to sea level rise

Sea level rise induced by the global warming will bring direct effect to coral reefs. Projected rise of sea level ranges from 20 to 60 cm by the end of this century with a mid value of 40 cm. The wide range for prediction is resulted from uncertainty in CO_2 emission scenario and in climate model. The reef response potential to sea level rise was evaluated by reef drilling survey in the Palau Islands (Kayanne et al., 2002).

The Palau Islands are situated in the northwest Pacific. The barrier reef 1 to 3 km wide stretches NE-SW off the western and eastern coasts of the islands and acts as a huge natural breakwater protecting the islands from out-ocean waves and swells (Fig. 4). By allowing for the examination of the internal structure and growth rate of the barrier reefs, the drill cores reveal in detail how the reef formed as the sea level rose (Fig. 5). The lower part of the oceanward barrier reef is formed of branching *Acropora*. From 8000 to 7000 years ago, branching *Acropora* grew at

a vertical accumulation rate of 30 m/1000 years. The cores show that this facies is overlain by a rigid framework of a digitate type of *Acropora*, which corresponds to *Acropora digitifera*, the coral species found on the oceanward surface of the barrier reef flat before the 1998 bleaching event.

Figure 4: Landform of the barrier reefs in the Palau Islands (a landform model at Palau International Coral Reef Center).

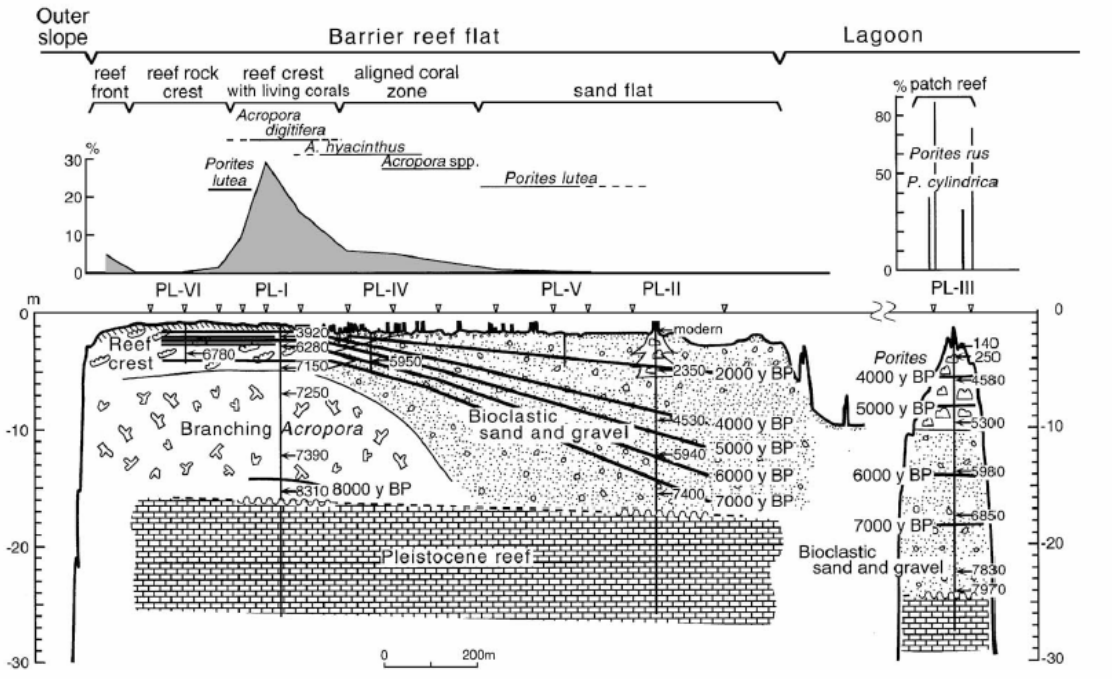

Figure 5: Reef zonation, percent living coral coverage with dominant species (top) and cress-sections with interpolated time-growth surface lines and internal facies (bottom) of the barrier reef flat (left) and lagoon patch reef (right). From Kayanne et al. (2002).

The vertical accumulation rates revealed by the cores are shown together with the increase in sea level. The lower branching *Acropora* facies accumulated very quickly, at 30 m/1000 years at the drill site of PL-I on the reef crest, keeping pace with the rising sea level. However, the surface

of this facies never caught up with the rise in sea level. The rigid framework of the reef crest, dominated by *Acropora digitifera*, lagged the sea level rise at a slower rate of 2.2 m/1000 years after the sea level stabilized.

Reef crest is the key feature of coral reefs that acts as a breakwater, and formation of the reef crest results in reef zonation. Submergence of reef crest by sea level rise this century will degrade these functions. Upward growth rate of the reef crest is 0.1 to 0.4 m/100 years. The highest value matches with the mid value of the predicted sea level rise. The high growth rates are maintained by healthy growth of *Acropora* species. Thus, to cope with the rising sea, conservation of *Acropora* community on the reef crest is most important.

In this century, the sea level is projected to rise at a rate of 20–60 cm/100 years (IPCC, 2007). The reef crest is accumulating at a rate of 2.2 m/1000 years, or 22 cm/100 years. Thus, from a geological point of view, the Palau barrier reef has the potential to keep pace with the lower predicted rates of sea level rise. However, the reef crest growth rate is based on a reef crest facies dominated by *Acropora digitifera*.

However, after the extensive bleaching event in Palau in 1998, the reef crest was replaced by fresh brown algae and sparse coverage of *Porites* (Fig. 6). The living coral cover decreased from 8.1 to 1.4%. Before the 1998 bleaching event, the reef crest facies of the outer barrier reef flat had been dominated by *Acropora digitifera* for the last 7000 years. The PL-I core taken at the reef crest does not reveal any massive growths of *Porites*. Thus, *Porites* has never dominated the reef crest because it cannot form a rigid framework against strong breaking waves. Only digitate or corymbose types of *Acropora* can perform this function. Therefore, the present *Porites*-dominated community on the reef crest is exceptional for the last 7000 years.

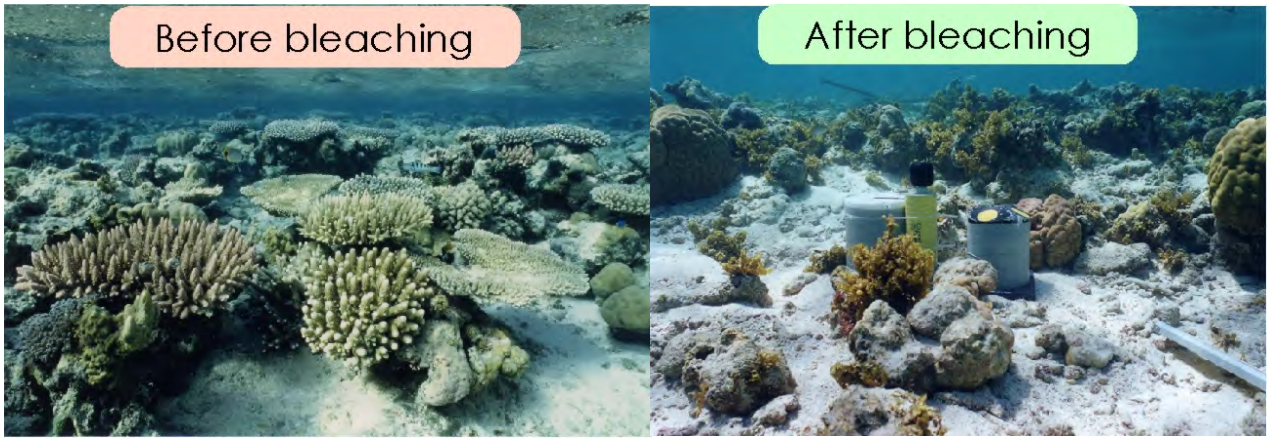

Figure 6: Original coral community dominated by *Acropora digitifera* on the barrier reef flat close to PL-I in 1991 before the bleaching event in 1998 (left), and with sparse Porites heads and dense brown algae (*Turbinaria* and *Sargassum*) at the same site in 2000 after the bleaching event (right).

The degraded potential of reef formation after the bleaching was also shown by the decrease in calcification rates, measured by seawater alkalinity depletion flowing over the barrier reef. Before the bleaching event, the calcification rate was 130 mmol C/m^2/day, or roughly equivalent to 34 cm/100 years of vertical accumulation, assuming 50% porosity. After bleaching,

calcification decreased to 74 mmol C/m^2/day, or about 19 cm/100 years (Kayanne et al., 2005). Thus, the decrease in calcification results in the loss of vertical accumulation potential.

The degradation of the original reef crest facies strongly decreases the potential of the reef crest to keep pace with the rising sea level. If the barrier reef flat cannot maintain an adequate growth rate and eventually becomes submerged, it will lose its function as a natural breakwater. Open ocean swells will break inside the barrier reef system, affecting the lagoon and islands, and coastal erosion will be enhanced. Both the sea level rise and coral bleaching are attributed to global warming. Human-induced local environmental changes will introduce additional stress to coral communities on the reef flat. Restoring the original coral communities and their landform-based habitats is critical to the rehabilitation of the reefs. On the reef flat of the Palau barrier reef system, *Acropora digitifera* is the most prominent feature, and its recovery is the key to rehabilitation.

Vulnerability of atoll islands against sea level rise

An atoll is one of the three major types of coral reef landforms: a ring-shaped reef enclosing a shallow lagoon. The diameter of the ring is from as large as several tens of kilometers to as small as a few kilometers. The width of the reef, which forms strings of the ring, is generally one to two kilometers in maximum, and the depth of the lagoon is several tens of meters. If a coral reef forms a circular or elliptical flat without a lagoon, it is called a table reef.

Approximately 500 atolls are distributed in the world ocean: 400 in the Pacific Ocean, 70 in the Indian Ocean, and 30 in the Caribbean Sea (blue dots in Fig. 1). Most of the atolls exist in the Pacific Ocean. Some small-island countries and regions (Republic of the Marshall Islands, Federated States of Micronesia, Tuvalu, Republic of Kiribati, and French Polynesia in the Pacific, and Republic of Maldives in the Indian Ocean) fully or mostly consist of atolls. Many atolls also distribute in the Southeast Asia and the South China Sea (e.g. Spratly Islands), yet we have little information on them.

Islands distributed on atolls are called atoll islands (other terminologies for them are reef islands, atoll-reef islands or motu). Since the surface of reef flats only reaches low tide level, islands above high tide level are formed by bioclastic sand thrown up on to the reef flats, by remnants of an emerged reef, or by a composite process of the both. Elevations of most of the islands is one to two meters. More than 500 thousands people live on atoll islands. Some atoll islands (e.g. Majuro Atoll in the Republic of Marshall Islands and Funafuti Atoll in Tuvalu) are densely populated and urbanized (Fig. 7). Residence and infrastructure extend on the small and low islands. Therefore, their vulnerability to environmental stresses is extremely high. Among various threats to atoll islands, submergence by sea level rise induced by the global warming is most serious, as it leads to loss of national land.

Figure 7: Urbanized atoll islands. Uliga Island, Majuro Atoll, Republic of Marshall Islands (left) and Fongafale Island, Funafuti Atoll, Tuvalu (right).

Atoll island landform consists of coral reef flat, storm ridge, central depression and beach ridge from lagoon to ocean (Fig. 8). The sediment is composed of coral debris, foraminifera sand and others. The central body of the island was formed to expose its surface above high water level at 2000 years B.P. The formation of the island occurred within 100 years, which was triggered by the eustatic fall of sea level. The island was colonized by a people almost at once its exposure at 2000 years B.P., and continuously has been settled since then. The coincidence of the island formation and people colonization means that the pioneering people migrated to colonize on the almost bare island without dense vegetation just after the exposure above the sea.

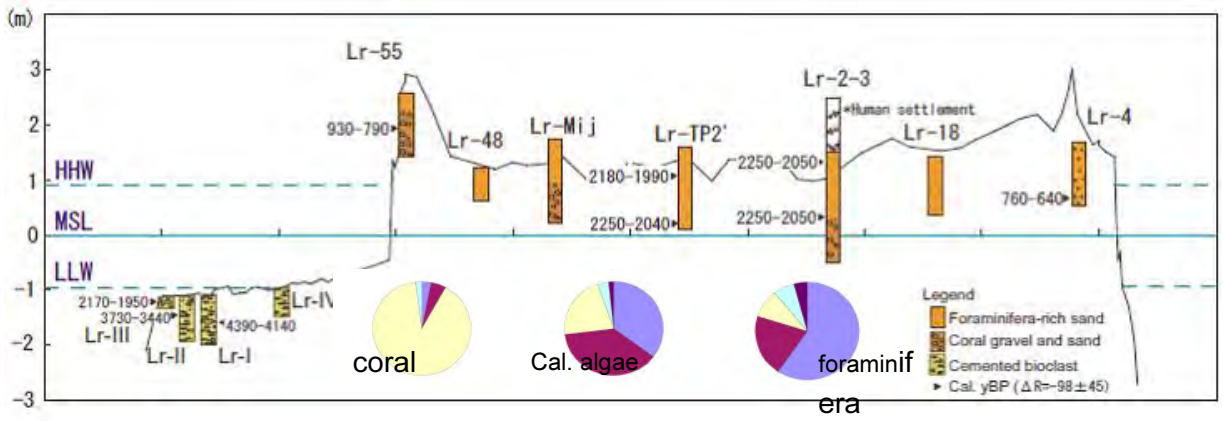

Figure 8: Geomorphic section with sediment contents of Laura Island, Majuro Atoll. Coral reef. Storm ridge, central depression and beach ridge are arranged from lagoon side (left) to ocean side (right).

Tests of large benthic foraminifera are one of the major components of bioclastic sediments in reef islands on many Pacific atolls. However, sources and rates of sediment production by large foraminifera on atolls are not fully understood. Fujita et al. (2009) investigated the distribution and annual sediment production of large benthic foraminifera on reef flats of Majuro Atoll, and the present status and causes of population declines of large benthic foraminifera on ocean reef flats from sparsely populated islands through densely populated islands.

Dominant large benthic foraminifers were *Calcarina gaudichaudii* and *Amphistegina lobifera*. Both species were found mainly attached to macrophytes, particularly to turf–forming algae. The population density varied with substratum types and locations. Different distribution patterns were shown by species. Both species were particularly abundant on ocean reef flats and in inter-island channels near windward, sparsely populated islands. Sediment production rates by these foraminifera were highest on ocean reef flats and in inter-island channels near windward, sparsely populated islands (ca. 1 m^3/yr/100 m^2). These results suggest that a combination of physical factors (water motions and water depth/elevation relative to a low-tide level) and the distribution of suitable substratum mainly affect foraminiferal distribution and production (Fig. 8). The total amount of foraminiferal sand produciton all over the Majuro Atoll is estimated to be 15,000 m^3 for a year. Sand transportation potential along the lagoonal coast is estimated to be 300 m^3 for a year, thus only 2% of the sand production is transported to form atoll islands in Majuro.

However, the population density of large benthic foraminifers declined from reef flats near sparsely populated islands to those near densely populated islands. *Calcarina*, the most dominant foraminifers in the study area, was absent on reef flats near densely populated islands. The decline of foraminiferal density is inversely proportional to the increase in human population on ocean reef flats of NE Majuro. Increasing human populations and activities have resulted in high nutrient loading in groundwater and possibly into nearshore water. Increasing nutrient concentrations may have direct and indirect negative effects on foraminifera, which may result in the decline of foraminiferal density in populated area.

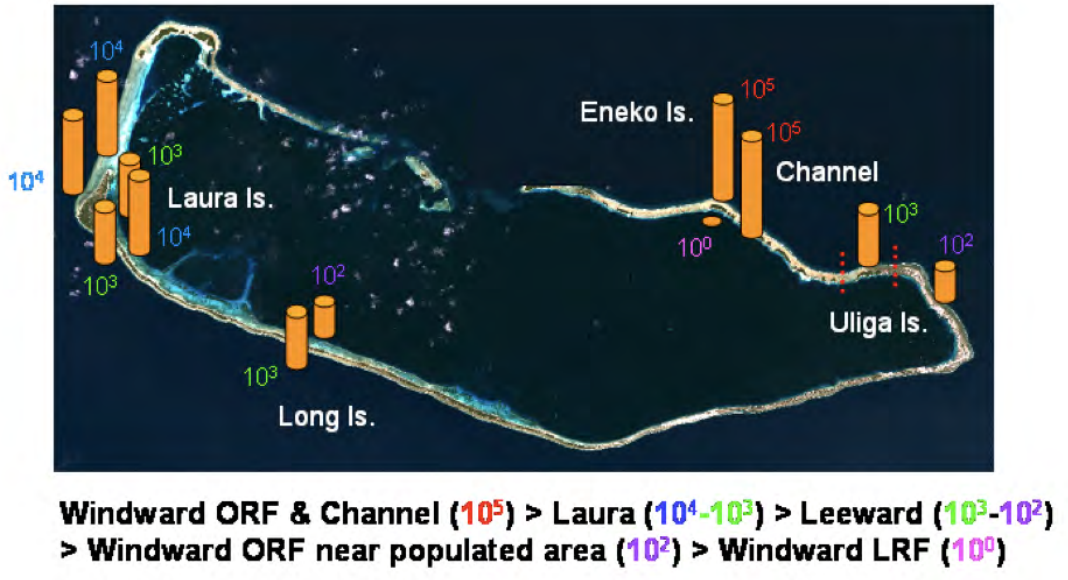

Figure 9: Sediment production rates of foraminifera on Majuro Atoll. Units in 10^{-3} m^3 yr^{-1} m^{-2}. (from Fujita et al., 2009).

Tuvalu is reported by media and scientific journals to be submerged by on-going sea level rise (Patel, 2006). Actually, in Fongafale Island, Funafuti Atoll, Tuvalu, during spring high tide (King Tide), sea water innundates inside the island within a residential area.

Figure 10: Media reports the inundation of Fongafale in March 2008.

However, sea levels rose only 10 to 15 cm during the 20th century (Church et al., 2006), and this part of the island may have flooded even before global warming. Many factors not only environmental but also economic and social, determine the vulnerability of the island to sea level rise. Yamano et al. (2007) reconstructed the last 108 years changes in topography, land use/cover, population and residential areas at Fongafale Island, and found that the vulnerability of the island relates to original landform characteristics (Fig. 11). The central part of the island was formerly dominated by swampland fringed with mangrove forest. It was flooded by sea water during spring high tide well before the global warming in 1896! During the World War II, U.S. army constructed an airfield on the swampland, which hid the original landscape. Fongafale Island experienced greater population in-migration and centralization beginning in the 1970s following the independence of Tuvalu and Kiribati from England. At the independence the capital was set at Fongafale Island, and greater population has gathered this small island. Migrants were also responding to declines in overseas mining operations and limited options for paid employment. As the population increased, construction took place in vulnerable swampland areas.

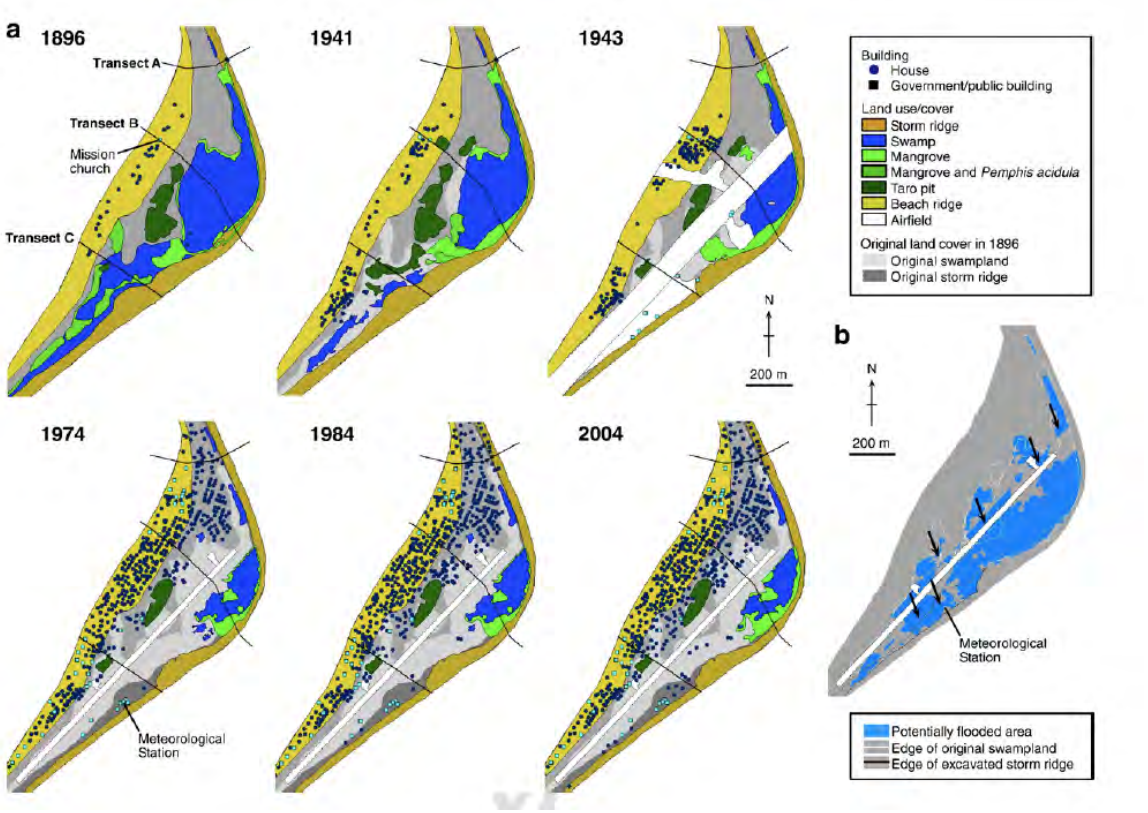

Figure 11: Changes in land use/cover and distribution of buildings (shown by dots) at the central part of Fongafale Island from 1896 to 2004 based on interpretations of historical maps, aerial photographs and the IKONOS satellite image. (from Yamano et al., 2007).

Therefore, the present problem in Tuvalu is not as simple as that of submergence as a result of sea level rise, induced by global warming, but also includes the expansion of residential areas into a vulnerable part of the island. However, if the sea level rises as projected, by the end of 21st century, most parts of Fongafale will be inundated.

Combined stresses and countermeasure plans

Human activities have stressed and degraded the local ecosystem. As noted above, Fongafale consists of coral and foraminifera sand, but ecosystem degradation has led to reduced sand production. Global warming and ocean acidification will also contribute to ecosystem degradation. Thus, the threat to the Pacific islands is not a single global threat but a combination of local and global stresses (Fig. 12). The major threat to the Pacific islands is not as simple as submergence of the islands by sea level rise, but is the complex and combined ones. By now the major problem in the Pacific islands is the local rather than global one. Local stresses have increased the island nation's vulnerability and harmed its natural resistance to the projected rise in sea level and other global environmental stresses.

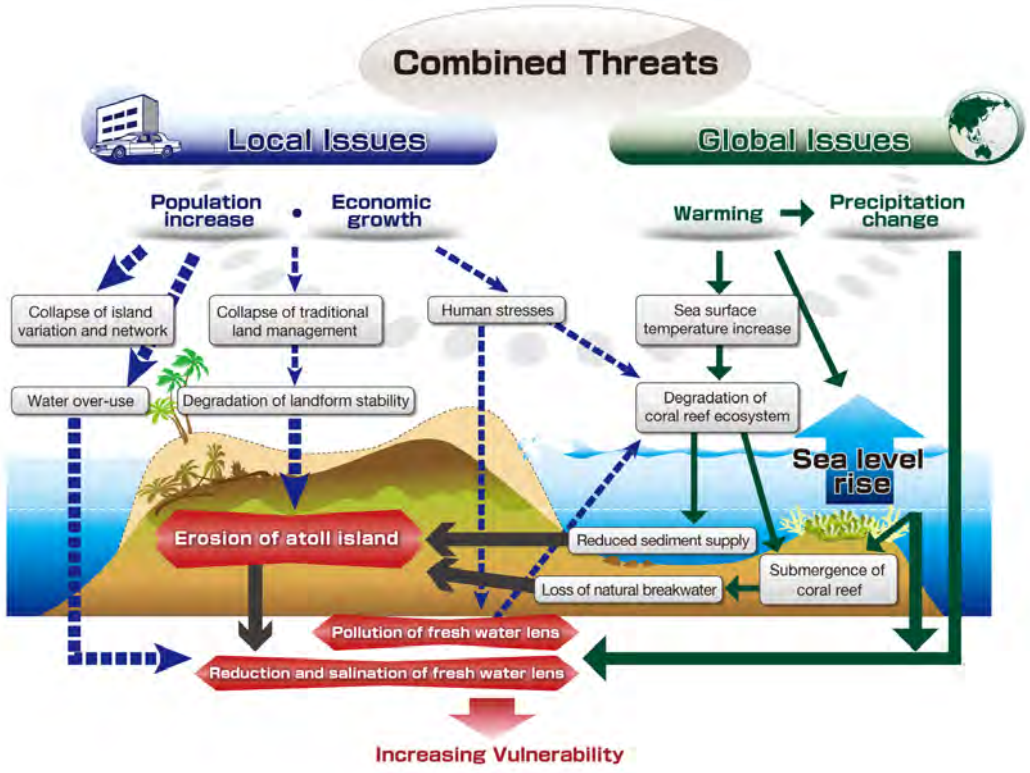

Figure 12: Global and local combined threats upon atoll islands.

To increase the resilience of the Pacific island nations' coast against sea level rise, not only conservation but also rehabilitation of ecosystem is necessary to enhance sand production and sedimentation processes. Countermeasure plans must be based on helping to promote natural island maintenance processes (coral reef formation process, sand production and sedimentation processes, and the traditional land/vegetation management system) and must not conflict with natural resilience potential. For example, an artificial breakwater or bank protection against immediate coastal erosion may prevent sand transportation and sedimentation processes. They should be carefully designed not to prevent but enhance natural sand transportation and sedimentation processes. Human activities and engineering countermeasures should be evaluated based on a reef, habitat-sedimentation map. In addition, based on these evaluations, eco-technological countermeasure plans to enhance reef formation, sand production and sedimentation, including coral and foraminifera farming, should be developed and applied to the Pacific islands.

Coral reefs will be rehabilitated and a sandy coast will be recovered along the Pacific islands both through short-term and long-term countermeasures. The traditional local land and vegetation management system will be regenerated within a modern social framework, and the capacity to monitor and maintain coastal rehabilitation will also be established.

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Management responses to changing ecosystems in the Pacific.

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Abstract

Over the past 40 years, environmental assessments have shown that many island, coastal and marine ecosystems of the South Pacific have changed as a consequence of human resource uses and impacts (Huber, 2009). The human drivers of these impacts are increasing with economic development and population changes. An ecosystem based approach for management to address to current and expected human impacts is an important and fundamental requirement for adaptation to the emergence of the expected effects of climate change in coming decades.

Keywords: Pacific, human drivers of ecosystem change, climate change adaptation, ecosystem based management.

Introduction

Coastal and lagoon ecosystems are critical natural assets for food production, food security, cultural and recreational activities and livelihoods for many people in Pacific island States. The shallow ecosystems and productivity of mangroves, seagrass beds, coral reefs and inter-reef seabed are also important assets for protection of coasts against storm surges and for production of carbonate sands and debris to nourish beaches. These ecosystems are easily damaged through reclamation, drainage, pollution and destruction of critical habitats for fish and other food species. Once destroyed they are not readily or cheaply restored or replaced.

In recent decades many reports have been prepared assessing the status of marine ecosystems. In 2005 the United Nations General Assembly requested a synthesis of assessments. The Assessment of Assessments (UNEP and UNESCO-IOC, 2009) presented 21 regional summaries and a global overview. It presents a pattern of ecosystems changing through superimposition on natural dynamics of human impacts from terrestrial activities and uses of marine resources. The global extent of human impacts has been presented in map form by Halpern et al (2008)

Climate change is recognised as an additional human impact with profound and increasing implications of major ecosystem change during the rest of the present century. There is increasing recognition that ecosystem management should seek to remove or minimise other forms of human impact so that ecosystems can have maximum resilience, or self-repair capacity, in the face of the expected growing impacts of climate change.

Ecosystem change and human drivers

Ecosystems are dynamic and factors such as those listed below have changed over scales of decades or centuries.

- Biological productivity
- Biological diversity
- Ecosystem processes
- Shoreline and beach dynamics
- Water flows
- Water chemistry
- Water temperature
- Sealevel

In the past two centuries and particularly in recent decades human activities have increasingly overtaken biophysical dynamics to become dominant drivers of ecosystem change. There is increasing concern at the security implications of anthropogenic change (eg Jackson, 2008). Table 1 illustrates the nature and overlaps of some areas of concern and specific issues over ecosystem change that are reflected in assessments. They reflect a broad range of social, economic and ecological considerations.

The regional summary for the South Pacific Ocean in the Assessment of Assessments (Huber, 2009) identifies 8 substantial long-standing issues in marine and coastal environment change. These issues have been consistently identified in the past 3 or 4 decades and are now joined by climate change adaptation.

Addressing the long standing issues is an important first step in any program for Pacific climate change adaptation. This is a substantial challenge because they go to the heart of economic and ecological management challenges for the Pacific Region.

Table 1	
Area of concern	Specific issues
Marine ecosystems	biological diversity ecosystem processes seafood production carbonate production
Island and coastal ecosystems	Coastal integrity beach protection agriculture wild food production biological diversity
Food and resource security	natural resource base integrity reduced food security decline in catch contaminated fresh water supply eutrophication and human heath risks in coastal waters contaminated seafood fishery extended to previously non-target species external competition for once exclusive stocks
Physical security	beach, coastline and island erosion loss of ecosystem resilience carbonate production
Long term security	Quality of life Standard of living Maintenance of culture Maintenance of amenity Maintenance of economic options

Part of the challenge in many cases is that the changes are relatively slow. Pauly (1995) used the term “shifting baselines” to describe the situation where members of each generation view change against the conditions that applied when they first went fishing or experienced the ecosystem. This can mask perceptions of a significant change occurring gradually over a period of decades with increasing costs to remedy inadequate management when the consequences of change is recognised.

The situation is further complicated because management of Pacific Islands has to respond to the combined effects of changing populations and increasing engagement with the regional and global economies. Typically populations of outer islands are decreasing through educational and economic migration to capital cities and larger centres and short or longer term overseas migration. Remittances from family members overseas or in the capital city are a significant economic factor affecting the levels of impact and the demand for and feasibility of investment to address current and future environmental management needs.

Table 2 Management issues for the South Pacific Ocean

- Coastal vulnerability to coastal modification and altered lagoonal dynamics;
- Increased sediment and nutrient loads from land use change;
- Solid waste disposal in coastal lagoons and wetlands;
- Liquid organic effluents (particularly from sewage and food processing plants);
- Nutrient overload – eutrophication;
- Microbiological and toxicant pollution In a few urban areas;
- Habitat loss and alteration (particularly coral reefs, mangroves and seagrass beds);
- Over-exploitation and destructive practices in coastal fisheries;
- Conservation of threatened species; and
- Climate change adaptation.

(Huber, 2009)

Managing change

Increasing populations and economic expectations in urban centres are typically addressed by expansion of town and cities to provide settlements.

Increasing urban population generally involves engineering to create home sites with the consequence of habitat destruction directly or through replacement of coastal or agricultural land converted for housing. This creates the need to avoid or minimise the impacts of ongoing use of the converted lands which add to ongoing needs to address inadequate infrastructure that is already impacting ecosystems services, health and quality of life.

Most of the management issues presented by Huber (2009) can be addressed using existing technologies but this requires longer term policy, investment and action horizons than are provided in most political and commercial systems.

Coastal modification through reclamation and infrastructure measures such as port development or causeway construction typically alters the dynamics of lagoonal and stream flows. These changes in turn affect sediment movement leading to erosion or growth of beaches and shorelines. Pro-active management requires engineering measures designed to minimize impacts on water and sediment flows for new developments. In the context of

adaptation for the expected effects of climate change, a greater challenge is to review and address existing problems without transferring impacts to other areas or increasing vulnerability to severe storm events.

Measures for reduction of sediment and nutrient loads from land use may address large area land use such as agriculture and storm water drainage from urban and industrial areas. Significant reductions can be achieved over time through change of agricultural practice on soil disturbance and fertilizer use. Measures for urban and industrial areas should address the construction phase of site development through measure such as silt curtains or traps and the operational life of developments through drainage systems with sediment traps such as ponds and wetlands.

Solid and liquid wastes are critical elements of change management for climate change adaptation. Typically as settlements and communities grow there should be a progression from informal dumping and disposal, to septic systems for sewage and landfill for solid waste, to tertiary sewerage with nutrient reduction and solid waste stream sorting and management. The populations of Pacific island cities are generally too small to justify installation and operation of advanced tertiary sewage and solid waste systems on economic grounds. An immediate priority of change management is to ensure proper regular maintenance and monitoring of septic systems but in the longer term there may be circumstances to create a case for advanced management for small island communities on the basis of broader needs for climate change adaptation.

Because of their central roles in market and subsistence economies, fisheries and their management are major elements of the programs of most Pacific Island nations and relatively well supported by international funding and technical support

Climate change adaptation comes on top of these long standing management issues and adds to the urgency with which they should be addressed. As the largest ocean, the Pacific plays a major and relatively poorly understood role in global the ocean and atmospheric dynamics flowing from accumulation of carbon dioxide and other greenhouse gases.

The coral reefs of the South Pacific have an iconic role in global conservation policy because of their remoteness and vulnerability to the expected effects of climate change through ocean warming, coral bleaching and ocean acidification. This is reflected in national programs to implement actions required under multi-lateral environment and fisheries agreements, conventions and treaties. Examples include implementation of the United Nations Food and Agricultural Organisation's Voluntary Code of Conduct for Responsible Fisheries (*FAO, 1995*) , the global Marine Protected Area targets under the Convention on Biological

Diversity (UNEP, 1972), and the World Summit on Sustainable Development in Johannesburg in 2002. (Wood 2008).

Ecosystem based adaptive management

Planning for adaptation for climate change highlights the major longstanding challenge of achieving watershed, coastal and marine governance systems that integrate all aspects of policy and implementation to achieve sustainable ecosystem based management.

Principles 4 and 14 of the United Nations Conference of the Human held in Stockholm in 1972 (UNEP, 1972) are early statements of the global importance of integrated and adaptive management:

Principle 4

> In order to achieve a more rational management of resources and thus to improve the environment, States should adopt an integrated and coordinated approach to their development planning so as to ensure that development is compatible with the need to protect and improve environment for the benefit of their population.

Principle 14

> Rational planning constitutes an essential tool for reconciling any conflict between the needs of development and the need to protect and improve the environment.

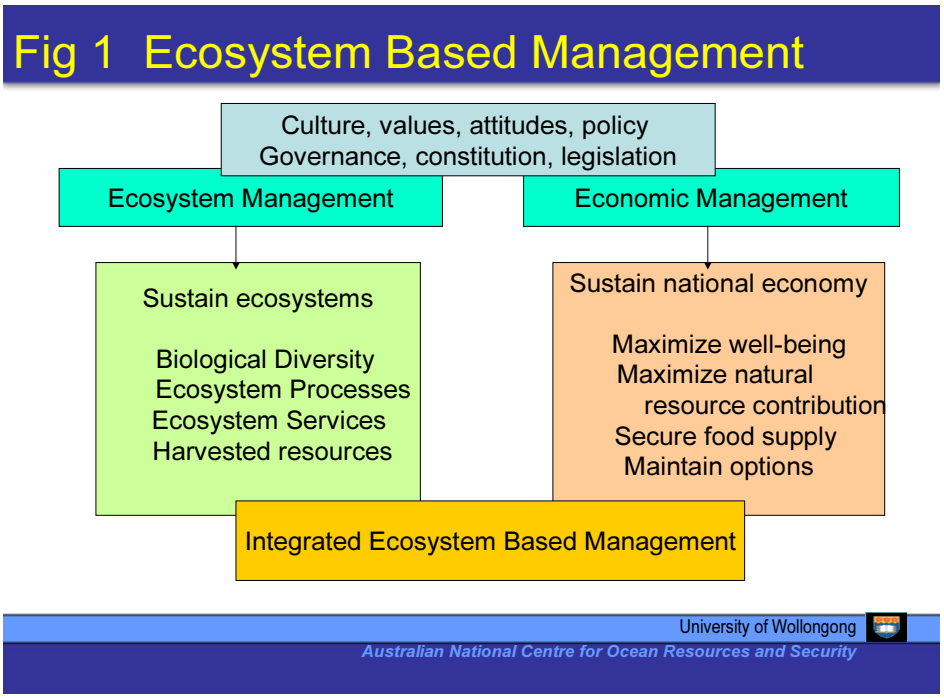
The same need is reflected in the World Conservation Strategy (WCED, 1987)
which called for Ecologically Sustainable Development (ESD):

> "Sustainable development through integration of environmental, social and economic management strategies in adaptation for climate change highlights the major longstanding challenge of achieving watershed, coastal and marine governance systems that integrate all aspects of policy and implementation."

Successful design of such systems involves nationally, and often locally, specific planning which reflects the governance system of the area being addressed. This is reflected in a large range of titles and acronyms for management systems.

The term Ecosystem Based Management (EBM) has achieved a wide degree of contemporary acceptance for multiple use management regimes that seek to balance conservation and socioeconomic uses. There is an increasing range of EBM handbooks and web accessible materials (eg http://ecosystembasedmanagement.com)

The essential elements of an EBM approach include clear decision making process that involves and takes into account the range of interests and expectations of people, sectors and management who will be affected by the resulting management regime. That process should integrate sustainable economic and ecological management objectives. It should be adaptive and specifically include monitoring to provide a robust basis for performance review and adaptation. This is illustrated in figure 1



The design and implementation of an effective program with the objectives of EBM has to based within the culture, attitudes and governance of the communities whose behaviour will determine program success. In the context of island, coastal and marine ecosystems many terms and acronyms have been developed to address particular contexts. These include Integrated Coastal Management (ICM), Integrated Coast and Ocean Management (ICOM), Integrated Coastal Area Management (ICAM) and Integrated Coastal Zone Management (ICZM). They typically have the same broad objectives as EBM but reflect different circumstances of cultural, sectoral and governmental jurisdiction. Table 3. lists objectives for ecosystem based management drawn from http://ecosystembasedmanagement.com.

Table 3. Objectives: Ecosystem Based Management should:

- Integrate ecological, social, economic, and institutional perspectives, recognising their strong interdependences
- Explicitly account for the system intraconnectedness, recognising biophysical interactions between many target species or key services and other non-target species, and governance interactions between sectors that use or impact marine ecosystems;
- Acknowledge interconnectedness among systems, such as between air, land and sea;
- Emphasise the protection of ecosystem structure, functioning and key processes; and
- Be placed-based by focusing on a specific ecosystem or ecosystems and the range of activities and impacts affecting them;

After http://ecosystembasedmanagement.com

Effective processes for planning and management to implement ecosystem based management reflect the cultural and governance contexts of the area to be managed. They are also reviewed and adapted in the light of monitoring, management experience, changing community attitudes and new information. Table 4 summarises lessons of experience from programs that address ecosystem based management to identify some core elements that should be explicitly addressed in planning and management.

Table 4. Elements of effective EBM Planning and management

- Clear Vision, Goals and Decision Rules
- Strong legal/cultural social framework
- Clear information on the area - based on the best available research on biophysical nature, linkages and socio economic uses, dependencies and impacts
- Community understanding and support
- Engagement and commitment of all sectors
- Commitment to enforcement
- Performance monitored in relation to goals
- Adaptive in the light of monitoring, experience, new knowledge, contemporary community views and understanding of the medium and longer term ecosystem outlook.

Conclusions

Pacific ecosystems are undergoing increasing change driven by human use of marine natural resources and by pollution and other impacts from the development and use of land. In the past 4 decades and currently local human impacts are the major drivers ecosystem change on south Pacific Islands and marine environments. Addressing the long standing and increasing impacts of current human activities is a fundamentally important and urgent task to maximise the resilience or self repair capacity of Pacific ecosystems in the face of the expected impacts of climate.

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The socio-economic effects of climate change and variability on an island society: A case study in the Federate States of Micronesia

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Abstract

Research was conducted on the islands within Pohnpei State, which are part of the Federate States of Micronesia, in November 2007. We asked selected household members on each island to fill out a questionnaire with the assistance of local counterparts. The household survey included questions on general and family background, meals and drinks, lifestyle, and anxiety about environmental changes. Our survey showed that people on the islands were deeply worried about the impact of climate change on their island societies and natural environments.

Keywords: atoll, globalization, global warming, Pohnpei, questionnaire

Introduction

Various environmental changes, such as globalization and global warming, are affecting the lives of people on this planet in many significant ways. Due to their small size and delicate ecology, islands are especially affected by such large processes.

Global warming leads to temperature increases that cause the seas to rise. Low-lying islands such as atolls, which are made of coral, are particularly vulnerable to a rise in sea level. There are many low-lying islands and atolls in the Pacific. It has also been reported that many may sink below sea level due to global warming (e.g. IPCC 2007).

The El Niño effect related to climate change was studied from 1997 to 1998 in the Pacific Ocean area; the results of that study showed that it affected the ecosystem, the production of crops, and other environmentally related areas (e.g. Drexler & Ewel 2001). The increased incidence of typhoons is another consequence of climate change. Typhoon SUDAL, for example, affected local communities and people's health in Yap State in the Federate States of Micronesia (FSM) (e.g. Nakajima & Ohashi 2004, Durand *et al*. 2005). Tidal surges occurred in 2007 and 2008 in FSM.

In the Pacific Islands, traditional social systems are still relatively prevalent. These traditional societies have been influenced by globalisation and are becoming modern. Hence, it is preferable to study the relationship between society and climate change from the viewpoint of globalisation. Due to the complexity of social and natural environments, it is important to understand the impact of these changes through a focus on human adaptation and humans' efforts to maintain their social environment. To understand these relationships, our research group studied how local people view these environmental changes through household questionnaires.

Method

Research was conducted on three islands (Pohnpei Island, Mokil Atoll, and Pingelap Atoll) in Pohnpei State, FSM, in November 2007 (Kawai et al. 2010). We asked selected household members on each island to answer a questionnaire with the assistance of local counterparts. The household survey included questions about the general and family background, dietary patterns, and lifestyle of the local people and about their concerns regarding environmental changes.

Results and Discussion

Consciousness of the effects of global warming

Figure 1 shows people's consciousness of the effects of global warming on three islands in Pohnpei State. The left axis shows public concern about global warming. The figure indicates that the people on these three islands are very concerned about the effects of global warming. The people of Mokil and Pingelap are not very worried about heavy rain; in contrast, the people of Pohnpei are concerned about it. Generally, fresh water is a very important resource on the islands. Pohnpei is a famous place where the amount of rainfall per year is very high (e.g. Lander & Khosrowpanah 2004). On the other hand, Mokil and Pingelap Islands are atolls, and Mokil receives approximately 380 mm of rain per year (personal data). Hence, fresh water is a very important resource on both of these islands. This is the reason why the people of Mokil and Pingelap do not worry about heavy rain.

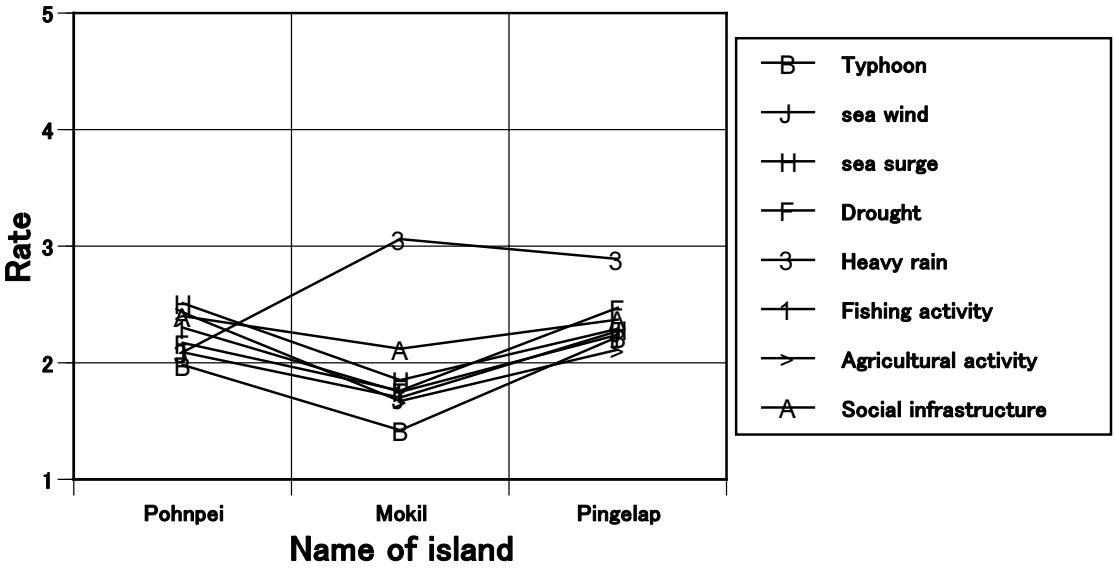

Fig.1. Average values in the awareness of increased typhoons, sea winds, sea surges, droughts, heavy rains, and of the effects of these climate changes on fishing and agricultural activities, and social infrastructure; 1: very very worried, 2: very worried, 3: worried, 4: not so worried, 5: not at all (Kawai et al. 2010).

The effect of the tidal surge on life and food

Climate change involves many phenomena, and a society is a very complicated system. Hence, in order to clarify the relationship between climate change and society, this paper focuses on the effect of the tidal surge on islanders' lives and food.

Figures 2a-b demonstrate the damage caused by a tidal surge. These pictures show that the results of coastal erosion and the effects of tidal surges were frequently observed on all islands.

Figures 2 c-d show a traditional men's house and a coastal house. When big waves lashed the shore, these houses were inundated with sea water. Hence, people have now moved inland. On some islands, to protect against the tidal surge, cement walls have been constructed on the seaside (Fig. 2e) and in inland areas (Fig. 2f).

The traditional food in Micronesia includes fresh fish (Fig. 2g), swamp taro (Fig. 2h), and taro (Fig. 2i). The effect of climate change on fresh fish is well known. Tidal surges sometime break the coral, which is the habitat of fish. This might decrease the fish catch for the local people. Taro is generally grown near both coastal areas and inland areas. However, since the coastal areas are covered with sea water in the event of a tidal surge, taro is no longer grown in those areas; rather, it is only grown in inland areas.

Fig. 2. Pictures show coastal erosion (a, b), coastal house (c), men's house (d), cement walls on the sea side (e) and in inland areas (f), cooked fresh fish (g), swamp taro (h), taro (i), cooked rice (j), canned fish and meat, ramen (k), bread (l), rice in shop (m), and human waste (n).

Figure 2f shows a taro patch in which swamp taro was cultivated. When the sea water enters the inland area and mixes with the fresh water in the taro patch, the growth rate of taro decreases, as does the productivity of swamp taro. The low productivity of swamp taro is currently one of the biggest problems in these areas.

The effects of tidal surges on islanders' lives and the type of food that they eat were concluded as follows. Coastal areas have many flat spaces suitable for agriculture and general life. Tidal surges result in coral breakage and cause a decrease in the fish catch in coastal areas. Since the sea water then enters the inland areas, cement walls have been constructed to protect the land. If people cultivate taro in the coastal areas, it will be affected by sea water. Hence, the cultivation areas should be shifted to inland areas or mountainous areas. Yet, people cannot move taro patches; therefore, when tidal surges occur, the productivities of swamp taro decrease.

The effect of tidal surges on the quality of food

Figure 3 shows the number of times per week that people on the three islands eat traditional food. While fresh fish is consumed almost every day, other traditional foods are consumed only once or twice a week.

The types of typical modern food consumed by people on these islands are as follows: rice (Fig. 2j), canned fish and meat, ramen (Fig. 2k), and bread (Fig. 2l). Figure 4 shows the number of times per week that people ate modern food. Modern food, except rice, was consumed twice or thrice per week. Rice is consumed very frequently, around 5.5 times per week.

These results suggest that on the islands, people eat modern food more often than traditional food. A decrease in the productivity and cultivated areas of traditional food might affect this trend. In particular, rice is very important because it is easy to store (Fig. 2m) and is relatively inexpensive, while other types of modern food are more expensive. Furthermore, money is required to construct cement walls and new houses. This means that the monetary system has penetrated well. While globalisation generally affects eating habits, these results suggest that climate change has accelerated those effects.

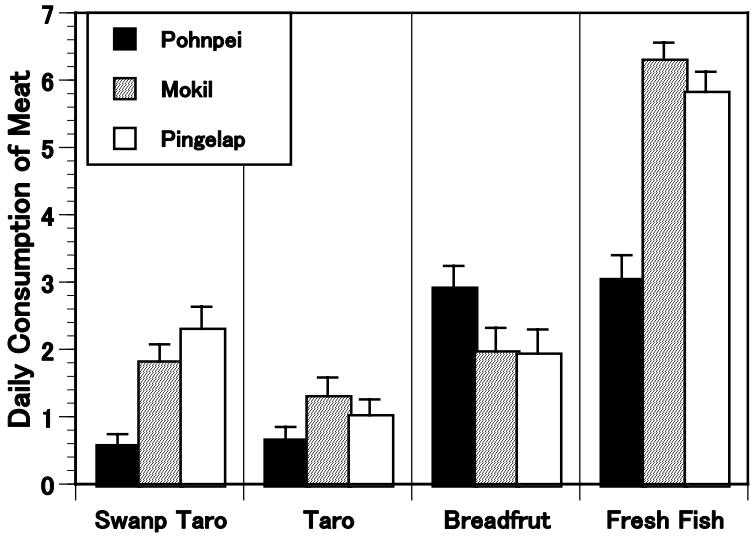

Fig. 3. Average daily consumption of traditional food (swamp taro, taro, breadfruit, and fresh fish) on Pohnpei, Pingelap, and Mokil. Vertical bars at the top of columns show the standard error for such a sample (Kawai et al 2010).

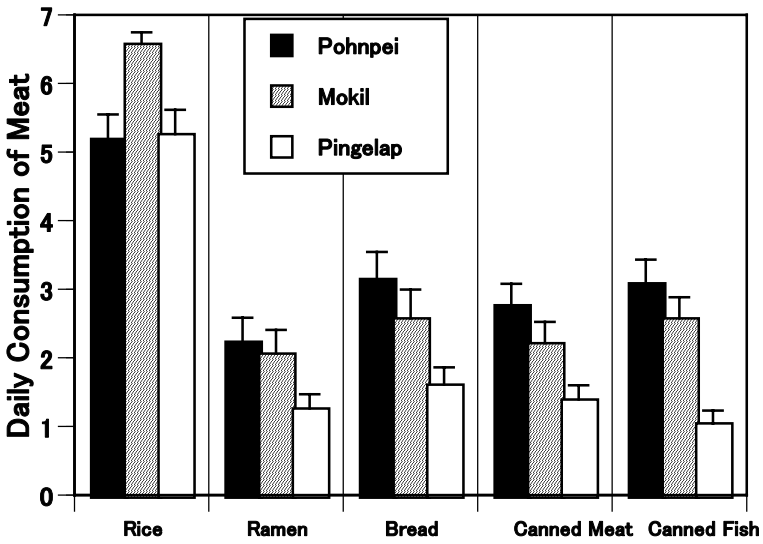

Fig. 4. Average daily consumption of modern food (rice, ramen, bread, canned meat, and canned fish) on Pohnpei, Pingelap, and Mokil. Vertical bars at the top of columns bars the show standard error (Kawai et al 2010).

Consciousness of the effects of the monetary system

Figure 5 demonstrates the way in which people think about the effects of the monetary system. People are worried about dependency on money and about increased prices, which are

closely related to the monetary system. People are also relatively worried about the increase in the amount of imported food and goods. Although these goods are useful for life, they increase the amount of human waste because these islands do not have a recycling system (Fig. 2n). Hence, people are very worried about human waste.

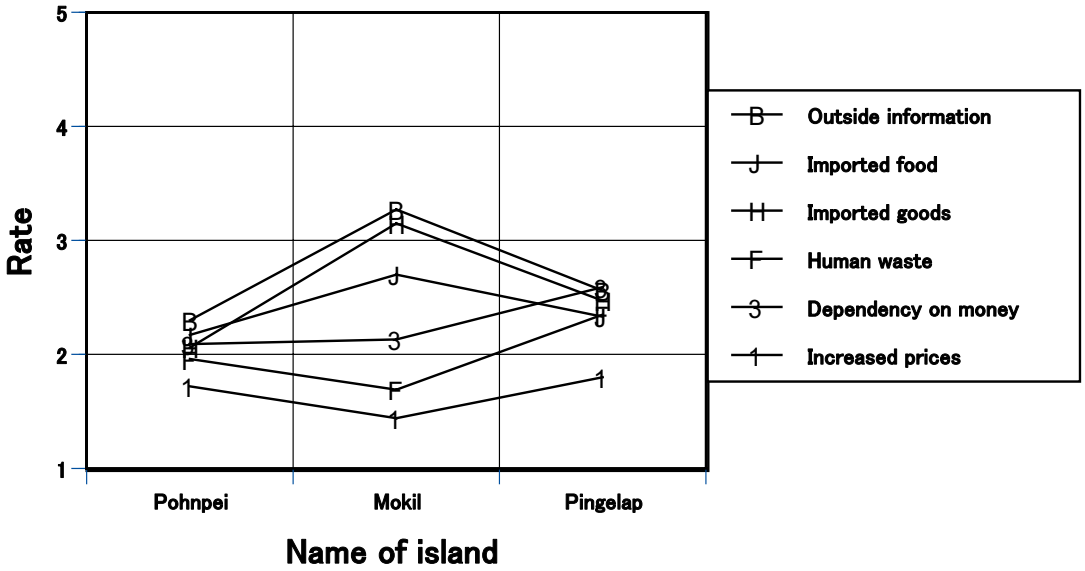

Fig.5. Average values in the consciousness of the effects of outside information, imported food, imported goods, human waste disposal, dependency on money, and increased prices on the local island community; 1: very very worried, 2: very worried, 3: worried, 4: not so worried, 5: not at all (Kawai et al 2010).

Consciousness of the effects of the monetary system on society

The monetary system is prevalent even on remote islands. However, it is very difficult to find employment and earn money on those islands. Hence, people have to go to the capital islands or big cities, such as Guam and Hawaii. This considerably affects the community structure and traditional customs.

Figure 6 shows how people view the ongoing social changes. People are worried about the decrease in population and the changes to traditional society. These data suggest that local communities have been changing into modern social systems, or possibly that they have been breaking down.

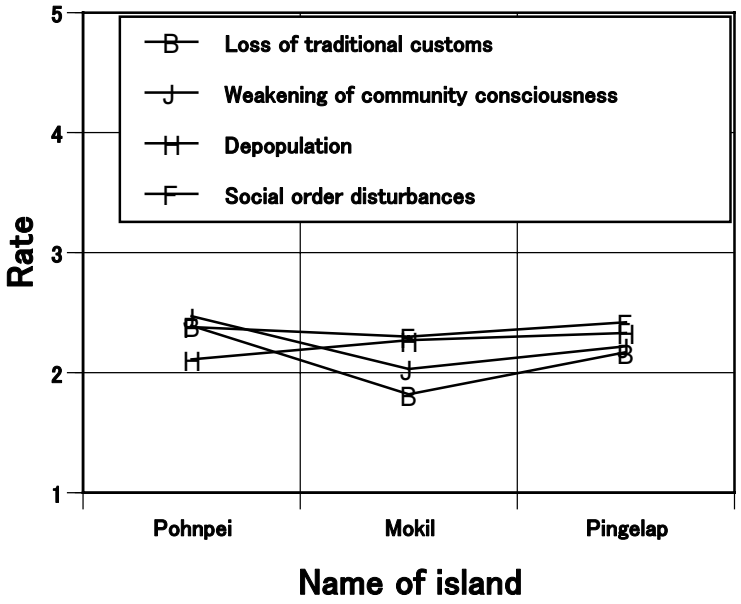

Fig.6. Average values in the concern for loss of traditional customs, the weakening of community consciousness, and disturbances to the social order related to globalization; 1: very very worried, 2: very worried, 3: worried, 4: not so worried, 5: not at all (Kawai et al 2010).

Thus, I can conclude that climate change both directly and indirectly affects island societies. Tidal surges directly cause: (1) coastal erosion, (2) the destruction of houses due to inundation with sea water, (3) a reduction in cultivable areas for growing taro, (4) a decrease in the productivity of swamp taro, and (5) a shift from the natural coastline to a cemented coastline. Tidal surges indirectly cause: (1) an acceleration to the monetary system from a sustainable system and (2) the possibility of a breakdown of the traditional social system.

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The International Legal Implications of Climate Change/Variability for the Rights of Island States over Their Surrounding Waters

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Abstract

One of the impacts of climate change and variability on coastal and island states is the possible change in the location of baselines for their maritime zones due to sea level rise. According to the UN Convention on the Law of the Sea (UNCLOS), baselines are the starting points for measuring the limits of the territorial sea, the contiguous zone, the exclusive economic zone (EEZ), and the continental shelf. Baselines also often play important roles for delimitation of maritime boundaries between neighboring states because they are essential for establishing equidistance or median lines, which are adopted as the basis of the majority of existing maritime boundaries.

The paper first reviews the rules of international law relevant to various types of baselines. Then it addresses the specific manner in which sea level rise affects such baselines. A rise in sea level would shift baselines landward, and as a consequence the outer limits of the coastal state's maritime zones must be moved landward, except the continental shelf which may be fixed permanently under UNCLOS. The special effects that sea level rise would bring upon small islands and rocks are also discussed.

The paper then examines the problems that sea level rise causes for island states, including in particular the problems caused by the total submergence or serious inundation of all the islands belonging to a state. The paper briefly explores the options available for an island state facing such possibility in order to maintain its rights over the maritime zones.

Keywords: climate change; sea level rise; baseline; maritime zones; island states; UNCLOS

Introduction

One of the impacts of climate change and variability on coastal states, including island states, is the possible change in the position of baselines for measuring their maritime zones due to sea

level rise. According to international law as codified in the UN Convention on the Law of the Sea (UNCLOS), baselines are the starting point for measuring the limits of the territorial sea, the contiguous zone, the exclusive economic zone (EEZ), and the continental shelf of 200 nautical miles (nm)[1]. Baselines also often play important roles for delimitation of maritime boundaries between neighboring states because they have a direct bearing on the construction of an equidistance or median line adopted as the basis of the majority of existing maritime boundaries.[2] This paper first addresses the specific manner in which sea level rise affects baselines used for these purposes. The paper then focuses on the special problems that sea level rise causes for island states. Before doing so, however, the international law rules relating to baselines are reviewed briefly.

Normal and other baselines

There are several types of baselines, which are defined under UNCLOS. It provides first that the *'normal baseline'* for measuring the breadth of the territorial sea is "the low-water line along the coast as marked on large-scale charts officially recognized by the coastal state" (Art. 5). UNCLOS then provides for other types of baselines.

In the case of *islands situated on atolls* or of *islands having fringing reefs*, the baseline is defined as "the seaward low-water line of the reef, as shown by the appropriate symbol on charts officially recognized by the coastal state" (Art. 6).

Low-tide elevations, which appear above water at low tide but submerge at high tide, do not normally generate maritime zones. However where a low-tide elevation is situated wholly or partly at a distance not exceeding the breadth of the territorial sea from the mainland or an island, the low-water line on such elevation may be used for measuring the territorial sea (Art. 13). Thus a low-tide elevation situated at 12 nm from the baseline can generate further area of the territorial sea up to 12 nm around it into the sea.

UNCLOS further provides that, in certain localities where the coastline is deeply indented and cut into, or if there is a fringe of islands along the coast in its immediate vicinity, the coastal state may use '*straight baselines*', joining appropriate points in drawing the baseline in

[1] To be more precise, in certain cases, the continental shelf could be extended up to 350 nm from the baseline. See the UN Convention on the Law of the Sea, Art. 76 (5).
[2] C. Schofield, "Against a Rising Tide: Ambulatory Baselines and Shifting Maritime Limits in the Face of Sea Level Rise," OPRF, P*roceedings of International Symposium on Islands and Oceans, Tokyo, January 22 and 23, 2009*, p. 72.

accordance with the detailed rules and conditions specified in Article 7. Such 'appropriate points' may be small islands or rocks which are above water at high tide. Low-tide elevations may not be used for drawing straight baselines unless lighthouses or similar installations that are permanently above sea level have been built on them or where the drawing of straight baselines to and from such elevations has received general international recognition (Art. 7 (4)).

For a river flowing directly into the sea, straight lines are to be drawn across its mouth between points on the low-water lines of its banks (Art. 9). In the special case, like the mouth of the Ganges, where the coastline is highly unstable due to the presence of a delta and other natural condition, UNCLOS allows the coastal state to draw a straight line across the river by selecting appropriate points along the furthest seaward extent of the low-water line, and provides that, in such a case, even if the low-water line moves landward subsequently, the straight baseline remains effective until the coastal state changes in accordance with the UNCLOS provisions (Art. 7(2)).

With regard to a bay which meets the definition in Article 10, a *straight closing line* may be drawn as baseline between the low-water marks of its natural entrance points where the line does not exceed 24 nm (Art. 10 (4)).

Lastly, an archipelagic state may draw *'straight archipelagic baselines*' in accordance with the provisions of Article 47, by joining 'the outermost points of the outermost islands and drying reefs[3] on the archipelago', provided that within such baselines are included the main islands and an area in which the ratio of the area of the water to the area of the land, including atolls, is 1 to 1 and 9 to 1 (Art. 47 (1)).

Impact of sea level rise on baselines

A rise in sea level would cause baselines generally to shift landward. In the case of normal baselines, the current low-water-line inevitably recedes. This is the case also with respect to islands situated on atolls or islands having fringing reefs, where the seaward low-water line of

[3] It is not clear whether 'drying reefs' mean fringing reefs or one type of low tide elevations. If it means the latter, there is an inconsistency with paragraph 4 of the same Article, which provides that straight archipelagic baselines shall not be drawn to and from a low-tide elevation unless lighthouses or similar installations which are permanently above sea level have been built on it or where it is situated wholly or partly at a distance not exceeding the breadth of the territorial sea from the nearest island. L.M. Alexander, *Alternative Interpretations of Geographic Articles in the 1982 LOS Convention* (Kingston, RI: University of Rhode Island, 1990), pp. 58-59.

the reef would move away from the sea. The closing lines of rivers and bays would similarly have to be shifted landward. Straight baselines must be redrawn if the islets or rocks which have been used as anchor points for drawing the baselines should such islets or rocks submerge permanently. Similar need for baseline shifting applies also with regard to straight archipelagic baselines. Since such archipelagic baselines may in some cases be as long as 100 nm, or exceptionally even 125 nm (Art. 47 (2)), the submergence of an island used for an anchor point of such baselines could cause substantial change in the size of archipelagic waters.

An important consequence of such "ambulatory" nature of baselines is the reduction of part of the maritime zones that the coastal state concerned has validly claimed. In the case of relatively flat coasts, where the baseline recedes considerably, the loss of the sovereignty over some portion of the outer limits of the territorial sea could be significant. It was pointed out that in some areas, a rise in the sea level of 50 cm could shift the baseline for tens of kilometers[4]. Similarly, the coastal state would no longer be able to engage in the enforcement of its law with regard to customs, fiscal, immigration and sanitary matters, as well as historical and archaeological objects on the seabed, within some areas along the original outer limit of its contiguous zone. It would also lose its sovereign rights over portions along the original outer limits of the EEZ. Such loss could be significant if the area concerned happens to be rich in natural resources.

The situation is rather complicated with regard to the seabed area beyond the territorial sea. Every coastal state is entitled to the continental shelf up to at least 200 nm from the baseline. In some cases, the coastal state may establish its outer limits beyond 200 nm on the basis of the recommendation of the Commission on the Limits of the Continental Shelf. In the latter case, such outer limits will become "final and binding" (Art. 76 (8)). Further, the coastal state is obliged to deposit with the UN Secretary-General charts and relevant information "*permanently* describing the outer limits of its continental shelf" (Art. 76 (9)) (Emphasis added). These provisions imply that once a coastal state has deposited such charts, the outer limits will become permanently fixed, even if the baseline position changes subsequently.

These provisions do not indicate whether the permanent nature of the outer limits applies also to the outer limit of 200 nm. It would, however, be unjust if the permanent nature applies only to the area extending beyond 200 nm and not to the area within the limit of 200 nm[5]. It would be more reasonable to consider that the provisions concerned apply also to the outer limit of 200

[4] A.H.A. Soons, "The Effects of a Rising Sea Level on Maritime Limits and Boundaries," *Netherlands International Law Review*, vol. 37 (1990), p. 216.
[5] *Ibid*., p. 217.

nm as well as the limits of the continental shelf extending beyond. It may thus be concluded that the outer limit of the continental shelf at 200 nm may also be fixed by describing it permanently on the charts submitted to the Secretary-General. Otherwise, the outer limits of 200 nm must be moved landward when the baseline recedes.

Another consequence of potentially a serious nature concerns small islands or rocks. According to UNCLOS, an 'island', defined as a naturally formed area of land, surrounded by water, which is above water at high tide, is entitled to the various maritime zones just as other land territory, and "rocks" which cannot sustain human habitation or economic life of their own have no EEZ or continental shelf (Art. 121). Sea level rise may cause some of such islands and rocks submerged completely, with no baselines left from which maritime zones are to be measured. Although no authentic interpretation has been given on the highly ambiguous provision of Article 121, and state practice is divergent regarding the treatment of such islands or rocks, a literal interpretation of the article appears to imply that if an island or rock become totally submerged, the state to which they belong would lose the maritime zones generated by them, *except* the continental shelf whose outer limits have been established permanently following the procedures mentioned above.

What happens, then, to the seabed area created by the submerged island and its territorial sea? One interpretation could be that it becomes part of the high seas, just like a donut hole created by the surrounding continental shelf in the case of a remote island. Such interpretation, however, would result in a rather unreasonable situation, where the state to which the island used to belong would no longer have any rights over the seabed area created by the former island and yet retains the sovereign rights over the continental shelf it had generated. A more reasonable interpretation, therefore, would be that the seabed area formed by the submerged island sea would be regarded still as part of the subsoil of the territory, and becomes part of the territorial sea. This conclusion may be derived from the general international law principle that the territory of a state consists not only of the land, including the territorial sea, but of its air space and its subsoil[6]. The subsoil of the land territory may arguably belong to the state even if it becomes covered by water. The contiguous zone of the state, if claimed, could also be retained.

Another problem with ambulatory baselines would be the inevitable ambiguity regarding the exact limits of the various jurisdictional zones, since coastal states would tend to be slow in changing their baselines and in adjusting the outer limits of their maritime zones. It is likely that in many cases, coastal states would take no action particularly where such adjustment would

[6] R. Jennings and A. Watts, eds., *Oppenheim's International Law*, 9th ed., vol. I (1996), pp. 572-573.

result in the loss of their rights over some part of the maritime zones they have been claiming. This would leave the situation legally unstable, which may in turn lead to friction and conflict over various claims between neighboring states.

The ambulatory baselines cause further consequence on those delimitation agreements which use distance criteria as measured from such baselines for drawing delimitation lines. In fact, most of recent delimitation agreements will not be affected by sea level rise since they use geographical coordinates to show the boundaries, and/or depict them on charts. However, where the delimitation is defined simply in terms of median or equidistance line between the two coasts concerned without showing it on charts, the shifting of baselines or submergence of islets would affect the delimitation line to the advantage of either of the two parties. Such a situation could cause serious consequences, including disputes, particularly where the areas along the median or equidistance line are rich in natural resources.

In this connection, the question may arise whether one of the parties to such a delimitation agreement can unilaterally terminate the agreement invoking the rule of fundamental change of circumstances under Article 63 of the Vienna Convention on the Law of Treaties by arguing that the parties had never anticipated that the delimitation line might be affected by future sea level rise. The answer is clearly negative since the Convention has a provision exempting from its application specifically those treaties which establish a boundary (Art. 62 (2) (a)).

Special problems of island states

Although the various consequences described above caused by sea level rise apply also to island states, these states may have to face additional serious impacts. First, a state consisting only of small flat islands and rocks will lose its land territory when they become completely submerged. Secondly, the islands may become totally uninhabitable due to the near submergence or other adverse effects of sea level rise. In both cases, its entire population will be forced to move somewhere else.

In the case of total submergence, it is generally believed that the submerged island state will lose its entitlement to the territorial sea, the contiguous zone and the EEZ, all of which are measured from the baselines on land[7]. However, another, better interpretation, as suggested above, is that assuming that the state itself survives in some form or another, it would lose its rights over the EEZ, but retains its sovereignty over the seabed area created by the submerged

[7] See Soons, *supra* note 4, pp. 216-217.

island, including its territorial sea, as part of the expanded territorial sea. The contiguous zone, if the state had claimed, could also be retained.

In the second case, with some islands left but uninhabitable, the territorial sea and the contiguous zone, if claimed, still remain, but the state will lose its EEZ unless at least one of such uninhabitable islands could still be regarded as "island", or as "rocks" which can sustain economic activities of their own, under Article 121.

As far as the continental shelf is concerned, as discussed above, whether or not an island state becomes totally submerged or nearly submerged, it continues to retain its sovereign rights over the shelf in the case where it has submitted the charts permanently describing the outer limits of the shelf to the UN Secretary-General in accordance with Article 76 (9).

The conclusions suggested above are based on the assumption that the people and their government which existed before the submergence or near submergence of the islands concerned have moved to a new location outside the islands, so that they may continue to exercise their sovereignty and sovereign rights over the maritime zones[8]. This would be possible if the island state had obtained a new territory, or concluded an agreement with another state to form some type of union or federal state, with an arrangement whereby the government of the former island state, or the union's central government, would exercise the rights over the maritime zones in question. Alternatively, the island state would merge with another state, to which the population of the former would relocate, and the latter would become the successor state of all the rights of the former. In such a case, the island state would cease to exist and therefore can no longer exercise its rights regarding the management of its former maritime zones. Thus, the disappeared state would basically have purchased its relocation to a new state with its maritime zones[9].

Concluding Thoughts

The above discussion has been limited to the situation prevailing under the current international law framework. Various other legal and policy options are available for island states to pursue in order to mitigate the adverse effects of sea level rise.[10] In the author's view, which is based on

[8] According to international law, a defined territory, a people and a government are essential components of a sovereign state. Jennings and Watts, *supra* note 6, pp. 121-122.
[9] R. Rayfuse, "W(h)ither Tuvalu? Ocean Governance and Disappearing States," OPRF, *supra* note 2, p. 98.
[10] See M. Hayashi, "Sea Level Rise and the Law of the Sea: Legal and Policy Options," OPRF, *ibid.*, p. 78 *et seq.*

similar suggestions of other scholars[11], one of the most effective legal options is to negotiate a modification of UNCLOS provisions or a new agreement supplementary to UNCLOS with a view to freezing or fixing permanently the current baselines as established under UNCLOS rules, so that sea level rise would not oblige the coastal states to shift their baselines. The suggestion has considerable merits. Among others, it is fair and equitable since it would enable the coastal or island state to retain its sovereignty or sovereign rights over the maritime zones it claims lawfully, including those generated by islands, even after the islands become submerged or uninhabitable. The suggestion would not deprive any other state of any of its maritime space nor would it reduce the area of the high seas[12].

The core provision of such new rules that the author suggested tentatively elsewhere would read:

> *A coastal state may declare the baselines established in accordance with the relevant provisions of UNCLOS as permanent once it has shown them on charts of an adequate scale or described them by a list of geographical coordinates, and given due publicity thereto, notwithstanding subsequent changes in geographic features of coasts or islands due to sea level rise.*

At the same time as the negotiation for new rules at an appropriate global forum, it is suggested that the island states facing the possibility of submergence or near submergence negotiate a bilateral treaty with another country for establishing some kind of union or merger under which the island state or its successor state may continue to exercise its rights that it currently enjoys over maritime zones.

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[11] Soons, *supra* note 4, p. 225; D. Caron, "When Law Makes Climate Change Worse: Rethinking the Law of Baselines in Light of a Rising Sea Level," *Ecology Law Quarterly*, vol. 17 (1990), pp. 623, 640-641; D. Caron, "Climate Change, Sea Level Rise and the Coming Uncertainty in Oceanic Boundaries: A Proposal to Avoid Conflict," in S. Hong and J. van Dyke, eds., *Maritime Boundary Disputes, Settlement Process and the Law of the Sea* (2009), p. 14; J. L. Jesus, "Rocks, New-born Islands, Sea Level Rise and Maritime Space," in J. Frowein, *et al*., eds.,*Verhandeln für den Frieden. Negotiating for Peace* 2003), pp. 602-603; Soons, *supra* note 4, p. 225.

[12] Hayashi, *supra* note 10, p. 83.

Session III

Island-based Management of Ocean Areas

Research on Implementation and its Problem of Marine Boundaries for Island States

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Abstract

The limits of the continental shelf are principal parts of marine boundaries of island states, so that currently a number of island states are making submissions on the limits of the continental shelf to the United Nations according to UNCLOS (United Nations Convention of the Law of the Sea). 51 submissions were made by coastal states by 2009 and additionally 44 preliminary submissions were made as well. Among 51 submissions United Nations made 9 recommendations on the limits of the continental shelf of the coastal states by 2009. These figures are not only for island states but also for mostly continental states. However even continental states have some islands in its offshore area in many cases. Those islands of the continental states may have EEZ (Exclusive Economic Zone) and may provoke the continental shelf beyond the EEZ. Therefore there are many cases on the limits of the continental shelf of islands observed in the submission made and recommendations made.

There are vast variations on the morphology and geology of the islands of the world by themselves. Some islands stand as independent isolated volcanic island, some sit on ridge feature morphology, some are parts of large oceanic plateau, some form chained island arcs, some are fragments of continent itself, and so forth. In this presentation, the author will introduce Article 76 of UNCLOS which defines the continental shelf of the coastal states and then introduce the parts of submissions and recommendations with the reviews of morphology and geology of related islands. All the presented resources will be cited from the open documents of the UNCLOS and CLCS (Commission on the Limits of the Continental Shelf), executive summaries of submissions, executive summaries of recommendations, and notes verbales of coastal states, which are all available at United Nations home pages.

EEZ and continental Shelf

One of the critical issues on the marine boundaries of island states is the limit of the continental shelf beyond the 200 nautical miles of the EEZ (Exclusive Economic Zone) that is finely defined in Part V of UNCLOS (United Nations Convention on the Law of the Sea). The area of the EEZ of island states becomes quite large compared to its rather small land territories. The EEZ provides island states large opportunities to utilize and explore marine natural resources such as fisheries, oil and natural gas, and mineral resources. At the same time the states have the responsibility for the protection and preservation of the marine environment (Article 56 of UNCLOS *"Rights, jurisdiction and duties of the coastal State in the exclusive economic zone"*).

Besides the EEZ coastal states have opportunity to extend its right over the area beyond EEZ as its continental shelf according to Article 76 of UNCLOS *"Definition of the continental shelf"*. Coastal states are entitled with sovereign rights for the purpose of exploring it and exploiting its natural resources (Article 77 of UNCLOS *"Rights of the coastal State over the continental shelf"*). The continental shelf provides island states further opportunity for exploring offshore natural resources. However, as the extent of the limits of the continental shelf depend on morphological and geological continuity of its island landmass, the area of the continental shelf become variable from states to states. In this presentation the author review the content of Article 76 and its application to the island states.

Article 76 of UNCLOS

Rules to define the limits of the continental shelf are written in a clear and simple manner. The rules are summarized in Figure 1. There are two options to extend the outer limits of the continental shelf (red colors in Figure 1);

(1) the extent to the 60 nautical miles from the foot of continental slope, or

(2) the extent to the 100 times distance of its sediment thickness beneath the limit from the foot of continental slope.

The coastal states can choose either one while usually they choose the furtherly extended one. It should be noted that the foot of continental slope is the base point to measure the extension. The foot of continental slope is defined as "*the point of maximum change in the gradient at its base"* (Paragraph 4(b) of Article 76). The identification of the foot of the continental slope is the first step and most important task to define the limit continental shelf. If the foot of the continental slope is set the further side, the coastal state have more chance of extension of the continental shelf. To identify the foot of continental slope explicitly, the high quality of bathymetric mapping data becomes important.

There are other two rules to set the maximum limit of the extension of the continental shelf (blue colors in Figure 1);

(3) no more than 350 nautical miles from the baselines on the coastal states, or

(4) no more than 100 nautical miles from the 2,500 meter isobaths.

The coastal states can choose either one of above limits.

It should be noted that in the case of (4) in the above some shallowly continued water depth beyond EEZ may make the extent of limits far beyond 350 nautical miles. To limit the extension of some cases the Paragraph 6 of Article 76 adds additional rules.

(5) *"on submarine ridges, the outer limit of the continental shelf shall not exceed 350 nautical miles from the baselines from which the breadth of the territorial sea"*,

(6) the above rule (5) does not apply to *"submarine elevations that are natural components of the continental margin, such as its plateaux, rises, caps, banks and spurs"*.

Two categories, the submarine ridges and the submarine elevations, are introduced in this paragraph. In the case of submarine ridges only Rule (3) of above is applied and there is no chance to extend the continental shelf beyond 350 nautical miles from the baselines. In the case of submarine elevations Rules (3) and (4) are applied and there are chances to extend the continental shelf beyond 350 nautical miles.

Present status of submission of the coastal states to the United Nation

51 submissions were made by coastal states by 2009 and additionally 44 preliminary submissions were made as well. Among 51 submissions United Nations made 9 recommendations on the limits of the continental shelf of the coastal states by 2009. The made 9 recommendation does not include the ones of island states. However, some costal states among these 9 states made submission including isolated island within their territory and those recommendation may provide suggestion to the island coastal states on the probability of their limits of the continental shelf. Figure 3, the case of New Sealand, is just shown as the typical case of the recommended continental shelf beyond EEZ for reference.

Case studies from the island states submissions

There are variations on the cases of extension of the continental shelf of the island states. Some islands have continental crusts that are formed by the separation of the major continents by earth surface plate motion. Some are chained volcanic island arcs formed along the deep sea trenches. Most of others are oceanic islands in the central parts of the oceans. Among oceanic islands some are morphologically isolated while some others are on the ridges,

rises, and plateaus. The possibility and application of the extent of the continental shelf are variable depending on the setting of morphology and geology.

Figure 3 shows the case of the Hard Island of Australia. Recommendation on the limits of the continental shelf to Australia by CLCS was made in 2008. The Hard Island sits on the Kerguelen Plateau, one of the largest oceanic plateaus in the world. The foot of continental slope is set around the Kerguelen Plateau so that the extended continental shelf becomes quite large in this case even beyond 350 nautical miles limit, which may represent the case of the maximum extension of the continental shelf for the oceanic island.

Figure 4 shows the case of the Cook Islands in the mid-Pacific presented in the submission of the Cook Islands. Some islands of the Cook Islands sit on the Manihiki Plateau, another one of largest oceanic plateaus in the world. The extended continental shelf of the Cook Islands appears to be similar to the case of the Hard Island on the Kerguelen Plateau.

Figure 5 shows the case of Iceland in the northern Atlantic Ocean presented in its submission. It is said in its executive summary of the submission that its limits of the continental shelf are based on the foot of continental slope plus 60 nautical miles and 2500 m isobaths plus 100 nautical miles.

Boundaries of the continental shelf with the neighboring states

In many cases the extended continental shelves bound with those of neighboring states. There are two cases of fixing the boundaries with neighboring states. The one is the case that the neighboring states make agreement about the boundaries before submission to the United Nations. Figure 6 shows the case of the boundaries between the continental shelves of Australia and New Zealand. The both states made independent submission on its limits of the continental shelf to the United Nations with the identical boundaries between the two states. The recommendation by CLCS was made accordingly.

The other case is the joint submission of multiple states. The best examples is the joint submission made by the Republic of Mauritius and the Republic of Seychelles, the two island states (Figure 7). Mascarene Plateau connects to the two island states. The both states jointly claim the extended continental shelf along the Mascarene Plateau. CLCS examines the joint submission and make recommendation without prejudice to further delimitation between the two coastal states.

Conclusions

In the above present status on the delimitation of the continental shelves of the coastal states were reviewed with focuses on the cases of island states by referring the executive summaries of the submission of the coastal states and some of recommendations made by CLCS. Even the small island states have opportunities to extend its continental shelf depending on its morphological and geological setting. Delimitation of continental shelves of most coastal states will be completed in a couple of coming decades. The author expects that it will provide incentives for utilization and developments of deep sea floors within EEZs, extended continental shelves and further in open Seas including production of mineral resources.

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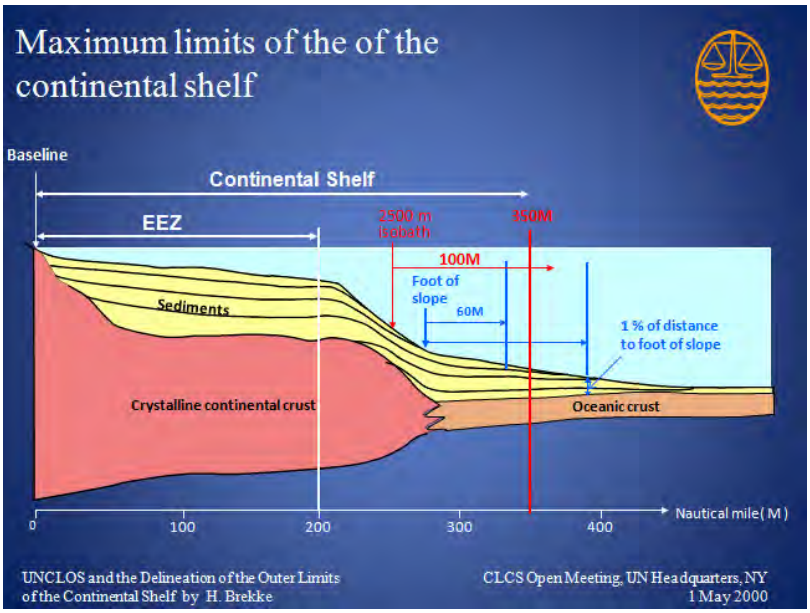

Figure 1: Rules for the limits of the continental shelf (red and blue colors). The figure is modified from the tutorial documents of the UN Commission on the Limits of the Continental Shelf.

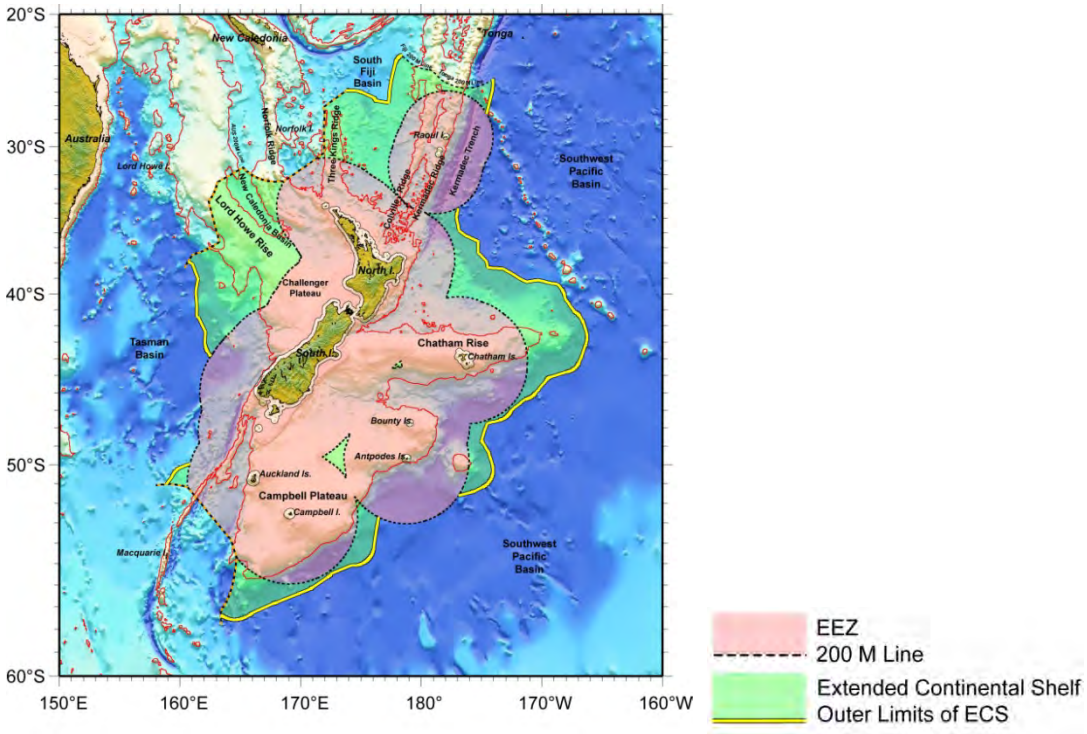

Figure 2: Recommendation on the limits of continental shelf: the case of New Zealand which recommendation was issued on 2008 by CLCS. The map is from home page of Land Information New Zealand (LINZ), New Zealand Government.

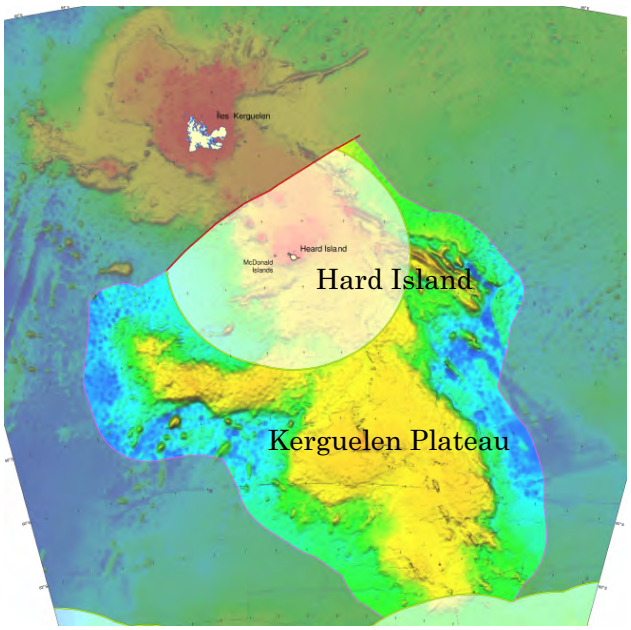

Figure 3: Recommended continental shelf of the Hard Island, Australia made by CLCS in 2008. Brighter zone in color shows extended continental shelf of Hard Island. Circular line is EEZ boundary of the Hard Island.

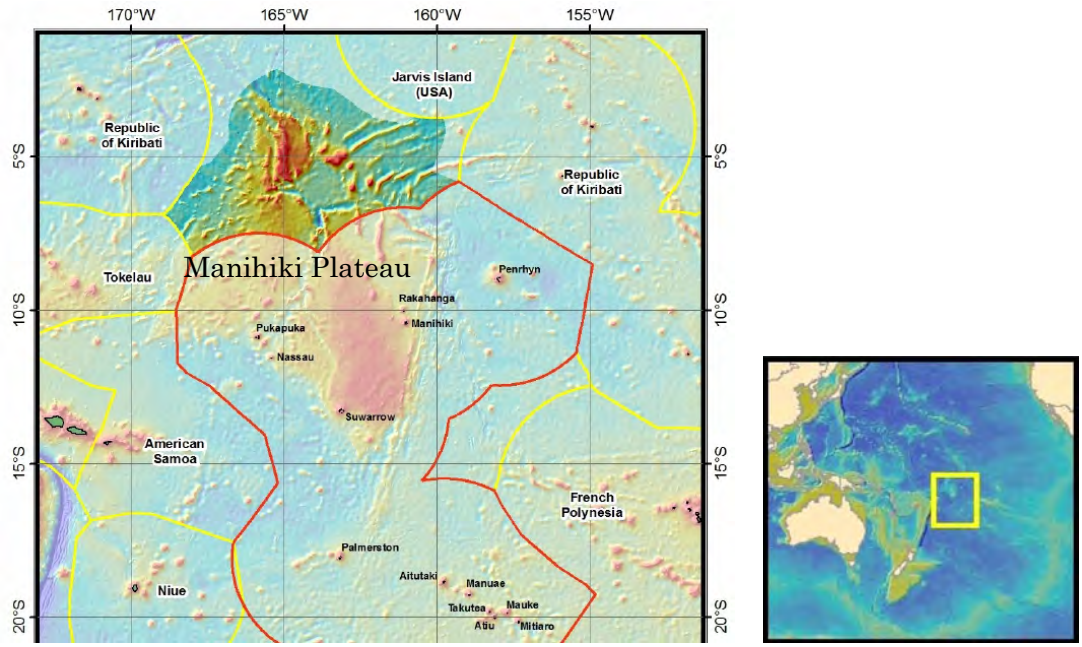

Figure 4: Extended continental shelf (bright color zone) submitted to United Nations by the Cook Islands. Red lines are EEZ boundaries of the Cook Islands and yellow colors are EEZ boundaries of neighboring states.

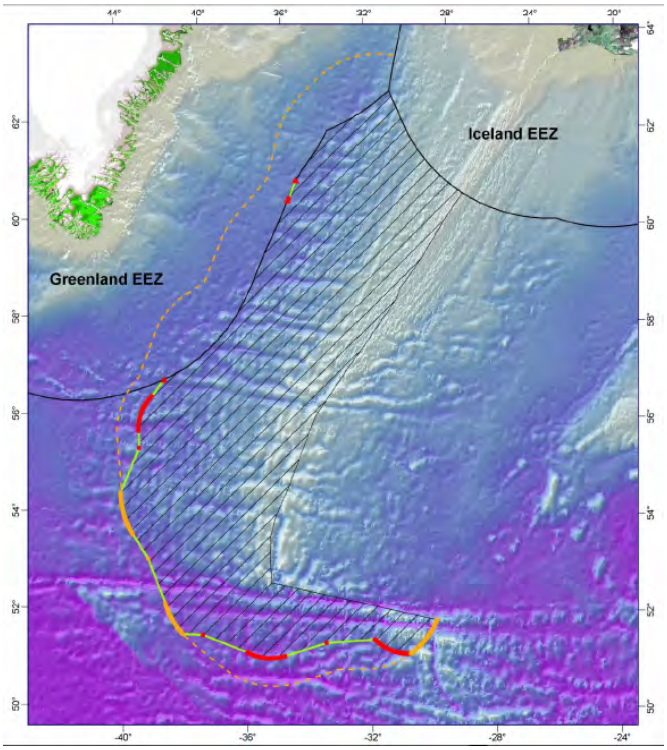

Figure 5: Extended continental shelf submitted to United Nations by Iceland. Colored lines show limits of the continental shelf.

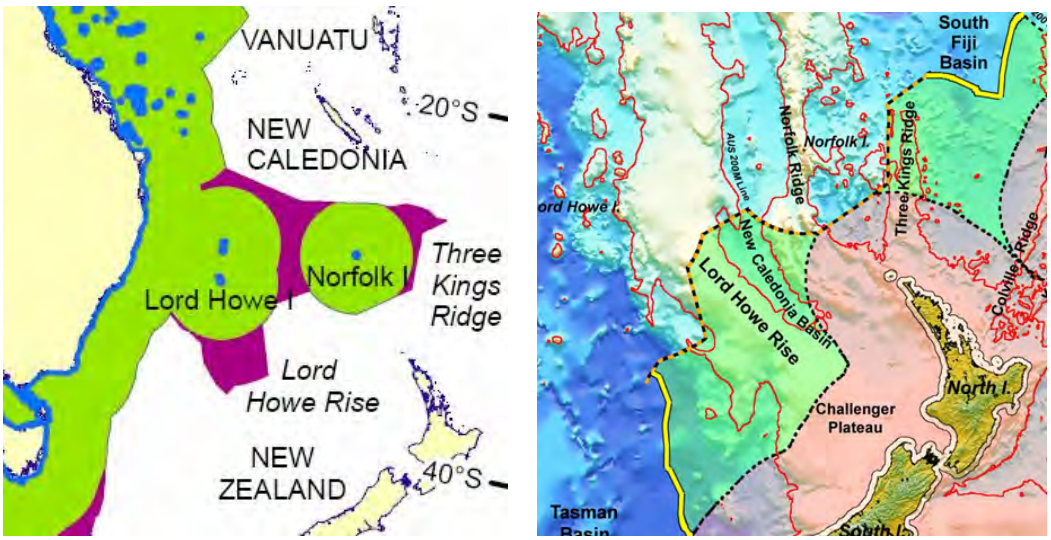

Figure 6: The boundaries of the continental shelves between Austraria and New Zealand. Left is the extended continental shelf (purple color) of Australia. Right is that of Newzealand (light green color). The boundaries of the continental shelves of both countries are coincident.

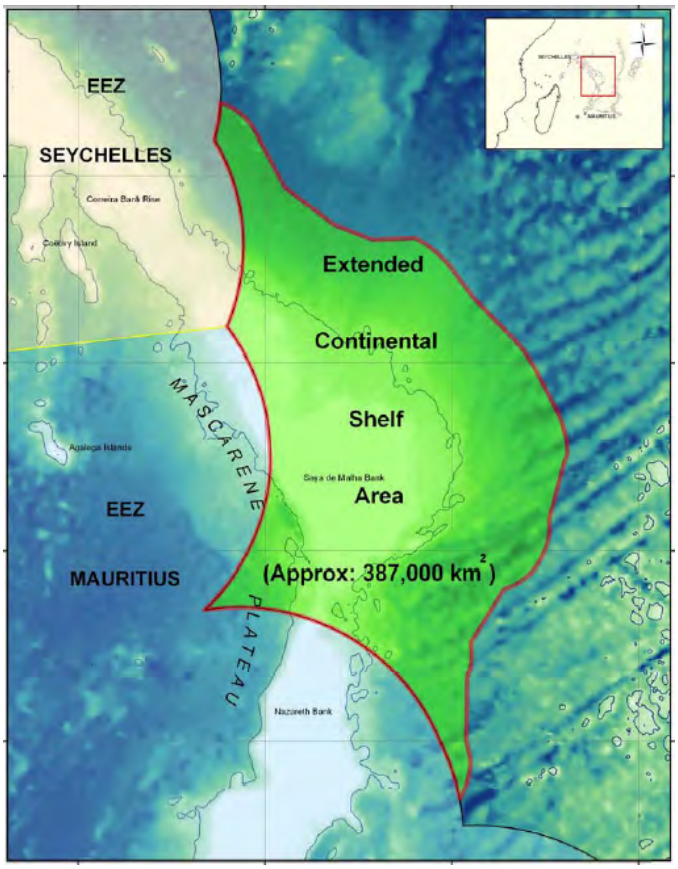

Figure 7: Extended continental shelf shown in the joint submission by the Republic of Mauritius and the Republic of Seychelles.

Pacific Seafloor Mineral Resources: Development and other Issues

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Abstract

In keeping with the increase in world demand for metals, all countries are now giving high priority to securing reliable supplies of metallic resources. Seafloor mineral development, which has lagged behind for economic reasons, has again become an object of keen interest. Among these seafloor mineral resources, the highest expectations are for Seafloor Massive Sulfide (SMS). However there is no precedent for its development, many obstacles remain. Due to the resource is found on the Pacific seafloor, Pacific island states are expected to provide sites for retention facilities and refining plants for the ore and ports for the mining vessels means that island states would likely play a vital role. When SMS development is undertaken in an island state context, a certain amount of environmental damage will occur no matter the best of intentions to aim for sustainable development. With that understanding, whether to undertake development of SMS, or to give priority to present activities in order to maintain harmony with nature, is a decision that will have to be made based on each country's unique circumstances. Whatever the case, the undertaking of SMS development will have large consequences not only on a country's economics, but on the natural environment, population, infrastructure, and distribution and transport systems.

Keywords: seafloor massive sulfide; mineral resource: Pacific; development; mining; environment

Introduction

As the shortage of metals becomes increasingly acute around the world, the mineral resources to be found on the Pacific seafloor are gaining more and more attention（Sawada, 2008; Miyake, 2009). Among them, Seafloor Massive Sulfide (SMS) attract attention most (Fig. 1). Their distribution patterns vary, however, placing them both within and outside of coastal states' EEZs (Fig. 2). It goes without saying, that should development of seafloor mineral resources within the EEZ of a coastal or island state take place, it would have a large impact on their economy and environment. However, even if the development takes place outside of their EEZ, the provision of sites for retention facilities and refining plants for the

ore and home ports for the excavation vessels means that island states would likely play a vital role. At the same time, the possibility of adverse influences on island fishing industries caused by pollution of the environment due to development activities must also be considered (Fukushima, 2009). Besides, new problems are arising as the result of increasing diversity of ocean use, and the developer will be required considering possible trade-off problem between SMS development and the other activities such as bioprospecting (Ocean Alliance, 2009). In either case, should development of seafloor mineral resources get underway, the Pacific island states will undoubtedly become the focus of much attention. It is against this background, and after introducing Japan's recently begun development of SMS, that I would like to consider the future of Pacific island states and seafloor mineral resource development.

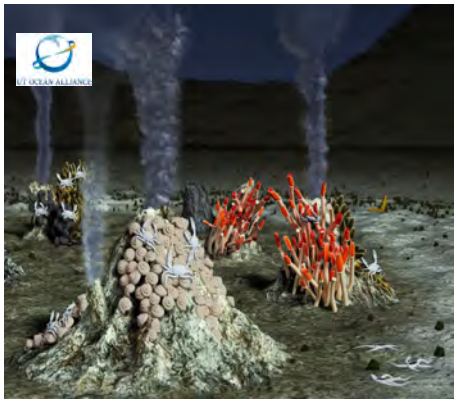

Figure 1: An illustration of hydrothermal vent

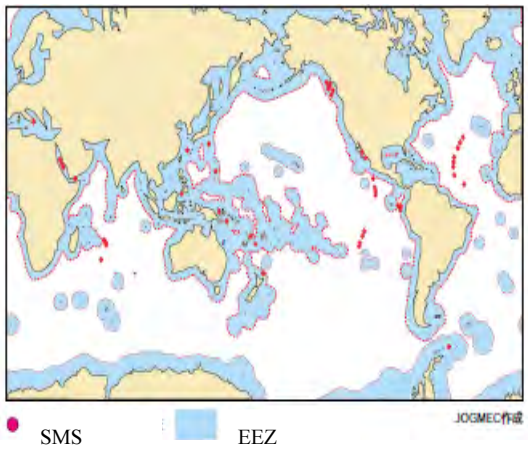

Figure. 2: Distribution of SMS in the pacific Ocean (JOGMEC HP).

Increasing Public Awareness in Japan

Since the beginning of the century, metallic resources have been under strain, leading to collapse of the supply and demand balance, soaring prices, and incidents of metals theft around the world (Yamada *et al*., 2009, Fukushima, 2009). Against those context, serious discussion in Japan about development of SMS got its start with a symposium hosted by a group of researchers (Table 1).

In 2003, the Ocean Resources and Development Committee（Tetsuo Yamazaki, Chairman）of the Mining and Materials Processing Institute of Japan (MMIJ) predicted a shortage of copper in the near future and began to urge the development of seafloor mineral resources within the EEZ. The same committee then hosted a series of symposiums to highlight the problem: the *Symposium on Potential for Deep Seafloor Energy and Mineral Resource Development* (March, 2004), the *Symposium to Consider Extension of the*

Continental Shelf and the Importance of its Resources (November, 2003), and *Copper Warning! New Challenges for Deep Seafloor Minerals* (July, 2005).

In 2007, the Ocean Technologies Forum (Tetsuo Yubara, Chairman) resumed the appeal with its *Emergency Policy Proposal Symposium: A Master Plan for Deep Seafloor Mineral Resource Development* (OTF HP). This forum received considerably more attention than previous symposiums, as it not only promoted development of SMS but also urged the development of new technologies and the creation of new marine industries. The aims of the symposium's organizers were given wide coverage in the news paper and television medias and books soon appeared on the subjects, resulting in some success in bringing the issue of deep seafloor resource development before the public.

Table 1: Public Awareness by Academic Societies

DATE	EVENTS
Mar. 2004:	Symposium on Potential for Deep Seafloor Energy and Mineral Resource Development. (ORDC of MMIJ)
Nov. 2004:	Symposium to Consider Extension of the Continental Shelf and the Importance of its Resources (ORDD of MMIJ)
July 2005:	Copper Warning! New challenges for Deep Seafloor Minerals (ORDC of MMIJ)
Mar. 2007:	Emergency Policy Proposal Symposium: A Master Plan for Deep Seafloor Mineral Resources Development (OTF)

ORDC: Ocean Resource Development Committee,
MMIJ: Mining Materials Processing Institute of Japan
OTF: Ocean Technology Forum

National Initiatives

Social environment surrounding the metal was to be reflected in the politics (Table 2). Japan passed its Basic Act on Ocean Policy, in 2007(refer to Akiyama(2007) for the detailed process of this interval). Along with demonstrating, both domestically and abroad, a posture of co-existence with the ocean, the law also marked a new epoch in its creation of a framework allowing unified responses to the problems of resources, environment, transport, safety, industry, and education, as they concern the ocean. The Basic Act takes as one of its 6 Basic Principles the Harmonization of the Development and Use of the Oceans with the Conservation of Marine Environment（Article 2）. Furthermore, among its 12 Basic Measures, the Basic Act includes the Promotion of Development and Use of Ocean Resources （Article 17）, and provides a framework for facilitating development and use, especially of living aquatic resources, petroleum, inflammable natural gas, manganese ores, and cobalt ores, and also outlines the necessary measures to be taken.

In 2008, pursuant to the Basic Act on Ocean Policy, the Basic Plan on Ocean Policy was decided upon by the Cabinet to provide ocean policy guidelines for the next five years. In Chapter 2, Section 1 of the Plan, Promotion of the Development and Use of Marine

Resources, the promotion of environmental assessment technologies and mining technologies is urged, along with the carrying-out of surveys to estimate SMS deposits and basic environmental surveys. Also, Chapter 2, Section 3, Promotion of Development of EEZ and Continental Shelves, declares the intention of formulating a development plan for ocean energy and mineral resources and sets a ten year goal for commercial development of SMS.

In response to the goals set out in the Plan, the Ministry of Economy, Trade, and Industry, along with formulating a development plan for ocean energy and mineral resources, established a Development Committee and Working Group on Environmental Impact Assessments as well as Working Groups on Resource Development and Smelting Technologies, thus creating a framework to facilitate cooperation and input from industry, government, and academia.

Table 2: National Initiatives for the SMS

DATE	EVENTS
May 2008:	Committee and Working Groups were established The Ministry of Economy, Trade, and Industry established a Committee and Working Groups. Development Committee Environmental Impact
July 2008:	A Development Plan for Ocean Energy and Mineral Resources was formulated The Ministry of Economy, Trade, and Industry established a Committee and Working Groups. Development Committee Environmental Impact
July 2008:	Field Research was launched Japan Oil, Gas and Metal National Corporation (JOGMEC)

Development Challenges

While plans and frameworks for the development of SMS are now in place, as the endeavor itself is unprecedented there are many technical challenges to be overcome. A list of only the major hurdles would include the following: estimating mineral deposits, creating mining systems, identifying target metals, building necessary infrastructures, and carrying out environmental impact assessments.

Although estimations of quantities of mineral deposit provide the most fundamental information for mineral resource development, at present we are able to do no more than determine the horizontal extension of promising deposits. What is now necessary therefore, are high-density boring surveys that will provide us with the information required to make decisions on development viability (Urabe, 2009).

Target metals under consideration were previously limited to copper, lead, zinc, gold, and silver, but given the prospects for future demand, rare earth elements should also be included in this list. Also, development of technologies for removal of toxic by-products such as arsenic is also required. In looking at the post-mining stage, a Distribution System Grand Design that includes the necessary infrastructure for the transport, storage, and smelting of the mined ores will be important. Furthermore, as we gain information on deposits and mining practices, the establishment of environmental impact assessment

techniques recognized internationally will be required.

As for a mining system, necessary mining, lifting, and positioning technologies must be successfully developed, but at the same time the creation of an overall system that will integrate these technologies is the largest challenge we face.

Regarding SMS development, Japan Deep Sea Technology Association (DESTA) has proposed a development system, taking the cease of hydrothermal activity as a precondition, composed of the following: mining, horizontal transportation (of the ore), ore collection system, riser system, surface platform, surface transshipment system and ore transport vessel(Fig.3) (Takagawa 2009).

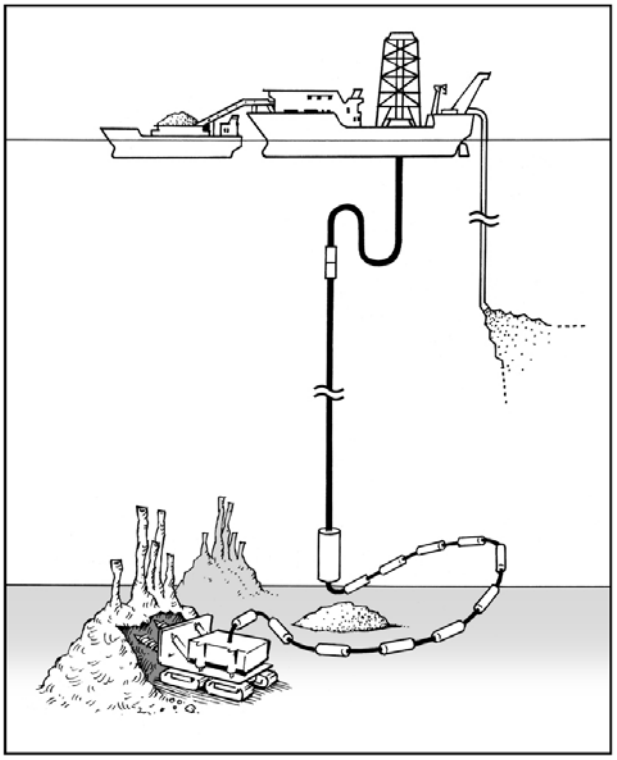

Figure. 3: Conceptual design of Total Mining System (after Fukushima and Okamatsu 2010)

Predicted environmental impacts caused by the SMS mining are listed on Table 3 and 4. There is a possibility that during the parts of the mining operation when the miner is moving epifauna might be exposed to direct injury, including sessile fauna, such as sea anemones and sea pens, and motile fauna, such as holothurians. Also, the sudden diffusion and sedimentation of particulate matter that occurs during extraction of the ore might clog the feeding / respiratory apparatus of suspension feeders, and there is a possibility that the feeding environment for epifaunal deposit feeders might deteriorate due to effects on surface accumulations of organic materials. Moreover, if the header destroys fluid flow pathways, micro-organic flora might also undergo change.

During ore collection, negative impacts on benthic organisms might here occur if the rapid accumulation of sprayed material physically buries the epifaunal organisms or if the feeding environment of deposit feeders deteriorates.

Besides, when waste water discharged to the upper layer , the total surface ecosystem, centering on the primary producers, will be affected; in case, discharged into the subphotic zone, animal plankton and micro nekton will be affected. In either case, the impacts are varied and complex.

While the mining of SMS is a threat to benthic organisms, it is an unwarranted leap of logic to conclude that impacts on the habitats of a limited number of benthic organisms constitutes a direct threat to bioprospecting. Especially, if the actual mining takes place in an area where hydrothermal activity has ceased, danger to the specialized chemosynthetic ecosystems can be avoided. In that sense, in theoretical and qualitative arguments, these both might and might not be rightfully considered threats.

Table 3: Potential impacts on benthic organisms caused by SMS mining (after Fukushima and Okamatsu 2010)

Action	Area	Physica-Chemical Effects	Extent	Impacts on benthic organisms	Probability
miner - movement	inside track	scour and compact sediments	limited area (1)	(ad) direct injury (epi)	certain
	outside track	resuspension & redeposition	slightly wider (2)	(ad) decrease of food stock (df)	likely
				(be) increasing food supply (df, suf)	unlikely
				(ad) clogging of oral/respiration organ (suf)	likely
				(ad) blanketing (all)	certain
	in- and out-side track	strong light	limited area (3)	(ad) damage the sensory organ (ls)	certain
		large sound	wider (4)	(ad) damage the sensory organ (ss)	unknown
		leaching of toxic substances (5)	limited area (?)	(ad) expose to toxic substance (all)	unknown
		affect fluid flow pathways (6)	unknown	(?) change aerobic/ anaerobic condition (cb)	unknown
ore - crushing	crusing site	large sound	wider (4)	(ad) damage the sensory organ (ss)	likely
		vibration	limited area (4)	(ad) damage the sensory organ (?)	likely
waste - dumping	dumping site	piling	limited area (7)	(ad) blanketing (epi)	certain
	around - dumping site	resuspension & redeposition	slightly wider (2)	(ad) decrease of food stock (df)	likely
				(be) increasing food supply (df, suf)	unlikely
				(ad) clogging of oral/respiration organ (suf)	likely
				(ad) blanketing (all)	certain
		leaching of toxic substances (1)	limited area (?)	(ad) expose to toxic substance (all)	likely

(1) width of the miner × moving distance (2) tens of meters at most (3) square meters at most (4) depending on the specification of miner

(5) harmful substances such as arsenic (6) changes of thermal water flow pathway by excavation (in active thermal sites)

(7) depends on quantity of waste (ad) adverse effect on benthic organisms (be) beneficial effect on benthic organisms (epi) epifaunal organisms

(df) deposit feeder (suf) suspension feeder (ls) light sensitive organisms (ss) sound sensitive oraganisms (cb) chemosynthesis bacteria

Table 4: Potential impacts on planktonic or nektic organisms caused by SMS mining (after Fukushima and Okamatsu 2010)

Action	Area	Physica-Chemical Effects	Extent	Impacts on upper layer organisms	Probability
discharge - waste	surface layer (1)	turbidness (decrease light)	limited area	ad: inhibition of primary production (pp)	certain
		increase nutrients		be: promote primary production (pp)	certain
				be: increase food supply (zp, etc)	certain
	surface or mid-water layer	increase suspended particles(2)	limited area	ad: uptake as food (zp, fi, fil)	likely
		cold water discharge		ad: intense stimulation (all)	unlikely
		lower dissolved oxgen water		ad: inhibition of respiration (all)	unlikely
		leaching of toxic substances (3)		ad: expose to toxic substance (?)	likely

(1) shallower than euphotic zone (2) ore fragments, sediment, etc. (3) harmful substances such as arsenic

(pp) phytoplankton (zp) zooplankton (fi) fish (fil) fish larva

Problems and the Pros and Cons of Development

With public opinion having urged its necessity, appropriate legislation passed, an operating plan agreed upon, and an implementation framework set up, investigation into techniques for the development of SMS is now underway. To this point, the process has been a clear and systematic one. However, there are also those who feel that development of SMS is unnecessary, and among those in favor of it, there no doubt exist differences of opinion concerning priorities and development timetables. This is true especially for those in situations where mineral resource development will mean a trade-off in profits or potential, in the competition between scientific surveys, the fishing industry, and bio-prospecting, for example, or regarding harmonization with the new environmental protection policy of marine protected areas. These are problems that challenge the very idea of mineral resource development and for which no regular resolution processes exist.

a. Competing activities

Scientific surveys : Areas around SMS vents are of endless interest to physical and biological scientists and so are in great demand as research fields. Should mining activities take place in these areas, those research fields will disappear.

Fishing resources : depletion of marine biological resources and the increasing fragility of marine ecosystems are often pointed out in United Nations forums and elsewhere, with thermal vents being cited as among the most vulnerable. It goes without saying, that SMS development and protection of marine biological resources are not complementary activities.

Bio-prospecting activities: there are great expectations for genetic resources from marine biota, especially in the medical and new materials fields. The unique ecosystems around thermal vents are the object of much attention for this reason, and bio-prospectors therefore view deep-sea mining as a threat likely to interrupt their genetic resource bio-prospecting activities.

b. New environmental protection policies

Marine Protected Areas : Marine Protected Areas are the object of much debate both domestically and abroad. Canada has put in place initiatives for the protection of deep-sea ecosystems, having designated areas surrounding thermal vents Marine Protected Areas in

2003 and 2008. Calls for MPAs around similar areas in Japan's EEZ should therefore come as no surprise.

Conservation of Biodiversity : 2010 has been designated the International Year of Biodiversity and will see the holding of COP 10 and assessments of the 2010 Goals.
Marine biodiversity was the object of much discussion at COP 9 in 2008 and many initiatives on marine biodiversity are now underway in the international community. These trends are obviously not unrelated to the concern raised by the United Nations Informal Consultative Process on Oceans and Law of the Sea (UNICPO) among others, that mineral resource development is one of the activities that may have an adverse effect on marine biodiversity.

Precautionary Approach : The principles of the Precautionary Approach are in the process of being incorporated into environmental law both in Japan and abroad(Nakatani, 2009). However, it has yet to be established as a principle of international customary law and has the potential to develop in many different directions in the future. It may, for example, prove to be a serious obstacle to SMS development.

Conclusion

In regards to SMS development, I have treated separately those problems to be overcome for successful development and those challenges to the idea of development itself. The former are standard problems attendant on all new developments; the latter are new problems arising out of the contemporary diversity of ocean use, and, as the circumstances differ for each stakeholder involved, a single process leading to resolution is not possible.

When SMS development is undertaken in an island state context, a certain amount of environmental damage will occur no matter the best of intentions to aim for sustainable development. With that understanding, whether to undertake development of SMS, or to give priority to present activities in order to maintain harmony with nature, is a decision that will have to be made based on each country's unique circumstances. Whatever the case, the undertaking of SMS development will have large consequences not only on a country's economics, but on the natural environment, population, infrastructure, and distribution and transport systems.

Ecological footprints, Triple I, and risk assessments are methods for the standardization and comparison of a range of factors, but unfortunately they are not sufficient to take into account all of a country's or island's circumstances. The conclusion to be drawn from this, while unremarkable, is that, at present, the single best approach is repeated consultations among stakeholders leading to consensus; in other words, a regional and cross-cutting approach.

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The Delimitation of Maritime Boundaries among the Pacific Island States

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Abstract

The Pacific island States possess limited land territory but enormous maritime entitlements. Claims to maritime jurisdiction out to 200 nautical miles offshore, and in some cases the existence of continental shelf rights extending beyond the 200 mile limit, have resulted in overlapping claims and the creation of numerous "new" international maritime boundaries. The majority of these potential maritime boundaries both among the Pacific island States and between the Pacific island States and their maritime neighbours have yet to be delimited. The paper outlines relevant claims to maritime jurisdiction including recent submissions regarding outer continental shelf limits, explores how maritime boundaries are to be delimited and examines progress towards the delimitation of potential maritime boundaries in the Pacific islands region before concluding with some preliminary thoughts on the key challenges involved in this context.

Keywords: Pacific, maritime delimitation, overlapping claims, baselines, exclusive economic zone, outer continental shelf, territorial disputes, capacity

Introduction

Although the Pacific island States generally have restricted land territories, at least in terms of their areas, they nevertheless also tend to possess expansive maritime jurisdictional entitlements. This scenario is essentially the result of the significant extension of national maritime claims offshore, coupled with the remote location of these States both from one another and their Pacific Rim neighbours. A further direct consequence of the advent of the extension of coastal State maritime claims to the 200 nautical mile (nm)[1] limit (and in some cases beyond, see

[1] Technically the correct abbreviation for a nautical mile is "M" with "nm" referring to nanometres. However, "nm" is widely used by many authorities (for example the UN Office of Ocean Affairs and the

below) has been the creation of numerous "new" potential maritime boundaries and, perhaps inevitably, in the absence of their delimitation, the existence of overlapping claims to maritime jurisdiction. The majority of the potential maritime boundaries that exist in the Pacific islands region have yet to be delimited.

This situation has in recent times been exacerbated as a consequence of States from the region making submissions regarding the outer limits to their continental shelf rights extending beyond 200nm from their coasts. As a number of the areas of 'outer' or 'extended' continental shelf subject to these submissions overlap with one another, additional potential maritime boundaries have come into existence that have also yet to be delimited.

This paper outlines the claims to maritime jurisdiction that the Pacific island region States have made, including outer continental shelf submissions and assesses the relevant international legal principles relevant to the delimitation of maritime boundaries in the light of recent developments in cases before international courts and tribunals. The paper then reviews the progress that has been made towards the delimitation of maritime boundaries in the Pacific islands region before briefly addressing some of the key impediments to maritime delimitation that exist.

The Maritime Claims of the Pacific Island States

The Pacific island States comprise twelve independent States located in the western and central Pacific Ocean: the Federated States of Micronesia (FSM), Fiji, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea (PNG), Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. Additionally, two States, Cook Islands and Niue, are freely associated with New Zealand whilst another territory, Tokelau, is dependent on New Zealand. Furthermore, there are a number of territories dependent on or in free association with extra-regional metropolitan powers such as France (French Polynesia, New Caledonia, Wallis and Futuna) the United Kingdom (Pitcairn Islands) and the United States (American Samoa, Guam and Northern Mariana Islands).[2] The terms "Pacific island States" and "Pacific islands region" are used in this paper to collectively refer to the

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Law of the Sea), appears to cause less confusion than "M", which is often assumed to be an abbreviation for metres, and is therefore used as the abbreviation for nautical miles in this paper.

[2] See Tsamenyi, B.M. and Manarangi-Trott, L. "The Role of Regional Organizations in Meeting LOS Convention Challenges: The Western and Central Pacific Experience" in Elferink, A.G.O. and Rothwell, D.R. (eds) *Oceans Management in the 21st Century: Institutional Frameworks and Responses*, The Hague, Kluwer, 2004, pp. 187-208.

above-mentioned independent, freely-associated and dependent States and territories. Additionally, the maritime claims of a number of States which adjoin the Pacific islands region, and can thus be regarded as the immediate maritime neighbours of the Pacific islands States, are considered here. These States include Australia, Indonesia, Japan, the Philippines and New Zealand (see Figure 1).

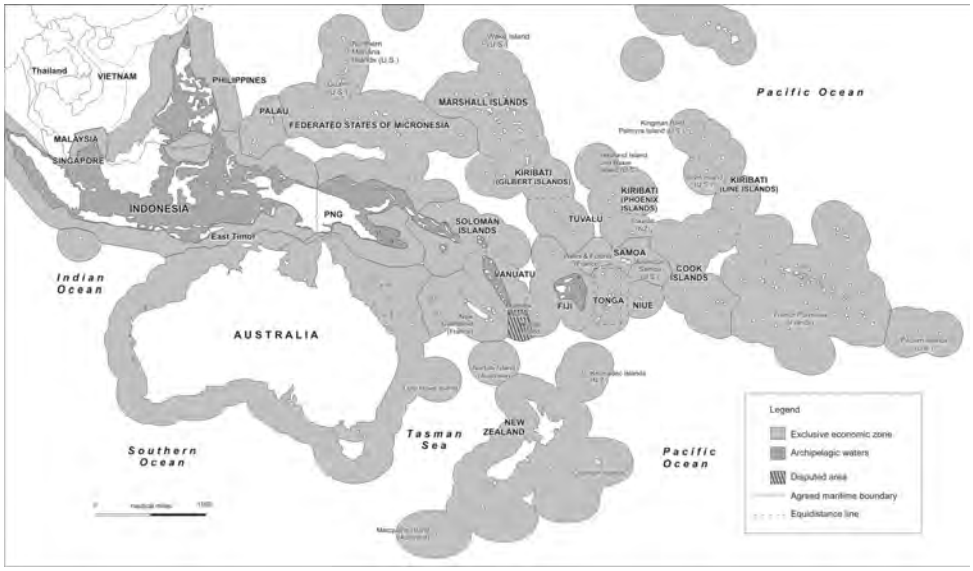

Figure 1: The Maritime Claims of the Pacific Island States. Source: Adapted from Hanich, Q., Schofield, C.H. and Cozens, P. (2009) 'Oceans of Opportunity?: The Limits of Maritime Claims in the South Pacific', pp.17-46 in Hanich, Q. and Tsamenyi, M. (eds), *Navigating Pacific Fisheries: Legal and Policy Trends in the Implementation of International Fisheries Instruments in the Western and Central Pacific Region*, (Wollongong: Ocean Publications), p.22.

The United Nations Convention on the Law of the Sea (LOSC) of 1982[3] provides the fundamental international legal framework for claims to maritime jurisdiction and the delimitation of maritime boundaries. LOSC has gained widespread international recognition and at the time of writing there were 160 parties to it.[4] All of the South Pacific's independent States

[3] United Nations, *United Nations Conventions on the Law of the Sea*, Publication No. E97.V10. United Nations, New York, 1983. Available at: <http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm> (hereafter "LOSC").

[4] Comprising 159 States plus the European Community. See, United Nations (2010) *Status of the United Nations Convention on the Law of the Sea, of the Agreement relating to the implementation of Part XI of the Convention and of the Agreement for the implementation of the Convention relating to the conservation and management of straddling fish stocks and highly migratory fish stocks* (New York: United Nations, updated to 1 January 2010), available at <http://www.un.org/Depts/los/reference_files/status2008.pdf>

have ratified LOSC, as have most of the extra-regional states with territory in the region.[5] The notable exception to this rule is the United States.[6]

LOSC articulates the rights and responsibilities that coastal States have over their adjacent waters and enables coastal States to claim sovereignty within territorial seas out to 12nm offshore and over archipelagic waters (within archipelagic baselines, see below), as well as specific rights within contiguous zones out to 24nm offshore and sovereign rights over exclusive economic zones out to 200nm and continental shelf areas which may extend beyond the 200nm limit where the continental margin extends that far offshore (see below). Such maritime claims are measured from a coastal State's baselines. In accordance with LOSC, a coastal State's "normal" baselines will consist of "the low-water line along the coast as marked on large-scale charts officially recognized by the coastal State" (LOSC, Article 5). Under certain circumstances a variety of straight line types of baselines may be defined along the coast, notably straight baselines, river and bay closing lines, as well as closing lines for ports and roadsteads (see LOSC, Articles 7-12). In particular, a number of Pacific island States, notably Fiji, PNG, the Solomon Islands and Vanuatu,[7] claim archipelagic status and have designated archipelagic baselines in accordance with Article 47 of LOSC. Indonesia and the Philippines are also archipelagic States.

Taken altogether, the Pacific island States total just over 550,000km^2 of land (84 per cent of which is provided by Papua New Guinea) scattered over the vast 165 million km^2 Pacific Ocean which encompasses around one third of the surface of the earth.[8] The remote location of the Pacific island States both from one another and their maritime neighbours, coupled with 200nm

[5] Although Fiji was the first state to sign LOSC, the Pacific small island developing States were not especially swift to adopt the LOSC due to a number of political, practical and policy considerations. See, Wolfers, E.P. "The Law of the Sea in the South Pacific" in Crawford, J. and Rothwell, D. (eds) *The Law of the Sea in the Asian Pacific Region*, Kluwer, The Hague, 1995, pp. 41-49, at pp. 41-46.

[6] United Nations, *Status of the United Nations Convention on the Law of the Sea, of the Agreement Relating to the Implementation of Part XI of the Convention and of the Agreement for the Implementation of the Convention Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks*, United Nations, New York, updated to 4 June 2008, available at <http://www.un.org/Depts/los/reference_files/status2008.pdf>

[7] Kiribati claims archipelagic status but has yet to define archipelagic baselines.

[8] Anthony, J.M. "Conflict Over Natural Resources in the Pacific" in Ghee, L.T. and Valencia, M.J. (eds) *Conflict Over Natural Resources in Southeast Asia and the Pacific*, Oxford University Press, Oxford,/United Nations University Press, 1990; and Tsamenyi and Manarangi-Trott, 2004: 187-189.

exclusive economic zones (EEZs),[9] means that the Pacific island States have enormous claims to maritime jurisdiction, encompassing an estimated area of 30,569,000km^2 (see Figure 1 and Table 1).[10] Additionally, a number of Pacific island States are in a position to assert rights over substantial areas of continental shelf extending beyond their 200nm limits.

"Additional" Maritime Areas: Outer Continental Shelf Submissions

In accordance with the EEZ concept every coastal State has the right to claim sovereign rights over both the seabed and the water column out to 200nm, regardless of whether the continental margin actually extends that distance offshore, and provided there are no overlapping claims with neighbouring states. However, where coastal States are positioned on broad continental margins, they are able to assert rights over those parts of the continental shelf beyond the 200nm EEZ limit forming part of their natural prolongation. These areas of continental shelf beyond the 200nm limit are frequently referred to as the 'outer' or 'extended' continental shelf.[11]

Article 76(1) of LOSC establishes that the continental shelf of a coastal State consists of "the seabed and subsoil of submarine areas", extending to a distance of 200nm from relevant baselines or "throughout the natural prolongation of its land territory to the outer edge of the continental margin." Article 76 goes on to set out a complex series of formulae through which the coastal State can establish its rights to, and the outer edge of its continental shelf areas seaward of the 200nm limit.[12] These provisions are complex and require considerable investments in order to gather the required information on the morphology of the continental margin in question together with its geological characteristics, as well as bathymetric

[9] Regarding the breadth of the EEZ, Article 57 of LOSC provides that: "The exclusive economic zone shall not extend beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured." As most coastal States claim a 12nm territorial sea the actual breadth of the EEZ is usually 188nm seaward of territorial sea limits.

[10] Gillet, R. "Pacific Island Countries Region' in *Review of the State of World Marine Resources,* FAO Fisheries Technical Paper 457, FAO, Rome, 2005, pp. 144-157.

[11] The term 'extended' continental shelf gives a somewhat misleading impression that coastal States are somehow advancing claims to "additional" areas of continental shelf. This is not the case as coastal State sovereign rights over the continental shelf are inherent (see LOSC, Article 77(3)).

[12] Essentially, Article 76 provides two formulae according to which coastal States can establish existence of a continental margin beyond the 200 nm limit – the "Gardiner Line", based on reference to depth or thickness of sedimentary rocks overlying the continental crust, or the "Hedberg Line" consisting of 60nm from the foot of the continental slope. Two maximum constraints, or 'cut-off' lines are then applied - either a distance of 350nm from relevant baselines or 100 nautical miles from the 2,500 metre isobath. See, LOSC, Article 76(4-5).

information relating to water depth. However, they represent a significant development as compared with the open-ended definition of the continental shelf under the relevant 1958 Convention, under which conceivably the entirety of the sea floor of the oceans could ultimately be subject to national claims.[13]

Table 1: Maritime Jurisdictional Claims of the Pacific Island States, States Neighbouring the Pacific Islands Region and Extra-regional States with Territories in the Pacific Islands Region

State	Law of the Sea Convention		Territorial Sea	Contiguous zone	Exclusive Economic Zone
	Signature	Ratification/ Accession(a)			
Australia	10/12/82	5/10/94	12	24	200
Cook Islands	10/12/82	15/2/95	12		200
FSM	-	29/4/91(a)	12	-	200
Fiji	10/12/82	10/12/82	12	-	200
France	10/12/82	11/4/96	12	24	200
Indonesia	10/12/82	3/2/86	12	-	200
Japan	7/2/83	20/6/96	12	24	200
Kiribati	-	24/2/3(a)	12	-	200
Marshall Islands	-	9/8/91(a)	12	24	200
Nauru	10/12/82	23/1/96	12	24	200
Niue	5/12/84	11/10/06	12	-	200
Palau	-	30/9/96(a)	3	-	200
Philippines	10/12/82	8/5/84	12	-	200
PNG	10/12/82	14/1/97	12	-	200
Samoa	29/8/94	14/8/95	12	24	200
Solomon Islands	10/12/82	23/6/97	12	-	200
Tokelau (New Zealand)	10/12/82	19/7/96	12	-	200
Tonga	-	2/8/95(a)	12	-	200
Tuvalu	10/12/82	9/12/02	12	24	200

[13] Article 1 of the Convention on the Continental Shelf of 1958 defined the continental shelf as "the seabed and subsoil of the submarine areas adjacent to the coast but outside the area of the Territorial Sea to a depth of 200 metres", "or to a depth beyond that limit where exploitation of resources was possible". McDorman has stated that the fact that "the real achievement" of Article 76 of LOSC lies not in the complexity of its provisions or in the establishment of the CLCS but in the fact that it provides for "a definable limit" to continental shelf claims "however difficult the defining of that limit may be". See, McDorman, T. "The Role of the Commission on the Limits of the Continental Shelf: A Technical Body in a Political World" in *International Journal of Marine and Coastal Law*, Vol. 17, No. 3, 2002, pp. 301-324, at p. 307.

United Kingdom (Pitcairn)	-	25/9/97(a)	3	-	200
USA	-	-	12	24	200
Vanuatu	10/12/82	10/8/99	12	24	200

Sources: United Kingdom Hydrographic Office (UKHO) *National Claims to Maritime Jurisdiction*, Annual Notice to Mariners, No.12 (12/10), available at <http://www.ukho.gov.uk/ProductsandServices/MartimeSafety/Pages/NMPublic.aspx>; and, *Status of the United Nations Convention on the Law of the Sea, of the Agreement Relating to the Implementation of Part XI of the Convention and of the Agreement for the Implementation of the Convention Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks*, United Nations, New York, updated to 1 January 2010, available at <http://www.un.org/Depts/los/reference_files/status2008.pdf>.

A submission on a State's proposed outer continental shelf limits then needs to be made to a specialised United Nations body, the Commission on the Limits of the Continental Shelf (CLCS). The CLCS is a body consisting of 21 scientists. Importantly, the CLCS is not a legal body and it does not therefore adjudicate on submissions. Instead, the CLCS plays, or was intended to play, a technical role, evaluating whether coastal States, through their submissions, have fulfilled the requirements of Article 76. On the basis of this assessment the CLCS makes recommendations to the coastal State on the basis of which the coastal State can establish limits that are "final and binding" (LOSC, Article 76(8)).

The original deadline for submissions to the CLCS was in 2004 (ten years after LOSC entered into force, see LOSC, Annex II, Article 4) . It became clear, however, that many potentially interested States would struggle to formulate their submissions in time so the deadline was extended, for most states, to 13 May 2009.[14] Furthermore, as the May 2009 deadline approached it became clear that numerous potentially eligible States required additional time to draft their submissions. Consequently, the submission rules were relaxed so as to allow for the submission of preliminary information to the CLCS.[15] A number of the Pacific island States have either made submissions to the CLCS or, alternatively, have made submissions of preliminary information as a prelude to making full submissions to the Commission in due course (see Tables 2 and 3).

[14] Rather than the date of LOSC entering into force, the date of the adoption of the Commission's Scientific and Technical Guidelines, 13 May 1999, was instead taken as the start of the 10-year clock, at least for those States that were parties to LOSC before that date. See: <http://www.un.org/Depts/los/clcs_new/issues_ten_years.htm>. See also: SPLOS/72 at <http://www.un.org/Depts/los/meeting_states_parties/SPLOS_documents.htm>.

[15] See also: Decision of the eighteenth Meeting of State Parties, SPLOS/183 at <http://www.un.org/Depts/los/meeting_states_parties/SPLOS_documents.htm>.

Table 2: Outer Continental Shelf Submissions made by States of the Pacific Islands Region, States Neighbouring the Pacific Islands Region and Extra-regional States with Territories in the Pacific Islands Region

Submitting State(s)	Date of Submission	Status
Australia	15 November 2004	Recommendations adopted
Cook Islands	16 April 2009	Recommendations pending
Fiji (partial)	20 April 2009	Recommendations pending
FSM/PNG/Solomon Islands (joint)	5 May 2009	Recommendations pending
Indonesia (partial)	16 June 2008	Recommendations pending
Japan	12 November 2008	Recommendations pending
New Zealand	19 April 2006	Recommendations adopted
Palau	8 May 2009	Recommendations pending
Philippines (partial)	8 April 2009	Recommendations pending
Tonga	11 May 2009	Recommendations pending

Source: *Submissions, through the Secretary-General of the United Nations, to the Commission on the Limits of the Continental Shelf, pursuant to article 76, paragraph 8, of the United Nations Convention on the Law of the Sea of 10 December 1982*, United Nations, New York, updated to 30 October 2009, available at <http://www.un.org/Depts/los/clcs_new/commission_submissions.htm>.

Among the above-mentioned submissions the Commission has recommended that 95 per cent of Australia's submitted outer continental shelf area (excluding areas off Antarctica), or 2.56 million km^2, form part of its outer continental shelf.[16] Of New Zealand's submitted area, 97 per cent or 1.7 million km^2 of seabed, were confirmed as part of New Zealand's outer continental shelf.[17]

[16] Symonds, P., Alcock, M. and French, C. (2009) "Setting Australia's Limits: Understanding Australia's Marine Jurisdiction", *AUSGEO News*, Issue 93 (March).

[17] New Zealand MFAT, 2008. UN confirms NZ's extended seabed claim. Accessed on 26 April 2008 from <http://www.mfat.govt.nz/Media-and-publications/Features/990-NZ-extended-seabed-claim.php>.

Table 3: Submissions of Preliminary Information on the Outer Continental Shelf by States of the Pacific Islands Region, States Neighbouring the Pacific Islands Region and Extra-regional States with Territories in the Pacific Islands Region

Submitting State(s)	Date of Submission
Fiji	21 April 2009
Fiji/Solomon Islands (joint)	21 April 2009
Fiji/Solomon Islands/Vanuatu (joint)	21 April 2009
France (French Polynesia and Wallis and Futuna)	8 May 2009
FSM	5 May 2009
New Zealand (Tokelau)	11 May 2009
PNG	5 May 2009
Solomon Islands	5 May 2009
Vanuatu	10 August 2009

Source: Preliminary Information indicative of the outer limits of the continental shelf beyond 200 nautical miles, United Nations, New York, updated to 9 November 2009, available at, <http://www.un.org/Depts/los/clcs_new/commission_preliminary.htm>.

The CLCS will, in due course, consider pending submissions, make recommendations and the coastal States will declare their "final and binding" outer continental shelf limits. However, it is clear that the CLCS is facing a huge workload and backlog of submissions to examine as a result of the rush of submissions stimulated by the May 2009 deadline. One year prior to this deadline a mere 11 submissions had been lodged with the CLCS. By 14 May 2009, however, the number of full submissions stood at 50 (and has since risen to 51). Additionally, because numerous states were struggling to meet the 13 May 2009 deadline, and 43 sets of such preliminary information were also lodged with the Commission by the deadline.

It also apparent that many of the above-mentioned submissions overlap with one another where neighbouring States are located on shared continental margins. For example, there exist multiple overlaps between the areas of outer continental shelf subject to submissions by Australia, New Zealand, Fiji, France (on behalf of New Caledonia) and Tonga, located north of New Zealand (the Lord Howe Rise, Fiji Basin and Kermadec Ridge). Additionally, it is worth noting that France and Vanuatu dispute sovereignty over Matthew [Umaenupne] and Hunter [Umaeneag] Islands and has protested that part of France's submission relating to these islands. Moreover, it is notable that France's submission on behalf of New Caledonia not only overlaps with the northern areas of Australia's outer continental shelf submission, but crosses the international maritime boundary between Australia and New Zealand agreed in 2004.[18] Similarly, Palau and Japan have overlapping submissions to parts of the Kyushu-Palau Ridge. Further to the south

[18] Treaty between the Government of Australia and the Government of New Zealand establishing certain Exclusive Economic Zone and Continental Shelf Boundaries, 25 July 2004 (entry into force, 25 January 2006). Treaty text available at [2006] ATS 4 [hereafter, Australia-New Zealand Treaty].

there exist potential overlaps between the outer shelves of the Federated States of Micronesia and Papua New Guinea with a further partial submission by Indonesia. Additionally, the Cook Islands has made a submission in respect of outer continental shelf areas on the Manihiki Plateau region to its north as has New Zealand, on behalf of Tokelau. France has also indicated that it will make a submission to this area (on behalf of Wallis and Futuna Islands). There also exist overlapping outer continental shelf submissions between France and the Cook Islands to the west and between France and the UK (on behalf of the Pitcairn Islands) to the east. It is the case, however, that in a number of instances the interested States have sought to head off potential outer continental shelf disputes and facilitate the work of the Commission by either making joint submissions or indicating to the CLCS that the States involved have no objection to Commission examining an individual State's submission without prejudice to the delimitation of maritime boundaries.

This highlights the fact that multiple "new" outer continental shelf boundaries have been brought into existence. However, in this context it should be emphasised that the Commission is a scientific rather than technical body. As such it does not have the mandate to consider areas subject to a sovereignty dispute or subject to overlapping maritime claims. Furthermore, the Commission's recommendations are specifically without prejudice to the delimitation of maritime boundaries. Ultimately, it will up to the coastal States themselves to resolve any overlapping maritime claims and disputes and delimit their "new" outer continental shelf boundaries.

Maritime Boundary Delimitation and the Pacific Islands Region

A key consequence of the significant extension of the spatial extent of national claims to maritime jurisdiction seawards, has been the creation of a multitude of 'new' maritime political boundaries as States 400nm distant from one another abruptly found themselves to be maritime neighbours with potentially overlapping claims to maritime jurisdiction. Furthermore, in the context of outer continental shelf entitlements, maritime neighbours in need of the delimitation of a seabed boundary may hypothetically be in excess of 700nm distant from one another.[19]

The provisions of LOSC governing the delimitation of maritime boundaries provide only limited guidance as to how such boundaries are to be defined and delimitation disputes may be

[19] Prescott, J.R.V. and Schofield, C.H. (2005) *The Maritime Political Boundaries of the World*, Leiden/Boston: Martinus Nijhoff Publishers, p. 216.

resolved. In relation to the delimitation of the territorial sea, Article 15 of LOSC favours the use of an equidistance or median line. However, this does not apply should the States concerned agree to the contrary or there exists an "historic title or other special circumstances" in the area to be delimited which justify a departure from the equidistance line. The median line was also given preference under Article 6 of the 1958 Convention on the Continental Shelf unless, similarly, an agreement to the contrary or "special circumstances" existed that justified an alternative approach. Under LOSC, however, Articles 74 and 83 of LOSC, dealing with delimitation of the continental shelf and EEZ respectively, merely provide, in identical general terms, that agreements should be reached on the basis of international law in order to achieve "an equitable solution". No preferred method of delimitation is indicated.

Even though there has been a marked shift away from preference for equidistance when the 1958 and 1982 Conventions are compared, it is nonetheless apparent that in practice the equidistance method has proved more popular than any alternative method by far and most agreed maritime boundaries are based on some form of equidistance.[20] Consequently, equidistance lines are often constructed at least as a means of assessing a maritime boundary situation or as the starting point for discussions in the context of maritime boundary negotiations. Such lines have also frequently been adopted as the basis for the final delimitation line, especially where there is no major disparity between relevant coastal fronts. Furthermore, it is evident that in recent cases the International Court of Justice's (ICJ) approach has been to construct an equidistance line as a provisional delimitation line in the first instance. Indeed, in its, at the time of writing, most recent judgment involving maritime delimitation, that in the Black Sea Case between Romania and Ukraine, the Court was explicit in stating that "[i]n keeping with its settled jurisprudence on maritime delimitation", a provisional delimitation line should be established consisting of an equidistance line "unless there are compelling reasons that make this unfeasible in the particular case."[21] The ICJ's practice has then been to determine whether there exist any reasons to modify the provisional equidistance line in order to achieve an equitable result.[22]

In the Pacific islands region progress towards the delimitation of potential maritime boundaries has been slow. Table 4 shows that fifteen maritime boundaries have been concluded to date

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[20] Legault, L. and Hankey, B. (1993) 'Method, Oppositeness and Adjacency, and Proportionality in Maritime Boundary Delimitation', pp.203-242 in Charney, J.I. and Alexander, L.M. (1993) (eds) *International Maritime Boundaries*, Vol.I, (The Hague: Martinus Nijhoff): 205

[21] *Case Concerning Maritime Delimitation in the Black Sea* (Romania v. Ukraine), Judgment of 3 February 2009, available at <http://www.icj-cij.org/docket/files/132/14987.pdf>, paras.116-118.

[22] Prescott and Schofield 2005: 240-241.

whilst Table 5 indicates that a further 30 remain to be delimited. These agreed and undelimited maritime boundaries are also illustrated on Figure 1.[23] It is worth noting that these figures only relate to maritime boundaries within 200nm of the coast, that is, between overlapping EEZs, rather than to outer continental shelf delimitations.

Concluding Thoughts: Overcoming Impediments to Maritime Delimitation among the Pacific Island States

The extension of coastal State maritime claims to the 200nm limit and in some cases beyond it has led to overlapping claims to maritime jurisdiction and the creation of numerous "new" maritime boundaries among the Pacific island States and between them and States neighbouring the Pacific islands region. As noted above the majority of potential maritime boundaries in the Pacific islands region have yet to be delimited.

In some respects this is surprising as many of the potential boundaries in question involve small islands, and thus analogous coastal fronts, on both sides that would on the face of its seem well suited to the application of equidistance lines as the basis for delimitation. Such an approach would be consistent with the approach currently adopted among these States in the past as well as with prevailing international legal practice. Furthermore, while territorial and maritime jurisdictional disputes are not completely absent from the region such disputes have not served as the major impediments to maritime delimitation that they have elsewhere, for example in Southeast and East Asia.[24]

It is the case that certain technical and capacity arise. In particular, the delineation of baselines remain a challenging task.[25] A further reason why progress towards maritime delimitation in the

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[23] Prescott, J.R.V. and Boyes, G. *Undelimited Maritime Boundaries in the Pacific Ocean Excluding the Asian Rim*, Maritime Briefing, Vol. 2, No. 8, 2000, International Boundaries Research Unit, Durham; and, Prescott and Schofield, 2005: 397-428.

[24] Problematic issues within the region in this respect include the island sovereignty dispute between France and Vanuatu mentioned above, Tonga's claims in respect of the so-called "Tongan Box" arising from that country's Royal Proclamation of 1887 as well as Tonga's claims to sovereignty over North and South Minerva Reefs [Teleki Tokelau and Teleki Tonga] which lie within 200nm of Fiji.

[25] In this context it is worth noting that the South Pacific Applied Geosciences Commission (SOPAC), based in Fiji, hosts the Pacific Island Regional Maritime Boundaries Project, with the objective of assisting countries around the South Pacific region in the delimitation of their maritime boundaries. See: <http://www.sopac.org/tiki/tiki-index.php?page=Pacific+Island+Regional+Maritime+Boundaries+Project>

Pacific islands region has been limited thus far relates to the issue being given limited priority. Political will is clearly a crucial ingredient to effecting the delimitation of maritime boundaries. Instead in the Pacific islands region collective approaches have been developed designed to circumvent disputes and to a large extent obviate the need for formal maritime boundary delimitation. This is especially clear with regard to the key marine resource in the region: fisheries. In this context interim maritime boundaries, based on equidistance lines, have been employed to determine the distribution of a substantial portion of the access fees among Forum Fisheries Agency (FFA) States, and this has largely served to defuse the issue and relegate maritime boundary delimitation to the back-burner in policy terms. It remains to be seen whether this becomes a more urgent concern as other activities develop, for instance sea floor mining activities and developments on the outer continental shelf, especially where national submissions overlap. Arguably there is a growing requirement within the Pacific islands region for the jurisdictional certainty and clarity that the delimitation of maritime boundaries provides.

Table 4: Agreed Maritime Boundaries in the Pacific Island States Region

Cook Islands – France (French Polynesia)
Cook Islands – United States of America (American Samoa)
Federated States of Micronesia – Marshall Islands
Federated States of Micronesia – Palau
Fiji – France (New Caledonia)
Fiji – France (Wallis and Futuna)
France (New Caledonia) – Papua New Guinea
France (New Caledonia) – Solomon Islands
France (Wallis and Futuna) – New Zealand (Tokelau)
France (Wallis and Futuna) – Tonga
France (Wallis and Futuna) – Tuvalu
France (French Polynesia) – UK (Pitcairn)
New Zealand (Tokelau) – United States of America (American Samoa)
Niue – United States of America (American Samoa)
Papua New Guinea – Indonesia

Table 5: Undelimited Maritime Boundaries in the Pacific Island States Region

Cook Islands – Kiribati

Cook Islands – New Zealand (Tokelau)

Cook Islands – Niue

Federated States of Micronesia – Papua New Guinea

Federated States of Micronesia – United States of America (Guam Island)

Fiji – Tonga

Fiji – Tuvalu

Fiji – Vanuatu

France (French Polynesia) – Kiribati

France (New Caledonia) – Vanuatu

France (Wallis and Futuna) – Samoa

Indonesia – Palau

Japan – United States of America (Northern Mariana Islands)

Kiribati – Marshall Islands

Kiribati – Nauru

Kiribati – New Zealand (Tokelau)

Kiribati – Tuvalu

Kiribati – United States of America (Baker and Howland Islands)

Kiribati – United States of America (Jarvis Island)

Kiribati – United States of America (Palmyra Atoll and Kingman Reef)

Marshall Islands – Nauru

Marshall Islands – United States of America (Wake Island)

New Zealand (Tokelau) – Samoa

Niue – Tonga

Niue – United States of America (American Samoa)

Palau – Philippines

Samoa – Tonga

Samoa – United States of America (American Samoa)

Solomon Islands – Vanuatu

Tonga – United States of America (American Samoa)

Pacific Islands States Regional Response to the Challenges and Constraints of EEZ Management

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Abstract

Negotiations during the Third Law of the Sea Conference (UNCLOS III) and the subsequent United Nations Convention on the Law of the Sea (LOSC) sanctioned extended claims to marine jurisdiction by coastal States in the form of the exclusive economic zone (EEZ). One of the consequences of this significant development is that the marine jurisdictions of many coastal States overlap, necessitating closer cooperation than was previously the case. Cooperation at the sub-regional, regional and international levels became necessary to address a host of ocean management issues, including marine pollution prevention, trans-boundary fisheries management, and increasingly, maritime security concerns.

The 22 States and territories of the Pacific Islands region consist of only 550,000 km^2 of land, spread across 29 million km^2 of ocean. In contrast, the combined EEZs of the Pacific Island region occupy about one sixth of the Earth's surface, an area three times larger than the United States or China. The small land masses distributed over a large area of ocean are linked and controlled by the marine environment.

The coastal and marine ecosystems of the Pacific Islands region are also extremely important habitats for sustaining the livelihood of the Pacific Islanders by providing food and nutritional security. Economic activities, such as fisheries and tourism, are also highly dependent on the marine environment. With limited arable land and poor soils in the low-lying islands, the reliance on marine resources is extremely important. The region supports the world's largest tuna fishery

Regionalism has been a key strategy adopted in the Pacific Islands to respond to these pressures. This approach was dictated largely by problems of isolation, vulnerability and scarce natural and human resources. This regionalist strategy is achieved through a number of regional institutions. The presentation reviews progress achieved to-date by the South Pacific States and Territories in marine regionalism and assesses their challenges for small island developing States.

Introduction

Negotiations during the Third Law of the Sea Conference (UNCLOS III) and the subsequent United Nations Convention on the Law of the Sea sanctioned extended claims to marine jurisdiction by coastal States. One of the consequences of this significant development is that the marine jurisdictions of many coastal States overlap, necessitating closer cooperation than was previously the case. Cooperation at the sub-regional, regional and international levels became necessary to address a host of ocean management issues, including marine pollution prevention, trans-boundary fisheries conservation, and maritime security concerns. The preamble to the LOSC recognized this imperative by reminding States that "the problems of ocean space are closely interrelated and need to be considered as a whole." The response by the States and Territories in the central and south western Pacific region (the Pacific Island States and Territories) was the establishment of a number of regional institutions and the conclusion of a host of treaties to address many of the coastal and marine resources issues facing the region. This paper reviews progress achieved to-date by the South Pacific States and Territories in marine regionalism and assesses the challenges they face.

The Pacific Island States and Territories

The South Pacific is usually used to describe the island States and independent territories in the western and central Pacific ocean (see Map 1 below). Geographically, the region extends from French Polynesia in the east to Papua New Guinea in the west. There are a number of unique characteristics of the region.

- The region is a vast one, occupying around 30 million square kilometers of the Pacific Ocean, an area more than three times larger than the United States of America or China. The States and territories of the region consist of only 550,000 km2 of land with 5.2 million inhabitants.
- The Island States and Territories in the region are at different stages of political and economic development. Ten are politically independent but with substantial dependence on foreign aid (Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu). Two are independent but affiliated with New Zealand (Cook Islands, Niue). One is part of New Zealand (Tokelau) and the rest are dependent territories of either the United States, France, or the United Kingdom. (American Samoa; Guam; Northern Marianas; French Polynesia; New Caledonia; Wallis and Futuna; and Pitcain Islands).

Map 1.UN map of Pacific Islands

- As a result of its isolation from major commercial centres and shipping routes and small population and lack of industrialization, the Region is relatively free from the major marine environmental problems facing other parts of the world.
- For most of the island States and Territories, marine fisheries provide the only economic activity. It is not surprising, therefore, that most domestic and international issues in the region revolve around the marine environment.

Law of the Sea Framework for Marine Regionalism Generally

Regional, sub-regional and international cooperation to protect the marine environment is now a core obligation under general international law. As part of their general obligation to protect the marine environment under Article 192 of the Law of the Sea Convention, States are required to take measures at the sub-regional, regional and international levels to protect the marine environment. For example:

- States are to take individual or joint actions that are necessary to prevent, reduce and control pollution of the marine environment from any source (Art. 194(1)).
- States are to cooperate on a global or regional basis, directly or through competent international organizations to formulate and elaborate international rules, standards and recommended practices and procedures for the protection and preservation of the

marine environment, taking into account the characteristics of each region (Art. 197).

- States are to cooperate directly or through competent international organizations to promote scientific research and the exchange of information and data required to protect the marine environment (Art. 200).
- States are to cooperate directly or through competent international organizations to establish appropriate scientific criteria for the formulation and elaboration of rules, standards and recommended practices and procedures for the prevention, reduction and control of marine pollution (Art. 201).
- States are to cooperate at the global or regional levels to promote capacity building programmes in developing countries that are necessary to protect and preserve the marine environment (Art. 202).
- States are to seek, either directly or through appropriate sub-regional or regional organizations, to agree upon the measures necessary to co-ordinate and ensure the conservation and development of trans-boundary and shared stocks (Art. 63).
- Coastal States and States whose nationals harvest highly migratory species are to cooperate directly or through regional or international organizations to achieve the sustainable management of the stock (Art. 64).
- States are to cooperate with a view to the conservation of marine mammals (Art. 65).
- Sates are to cooperate to achieve the sustainable management of high seas fisheries (Art. 118).
- States bordering enclosed and semi-enclosed seas are to cooperate with each other to protect the marine environment of such seas (Art. 123).

The Institutional Framework for Marine Regionalism in the South Pacific

Regional cooperation by the South Pacific States and Territories to protect their marine environments is achieved through the establishment of six regional institutions. These are described below.

The Pacific Community: The Pacific Community (formerly the South Pacific Commission) (SPC), located in Noumea, New Caledonia, is the oldest of the regional organizations in the central and western Pacific region. The Pacific Community was created by the "Canberra Agreement" of 1947 and has evolved from a co-ordinating group of former colonial powers to a regional organization on which both metropolitan powers and independent regional governments are represented and to which observers from interested States and Organizations outside the region have access. The South Pacific States and Territories participating in the Pacific Community include: American Samoa, Cook Islands, Commonwealth of Northern

Marianas, Fiji, Federated States of Micronesia, French Polynesia, Guam, Kiribati, Marshall Islands, New Caledonia, Niue, Nauru, Palau, Papua New Guinea, Pitcairn Islands, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Samoa, and Wallis and Futuna. The marine-related activities of the Pacific Community are coordinated through the Marine Resources Division. This Division focuses on three programmes:

- the Coastal Fisheries Program provides assistance in respect of assessment, development, management advice, technical and scientific training to develop and manage small-to medium-scale inshore and domestic coastal fisheries;"
- the Oceanic Fisheries Program (previously known as the Tuna and Billfish assessment Program) undertakes stock assessments and scientific research into the tuna resources in the region; and
- the Regional Maritime Program, aimed at assisting Pacific Island States and Territories to comply with international maritime conventions

***The Secretariat of the South Pacific Forum*:** The South Pacific Forum was established in 1971 as an annual conference of Heads of State and Government of the independent and self-governing countries (including Australia and New Zealand) to address all issues of regional interest. The secretarial functions of the South Pacific Forum are coordinated by the Forum Secretariat, based in Suva, Fiji. The Annual meetings of the Forum provide significant political platforms to take concerted action on regional environmental issues. Indeed, regional cooperation to address major environmental issues in the region such as nuclear testing, driftnet fishing, and the transport of nuclear and hazardous wastes through the region have been initiated by the Forum. The Forum Secretariat also provides policy advise to member countries on matters relating to marine resources and international trade in such resources.

The Pacific Islands Forum Fisheries Agency: The Pacific Islands Forum Fisheries Agency (FFA) was established in 1979 under the South Pacific Forum Fisheries Agency Convention (FFA Convention); with its headquarters in Honiara, Solomon Islands. The core function of the FFA is to provide its members technical advice and policy coordination in dealing with distant water fishing nations. Since its establishment, the FFA has been very successful in fostering regional cooperation among its members on international and domestic fisheries issues. Among the successful harmonized activities of the FFA are the introduction of the Regional Register of Foreign Fishing Vessels; the Minimum Terms and Conditions of Access for Foreign Fishing Vessels; the negotiation of a regional tuna treaty with the United States of America; the ban on driftnet fishing in the region and recently, the development and introduction of a satellite-based vessel monitoring system for all foreign fishing vessels in the region.

The Secretariat of the South Pacific Regional Environmental Program (SPREP)**:** At the forefront of developing regional environmental policies and standards in the central and western Pacific is SPREP, located in Apia, Samoa). Since June 1993, SPREP has been independently constituted under its own convention, the *Agreement Establishing the South Pacific Regional Environment Program* (the SPREP Agreement). The functions of the SPREP Secretariat are the development of regional environmental expertise, co-ordiantion of provision of expert assistance to governments, facilitation of environmental monitoring and research, and facilitation of information exchange.

The South Pacific Applied Geosciences Commission (SOPAC): SOPAC) was created under the *Agreement establishing the South Pacific Applied Geoscience Commission (SOPAC)* in 1990. The headquarters of SOPAC is located in Suva, Fiji[1]. The core objectives of SOPAC relate to all aspects of marine and coastal environmental issues. These include:

- the provision of information on the physical environment of coastal areas to assist with resource and environmental management, hazard evaluation, coastal protection works, and with planning and implementation of coastal development projects; the investigation of the resource potential for on-land, coastal and deep-sea minerals including construction materials, phosphates, cobalt-rich crusts, manganese nodules, polymetalic sulphides, and detrital minerals such as gold;
- the assessment and promotion of the hydrocarbon, wave and geothermal energy potential of the region;
- the coordination of marine geological and geophysical research carried out in the region and managing the resulting data on behalf of the member countries;
- the training of member country nationals and improving the institutional capabilities of member countries in the application of geoscience to the management and development of their non-living resources and coastal zone.

University of the South Pacific**:** The University of the South Pacific (USP), based in Suva, Fiji, was set up by Royal Charter in 1970. The participating members of USP include: Cook Islands, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu and Vanuatu. Although USP is not formally regarded as a regional organization, it has, over the years, achieved a de-facto regional organization status because of its interaction with the formal organizations in the region. The research and training activities of USP in coastal and marine

[1] The parties to the SOPCA Agreement include: Australia, Cook Islands, Fiji, Federated States of Micronesia, Guam, Kiribati, Marshall Islands, New Zealand, Niue, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

related activities are very important for institutional development and capacity building in the region.

General Evaluation of Marine Regionalism in the South Pacific

Valencia defines a marine policy regime a

> a system of governing arrangements, together with a collection of institutions (formal or informal) for the implementation of these arrangements, in a given social structure or marine region."[2] Valencia argues further that "a marine policy regime is a set of agreements among a defined group of actors specifying: (1) the distribution of power and authority for the marine geographical region; (2) a system of rights and obligations for the members of the group; and (3) a body of rules and regulations that are supposed to govern the behavior of the members.[3]

Following from the above definition, Valencia identifies five different approaches to regional marine policy cooperation. These include: (a) joint activities; (b) regional organizations; (c) treaty arrangements; (d) harmonization of laws and policies; and (d) informal contracts.[4] Applying Valencia's framework the South Pacific, it can be argued that despite the long history of marine regional cooperation in the South Pacific region, the region has not yet achieved a marine policy regime. Infact, it is doubtful whether a marine policy regime, according to Valencia's definition, exists presently anywhere in the world.

Although regional cooperation to address marine resources and environmental issues in the South Pacific has fostered a high sense of identity among the South Pacific States and Territories, an achievement which is envied by many States, marine regionalism in the South Pacific has also revealed some pitfalls.

- A major difficulty in achieving true marine regional integration in the South Pacific relates to the differential membership of the various organizations. The organizations in the region fall into one of three categories: (a) the organizations whose membership comprise only the independent Pacific Island States (including Australia and New Zealand): the so-called Forum members (the Forum Secretariat and the Forum Fisheries Agency); (b) the organizations whose membership comprise all the Pacific Island States and Territories, including Australia, New

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[2] Valencia, M., 'Regional Maritime Regime Building: Prospects in Northeast and Southeast Asia", *Ocean Development and International Law,* vol.31, No.3, 2000, p.231.

[3] *Ibid.*

[4] Ibid. p.232.

Zealand, France, United Kingdom and the United States (SPREP and the Pacific Community); (c) the organizations with limited membership (the University of the South Pacific[5] and SOPAC[6]). The differential membership of the various agencies involved in marine sector activities in the region serve as a "substantial impediment to pursuing all avenues for achieving institutional efficiencies."[7]

- Another issue is the financial constraints associated with the multiplicity of organizations in the region. Each of the organizations have its own governing body, its financial obligations and its own set of meetings. Increasingly, the work programmes of nearly all the organizations depend on donor funding. The financial cost of servicing all these organizations is becoming a major concern for their members.

- With the exception of the Forum Secretariat which has a broad policy and coordinating role, all the other organizations in the region have been established to address specific sectoral functions, some of which overlap. This gives rise to the potential for duplication of effort and allocation of scarce financial resources. Further, the absence of any coherent framework for the integration of the work programmes of the various organizations created the potential for the organizations to compete with each other for donor funding. Although some collaboration occurs among the institutions in the region through annual consultations and memoranda of understandings this have not entirely eliminated the problem of duplication and competition for funds.

Addressing the Problems

The Pacific Island States and Territories have recognized the problems outlined above and have, over the last ten years, taken a number of steps to achieve a better coordination.

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5 Cook Islands, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu and Vanuatu

4 Australia, Cook Islands, Fiji, Federated States of Micronesia, Guam, Kiribati, Marshall Islands, New Zealand, Niue, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

7 Review of Institutional Arrangements in the Marine Sector, Final Report, July 1995.Review, 1995:12).

The South Pacific Organizations Coordinating Committee

In the early 1990s, the Pacific Community; the Forum Secretariat; the FFA; SPREP and USP established the South Pacific Organizations Coordinating Committee (SPOCC) with the objective of achieving better coordination among the respective organizations. In May 1994, SPOCC commissioned a Review of Regional Institutional Arrangements in the Marine Sector. The Report of the Review, released in July 1995, made a number of recommendations The most relevant of these recommendations include the following:

- In the interest of a coordinated and consistent national policy on marine related issues, it is desirable that the regional States and administrators establish appropriate and effective national mechanisms for the ongoing coordination of marine policy.
- A comprehensive marine sector strategy should be developed on a five year cycle to help guide the governing councils of the SPOCC agencies and the region's donors in promoting marine resource and conservation projects.
- SPOCC pursue the establishment of a marine sector sub-committee to focus the effective development and implementation of a regional marine strategy.[8]

The Marine Sector Working Group (MSWG) recommended by the Review Team, was established. The central focus of MSWG is to promote better co-ordination of activities among all the SPOCC agencies.

Pacific Islands Regional Oceans Policy

One of the ambitious initiatives developed by the MSWG was the development of a regional ocean policy between 2002 and 2004. The key aspects of the Pacific Islands Oceans Policy included: improving understanding of the Ocean; sustainable development and management of ocean resources; maintaining the health of the Ocean; promoting the Peaceful uses of the Oceans; and creating partnerships and promoting cooperation.

There are several potential advantages of implementing a South Pacific regional ocean policy. These include:

- Provision of an effective framework for accessing and managing high-cost managerial technologies and infrastructures for Ocean governance;
- Avoiding duplication of efforts;
- Avoiding politically and economically damaging marine resource demarcation disputes in the region;

8 *Ibid.* 3-5.

- Strengthening current functional task-orientated approaches to regional unity;
- Attracting donor funding due to policy's coordinated and long-term focus;
- Assistance with capacity-building and improvements in managerial expertise;
- Developing and presenting regional positions in international for;

The initiatives to develop an ocean policy in the South Pacific was ground- breaking. However, the regional oceans policy failed to achieve its objectives for a number of reasons. The main reasons for lack of impact included: lack of support at the national level and lack of support at the regional institutional level.

Reforming of Regional Institutions

Another initiative developed through the Forum Secretariat was the attempt to reform regional institutions in the Pacific. The Report of the Regional Institutional Framework Review (RIF) in August 2006 recommended major changes to existing regional institutions in the region, including the merging of a number of institutions. The five key recommendations included:

- Existing CROP agencies should be reorganised in a regional institutional framework that is based on three pillars; namely: (a) a political and general policy institution – the Pacific Islands Forum and its secretariat; (b) a sector-focused technical institution – the Pacific Community and its secretariat; and (c) academic and training organisations, namely the Fiji School of Medicine, the Pacific Islands Development Programme and The University of the South Pacific.
- The Pacific Islands Forum Secretariat should, within two years, assimilate the current functions of the Forum Fisheries Agency that relate to political and international legal issues and negotiations.
- The Pacific Community Secretariat should, within two years, integrate the current work programmes of SOPAC, the South Pacific Board for Educational Assessment, SPC and SPREP along with FFA's technical functions, in particular its fishery development work.
- The South Pacific Tourism Organization should be integrated into the Pacific Community Secretariat if and when membership issues are addressed in a way that makes its integration feasible and desirable.
- Governance and management arrangements of the academic and training institutions that are current members of CROP should not be changed.

In 2007, the Pacific Islands Heads of Government agreed, among other things that:
Pacific Leaders agreed among other things that:-

- The inclusion of the Pacific Islands Forum Fisheries Agency (FFA) into Pillar 1, in order to recognise the Agency's central regional role and to provide fisheries issues with the political profile they require
- The need to rationalise the functions of SOPAC with the work programmes SPC and SPREP with the view to absorbing those functions of SOPAC into SPC and SPREP.

In 2009, the Pacific Islands Heads of Government further decide as follows:

- All work to define the new institutional arrangements, as well as plans for implementing those arrangements, to be finalised and jointly agreed by the CEOs of the relevant agencies for presentation to Leaders at the 2009 Leaders' meeting
- All the final decisions on the new institutional arrangements and implementation plans, with implementation to commence immediately after the Governing Council meetings and no later than 1 January 2010. It was also agreed that rationalisation of SOPAC functions into SPC and SPREP should not result in any substantive diminution in SOPAC functions.

The RIF process, like previous efforts before it such as the regional oceans policy, is not likely going to address the problems of Pacific regionalism identified above. The process was driven largely by government officials, with too much focus on cost reduction to members rather than integration and coordination of activities and functions. More fundamentally, it failed to adequately considered legal issues associated with amalgamating different institutions.

Conclusion

Developing and implementing an effective regional organizations framework for oceans governance in the Pacific islands region continues to be a challenge. Although a lot of progress has been made, a number of challenges still remain to be addressed. These challenges which require further detailed research and analysis include:

- Multiple organisations with differential membership; multiple governing bodies and financial obligations; meeting overload and fatigue; competition for donor funding and lack of synergy between regional and international instruments.
- Dependency - reliance on regional expertise, projects and funding; limited initiative for national action and lack of national human capacity to implement regional and international initiatives.

The Role of Remote Islands in the Management of the Seas with a focus on Japan's Remote Island Policy

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The Role of Remote Islands in the Management of the Seas

Japan is a country comprised of 6,852 islands located in the northwest quadrant of the Pacific Ocean. With a total land area of 380,000 sq kilometers it is the sixtieth largest country[1)] in the world in terms of landmass. The sea area under its national jurisdiction is expansive and including its territorial waters the country's exclusive economic zone (EEZ) totals 4.47 million sq kilometers, sixth largest[2)] in the world (larger than the entire landmass of the 27 countries comprising the European Union). If the total volume of this area is calculated it reaches 15.8 million cubic kilometers, the world's fourth largest[3)]. Putting these rankings aside, what is of importance is the fact that Japan has a sea area under its national jurisdiction 12 times the size of its total landmass, and that 60% of that sea area is created by both inhabited and uninhabited remote islands.

The right of coastal states to claim extensive areas of ocean is based on the provisions provided for in the 1982 United Nations Convention on the Law of the Sea (UNCLOS). However, we must not forget that this treaty does not just simply grant such states the simple right to expand the sea areas under their jurisdictions. UNCLOS, while allowing coastal states to establish EEZs, also entrusts upon these states the responsibility of properly managing these vast zones by imposing upon them various duties such as the obligation to conserve the waters under their control to ensure that living resources can be sustainably developed (Articles 61, 62); the obligation to also take into account the needs of land-locked and geographically disadvantaged States when considering the most suitable application of any developed resources (Articles 69, 60); and the obligation to preserve and protect the marine environment (Articles 56, 192) and so on. These obligations were innovative additions to the law of the sea[4)].

The scope of the environmental preservation mentioned above has been showing drastic change since the Convention's adoption. Through actions such as the Rio Declaration, Convention on Biological Diversity (CBD), Agenda 21, Jakarta Mandate on Marine and Coastal Biological Diversity, and the Johannesburg Declaration, the meaning of

environmental preservation is expanding from its original definition of simply preventing the "introduction by man of substances or energy into the marine environment" (Article 1, paragraph 4), to mean the preservation of the ecosystem, a circulatory system of life supporting biodiversity that uncovers value in the very existence of various living things. The efforts of one country alone are insufficient and cooperation on a global scale is required if this goal is to be achieved.

Consequently, the rights and responsibilities of signatories to UNCLOS can be said to be the development of marine resources in harmony with the preservation of biodiversity and ecosystems, in other words the realization of "sustainable development". The seriousness of these rights and obligations cannot be forgotten or ignored by coastal states possessing jurisdiction over large expanses of sea.

Incidentally, for islands, the UNCLOS provisions for the expansion of jurisdiction (over areas of sea) are different to those that have been established for continental landmasses. More specifically, under the title of "Regime of Islands", paragraph one of the article 121 states, "*An island is a naturally formed area of land, surrounded by water, which is above water at high tide*", and paragraph three sets for that, "*Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf*".

Thus only islands meeting the definition stated in paragraph one and not meeting the criteria listed in paragraph three are recognized as being allowed to possess an EEZ and a continental shelf (There is dissension surrounding this interpretation of this article however it is not dealt with in this paper[5]). As a result, efforts aimed at clearing the standards set forth in paragraphs one and three are being explored and enacted around the world[6], however, what cannot be forgotten is that this article is a integral part of the entire UNCLOS. In interpreting and applying this provision, what is required for contracting parties is to carry out efforts in their context and in the light of its object and purpose of this Convention (see eg. Article 31 of the Vienna Convention on The Law of Treaties). The "sustainable development" is one of such purposes.

It is also a fact that islands possess unique characteristics which differ from those of continental landmasses. In particular these days, remote islands and their surrounding seas are understood to be a single unit and their ecological, cultural, and scientific merits are being reassessed. As such their preservation and utilization is not just perceived as a national matter, but seen as an international issue of common concern as well. Remote islands are no longer simply just "dangers" as depicted on a nautical chart.

Evidence of this new perception include:

1) ***The Establishment of Marine Protected Areas (MPA)*** [7]**:** The CBD (Particularly Article 8) states that protected areas should be utilized as a means of conserving ecosystems and biological diversity (in general protective areas established over areas of the seas are known as Marine Protected Areas: MPA). At the Seventh Conference of the Parties to CBD held in 2004, Decision VII/28 which states as an objective, "*the establishment and maintenance by 2010 for terrestrial and by 2012 for marine areas of comprehensive, effectively managed, and ecologically representative national and regional systems of protected areas that collectively, inter alia through a global network"* was adopted and signatory countries are proceeding with the designation of MPAs for the purpose of achieving the targets set forth in the Decision by 2012[8]. Contributing the most towards the achievement of this goal in marine areas is the protected zones that have been established in the past few years around solitary islands in remote parts of the pacific ocean. Though these remotely located islands are blessed with endemic species of life, their vulnerability against alien species is weak and thus instances of establishing protected areas that not only comprise the island itself, but encompass wide areas of the surrounding oceans as well are increasing.

2) ***World Heritage Registration*****:** Though there are currently 890 properties listed on the World Heritage List (created by the UNESCO World Heritage Convention), only 49 of them are properties with marine (and coastal) components[9]. Of those 49 properties 26 are remote islands registered by 19 different countries as natural heritage sites. UNESCO is aiming to rectify this situation and has established the World Heritage Marine Program in order to facilitate the designation of marine areas as heritage sites[10].

3) ***The Necessity of Defining the Borders of Continental Shelves and EEZs Belonging to Remote Islands***: Accompanying the increased activity and progress of oceanic exploration and development is the spread of offshore development locations. To date numerous incidents pertaining to the demarcation of marine boundaries have been referred to international courts but since the year 2000 many of these incidents have involved remote islands. Examples of cases disputing the demarcation of marine boundaries related to islands being argued before The International Court of Justice (ICJ) include the "*Case Concerning Maritime Delimitation and Territorial Questions between Qatar and Baharain (2001), Case Concerning Sovereignty over Palau Lighitan and Palau Sipadan (2002), Case Concerning Territorial and Maritime Dispute between Nicaragua and Honduras in the Caribbean Sea (2007), Case concerning Sovereignty Over Pedra Branca/Palau Puteh, Middle Rocks and south Ledge (2008) and Maritime Delimitation in the Black Sea (2009)"*.

In the rulings relating to these cases remote island management methods and their legal significance are being argued.

4) ***Submissions Seeking the Expansion of Continental Shelf Boundaries*:** Based on the UNCLOS, coastal states can, under prescribed conditions, apply to have the limits of their continental shelves expanded. The submission deadline (for Japan and many other countries) for such applications was 12 May, 2009. The Commission on the Limits of the Continental Shelf (CLCS) received 51 submissions and 44 preliminary Information reports[11], among these the number using solitary islands in remote areas of the ocean as base points was decidedly not small[12].

What we can learn from this development is that the management of remote islands is no longer just a domestic issue. Remote islands and their surrounding seas compromise an important part of ocean management which regards them as single integrated units. And as such, they are closely related to the securement of both national and internationally shared interests as established in international conventions and treaties such as UNCLOS and CBD.

However, it is not an exaggeration to say that to date, remote island management in Japan has only focused on domestic socio-economic issues. Yet, this is showing signs of change. From the perspective of the role remote islands play in the management of the seas, this paper will examine recent developments in Japan's remote island policies and explore possible future challenges.

The History of Japan's Remote Island Policies

According to Japanese law, the five islands of Hokkaido, Honshu, Shikoku, Kyushu and Okinawa form the country's mainland while the remaining 6,847 islands are classified as remote islands. Of those remote islands only 422 support human populations, the remaining 6,425 are uninhabited. Yet, even though up until now there has existed in Japan legislation governing inhabited islands, there has been no mention of uninhabited remote islands in legislative or policy documents even for remote islands that would be important as base points for establishing EEZs.

However, Japanese government has recognized the international developments that were explored at the start of this paper and the situation has been changing drastically since the country enacted the Basic Act on Ocean Policy in 2007. Following below we will explore the history of Japan's management policy both before and after the establishment of this Act.

(1) Prior to the Establishment of the Basic Act on Ocean Policy

Prior to the establishment of the Basic Act on Ocean Policy, there existed the Remote Islands Development Act, legislation created on July 22, 1953 for the purpose of dealing specifically with issues related to remote islands in Japan. At first it was created as temporary legislation with a 10 year term limit, however, after being amended five times it is still in effect today (its most recent amendment took place in 2002 and its current lifespan is set to expire on March 31, 2013) [13]. The purpose of this piece of legislation is set forth in Article 1:

> *Concerning remote islands which play an important role in matters such as the conservation of the natural environment, utilization of marine resources, and the preservation of the territory of Japan and its exclusive economic zones (prior to amendment: country), together with improving the conditions of their industrial base and living environments which are lower when compared to other regions of the country, and while utilizing the creativity and originality of the region in order to plan development that leverages the geographical and natural characteristics of remote islands (prior to amendment: to remove the inherent backwardness due to the special circumstances of being isolated from the main islands) measures related to improving the basic conditions and industrial development, etc (prior to amendment: "etc" was not included) of such islands will be established, by taking special measures for the purpose of revitalizing the remote islands projects based on this will be speedily and strongly implemented, the autonomous development of remote islands will be encouraged, (prior to amendment: economic strength will be nurtured), contributing to the improvement of the welfare and stability of the islanders' lives, along with advancing the national interests (prior to amendment: this wording was absent) and economic development of the country's citizenry.*

Frankly speaking what this law is saying here is that in comparison to the main islands the industrial development of inhabited remote islands is lagging, or in other words, there are problems on the islands. Consequently, the law is only targeting inhabited islands.

In order to achieve the goals set forth in the Remote Islands Development Act the central government (Ministry of Land Infrastructure, Transport and Tourism; Ministry of Internal Affairs and Communications; Ministry of Agriculture, Forestry and Fisheries) formulized the Basic Policy for Remote Islands Development as its general plan, and based on that policy local municipal governments (25 prefectures are involved) in charge of administering remote islands designated as "Areas for the Implementation of Remote Islands Development"

established the Remote Island Development Plan (prior to the Act's amendment in 2002 the central government had been creating this plan). For example, in 2003, The Tokyo Metropolitan Government, following the central government "Policy" directive created the "Tokyo Remote Islands Development Plan". Tokyo's plan only targets the nine inhabited islands of the Izu Islands Region and sets out programs for industrial development and improving the living environment.

Thus it can be said that the only law in Japan that deals with remote islands themselves, only deals with problems on the islands, discussing policies that are "inward looking" so to speak. This "inward looking" only indicates the direction of the policy and it goes without saying that this is important as ever. However, while it eliminates uninhabited islands and the seas surrounding islands, and is void of an "outward looking" point of view in regard to ocean management for remote islands, the law will remain extremely inadequate.

(2) After the Establishment of the Basic Act on Ocean Policy

It took the appearance of the Basic Act on Ocean Policy to raise awareness of "outward looking" policies in addition to "inward looking" ones. I will give a brief explanation of developments since the establishment of the Basic Act on Ocean Policy.

1. Basic Act on Ocean Policy (Enforced from July 20, 2007)

The Basic Act on Ocean Policy is the legislation sponsored by a cross-party group of lawmakers. The Act is enacted by the Diet which establishes the framework for a national policy across all governmental ministries and agencies for political measures dealing with the oceans. Included in the list of "Basic Measures" is one dealing with the issue of remote islands. Its inclusion signifies that not only is there a permanent law for dealing with remote islands but also that the management of remote islands is positioned in the context of an overall ocean policy. Article 26 (Conservation of Remote Islands, etc.) states the following:

> *The State, with regard to the remote islands, shall take necessary measures including conserving the seacoasts and others, securing the safety of navigation as well as establishing the facilities for the development and use of ocean resources, conserving natural environment in adjacent sea areas, maintaining infrastructure for the life of inhabitant and executing others, in consideration of such fact that the remote islands bear an important role in conserving our territorial sea and the Exclusive Economic Zone and other areas, and in securing the safety of navigation in the development and use of ocean resources as well as in conservation of the marine environment.*

Though similar to Article 1 of the Remote Islands Development Act, an important change is evident in these provisions. Namely, the use of the wording "marine environment" rather than "natural environment" in describing some of the roles played by remote islands, and the addition of "conserving natural environment in adjacent sea areas" as one of the Act's necessary measures. Consequently, management of uninhabited islands as well as the sea areas adjacent to remote islands are included in the measure for remote islands under the Basic Act. Hence we can see here a shift from away from traditional "inward looking" policies.

Incidentally, something that cannot be forgotten in the implementation of the "Conservation of Remote Islands, etc.", Article 26 of the Basic Act on Ocean Policy, is the import stipulation laid out in Article 7 of the general provisions. This Article, titled "International Partnership with regard to the Oceans", raises the idea that "*the oceans are the common heritages of mankind*", and that Japan, while recognizing "*that the economy and society of our State have been conducted in close international relationship*", shall, in the promotion of measures with regard to the oceans "*execute them under the international partnership*", and the Article goes on to mention that Japan is "*aiming at bearing the leading role for the formation and development of the international order*". This provision, which could be called Japan's "Policy Speech as a Maritime Country", serves as the foundation of the Basic Act on Ocean Policy itself and all the ocean related policies being advanced under it.

2. Basic Plan on Ocean Policy (Cabinet Decision made on March 18, 2008)

The Basic Plan on Ocean Policy is a five year plan effective through to 2012 created by the Headquarters for Ocean Policy which was established under the Basic Act on Ocean Policy and of which the Prime Minister serves as director-general. Its purpose is to promote the measures laid out in the Basic Act on Ocean Policy in a comprehensive and systematic manner. Remote island issues are included in paragraph 10 "Preservation of the Islands" of Chapter 2 "Measures that the Government Should Take Comprehensively and Systematically with Regard to the Sea".

The policy measures related to remote islands in the Basic Plan are divided into two subsections; 1- Preservation of the Islands and; 2- Revitalization of Islands. Policies in subsection two are "inward looking" policies carried over from the Remote Islands Development Act and are concerned with inhabited islands. These "inward looking" policies will continue to be implemented through the measures provided for in subsection two.

On the other hand it can be said that subsection one of the Basic Plan provides welcome

innovation. Regarding remote islands which play a "*significant role as foundations for the establishment of vast areas of jurisdictional seas, in the securement of maritime transport safety, development and utilization of marine resources and preservation of the marine environment*", the plan is promoting actions such as the "*securing of maritime transport safety*", "*supporting the development and use of marine resources*", and "*preserving the natural environment in the surrounding marine zones*", for their management. These types of initiatives aren't limiting themselves to dealing only with issues "on the islands themselves" but are "outward looking" polices that manage the islands and their surrounding seas as an integrated whole.

In fact the Basic Plan states that "*It is necessary to clarify the position of islands including uninhabited islands in promoting the government's ocean policy and establish the "Basic Policy concerning Preservation and Management of Islands for Management of the Sea (provisional title)," which stipulates appropriate management systems, measures, and schedules of implementation*", specifically mentioning uninhabited islands for the first time.

3. The Report of the Investigative Committee concerning Preservation, Management, and Utilization of Islands for Management of the Sea (September 3, 2009)

In preparation for drawing up the "Basic Policy concerning Preservation and Management of Islands for Management of the Sea" which was called for in the Basic Plan on Ocean Policy, the Ocean Policy Division, Policy Bureau, of the Ministry of Land, Infrastructure, Transport and Tourism convened the "Investigative Committee concerning Preservation, Management, and Utilization of Islands for Management of the Sea" to examine the issue (The committee convened a total of four times between August of 2008 and June of 2009). This committee, which for the first time in Japan discussed management policies for uninhabited islands in Japan (this author is also a member of the committee) filed "The Report of the Investigative Committee concerning Preservation, Management, and Utilization of Islands for Management of the Sea[14)]" on September 3, 2009.

While basing itself on the policies of the Ministry of Land, Infrastructure, Transport and Tourism, this report examined uninhabited islands in the open ocean from the angle of "Preservation, Management, and Utilization of Islands for Management of the Sea". It offers "outward looking" polices and gives shape to the content used in subsection one "Preservation and Management of Islands" in the Basic Plan on Ocean Policy.

The report is built around the premise that both "*contributing to international public interests*" and the "*sound development of the State's economy and society as well as*

improving the lives of the citizenry (in other words national interests)" are important in advancing the ideas and policies of remote islands for managing the seas. The report goes on to state that "*these two interests are not exclusive of one another, rather they connect with each other on many fronts. Additionally, even though the policy aims are only genuinely concerned with the latter, there can be no deny that as a matter of course they are beneficial to both*".

More specifically with regard to "*contributing to the international public interests*", bearing in mind that various countries are adhering to the demands set for in current international regulations governing the oceans such as UNCLOS and CBD, management policy that implements the protection of the natural and cultural assets of islands and their surrounding seas (Establishment of MPAs, World Heritage registration, etc) should be promoted as remote island preservation measures. And as island resource utilization measures, management policy that deals with preventing maritime disasters, the acquisition and sharing of scientific knowledge, securing maritime transport safety and other such actions which are of a shared societal benefit to people all around the world, should be promoted.

On the other hand from the viewpoint of "national interests", the report suggests preservation measures that work to physically preserve the land area of an island in order to secure its status as an "island" as noted in Article 121 of the UNCLOS are necessary. And that as utilization measures, ones that secure natural resources and energy and use islands as development bases are needed.

A salient feature of this report is that for the first time management policies for dealing with uninhabited islands are introduced and their importance in the context of overall ocean management was clarified. Furthermore the report acknowledged that realizing not only national interests, but international public interests as well, was also an import point of consideration in regard to management policy. It goes without saying that in orienting towards "outward looking" policies, issues surrounding remote islands are being positioned in an international context. Additionally, in the body of the report it states that "*If there are common polices that target uninhabited islands as well as the inhabited ones which are necessary for the management of exclusive economic zones and such in the open ocean, it is possible to consider both inhabited and uninhabited islands from the same perspective*".

4. Basic Policy concerning Preservation and Management of Islands for Management of the Sea (Cabinet Decision made on December 1, 2009)

Approximately three months after the investigative committee's report was made public the Headquarters for Ocean Policy of the Cabinet Secretariat compiled the "Basic Policy concerning

Preservation and Management of Islands for Management of the Sea[15]" which received cabinet approval on December 1, 2009.

This is the most recent basic policy related to national remote island measures which were established based on the Basic Plan on Ocean Policy and stipulates that, "*the State, in managing the seas over which it has jurisdiction through the proper enforcement of rights and the fulfillment of obligations, recognizes that remote islands occupy an important position, and while clarifying the roles of these remote islands, will unerringly carry out the preservation and management of remote islands in cooperation with the relevant governmental ministries and agencies*".

Additionally, this Basic Policy, while recognizing the various measures relating to remote islands that have been implemented thus far, primarily the "*Policy for the Development of Industry and Improving the Stability and Welfare of Island Residents*",—measures that we call "inward looking" in this paper— (the Basic Policy noted these measures should as a matter of course be continued to be promoted), also establishes that "*the seas should be managed from the ocean's point of view*" or putting it another way, "*measures should be promoted that appropriately demonstrate the importance and role of remote islands in the management of the seas*". This policy, in other words, deals with "outward looking" remote island management measures.

To start with the Basic Policy states as a goal unerring performance in the preservation and management of remote islands in order to appropriately manage EEZs and other areas of the sea which are under the State's jurisdiction and account for an area that is approximately 12 times the size of the nation's territorial landmass. Why? Because the existence of this vast area of sea under the State's jurisdiction is "*the foundation of our nation's development and continued existence*" and also because "*preservation of the marine environment in its proper state is an obligation which the country must fulfill for the sake of the continued existence of humankind*". In short, the reason behind the promotion of remote island management is that "*the State, in managing the seas over which it has jurisdiction through the proper enforcement of rights and the fulfillment of obligations, recognizes that remote islands occupy an important position*".

Within this framework the fundamental thinking behind measures geared towards realizing the role and importance of remote islands in the Basic Policy can be summarized in the following three points:

- **The stable existence of remote islands will become the foundations of seas areas such as exclusive economic zones (EEZ) falling under the State's jurisdiction**

Policies relating to remote islands which are the basis for the outer boundaries of EEZs and other zones are preferentially worked out. These include the "*collection of data and assessing the situation*", "*strengthening the surveillance of remote islands and their surrounding seas*", "*promoting the regulation of acts which allow low tide lines to be modified*", "*creating a system which supports the sharing of information among governmental ministries and agencies for the preservation of remote islands*", and "*appropriate management of remote island titles*".

・**Remote islands are bases for promoting the support of various activities in vast areas of the ocean**

Measures raised under this entry include "*support for the development and utilization of marine resources*", "*strengthening of bases of activity in remote islands which are in isolated locations*", "*securing the safety and security of the oceans*". In other words the policy is stating that maintenance of remote islands should be comprehensively carried out

so that they may be utilized as hubs for marine development.

・**The rich natural environment formed by the oceans and the history and traditions formed from the relationship between people and the seas should be continued**

In addition to reconfirming that not only remote islands, but their surrounding seas as well,

are important places for supporting marine ecology, measures cited here include the "*collection of data and assessing the situation*", "*promotion of preservation and management*

through the establishment of Marine Protected Areas", and the "*promotion of initiatives for preserving the natural environments of remote islands*".

In addition to the above reference is made in the Basic Policy to "*measures related to the continuation of the history and traditions of remote islands formed from the relationship between people and the sea*", and "*public awareness measures for the nation's citizenry*". It should be duly noted that the Basic Policy is not just simply listing a wide range of activities. It also mentions that an inter-agency system of cooperation will be established and that a centralized system for managing remote islands will be created within the government. In other words the Basic Policy is indicating that remote island policy won't be made to conform to the structure of the government, but that rather government structure will be adapted to the promotion of remote island policy.

Additionally, it must be remembered that the Basic Policy is also taking into consideration that "*these wide ranging activities also widely contribute to the international community*". This, taken in combination with Article 7 of the Basic Act on Ocean Policy and its higher standards, means that Japan's remote island management policy is being promoted within an international context and intends to fulfill a leading role.

A framework has now come into existence for promoting the development of "outward looking" policies and measures that position remote islands and their surrounding seas as bases of implementation for ocean management practices possessing an international influence.

Conclusion

The establishment of the Basic Act on Ocean Policy signified a turning point in Japan's management of its remote islands. Though the polices focusing on economic and societal issues on the islands themselves which have continued since 1953 and were carried over from the Remote Islands Development Act, the so-called "inward looking" polices, remain as an important component, the new Basic Policy also added a innovative component of "outward looking" policies that will manage remote islands from the perspective that "*the seas should be managed from the ocean's point of view*".

Viewing the islands and their surrounding seas as a single unit, bearing in mind the need to preserve biodiversity and the ecosystem for the benefit of the international community, and implementing policies while seeking international cooperation, will become important elements of these "outward looking" remote island management measures.

As ways of putting these types of measures into practice various foreign countries are establishing MPAs, registering World Heritage Sites, concluding international treaties, and managing with the aid of international organizations. Through multilayered measures they incorporate the previously mentioned important elements while continuing to contribute internationally and secure their national interests[16].

What is the situation like in Japan? A good example symbolizing the present situation is the Ogasawara Islands. Also known as the *"Galapagos of the Orient"* they are a group of ocean islands and include uninhabited ones. Recently efforts have begun to expand the sea area of a nature park there and on January 18, 2010 the national government submitted documentation to the World Heritage Committee recommending the islands as candidates for listing as a natural heritage site [17]. However the recommended area is comprised almost entirely of land, including

only 10 sq kilometers of ocean area. Though these kinds of initiatives are starting to be undertaken they are lacking awareness in treating islands and their surrounding seas as a single integrated unit.

As a starting point the Basic Policy once again put awareness of remote islands issues on par with that of depopulation, and while listening to the requests of the international community, I hope that debate is carried out on a national level in order to rediscover the value of the "frontiers," many remaining remote islands.

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1) The Central Intelligence Agency (CIA) of United States, *The World Factbook*, data available at <https://www.
cia.gov/library/publications/the-world-factbook/rankorder/rawdata_2147.text>.

2) Ocean Policy Research Foundation, *Oceans White Paper 2007*, Seizando Shoten Publishing CO.,Ltd, p. 10 (in Japanese). The sixth place ranking has already been cited in many other sources but it is probably not exact because it does not place the United Kingdom and France (they have many remote islands) in the upper rankings. According to the Pew Charitable Trust, France is number two in the world and possesses EEZs totaling 10,084,201 sq kilometers in area. Pew Charitable Trust, Sea Around Us Project, *Country Data*, at <http://www.seaaroundus.org/eez/eez.aspx>.

3) Matsuzawa, T. "What is the Volume of the 200 nautical mile sea area of our country?", *Ship and Ocean*
Newsletter, No. 123 (September 20, 2005) (in Japanese).

4) Kagami, Y. "Reconsidering Exclusive Economic Zones", *25th Oceans Forum* (Lecture Points) , Ocean Policy
Research Foundation (March 23, 2005) (in Japanese).

5) See e.g., Barbara Kwiatkowska and Alfred H. A. Soons, "Entitlement to Maritime Areas of Rocks which cannot
sustain Human Habitation or Economic Life of Their Own," 21 *Netherlands Yearbook of International Law*, 1990, pp.139-181, Alex G. Oude Elferink, "Is it Either Necessary or Possible to Clarify the Provision on Rocks of Article 121(3) of the Law of the Sea Convention?" in M. A. Pratt and J.A. Brown (eds.), *Borderlands Under Stress*, Kluwer Law International, 2000, pp. 389-407.

6) In July of 2003 China enacted the "Uninhabited Ocean Island Preservation and Utilization Management Regulations", (See in detail, Ocean Policy Research Foundation, *Oceans White Paper 2006*, Seizando Shoten Publishing CO., Ltd, 2007, pp 58 and 199-200) (in Japanese); furthermore its content was supplemented and strengthened with the passage of the "Ocean Island Protection Law" by the State Council of the People's Republic of China on December 26, 2009, which is scheduled to be implemented from March 1, 2010 (*Yomiuri Newspaper*, December 27) (in Japanese). In Korea also the "Uninhabited Island Control Law" was

established on April 21, 2005 for the purpose of comprehensively managing and developing uninhabited islands, and the "Uninhabited Islands Management Committee" was created for the preservation, utilization, and development of the country's 2,679 uninhabited islands. Looking to prevent "Inhabited Islands from Becoming Uninhabited" many measures are incorporated to support people wishing to reside on uninhabited islands (JoongAng Ilbo Newspaper April 21, 2005) (in Japanese).

7) On MPA (in international legal perspective), see e.g., Julian Roberts, *Marine Environment Protection and Biodiversity Conservation: The Application and future development of the IMO's Particularly Sensitive Sea Area Concept*, Springer, 2007, Yoshifumi Tanaka, *A Dual Approach to Ocean Governance: The Cases of Zonal and Integrated Management in International Law of the Sea*, Ashgate, 2008, pp.209-241.

8) However, related documentation submitted at CBD COP8 is offering a more pessimistic perspective, saying that at the current pace of increase the goal will not be reached until the year 2069. See UNEP/CBD/COP/8/INF/4, 8 March 2006, *Summary Report of The Current Status of The Global Marine Protected Area Network, and of Progress Monitoring Capabilities* (Note from the Executive Secretary), pp. 7-9.

9) Fanny Douvere, "World Heritage Marine Programme: The Future 2010-2013," Power point presentation (26 Jan. 2010), at <http://whc.unesco.org/uploads/activities/documents/activity-13-7.pdf>.

10) See UNESCO web site, at <http://whc.unesco.org/en/marine-programme>.

11) Division for Ocean Affairs and the Law of the Sea (DOALOS), Commission on the Limits of the Continental Shelf (CLCS), at <http://www.un.org/Depts/los/clcs_new/clcs_home.htm>.

12) See e.g., "The scramble for the seabed," *The Economist*, May 16th 2009, p. 30.

13) Additionally, three special measures acts, the Act on Special Measures for the Amami Islands Promotion and Development, the Act on Special Measures for the Ogasawara Islands Development, and the Act on Special Measures for the Promotion and Development of Okinawa were established for certain inhabited islands. For recent information regarding the Remote Islands Development Act, see e.g. Yamaguchi, Y. "Current Issues of the Remote Islands Development Act –Survey and Information," *ISSUE BRIEF*, No. 635 (26 Feb. 2009), pp. 1-10 (in Japanese), and Tanaka, K. "Basic Plan on Ocean Policy and Remote Islands Development", *Kikan Shima* (*Island Quarterly*), July, 2008, pp. 54-64 (in Japanese).

14) Ocean Policy Division, Policy Bureau, Ministry of Land, Infrastructure, Transport and Tourism, "The Report of the Investigative Committee concerning Preservation, Management, and Utilization of Islands for Management of the Sea" (September 3, 2009), at <http://www.mlit.go.jp/common/000048460.pdf>.

15) Headquarters for Ocean Policy of the Cabinet Secretariat, "Basic Policy concerning Preservation and Management of Islands for Management of the Sea" (December 1, 2009), at <http://www.kantei.go.jp/jp/singi/kaiyou/dai6/siryou2.pdf>.

16) See in details, Kagami, Y., "Environmental Policy for Desert Islands - Beyond 'Island or Rock'," *Proceedings of International Symposium on Islands and Oceans* (January 22 & 23, 2009, Ocean Policy Research Foundation), pp. 108-9.

17) UNESCO, Tentative List of the World Heritage, Ogasawara Islands, at <http://whc.unesco.org/en/tentativelists/5095/>.

Regional Fisheries Management in Ocean Areas Surrounding Pacific Islands States

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Abstract

The Pacific islands region has developed a number of cooperative instruments to enable and support the conservation and management of tuna stocks as they migrate through the ocean areas surrounding the Pacific island States. These instruments have set global precedents and have significantly boosted the capacity of the region to manage and sustainably develop its tuna fisheries.

The success of this cooperation is vitally important in the Pacific islands region due to the highly migratory nature of the region's tuna fisheries and the region's high dependence upon these fisheries. It is crucial that the fisheries are managed effectively throughout their range, both within and between national exclusive economic zones, and on the high seas. Unrestrained exploitation in a particular exclusive economic zone or on the high seas has the potential to significantly impact on catches elsewhere with potentially devastating consequences for small island States that have few alternate resources.

In this light, the Pacific island States led the negotiation of a regional fisheries management organisation that would ensure the long term conservation and sustainable use of the tuna fisheries throughout their range in the Western and Central Pacific Ocean. The Western and Central Pacific Fisheries Commission was established in 2004 and has since developed a number of conservation measures to support the conservation and management of the region's tuna fisheries.

This paper reviews the performance of the Commission and its conservation measures, and discusses the key challenges to the management of these fisheries as they migrate through the ocean areas surrounding Pacific island States.

Keywords: Pacific island fisheries, governance, regional cooperation

Introduction

In January 2009, the author presented a paper to the International Symposium on Islands and Oceans hosted by the Ocean Policy Research Foundation in Tokyo.[1] The paper focused on national challenges to the management of the Pacific island tuna fisheries, and noted that implementation of conservation and management measures requires effective national institutions and governance, and a political will to implement often contentious and difficult conservation measures. The paper suggested further sub-regional cooperation and capacity building to support national implementation.

Following on from that paper, the author briefly explores the regional conservation and management framework for the Pacific island tuna fisheries, focusing on the Western and Central Pacific Fisheries Commission (WCPFC). Regional co-operation is critically important in the Pacific islands region due to the migratory nature of the region's tuna fisheries and the limited capacity of most Pacific island States. In response, the region has cooperated to establish global precedents in fisheries management and has significantly boosted their capacity to manage regional tuna fisheries and conserve the critical tuna stocks.

In recent years, the problems of overfishing and overcapacity (i.e too many fishing boats) have increased and now threaten the long term sustainability of some of the region's key fish stocks. The WCPFC Scientific Committee has repeatedly expressed concerns regarding fishing levels since its inaugural meeting in 2005 and each year recommends increasingly tougher reductions in fishing mortality.[2] Furthermore, economic studies have shown that fishing effort is

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[1] Hanich, Q. (2009) Implementing Oceans Governance in the Pacific Islands Region: Regional Solutions to National Challenges. In Proceedings of Internatonal Symposium of Islands and Oceans; Terashima, H. Eds.; Ocean Policy Research Foundation: Tokyo, 2009; pp 116-126.

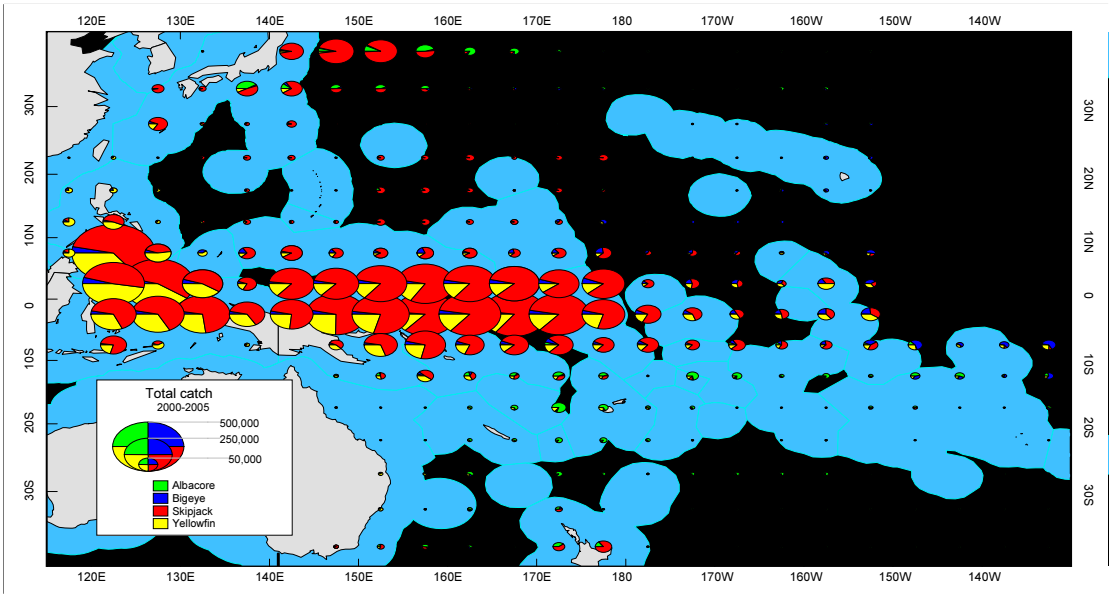
[2] WCPFC Scientific Committee (2005). The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. Scientific Committee. Fourth Regular Session, 8-19 August 2008, Noumea, New Caledonia.: WCPFC Scientific Committee (2006). The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. Scientific Committee. Fourth Regular Session, 7-18 August 2008, Manila, Philippines: WCPFC Scientific Committee (2007). The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. Scientific Committee. Fourth Regular Session, 13-24 August 2008, Honolulu, United States of America: WCPFC Scientific Committee (2008). The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. Scientific Committee. Fourth Regular Session, 11-22 August 2008, Port Moresby, Papua New Guinea. WCPFC Scientific Committee (2009). The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. Scientific Committee. Fifth Regular Session, 10-21 August 2009, Port Vila, Vanuatu.

significantly above optimal levels, thereby reducing the profitability of the fishery and undermining opportunities for Pacific island States to develop fishing and related industries.

Resolving these management challenges is the key oceans governance challenge for the Pacific islands region. The Western and Central Pacific Ocean (WCPO) tuna fisheries are the only significant resource for many Pacific island States and have long been viewed as the primary development opportunity for many of the region's developing island states. This paper briefly backgrounds the Pacific islands region and its tuna fisheries, briefly introduces the key regional fisheries instruments, and then focuses discussion on the development and operation of the WCPFC.

Pacific Islands Tuna Fisheries

The four key tuna species of interest (albacore, skipjack, yellowfin and bigeye) migrate across the EEZs and high seas pockets of the WCPO. Unlike Atlantic, Indian and Eastern Pacific tuna fisheries, the majority of fishing effort in the WCPO occurs within the EEZs of the Pacific island States, Indonesia and the Philippines. Approximately 57% of all WCPO catches for the four key tuna species are taken from the Pacific island EEZs,[3] and an additional 15-25% from the Indonesian and Philippines EEZs.



Source: Oceanic Fisheries Programme, Secretariat to the Pacific Community, Noumea. 2009.

Figure 1: Total tuna WCPO catch

[3] For the purposes of this estimate, this includes the EEZs of: (FFA members) Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu (and non-FFA members) American Samoa, French Polynesia, New Caledonia, Pitcairn Island, and the French territory of Wallis and Futuna.

The value of the WCPO tuna fisheries[4] have increased 60% since 2005 – from approximately 271.5 billion yen in 2005 to approximately 435 billion yen in 2008. WCPO tuna catches only increased by 13% over this period, largely due to reported rises in catches from Indonesia, Philippines and Papua New Guinea.

The key drivers behind the dramatic increase in value were the significant increases in the composite prices for skipjack (86% increase), yellowfin (28% increase) and bigeye (27% increase) over the period 2007-2008. This resulted in the landed value of WCPO skipjack increasing by 54% in 2007 and another 24% in 2008.

The total tuna catch for 2008 was estimated to be approximately 2,426,195 mt, a new record highest annual catch (but only by 0.25%). This catch was approximately 81% of the total Pacific ocean catch (estimated to be approximately 3,009,477 mt) and 56% of the global tuna catch (estimated to be approximately 4.3 million mt). The following two tables describe the catch by species and catch by fleet.

Table 1: Catch by species

Species	Catch in mt	Percentage of catch	Value in JPY (to nearest billion)
Skipjack	1,634,617	67%	246 billion
Yellowfin	539,481	22%	100 billion
Bigeye	157,054	6%	64 billion
Albacore	95,043	4%	24 billion

[4] All values converted from US$ and AU$ to JPY on 1 March 2010 at 89JPY to US$1 and 80JPY to 1AU$. All subsequent data on catch and value data sourced from the following papers: WCPFC Scientific Committee (2005): WCPFC Scientific Committee (2006): WCPFC Scientific Committee (2007): WCPFC Scientific Committee (2008): WCPFC Scientific Committee (2009): Gillett, R. 2009. The Contribution of Fisheries to the Economies of Pacific Island Countries and Territories. Asian Development Bank, AusAID, World Bank, SPC and FFA.

Table 2: Catch by fleet

Fleet	Catch in mt	Percentage of WCPO catch	Species composition	Value in JPY (to nearest billion)
Purse seine	1,783,669	74%	Skipjack = 70 to 85% Yellowfin = 15 to 30% Bigeye = small amounts	278 billion
Longline	231,003	10%	Skipjack = 2% Yellowfin = 30% Bigeye = 38% Albacore = 30%	103 billion
Pole and line	170,805	7%	Skipjack = 70 to 85% Yellowfin = 5 to 10% Bigeye = 1 to 6% Albacore = 8 to 20%	32 billion
Other (troll & artisanal gears mostly in Indo/Phil)	n/a	10%	n/a	n/a

These highly valuable fisheries represent the primary economic opportunity for many Pacific island States. Pacific island states depend upon these stocks: as a traditional and important source of food; as a critical form of revenue (approximately 7 billion yen in access fees[5]); income (expenditure by locally based vessels is estimated to be approximately 11.5 billion yen);[6] and employment (estimated at approximately 12,286 for employment on tuna vessels and in onshore tuna facilities).[7]

Access fees to Pacific island States from foreign fishing vessels deliver much-needed financial contributions to governments. In 2007, the total of access fees paid to all Pacific island States was estimated to be 7 billion yen. For comparison purposes, it is interesting to note that access fee revenue to Pacific island States only increased by approximately 25% from 1999 to 2007, despite a 55% increase in the value of the WCPO tuna fisheries during that time, from approximately 223 billion yen in 1999 to 347 billion in 2007.

[5] Gillett, R. (2009)

[6] Gillett, Robert, McCoy, Mike, Rodwell, Len and Tamate, Josie (2001). *Tuna. A Key Economic Resource in the Pacific Island Countries.* A Report Prepared for the Asian Development Bank and the Forum Fisheries Agency.

[7] Gillett, R. (2009)

Overfishing

Unfortunately, WCPO tuna fisheries are increasingly under pressure to reduce overfishing in key fisheries. Furthermore, economists have suggested that fishing capacity in some WCPO tuna fisheries is significantly above optimal levels, thereby reducing the profitability of these fisheries.[8] The key concerns relate to the impacts of various fleets on bigeye and yellowfin.

In 2009, the WCPFC Scientific Committee reported that overfishing of bigeye and possibly yellowfin was occurring and recommended a 34% to 50% reduction in fishing mortality for bigeye, and no increase in fishing mortality for yellowfin. Key threats to bigeye include high catches of bigeye by longline fleets, high mortality of juvenile bigeye by purse seine fleets using fish aggregating devices, and high mortality of juvenile by various gears in Indonesia and Philippines.
[9]

Regional Cooperation

It is critically important that the region's institutions are able to address overfishing challenges and effectively manage the region's tuna fisheries given the high dependence by Pacific island States upon fisheries resources. Any serious threat to the sustainability of the tuna resource can be viewed as a threat to the region's economic viability and food security.

The Pacific islands States depend upon regional cooperation and the effective operation of regional institutions and a number of key arrangements to enable and support effective fisheries management and development. Agencies such as the Pacific Islands Forum Fisheries Agency (FFA) and the Secretariat of the Pacific Community (SPC) provide high quality technical advice and support while the Harmonised Minimum Terms and Conditions of Access for Foreign Fishing Vessels (HMTCs), the Vessel Day Scheme (VDS) and the Niue Treaty enable collective management, enforcement and exploitation of the Pacific island region's tuna fisheries. Across, and beyond the Pacific islands region, the WCPFC is responsible for conserving and managing tuna fisheries throughout the WCPO and includes all relevant coastal States and distant water fishing nations (DWFN) within its membership.

[8] Bertignac, M., Campbell, H., Hampton, J. and Hand, A. (2001). 'Maximising Resource Rent from the Western and Central Pacific Tuna Fisheries' in *Marine Resource Economics*, Vol. 15, 2001, pp. 151-
[9] WCPFC Scientific Committee (2009).

The following sections describe the various developments in regional cooperation, from the formation of SPC through to the decisions of the WCPFC.

Secretariat of the Pacific Community – Oceanic Fisheries Programme (1947)

The Secretariat of the Pacific Community (SPC), formerly the South Pacific Community, was the first of the regional fora to be established and was founded in 1947 by the colonial powers of the time: Australia, New Zealand, Netherlands, France, United Kingdom (UK) and the United States of America (USA). The membership evolved through the period of de-colonisation and now includes the independent Pacific island States,[10] the Pacific island territories[11] and Australia, New Zealand, France and the USA. The organisation is headquartered in Noumea, with regional offices throughout the Pacific islands region.

The Oceanic Fisheries Programme (OFP) is one of a number of SPC programmes that aim to build capacity within the Pacific islands region and support members with technical assistance. The OFP provides fisheries science services to its members (primarily relating to tuna) and is also a contracted science provider for the WCPFC Scientific Committee.

Pacific Islands Forum Fisheries Agency (1979)

The Pacific Islands Forum Fisheries Agency (FFA) has played a central role in fostering regional cooperation amongst its membership in their management and development of the region's tuna fisheries.

The FFA was founded in 1979 by the independent Pacific island States, Australia and New Zealand and sits within the Pacific Islands Forum umbrella. In 1979, the independent members of the Pacific Islands Forum (then named the South Pacific Forum) foresaw the challenges involved in managing and developing their newly proclaimed EEZs and recognised that individually they did not have the capacity to adequately respond to these challenges. With remarkable vision they combined their resources and established the FFA to promote intra-regional cooperation and harmonisation of fisheries management policies. The mission of the FFA is to support and enable Pacific island States to achieve sustainable fisheries and maximise their social and economic benefits in harmony with the broader environment. The FFA itself

[10] Cook Islands, Federated States of Micronesia (FSM), Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea (PNG), Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu.

[11] American Samoa, French Polynesia, Guam, New Caledonia, Northern Mariana Islands, Pitcairn Islands, Tokelau, Wallis and Futuna.

does not manage the tuna fisheries and has no such mandate, nor any authority to enforce decisions of its governing council.

The FFA supports the interests of the Pacific island States through facilitating regional cooperation in their favour and providing technical and policy advice. Australia, New Zealand, Japan and the European Community (EC) all contribute significant funds to FFA programs.

FFA works closely with the SPC's OFP to facilitate regional cooperation and support management and development of the region's tuna fisheries, at national, sub-regional and regional levels. FFA has been most successful in its work to support sub-regional and regional cooperation relating to access by foreign fishing fleets into EEZs. In this area, the FFA has facilitated the development of a number of key regional arrangements. The most significant of these include the following.

Nauru Agreement (1982)

The key framework for subsequent successes in Pacific island fisheries cooperation was established in 1982 by a sub-set of the FFA membership who have since become the driving force within the FFA, and consequently have benefited most from regional cooperation. The 1982 Nauru Agreement Concerning Cooperation in the Management of Fisheries of Common Interest (Nauru Agreement)[12] was negotiated by the equatorial Pacific island States whose waters include the most significant fisheries.[13]

The Parties to the Nauru Agreement (PNA) recognised that they were in a weak position when negotiating access arrangements individually with DWFNs, particularly when DWFNs played each State against each other in negotiations over access fees and conditions.[14] In response, the PNA negotiated the Nauru Agreement in order to coordinate and harmonise their fisheries management and access conditions, thereby placing themselves in a stronger strategic position when negotiating with DWFNs. The Nauru Agreement promoted the following objectives:

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[12] Nauru Agreement. (1982). Full title: The 1982 Nauru Agreement Concerning Cooperation in the Management of Fisheries of Common Interest. Accessed online 10 March 2009 at http://www.ffa.int/node/93#attachments

[13] Papua New Guinea, Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Solomon Islands were all original signatories. Tuvalu subsequently became a party in 1991.

[14] Lodge, M. (2002). Minimum Terms and Conditions of Access: responsible Fisheries Management Measures in the South Pacific Region. *Marine Policy.* July 1992. pp277-305.

- coordinate and harmonise management of common fish stocks between PNA, without derogating any of their sovereign rights (Article 1);
- priority consideration for licensing PNA vessels over foreign vessels (Article 2a);
- establish minimum terms and conditions for foreign vessel access (Article 2b);
- cooperate and coordinate fisheries monitoring, control and surveillance (Articles 6 and 7).

The Nauru Agreement became the cornerstone for regional cooperation and enabled subsequent cooperative agreements to develop increasingly harmonised approaches to common fisheries that would extend beyond the limited membership of the PNA. Throughout 1982 and 1983, work began on negotiating the first of three implementing arrangements that would operationalise the treaty's objectives.

First Implementing Arrangement to the Nauru Agreement (1983)

The First Implementing Arrangement to the Nauru Agreement[15] was adopted in September 1983 and established agreed Harmonised Minimum Terms and Conditions for foreign fishing vessels (HMTCs). While these conditions were originally intended to only apply to PNA, the broader FFA endorsed a draft of the conditions during their negotiations and began a parallel initiative that quickly extended the application of the HMTCs to the entire FFA membership. The HMTCs harmonised licensing procedures and catch reporting and established a regional register of fishing vessels. Each Pacific island State is responsible for the implementation of these conditions at the national level.[16]

USA Multi-Lateral Treaty (1988)

In 1987, the FFA negotiated a multi-lateral fisheries treaty between its members and the USA that recognised coastal State rights over migratory fisheries and significantly increased benefits to Pacific islands States. The Treaty on Fisheries Between the Governments of Certain Pacific

[15] 1IA. (1983). Full title: An Arrangement Implementing the Nauru Agreement Setting Forth Minimum Terms and Conditions of Access to the Fisheries Zones of the Parties. Copy available in Appendix 2 of: Lodge. (1992). Minimum Terms and Conditions of Access: Responsible Fisheries Management Measures in the South Pacific Region. In Marine Policy. July 1992. pp 277-305.

[16] Aqorau, Transform. (2002). Cooperative Management of Shared Fish Stocks in the South Pacific. Paper Presented at the Norway-FAO Expert Consultation on the Management of Shared Fish Stocks - Bergen, Norway, 7-10 October 2002

Island States and the Government of the United States of America (USMLT)[17] commenced in 1988 and has since been renewed three times.

Wellington Convention (1989)

In 1989, various FFA members raised concerns regarding the environmental impacts of large-scale pelagic driftnet fishing on the high seas. In July 1989, the Pacific Islands Forum adopted the Tarawa Declaration and called on Japan and Taiwan to immediately abandon their driftnet operations in the South Pacific. This was quickly followed by the 1989 Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific (Wellington Convention).[18] The Convention banned the use of driftnets in the South Pacific and paved the way for a global moratorium on driftnet fishing on the high seas. Following the Wellington Convention, the UNGA subsequently adopted a series of resolutions to address driftnet fishing, eventually calling on all members of the international community to implement a global moratorium on all large-scale pelagic driftnet fishing on the high seas of the world's oceans and seas by December 1992. These FFA led initiatives largely resolved the problems of driftnet fishing in the south and equatorial Pacific Ocean, although some vessels continue to engage in large-scale high seas driftnet fishing in the North Pacific Ocean.

Second Implementing Arrangement to the Nauru Agreement (1991)

In April 1990, the PNA developed a second implementing arrangement following a significant increase in the number of vessels fishing in PNA waters. The Second Implementing Arrangement to the Nauru Agreement[19] came into affect in January 1991 and expanded the HMTCs to also incorporate observer requirements, prohibit transhipments at sea, expand monitoring and surveillance, and introduce an annual registration for the regional vessel register.

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[17] USMLT. (1988). Full title: Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America. Opened for signature April 2. 1987. Reprinted in 26. International Legal Materials. 1048. 1987.

[18] 1989 Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific (Wellington Convention). Available at http://untreaty.un.org/English/UNEP/driftnets_english.pdf Accessed online 2 March 2010.

[19] 2IA. (1991). Full title: A Second Arrangement Implementing the Nauru Agreement Setting Forth Additional Terms and Conditions of Access to the Fisheries Zones of the Parties. Copy available in Appendix 2 of: Lodge. (1992). Minimum Terms and Conditions of Access: Responsible Fisheries Management Measures in the South Pacific Region. In Marine Policy. July 1992. pp 277-305.

Simultaneously with the PNA, the FFA endorsed the expanded HMTCs and agreed that the conditions should be implemented throughout all FFA member's EEZs.

Subsequently, the FFA expanded the HMTCs for all FFA members to also include a centralised satellite based vessel monitoring system (VMS) that is operated by the FFA secretariat and forwards vessel positions to national officers to monitor.

Niue Treaty (1993)

In May 1993, the Niue Treaty on Co-operation in Fisheries Surveillance and Law Enforcement in the South Pacific Region[20] (Niue Treaty) entered into force and provided a framework for FFA member States to cooperate in surveillance and enforcement and share surveillance assets. The treaty is essentially an umbrella arrangement that supports the development of subsidiary agreements to implement surveillance and enforcement cooperation at the bi-lateral or sub-regional level.

There are now four subsidiary agreements in effect,[21] a further six awaiting government endorsement, and an increasing number of regular multi-lateral fisheries surveillance operations that include Niue Treaty members and non-members providing support (such as aerial surveillance).[22] FFA members are now considering the development of a multilateral subsidiary agreement and invoking Article XII(5) of the Niue Treaty to enable US and France to participate.

The FSM arrangement (1995)

Throughout the 1980s and 1990s, Pacific island States increasingly aspired to replace DWFN fleets with locally based domestic fleets. In response to these aspirations, PNA members established the FSM Arrangement for Regional Fisheries Access[23] (FSM Arrangement) in 1995.

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[20] Niue Treaty. (1993). The Niue Treaty on Co-operation in Fisheries Surveillance and Law Enforcement in the South Pacific Region. Reprinted in Commonwealth Law Bulletin. 702. 1993. 32. International Legal Materials.

[21] Federated States of Micronesia, Palau and Marshall Islands: Australia and Papua New Guinea: Tonga and Tuvalu: Samoa and Cook Islands.

[22] For example: Operations Bigeye and Island Chief in Micronesia: Operations Kurukuru and Tui Moana in Polynesia: and Operation Rai Balang between Palau and the Federated States of Micronesia.

[23] FSM Arrangement. (1995). FSM Arrangement for Regional Fisheries Access. Accessed online 11 March 2009. http://www.ffa.int/node/30#attachments

The Arrangement further elaborated the Nauru Agreement's objectives of supporting local development and promoting PNA vessels over DWFN vessels. In this regard, the FSM Arrangement provided for lower cost licenses and access to the waters of all PNA States for domestic and locally based vessels that met specific criteria.

Palau Arrangement (1995) and Vessel Day Scheme (2007)

During the late 1980s and early 1990s, the PNA became increasingly concerned at the rapid expansion of the purse seine fishery and its potential impact on the long term sustainability of the WCPO tuna fisheries. In light of these concerns, PNA initiated discussions in 1990 to develop arrangements that might limit purse seine numbers within the PNA sub-region. During these discussions, PNA agreed to introduce interim limits on how many purse seine vessels they would license to fish in their collective EEZs while negotiating a more comprehensive arrangement to limit purse seine fishing across all PNA EEZs. In 1993, the PNA concluded negotiations and signed the legally binding Palau Arrangement for the Management of the Purse Seine Fishery in the Western and Central Pacific[24] (Palau Arrangement) which subsequently entered into force in 1995. Prior to the establishment of the WCPFC, the Palau Arrangement was the only mechanism available to control purse seine fishing effort in the WCPO.

The Palau Arrangement aims to protect tuna stocks from overfishing and improve the economic benefits to PNA from access fees and fisheries development. It primarily does this through limiting the licenses available to fish within the PNA EEZs (therefore limiting catches and hopefully increasing prices) and enabling further cooperation in management of the purse seine fisheries between PNA. Given its exclusive coastal State membership, the scope of the Arrangement was effectively limited to EEZs. However, significantly, the preamble to the arrangement did emphasise the special interest of coastal States in tuna in adjacent high seas areas.

Until 2007, the Palau Arrangement limited licenses through establishing a cap on purse seine vessels. However, while the vessel cap of 205 remained stable, the vessel cap became increasingly seen as a blunt and not particularly effective tool at promoting conservation and development interests. In response, the PNA reviewed the vessel cap and agreed to introduce a limit on the number of purse seine days. Vessel days could be sold in such a way as to maximise

[24] Palau Arrangement. (1995). The Palau Arrangement for the Management of the Purse Seine Fishery in the Western and Central Pacific. Accessed online 10 March 2009 at http://www.ffa.int/node/91#attachments

economic returns and would introduce greater fleet flexibility and better enable conservation outcomes.

In December 2007, the PNA commenced operation of the Vessel Day Scheme (VDS) which aims to constrain catches to sustainable levels and increase benefits from fishing activities through access fees paid by DWFNs. The VDS replaces the broad purse seine vessel number cap with a set number of days that can be fished in the combined EEZs of the PNA. Vessel days are then allocated to each PNA. A key objective of the VDS is to create competition between DWFN vessels to purchase fishing days at the maximum price. As the VDS has been introduced, allocations have been made for vessels that fish within the FSM Arrangement and the USMLT.

Western and Central Pacific Fisheries Commission (2004)

In 1994, the FFA hosted a multi-lateral high level conference of Pacific island States and DWFN on the future management and conservation of straddling and highly migratory fisheries within the WCPO. This meeting agreed on the need to co-operatively and sustainably manage WCPO tuna resources across their entire range.

This was followed by six further conferences until negotiations concluded in 2000 with the successful adoption of the Western and Central Pacific Fisheries Convention [25] (WCPF Convention, 2000) which subsequently entered into force in July 2004. The objective of the WCPF Convention, as described in Article 2, is to ensure the long term conservation and sustainable use of WCPO straddling and highly migratory fish stocks in accordance with the 1982 Convention (LOSC) and the Agreement (UNFSA). The Convention establishes the decision making Western and Central Pacific Fisheries Commission (WCPFC), which meets annually, and a secretariat which is headquartered in the Federated States of Micronesia.

The Pacific island States are a critical membership bloc of the WCPFC and were a key driver behind its development. Other WCPFC members include (amongst others) Indonesia, Philippines and the DWFNs: Japan, Korea, China, Taiwan, USA and the European Community. The WCPF Convention binds these members to implement its provisions and WCPFC conservation and management measures. Since its establishment in 2004, the WCPFC has agreed on a number of conservation measures that impose specific obligations on all members.

[25] WCPF Convention. (2000). Full title: is Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. Signed September 2000. Honolulu, USA. Entered into force, 2004. Accessed online 10 July 2006 at http://www.wcpfc.int/

The WCPFC closely follows the framework established by the United Nations Fish Stocks Agreement [26] and emphasises a precautionary and ecosystem based approach to fisheries management. The WCPF Convention applies to all waters of the WCPO, including both high seas and EEZs. However, the WCPF Convention clearly states in Article 4 that nothing in the Convention shall prejudice the rights, jurisdiction and duties of States under the LOSC and UNFSA, and that the WCPFC shall be interpreted and applied in the context of, and in a manner consistent with the LOSC and UNFSA. This is a critical point for Pacific island States given their heavy dependence upon the fishery and aspirations for development, and their sovereign rights over much of the fishery within their EEZs.

Article 7 further recognises the special needs of small island developing States and requires members of the Commission to give due consideration to the respective capacities of developing coastal States, in particular small island developing States, to apply WCPFC provisions within areas under national jurisdiction and their need for assistance as provided for in the Convention.

Since its establishment in 2004, the WCPFC has adopted a number of binding conservation and management measures. Members and co-operating non-members are obliged to implement these members in accordance with their commitments to the WCPFC. Some of the key issues addressed by conservation and management measures include:[27]

- Record of fishing vessels and authorisation to fish. Only vessels on the WCPFC record that are authorised appropriately are allowed to fish in the WCPO tuna fisheries;
- Establishment of procedures, obligations and responsibilities for cooperating non-members who wish to participate in the WCPO tuna fisheries;
- Transhipment regulations prohibit transhipments by purse seine vessels and restrict all other at-sea transhipments to exceptional circumstances. In port transhipments must abide by detailed monitoring and reporting requirements;
- Prohibition on the use of large scale driftnets;
- Establishment of a Regional Observer Scheme. Fishing vessels must carry an observere from an accredited programme in accordance with the measure's requirements;

[26] UNFSA. (1995). Full title is Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Stocks and Highly Migratory Fish Stocks. Signed December 1995. New York, USA. Entered into force 2001. Accessed online April 2005 at http://www.un.org/Depts/los/convention_agreements/convention_overview_fish_stocks.htm

[27] All WCPFC Conservation and Management Measures can be downloaded from: www.wcpfc.int

- Establishment of a satellite based centralised vessel monitoring system. All tuna fishing vessels must report to the WCPFC VMS when fishing for tuna on the high seas within the Convention area. ensure that all vessels registered to Kiribati and authorised to fish on the high seas are required to report to the WCPFC VMS in accordance with specific requirements;
- Establishment of a list of vessels presumed to have carried out illegal, unreported and unregulated (IUU) fishing activities in the WCPO. Provides for vessels to listed if found to be involved in IUU fishing. IUU listed vessels are prohibited from further fishing or any fishing related activity until the violation has been satisfactorily addressed;
- Establishment of procedures for boarding and inspections of fishing vessels on the high seas by foreign government patrol vessels;
- Conservation and management to mitigate the impact Seabird bycatch;
- Conservation and management to mitigate the impact of Sea Turtle bycatch;
- Conservation and management for Striped Marlin;
- Conservation and management for Swordfish;
- Conservation and management for Sharks;
- Conservation and management for Pacific Bluefin Tuna;
- Conservation and management for North Pacific Albacore;
- Conservation and management for South Pacific Albacore;
- Conservation and management for Bigeye and Yellowfin tuna.

The key conservation and management issue that is most seriously challenging the WCPFC is the high impact of overfishing on bigeye tuna stocks. The WCPFC has adopted three conservation and management measures (2005, 2006 and 2008) to halt overfishing, but each has failed to adequately reduce mortality of bigeye and limit fishing impacts to sustainable levels. The 2008 conservation and management measure (CMM 2008-01)[28] replaced the 2005 and 2006 measures and was intended to ensure, through compatible measures for the high seas and EEZs, that bigeye and yellowfin are maintained at levels capable of producing maximum sustainably yield (MSY). The measure described a packed of measures for high seas and EEZs that were intended to reduce mortality of bigeye by 30% from 2001-2004 average levels. The measure included the following provisions:

- Phased 30% reduction of longline bigeye catch of 2001-2004 levels by 1/1/2012;
- Limits on purse seine effort in EEZs and high seas to 2001-2004 levels;

[28] WCPFC CCM 2008-01 (2008). Conservation and Management Measure for Bigeye and Yellowfin Tuna in the Western and Central Pacific Ocean. Accessed online 4 April 2009 at www.wcpfc.int

- Closure of two high seas pockets;
- Annual 3 month prohibitions on purse seine sets on FADs;
- Encouragement for archipelagic States to ensure measure is not undermined through transfer of effort into archipelagic waters and territorial seas;
- Limits on other commercial fisheries catching bigeye to 2001-2004 levels.

However, in 2009 the SPC Oceanic Fisheries Programme (WCPFC science provider) presented two papers[29] to the WCPFC which found that the 2008 measure was highly unlikely to achieve its objective of a 30% reduction in bigeye fishing mortality or maintain bigeye stocks at levels capable of producing MSY over long term. This was due to the limited effectiveness of the FAD prohibition and the high seas pocket closure, increases in purse seine effort allowed under various exemptions (resulting in 30% increase over 2001-2004 levels), increases in purse seine catchability, and the lack of application to archipelagic waters.[30]

SPC's Oceanic Fisheries Programme provided modelling results on the conservation actions required to meet the WCPFC MSY commitments for bigeye. In order to halt overfishing for bigeye and maintain the stock at levels capable of producing, the modelling suggested that the WCPFC would have to reduce the use of fish aggregating devices (FADs) by purse seiners by 80%, reduce longline catch of bigeye by 50% and reduce fishing effort for bigeye in Indonesia and the Philippines.[31]

In response, the 2009 meeting of the WCPFC discussed possible amendments to the measure to strengthen its effectiveness. Some delegations pushed for additional measures (i.e additional high seas closures), others pushed for weakening or postponing measures (i.e high seas closure) and various delegations pushed for replacement of some measures (i.e FAD closures) with other measures (i.e seasonal closures on all purse seine fishing). Ultimately,
WCPFC 2009 was unable to reach any agreement and CMM2008-01 continued unamended.

[29] WCPFC 6-2009/IP17 (2009) Assessment of the Potential Implications of Application of CMM 2008-01 for Bigeye and Yellowfin Tuna. Paper prepared by SPC-OFP. WCPFC 6-2009/IP18 (2009) Further Consideration of CMM 2008-01 With Respect to Bigeye Tuna. Paper prepared by SPC-OFP.
[30] WCPFC Summary Report (2009).
[31] OFP-SPC (2009). Powerpoint Presentation to WCPFC. CMM 2008-01 Evaluation.

Conclusion

The past 30 years has demonstrated a remarkable level of cooperation in the Pacific islands region that has substantially increased the capacity of the region to manage their fisheries and successfully negotiate with far more powerful DWFNs – most particularly the USA and Japan.

However, the capability and effectiveness of the FFA, PNA and the WCPFC will be heavily tested over the coming years as these bodies come under increasing pressure to significantly reduce catches and vessel numbers in response to over-fishing and over-capacity concerns.

In order to achieve conservation and development objectives, the region will need to significantly strengthen WCPFC conservation measures and develop strong monitoring, control and surveillance tools to ensure compliance. To achieve these goals, the WCPFC will have to develop creative strategies that recognise the sovereignty of coastal States over their archipelagic waters and allow for the negotiation of some form of compensatory arrangement that motivates these States to reduce fishing effort within their waters. Without such compensatory arrangement, it is hard to see why a coastal State would implement costly fisheries reductions on its own fisheries when it is under no specific legal obligation to do so. Particularly given that it will receive little or no benefit as most benefits will migrate out of their waters and into neighbouring EEZs and high seas.

Even if these issues were resolved and the WCPFC successfully came to consensus on a strong package of conservation measures, implementation is a critical challenge.

Pacific island States, Indonesia and the Philippines all suffer from significant institutional capacity limitation that undermine their ability to implement fisheries management within waters under their national jurisdiction. As discussed in the author's 2009 paper, a concerted capacity building strategy is required to support national implementation.[32]

Furthermore, implementation by DWFN has also historically been weak and high levels of illegal, unreported and unregulated (IUU) fishing are continuing to present significant challenges. In the period 2000-2003, the catch taken by IUU fishers was estimated to be valued at between 63 billion and 139 billion yen from the WCPO tuna fisheries. [33]

[32] Hanich, Q. (2009).

[33] Agnew DJ, Pearce J, Pramod G, Peatman T, Watson R, et al. (2009) Estimating the Worldwide Extent of Illegal Fishing. PLoS ONE 4(2): e4570. doi:10.1371/journal.pone.0004570

For Pacific island States, these problems are particularly challenging in regard to ensuring compliance by DWFN vessels with fisheries regulations and licensing conditions, especially in the vitally important area of monitoring and reporting. Unfortunately, the history of DWFN vessel compliance with reporting obligations has been poor with high levels of misreporting. In 2009, the FFA MCS Strategy study – 'Safeguarding the Stocks' noted that the majority of IUU fishing in the Pacific islands region was associated with licensed vessels and identified underreporting and misreporting of catch as a key compliance concern.[34] The study recommended that the improvement of catch monitoring was critical to the achievement of FFA regional fisheries goals.

Misreporting is a form of fraud where licensed vessels intentionally understate catches for financial gain (similar to tax evasion). In the short term, misreporting effectively steals benefits from Pacific island States and undermines their ability to assess the value and status of their fisheries. Even where fees are paid in lump sums per vessel, or per day, misreporting steadily erodes the perceived value of that vessel or day and undermines future negotiations over fee structures. In the medium to long term, misreporting undermines the quality of scientific advice and exacerbates the level of uncertainty that is inherent in fisheries management.

Given the high dependence of the region on fisheries resources for revenue and food security, it is vital that these regional collective institutions achieve their conservation, management and development goals and enable the Pacific island States to implement the institutional and governance programs necessary to conserve and develop the WCPO tuna fisheries.

[34] Soutar, D. Hanich, Q., Korsten, M., Jones, T., & McCaffrie, J. (2009) Safeguarding the Stocks: A report on analytical projects to support the development of a regional MCS strategy for Pacific oceanic fisheries; Pacific Islands Forum Fisheries Agency: Honiara, 2009.

International initiative for harmonized deep-sea mining in Pacific

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Abstract

Seafloor massive sulfides have been a subject of interest for profitable commercial mining these ten years. However, less information is available for both the baseline ecosystems in the distribution areas and the environmental impacts on them caused by the mining. Owing to growing concern for the global and local environments, the quantitative understanding of the environmental impacts, the systematic environmental assessment, and the effective control and regulation methods of seafloor massive sulfide mining must be clarified. A systematic approach necessary for the clarification is discussed. An example design of artificial impact experiment and the monitoring are introduced. An international initiative is proposed.

Keywords: Seafloor massive sulfide (SMS); Environmental impact; Environmental assessment; Seafloor ecosystem; Baseline survey; Impact experiment; Post experiment monitoring; Chemosynthetic community

Introduction

Seafloor massive sulfides (SMS), which include metals such as Au, Ag, Cu, Zn, and Pb, received much attention as one of deep-sea mineral resources (Lenoble, 2000). SMS are formed by hydrothermal processes associated with spreading centers of plate-tectonic activity (Rona, 1985). The geological characteristics of the ocean ridge type SMS found in the Atlantic, Indian, East Pacific, and Red Sea areas were studied by several researchers (Haymon and Kastner, 1981; Malahof, 1981; Hekinian et al., 1983; Rona et al., 1984; Hekinian and Bideau, 1985; Rona, 1985).

Since the first discovery in the Okinawa Trough near Japan (Halbach et al, 1989), in the western Pacific, the back-arc basin and oceanic island-arc types of SMS have been found. The typical examples are the Izu-Ogasawara Arc near Japan (Iizasa et al. 1999), in the Lau Basin and the North Fiji Basin near Fiji (Fouquet et al., 1991; Bendel et al, 1993), and in the East Manus Basin near Papua New Guinea (Kia and Lasark, 1999). Because of the higher Au, Ag, and Cu contents, they have received much attention as commercial mining targets by private companies (http://www.nautilusminerals.com; http://www.neptuneminerals.com).

Ecosystem around Hyfrothermal Process

Quite unique and large biomass ecosystem communities have been found around active hydrothermal processes (http://www.whoi.edu/oceanus/viewArticle.do?id=2420). They are *Beggiatoa*, *Calyptogena*, *Bathymodiolus*, tubeworms (*Riftia pachyptila*), amphipods, copepods, snails, shrimps, crabs, sea urchins, sponges, and fishes. They are called chemosynthetic communities. All SMS in the western Pacific mentioned above accompany with the active hydrothermal processes and the ecosystem communities. The primary productions in the ecosystem are sulfur oxidation using hydrogen sulfide supplied from the venting water and immobilization (Fenchel and Bernard 1995; Hessler and Kaharl, 1995; Micheli et al., 2002). Some of them are expected to be an important biological resources (Little and Vrijenhoek, 2003).

Mining Targets and Expected Impacts

Expected Mining Targets

Phases of hydrothermal processes for mineralization and ore body formation and the possibilities for mining targets are classified into five categories as schematically illustrated in Fig. 1. The active phase is categorized in under hydrothermal mineralization processes which generally accompany with large chemosynthetic communities. The ending active is under off-peak hydrothermal mineralization accompanying with some chemosynthetic communities, the exposed dead immediately finished the mineralization with no chemosynthesis, the partial exposed dead being under burial, and the buried dead the oldest with no surface outcrops, respectively. The primary targets of SMS mining are considered to be the exposed dead ore bodies from viewpoints of resource potentials and operation safeties.

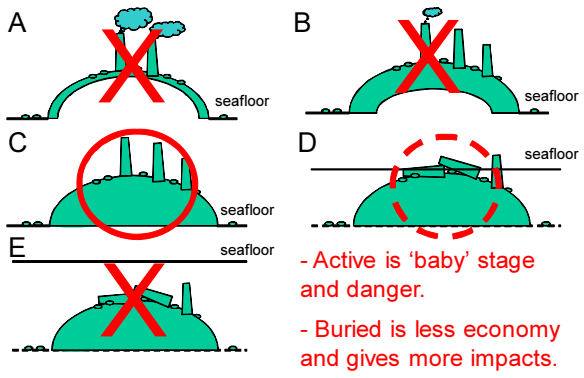

Figure. 1: Phases of hydrothermal processes, ore body formations, and possibilities for mining targets

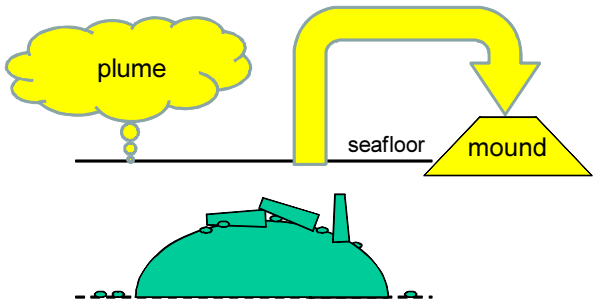

Figure. 2: Schematic view of overburden sediment removal before mining buried ore body

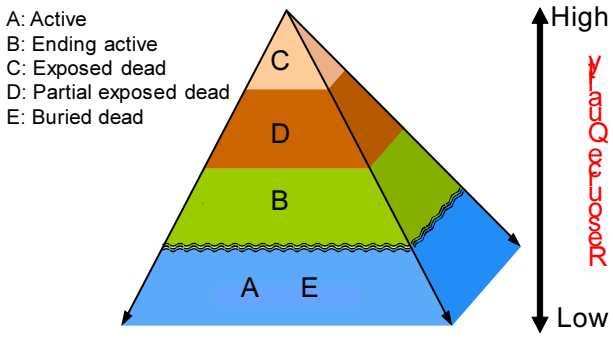

Figure. 3 Resource quality classification based on Fig. 1

The mineralization is under progress and less accumulation of sulfides is the general situation of the active. Keeping safe distance away from high temperature hot water for protecting the mining hardware is the other reason to select inactive ore bodies as the mining targets. Not only the active but also the ending active which accompany with the chemosynthetic communities are dangerous for the seafloor miner, because the vents have active hydrothermal flux routes through fissures and/or faults. High temperature water supply through the routes may be increased and/or induced with the excavation and removal of sulfide ore body. The miner's computer-based control and pressure-tight mechanisms are very weak against the high temperature even in the range of 40-50 ºC and higher. Avoiding direct contact with chemosynthetic communities is necessary for the safer mining operation. Therefore, the inactive ore bodies should be the primary targets of mining from this viewpoint, too.

The removal of overburden sediment layer before the mining of buried ore body causes a discharged sediment plume or a piled sediment mound as illustrated in Fig 2. They induce more environmental impacts or working capital costs for the mining venture. Both are not preferable situations. Therefore, the resource quality of the buried ore body is less than the exposed dead one. An example resource pyramid in case of SMS mining in general is shown in Fig. 3.

Expected Mining Impacts

Because of the geological formation mechanism of SMS, the exposed dead ore bodies are located adjacent to the active one as illustrated in Fig. 4. Transition ecosystem area affected by chemosynthetic communities is the biological situation of the mining target.

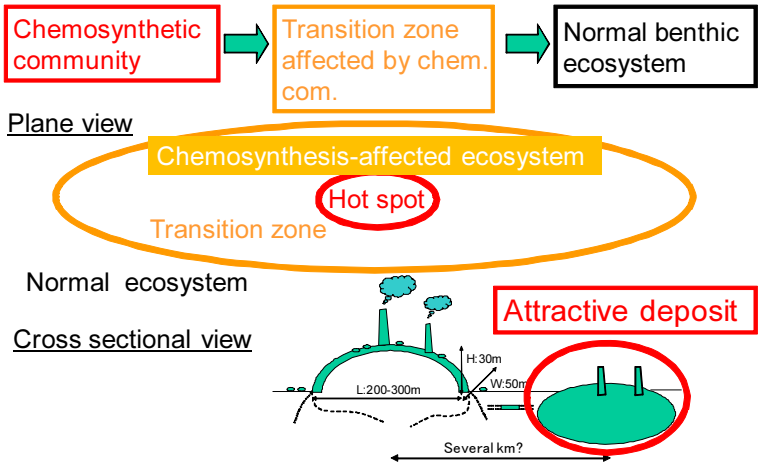

Figure. 4: Schematic relationship between active venting and mining target

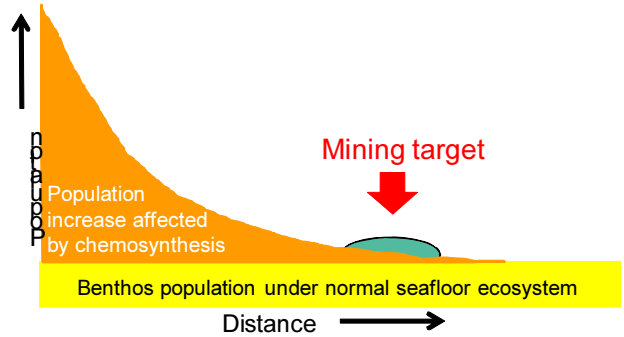

Figure. 5: Schematic image of biomass distribution between active hydrothermal venting and mining target

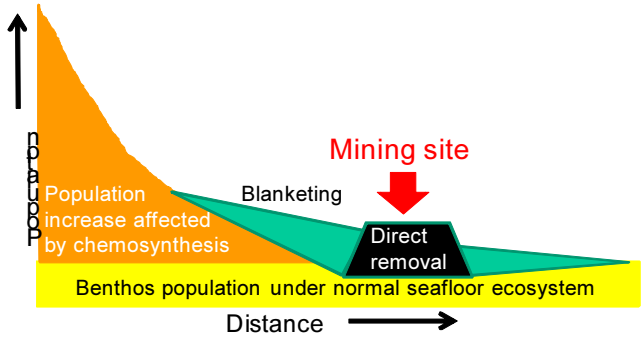

Figure. 6: Schematic image of environmental impacts caused by SMS mining

The additional primary production from the chemosynthesis causes the higher biomass around active hydrothermal venting than the one in normal deep-sea benthos population. Schematic image of biomass distribution around active hydrothermal venting and location of the mining target of SMS is introduced in Fig. 5.

Both a direct destruction and a blanketing on the ecosystems are expected as the important environmental impacts from the previous deep-sea artificial impact experiments (Yamazaki and Kajitani, 1999; Okubo and Yamazaki. 2003). The direct destruction of the ecosystem occurring on and in SMS ore body to be mined and the blanketing of the ecosystem in the surrounding area of SMS ore body with the resedimentation of fine particles separated from SMS ores are the expected environmental impacts on seafloor. The spatial image of the environmental impacts is introduced in Fig. 6.

Design of Artificial Impact Experiment

Important role of artificial small scale environmental impact experiment (e.g. mining test) and the post experiment monitoring has been widely recognized from previous researches related to manganese nodule mining on deep ocean floor (Schriever et al., 1997; Trueblood et al., 1997; Kotlinski and Tkatchenko, 1997; Desa, 1997). In case of SMS mining, it must be taken place at an ending active ore body, though it is slightly dangerous as mentioned already. Depending on the distance from the adjacent active vent and the mining site, the blanketing may reach the chemosynthetic communities around active site. Effects of a controlled blanketing on seafloor ecosystems including chemosynthetic community will be clarified from the monitoring results. The schematic image of the artificial impact experiment conducted at the ending active ore body is introduced in Fig. 7,

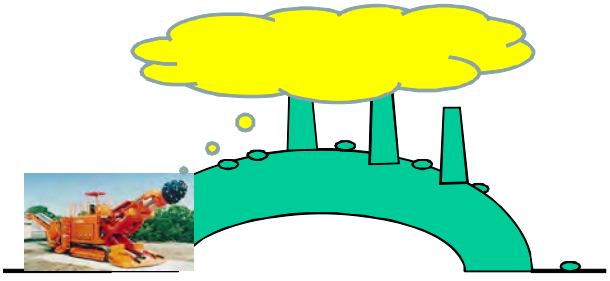

Figure. 7: Image of impact experiment at ending active site

Data and R&D Ecessary for Environmental Assessment

Because the chemosynthetic communities around hydrothermal vent are different from the normal seafloor ecosystem, the quantitative distribution and abundance data are necessary for baseline first of all. The ones of the chemosynthesis affected ecosystem are necessary, too. However, only many scientific and biological studies such as the chemosynthesis mechanism and DNA analyses are available in the literatures (Karl, 1995; Van Dover, 2000; Teske et al., 2003; Johnson and Mukhopadhyay, 2005; Nakagawa and Takai, 2009). Therefore, a baseline survey from the chemosynthetic community on the active hydrothermal vent near the mining target site, through the chemosynthesis affected ecosystem in the transition zone, to the normal ecosystem far away from the site are required. As already introduced by the authors, the continuous video image analysis of benthos biomass around the mining target site is one of effective method to obtain quantitative baseline data (Nakatani et al., 2009). In the analysis, the presence of bacteria mats and endosymbiotic shells was introduced as an important indicator of the chemosynthetic ecosystems, and the presence of other macro-benthos the chemosynthesis affected ecosystems, respectively. An example approach to quantify the biomass of bacteria mats was proposed, too.

It is necessary to clarify the approach at first with getting the higher resolution video records and the ground truth data by biological and geochemical sampling. Then, the application to the baseline survey becomes possible.

Following the baseline survey, the artificial impact experiment and the post experiment monitoring are necessary for deeper understanding the SMS mining impacts on seafloor ecosystem, as mentioned already. The video image analysis is also effective for the quantification of the monitoring results. In addition with the biological and physical phenomena, some chemical impacts on the ecosystem may occur, because SMS ore itself contains many heavy toxic metals (Arai et al., 2009). It is also must be clarified through the experiment and the monitoring.

On the basis of the understanding of the baseline and the monitoring results of the impact experiment, an environmental assessment technique which expects scaled up impact reactions of seafloor ecosystems including recolonization after the destruction and blanketing should be developed. It becomes an important tool to control and regulate the SMS mining activities.

International Initiative for Environmental Guidelines

Fortunately, we have time to prepare the environmental guidelines and the assessment techniques for SMS mining, because the economic crisis in 2008 has postponed the coming commercial mining (http://www.nautilusminerals.com). It is the timing to start a framework which creates effective control and regulation methods of SMS mining for the environmental protection.

The authors present the following two proposals to create the framework for the environmental guidelines of SMS mining.

- To join and collaborate with the environmental program in Japan's National SMS Development Project (in Japanese: http://www.kantei.go.jp/jp/singi/kaiyou/dai5/sankou1.pdf).
- To join and collaborate with the environmental program in the private company's commercial mining project (http://www.nautilusminerals.com)

An example time schedule is introduced in Fig. 8. In both the cases, an international initiative is necessary, because the preparation of the environmental guidelines and the assessment techniques are non-profitable task, but necessary for the environmental protection.

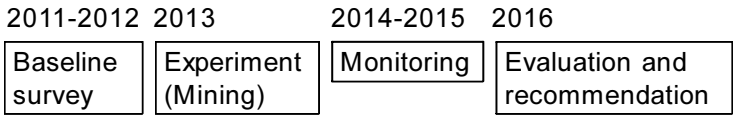

Figure. 8: Example time schedule of international initiative

Summary Remarks

Deep-sea mining has been a subject of interest for several groups and countries for over four decades, due to its potential for the economical recovery of large reserves of minerals that would provide an alternative resource of strategic metals for industrial development. The first target through 1960s to 1980s was manganese nodules lying on ocean floors at 4,000-6,000 m deep (Mero, 1965; Cronan, 1980). Then, secondary one in 1980s was cobalt-rich manganese crusts covering ocean seamounts at 1,000-2,500 m deep (Cronan, 1980; Manheim, 1986). Because the economic condition in 1990s was not good for the commercial mining, no actual deep-sea mining was realized. The third and current target in the last decade has been SMS depositing along seafloor spreading axes at 600-2,000 m deep. Because of the economic crisis in 2008, the commercial mining activities have been postponed. The recovery rate of metal market, however, is very quick and the activities are expected to re-start in a few years.

In the High Sea Areas defined by ANCLOS, all the mining activities are controlled and regulated by the International Seabed Authority. In the EEZs, the continental selves, and the terrestrial sea areas, each state has the responsibility to control and regulate the mining activities. Less information is available, however, for the environmental impacts of SMS mining and no effective method for the environmental assessment is provided. Owing to growing concern for the global and local environments, the quantitative understanding of the environmental impacts, the systematic environmental assessment, and the effective control and regulation methods of SMS mining must be clarified for the environmental protection. The problem is that no framework to collect sufficient information and to provide quantitative environmental

assessment method prior to the mining operation is available. An international initiative is one of the solutions of the problem.

Japan has learned many from the multi-disciplinary environmental studies (oceanography, geology, geochemistry, ecology and geotechnical engineering) in an ocean floor at 5,300 m deep (Yamazaki and Kajitani, 1999) and on a seamount at 2,200 m deep (Ohkubo and Yamazaki, 2003). Japan has a sufficient ability to satisfy the design criteria necessary for harmonized SMS mining with the environmental protection introduced in Fig. 9. In addition, Japan needs to chase the possibilities of SMS mining because of lack of on-land mineral resources for the industrial demands. Therefore, on the basis of collaboration with the Pacific countries and others, Japan should take a leadership for creating an international initiative framework.

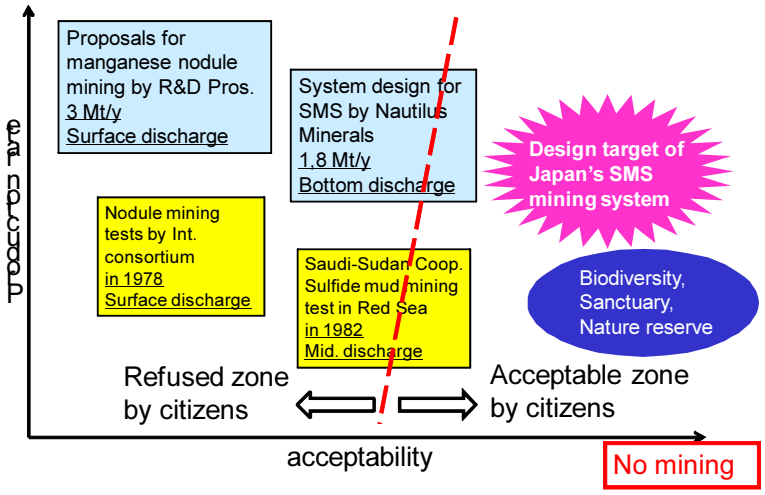

Figure. 9: Historical bench marks for acceptability versus economy in deep-sea mining

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Some Preliminary Remarks on International Legal Implications of Islands and EEZ Management

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UNCLOS and the Regime of Islands

The Third United Nations Conference on the Law of the Sea in 1973~1982 aimed originally at formulating international legal rules on islands in a much broader context than in the present Article 121 of UNCLOS. The subjects intended for discussion at the Conference relating to islands included not only the question on the legal qualification of islands for their maritime zones; namely, the question of whether or not an island is qualified to possess surrounding maritime zones including EEZ and continental shelf, but also the legal effect of islands in the demarcation of marine boundaries among neighboring states, and the legal status of islands under foreign domination. However, during the course of deliberation at the Conference, the latter two items were separated from the issue of islands regime. The item of archipelagoes was likewise treated separately from the beginning of the Conference, and was prescribed independently in "Part VI Archipelagic States". As a result, Art. 121 was the only survivor under the title of Part VIII "Regime of Islands", the scope of which became rather narrower in providing only with the aspect of the question on the legal qualification of islands for their maritime zone. The construction of Article 121 follows in essence, therefore, the traditional way of legal thinking as to whether a coastal state is entitled to possess surrounding maritime zones in the same way as other land territories. In this report, I intend to suggest the study of the regime of islands in much broader context, in the light of the later development of international order for the management and conservation of ocean space.

There has been much discussion among international lawyers on the interpretation of Art.121 of UNCLOS relating to the regime of islands. In particular, discussions have centered on the meanings of its para.3 introducing the new concepts of "human habitation", "economic life" or "rocks", as the paragraph provides that "rocks which cannot sustain human habitation or economic life of their own shall have no exclusive zone or continental shelf". Academic discussions have also referred to many other questions, such as those relating to the lawfulness of artificial strengthening of islands, the relation between para.1 concerning the legal definition of "island" and para.3 on "rocks", the legal status of "islands situated on atolls or islands having

fringing reefs", etc. It will be recalled that UNCLOS provisions on baselines for measuring the breadth of territorial sea from the seaward low-water line of the reefs in the case of islands on atolls or fringing reefs are based upon the proposal made by four South Pacific Islands States, i.e. Fiji, New Zealand, Tonga and West Samoa, although UNCLOS provisions and four states' proposal were slightly different in contents. It is not my intention to elucidate those points of issue here in this report; it will be enough here to say that, by introducing the terms like "human habitation", "economic life" and "rocks" lacking accuracy greatly as legal concepts in the context of islands, the interpretation of the provision as a whole are thrown into utmost confusion. Our OPRF Committee studied this article extensively, and reached to the conclusion that, taking into consideration the peculiar legislative history of para.3 in which UNCLOS failed to come to an actual agreement among opposing parties, further accumulation of states' practices together with coming academic theories and juridical judgments will be necessary for its proper application.

There has been also much discussion for the attempt to revise relevant rules of UNCLOS (e.g. baselines) to avoid or mitigate adverse effects of sea level rise on maritime zone claims. Not only this serious problem but also some other important issues (e.g., the development of micro-organism at the deep-seabed) which appeared and became an international issue after the adoption of UNCLOS are difficult to be solved properly within the present framework of UNCLOS. It seems unreasonable and unfair if an island loses at a single stroke its authority for surrounding maritime zones of EEZ or continental shelf, while the territorial competence was lawfully conferred under international law. Facing to the immediate situation where the state's land territory as the fabric of national life might be lost, law should be invoked to operate effectively to give relief to such an anomalous and urgent situation of *force majeure* . Similar problem may exist in the case of destruction of a small island by unlawful acts like terrorist activities. International society is now faced with a serious decision to modify existing rules or fill up the deficiencies of rules; elements of both "change" and "continuity" seem to be involved in legal consideration for the status of such sinking islands, since there is room for application of the principle of *rebus sic stantibus* and at the same time an island, whether inhabited or uninhabited, has had inseparably continuing historical ties in culture, politics and economy with the nation concerned to which the island belongs, as, for example, a base for various human activities for fishing, marine traffic safety and meteorological observations.

The Changing Structure of the Islands Regime

Before 200-mile exclusive fishing zones and EEZ regime were introduced, the geographical extent of maritime zones under coastal states' jurisdiction had comparatively narrow belts of sea, such as territorial sea, contiguous zones or fishing zones with the breadth of at most 12 miles in general, but today it became an issue to assign islands a proper place in relation to such a vast

ocean area as 200 mile EEZ and continental shelf. Nevertheless, the states' duty for managing marine environment was not so much pressed at the time of UNCLOS Conference as it is today. It is true that UNCLOS introduced many future-oriented rules and principles of the law of the sea, but it will be also recalled that another main mission of the Conference was to adjust various states' demands for maritime competences by means of political negotiation and compromise among participating states

On the other hand, however, after UNCLOS was adopted, many treaties and other international promises have been adopted mainly in the fields of fishery, marine environment, maritime crimes, so as to reinforce the so called the UNCLOS regime. Among these international documents, the Rio Declaration concerning "development and environment" adopted at the Earth Summit (UNCED) in 1992 was worthy of special mention, since the concept of "sustainable development" appeared on the stage at this Summit. In Chapter 17 of Agenda 21 adopted at the same time, it was pronounced and urged in its "objectives" that "coastal states *commit* themselves to integrated management and sustainable development of coastal areas and the marine environment under national jurisdiction": While the recommendation urges the *commitment* of coastal states for integrated management or governance of ocean space under their jurisdiction, there is now a wide support for the legitimacy and appropriateness of this direction: we need, therefore, re-examine the regime of islands in a much broader context of the emerging trend making a steady progress toward integrated ocean management (governance) as advocated in Agenda 21 and other international documents, In other words, we should look at the *raison d'etre* of islands in a contemporary perspective for their significant roles in managing and conserving marine environment "on behalf of international community ",which may be understood as a paradigm shift of the notion of "island regime".

Japan's Experiment for a New Island Regime

While, in the context of the object set for this symposium, problems such as ocean energy, wastes, disaster, atolls, reserves, ecosystem, information, etc. which were discussed here should be included in the new concept of islands regime, there is no reason to exclude the study of national regimes of islands in states other than Pacific island states, because of the universal nature involved inherently in the problems of the island regime.

In this connection, Japan's policy which was adopted recently for the management and preservation of islands may deserve to be introduced briefly. In Japan, there exist 6,852 islands in total which are divided into 5 mainland and remaining 6,847 islands called "*ritou*" (solitary islands) in Japanese. Islands called "*ritou*" are further divided into 422 inhabited islands and 6,425 uninhabited islands. In addition to the existing "Law for Revitalization of Islands", Japan adopted at the end of last year (2009) the basic plan (policy) for "*ritou*". This

policy was formulated in accordance with the “Basic Plan on Ocean Policy” of 2008 on the basis of the “Basic Ocean Act” of 2007. Chapter 2(10) of Part 2 of the Basic Plan of Ocean Policy relating to the preservation, etc. of islands specifies the measures for preservation and management of islands so as to secure maritime transport safety, support development and use of marine resources, preserve the natural environment in the surrounding marine zones, establish policies concerning preservation and management, together with measures for revitalization of islands. Along these contents of the Basic Plan of Ocean Policy, the “basic plan concerning how the preservation and management of islands should be for ocean management” was approved by the Headquarters for Ocean Policy of the Japanese Cabinet in December, last year. According to this basic plan, the following three roles of islands are emphasized: (1) the role of islands as the ground for Japanese jurisdiction to maritime zones of EEZ etc. (2) the role of islands as the base for supporting and promoting various activities in the extensive maritime zones, and (3) the role for succeeding the formation of abundant natural environment of ocean and the history and tradition formed by the relationship of man and ocean. The plan introduces then many concrete measures for these roles, incorporating also the system to promote measures and the dissemination and education to the Japanese nationals for preservation and management of islands. Professor Kagami has already explained on the content of the plan and its significance in more detail.

Thus, Japan, as one of the ocean island states, has newly formed a basic and comprehensive plan for the preservation and management of maritime zones of her *ritou* islands. Legislation for this plan will perhaps be made shortly. Being based on the experiences to be obtained in the course of implementing those policies, Japan is expected in the future to contribute to the formation and development of a new regime of islands.


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