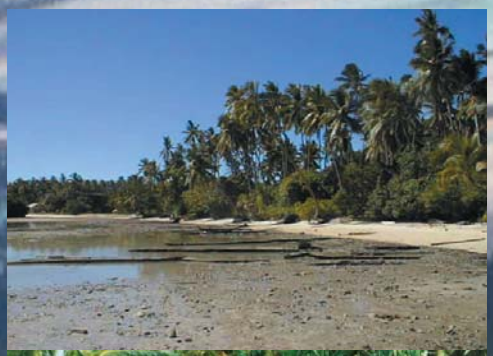

APN
Asia-Pacific Network for Global Change Research

Global Change Coastal Zone Management Synthesis Report

Message from the Director

The endeavour to create an APN Synthesis Report of APN-funded activities on coastal zones and inland waters in the Asia-Pacific region was a challenging and rewarding initiative for APN. Moreover, the present synthesis report not only summarises past APN-funded coastal projects, but also outlines research gaps and identifies future research directions for coastal environments. Researchers, decision-makers and educators alike will, therefore, find this report a useful resource. I would also like to extend my sincere gratitude to everyone who contributed to this publication.

Sombo T. Yamamura
Director, APN Secretariat

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(APN Global Change Coastal Zone Management Workshop, Kobe, Japan, November, 2004.)

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Cover photos: (*Main photo*) Aerial view over Tarawa Atoll, Kiribati: photo Nick Harvey; (*Inset photos*) ① Coastal erosion, Viti Levu, Fiji: photo Patrick Nunn; ② Reclamation of land on Tarawa Lagoon, Kiribati: photo Nick Harvey; ③ Highly developed coast, Kobe, Japan: photo Nick Harvey; and ④ Women removing debris from gill nets, Phang Nga Bay, Thailand: photo Liana McManus.

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Executive Summary

The Asia-Pacific Network for Global Change Research (APN), at its 8th Inter-Governmental Meeting (IGM), commissioned this APN Global Change Coastal Zone Management Synthesis Report to be prepared in time for its 10th anniversary in 2005. The report is the first output of a larger synthesis study, which will result in a more detailed scientific publication, in book form, scheduled for 2006.

The purpose of the synthesis project is to:

- Evaluate achievements of APN coastal projects,
- Review current coastal issues and research needs for the region,
- Identify future coastal research directions for the region, and
- Report results to the APN to assist with future policy directions.

The present synthesis report demonstrates that since 1998 APN has provided US $750,000 in funding for twenty coastal research projects in the region. Of these, eleven projects had coastal issues as their main focus and nine projects dealt with the coast as a cross-cutting theme. Two approaches were used to assess the achievements of these projects. First, an independent reviewer assessed the eleven core coastal projects against the six goals in the APN First Strategic Plan. Second, a group of international coastal experts conducted a separate review of all twenty coastal projects against the same goals.

The results of both reviews show that much has been achieved by APN-funded coastal projects. In particular, the APN goal of 'supporting regional cooperation on global change research' stands out as an excellent outcome in addition to a number of projects achieving cooperation with other global change programmes and networks, such as LOICZ (Land-Ocean Interactions in the Coastal Zone). Many of the projects were successful in terms of the APN goals of 'capacity building' and 'scientific data exchange' but this could have been improved with better targeting of these goals within individual project design and development of linkages to longer term funding sources extending beyond the initial APN input. The APN has already responded in part to this with the introduction of some multi-year project funding. Furthermore, the present report has identified potential for other funding agencies to capitalise on the good foundation work established by APN-funded projects. This would also assist in achieving the APN goal of 'technology transfer,' which received a lower rating from both reviews.

The present synthesis report notes that an important area for improvement for the coastal projects is the issue of 'science and policy interaction' (APN Goal 6). In part, the design of the projects may have accounted for this because very few managed to establish firm linkages with decision-makers. However, given the relatively short time frame of most projects this may have been an unrealistic goal. Notwithstanding the low rating of this goal for most projects, the report notes that effective science-policy interaction is an important issue in coastal zone management, which may need the development of alternative strategies in the future.

A number of APN-funded projects stand out as successful and three examples of best practice projects are recorded in the present synthesis report. It is important to note that many of these projects have achieved important outputs after APN funding has ceased. For example, one of the earliest projects (APN 1998-11) supported a Pacific-based workshop from which a number of coastal projects have subsequently been successfully developed. However, some project outputs such as scientific publications are absent from final reports because publications take place some time after research is completed.

The present synthesis report comments on the significance of the Asia-Pacific region for global change research. Significant atmospheric and oceanic phenomena occur in the region, such as the Asian Monsoon and the El Niño–Southern Oscillation (ENSO) phenomena, which affect the world's climate. The region also has diverse marine and terrestrial ecosystems, including the world's largest areas of coral reefs and mangroves. The Asia-Pacific region has a population of around 4 billion, which is almost two-thirds of the world's total population. In addition, its economic growth rate is the highest of any

region in the world. Degradation of the environment, such as deforestation and over harvesting is becoming a matter of great concern, as floods and droughts occur as a result of this degradation. The tsunamis, caused by the Sumatra earthquake on 26 December 2004, induced unprecedented damage on many coastal countries in the Indian Ocean, highlighting the extreme vulnerability of these coastal communities.

The present synthesis report identifies important global change issues for the Asia-Pacific region which act as a driver for some of the changes and is also impacted by them. The most important among these issues is global warming and accelerated sea-level rise. The potential impacts are compounded by current issues, such as unsustainable use of coastal resources; coastal impacts from poor catchment management; population increase and urbanisation pressure; and development pressures on rural coasts. Methods for tackling these issues, such as 'integrated coastal management,' have few examples of best practices. There is a need to recognise the diversity of coastal management practices in the Asia-Pacific region, and to develop appropriate national and local policies. Similarly, there is a need for this to be accompanied by appropriate education putting less reliance on English language-based material and western concepts.

The present synthesis report stresses the continued focus on coastal issues relating to global change and its regional implications, and concludes by identifying ten additional priority areas addressed by the APN's future research funding strategies. Areas where the APN should focus funding for the next five years are: 1) continue to focus on coastal issues relating to global change and its regional implications, particularly coastal ecosystem health and human impacts on the coastal zone; 2) encourage applicants to devise more effective ways to achieve the APN goals, other than through workshops. These may include joint research projects, strengthening research networks, field and laboratory work, publications, team research and support for targeted and specialised training; 3) expand opportunities for young scientists and students to participate in its projects; 4) more attention should be paid to enhance linkages between research and policy development; 5) follow-up of funded projects is very important. The APN should have a mechanism to encourage project participants to publish academic papers and to develop follow-up projects; 6) seek opportunities to collaborate with other donors and governments to ensure long-term sustainable projects and activities for scientific capacity building, i.e. capacity that lasts, and strengthening linkages between research and policy development. There is a global push for researchers to network and work as teams. There are several benefits if like minded donor agencies form networks as well; 7) development of strategies for reducing the undesirable impacts of future global change; 8) require more effective outputs from projects, particularly associated with empowering decision-makers in the region through project results; 9) development of measures and strategies to reduce the impacts of hazards; and 10) produce appropriate materials to inform and empower decisions about particular coasts in the Asia-Pacific region.

1.1 Background of APN

The Asia-Pacific Network for Global Change Research (APN) is an inter-governmental network with the primary aim of fostering global change research in the Asia-Pacific region, increasing developing country participation in that research, and strengthening links between the science community and policy-makers.

The APN believes that international cooperation among governments and scientists will help increase the understanding of the complex mechanisms and impacts of global change on ecosystems and human society in the Asia-Pacific region. This is necessary to identify and address the problems that may arise from that change.

By assembling researchers and policy-makers from different countries in the region to work together, the APN seeks to address those issues which are relevant throughout Asia and the Pacific.

The APN currently has 21 member countries in the Asia-Pacific region (Figure 1) as follows:

Australia	Japan	Philippines
Bangladesh	Lao PDR	Republic of Korea
Cambodia	Malaysia	Russian Federation
China	Mongolia	Sri Lanka
Fiji	Nepal	Thailand
India	New Zealand	USA
Indonesia	Pakistan	Viet Nam

Figure 1. APN member countries

Source: APN Secretariat

1.1.1 APN objectives

The APN has six main goals as highlighted in its First APN Strategic Plan* (1999-2004):

Goal 1 *Support regional cooperation in global change research on issues particularly relevant to the region.*

Goal 2 *Strengthen the interactions among scientists and policy-makers, provide a scientific input to policy decision-making and scientific knowledge to the public.*

Goal 3 *Improve the scientific and technical capabilities of nations in the region.*

Goal 4 *Facilitate the standardisation, collection, analysis and exchange of scientific data and information relating to global change research.*

Goal 5 *Cooperate with other global change networks and organisations.*

Goal 6 *Facilitate the development of research infrastructure and the transfer of know-how and technology.*

1.1.2 APN activities

The APN conducts a number of different activities, including:

- Supporting collaborative research and training activities,
- Organising planning and scoping workshops to develop new research projects,
- Disseminating global change information to scientists and policy-makers, and
- Providing opportunities for governments and scientists to discuss regional research priorities and other global change issues.

1.1.3 Why does the APN focus on the Asia-Pacific region?

The Asia-Pacific region is an important region for the understanding of global environmental problems. Important atmospheric and oceanic phenomena occur here, such as the Asian Monsoon and the El Niño—Southern Oscillation (ENSO) phenomena, which affect the world climate. The region also has tropical forests, deserts, diverse marine and terrestrial ecosystems, and mountains. It is home to the world's largest bio-geographical region of coral reefs and mangroves. The Asia-Pacific region also has a population of around 4 billion, which is almost two-thirds of the world's total population. In addition, its economic growth rate is the highest of any region in the world. The population growth rate and economic activity of this region means that it contributes to global climate change in a major way. Degradation of the environment resulting from deforestation, desertification, and over harvesting is becoming a matter of great concern, as are natural disasters which occur as a result of this degradation, such as cyclones/typhoons, floods and droughts. The Asia-Pacific region also forms part of the 'Pacific Rim of Fire' and, therefore, is vulnerable to earthquakes and tsunamis, of which the world is all too aware after the Sumatra earthquake on 26 December 2004 and its accompanying tsunamis.

Destruction after Cyclone Heta wreaked havoc in Niue: photo University of the South Pacific

* The Second Strategic Plan will be implemented from 2005-2009.

Thus, observation, monitoring, and research on global change in the Asia-Pacific region are indispensable to understanding environmental changes taking place on a global scale and its socio-economic implications. In addition, stronger links are needed between the science community and policy-makers. The APN was created to address these needs.

1.2 The APN Global Change Coastal Zone Management Synthesis

The 7th APN Inter-Governmental Meeting (IGM) endorsed the production of synthesis reports to assess how the results of APN-funded projects have contributed to the Asia-Pacific region in terms of the six main goals highlighted in the First APN Strategic Plan (1999-2004). The initial plan was that the theme for the synthesis report should change each year, with the first on *Land-Use and Land-Cover Change* published in 2003. However, it was subsequently decided that a one year time frame is too restrictive for syntheses studies.

Consequently, when the second synthesis activity was approved by the 8th IGM in Hanoi, Viet Nam, in 2003 it was planned over a two year time period, 2003-2005, with the synthesis report to be presented at the 10th anniversary of the APN in April, 2005 in Kobe, Japan. The IGM determined that this synthesis should be on *global change coastal zone* management. The IGM provided a brief for the global change coastal zone management synthesis as follows:

Objectives:

a) *Evaluate achievements and present status of APN coastal zone activities by reviewing past projects.*
b) *Review present status and major problems of coastal environments and identify urgent research needs. In-so-doing, the APN can identify gaps between research needs and APN activities.*
c) *Identify research directions, for the future, for coastal environments that are relevant to the region.*
d) *Report the results to the IGM to review and determine future APN policies.*

Major expected outcomes:

1) *The APN Global Change Coastal Zone Management Synthesis Report*
2) *Synthesis Book: "New Directions in Global Change Coastal Research for the Asia-Pacific Region"*

1.3 Defining the APN Coastal Zone

Three of the APN's 21 member countries (Lao PDR, Mongolia and Nepal) do not have a coastline. In addition, there are a number of coastal countries in the Asia-Pacific region which are currently not APN member countries, such as:

- Brunei
- Democratic People's Republic of Korea
- East Timor
- Myanmar
- Singapore

Although Fiji and New Zealand are the only 'official' APN members from Pacific Island Countries (PICs), these countries have a special status as 'approved countries' and have been actively involved in the APN scientific activities.

APN-sponsored coastal research in the region has had impacts beyond the 18 APN member coastal countries alone. In addition, many of the research projects were deliberately designed to foster further research and to provide capacity building for coastal research expertise in the region. For example, APN project 1998-11, Planning Workshop—Marine and Coastal Zone Studies in the Asia-Pacific Region, (Table 1, Section 2, p8) was one of the APN's first coastal projects and had the specific goal of planning further coastal research activities. From this one APN project alone, four projects were initiated on climate change and vulnerability and adaptation assessment, three on ocean-atmosphere interactions, two on island-ocean interactions, one on mangrove management and one on human dimensions. Furthermore, the global change SysTem for Analysis, Research and Training (START) Oceania Secretariat was also inaugurated during this 1998 Workshop held in Suva, Fiji.

The scope of APN coastal zone research is, therefore, much broader than the APN member countries and can be considered to cover the whole of the Asia-Pacific region, including small island states in the central Pacific, such as Tuvalu, Kiribati and the Marshall Islands. The definition of this region is problematic, given that other regional organisations such as the Asia-Pacific Economic Cooperation (APEC) includes the Americas. The global change research community, however, has its own separate organisation, the Inter-American Institute for Global Change Research (IAI), which is the APN's sister network. For that reason, the APN coastal zone is defined here to include only the Asian and Pacific country coastlines.

It is important to recognise that the present APN global change coastal zone synthesis provides a focus for coastal research results and directions provided by APN-funded projects. These are placed in the context of the extensive global change coastal research that has already been conducted, or is currently underway in the region.

Table 1. APN coastal zone and inland water projects

APN Project Reference Number	Project Leader	Title	Number of Participating Countries	Regional Focus	Funding (US$)	Major Outputs
1998-02	Max FINLAYSON	Vulnerability Assessment of Major Wetlands in the Asia-Pacific Region	3	Asia-Pacific	50,000	Published project report
1998-05	Jeffrey RICHEY	Toward an Integrated Regional Model of River Basin Inputs to the Coastal Zones of Southeast Asia	4	Southeast Asia	30,000	Systematic synthesis provided a 'decision supporting system' for river basin development and management
1998-09	Steve LONERGAN	Workshop on Water and Human Security for Asia	15	Asia	30,000	Thirty-eight scholars from fifteen countries attended the workshop, and fifteen papers were presented over three days
1998-11	Kanayathu KOSHY	Planning Workshop—Marine and Coastal Zone Studies in the Asia-Pacific Region	9	Asia-Pacific	20,000	Developed follow-up projects START-Oceania Secretariat inaugurated during Workshop
1999-14	Hartwig KREMER	LOICZ Open Science Meeting	3	East Asia	10,275	SAmBas initial workshop led to the East Asia Basins assessment and synthesis in 2001 (with APN support)
2000-06	Nick HARVEY	International Human Dimensions Workshop 2000—Human Dimensions Issues in the Coastal Zone	4	Asia-Pacific	10,000	Developed a network of young scientists in developing regions
2000-07	Janaka RATNASIRI	Training Workshop for Capacity Building and Networking in the Area of Bio-geochemical (BGC) Budgeting and Socio-Economic Modelling including Human Dimensions Aspects in the Coastal Systems of South Asia	12	South Asia	21,500	Capacity building in bio-geochemical budgeting, using both LOICZ models and community models APN project allowed developing countries to undertake coastal studies in a more systematic and sustainable manner Networking between leading research institutes and universities Follow-up proposal received funding (APN 2002-05-Ratnasiri)
2000-09	Nobuo MIMURA	APN/SURVAS/LOICZ Joint Conference on Coastal Impacts of Climate Change and Adaptation	20	Asia-Pacific	75,000	Open symposium for civil society and policy-makers Proceedings published Results submitted to the Global Synthesis Workshop contributed to a global database of the impacts of climate change and sea-level rise
2000-11	Nick HARVEY	Recent Sea-level Change and Coastal Management Implications for Oceania	7	Oceania	84,900	Capacity building component through field training of coastal researchers in the region Provided new scientific data on sea-level change Workshop proceedings Graduation of selected regional coastal researchers with professional tertiary training in integrated coastal management

APN Project Reference Number	Project Leader	Title	Number of Participating Countries	Regional Focus	Funding (US$)	Major Outputs
2000-20	Hartwig KREMER	East Asia BASINS Workshop	3	East Asia	6,000	Hong Kong Workshop in February 2001 Produced LOICZ R&S report <www.loicz.org> and a special issue of the Journal Regional Environmental Change by Springer Follow-up proposal
2001-07	Hideaki NAKATA	Workshop on the Causes and Consequences of Climate-Induced Changes in Pelagic Fish Productivity in East Asia	6	East Asia	35,000	Project identified research gaps and potential new projects Present status of GLOBEC-SPACC projects of each participating country are well documented
2001-11	Jon BARNETT Mark BUSSE	Ethnographic Perspectives on Resilience to Climate Variability in Pacific Island Countries	11	Pacific	46,800	Established a network of social scientists, climate change researchers, and climate change policy officers in the region Identified future research and policy needs Produced a book of abstracts and short papers
2001-20	Janaka RATNASIRI	An Assessment of Nutrient, Sediment and Carbon Fluxes to the Coastal Zone in South Asia and their Relationship to Human Activities	5	South Asia	40,000	First ever nutrient budget calculation in South Asia Project strengthened the network of researchers and institutions involved in studies related to the sources, quantification and impacts of nutrient and sediment fluxes Proceedings of regional workshop
2002-05			7		63,000	
2002-11	Sun SHU	Joint Support for Symposium on Adaptation of Asia and Pacific to Global Change in the 20th Pacific Science Congress	8	Asia-Pacific	30,000	Produced Proceedings and preparation for further adaptation studies in the Asia-Pacific region
2002-16	Nick HARVEY	Atoll Island Change and Linkages to Sea-Level Variations in Oceania	6	Oceania	22,930	Produced APN Atoll Monitoring Workshop Proceedings Established a Pacific Atoll Coastal Monitoring Analysis Network (PACMAN) Completed an 'on-ground' geo-referenced atoll island baseline survey Convened two PACMAN meetings in separate atoll island nations

APN Project Reference Number	Project Leader	Title	Number of Participating Countries	Regional Focus	Funding (US$)	Major Outputs
2002-17	Dieter MUELLER-DOMBOIS	PABITRA Network for Collaborative Research on the Ecology of Global Change in Island Landscapes of the Tropical Pacific	9	Oceania	45,000	Certificate of Participation awarded to students
2003-06			7		31,815	Project posters feature on PABITRA website <www.botany.hawaii.edu/pabitra>
2004-06-CMY*	Zhongyuan CHEN	The Mega-Deltas of Asia: A Conceptual Model and its Application to Future Delta Vulnerability	12	Asia	35,000	Website for scientists and policy-makers <www.megadelta.ecnu.edu.cn> Synthesise existing database Build capacity networks Knowledge-diffusion to scientists and policy-makers
2003-13	Zafar ADEEL (Caroline KING)	Capacity Development Training for Monitoring of POPs in the East Asian Hydrosphere	10	East Asia	41,000	Comprehensive policy summary paper under development by the United Nations University (UNU) UNU website containing abstracts, presentations and summary of the workshop: <http://landbase.hq.unu.edu/Workshops/TokyoSept2003/programme.htm> Proceedings (book form) containing papers and abstracts of the workshop presentations and a summary report
2003-15	Mary ZAWOYSKY	Travel support for Asian Marine Scientists to Attend the Final JGOFS Open Science Conference	10	Asia	12,000	Conference website <http://usjgofs.whoi.edu/osc2003.html>
2004-18-NMY*	Vladimir S. KASYANOV	Climate Variability and Human Activities in Relation to Northeast Asian Land-Ocean Interactions and their Implications for Coastal Zone Management	3	East Asia	15,000	Project website will contain databases, lists of relevant references and a description of project related global change research activities <http://www.imb.dvo.ru/misc/apn/index.htm> Monograph is being planned for publication

* APN 2004-06-CMY (Chen) is due to be completed in 2005 and APN 2004-18-NMY (Kasyanov) is due to be completed in 2006

3. Impacts of APN Funded Projects: Highlights and Best Practices

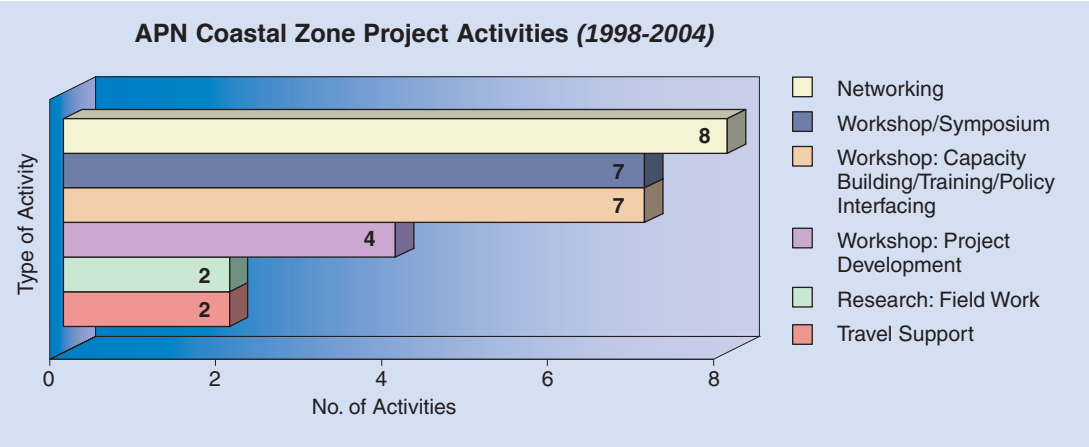
3.1 Nature of Projects

The APN has funded a number of important projects in the Asia-Pacific region devoted to global change coastal zone research. Moreover, many of the projects have established and strengthened networks of regional scientists, coastal managers and policy-makers and developed and enhanced their capacity and interactions. APN projects have also harnessed global change programmes and their projects with new sources of support. Through its broad agenda, the APN has made it possible to engage Asia-Pacific scientists in the larger international community of global change scientists in a proactive manner. The aforementioned APN-funded project achievements have, for example, been facilitated by activities that include:

- Capacity building and training workshops,
- Practical field work studies,
- Participation at international fora,
- The publication of proceedings and journals, and
- Networking and awareness raising.

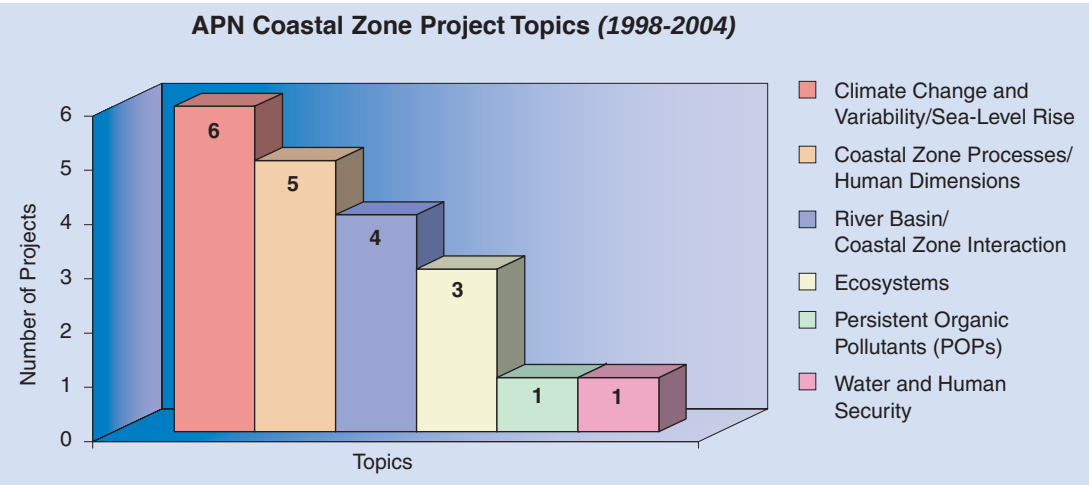
Project topics have covered a variety of coastal zone issues, such as climate change and variability and sea-level rise, land-ocean interactions, coastal zone processes and the human dimensions of global change as applied to coastal situations.

Figure 2. APN project activities



Source: APN Secretariat

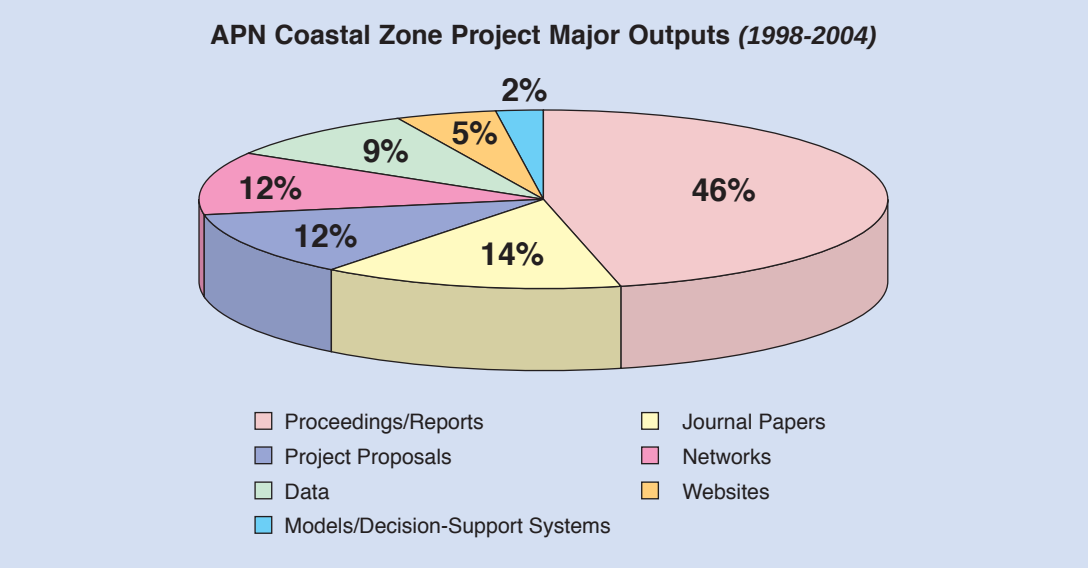
Figure 3. APN project topics



Source: APN Secretariat

As shown in Figure 4, below, these APN projects produced a variety of outputs, ranging from proceedings and reports to project proposals and networks.

Figure 4. APN project major outputs



Source: APN Secretariat

3.2 Significance and Impacts

APN-funded coastal projects have some significant accomplishments and impacts. Selections of these are highlighted by aligning project activities and major outputs related to the APN goals (as outlined on page 5 of the present synthesis report).

Table 2. Overall project ratings in relation to the APN goals (rank order)

Ranking	Independent Reviewer	Synthesis Workshop Report
Excellent	Goals 1 and 5	Goal 1
Good	Goal 4	Goal 3
Average	Goals 3 and 6	Goals 2 and 5
Poor	Goal 2	Goals 4 and 6

Aware that the APN's 10th anniversary in 2005 would be an opportunity to review the past progress and develop a plan for the future, the APN launched a review with the following objectives: (1) to review and summarise APN activities, (2) to assess the strengths of these activities, and (3) to reflect on lessons learned and incorporate them into the Second Strategic Plan for 2005–2009. The review was conducted by a consultant based on two components—scientific and institutional. As part of the evaluation of the APN scientific activities, an Augmented Steering Committee Meeting (ASCM) convened in Kobe, Japan, 27-28 October 2004. Moreover, during this ASCM a scientific expert, who was charged with conducting an independent review of the APN coastal zone and inland water projects, rated these projects against the APN goals (Table 2). In particular, the reviewer noted the following:

In terms of regional cooperation (Goal 1), and linkage with global change organisations (Goal 5), APN projects in the theme area of changes in coastal zones and inland waters were constructed around regional cooperation, and most of them also operated within the framework of a global change programme's core project, such as the Land-Ocean Interactions in the

Coastal Zone (LOICZ). In general, projects were rated 'Excellent' in meeting these goals. In terms of data standardisation, collection and exchange (Goal 4), these were well addressed since most projects worked within the framework of LOICZ; this ensured that questions of data standardisation were well addressed. Data collection and sharing were included as part of some projects and addressed reasonably well, though not so well in others. Overall, projects were rated 'Good' in meeting this goal. In terms of capacity building (Goal 3) and transfer of technology (Goal 6), which are in many ways interconnected, since most projects had these elements as the driver, the overall rating *should* have been 'Good'. The reasoning behind an overall 'Average' rating was because projects did not target capacity building in a sustainable way, with the result that capacity building continued only as long as the project received funding. This is clearly an important issue for the APN Second Strategic Plan (2005-2009). Regarding science and policy interactions (Goal 2), one project made this an express element of its construct by reserving a full day for briefing the general public and decision-makers. Other projects also mentioned this aspect, however, no firm linkages with decision-makers were established and a general rating of 'Poor' was given in achieving this goal.

In addition to the independent review of the 11 coastal projects by a scientific expert, a broader review of 20 projects was conducted by international coastal experts at a workshop that convened in Kobe, Japan, in November 2004. That review assessed the same 11 core coastal projects but included another 9 projects which had coastal issues as a cross-cutting theme. Consequently, the resultant ranking against the six APN goals is somewhat different from the individual review of fewer projects (Table 2), apart from the APN goal of 'supporting regional cooperation on global change research;' which had the highest ranking in both reviews. However, when the full 20 coastal projects were assessed, fewer projects achieved a high rating for the APN Goal 5 'cooperation with other global change networks'. This probably relates to the dominance of linkages with core projects, such as LOICZ, which resulted in a higher ranking.

Capacity building (Goal 3) and science-policy interactions (Goal 2) for the 20 projects were rated higher by the coastal experts than in the independent review, although it is acknowledged that these impacts are short term. It appears that many of the APN-funded coastal projects acted as a catalyst for achieving a number of the APN goals, but in order to sustain longer-term impacts there need to be targeted linkages with both policy-makers and funding agencies.

The goals that rated lowest in the coastal expert review related to scientific data for global change research (Goal 4*) and research infrastructure (Goal 6). Here it is clear that, with some exceptions, such as the bio-geochemical fluxes project (APN 2000-07), the short-term nature of the APN funding made it unrealistic to expect these goals to be met without significant backup support from governments or other funding agencies.

These APN coastal projects generally had a wide-spread impact on the scientific community, policy-makers and the general public, as illustrated by the following example of an early project which acted as a catalyst for subsequent coastal projects. This is followed by three examples of 'best practice' APN coastal projects.

* *Editor's note*: This goal is no longer considered realistic and will not be considered in the APN Second Strategic Plan (2005-2009).

3.3 Catalyst Effect of Projects

One of the earliest projects 'Planning Workshop—Marine and Coastal Zone Studies in the Asia-Pacific Region, APN 1998-11-Koshy' had a wide-spread effect by acting as a catalyst for a number of subsequent projects. The planning workshop developed project proposals in the thematic areas of climate change vulnerability and adaptation, ENSO related climate variability, model based scenario generation, monitoring (APN 2002-16-Harvey), island ocean interactions (APN 2000-11-Harvey) and mangrove management. A climate change vulnerability and adaptation training course has been developed over a period of five years, and about seventy-five persons have been trained so far at the University of the South Pacific (USP). This training course was developed to address the regional need to train people to fulfill their countries reporting obligations under the United Nations Framework Convention on Climate Change (UNFCCC) and related climate change treaties and commitments, such as the Pacific framework for climate change and sea-level rise. Recently, through the APN Scientific Capacity Building/Enhancement for Sustainable Development Programme (CAPaBLE), a two-week climate and extreme events training institute was convened. This training—based on ENSO related droughts and cyclone related floods—has developed and trialed new generation modelling with capacity to generate scenarios at scales relevant to small island countries. This new generation modelling has been developed as part of the Global Environment Facility (GEF) funded Assessment of Impacts and Adaptation to Climate Change (AIACC). AIACC is a global initiative developed in collaboration with the UNEP/WMO Intergovernmental Panel on Climate Change (IPCC) and executed by START and the Third World Academy of Sciences (TWAS). Atmospheric monitoring of greenhouse gases, such as carbon dioxide and methane has also been taking place on a continuous basis. For example, a major synthesis of Fiji mangroves was conducted as part of an Organisation for Economic Co-operation and Development (OECD) study. Four Master students have graduated from studies related to the aforementioned projects.

APN CAPaBLE climate and extreme events training institute participants of the South Pacific: photo USP

3.4 Outstanding Projects

During the evaluation of the APN scientific activities at an Augmented Steering Committee Meeting (ASCM) that convened in October 2004 in Kobe, Japan, three coastal projects were acknowledged as outstanding. From these outstanding projects, examples of best practices have been highlighted as follows:

Outstanding Project (1): Capacity Development Training for Monitoring of Persistent Organic Pollutants (POPs) in the East Asian Hydrosphere. Project Leader: Zafar Adeel. APN 2003-13

The United Nations University (UNU) East Asian Hydrosphere project focused on regional collaboration through a monitoring network developed by UNU and its partner institutions. This network has been gathering water pollution data in the East Asian region for over eight years. It utilises regional expertise and provides training opportunities to young researchers and technicians.

The APN-funded workshop discussed the development of guidelines for acceptable Persistent Organic Pollutants (POPs) pollution levels in the environment. Regionally-acceptable guidelines can help harmonise pollution control efforts and help identify hotspots. The discussions highlighted the scientific and policy challenges for such development. The participants agreed that the 'trigger value' approach adopted by Australia and New Zealand can serve as a practical model for East Asia. It was suggested that further work should be undertaken by a group of dedicated experts; which is being pursued further by UNU.

At the end of the workshop, a three-day hands-on training session was held to further improve the analysis of water and sediment samples. A regional inter-laboratory calibration exercise was initiated to evaluate the data quality of the partner laboratories. This was important to ensure the quality of data included in the harmonised UNU database on POPs. The database is the only one of its kind available in the region, and has been used by international organisations. The sustainability of this project is ensured by UNU's partnership with Shimadzu Corporation of Japan through a long-term commitment to support the UNU's pollution monitoring activities.

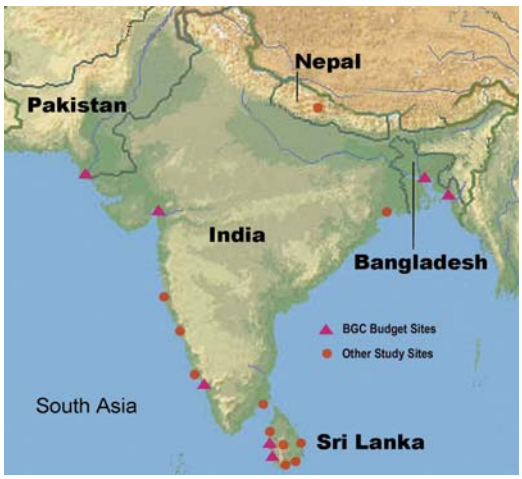
Participants during capacity development training: photo UNU

Outstanding Project (2): An Assessment of Nutrient, Sediment and Carbon Fluxes to the Coastal Zone in South Asia and their Relationship to Human Activities. Project Leader: Janaka Ratnasiri. APN 2001-20/2002-05

The project was a continuation of an activity initiated in 1999 with a view to understanding regional coastal processes including estuarine modelling and budgeting, nutrient and material fluxes to the coasts and their human interactions. These activities followed a sequence of a scoping workshop in 1999, a training workshop in 2000, a three-year gap-filling field study and a results-comparison workshop in 2002. The project's success could be attributed mainly to this logical sequence of events.

Several coastal scientists from Bangladesh, India, Nepal, Pakistan and Sri Lanka, after receiving training in LOICZ methodologies for bio-geochemical budgeting under a previous APN project (2000-07), collected the necessary gap-filling data and returned to the third workshop along with draft nutrient budgets. They worked with the LOICZ resource persons to improve their budgets, resulting in the development of seven bio-geochemical (BGC) budget sites. In addition, nutrient flux studies at several other sites were completed (Figure 5). Further details can be found on the following website: <www.nsf.ac.lk/slaas/cfweb>.

Figure 5. Study sites



Source: Kishan Peiris

The limited funding available for gap-filling studies went a long way to fill gaps in knowledge in the application of bio-geochemical and socio-economic models, to mobilise existing capacity and capability to undertake essential research and to 'add value' to on-going programmes.

The outcome of the project is a network of energised coastal researchers. A major subsequent development is the establishment of the Regional IPO Node of LOICZ II for South Asia in Colombo, Sri Lanka.

Outstanding Project (3): APN/SURVAS/LOICZ Joint Conference on Coastal Impacts of Climate Change and Adaptation. Project Leader: Nobuo Mimura. APN 2000-09

This joint event (workshop and open symposium) was a unique opportunity to communicate between different study areas, one of them being a synthesis of country-based vulnerability studies, and the other being academic studies on broad topics relating to coastal environmental changes. Forty-four oral presentations and more than ten poster presentations were made, along with lively discussions during both the workshop and the open symposium.

The open symposium for the public was held to introduce the results of the workshop, as well as the latest knowledge relating to global warming and climate change. Over eighty policy-makers, researchers, and the general public attended the symposium. Workshop participants pointed out the importance of convening such an open symposium held back-to-back to the workshop as a measure to promote peoples awareness of the issues being studied.

After the joint event, copies of Proceedings consisting of papers prepared by the presenters were published and circulated globally. Furthermore, a set of inquiries was developed by a

Synthesis and Upscaling of Sea-level Rise Vulnerability Assessment Studies (SURVAS) Steering Team, which then provided a common set of knowledge on the vulnerability of participating countries. The final results were then, together with the Proceedings papers, aggregated into a database for SURVAS. More details can be found on the SURVAS website <http://www.survas.mdx.ac.uk/>.

Factors attributed to project success:

1) Regional networks of researchers and policy-makers have been developed in the region, in which the APN is an important player.
2) The project was positioned within a large framework of international programmes that seek to understand and determine the vulnerability of climate change and response strategies for effective interactions between policy and research communities.
3) The joint event was organised by an international organising committee, members of which shared common research interests and a shared project purpose.
4) The open symposium, which was proposed by the APN Secretariat, provided an excellent opportunity to present the latest knowledge on climate change to the public. Indeed, the symposium attracted many people, and was covered by local media. The symposium, therefore, became a platform for the APN to showcase itself as well.
5) APN funding was instrumental. Project proponents had discussed such a project for a long time, but it was very difficult to find appropriate funding. Moreover, the APN competitive research funding process, focusing on global change research, is important for researchers and policy-makers in this region who want to coordinate regional projects. The APN has been, and continues to be, a unique driving force promoting global change research and scientific capacity building focussing on regional priorities.

APN/SURVAS/LOICZ Open Symposium in November 2000: photos Tomoya Motoda

3.5 General Observations and Gaps in APN Project Activities

From the reviewers' comments, the overview data of the 20 projects and examples of best practice, it is possible to draw a number of conclusions on both the project successes and areas where project outcomes could have been improved. These conclusions have been grouped below around a number of sub-headings.

3.5.1 Key issues

It is clear that climate change and sea-level rise, coastal processes and the human dimensions are the main drivers of the APN coastal projects. This is consistent with the goals of the

APN's First Strategic Plan. However, these 20 projects did not address all of the critical issues for Asia-Pacific coasts outlined in section 4 of the present synthesis report. This indicates that there is scope for redefining some of the research goals so that future projects deal with critical issues in the years ahead.

3.5.2 Linkages with other global change programmes

Many projects demonstrate a strong linkage with the global change research programmes and their core/joint projects, especially LOICZ. This is to be expected as LOICZ is the key coastal programme of its type. There were also linkages with the International Human Dimensions Programme on Global Environmental Change (IHDP) in human dimensions research and the regional networks of START (Oceania, South Asia (SASCOM), Southeast Asia (SARCS) and Temperate East Asia (TEACOM)) in the area of capacity building.

3.5.3 Geographical coverage

The project requirements of involving a number of countries appears to have been effective in achieving a balance in the sub-regional representation of projects. As noted earlier, the geographic coverage is not restricted to the 18 APN coastal countries alone and, in particular, has achieved good coverage across the smaller Pacific Island Countries.

3.5.4 Outputs and outreach activities

The majority of project activities have focused on workshops which are consistent with the capacity building goal. In addition, a number of projects were specifically targeted to help young scientists and students from the region either to enable their travel and participation in workshops and meetings or specifically designed training programmes and, in some cases, resulting in formal university qualifications. However, the general consensus from reviews was that presentation and outreach of the project results could have been better.

There are few research, laboratory and fieldwork related projects, and in terms of scientific outputs, projects do not appear to have produced many peer-reviewed journal papers or scientific books. This, however, is probably related to the short timeframe of the projects.

3.5.5 Sustaining coastal zone management and research

The APN's funding has clearly served as a catalyst in developing regional networks and future projects, but not for the promotion of substantial, longer term research. There has been a general reluctance to fund research projects that involve data collection beyond one or two years. In order to sustain the effectiveness of a number of management and research projects there is a need either for longer-term funding support from the APN for selected projects or a clearer linkage to the continuation of funding through other agencies.

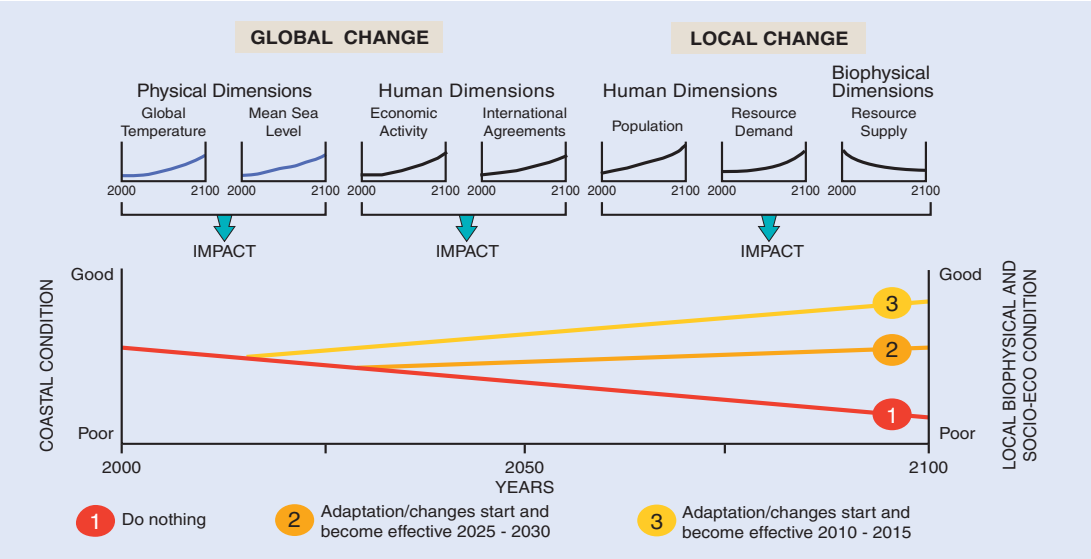
3.5.6 Emerging issues and priorities

A number of new projects in the region have focused on regional issues, such as sea-level monitoring in atoll islands, coastal profiling, the Pacific-Asia Biodiversity Transect (PABITRA), and fishery resources. These are illustrative of priorities such as the need for coastal monitoring to provide data about actual coastal changes in order to provide evidence for, often emotive, arguments related to effects of sea-level change. Similarly, some of the projects have emphasised the need to focus future research on priority issues in the region such as ecosystem biodiversity, Persistent Organic Pollutants (POPs), and deltas.

4.1 Introduction

A number of important global change issues have been identified for the Asia-Pacific coastal zone. The most significant of these is the need to adapt to the potential impact of global warming and accelerated sea-level rise. As shown below in Figure 6, there are both physical and human dimensions to global change and regional/local change which will have an impact on coasts in the future. There are three main global change drivers affecting coasts which should be acknowledged in coastal management. First, there are natural phenomena, such as climate change and variability including global warming and sea-level rise, and major regional influences with global climate linkages such as ENSO and the Asian Monsoon. Second, there are globally driven socio-economic changes as evidenced by globalisation of economic activity and the dominance of international corporations, many of which are more powerful than small countries. The effect of global demand and international trade can have an impact on the Asia-Pacific coast, such as mangrove clearance for shrimp farming even though the major driver/demand may be external to the region. Third, there are global influences on the management of various natural coastal environments such as world heritage or marine protected areas. There are also important local influences, such as the naturally dynamic coastal processes, and population pressure on coasts, such as coastal resource use, waste disposal, mining and coastal development and pollution.

Figure 6. Future coastal condition—three scenarios



Source: Roger McLean and Nobuo Mimura

Both global and local drivers can be divided into two groups of 'dimension,' namely biophysical and human. Most of these will show increases in the future, such as sea-level rise, economic activity and population, which will inevitably result in a declining supply of coastal resources (Figure 6). As a result of these trends, the 'coastal condition' will decline and with it the local biophysical and socio-economic condition shown as Line 1 for the 'do nothing' option. In order to improve conditions, appropriate adaptations must be put in place and, as shown in Figure 6, the earlier this is done, the better the outcome (Line 3). If the adaptation measures are delayed there will be a poorer outcome (Line 2).

Most of the themes implicit in Figure 6 are dealt with as issues in the following section. For example, the potential impacts from global change issues are compounded by current issues,

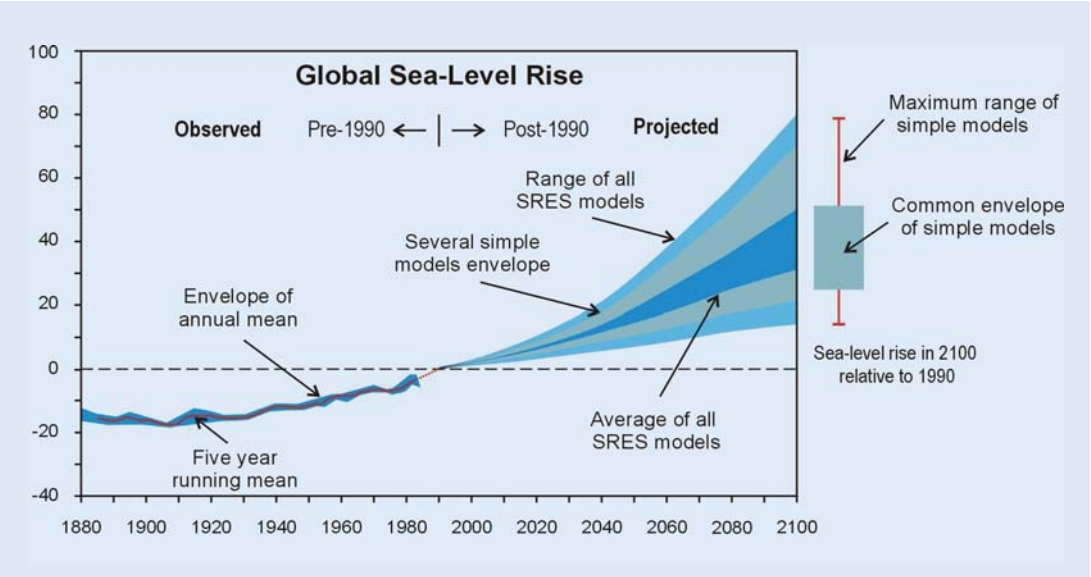
such as unsustainable use of coastal resources; coastal impacts from poor catchment management; population increase and urbanisation pressure; and coastal resource and development pressure on rural coasts. Methods for tackling these issues, such as 'integrated coastal management' have few examples of best practice. There is a need to recognise the diversity of coastal management practices in the Asia-Pacific region and to develop appropriate national and local policies. Similarly, there is a need for this to be accompanied by appropriate education putting less reliance on English language-based material and western concepts.

4.2 Living with Global Warming and Accelerated Sea-Level Rise

4.2.1 Future coastal scenarios

Future global warming and accelerated sea-level rise in the Asia-Pacific coastal zone will restrict the activities of the people who occupy it and the ability of the environment to sustain it. Some of the most important of these restrictions in the Asia-Pacific region will arise from coastal inundation, exacerbation of river flooding, beach erosion, and groundwater salinisation, and coral bleaching resulting from increasing Sea Surface Temperature (SST). Each of these effects will trigger a series of other impacts on managed and non-managed environments, human society and the economy.

Figure 7. Global sea-level rise



Source: Climate variability and change and sea-level rise in the Pacific islands region. John E. Hay et al. Ministry of the Environment, Japan and SPREP (2003)

The intensity of coastal-zone use in the Asia-Pacific region and the rapidly growing coastal population reinforces the need for accurate predictions of future climate changes as a basis for forecasting impacts and developing appropriate response strategies. For the coastal zone the most important climate change variables include: increases in air temperatures and sea-surface temperatures; sea-level rise; and changes in the magnitude, frequency and distribution of interdecadal (e.g. Pacific Decadal Oscillation), interannual (e.g. El Niño–Southern Oscillation) and seasonal extreme events (e.g. typhoons/cyclones and droughts). Another important issue for the whole region is to identify sectors and areas most vulnerable to these climatic and oceanic conditions using a multisectoral and integrated approach to managing and living on the coast.

4.2.2 Major research issues

There are six issues where there is a critical need for better understanding of the effects of future warming and sea-level rise:

- Impacts on the natural environment,
- Impacts on human society,
- Multiple stresses on environment and society,
- Achieving sustainable development under conditions of global warming and accelerated sea-level rise,
- Identifying process thresholds and their implications, and
- Inputting results of scientific research to more effective coastal management.

Many of the aforementioned issues are dealt with in more detail elsewhere in Section 4 of the present synthesis report. For these, only a short summary is given here.

Impacts on the natural environment

Future accelerated sea-level rise will render many coastal areas in the Asia-Pacific region unusable by humans for the purposes they are currently used for. Adaptation will involve adjusting human lifestyles and reorganising the geography of coasts through informed management of vulnerable areas.

Impacts on human society

Many coastal-dwellers in the Asia-Pacific region will be unable to continue living in the way they do at present. Climate change and variability is projected to adversely impact human health and, therefore, lifestyle adaptations will be necessary.

Multiple stresses on environment and society

Models of the multiple stresses projected to affect people occupying Asia-Pacific coasts will help anticipate changes in both time and space. This approach, which requires large amounts of data, is an essential component of integrated coastal planning and management and is preferable to a sectoral or piecemeal (localised) approach.

Achieving sustainable development under conditions of global warming and accelerated sea-level rise

Sustainable development is a goal of many countries in the Asia-Pacific region under conditions of present-day climate and sea-level, and climate and sea-level variability. As these conditions change in the future, so the challenge of achieving sustainable development will become more complex. Climate change and variability must be mainstreamed into national development strategies.

The identification of process thresholds and their implications

Sea-level rise, and the other components of global warming, are not likely to accelerate or change uniformly either in time or in space. There will probably be times within the next 100 years when there is rapid change, and these will cause considerable disruption to Asia-Pacific coasts. Prediction and anticipation of the nature of future climate changes and especially sea-level rise will aid planning for rapid rises.

Scientific research for more effective coastal management

There is considerable scientific research relating to Asia-Pacific coasts that is currently not being used to inform coastal management. Understanding the pathways of decision-making about coastal management will aid the effective use and application of scientific understanding and data.

4.2.3 Needs

Among the critical needs, related to living with global warming and accelerated sea-level rise in the Asia-Pacific region, are:

- Improved monitoring, and input of monitored data to appropriate models,
- Improved impact and vulnerability assessment,
- Improved discussion of common and specific adaptation options, and
- Enhancement of human resilience and adaptive capacity.

4.3 Coastal Resources and Sustainability

4.3.1 Coastal ecosystems and biodiversity

Coral reefs, mangrove forests and seagrass meadows are the three most productive coastal ecosystems in the Asia-Pacific region. Millions of people depend upon them for their livelihood. They are vital because they supply a wide range of goods and services including:

- Food products, building materials and fuel wood,
- Natural protection to shorelines,
- Nurseries for other species, and
- Resources for tourism and recreation.

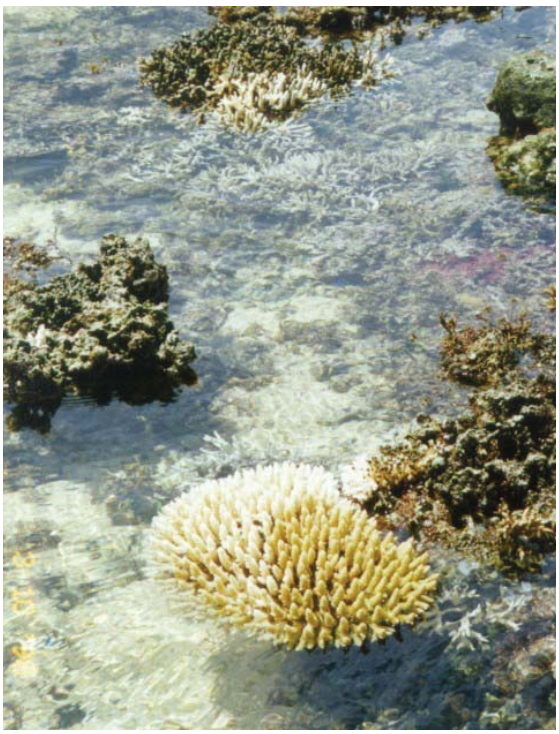
Demands for such goods and services are growing, but the capacity of many of these ecosystems, to meet this demand, has been substantially reduced. While there are pristine coral reefs, mangrove forests and seagrass meadows in the region, many are in serious decline. Others have been completely destroyed. This is particularly the case near the megacities and other densely populated areas, whose imprint on coastal ecosystems extends far beyond the boundaries of those areas, including to other coastal states. Moreover, all three ecosystems are intertidal or immediately subtidal. That is, they are intimately connected to the land, and are, therefore, subject to land-sourced sediment and nutrients and land-based pollutants. Other human associated activities that degrade these ecosystems include the mining of reefs, defor-

Mature mangrove forest in the Federated States of Micronesia: photo Roger McLean

estation of mangroves for firewood and timber, and the clearance of seagrass beds. Throughout the region, these activities continue to increase, reducing both habitat health and coastal biodiversity. Superimposed on these local stresses are those associated with global warming, eustatic sea-level rise and natural hazards, as well as those associated with the globalisation of economic activity, such as tourism and trade, starkly exemplified by the conversion of mangrove forest to shrimp ponds.

The Asia-Pacific region has the highest concentration of coral reefs, mangrove forests and seagrass meadows in the world, and also the greatest number and diversity of reef, mangrove and seagrass species and communities. On the other hand, the human pressures on, and the scale of degradation and destruction of these ecosystems is also greater than elsewhere. Fundamental global change impacts include increased sea surface temperature and sea-level rise, as well as a possible increase in the frequency and intensity of both storms and climate-regime oscillations such as ENSO. Although some impacts may be difficult to determine, and while some benefits may accrue from plant growth and biomass increases from elevated carbon dioxide in the atmosphere; there is little doubt that the majority of global change impacts on coastal ecosystems will be negative. While it may be possible to reduce the depletion and degradation of reefs and mangroves through rehabilitation and reseeding projects, the scale of such reduction is, however, likely to be minor in relation to the destructive effects. Moreover, the loss of resilience and buffer capacity of these coastal ecosystems impairs the capacity of reefs, mangroves and seagrass meadows to recover and, as a consequence, the quality and quantity of their provision of goods and services is reduced. In some situations, ecosystem adjustment and adaptation to global change forces is geographically constrained. For example, landward migration of mangroves may be impeded by the presence of coastal infrastructure.

Coral reefs, mangrove forests and seagrass meadows contain great biodiversity. As natural ecosystems, there are strong interactions among the plant, animal and abiotic components of each ecosystem, and weaker, though important interactions, between the three ecosystem types when geographically juxtaposed. They are also subject to continual natural change, and to be sustained they must be allowed to continue to function in this manner. Clearly, this is not possible when the ecosystems have been substantially degraded or destroyed and much of their biodiversity lost. In such cases, the replacing habitat may provide some alternative products and/or services for the local community, though frequently the range of products is substantially reduced and/or production from the area is not for local consumption, but rather, exported out of the region.



Coral bleaching on the Coral Coast, Viti Levu, Fiji: photo Roger McLean

4.3.2 Threats to sustaining food security in coastal regions

Indeed, the conversion of a multi-use community resource, like a mangrove forest, to a single-use resource, such as aquaculture, impacts local food security and human health, as well as reducing access to a previously 'common' resource. Research in the region clearly shows that degradation of reefs, mangroves and sea grass beds tends to harm rural populations more directly than urban populations, and has its most direct and severe impact on poorer people.

Throughout the region subsistence agricultural production systems and artisanal fisheries are stressed as a consequence of high coastal population growth, pressure from commercial activities as well as extreme natural events such as floods and droughts. In addition to these stresses coastal agriculture and food security can be impacted by sea-level rise in at least two ways:

- Coastal land may be permanently inundated, making it unsuitable for agricultural production, and
- Land may be subject to periodic inundation from extreme events such as king tides, storm surge and tsunami or intrusion of salt water into freshwater lenses contaminating the freshwater lens.

Theoretical adaptations to these stresses include the conversion of coastal lands to mariculture, and the growth of salt tolerant species. However, such adaptations are not likely to be undertaken rapidly, nor without the provision of agricultural and fisheries extension services. Many of the medium-term impacts of climate change and sea-level rise on coastal ecosystems and resources are already familiar to coastal dwellers within the Asia-Pacific region, and some have experience in coping with them. However, the additional global change stress associated with external economic pressures on those ecosystems and resources does bring into sharp relief the question of adaptation, food security and sustainability.

4.4 Catchment-Coast Interaction

4.4.1 Regional catchment and coastal characteristics

Throughout the Asia-Pacific region there are a number of globally important large rivers (e.g. Indus, Brahmaputra-Ganges, Mekong, Red, Pearl, Changjiang and Yellow Rivers), together with numerous smaller ones. As a result of the monsoon climate, the large population of the region and environmental pressures, there are influential aspects controlling the environmental characteristics of adjacent coasts. Modifications to the coastal environment, in turn, affect the catchment areas. There have been many studies on the catchment-coast interaction issue, but knowledge gaps exist regards catchment-coast characteristics, the related processes and mechanisms, methods and techniques to improve investigations, and applications of the scientific output to management practices.

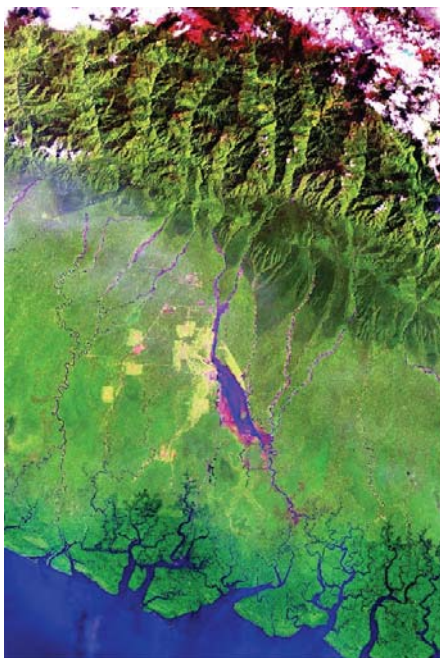
Aerial view over Red River Delta, Viet Nam indicating mangrove clearance and intense resource use: photo Nick Harvey

Rivers in Southeast Asia deliver a large percentage of the global freshwater and sediment discharges into the coastal zone. The quantity of water and sediment inputs from some large rivers of the region have been monitored and calculated. However, little is known about the dynamics of the discharges for the future, in response to a changing climate (in terms of both average conditions and occurrences of extreme events) and intense human activities. For example, the construction of the Three Gorges Dam in China will considerably change the patterns of water and sediment transport, with different monthly discharge distributions. As a result, the growth rate of the Changjiang River delta will be reduced or even subject to coastal erosion. Furthermore, salt intrusion into the lower reaches of the river will be intensified, the catchment geomorphology (river channel geometry) will be in a non-equilibrium state, and the ecosystem of the catchment-coast system will be affected.

Nutrient and pollutant discharges are even more complicated. The catchment areas of the region are generally densely populated, with an extremely large scale of rice-based agriculture. Artificial fertilizers and pesticides are extensively used, resulting in heavy nutrient (e.g. phosphorus and nitrogen) loads and POPs. In addition, the majority of the region is under pressure from development. Chemical industries and other pollutant-generating factories have been established in many developing countries. An unknown, but large amount of pollutants are, therefore, discharged into the rivers and coastal waters every day. Although the effect of the nutrient and pollutant discharges may be evaluated by a scenario-based modelling approach, there is a need for obtaining quantitative information on the nutrient and pollutant inputs.

Important issues associated with water, sediment, nutrient and pollutant discharges from the Asia-Pacific region include:

- Patterns of catchment hydrological cycles and freshwater discharges, under the influences of climate change, water use, and dam construction,
- Sediment yield and input to the coast, in response to dam construction,
- Modifications to the estuarine-deltaic areas due to catchment development, in terms of morphodynamics and seawater intrusion,
- River catchment morphological evolution in response to changes in the hydrological cycle and river mouth morphology,
- Nutrient and pollutant emissions: quantity and spatial distribution,
- Catchment and coast water quality, in relation to nutrient and pollutant emissions, and
- Timing of material (water/sediment/nutrient/pollutant) input and budgeting in the coastal zone.



1996 Landsat image of the impact of the Freeport mine in Papua Province of Indonesia: image courtesy of David Paull and Glenn Banks

4.4.2 Processes and mechanisms

It is insufficient to merely have the numbers of the recorded material input from the catchment to the coast. In order to enhance our ability to predict future changes in the behaviour of the catchment-coast system, a better understanding of processes and mechanisms, that are responsible for the observed data, is required. For instance, it is difficult to predict future

freshwater discharges from the Changjiang River if provided with a ten-year record of water discharge data alone. On the other hand, if the factors that control the discharge and the way the factors work are known, then a better predictive model may be formulated.

The terms 'process' and 'mechanism' should not be used in a vague sense. For the purpose of promoting 'earth system science' and encouraging interdisciplinary research, they may be understood within a framework of the systems theory. Thus, 'process' means the response of the system to external forcing, and 'mechanism' refers to the various combinations of different processes. This way, the mechanisms for a given phenomenon can, therefore, be identified. From this viewpoint, the following research topics of the processes and mechanisms for the catchment-coast interaction may be appropriate:

- Coastal morphodynamics influenced by sediment input changes,
- Factors controlling catchment hydrological cycle changes,
- Catchment and coast morphodynamics under constant environmental forcing and shifting external forcing,
- River ecosystem evolution in response to constant environmental forcing and shifting external forcing,
- Mixing and dispersal processes for nutrients and pollutants,
- Retention of materials (sediment/nutrient/pollutant) within the catchment and coastal zone, and
- Comparison between large and small catchment systems in the material cycle patterns.

4.4.3 Methods and techniques

Apart from the studies of regional characteristics and the processes and mechanisms involved, there is a need to develop suitable methods and techniques for both monitoring and investigating. In particular, emphasis should be placed on modelling and simulation approaches and geochemical tracing techniques. The procedures of the modelling investigations may consist of: (1) conceptual modelling, to identify the major factors that need to be considered and to gain insight into the scientific problem involved; (2) process and mechanism studies; and (3) formulation of process and prediction models. This way, the models will not only give the output (i.e. numbers), but also provide a useful tool to understand the real world. Furthermore, as a parallel effort, geochemical tracing techniques should be developed, which are highly beneficial to the study of nutrient and pollutant dispersal, incorporating the various physical and geochemical processes. Relevant research topics include:

- Selection of key study areas for the measurement/observation of material cycle patterns,
- Conceptual models of river channel and delta evolution, which are controlled by sediment supply and marine/estuarine hydrodynamics,
- Process modelling to identify important processes/mechanisms for material input from catchments,
- Geochemical tracing methods to define material retention in catchments and estuaries,
- Multi-layer database for the simulation of the catchment-coast system behaviour,
- Methods to generate appropriate scenarios of future external forcing, and
- Computer models for integrated catchment-coast management.

4.4.4 Applications

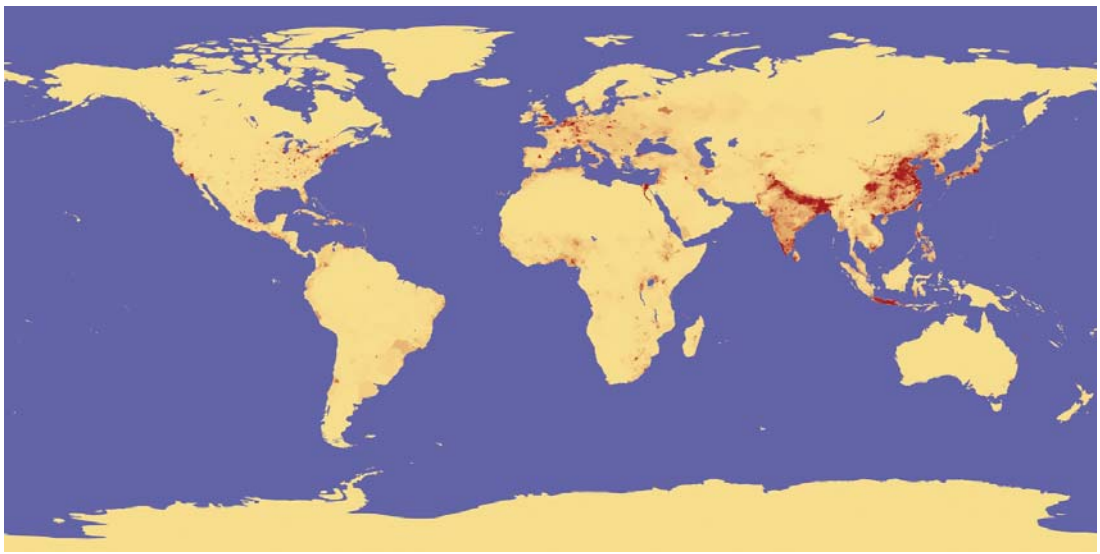
The purpose of the research previously outlined is to support the integrated, effective management of the catchment-coast system. In the past, the collection of scientific data was often considered of interest to scientists, and at best, as background information for management. As a result, in developing countries it has been a general practice that management activities are separate from research activities. To solve this problem, interdisciplinary efforts are required; researchers with different knowledge backgrounds (i.e. natural and social sciences) should work together with the managers, policy-makers and stakeholders, to formulate management models and tools. The following are some examples for investigations into the application of scientific results into management practices:

- Catchment-coast management methods and tools,
- Catchment development schemes and management patterns (agricultural land-use in the catchment, urbanisation and large-scale engineering schemes, etc.),
- Impact assessment of tidalflat reclamation in the coastal zone on the ecosystems of adjacent wetlands,
- Assessment of coastal environmental changes in response to catchment development activities,
- Assessment of the intensity and frequency of flooding and saline water intrusion of the catchment, in relation to coastal changes,
- Assessment of the effect of sand mining in the river channel on the river basin morphological stability, and
- Assessment of the effect of pollutant/nutrient discharges on catchment and coastal water quality.

4.5 Increasing Population and Urbanisation Pressure

The problems of future global change faced by cities in the Asia-Pacific coastal zone will increase with increasing population and urbanisation pressure. On the one hand, cities are major contributors to greenhouse gas emissions, while, on the other hand, coastal cities become more vulnerable to the consequences of global warming, accelerated sea-level rise and changes in the patterns and dimensions of extreme events.

Figure 8. Population pressure in the Asia-Pacific Region in a global context



Source: NASA visible earth

About 55% of the world's coastal cities with populations between 1 and 10 million people are in Asia; and about 83% of the megacities (more than 10 million people) are also in Asia with the fast-growing ones in the tropics. By 2015, half of the world's megacities will be in Asia; most of which will be coastal.

Cities attract people as they offer economic, social and cultural opportunities, and are strongly associated with an improved quality of life. However, in many developing countries of the Asia-Pacific region, urbanisation is still saddled with problems of insufficient infrastructure, water shortage, poor sanitation, air pollution, and traffic congestion. Much of the migrant poor can only find shelter in squatter colonies that grow around the cities.

The development of coastal cities in the Asia-Pacific region has negative impacts on the marine and coastal environments. These cities contribute to domestic and industrial wastewater and solid waste, hazardous waste, and waste gases. The more significant impacts on the coastal environment include:

- Degradation of seawater and sediment quality,
- Toxicity to fish, shrimp, and algae,
- Eutrophication, which results in 'red tides,' and
- Wetland destruction, habitat modification, and biodiversity loss.

With increasing population and urbanisation in the coastal zone, it will be necessary to identify the potential urban 'hotspots' that are vulnerable to various types of problems:

- 'Grey' agenda issues, e.g. water supply, sanitation, and infectious diseases,
- Combination of 'grey' agenda and 'brown' agenda issues, e.g. air and water pollution, and other negative aspects of industrial processes, and
- 'Green' agenda issues, e.g. consumption-related problems, ecosystem health, ozone depletion, and greenhouse gas (GHG) emissions.

Table 3. Asian megacities in 2015

Urban conglomeration	Population (millions)
Tokyo, Japan	36.2
Mumbai, India	22.6
Delhi, India	20.9
Dhaka, Bangladesh	17.9
Jakarta, Indonesia	17.5
Calcutta, India	16.8
Karachi, Pakistan	16.2
Shanghai, China	12.7
Metro Manila, Philippines	12.6
Osaka-Kobe, Japan	11.4
Beijing, China	11.1

Source: World Urbanization Prospects: The 2003 Revision. UN Department of Economic and Social Affairs/Population Division

The identification and prioritisation of issues are important initial steps to ease the problems, as many will worsen with global warming and accelerated sea-level rise. 'Grey' and 'brown' agenda issues are faced by rapidly growing coastal cities, such as Bangkok, Jakarta and Shanghai. A few large coastal cities, such as Tokyo, Seoul and Taipei, are more concerned with 'green' agenda issues.

The problems associated with increasing population and urbanisation pressure cannot be treated in isolation from the rest of the coastal environment. Many are cross-sectoral and some are trans-boundary in nature. Policy-makers need to know the severity of the problems, and their relationships to global warming and accelerated sea-level rise in the coastal context, to mobilise resources to achieve maximum effect. Some, if not many, of these problems have to be included within the context of appropriate coastal zone management. In addition, poor monitoring protocols and facilities, lack of adequate policy and regulatory measures and institutional weakness contribute to the complexity of the problems.

4.6 Rural Coasts

4.6.1 Background

The rural coast of the Asia-Pacific region is home to about 1 billion inhabitants, approximately a third of the total population of the region, and about one-sixth of the global population. Of this, approximately 5.5 million reside in small island states in the Indian and Pacific Oceans. With the threats of over fishing and degrading coastal ecosystems, sustaining the livelihoods of fishers, fish farmers, fish traders and small-scale tourism entrepreneurs, among others, are critical development issues for the region at large. This overview discusses key economic activities and pressures on the region's rural coasts, and also identifies new areas of research needed to provide vital information to sustain the social-ecological systems these support.

4.6.2 Fishing in rural coasts

Capture fisheries and extensive methods of fish farming are common livelihood activities in rural coasts. FAO (2002) estimates that there are approximately 29.6 million fishers and fish farmers in Asia and Oceania, accounting for 86% of the global count. About 1.1 million decked vessels, 1.5 million unpowered and undecked vessels, and 0.5 million powered but undecked vessels comprise Asia's fishing fleet. Oceania adds a further 2,600 decked boats to the region's vessel count.

Coastal village on stilts, Phang Nga Bay, Thailand: photo Liana McManus

Harvesting acetes shrimps used for making shrimp paste, Phang Nga Bay, Thailand: photo Liana McManus

From 1972 to 1998, the Asia-Pacific region contributed 45% to 62% of global fish production for human consumption. Over the same period, it contributed 68% to 87% of the world's aquaculture production, and 44% to 51% of total capture fisheries. Tuna exports from the region rose from 34% (0.11 million tonnes) in 1977 to 66% (0.41 million tonnes) of the contribution from developing countries in 1997. For shrimp, the region accounted for 63% (0.45 million tonnes) of those exported, mainly to developed nations, in 1997. It is projected that by the year 2020, the region will contribute 67% (86.8 million tonnes) of the global fish production for human consumption.

Using national statistics, the amount of seafood supply to the region, including the amount available for consumption, reached 57 million tonnes in 1997, and is projected to reach about 66% (84 million tonnes) of the world's total in 2020. Supply (also called apparent consumption) is determined by country production less exports plus imports. For the rural population of the region, it is unclear how this supply may be accessed for actual consumption. Given the increasing demand for fish, it could be that fish can become highly priced commodities so that they may be bartered for their cash equivalents, rather than directly consumed by fishing households. As such, marine-based protein security may become an emergent issue.

4.6.3 Quality of life indicators

Life in rural coastal areas of the Asia-Pacific region has its share of challenges that render the social-ecological systems these support vulnerable. It is estimated that about 1.8 billion people in rural Asia, most likely including those living in rural coastal areas, have no access to sanitation. Approximately 474 million inhabitants have no access to safe water, and about the same number are not reached by basic health services. Even more sobering is the statistic that 750 million rural inhabitants of Asia live on less than US $1 per day, i.e. they live in absolute poverty.

The absence of basic services can lead to further compromise of the coastal environment. In addition to fertilizer runoff from agriculture in adjacent catchments, sewage loading can decrease coastal water quality and alter natural productivity of coastal ecosystems. Immediate effects can include the spread of water-borne pathogens and growth of noxious blooms that can affect fin- and shellfish fisheries. In tandem with heavy exploitation, coastal ecosystems can undergo phase shifts to states that limit their life support functions and their own resilience to recover from stress.

The vulnerability of rural coastal areas in the Asia-Pacific region was manifested at its worse when the Indian Ocean tsunami struck the shores of northwest Sumatra (Indonesia), Thailand, Sri Lanka, Maldives, and southeast India on 26 December 2004. Close to 200,000 people perished and about 1.2 million were displaced. In an instant, the impoverished population of the region increased by 2 million (ADB 2005).

4.6.4 Emergent research foci

Rural coastal areas are a priority for further research because of the paucity of data to describe the human-environment dynamics at the appropriate spatial scale. These dynamics interact with the adjacent catchments upstream and the marine environment further offshore. Furthermore, these interactions are embedded in patterns of urbanisation, migration and consumption that have local, national and global drivers.

In the rural coasts of the Asia-Pacific region, the poorest inhabitants live off the fertility of the land and the productivity of the coastal waters. New knowledge should be generated to

understand what scale of economies can improve the quality of life and which can, at the same time, sustain the natural life-support systems. Innovative management, aimed at considering population, health and environment in a holistic view, should be requisite targets of study, including the necessary human institutions which can foster this integration. Moreover, predicting trajectories of coastal change, as a function of globalised trade and climate change, may enable coastal societies to enhance their resilience to cope with change.

4.7 Approaches to Coastal Management

4.7.1 Background

Coastal management should sustain the resources of coastal states in the region, safeguard traditional community access to coastal resources and nurture traditional community management responsibilities.

The recent evolution of coastal management in the Asia-Pacific region has, to a large extent, been driven by external forces. The prevailing paradigms of management, which evolved in the west over the last two decades, have been promoted as a solution to issues of resource depletion in the region. These paradigms have subsequently been promoted through international agreements, foreign aid, NGO activity and research. External forces have also contributed to resource depletion. Globalisation of trade, combined with the rapid growth of regional economies, has fuelled changes in patterns of resource access, use and consumption. These changes are exerting chronic stress on coastal resources, particularly coral reefs, mangroves and fisheries. Demand for coastal space is increasing, leading to the privatisation of coastal lands and the decline of common property resource management by local communities.

4.7.2 Characteristics of coastal management in the region

Contemporary coastal management is a recent development in the region, compared with long-established traditional practices. Approaches to coastal management in the Asia-Pacific region are as diverse as the states are numerous. In most states, at a local level, there still exists a range of traditional customs and taboos that govern access to coastal resources. These practices underlie, and in many cases, co-exist with recent forms of coastal management that are statute and regulation based, derived from western models of centralised environmental management. This is still true, even in the most urbanised coastal states, including Japan and Hong Kong, but more so on rural coasts throughout the region.

These traditional approaches have shown remarkable resilience over time. They are flexible and responsive to local circumstances. The goal of these approaches is to sustain resources, such as fisheries, by modifying rates and patterns of harvest depending on local resource availability. This approach is entirely consistent with modern concepts of sustainability, but seldom recognised and protected. In contrast, many states in the region have adopted western models of coastal management, which have tended to be formalised and prescriptive, highly centralised, and hierarchical.

There are fundamental difficulties applying this western model of coastal management in the region, where emphasis has been on conflict resolution between competing users of coastal resources, with few constraints on urbanisation and development. This development has occurred with little consideration of the pre-existing property rights of coastal communities.

This is, however, not always the case. For example, the access rights of Japanese fishermen have been safeguarded for 150 years (gyo-gyo-ken). In many other states, however, the status of coastal communities is reduced to that of 'stakeholder'. Most states in the region have implemented coastal law and policy and have established central and regional government agencies. These have been largely ineffective, in part because such regulatory regimes rely on accurate information, such as estimates of the carrying capacity of ecosystems, which is seldom available. Furthermore, enforcement of standards and regulations is difficult, if not impossible.

4.7.3 Integrated Coastal Management (ICM)

There are few examples of successful implementation of ICM in the region. It appears that many countries have not progressed very far beyond the 'centralised' phase of coastal management development. With decentralisation, Indonesia is moving to more Community Based—Coastal Resource Management (CB-CRM). In many states, ICM has facilitated a shift of management authority from resource users to governments and their institutions. Subsequent loss of community management responsibility and authority has often involved the transfer of marine tenure from the community to the government, effectively placing the resources under an open-access regime because of the ineffectiveness of enforcement measures. CB-CRM recognises that communities are potentially the best resource managers, since they have the biggest stake in the sustainability of natural resources. However, the need to safeguard the rights and interests of local communities has been largely overlooked. There is a need to shift the emphasis from a regulatory, legalistic, and sectoral approach, to education and voluntary compliance.

Sustainable development is generally accepted as the central objective of ICM. Sustainable development requires patterns and intensities of resource use today, that do not compromise the ability of future generations to meet their needs. ICM has been widely promoted as a means towards this end. The elements of integrated coastal management include integration of:

- Programmes and plans for economic development, environmental quality management and ICM,
- Integration of ICM with programmes for such sectors such as fisheries, energy, transportation, water resources management, tourism and natural hazards management, and
- Integration of responsibilities for various tasks of ICM among the levels of government—local, state/provincial, regional, national, international—and between the public and private sectors.

Community-based mangrove replanting in the Pacific, seen here at the OISCA-sponsored scheme at Yadua village in southwest Viti Levu Island, Fiji: photo Patrick Nunn

Experience has demonstrated that there are significant barriers to implementing environmental policy towards ICM, even in the developed nations of the region. These obstacles include insufficient investment, lack of information and skilled human resources, weak analytical tools, inadequate political will and fragmented institutional frameworks. Furthermore, coastal management spans a wide range of instruments and initiatives, from international agreements to governmental agency programmes, to local and community initiatives. In most countries, national planning bodies, department of fisheries, department of environment, ministry of lands, villagers and NGOs have a stake in coastal matters. At the national level, there are major disincentives to achieving sustainable patterns of resource use, including the lack of incentives for business and government, the time horizons of elected officials and the centralisation of management. ICM can be criticised for legitimising the reorganisation of society and space, for the primary purpose of stimulating national and international economic development. Pre-existing resource management regimes are displaced by ICM regimes, which facilitate the further subdivision of community resource management systems by encouraging national and global capital penetration. ICM regulation creates space for the new global economy, by organising the coast into new arenas for investment and by politically and spatially marginalising pre-existing resource users. This process has been reinforced by the major donors and lending agencies such as the United States Agency for International Development (USAID) and the World Bank.

ICM is clearly not a panacea to problems of resource depletion in the region. Without safeguards, that protect the relationship between local communities and associated coasts, ICM may even be counter-productive. Community management responsibility and authority should be retained as the basis for effective ICM. The direct transfer and application of methods of management developed in the west, marine protected areas, for example, is unlikely to work without significant community support. Management should occur at an appropriate scale, recognising local, regional and national communities of interest. National and local policies and programs should be complementary and benefit both constituencies. In many states, this will require a major reconsideration of the importance and role of local communities.

4.8 The Need for Appropriate Education

4.8.1 Time to change peoples' attitudes

Change often causes anxiety. Much of what has been communicated to the public has focused on the negative aspects of global change and, in consequence, has caused considerable anxiety among the general population in some parts of the Asia-Pacific region. This is especially true in the island-Pacific and the low-lying and delta areas of Asia subject to typhoons and storm surges. The dangers of focusing on the negative aspects of global change is that it may lead to a culture of despair and even denial, and that people will not help themselves by appropriate anticipatory adaptation.

It is in the interests of everyone living in (or concerned about) the Asia-Pacific region that they should encourage self-help adaptation. This is not only because the region is so vast, but also because most governments have insufficient control over the management of every part of their country's coastline to be able to derive, implement, and sustain appropriate coastal management strategies.

4.8.2 Priority areas

There are two areas of priority regarding education about global change for the coasts of the Asia-Pacific region:

1. The message

The focus on negative aspects of global change, which is so meaningful to scientists and others whose training allows them to see what is occurring now and projected for the future in their historical and geographical context (and who do not live directly off the land and sea), is often alarming to the general public, who do not have the benefit of the necessary training to contextualise global change (and who often live directly off the land). The public needs to be informed. The public also needs to be persuaded of the imperative of developing, implementing, and sustaining appropriate adaptation strategies for that part of the coast they occupy and (help) manage. It is, therefore, suggested that discussions and information material concerning global change:

- Be refocused on positive rather than negative aspects of global change—to emphasise the do-able rather than the apparent insurmountable challenge ahead,
- Mainstream discussions of appropriate and feasible adaptations to global change,
- Emphasise no-regrets adaptation options,
- Teach about how people in the past in particular areas coped with the effects of global change (and associated extremes) to demonstrate that communities can survive the kinds of challenges associated with future global change, and that traditional knowledge can be usefully employed in the future, and
- Replace the language of pessimism with the language of optimism.

Education must also be appropriate. Most of the general public in the Asia-Pacific region are not familiar with regional geography or global change issues in places other than their own local area. It makes little sense to try and convey information about global change issues and solutions to them by using examples from distant places. Local case studies are required.

Key target areas for education are coastal ecosystems, commercial activities on the coast (fisheries, tourism, agriculture, infrastructure), and pollution. Through education, a balanced view of climate change impacts on the coastal zone must be provided. A clear knowledge of the way in which our environment works offers us better choices in accommodating the unavoidable—changes due to natural causes—and better decision-making capacities to ameliorate the consequences of the avoidable—the human induced changes. In both cases, failing to take prudent action leads to adverse impacts. The education curriculum should accommodate locally and regionally relevant examples and case studies and must promote inter-disciplinary approaches to teaching and learning.

2. The medium

Most people in the Asia-Pacific region do not speak English as a first language, and those who do conceptualise in their native language. The language of global change is largely English, the concepts (the ways in which problems are framed and solutions are suggested) are largely derived from English systems of thinking. Much will be gained by producing appropriate educational material for various parts of the Asia-Pacific region in vernacular languages. The issue of conceptualisation has hardly been addressed, but simple translation of concepts from the English language often leads to their dismissal by local communities as alien constructs and, therefore, inappropriate.

Many governments in the Asia-Pacific region continue to try and implement coastal management policies from the top-down—with little success. There needs to be a shift away from policy development and top-down approaches towards community-level empowerment. This requires targeting 'people of influence' at the community level, be they traditional chiefs, elected leaders, or religious leaders, and giving them the information necessary to guide informed and appropriate decisions concerning the coasts in their particular 'spheres of influence'.

There remains a need for capacity building but this needs to target 'people of influence' rather than simply assume that people in government decision-making positions are only those (or the best of those) able to influence coastal management. Endorsing the view that through education should come the planning, decision-making, action and the code of behaviour necessary for the conservation and sustainable use of natural resources and the protection of intellectual property rights, we need to pursue an education policy which incorporates both formal and non-formal programs in its environmental education and awareness building.

APN workshop participants at drilling site, Buota, North Tarawa, Kiribati: photo Nick Harvey

There are a few successful examples of 'top-down' coastal management in the Asia-Pacific region (such as China), and it may benefit other countries to learn more about such approaches. Both top-down and bottom-up approaches are useful with some very useful middle of the road approaches as well. The Locally Managed Marine Area (LMMA) approach used in Fiji, as a means of managing coastal resources sustainably, involves village communities, University researchers and NGOs.

5. Looking to the Future: Priority Areas for Action

5.1 Priority Areas

1) To improve understanding of the ***PATHWAYS*** of coastal management in the Asia-Pacific region, specifically to:
   - ➤ Improve understanding of the linkages between research and policy and coastal management,
   - ➤ Understand the limitations of policy and top-down approaches to management in many countries,
   - ➤ Identify the people who have the most influence over management of the coastal zone at community (or sub-regional) level, and
   - ➤ Build the capacity of those people to make informed decisions about the future of the coasts for which they are responsible.

2) To ***ENHANCE*** coastal management in the Asia-Pacific region by the development of more appropriate, more targeted and more effective strategies, specifically to:
   - ➤ Encourage the development and adoption of country-specific (or sub-region specific) systems of integrated coastal management, and
   - ➤ Encourage the recognition, protection, and dissemination of traditional coastal-management practices.

3) To continue to develop realistic future ***SCENARIOS*** of global change for the Asia-Pacific coast that can be used as a basis for forward planning, specifically to:
   - ➤ Extend the acquisition of data by monitoring, data referring to both environmental and human (societal) change, and
   - ➤ Continue to develop sub-regional models of future change for key areas such as megacities.

4) To continue ***DIALOGUE*** between decision-makers in the Asia-Pacific region with particular focus on:
   - ➤ Discussion of commonalities (in environments, challenges, solutions) within and between countries,
   - ➤ Cooperation to address transboundary issues, and
   - ➤ The development of region-level initiatives to fulfil specific goals (as given elsewhere in this section).

5) To generate and share appropriate ***INFORMATION*** intended to solve problems associated with future global change, specifically to:
   - ➤ Develop solutions which are appropriate to the cultures and environments of the Asia-Pacific region,
   - ➤ Share the results of new approaches to coastal management, and
   - ➤ Trial new technologies for coastal management.

6) To improve understanding of the geographical distribution and current condition of those coastal ***ECOSYSTEMS*** that (help) sustain coastal populations in the Asia-Pacific region in order to:
   - ➤ Understand their (potential) role in sustaining future coastal peoples,
   - ➤ Identify key areas where rapid change is occurring or is threatened, and
   - ➤ Develop management strategies (such as ecosystem restoration) for the future productivity of these ecosystems.

7) To improve understanding of the degree and sources of ***POLLUTION*** affecting Asia-Pacific coasts, specifically:
   - ➤ In order to improve the condition of these coasts with a view to their role in sustaining humans in the future, and
   - ➤ To contribute to global strategies for (atmospheric) pollution reduction.

8) To develop a public ***MESSAGE*** about future global change in the Asia-Pacific coastal zone that is:
   - ➤ Culturally appropriate,
   - ➤ Positive (focused on what can be done) rather than negative (highlighting the huge challenges) in tone,
   - ➤ Accessible through vernacular languages, and
   - ➤ Uses concepts and examples that are familiar to target audiences.

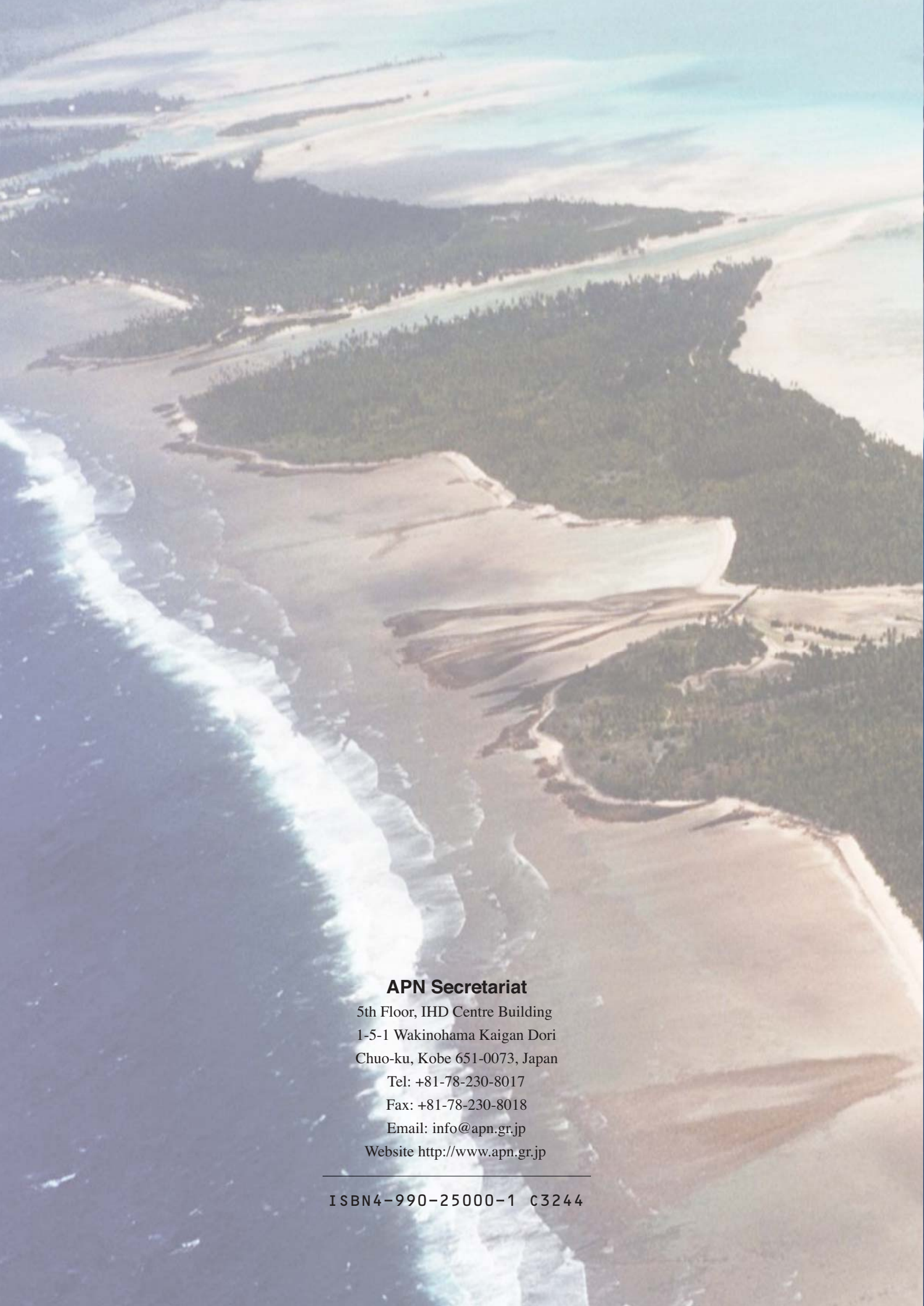
9) To pay special attention to the most ***VULNERABLE*** environments of the Asia-Pacific coast, including:
   - ➤ Atoll islands and other low-lying inhabited islands where in-island adaptation options are severely restricted,
   - ➤ Delta coasts where people occupy low-lying areas of land and are subject to environmental stresses from both the sea and rivers,
   - ➤ Areas of rapidly increasing population where there will be insufficient land area to accommodate future populations and insufficient resources to sustain them, and
   - ➤ Coastal areas threatened by earthquakes and tsunamis.

5.2 Synthesis: What Next?

This concluding section provides recommendations for future research foci on coastal zone management in the Asia-Pacific region.

- ➤ Continue to focus on coastal issues relating to global change and its regional implications, particularly coastal ecosystem health and human impacts on the coastal zone,
- ➤ Encourage applicants to devise more effective ways to achieve the APN goals, other than through workshops. These may include joint research projects, strengthening research networks, field and laboratory work, publications, team research and support for targeted and specialised training,
- ➤ Expand opportunities for young scientists and students to participate in its projects,
- ➤ More attention should be paid to enhance linkages between research and policy development,
- ➤ Follow-up of funded projects is very important. The APN should have a mechanism to encourage project participants to publish academic papers and to develop follow-up projects,
- ➤ Seek opportunities to collaborate with other donors and governments to ensure long-term sustainable projects and activities for scientific capacity building, i.e. capacity that lasts, and strengthening linkages between research and policy development. There is a global push for researchers to network and work as teams. There are several benefits if like minded donor agencies form networks as well,
- ➤ Development of strategies for reducing the undesirable impacts of future global change,
- ➤ Require more effective outputs from projects, particularly associated with empowering decision-makers in the region through project results,
- ➤ Development of measures and strategies to reduce the impacts of hazards, and
- ➤ Produce appropriate materials to inform and empower decisions about particular coasts in the Asia-Pacific region.

It is anticipated that many of the above recommendations for future research will be expanded upon in the second output of this APN synthesis project, which will be in the form of a scientific book planned for publication in 2006.



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