APN/SURVAS/LOICZ Joint Conference on Coastal Impacts of Climate Change and Adaptation (APN2000-09)

FINAL REPORT

Project Leader:
Nobuo Mimura

Preface

APN/SURVAS/LOICZ Joint Conference on Coastal Impacts of Climate Change and Adaptation in the Asia-Pacific Region was held on November 14 to 16, 2000, at the APN Center in Kobe, Japan, under the auspices of the Organizing Committee of the Conference, the Asia-Pacific Network for Global Change Research(APN) and the Science Council of Japan. It is widely recognized that the Asian countries with low-lying deltas and coastal planes and small islands in the Pacific are particularly vulnerable to climate change and sea-level rise. However, the extent and degree of the vulnerability of the region and each country are still left unclear. The whole picture of the future threats is not determined yet either. Understanding of the vulnerability is a prerequisite for developing response strategies. Therefore, the conference aimed at bringing relevant researchers and policy-makers in this field to develop a comprehensive understanding on the present knowledge of the national and regional vulnerability and possible adaptation strategies. More than 60 participants from 20 countries and 5 international organizations attended the conference.

The joint conference was very successful. Such success has been brought about by the assistance, both financial and logistic, provided by the APN and APN Secretariat to the conference. I would like to extend my sincere thanks to them for their assistance and hard work.

This final report consists of the following contents.

- Agenda of the APN/SURVAS/LOICZ Joint Conference on Coastal Impacts of Climate Change and Adaptation in the Asia-Pacific Region
- Summary of Project
- List of Participants
- Abstracts of Presentations

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Summary of the Project

1. Funding

APN: US$ 75,000

Additional funds were provided by the Science Council of Japan and Asahi Glass Foundation

2. Participants were funded from the following countries

Australia, Bangladesh, Cambodia, China, Cook Islands, Federated States of Micronesia, Fiji, India, Indonesia, Japan, Korea, Malaysia, Nauru, Philippines, Samoa, Thailand, Vanuatu, Vietnam, SOPAC

3. Introduction/Background

The Asia and Pacific region has been recognized as a focus of the impacts of climate change and sea-level rise. However, the linkage between global climate change and societal impacts, and the feasibility of adaptation are poorly understood. It is also questioned how the present environmental problems and development practices are related to the future threats.

In order to respond to these questions, international initiatives have started. The *Synthesis and Upscaling of Sea-Level Rise Vulnerability Assessment Studies* (SURVAS) was proposed to synthesize and aggregate national vulnerability assessments and other pertinent studies by networking and workshop activities in Europe, Africa, the Americas, Asia and the Pacific. If such global network can be developed, it will significantly increase the knowledge base on coastal vulnerability and hence to support integrated assessments and policy development.

Another initiative is IGBP/LOICZ in Asia and the Pacific. Land-Ocean Interactions in the Coastal Zone(LOICZ) is a core project of IGBP. The Asia and Pacific LOICZ has focused on the economic and social impacts of global change on coastal system among other subjects. The Japanese IGBP Scientific Committee in the Science Council of Japan determined to host IGBP International Conference focusing on LOICZ in Japan.

APN/SURVAS/LOICZ Joint Conference on Coastal Impacts of Climate Change and Adaptation in the Asia-Pacific Region is planed to bring relevant researchers and policy-makers in this field to develop a comprehensive understanding on the present knowledge of the national and regional vulnerability to climate change and sea-level rise, and possible adaptation strategies. The conference is held on November 14-16, 2000, at the APN Center in Kobe, Japan, under the auspices of the Asia-Pacific Network for Global Change Research and the Science Council of Japan.

The concrete objectives of the Joint Conference are:

1) To synthesize and aggregate the country studies on the impacts of sea-level and climate change.
2) To examine the capacity and possible measures of adaptation to the coastal impacts in the region.
3) To share the results of country studies and IGBP/LOICZ studies in the Asia and Pacific region with other regions in the SURVAS project, to develop a global database for coastal vulnerability.
4) To enhance the network of the researchers in the region to promote the scientific cooperation for the capacity building and the policy making process in terms of the mitigation and adaptation of climate change.

4. Outline of activities conducted

APN/SURVAS/LOICZ Joint Conference on Coastal Impacts of Climate Change and Adaptation in the Asia-Pacific Region was held on November 14 to 16, 2000, at the APN Center in Kobe, Japan, under the auspices of the Organizing Committee of the Conference, the Asia-Pacific Network for Global Change Research(APN) and the Science Council of Japan. The Asia and Pacific region has been recognized as a focus of the impacts of climate change and sea-level rise. However, the linkage between global climate change and societal impacts, and the feasibility of adaptation are poorly understood. It is also questioned how the present environmental problems and development practices are related to the future threats. To answer such questions, the conference aimed at bringing relevant researchers and policy-makers in this field to develop a comprehensive understanding on the present knowledge of the national and regional vulnerability and possible adaptation strategies. The conference was attended by more than 60 participants from 20 countries and 5 international organizations.

The conference consists of three different themes. The first one was synthesis of the impacts of climate change and sea-level rise on the coastal. Country representatives presented summary of the assessment studies on the possible impacts and vulnerability of individual countries. Many countries in the region were revealed to be significantly vulnerable to the sea-level rise and changes in the cyclones and storm surges. Large cities in the low-lying coastal plains, such as Shanghai, Bangkok, Jakarta, Tokyo, Osaka will face future threats of inundation and flooding. Adverse effects of coastal erosion and saltwater intrusion on the land use, agriculture, and water resources are another problems for the deltaic areas. Small islands in the South Pacific are threatened by all these factors. Though the stage of the vulnerability study differs with countries, systematic and comprehensive studies are still needed in most countries to fully identify the vulnerable areas and sectors in each country.

The second theme was the present status and results of the IGBP/LOICZ studies. In this session, 23 presentations were made including 15 poster presentations. The subjects presented include the biogeomorphological effects of global warming, the Bay of Thailand Project, SEAWATCH Project in Indonesia, long-term sea level change during the Holocene in the Philippines, global mapping, salt water intrusion into rivers, and modelling of coastal erosion. A wide range of presentations activated discussions and communications among different disciplines.

The third theme was vulnerability and adaptation overview. Discussions in a plenary session pointed out the importance to perform accurate and comprehensive vulnerability assessment to set a firm basis for the adaptation planning. It was also emphasized that development of the integrated coastal management plan was important as a measure for the adaptation. International network and mutual exchange of information were recognized to be essential, and some countries like Japan were requested to take initiative to develop and maintain such activities.

On the next day of the Joint Conference, November 17, an open symposium for the public was held to introduce the results of the conference and the latest knowledge on the global warming and climate change. Over eighty of policy-makers, researchers, and the general public attended the symposium. Foreign participants pointed out the importance of such open symposium attached to the conference as a measure to promote people's awareness for these issues.

5. Outcomes/Products

Proceedings of the Joint Conference, which includes papers presented in the conference, will be published. SURVAS, Synthesis and Upscaling of Sea-Level Rise Vulnerability Assessment Studies, was proposed to synthesize and aggregate national vulnerability assessments and other pertinent studies by networking and workshop activities in Europe, Africa, the Americas, Asia and the Pacific. It also plans to organize the Global Synthesis Workshop of SURVAS to summarize the results of these conferences and workshops. The results of the present Joint Conference and its Proceedings will be submitted to the Global Synthesis Workshop to contribute to drawing a global picture of the impacts of climate change and sea-level rise.

6. Future directions/follow-up work

The regional and global synthesis achieved in this project is an important step to understand the vulnerability to climate change and sea-level rise. As a next step, more site-specific analysis of vulnerability is needed to develop the response strategies to future threats, i.e. adaptation to the warmer world. To this end, mutual exchanges of experience and results of such advanced vulnerability analysis through a network established by this project and SURVAS is a necessary future direction. This workshop also revealed that the stage of the vulnerability assessment is different among the countries in the region. Therefore, development of technical methods and its guidelines for the vulnerability and adaptation studies is another important task to help less advanced group of countries.

The APN/SURVAS/LOICZ Joint conference was very successful. Such success has been brought about by the assistance, both financial and logistic, provided by the APN and APN Secretariat to the conference. I would like to extend my sincere thanks to them for their assistance and hard work.

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(Kobe, Japan, 14-16 November 2000)

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APN/SURVAS/LOICZ Joint Conference
Coastal Impacts of Climate Change in the Asia-Pacific Region
Agenda

November 14 (Tue) 09:00-17:00

09:00-09:30	Registration
09:30-10:00	Opening Ryutaro Yatsu (Director, APN secretariat) Nobuyuki Yonekura (Science Council of Japan) Nobuo Mimura (Co-Chairperson)

[SURVAS Country Studies Session]

10:00-10:40 Keynote 1:	(Chair: Tetsuo Yanagi) Global Assessment of the Impact of Sea Level Rise-Overview of SURVAS Project Robert Nicholls (Middlesex University, UK)
10:40-11:00	Break

11:00-12:40
South & Southeast Asia (Chair: Ong Jin Eong, Masatomo Umitsu)

India	Diksha Aggarwal (Indian Institute of Technology)
Bangladesh	Anwar Ali (Bangladesh Space Research and Remote Sensing Organization)
Sri Lanka	Winston De Silva (Saviya Development Foundation)
Philippines	Rosa T. Perez (Weather and Flood Forecasting Center)
Indonesia	Puthut Samyahardja (Research Institute for Human Settlement Technologies)
12:40-13:40	Lunch

13:40-15:00
Southeast Asia (Chair: Anwar Ali, Yukihiro Hirai)

Thailand	Sripen Durongdej (Kasetsart University)
Vietnam	Nguyen Ngoc Huan (Hydrometeorological Service)
Malaysia	Ong Jin Eong (Universiti Sains Malaysia)
Cambodia	Peou Vanna (Climate Change National Technical Committee)
15:00-15:20	Break

15:20-17:00
East Asia & South Pacific (1) (Chair: Rosa T. Perez, Tamio Sekiguchi)

Japan	Haruyuki Kojima (Kyushu Kyoritsu University)
Korea	Dongchull Jeon (Korea Ocean Research and Development Institute)
China	Li Congxian (Tongji University)
Australia	Roger McLean (University of New South Wales)
Fiji	Leone Limalevu (Department of Environment)
18:30-	Reception

November 15 (Wed) 09:00-17:00

09:00-10:20 South Pacific (2)	(Chair: Hideyuki Kobayashi, Leone Limalevu)
Federated States of Micronesia	Henry Susaia (Ponphei State Environment Protection Agency)
Cook Islands	Pasha M. Carruthers (PICCAP Cook Islands)
Samoa	Violet Wulf (Department of Lands, Survey and Environment)
Vanuatu	Brian Phillips (Vanuatu Meteorological Services)
10:20-10:40	Break
10:40-11:40 South Pacific (3)	(Chair: Eiji Ohno, Brian Phillips)
Kiribati	Etuati Baranika (Ministry of Environment and Social Development)
Nauru	Tyrone Deiye (Mministry of Industry and Economic Development)
SOPAC	Russell J. Maharaj (SOPAC Secretariat)
11:40-13:00	Lunch

[LOICZ Session]

13:00-14:20	(Chair: Hiromune Yokoki)
Keynote 2:	LOICZ Activities in East and Southeast Asia Tetsuo Yanagi (Kyushu University, Japan)
Keynote 3:	Biogeomorphologic Responses to Environmental Changes in the Tropics Colin Woodroffe (University of Wollongong, Australia)
14:20-14:40	Break
14:40-15:40 LOICZ (1)	Poster Presentations (Chair: Yoshiki Saito, Vilma Dupra)
	A Multiple Approach to the Establishment of Sea Level and Paleoenvironment Changes during the Holocene in SW Bohol, Philippines R. D. Berdin (University of Philippines) et al.
	Short-term and Long-term Sea Level Changes in the Philippines F. P. Siringan (University of Philippines) et al.
	The Historic Environment Changes Inferred by Diatom Fossil Assemblages from Drilling Core Samples at Brackish Lagoons in Japan Kaoru Kashima (Kyushu University, Japan)
	Saline Water Intrusion at Estuary River Takao Tokuoka (Shimane University, Japan)
	Assessment of Impacts of Sea Level Rise on the Songkla Lake in South Thailand Yukihiro Hirai (Senshu University, Japan)
	Evaluations of Submarine Groundwater Discharge in the Coastal Zone Makoto Taniguchi (Nara University of Education, Japan)

Locality of Indonesian Coastal Cities and Approaches for Quantitative Evaluation of Possible Impact on Global Warming
Hideyuki Kobayashi (Building Research Institute, Japan)

Case Study on Impacts of Sea-Level Rise on Coastal Zone at Shichiri-Mihama Coast
Norimi Mizutani (Nagoya University, Japan) et al.

Technology Assessment of Coastal Protection System in the South Pacific Countries
Paulo Vanualailai (Ibaraki University, Fiji) et al.

Integration of Basic Geographic Data for Impact Assessment of Sea-Level Rise
MasayukiT Shimizu (Geographical Survey Institute, Japan) et al.

Three-Dimensional Beach Deformation Model for Nonlinear Multidirectional Waves
Hiroshi Kobayashi (Tokyo Electric Services Co. Ltd, Japan) et al.

Numerical Modeling of Ecological Response
Mitsuru Hayashi (Kobe University of Mercantile Marine, Japan)

Impacts of Sea Level Rise on Japanese Ports and Harbors (Poster only)
Keita Furukawa (Port and Harbor Research Institute, Japan)

15:40-17:00 APN/SURVAS/ Workshop for Filling SURVAS Common Tables
(Chair: Roger McLean, Nobuo Mimura and Robert Nicholls)
Poster Exhibitions (Parallel)

November 16 (Thu) 09:00-17:00

09:00-10:40
LOICZ (2) (Chair: Norimi Mizutani, Collin Woodroffe)

Biochemical Modeling in the LOICZ Project for East and Southeast Asia
Vilma Dupra (University of Hawaii, USA)

The Bay of Thailand Project
Anond Snidvongs (Chulalongkon University, Thailand)

SEAWATCH Project in Indonesia
Subandono Diposaptono (Agency for the Assessment and Application of Technology, Indonesia)

Response of Coral Reefs to Global Environmental Change
Hajime Kayanne (University of Tokyo, Japan)

Rapid Sea-Level Rise Due to Global Warming and Mangrove Forest Survivability
Toyohiko Miyagi (Tohoku Gakuin University, Japan) et al.

10:40-11:00 Break

11:00-12:40	
LOICZ (3)	(Chair: Hajime Kayanne, Anond Snidvongs)
	Current Issues of Deltaic Coasts in Southeast and East Asia Yoshiki Saito (Geological Survey, Japan)
	Geo-environment and Effect of Sea-Level Rise in the Chao Phraya Delta Masatomo Umitsu (Nagoya University, Japan)
	Economic Evaluation of Impact of Land Loss Due to Sea Level Rise Eiji Ohno (Meijo University, Japan)
	Analysis of Primary Production in the Seto Inland Sea, Japan, Using a Simple Ecosystem Model Toshiya Hashimoto (Hiroshima University, Japan) et al.
	Introduction to EMECS 2001 International EMECS Center (Japan)
12:40-13:40	Lunch

[Vulnerability and Adaptation Overview]

13:40-15:00	(Chair: Robert Nicholls)
Keynote 4:	Present Status of the IPCC Assessment Roger McLean (University of New South Wales, Australia)
Keynote 5:	Distribution of Vulnerability and Adaptation Strategies in the Asia and Pacific Region Nobuo Mimura (Ibaraki University, Japan)
15:00-15:20	Break
15:20-16:30	Plenary Synthesis Session (Chair: Nobuo Mimura, Tetsuo Yanagi)
16:30-17:00	Closing Roger McLean (University of New South Wales, Australia) Tetsuo Yanagi (Co-Chairperson)

APN/SURVAS/LOICZ JOINT CONFERENCE ON
COASTAL IMPACTS OF CLIMATE CHANGE AND
ADAPTATION IN THE ASIA-PACIFIC REGION

ABSTRACTS

14-16 November 2000
APN Center, Kobe, Japan

Organizing Committee of the Conference
Asia-Pacific Network for Global Environment Research
Science Council of Japan

DAY 1
MORNING

NOVEMBER 14

OVERVIEW OF THE SURVAS PROJECT

Robert J. Nicholls and Anne de la Vega-Leinert

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It is estimated that 21% of the world's population live within 30 km of a shoreline and these populations are both urbanising and growing more rapidly than global mean trends. At the same time, global sea levels are rising and this rise is expected to accelerate significantly during the 21st Century due to human-induced global warming. These adverse trends raise questions about the possible impacts and human responses to the likely changes from the sub-national to the global scale.

The 1998 Intergovernmental Panel on Climate Change (IPCC) regional review identifies our limited knowledge about vulnerability to sea-level rise at the regional scale. There are a number of sub-national and national scale assessments, but they have been developed with differing methodologies and goals, and different climate and socio-economic change scenarios. This raises fundamental questions which are pertinent to the United Nations Framework Convention on Climate Change (UNFCCC) about the ability of different nations and regions to adapt to sea-level rise (a regional-scale question), and about the relative need for climate-change mitigation versus adaptation (a global-scale question).

The SURVAS "(*Synthesis and Upscaling of Sea-Level Rise Vulnerability Assessment Studies*)" Project has been launched by a global network of coastal researchers with the aim of developing regional and global perspectives on the impacts of sea-level rise (see http://www.survas.mdx.ac.uk/). It is co-ordinated from London, but as the Web Page shows, it involves a global network of interested scientists. The common factor is an interest in furthering the practical understanding of sea-level rise. Major funding has been received from the European Union and the Asian Pacific Network.

The specific objectives of the SURVAS project are:

- To develop comprehensive guidelines for synthesis and aggregation of sea-level rise studies, including quality assurance;
- To apply the guidelines to assess the vulnerability of Europe, Africa, the Americas, and the Asian/Pacific to sea-level rise. This will be accomplished via four regional workshops and related activities;
- To synthesise and upscale these results to provide improved regional and global perspectives on vulnerability to sea-level;

- To develop standardised data sets in a metadatabase on coastal vulnerability suitable for regional and global assessment models of sea-level rise impacts and integrated assessment.
- To facilitate further exchange and co-operation at all levels, including establishing common rules/standards for further local/national case studies where this is useful.

The European Expert Workshop in June 2000 was a great success in terms of exchange and discussion of ideas, and the *Proceedings* is available on our Web Page. Additional data on impacts was also identified, but huge gaps remain to be filled. The lessons and SURVAS to date will be reported.

VULNERABILITY OF INDIAN COASTLINE TO SEA LEVEL RISE

Diksha Aggarwal and M. Lal

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Coastal tract of India has been an important cradle of culture and civilization for many centuries. It stretches about 7500 kms on the mainland and about 1256 kms along the two island territories. Most of the known geomorphological features of coastal zones and associated ecosystems are found along the vast Indian coastline. The deltaic regions along the Indian coast are highly productive and sustain large populations. The key ports and harbours located along the Indian coast are economic engines of national and international trade and commerce. Indian coastal and marine ecosystems are very rich in biodiversity. Over 80% of the 3560 km^2 area under mangroves in India is found along the east coast. India has been one of five key producers of fisheries and aquaculture in Asia during the recent years. Coral reefs play a crucial role in fishery production and in protecting the coastline from wave action and erosion.

Indian coastline has come under increasing human pressures e.g. overexploitation of marine resources, dumping of industrial and toxic wastes and oil spills and leaks due to extraction of offshore oil and gas in recent decades which have resulted in substantial damage to its ecosystem. Large scale sedimentation and organic accumulation in deltas have changed the nature of coastal profile as well as species composition. Severe coral bleaching events with high mortality of branching species have also occurred.

The impact of global warming-induced sea level rise due to thermal expansion of near-surface ocean water has great significance to India due to its extensive coastline. Sea level rise is likely to result in loss of land due to submergence of coastal low-lying areas, inland extension of saline intrusion and ground water contamination and may have wide economic, cultural and ecological repercussions. Observations suggest that the sea level has risen at a rate of about 2.5 mm per year along the Indian coastline since 1950s. A mean sea level rise of between 15 and 38 cm is projected by the mid-21st century along India's coast. Added to this, a 15% projected increase in intensity of tropical cyclones would significantly enhance the vulnerability of populations living in cyclone prone coastal regions of India. Higher sea surface temperatures are likely to cause massive damage to coral reefs and other ecosystems in Indian Seas. Other impacts include erosion hazards, industry and agriculture, tourism and human settlements. Given that many potential climate change impacts on India's coastal zone feature irreversible effects, surprise outcomes and unpredictable changes, the appropriate national policy response should maximize flexibility and enhance the resilience and adaptation potential of these areas.

VULNERABILITY OF BANGLADESH COASTAL REGION TO CLIMATE CHANGE WITH ADAPTATION OPTIONS

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Bangladesh is situated at the interface of two contrasting settings with the Bay of Bengal and the North Indian Ocean to the south and the Himalayas to the north. This gives the country the life giving monsoons, on one hand, and the catastrophic disasters like tropical cyclones, storm surges, floods, droughts and erosion, on the other. These disasters cause huge loss of lives and properties and impede the development activities.

While Bangladesh is already perspiring copiously with these disasters, in the foreseeable future, the country is likely to be affected by the biggest ever, long lasting and global scale human-made disaster, i.e. the climate change and the sea level rise (CCSLR). The geographical location, low and almost flat topography, very high population density, etc. have made Bangladesh one of the most vulnerable countries of the world to be affected by CCSLR. This is more so for the coastal area of the country. Because Bangladesh is not large in area, effects in the coastal area are likely to be felt by the whole country. In order to safeguard the country against such a disaster, it is imperative to know the disaster and its impending dangers beforehand.

With these ends in view, the paper discusses the vulnerability of Bangladesh to CCSLR and identifies some adaptation options. It starts with a brief introduction of the coastal characteristics of Bangladesh and a description of the economic importance of the area to the national development activities. Then it outlines the CCSLR scenarios for Bangladesh. The possible impacts of CCSLR on the coastal area are discussed drawing examples from the existing studies and efforts and applying the best judgment where necessary. The fields covered include impacts of CCSLR on tropical cyclones, storm surges, floods and inundation, back water effects, agriculture, forestry, fisheries, water resources, erosion, salinity intrusion, ecosystem and bio-diversity, economy and human health. The extent of discussions depends upon the availability of information and data as well as the extent of studies made so far in each field. Finally a few adaptation options are explored and discussed.

ASSESSMENT OF VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN THE PHILIPPINES COASTAL RESOURCES SECTOR

Rosa T. Perez

Natural Disaster Reduction Branch (NDRB)
Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), Department of Science and Technology

The Philippines is an archipelago with a total discontinuous coastline of 32,400 kilometers, the longest in the world. About 70% of the country's 1,500 towns and cities share the coast, deriving numerous benefits and opportunities offered by the coastal zone and near-shore areas. The natural systems support major economic activities such as coastal lowland farming, fishing and tourism, and provision of human settlements with essential life support and development opportunities. Coastal fishing accounts for 40 to 60% of the total fish catch and represents about 4% of the GNP. The country's coastal and marine resources are varied and diverse, providing food and employment to over one million Filipinos, half of whom are engaged in small-scale fishing. Fish and other marine products supply up to 70% of the total animal protein intake of the populace.

At present, approximately 50 million people live in the coastal areas and are at risk from the impacts of natural hazards and extreme climatic events, sea level changes and degradation of coastal and marine ecosystems. Being in the Pacific Rim, the Philippines is a hot spot for natural hazard occurrences. It is highly prone to storm surges and riverine flooding, caused by storms and other environmental degradation. This is due to the fact that an average of 20 tropical cyclones pass yearly through the Philippine area and about nine of them crossed land (CAB, 1995). Flooding usually occurs in the low-lying coastal areas, including most places in the Metropolitan Manila during heavy rains. Year to year climate variability affect greatly the amount of rainfall in the country. During El Niño, below average rainfall occur causing drought, thereby affecting fresh water quality and availability. Above average rainfall contribute to flooding during La Niña episodes. With climate change, it is foreseen that the Philippines coastal resources sector would be exposed to more frequent and more intense impacts of these phenomena. The situation under the present climate shows that the natural systems, which help protect marine and coastal resources, are already degraded by anthropogenic activities. Mangrove, which buffers the land from storm surges and the sea from land based sources of pollution, are being depleted. Uncontrolled or ill-conceived development schemes, over exploitation of living marine resources such as coral reefs and fishes, and impacts related to urbanization, tourism and agriculture, all contribute to the decreased resilience of coastal and marine ecosystems. . As a consequence of these existing stresses to the natural system, the vulnerability to sea level rise of the Philippine coastal resources and infrastructure increases constantly [Perez, et al., 1999], underscoring the need for an integrated framework to address these issues. The inadequacy of data and lack of either suitable information system or a coordinated institutional structure in managing coastal and marine resources compound the difficulties.

Present efforts could be made such as strengthening of disaster mitigation and preparedness to address the effects of present day climate variability. Institutional actions can also be done such as the passage or implementation of policies and regulation on habitation and construction away from hazard prone areas, such as riverbanks, shores and steep slopes. Selective protection like building dikes or sea walls should be constructed only after thorough cost-benefit studies. Retreat, (e.g., relocation of settlers), can be opted for highly vulnerable areas and conditions. Constant monitoring of changes in the climate and sea level therefore is a high priority. Information and education campaign to include government officials and the general public on climate change issues and concerns must be carried side by side with other initiatives. Possible adaptation planning should include studies of potential impacts of climate change to identify particularly vulnerable areas or regions. Identification of policy options for adaptation and appropriate capacity building among others may also be done to prepare for eventual sea level rise.

DATA SOURCE IDENTIFICATION ON INDONESIAN COASTAL CITIES FOR QUANTITATIVE EVALUATION OF GLOBAL WARMING STUDY

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ABSTRACT

- As an archipelago area, Indonesia has numbers of cities identified as coastal areas. It is the fact that some cities, especially in Java Island, have more developed than cities in other areas. However, since the administration of data base system is similar for the cities, the availability has slight different.
- The difficulties and processes of data collection are not comparable for each data sources. It is needed a special data arrangement for getting the suitable information.
- Secondary data collection techniques will be present for the purpose of coastal cities studies in Indonesia

DAY 1
AFTERNOON

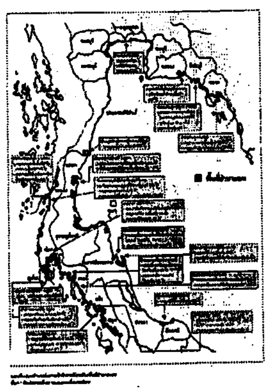
NOVEMBER 14

Land Use Changes in Coastal Areas of Thailand

Sripen Durongdej, Ph.D.
Kasetsart University, Thailand

Shoreline in Thailand

- Approximately 3,000 km.
- 24 provinces in central, eastern and southern regions – Andaman sea and gulf of Thailand
- Shortest length – 5 km. in Bangkok
- Longest length – 240 in Phang Nga



Mangrove Loss in 35 Years (1961-1996)

- 1961 – 2,299,375 rai or 0.71 % of total country area
- 1975 – 1,954,375 rai or 0.61 %
- 1996 – 1,047,390rai or 0.33 %
- Loss of mangrove in 35 years – approx. 10 million rai
- Loss of total forest in 35 years – approx. 88 million rai (1 rai = 0.0016 sq.km.)

Main Factors of the Loss

- Over cutting trees for fuel
- Road construction
- Increasing population
- Expanding industrial sector
- Mining in mangrove area
- Salt farming
- Confusing and conflicting government's policies
- Conversion to shrimp farming
- Calcification – loss of trees

Population and Shoreline Areas

- Total population along shoreline (collected from 19 provinces) – 4,096,984
- Total population of 24 provinces - 16,459,048 (as of 1997 data)
- Total shoreline areas (23 provinces) – 18,235 sq.km.
- Total shoreline distance – approx. 3,000 km.

(source: Office of Environmental Policy and Planning, 1998)

Government's Actions

- Cancellation of forest concession since 1996
- Conservation and reforestation - aims at 1 million rai of mangrove
- Controlling urban sprawl along shoreline
- Encouraging private sector in reforestation
- Decentralization
- Delineation reserved forest boundary
- Preparing action plans
- Decreasing numbers of solid wastes

VIETNAM COASTAL ZONE VULNERABILITY ASSESSMENT

Nguyen Ngoc Huan

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HMS of Vietnam

From November 1994 to April 1996 a Project had been conducted which assessed the flooding possibility and vulnerability of the entire Coastal Zone of Vietnam to the impacts of accelerated Sea Level Rise to Global warming and outlined the first towards Integrated Coastal Zone Management in Vietnam. The project was conducted according to the common Methodology recommended by the Intergovernmental Panel on the Climate Change(IPPC).

The project was executed by a Vietnamese project team working closely together with a European team of Polish and Dutch experts in coastal zone management. During the study extensive data on physical, socio-economic and institutional characteristics of the coastal zone formed the basic of GIS analyses with determined areas of different land use types inundated by various flood scenarios. Further analyses provided loss and risk figures for land use types, population and capital value: further development trends as well as institutional, organisational and legislative arrangements for coastal zone management were also reviewed and implications analysed.

People, capital value and habitats in the low lying areas of Vietnam were presently at high risk. The impacts of possible climate change will further aggravate the pressing situation. Appropriate measures need national and international cooperation.

The findings showed the high sensitivity of Vietnam to a rise in mean sea level which could severely impact development and growth. Vietnam's vulnerability was ranked as CRITICAL and costs of full protection measures were seen to be immense. Most sensitive areas, combining physical, socio-economic and environmental vulnerability are the Mekong and Red River Deltas, the Ho Chi Minh city-Vungtau area and the Hue- Da Nang area. Recommendations for increased momentum towards Integrated Coastal Zone Management have been made with associated actions to strengthen local capabilities for management.

MALAYSIAN REVIEW OF SEA-LEVEL CHANGE: VULNERABILITY AND ADAPTATIONS

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Malaysia, with a land area of some 330,000 km^2 and a coastline of some 4,800 km sits on the geologically stable Sunda Shelf. About half the coastline are beaches and slightly less than half is mangrove fringed; there is little rocky coasts. Geologically the coast on the Peninsula are oldest and the more jagged coast of Sabah, the youngest. It has been estimated that some 30% of the coastline is subject to varying degrees of erosion.

Sea level was some 120 metres below the present level during the last glacial (some 12,000 year BP) but rapidly rose to some 5 metres above the present level some 5,000 year BP before falling gradually to its present level. Thus over the last 5,000 or so years there has been a fall in sea level (a mean rate of about 1 mm per year) around the Malaysian coast. Unfortunately, there has not been any accurate enough measurements to show if this rate has changed in the past couple of hundred years (since the industrial revolution, when humans, through the burning of fossil fuels, have significantly increased the concentration of atmospheric carbon dioxide).

Its human population of 17.4 million (in 1989) is small for countries in the region but its population growth rate of some 2.2% (1989) is amongst the highest. Much of the population live along or close to the coasts. Although the human population is relatively small, development along the coasts and hinterland has been extensive. Extensive areas were harvested for timber or converted to rubber (and later to oil palm) and agriculture and alluvial tin mining was rampant (in the Peninsula). It must be noted that despite these activities some 210,000 km^2 of land was still under forest cover (with the an annual deforestation rate of around 2,200 km^2, for 1986 to 1990). Erosion is significant and may contribute to coastal sedimentations rates (in protected areas) of some 1 or 2 mm per annum. Many coastal area areas (especially where mangroves occur) have been bunded (to prevent saline or tidal intrusion) and reclaimed or have been raised above sea level by pumping in sand from the surrounding sea or from imported sand (sand is imported from Indonesia but sand was also exported to Singapore).

There is generally no feeling of vulnerability to sea level rise as the geological evidence show that Malaysia may not be (for the time being, at least) vulnerable to sea-level rise. The major concern is coastal erosion but this would be a minor problem if development is not allowed to closed to the water's edge (but laws are there to be broken?).

Vulnerability of Cambodia's Coastal Zones

Peou Vanna
National Technical Committee.

bstract: With its current population of 12 million, Cambodia is still relatively "rich" in some natural resources, e.g. forests, productive agricultural land as well as inland and Coastal fisheries. Cambodia is highly vulnerable to the impacts of Climate Change. Our agricultural production system is dependen on the annual flooding and recession of Tonle Sap lake, and is therefor ~~particul~~ ~~by~~ particularly sensitive to potential changes in local climate and monsoon regimes. Because much of the country is at low elevation, large part of the Mekong river flood plain could be also affected by rising sea leve

VULNERABILITY AND ADAPTATION TO SEA LEVEL RISE IN JAPAN

Haruyuki Kojima

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Introduction

The Japanese land stretches from latitude 20° 24' to 45° 30' and mainly faces the Pacific and Sea of Japan in the east and the west, respectively. Japan has over 34,000km of coastline and approximately 4.5million square km of ocean within its territorial sea. The majority of the population and economic activities in Japan are concentrated in coastal zones in three main bays, namely Tokyo Bay, Ise Bay and Osaka Bay. Coastal municipalities hold about 46% of the total population of approximately 124millions. Demands on coastal and marine resources have been constantly increasing, and as coastal areas become more developed, the vulnerability of human settlements to typhoon, storm surges, and flooding events also increases. Sea level rise is anticipated to increase, with dramatic impacts in those regions where the vulnerability to these events already exists. This paper describes a general overview of national coastal conditions and trends, and reviews studies on vulnerability assessment to impacts of sea level rise on the Japanese coastal zone. Conceivable response strategies and adaptation technologies are also discussed.

Present situation and problems in the coastal zone of Japan

Several researches have been carried out to understand how much mean sea level changes have been taking place around the Japanese coast. It is found that the rate of the changes vary from –1.0mm/year to +5.0mm/year, the rising rate being high along the Pacific coast in the northeastem part of Japan. The lower rate of 0.6mm/year was found on Sea of Japan and East China Sea coast.

Due to weather and oceanic conditions, various coastal features exist such as sandy beach, gravel beach, rocky coast, cliff, mud flat, tide land, coral reef, and mangrove swamp. The sandy beaches, that occupy 24% of the total coastline, have been eroded significantly, and the beach erosion has already been recognized as a serious problem. With 43percent of the sandy beach coastlines being eroded, 41percent in stable condition, and only 6 percents accreting, approximately 120km^2 of coastal land area have been lost over the past 70years.

Most of the major cities and infrastructures supporting industrial production, power generation, transportation, fisheries, etc are located in the coastal zones. For example, marine transportation and fisheries have highly developed in Japan, with 1,100 commercial and industrial ports and 2,950 fishing ports. Land reclamation and artificial islands, amounting to 1,357km^2, have been constructed to obtain lands for industrial factories, power plant facilities, farming ground, and other development. As Japanese coastal zones are intensively used, they are always on the verge of suffering from natural disaster.

Vulnerability assessment of coastal zone to sea level rise

Various government sectors and university researchers have studied the comprehensive vulnerability assessment. The assessment studies include erosions of the sandy coastlines, hazard potential risk, impacts of storm surges on highly populated bays and protection costs of coastal infrastructures such as port facilities and coastal protection structures. Among these, one of the most significant impacts is aggravation of beach erosion. It has been estimated based on the Brunn Rule model that 56.6, 81.7 and 90.3% in area of the existing Japanese sandy beaches would be eroded due to sea-level rises of 30, 65 and 100cm, respectively. As a macroscopic analysis of the coastal vulnerability, area, population and amount of assets at risk by sea level rise and storm surges were calculated. Even under the present situation, 861km^2 of land is already located below high water level, where about 2million people live and 54 trillion JP yen worth assets exist. If 1m sea level rise occurs, the area at risk will expand to 2,339km^2, 2.7times of the present amount, and population at risk will also increase to 4.1million.

Responses to sea level rise and adaptation options

Adaptive strategies can be classified as "managed retreat", "accommodation" and "protection", which are comprised of a variety of options. The protection option consists of hard and soft technologies: dikes, seawalls, revetment as a hard one and beach nourishment, wetland restoration as a soft one. Among them protection is most widely applied in Japan because socio-economic activities are highly concentrated in the coastal zones. Although land-use planning in coastal zones, such as using building setbacks or allocating low-lying vulnerable lands to lower value uses (for example, parks rather than housing), will help reduce the overall vulnerability to sea level rise, such a measure has not been seriously considered. It is thus strongly recommended that sea level rise and climate change issues should be incorporated into broader integrated coastal management frameworks.

SEA LEVEL CHANGE AND COASTAL EROSION IN THE NORTH PACIFIC ISLANDS

Dongchull Jeon

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Time series and spectral distributions of relative sea levels are analyzed at the selected tide-gauge stations in the western and central North Pacific Between equator and about 30°N, in association with different time scales of motions. Coastal response to these sea-level dynamics is discussed in detail, based on the aerial photographs of shoreline changes.

Long-term trend of relative sea-level rise during the past several decades (+1 to +5 cm/decade at most of the tide-gauge stations) us primarily affected by the local tectonism such as volcanic loading, plate movement and reef evolution, and subduction at the plate boundaries. Secondary reason for sea-level rise is the thermal expansion of sea surface waters due to global warming by increasing greenhouse gases, which may be potentially more significant in the near future.

Interannual sea-level fluctuations, associated with ENSO (El Nino Southern Oscillation) phenomena, seem to be the primary factor to cause serious beach erosion. Mean annual cycle of sea level and alternate annual wave conditions are the main causes of the cross-shore oscillation of sediment transport, although there is still some loss of sediments to deeper-water region.

Short-term change of beach profiles is basically caused by incoming wave conditions as well as by sea-level heights, sediment characteristics, and underlying geology. Higher waves result in faster offshore transport and deeper depth of active profile change, and beach recovery process is usually much slower than erosion process, especially after a storm surge.

SOME PROBLEMS ON VULNERABILITY AND ADAPTATION ASSESSMENT IN THE COASTAL ZONE OF CHINA

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Abstract: Chinese coastline across tectonic subsidence and uplift belts. The coastal zones in the subsidence belts receive more than 90% of all river-borne sediments transported into the sea, with near 500,000 tons sediments per km-coastline, and that in uplift belts receive less than 10% of the total, with 70.000 tons per km-coastline. This leads to form wide coastal low lands with thick Quaternary strata in the subsidence belts. The wide coastal low lands are main vulnerable areas in China and thick Quaternary strata trigger surface subsidence in case of ground water withdrawal, which is an important component of local relative sea level rise.

Coastline of large deltas overall are progadated because of abundant river-borne sediments although local erosion has been reported. For instance, the Huanghe sediments are reduced down to 400 million tons per year in average during 1990s, covering about 33% of that in 1960s and 1970s. However, the Huanghe Delta is still growing. Overall erosion-accumulation balance will be achieved when the annual suspended load is less than 245 millions tons/a or the ratio of suspended load/ water discharge is close to 0.0145. So coastline propagation still is a main trend in the large deltas, such as Yangtze, Huanghe, Zhujiang Deltas. The coast progradation renews the wetlands in the large deltas and associated region and the tendency of coastal wetland migrating seaward will be continuous for a long period. It may be a natural adjustment of the coastal ecosystem. The reclamation of the tidal flat will accelerate the coastal-wetland seaward migration. The coastal plains in the uplift belts, composed of sandy deposits, suffer from underground intrusion of sea water due to ground water withdrawal and sea level rise. Both ground subsidence and underground sea water intrusion are triggered by overpumping of ground water and in turn result in serious environmental problems. They should be included in vulnerability assessment of the Chinese coastal zone. Erosional coastline covers 70% of Chinese total, however most of erosional coasts are usually resulted mainly from sediment-supply change directly and indirectly controlled by human activity and climate change.

The Chinese coastal zone is populous and building coastal infrastructure is a unique choice. Chinese coastline protected by infrastructures of various types is about 12000 km, covering 2/3 of the main land totals (18000 km). The more economic developing the stronger infrastructures, and so the infrastructures ensure safety in the protected coastal zone. For example, the strong tropical cyclone no. 9216 (30/08-01/09, 1992) landed and influenced 5 provinces and two cities (Shanghai and Tianjing), causing economic loss of $1.2 billion, but in Shanghai the economic loss tent to be zero because of strong infrastructures. Therefore, the infrastructure building is an important adaptation measure in Chinese coastal zones and must be considered, when assessing vulnerability and adaptation.

FIJI'S COASTAL VULNERABILITY AND ADAPTATION OPTIONS TO CLIMATE CHANGE

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Department of Environment, Fiji

Like other high islands throughout the Pacific, much of the population infrastructure and economic activity is located in the low-lying coastal fringe. As noted by Mimura and Nunn (1998), the concentration of human activities in the coastal fringe makes these islands as socially and economically susceptible to climate change and sea-level rise as low-lying atoll environments.

With respect to the coastal zone of the main island of Viti Levu, the prevailing trade winds and wave action in the windward and semi-protected areas have provided a natural mechanism for moderating the problems originating from the coastal activities. By contrast, the Nadi waters area on the lee side of the island has shown generalised coral reef mortality where poor circulation is thought to be a major contributing factor allowing unspecified pollutants to concentrate.

Anticipated impacts of climate change and sea level rise on the coast of Fiji include shoreline erosion (including loss of low-lying islands, atoll islands and beaches), inundation, increased storm damage and flooding, salinity intrusion into water tables and increased salinity of rivers and embayments, disappearance of wetlands, alteration of reef productivity and possible reef destruction.

Previous studies have noted that human impacts on the coastal zone of Fiji are characterised by the over-exploitation of marine resources, coastal pollution, diminished nutrient loading through intoxication and urbanisation, ref.. Ehler et. al.(1995). These have: reduced the resilience of coastal systems to cope with climate variability, thus increasing its vulnerability; affected the coastal system's adaptive capacity to climate change, sea level rise and human activities; and increased susceptibility of coastal population, infrastructure and property investments to natural hazards such as storm surges, tsunamis, flooding and sea level rise.

There is the need for adaptation technologies for assessment of the characteristics and vulnerabilities of Fiji's coastal systems to sea level change. This exercise is essential for the formulation of dynamic site and island-specific adaptation strategies. This includes instrumentation and monitoring systems. More detailed consideration and research needs to be focused on the growing problems in coastal areas, such as: mangrove habitat destruction; pollution arising from various land based sources; the stress on beaches from increased tourism; and the effect of coastal flooding with salt intrusion into ground water.

Practical actions to reduce the impacts are described in the paper. The various actions ranges from the formulation and implementation of such policies as coastal zoning to simple community activities, which are mainly aimed at increasing the resilience of the natural systems to the impacts of climate change. Crucial to implementing adaptation is government's role, in assisting the relevant stakeholders to undertake the necessary programmes. These include: creating an enabling policy and legal framework, strengthening institutions; supporting collaborative programs; and mobilising public action.

DAY 2
MORNING

NOVEMBER 15

SAMOA'S VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE & SEA LEVEL RISE

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About 70% of Samoa's population and infrastructure are located in the coastal area. This is a serious concern because nearly all coastal settlements in Samoa are located in low-lying areas. The rapidly increasing population, coupled with the fast pace of economic development activities, is stretching the productive capacity of the biophysical environment to its limits. Poorly planned tourism activities are also contributing to the deteriorating condition of the coastal environment. Other human activities such as sand mining and land reclamation are also inducing stresses on the coastal environment and marine resources. The impacts of Climate change and sea level rise are also contributing to a further exacerbation of these natural resources. Sea level rise is currently wiping some of the coastlines in Samoa due to erosion and inundation.

Samoa is committed to the objectives of the UNFCCC and the Kyoto Protocol and has taken actions to implement the UNFCCC objectives and aims. In addressing the CC and SLR issue, studies such as GHG Inventory and Vulnerability Assessment have been undertaken to provide the foundation for developing suitable and practical mitigation and adaptation strategies. A Coastal Hazard Zone Mapping done for the whole of Samoa (climate change and sea level rise oriented) has just been completed to identify vulnerable and hazardous areas. The Samoa government has taken another step forward by developing its first climate change policy, which is still in a draft form to combat the threat pose by Climate change and Sea Level Rise.

Samoa's adaptation strategies should take a no regret approach. The development of the climate change policy should facilitate implementations of appropriate and effective mitigation measures. It should place a high priority on managing the effects of environmental and social change within development planning and should support Integrated zone management plan, a suitable land management plan and effective environmental and social impact assessments on all development projects and plans. A well- strengthened Institution will be more appropriate to ensure that implementation of each policies are in placed, and this should be well addressed by the government and all stakeholders involved.

Samoa is among those countries that are most vulnerable to the impacts of climate change, although it does extremely little to instigate them. Nevertheless, Samoa needs to take prompt actions in identifying potential risks and areas of high vulnerabilities and to raise awareness about the need to adapt accordingly. At the same time mitigation measures must be developed and implemented to ensure that the impacts of climate change both human and the associated infrastructure and the biophysical environment are minimized.

PACIFIC ISLANDS AT RISK: FORESHORE DEVELOPMENT AND ITS IMPLICATION FOR VULNERABILITY AND DEVELOPMENT OF ADAPTATION STRATEGIES TO CLIMATE CHANGE

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The south and central Pacific Ocean is dotted with thousands of coral atoll islands, many of which are inhabited along narrow coastal strips and the foreshore and used for various socio-economic activities, ranging from port development to marine aggregate extraction. In this region which is serviced by the South Pacific Applied Geoscience Commission (SOPAC), there are sixteen (16) Small Island Developing States (SIDS), occupying a total land area of about 560,000 km^2, in an ocean space of about 26 Million km^2. These countries are the Cook Islands, the Federated States of Micronesia, Fiji Islands, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. Many of these SIDS consist of Pleistocene-Holocene coral atolls, which are geologically young, have low elevations above mean sea level, and are generally flat. Elevation generally ranges from 1-5m above mean sea level, and on many of these islands, it is possible to see from one side to the other. This makes these islands entirely coastal, in terms of systems interaction, their influence by the sea, their geographical disposition and their relative relief.

As a result of their location and small land area, which varies between 0.0028 to 14.81% of their surrounding maritime area, many Pacific SIDS are exposed to large-scale regional oceanographic and weather phenomena. This include annual cyclones and storms, which wreck havoc along these atoll island coasts, resulting in damage and destruction of property, agricultural land and constructed/infrastructure facilities. These also cause flooding, coastal erosion/land loss and in some cases, loss of life. The aerial coverage of many natural hazards, like cyclones, in Pacific Island Countries (PICs), are in many cases several orders of magnitude larger than the size of individual island systems, and consequently, are capable of engulfing entire island states. In the South Pacific, statistical data show up to 17 major cyclones, with wind speeds ☮ 120 kph, and up to 4 cyclones, with wind speeds ☮ 185 kph, affected the region between 1958-1994. Data for 1990-present, show another 63 cyclones affected the region, with 6,046 deaths, over 406,000 people affected and with damage costs in excess of US $807 Million.

However, modification of coastlines for human habitation and extensive foreshore developments, like dredging, mining aggregate, port and harbour construction, airport construction, coastal protection works and reclamation and fill, make coastal communities more exposed to the sea and vulnerable to coastal erosion, increasing the risk to communities and infrastructure. These risks are compounded with the possible threat of global warming and associated sea-level rise, projected by IPCC to rise by 20-86 cm in 2100, and in these low SIDS, can exacerbate coastal erosion and property damage. Consequently, coastal communities are vulnerable and face the possible threat to their very existence.

These natural events and human occupation of fragile coastal areas cause loss of scarce land, a culturally important and invaluable natural resource in many on these small and non-market oriented developing economies. With Pacific SIDS having an average poverty rate of 15%; GNP/capita between US $2,210 to ≤ $760; GNP from less than US $96 - $1,748 Million and external debt, as a % of GNP, as high as 56%, any loss of land and damage to infrastructure and facility can seriously impair national and regional economic development. This point was also highlighted in an Interim Report of a Joint World Bank/Commonwealth Secretariat Task Force on Small States: Meeting the Challenge in the Global Economy in 1999 and at the Commonwealth Heads of Government Meeting in 1999, Durban, South Africa. With country population (=coastal) growth as high as 4.2%, over the past decade, Pacific SIDS are therefore confronted with having to look towards development of appropriate coastal adaptation strategies for protecting their coastal communities and addressing these current and future development hurdles and the possible threat of sea level rise. For all south Pacific atoll communities, retreat (based on IPCC's definition) is not possible, while accommodation is currently limited. Therefore, protection and sound planning (for accommodation) are essential, for successfully addressing the possible threats to sea level rise. To that end, development of ICZM or Island System Management plans and composite bio-engineering protection systems, are essential for Pacific atoll environments.

This paper examines various aspects of coastal/island systems in the south Pacific region, regional foreshore development activities and current and future environmental problems, in relation to sea level rise. These are discussed in context of coastal vulnerability, and within the framework of development of coastal adaptation technologies to climate change and sea level rise in the region. Examples are presented from several Pacific SIDS, including Fiji Islands, Nauru, the Federated States of Micronesia, Kiribati, and Marshall Islands.

DAY 2
AFTERNOON
+
POSTERS

NOVEMBER 15

LOICZ ACTIVITIES IN EAST AND SOUTHEAST ASIS

Tetsuo YANAGI

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LOICZ (Land-Ocean Interactions in the Coastal Zone) is one of core projects of IGBP (International Geosphere-Biosphere Program) and was established in 1993 by ICSU (International Council of Science Union). The aim of LOICZ is to clarify the role of coastal zone in the global change and to forecast the future change in the coastal zone due to the global change.

LOICZ covers the study area in the coastal zone from 200 m high to 200 m deep. LOICZ has four foci, that is, 1) the effects of changes in external forcing or boundary conditions on coastal fluxes, 2) coastal biogeomorphology and sea level rise, 3) carbon fluxes and trace gas emissions, and 4) economic and social impacts of global change on coastal systems. The international project office of LOICZ is situated in NIOZ (Netherlands Institute for Sea Research)of Netherlands (loicz@nioz.nl)

In the East Asia and the Southeast Asia, LOICZ oriented study on the material flux in the East China Sea (MASFLEX) was carried out from 1992 to 1996 and it was clarified that the East China Sea plays a sink of atmospheric carbon dioxide. Moreover, the phosphorus and nitrogen fluxes were investigated in some coastal seas in East and Southeast Asia on the basis of LOICZ biogeochemical budgeting guideline and the coupled model of material flux and socioeconoims has been established in this area.

LOICZ will end up its study stage by 2004 and enter the synthesis stage, and will make a summary by 2009.

BIOGEOMORPHOLOGICAL RESPONSE OF TROPICAL COASTS TO ENVIRONMENTAL CHANGE

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The form or shape of sedimentary coasts and the nature and rates of operation of coastal processes are constantly changing, involving movement of sediment. In the tropics these coastal morphodynamic adjustments are influenced by biota, which can contribute directly to sediment production, but also play substantial roles in dissipation of wave energy or the frictional attenuation of water movement. In the case of coral reefs and mangrove shorelines the life history of prominent organisms may coincide with significant environmental changes. In order to understand the role of biota in shaping the coast it is important to recognise a hierarchy of scales in time and space, from stochastic or deterministic relationships at small scales, to contingent relationships at regional or geological scales. Coral reefs grow where conditions are favourable along a series of environmental gradients. However, they are subject to frequent disturbance to which a series of responses, including a phase shift, are possible. A change of state may be induced by external factors, such as climate or sea-level change, but may also occur as a result of intrinsic thresholds within the system. Anthropogenic changes to these coastal systems may be envisaged as a perturbation from which the system may recover, or an alteration in external conditions. Synergy between human impacts and other stresses makes it increasingly difficult to discriminate between natural adjustments and anthropogenically-induced chronic stress. It will be increasingly important to differentiate between these adjustments in order to understand or simulate coastal systems as a basis for effective coastal management.

LOICZ ACTIVITIES IN EAST AND SOUTHEAST ASIS

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A MULTIPLE APPROACH TO THE ESTABLISHMENT OF SEA LEVEL AND PALEOENVIRONMENTAL CHANGES DURING THE HOLOCENE IN SW BOHOL, PHILIPPINES

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Sea level changes during the Holocene in Bohol, a small island system in the Philippines, and their consequent environmental changes were determined using a multiple-method approach. The response of coastal environments to sea level changes was then established. Sediment cores, ranging from 5 to 17 m in length, were acquired using a manual mud corer in seven sites in SW Bohol. Sedimentological, geochemical (C and S contents) and foraminiferal analyses of sediment cores were performed to determine the marine limit and reconstruct paleo-sea levels below the present mean sea level. The relative timing of these events was based on the radiocarbon ages of peat and marine shells. Elevations of previous sea levels higher than present were measured from coastal geomorphic features such as tidal notches and beach ridges. Based on these proxy sea level indicators, a continuous rise of sea level from –13 m to –4 m occurred in the study area from ca. 8 kya to 6 kya followed by a slow rise until about 5 kya. This slowing of sea level rise led to the establishment of mangroves in the area. A rapid rise ensued raising sea level to 0.6 m above the present mean sea level as indicated by tidal notches along the adjacent cliffed coasts. A *Porites* coral located at an altitude of 0.5 m along the adjacent reef flat associated with the tidal notch gave a U-Th age of 4.87 kya. This sea level high stillstand which caused the widespread progradation of the mangrove may have lasted until about 2.5 kya. Another rapid rise, indicated by a 3-m thick carbonate beach deposit above the present mean sea level, occurred in the area. This was followed by a sea level fall to the present position and the subsequent in-filling of channels and the re-establishment of the mangroves to its present position.

SHORT-TERM AND LONG-TERM SEA LEVEL CHANGES IN THE PHILIPPINES

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Short-term (few tens of years) and long-term (a few thousands of years) changes in sea level are established by examining tidal gauge records and geomorphic indicators in selected sites in the Philippines. Tidal gauge stations with at least 30 years of record and the emergence of well pipes are examined for the former. Tidal notches and uplifted marine terraces coupled with radiocarbon and 230Th/234U age dating was used in estimating paleo-mean sea levels for the latter. In both time scales, the direction and magnitude of sea level change are variable, even for adjacent coastal segments. Local geology explains these variations best. Tidal gauge at South Harbor in Manila Bay registers the highest rate of relative sea level rise of 2.35 cm from 1963 to 1980. In the adjacent delta region, 3 to 4 cm of yearly subsidence was documented based on the emergence of groundwater well pipes.

The rapid rates of sea level rise in the delta plain and in the South Harbor are mainly attributed to ground water withdrawal. In delta plain regions, ground subsidence is further indicated by increased incidence of flooding during high tide and conversion of farmlands to fishponds. Uplift or relative sea level fall is typically observed in regions undergoing tectonic compression such as along the northwest coast of Luzon where paleo-mean sea levels more than 1 meter higher than the present and with ages ranging approximately from 5 to 8 ky are documented. Zones where tectonic divergence is presently occurring display paleo-mean sea levels closer to the present. Overall, the short-term and long term trends of changes in sea level in the Philippines are consistent with each other and best explained by the local geology.

THE HISTORIC ENVIRONMENTAL CHANGES INFERRED BY DIATOM FOSSIL ASSEMBLAGES FROM DRILLING CORE SAMPLES AT BRACKISH LAGOONS IN JAPAN

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Maintaining the quality of natural resources in enclosed coastal seas and lagoons is rapidly becoming an environmental issue of the 1990s. Has the quality changed as a result of anthropogenic activity or as a result of naturally occurring environmental changes, such as climatic change? What was the timing, rate, and extent of environmental change, and how can we infer these aspects? However long-term monitoring data of their environment of high quality and quantity usually do not extend back more than a few centuries, and for many regions the historical record is much shorter. Palaeo-oceanographical studies using biological remains and chemical components in undisturbed sediment cores taken from lake bottoms can provide quantitative reconstructions of their environments for thousands years.

Diatoms are very small single-celled algae, and are abundant world-wide in all aquatic environment. They are good indicators for environmental assessments. Diatom cells are usually well preserved well in sediments because they are composed of resistant opaline silica. Diatom species have narrow optima and tolerances for many environmental variables, which make them exceptionally useful in quantifying environmental characteristics to a high degree of certainty. Therefore, distribution of diatoms preserved in sediment cores can provide a high resolution records of the aquatic environmental change of coastal lagoons.

Lake Shinji and Lake Nakaumi are estuarine lagoons located along the coast of the Japan Sea. Two small waterways (Ohashikawa waterway and Sakai waterway) link the two lakes with the sea. A unique aquatic ecosystem under brackish conditions have seen maintained for many years at the two lakes with salinities in the surface waters ranging about 5-10 permil at Lake Shinji, and 20 - 25 permil at Lake Nakaumi.

Diatom analysis of a 65cm-long (SJ89-1) at Lake Shinji showed that a series of oscillations between fresh, brackish and marine episodes has happened during the past 500 years. The lowest part of the core samples (pre 500 years BP) was characterized by marine water taxa, such as Grammatophora spp. and Nitzschia spp. These marine water species were abruptly replaced 500 years ago (14C method) by Aulacoseira granulata and other fresh water species indicating low saline until 50 years ago (by 210Pb method). After then, a marked increase in the brackish planktonic taxon Cyclotella caspia has happened, and the salinity of lake water has increased again.

On the other hand, two 150 cm long cores were taken at the central and eastern part of Lake Nakaumi. The abundant taxa from the core samples were Cyclotella caspia , Thalassionema nitzschioides, Fragilaria flavovirens ,Thalassiosira spp., Paralia sulcata and Cocconeis scutellum. The former five taxa were marine-brackish species very common in the plankton of many brackish lagoons and common in the present Lake Nakaumi. Cocconeis scutellum was benthic species common in present coast of Lake Nakaumi. The diatom assemblages have hardly changed since 1500 years ago dated by 14C method until now.

SALINE WATER INTRUSION AT ESTUARY RIVER
A CASE STUDY AT R. GONOKAWA, SHIMANE PREF., JAPAN

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Since 1992, our group has been developing new observation instruments for wide area and long-term measurements using ultrasonic waves, optical fiber temperature sensors, high-precise salinity and temperature sensors, etc., and has been carrying out the observation. The salt water (the high-salinity water) and the fresh water (the low-salinity water) are not easily mixed because of the density difference between them, and a halocline where the salinity rapidly changes is developed at the boundary of both waters. Reflections similar to a fish finder detecting fish are generated at this boundary, when ultrasonic wave is put in the brackish water. This is because an acoustic impedance (density x acoustic velocity) of the water also changes suddenly at the halocline. It is possible to examine distribution of the halocline and the thickness of the salt water layer using this measurement principle. In this way, the following were produced: "Underwater acoustic reflection profiling system for survey of halocline" and "Underwater acoustic reflection measurement system for long-term observation of halocline behavior".

Not only the salinity but also the temperature varies from salt water to fresh water. It means that we can estimate the salinity of water by measuring of water temperature. And it is possible to detect the flow of fresh and salt waters, if the water temperature is continuously measured on the bottom. "Thermometry system using optical fiber distributed temperature sensor" and "CT multi-sensor temperature salinity measurement system" are based on this principle, and they observe distribution and movement of the salt water mass. The measurement systems are, (1) An acoustic reflection profiling system for spatial distribution survey of halocline(Model SC-3), (2) An underwater acoustic reflection measurement systems for long-term observation of halocline behavior(On-line model, Model SC-2 ; Off-line model, Model CL-3), (3) A thermometry system using optical fiber distributed temperature sensor(Model DTS-80), (4) A temperature salinity measurement system using multiple CT sensors (Model MCTH-2).

Since 1997, the observation of saline wedge (saline intrusion along the bottom of river) has been performed at the lower stream of River Gonokawa of Shimane Prefecture. The final target is to establish the monitoring system to detect the sea level rise and its effect, because the effect of sea surface elevation by global warming appears at the very beginning in such tidal rivers. R. Gonokawa facing to the Japan Sea is the longest river in Chugoku Region and is well known as one of the typical tidal rivers because of largeness of water amount and narrow tidal level (about 20cm). Usually, saline water intrusion occurs in less than several kilometers and in dry season when the amount of outflowing water is less than 30m3/sec, it can attain to 8.2km point where a small mount is existed, interrupting invasion of saline water into upstreams. Historically it has been known that saline intrusion can attain up to 11.2km point when water amount decrease in less than 20m3/sec. Our observations have clarified the relationship between saline invasion limit and the amount of out flowing water is represented in a regression line.

ASSESSMENT OF IMPACTS OF SEA LEVEL RISE ON THE SONGKHLA LAKE IN SOUTH THAILAND

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Purpose of this study

The purpose of this study is to assess the impacts of sea level rise on coastal lagoons in Asian countries. A case study is done in the Songkhla Lake basin in south Thailand in this time.

Methodology

At first the author collected the data on physical and human conditions. And the characteristics of both natural and socioeconomic systems are delineated. The data on natural system is arranged from geomorphological and hydrological viewpoints. In the same way, the data on socioeconomic system is analyzed in relation to the land use pattern and water use conditions. Then the study area is divided into some homogeneous zones through integration of the data on natural and socioeconomic systems. After that, development factors in each zone is identified and the impacts of sea level rise will be estimated.

Classification of lacustrine lowlands in the Songkhla Lake basin

Lacustrine lowlands of the Songkhla Lake can be divided into following four zones; (a) beach ridge plain, (b) sand spit of Songkhla City area, (c)western coast of Thale Luang, and (d) deltaic lowlands of Thale Sap Songkhla. And the development factors of each zone are identified.

Assessment of impacts of sea level rise

According to the characteristics of both natural and socioeconomic systems and the development factors in each zones, some serious impacts will be estimated as follows when the sea level rises about 1m in future;

(1) In the beach ridge plain, coastal erosion will become more severely, especially where large-scale shrimp farming developed along the present coast will affected critically by the retreat of the shoreline.

(2)The area of Songkhla City should be protected by higher or stronger seawall against the severe coastal erosion.

(3)The channel linked the lake and the Gulf of Thailand will become bigger than present one because of the erosion of the north end of the spit. Then the groundwater in the littoral lowlands will be affected by the increase in salinity of the lake water.

(4) In the deltaic lowland of Thale Sap Songkhla, wide littoral area will be inundated. So the lacustrine lowlands newly covered with urban facilities, should be protected from severe floods or long-term inundation.

EVALUATIONS OF SUBMARINE GROUNDWATER DISCHARGE IN THE COASTAL ZONE

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Submarine groundwater discharge (SGD) in the coastal zone is now recognized as a potentially significant material pathway from the land to the ocean. Sea level change may alter the SGD rate and pathway resulting the change in material transports to the coastal zone. The process of SGD is evaluated in this study from the following perspectives: (i) the global water cycle; (ii) assessment of the magnitude of the process via direct measurements, modeling and calculation: (iii) spatial and temporal variations of SGD; and (iv) importance to the nutrient budgets of coastal waters. A worldwide compilation of observed SGD estimates shows that groundwater seepage from the land to the ocean occurs on a continental scale and it may include recirculated seawater. Direct measurements of SGD by seepage meters and piezometers in local areas may be scaled up to a regional basis by use of natural geochemical and geophysical tracers. Water balance estimates, although useful for rough estimates, are usually not very precise because the uncertainties in the various terms used to construct the balance are often on the same order as the groundwater discharge being evaluated. Groundwater flux (velocity) measurements are usually appropriate for smaller-scale studies, such as where seepage meters and piezometers are used, while volumetric discharge estimates are more appropriate for regional-scale investigations. Estimates of SGD via analytical and numerical methods depend mainly on the evaluations of the thickness of the aquifers and representative hydraulic conductivities. Unfortunately, it is usually difficult to obtain well-constrained values for these parameters except in very well-studied areas. The first intercalibration on the evaluation of SGD had been made using different methods including direct measurements by seepage meters and piezometers, tracers, and modeling in Gulf of Mexico, Florida on August, 2000. The second intercalibration on SGD will be held in Perth, Australia on November, 2000. Some results of the first intercalibration on SGD, results observed at Tannowa, Osaka, Japan, and a research plan for the second intercalibration will be also presented in the poster session.

LOCALITY OF INDONESIAN COASTAL CITIES AND APPROACHES FOR QUANTITATIVE EVALUATION OF POSSIBLE IMPACT OF GLABAL WARMING

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ABSTRACT

- Brief look at urbanization and housing conditions in Indonesian local cities, ,Jakarta, Palembang, Ujung Pandang, Banjarmasin, Ambon etc.
- Method of flood statistics in Japan, and applicability to Asia-Pacific coastal cities
  Household survey after flood.
  Correlation between depth of water and economic damage of houses.
  Number of houses and households in relation to contours.

CASE STUDY ON IMPACTS OF SEA-LEVEL RISE ON COASTAL ZONE AT SHICHIRI-MIHAMA COAST

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This paper is intended to discuss impacts of sea-level rise, which is one of the exposures of the global warming, on coastal zone and provide fundamental data for assemble adaptation technique. Shichiri-mihama coast, southern part of Mie Prefecture, Japan, has been chosen as a coast of case study. First, present situation of Shichiri-mihama coast has been investigated. Then, impacts of sea-level rise on this coast have been discussed and evaluated, assuming various values of sea-level rise.

The wave run-up height on the coastal dike has been found to increase much more than the amount of sea-level rise (see Fig.1). In particular, the increase of wave run-up height is obvious at beach where the erosion is significant. This indicates that it is very important to protect the beach from the erosion to minimize the effect of the sea-level rise on the coastal zone.

As far as the sediment transport rate is concerned, it has been found that it will increase as the sea-level rises because of increasing wave height, which is one expected exposure of the global warming. Moreover, the sea-level rise is considered to decrease the amount of sediment supply to the beach from the river. These two facts give negative impacts on the beach because the source of the sediment to the beach may reduce but transport rate may increase.

Thus, it has been found that the impacts of sea-level rise are very significant and may cause sever damages and it has been confirmed that the beach protection from erosion at present moment is very important to reduce the effects of sea level rise.

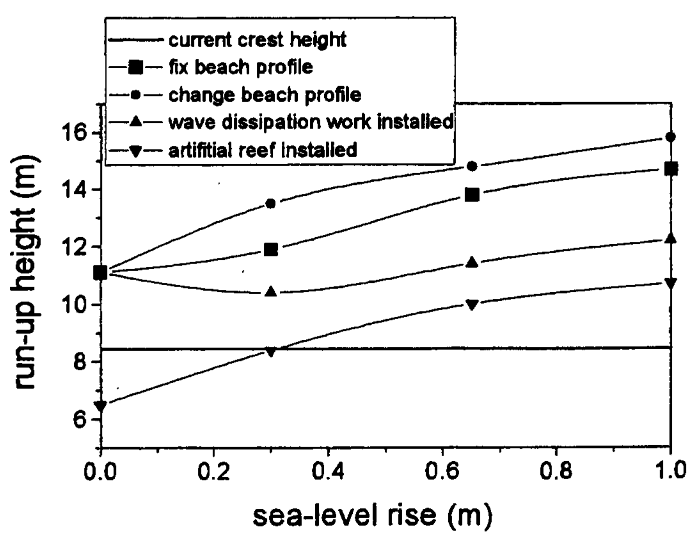

Fig.1 Wave run-up height change of coastal dike due to sea-level rise

TECHNOLOGY ASSESSMENT FOR COASTAL PROTECTION SYSTEM IN THE SOUTH PACIFIC COUNTRIES[1]

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Introduction and Objective

Fiji and other neighboring South Pacific Island's coastal protection structures (CPS's) and problems associated with their designs, appropriateness and utilization, have been extensively studied from various viewpoints. However practical counter measures and mitigation options in response to constraints and problems associated with these structures in relation to associated natural disasters that often plague low-lying areas of the region such as effects of sea-level rise and other natural phenomena are often vague and not well addressed. The objective of this report therefore is to; i) review past practices of coastal systems and identify major constraints of their effectiveness ii) suggest relevant system/structures for such constraints and to; iii) develop guidelines/criteria for assessment of existing technology as to implement appropriate technology in response to these constraints (Mimura & Nunn 1998).

Background

Fiji and other South Pacific Countries have to a large extent similar types of coastal defense system, which included hard and soft structures. For hard structures, (SOPAC[2], 1992) they are dykes, vertical seawalls, revetments, groines, gabions and small concrete cubes, coastal protection units (CPU's), artificial breakwater and causeways. Included also are Traditional method of hand placed rock seawalls (HPR's) in which beachrock are extensively used, (Sherwood 1994) as well as materials such as 44gallons drum filled with concrete, old tires, used electrical poles, coral boulders, and coconut trunks. Soft structures, includes mangrove planting, gravel, sand, soil and other locally existing materials available for coastal protection purposes and sand for beach replenishment. Moreover revegetation of coastal vegetation, preservation of reef environment and development of setback strategy are also applied practices.

Major Problems/Constraints

The following are mostly the recurring and commonly known problems in the region. They include, "scarped backfill, collapsed seawalls, subsidence of backfill, leaning of seawalls, overtopping, scoured base and sand depletion" (Sherwood 1994). Poor foundations, little or no firm material binding, and poor designs renders coastal systems very vulnerable to natural disasters such as hurricanes, storm surge, wave overtopping, erosion and flooding (Mimura & Nunn 1998). Sapped base and mass movement of fill (Solomon & Kruger 1996) are also recurring problems.

EnTA Preparation

In response to the above problems and constraints the following procedure and approach is attempted to assess technology in the region (see figure 1 below).

Conclusion

The study though focussed from civil engineering perspective, it tries as well to include social, political and economic issues that are integral part of the mitigation options in the region.

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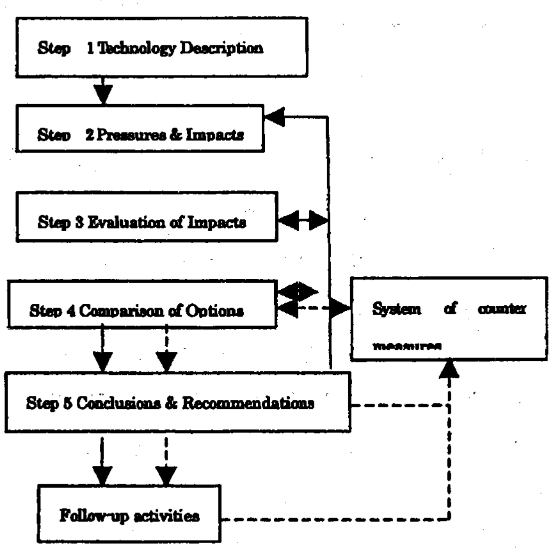

Fig.1. UNEP's EnTA Preparation Model & CZM System of Countermeasures (Hay & Noonan 2000)

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1. Fiji, W.Samoa, Kiribati, Cooks, Tonga, Tuvalu, FSM, Niue, Solomons, Marshall, PNG, New Caledonia, Guam and Vanuatu
2. South Pacific Geoscience Commission

INTEGRATION OF BASIC GEOGRAPHIC DATA FOR IMPACTS ASSESSMENT OF SEA-LEVEL RISE

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In general, existing various digital geographic data which are produced by national organizations and/or private sectors, have adapted different fundamental elements and formats individually. As establishing a study which has very wide test-site area such as Asia-Pacific region, researchers will collide of discrepancy of geographic data integration from aforementioned reasons. Still more, geodetic coordinate system and reference ellipsoid differences also make hazard to integration.

In this study, we selected de-fact standard formats or opened data format for geographic data, and to adopt WGS84 for geodetic coordinate system, ArcView shape-file format for vector data and TIFF format for raster image data.

On the other hand, detail altitude data is necessary for to grasp the primary impacts of sea-level rise influence in coastal zone. Existing major globally covered digital elevation data (DEM) such as GTOPO 30, ETOPO 5 and DTED are evaluated. However, it is clear that those DEM data have not enough accuracy for this study.

Therefore, TIN-modeling method is applied to creation for detailed DEM of part of test-site area by using ground altitude value of GPS survey.

THREE-DIMENSIONAL BEACH DEFORMATION MODEL FOR NONLINEAR MULTI-DIRECTIONAL WAVES

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INTRODUCTION

Global warming will have various impacts in the coastal area not only through sea-level rise but also through wave climate change. Among the impacts, coastal erosion will be accelerated severely. Therefore, prediction of beach deformation is one of the most important subjects to be studied. The accuracy of a beach evolution model is enhanced by improving the accuracy in the hydrodynamic model as well as in the sand transport model. In recent years, numerical models have been developed intensively in the field of nonlinear dispersive waves in the surf zone. The progress on sand transport models has also been made through a series of elaborate laboratory experiments in oscillatory flow tanks. Comprehensive models are proposed for sand transport under nonlinear velocity variations with various degrees of asymmetry and atiltness. Based on these progresses, a numerical model of three-dimensional beach evolution is developed in the present study by combining the improved nonlinear wave model with the sand transport model. The model is applicable to a wide range of nonlinear multi-directional wave fields.

NUMERICAL MODEL

Waves and currents were computed on the basis of the improved Boussinesq equations derived by Nwogu (1993). The energy dissipation due to wave breaking was modeled by introducing the eddy viscosity. A series of random waves with directional spreading was given at the incident wave boundary.

The net sand transport rate was calculated using the model proposed by Dibajnia and Watanabe (1997). The model was proposed on the basis of measurements in an oscillatory water tunnel, in which the net sand transport rates were evaluated for a wide range of conditions from sheet flow to suspended transport over ripples. The model is capable of estimating the net sand transport rate for various velocity variations with different degrees of asymmetry and atiltness.

RESULT AND CONCLUSIONS

A three-dimensional beach evolution model was developed on the basis of the improved Boussinesq equation and the extended sand transport model. The validity of the model was confirmed by comparing with laboratory experiments under multi-directional waves.

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NUMERICAL MODELING OF ECOLOGICAL RESPONSE

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Phosphorus cycling in the inner part of Osaka Bay is analyzed using numerical ecosystem model which consists of euphotic and aphotic layers. Since accuracy of this model is ±62 % except for POP in the aphotic layer, it is useful to discuss the characteristics of phosphorus cycling and lower trophic level ecosystem in the inner part of Osaka Bay.

Main path of phosphorus cycling in the euphotic layer is DIP → phytoplankton → detritus → DOP → DIP, or detritus → DIP. DIP in the euphotic layer is mainly supplied by decomposition, which is mainly controlled by water temperature, from DOP and detritus (49 % of total supply on annual average).

DIP transport from the aphotic layer to the euphotic layer (24 % of total supply on annual average) is almost equal to DIP supply from river and rain (27 % of total supply on annual average). Primary production is limited by DIP concentration in summer and by water temperature in winter.

DAY 3
MORNING

NOVEMBER 16

BIOGEOCHEMICAL MODELING OF CNP FLUXES THROUGH THE ESTUARINE SYSTEMS OF EAST AND SOUTHEAST ASIA

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The Land-Ocean Interactions in the Coastal Zone (LOICZ) study of the International Geosphere Programme (IGBP), the United Nations Environmental Programme (UNEP) and Global Environment Facility (GEF) in their common interest of understanding the global-scale CNP biogeochemical functioning of the coastal zone have established a joined project: "The role of the Coastal Ocean in the Disturbed and Undisturbed Nutrient and Carbon Cycles". To address this mutual interest, a series of regional workshops, which include East and Southeast regions, were held to construct biogeochemical CNP budgets for many coastal systems where data were available.

The combined effort has adopted LOICZ biogeochemical steady state budgeting method to assess net function of each of the coastal system as source or sink of CNP. The mass balance approach further involves indirect approximation of net ecosystem biological performance from stoichiometric analysis of net ecosystem nutrient flux. Details of the LOICZ biogeochemical budgeting are presented at http://www.nioz.nl/loicz and in Gordon *et al.*, 1996. Towards the objectives of classifying, integrating and up scaling the budgets to regional and global scale, a typology (classification of the coasts) based on natural and anthropogenic variables is being developed to interface with biogeochemical budgets. The typology may serve as a basis for extrapolating the budgets to coastal systems where data to construct biogeochemical budgets are not available. A tool for the typology called LOICZView has been developed and presented at http://www.palantir.swarthmore.edu/~maxwell/loicz.

Biogeochemical budgets for about 50 coastal systems have been constructed for East and Southeast Asia regions. These budgets provide a vital opportunity for assessment of trends in patterns of coastal systems performance and response to the major drivers, both natural and anthropogenic.

INTEGRATED REGIONAL MODELING OF DRAINAGE BASIN INPUTS TO COASTAL ZONE AS A TOOL TO ASSESS GHG SOURCES AND SINKS IN AQUATIC SYSTEMS OF SOUTHEAST ASIA

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Southeast Asian coastal waters and marginal seas are dominated by the inputs of freshwater as well as dissolved and particulate materials from land, as evidences by vertical stratification and horizontal distribution of surface chlorophyll and pCO_2 away from points of input. Modes of terrestrial input are ranging from large and small rivers and streams to direct overflow over land to permanent and seasonal groundwater inputs. Several technical difficulties limit the use of direct observation of discharge as the coastal boundary condition for the hydrodynamic and chemical mass balance modeling in the coastal zone. Thus, a geospatial model for precipitation-runoff has been developed for the entire Southeast Asia, including islands. The model has been run for the regional scale at the spatial resolution of 1 km and variable temporal resolution of 1 day to 1 month, depending on the available discharge data for model calibration. However, a finer resolution may be nested in the regional model using locally available data.

The hydrological model is available in 2 versions, the version 1 is based on the Carnegie-Ames-Ames Approach (CASA), while the version 2 was based on the Variable Infiltration Capacity (VIC) Concept. In addition to the model, regional data necessary to run the model, such as the virtual "physical" templates and important forcing are also available. The models and the "default" regional data for the whole Southeast Asia are now available free of charge from SEA START RC and a technical training workshop is planned for February 2001 in Thailand. Participants in this training workshop will be regarded as our partners to test the model and the associated data system on basins of their choice.

In addition to hydrological component we are coupling various chemical modules over the hydrological module. The chemical modules emphasize on components that directly and indirectly relevant to the major greenhouse gas source/sink function of limnitic and coastal environments in Southeast Asia. For examples, dissolved organic carbon, net ecosystem production, and dissolved carbonate.

This regional modeling exercise is a regional capacity building project to provide to developing countries in this region a tool to assess some of their greenhouse gas sources and sinks in the natural aquatic system. It is not intended to be a primary tool to gather regional data from local sources unless each partner is willing to share the data with other parties. However, sharing of data and information will be encouraged through out the project and SEA START RC will serve as a regional contact point for such information.

SEAWATCH PROJECT IN INDONESIA

Subandono Diposaptono

Agency for the Assessment and Application of Technology, Republic of Indonesia

Indonesia is an archipelagic country with more than 17.000 island. Approximately 3.1 million of the 5.0 million square kilometers of Indonesia territory is composes of marine and coastal waters. Therefore marine sector is one of the crucial sector which plays an important part in supporting Indonesian national development. There is also no doubt that the Indonesia archipelago has a strategic role in international waters. The need for the protection of marine and coastal areas arises as a result of the heavy pressures from destruction of resources, pollution, potential exploitation and global climate change. These pressures are the result of an accelerated rate of development and an expanding population with its increasing demands on resources.

Indonesia recognizes its role in coastal zone and marine environmental management in the global context, and therefore plays special attention to supporting marine and coastal protection, conservation and management to promote its economy as well as to fulfill the needs of its large coastal population trough sustainable use of coastal and marine natural resources.

To cope with all problems occurred on the Indonesian marine area, one of the activities has been done as a multi institution activity called SEAWATCH Indonesia.

SEAWATCH Indonesia is an Activity unit under the Directorate for Environmental Technology, Agency for the Assessment and Application of, Republic of Indonesia, which covers technology application for monitoring, forecasting, modelling and information system for marine and coastal environment. The SEWATCH Indonesia activity was started in the 1996.

SEAWATCH Indonesia has the objectives as follows :

1. Construction and Mooring of Observatory Buoys.
2. Acquisition, transmission, processing, distribution and utilization of collected data such as meteorology, waves, currents, temperature, salinity, oxigen, algae, nutrients, radioactivity, etc.
3. To provide data that contribute to the national and international programs for preserving and restoring the marine environment and the marine living resources.

RAPID SEA-LEVEL RISE DUE TO GLOBAL WARMING AND MANGROVE FOREST SURVIVABILITY

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Mangrove forest which develops between the **Mean tide level** to the **Highest high tide level**. The sea-level rise by global warming might be serious influence to the mangrove habitat because of their limitation of vertical tide range. In this occasion, we like to talk the followings. 1) The habitat dynamics of mangrove forest with special relation to the Holocene sea-level change is discussed based on the field measurement in Thailand and other several places. 2) Like to talk about the mangrove habitat and its sediment structure development in tidal zone. 3) Discuss the importance of the stable sea-level stage in these 1000 yrs. for the mangrove habitat survivability. 4) Estimate and illustrate the changing process of mangrove habitat and its forest structure by the influence of predicted sea-level rise in case of Thailand.

1) The mangrove habitat changed dynamically with the Holocene sea-level change. The mangrove peat as an evidence of mangrove forest which remain while the phase of sea-level rise gradually. The threshold of it is about 3 to 4 mm/y. The mangrove habitat can maintain the situation by peat accumulation only if the velocity of sea-level rise less than 2 mm/yr. During the 7000 yrs B.P. there are none of typical mangrove peaty deposits remain in the substructure. It means that the forest could not survive in such stage of rapid sea-level rise. The velocity of the sea-level might be 5 to 10 mm/yr. at the time.
2) The mangrove has a role of autonomic habitat development. The frontier species take a place and develop at the mean tide level. The complicated aerial root system concentrate and catch the sediment in the forest floor. The dominant species change to *Rhizophora* sp. with the rising ground level of the habitat. The sediment type and ground level change by the large amount of under ground biomass accumulation by root concentration. The process of ground level rise means the decreasing process of the chance and time of salt water flooding. These processes lead the change of forest to the *Ceriops* etc.
3) The mentioned process as an autonomic development occurred during this 1000 yrs. under the condition of stable sea-level. The relative situation of almost of the area of actual mangrove habitat is located to nearly mean high water level.
4) The two case of the mangrove habitat and rapid sea-level rise are estimated as follows. In the Macro tidal area, such as the Andaman sea, the vertical situation of the habitat is

located 0.5 to 2 meter higher than mean tide level because of the large sedimentation and the large tide amplitude. The mangrove habitat where located in the macrotidal area which has been preserved in spite of great change in the inner forest structure by 50 cm rise of sea-level in 100 yrs. because of the higher elevation of the habitat and the gradual accumulation of mangrove peat. The influence of rapid sea-level rise is relatively severe in the microtidal area. The reason suggested thinner tidal area of the upper portion of the microtidal range has greater effects from the rapid sea-level rise.

5) As the result, three factors which play a great role in the estimation of habitat change are asfollows **(1) the velocity of sea-level rise, (2) the tidal amplitude and (3) the rate of sedimentation Including the mangrove peat accumulation.** The tide amplitude is more or less 2m in almost all the world. In case of less than 50cm (5mm/yr.) rise of sea-level we can think that mangrove habitat can survive in almost all the area. In such case the mangrove forest can accumulate the mangrove peat. It means that mangrove forest has a role of CO2 sink and that mitigate the global worming.

CURRENT ISSUES OF DELTAIC COASTS IN SOUTHEAST AND EAST ASIA

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A delta, which is a low-lying area found at the mouth of a river, is an important feature of coastal topography. In particular, large Asian rivers form huge deltas in South, Southeast, and East Asia. More than 50% of the world population lives in Asia, and most of Asia's population lives in deltaic areas. Moreover, more than 80% of the world's total area with rice paddies is in Asia. The rice paddies are mostly in deltaic lowlands as well.

Deltaic lowlands in Asia are important also to the study of sedimentology and global sediment flux. Rivers in southern Asia and Oceania contribute about 70 to 80% of the world's sediment flux from the land to the ocean. These huge sediment deposits have formed large deltas during the last six thousand years.

Human activities in both coastal areas and drainage basins have been causing problems in deltas. These problems will be exacerbated by any future sea-level rise along deltaic coasts.

The Chaophraya delta in Thailand is a good and important example of coastal erosion caused by sea-level rise along a muddy tropical coast. The sea level rose relative to the coast mainly during the 1970s and 1980s because of excessive ground-water pumping. The rise was more than one meter in Bangkok and in the same period, the relative rise of sea level along the coast was tens of centimeters. The sea-level change induced coastal erosion and caused the shoreline to retreat more than 700 m. Cutting of the mangrove along the coasts by human activities accelerated the shoreline retreat. Since 1992, the shoreline has been stable because of regulation of ground-water pumping. These phenomena teach us that even a rise in sea level in the order of tens of centimeters result in severe coastal erosion along muddy mangrove coasts as well as along sandy beaches.

Deltaic coasts are affected by changes both on the land (in the drainage basin) and in the ocean. A sea-level rise is a typical example of a change in the ocean that may severely affect the coastline. Decreases in sediment and water discharge caused by dam construction, sand dredging in river channels, and water usage in drainage basins also impact coastal environments, often causing coastal erosion and saltwater intrusion. The Mekong and Red River deltas have experienced saltwater intrusion for the last 20 years. During the 1990s, the Huanghe (Yellow River) had severe problems caused by the drying up of the lower reaches and by coastal erosion. New dam construction and increasing water usage might yield future issues.

GEO-ENVIRONMENT AND EFFECT OF SEA LEVEL RISE IN THE CHAO PHRAYA DELTA

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Landforms and sediments of the Chao Phraya Delta were analyzed, and the effect of future sea level rise in the delta is discussed in relation to the geo-environment.

Landforms of the Chao Phraya Delta are classified into three types: the deltaic floodplain in the north, the deltaic plain in the central and south, and the tidal plain in the southernmost regions of the plain. Elevation of the tidal lowland in the southernmost region is around 1 m a.s.l., and its surface is very flat and low. Most of the region was originally lower than the high tide level, and the sediments of the region are thin tidalflat silt or clay over thick marine sediments. The deltaic plain with an elevation of 2-3 m, has been formed as a tidal and deltaic plain since the Holocene high stand around 6000 years BP. The surface sediments of the region which cover the marine sediments are soft silt and mostly consisted as tidalflat origin. There are few fluvial landforms and their sediments also few in the deltaic plain. Fluvial landforms such as natural levees and flood basins develop in the deltaic fluvial plain. Surface sediments of the region are characterized by fluvial silt or clay that cover tidal, silty sediments.

The Holocene sediments in the central plain mainly consist of silt and clay and occasionally organic matter. They are classified into four units: basal peat, marine, tidal and fluvial units from the lower to the top horizons. Radiocarbon ages of the basal peat and mid-Holocene tidal sediments show approximate former relative sea-level change. The maximum height of the sea-level was higher than 2 meters above the present sea-level, and was recorded at around 6000 yrBP. Holocene transgression extended towards the region around Ayutthaya, 100 km from the present coast, and most of the Chao Phraya Delta was submerged according to the transgression. Late Holocene tidal sediments develop in the central and southern parts of the plain, and they show that the plain expanded according to the retreat of tidal plain towards the south.

The effect of the future sea-level rise is one of the serious problems in the low and flat deltaic regions of Southeast Asia, and the issues of sea level rise are also being considered in the Chao Phraya Delta. The tidal plain of the delta is the region where the direct impact of the sea-level rise may occur. Coastal erosion is already occurring, and there is a possibility of submergence of the region according to the sea level rise. Acceleration of the already poor drainage conditions is anticipated in the deltaic plain because the surface gradient of the region is very low and the relative gradient of the drainage is going to decrease according to the sea level rise. As there is few relieves in the deltaic plain region except the artificial reclaimed land, the impact of sea level rise might greatly effect the region. Land subsidence also accelerates the effect of sea level rise. In the deltaic floodplain, difference in flooding conditions can be seen in relation to the micro landforms. Natural levees and other higher places suffer little flooding or no flooding at all. On the contrary, swampy areas of a flood basin suffer severe flooding. Most of them develop in areas surrounded by natural levees. The flooding condition has the possibility accelerate according to the future sea-level rise.

ECONOMIC EVALUATION OF IMPACT OF LAND LOSS DUE TO SEA LEVEL RISE IN THAILAND

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Recently, sea revel rise due to global warming is recognized as the great international environment problem that is becoming increasingly serious. It is said that sea level rise will give manifold impacts to beginning with socio-economy, and that its magnitude will be great as some countries are destroyed. From a report of UNEP (United Nations Environment Programs), Thailand is one of countries those are very vulnerable to sea level rise.

There is an estimate that the coastline in Thailand will go up 300 meters inland when sea level of Thai Bay will rise up 1.0 meter. Now, damage due to sea level rise is not only land loss on the spot. Changes in available land should be propagated into markets, as land rent and other market prices in the coast area will change. Then the utility level of people will change, and people may migrate to other safety regions. In these regions immigration of people will change markets. So, impact of land loss due to sea level rise in the coast area should be expanded to other regions even if inland through the market mechanism.

This study constructs a quasi-SCGE (Spatial Computable General Equilibrium) model which is a socio-economic model based on the general equilibrium theory. This model has some assumptions; the national land is divided into 5 regions (Bangkok, central, northern, northeastern, and southern), the industry consists of 16 sectors (crops, livestock, fisheries, forestry and so on), the economy consists of 2 sectors (labor and private firm), there are 4 markets (commodity, labor, land and capital), there are unemployed persons, and so on. By using this model, this study evaluates economic impact of land loss due to sea level rise in Thailand.

The results indicate that GDP (Gross Domestic Products) decrease 0.361 % and 0.685 % in comparison with GDP in 1993 due to sea level rise of 0.5 meter and 1.0 meter respectively. From the regional and the industrial viewpoints, the Bangkok Metropolitan Area and the Manufacturing Industry will have the most serious damage, about 61 % and 38 % in comparison with total damage respectively.

ANALYSIS OF PRIMARY PRODUCTION IN THE SETO INLAND SEA, JAPAN, USING A SIMPLE ECOSYSTEM MODEL

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The Seto Inland Sea in Japan is a semi-enclosed coastal sea. The Seto Inland Sea is well known as a large number of fishery resources. It is important for the management of fishery resources to understand environmental control of primary production because primary production is the first step in the marine food chain. In the present study we examine the basic mechanisms of the primary production system in the Seto Inland Sea using a simple ecosystem model.

A simple model of lower trophic level ecosystem has been created to analyze possible environmental control of primary production in eight sub-areas of the Seto Inland Sea. The primary production rates observed in these sub-areas are well reproduced by the model, including horizontal processes such as horizontal transport of nutrients and vertical processes such as vertical mixing, light intensity and sinking of particulate matter. Without taking account of horizontal processes, the model also successfully reproduces the observed primary production rates in some areas, but it fails to reproduce those in the others. This shows that the relative importance of the horizontal transport on the primary production differs area by area.

Further the possible mechanisms of nutrient supply for the primary production in each sub-area are investigated using this model. The main source of the nutrients for primary production is river discharge in Osaka Bay and Hiroshima Bay, *in situ* regeneration in Bisan-Seto and both river discharge and *in situ* regeneration in Bisan-Seto. That in Harima-Nada, Hiuchi-Nada, Iyo-Nada and Suo-Nada is mainly the vertical transport from lower depth. In Bisan-Seto, the supplied nutrients are not utilized enough for primary production and is quickly discharged out.

The entire processes including the biological processes are rather very complicated. Therefore, further improvements of the model and/or detailed observations would be necessary in the future.

DAY 3
AFTERNOON

NOVEMBER 16

DISTRIBUTION OF VULNERABILITY AND ADAPTATION STRATEGIES IN THE ASIA AND PACIFIC REGION

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Asia and the Pacific are considered as among the most vulnerable regions to climate change and sea-level rise. This is attributed by several factors, such as geographical setting, frequent cyclone occurrence, high rate of population growth and coastal development, and present-day environmental degradation. Therefore, many efforts have been made to estimate the vulnerability on the national and regional bases. However, the whole picture of the vulnerability in the region is still unclear owing to lack of data and relevant methodology for the assessment. This talk shows the distribution of the vulnerability to sea-level rise and climate change obtained by the integrated regional assessment. The assessment consists of three steps; setting scenarios for sea-level rise and external forces, assessing primary impacts on physical conditions in the coastal zones, and assessing secondary or higher-ordered impacts on natural and socio-economic systems. As external forces, sea-level rise, tide, and tropical cyclone are taken, and population, infrastructures, and coastal wetlands are used as the exposure units. Storm surge heights are calculated for all the recorded cyclones for the past 40 years. Then, the spatial distribution of inundated and flooded areas by sea-level rise and superposed storm surge are estimated to determine the affected amount of the above parameters using global databases. The estimated amount of inundated and flooded areas and population in these areas are quite large. As supposed, countries with large deltaic areas and small islands are particularly vulnerable.

Given the high vulnerability of the region, it is important how the natural environment and human society can adapt to such potential threats. Though the precautionary approach is recognized to be important, we do not yet have the concrete basis to implement adaptation options, such as precise and reliable estimate of the future changes in extreme events and adaptation technologies. In the presentation, I will discuss the conceptual approach to adaptation, and introduce adaptation policies and options ranging from monitoring and policy planning to natural disaster prevention structures.