Coastal Ecosystems Response to Climate Change and Human Impact in the Asia-Pacific Region (CERCCHI Project)

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In this presentation...

- Introduction
- Threats to the coastal ecosystem
- State of the coastal ecosystems & environment in East Asia and the Pacific
- Integrated Coastal Zone Management
- The CERCCHI Project
Importance of the Coastal Zone

- World's most important and intensely used of all areas settled by humans.
  - An estimated **50 to 70 percent of the world's population** lives in coastal zones.
- Given the definition of 200 meters of the sea level, the coastal domain
  - occupies **18% of the surface** of the globe;
  - is where about **25% of global primary productivity** occurs;
  - supplies approximately **90% of world fish catch**;
  - is where **90% of the global sedimentary mineralization** occurs;
  - accounts for **75 to 90% of the global sink of suspended river load** and its associated elements or pollutants;
  - accounts for **80% of the global organic matter burial**;
  - accounts for over **50% of present day global carbonate deposition**.
Predator plagues like crown-of-thorns starfish (COTS) may be initiated and certainly exacerbated by either over-fishing of key starfish predators; and/or increases in nutrient runoff from the land favors the planktonic stages of the starfish.’ (Goldberg and Wilkinson, 2004)
A growing body of evidence links severe coral bleaching and mortality to increasing rates of global climate change attributed to rising levels of anthropogenic greenhouse emissions (Goldberg and Wilkinson, 2004).
Sea level rise

Increased CO₂

Seawater warming

Forecasted effects of climate change on seagrass
(Modified from Duarte 2002 by Fortes)
Coastal Ecosystems in East Asia & the Pacific

World’s center of biodiversity

...globally significant for their biodiversity e.g. 30% of the world’s coral reefs (Wilkinson 2002), 33% of the world’s mangroves (Spalding et al. 1997), at least 10% of the world’s seagrasses (Green & Short 2003).
Coastal ecosystems are severely damaged:
- over 80% of the reefs are at great risk;
- mangroves have lost 70% of their cover in the last 70 years;
- seagrass bed loss ranges from 20-60% in the last 50 years

Unless managed, the reefs will collapse within 20 years, all mangroves will be lost by 2030, & seagrass beds will follow suit, so will the resources & revenues derived from them (PEMSEA 2003)

What must be done to avoid such a bleak future?
Focus on water quality per se

Focus on conservation

Integrated Coastal Ecosystem Management

Link science and decision-making (multidisciplinary approach)

Enable understanding of interrelationships across systems

Consider complex interactions in managing coastal resources

Urban urbanisation

Industry

Farms

Cattle raising

Aquaculture

Mariculture

Tourism

Management:
1. Detection of key threats
2. Improve awareness
3. Network & linkages
4. Develop policies
5. Local action

Resources:
- Forest
- Corals
- Seagrass
- Land

Processes:
- Weather/Climate
- Eutrophication
- Inundation
- Soil erosion

Threats:
- Sediment/Nutrient influx
- Global warming
- Sea level rise
- Excessive fishing
- Agricultural intensification
- Increase in temperature

Loss of/Damage of:
- Sediments, Nutrients
The CERCCHI Project

- Coastal Zone Management
  - must consider complex interactions between social, economic, environmental systems
  - must be responsive to local needs and in agreement with global efforts
- Present investigative efforts
  - narrow with results incompatible for understanding of interrelationships across systems

Scope
- Spatial and temporal aspects of change in natural and human systems in the tropical zone
- Measurement of dynamic parameters: CNP fluxes, sedimentation, sediment chemistry, tide level & wave action
- Remote sensing data analysis as a rapid, comparable and readily available source of spatial records
Integrated Coastal Zone Management

Underscores the need for improved assessment, monitoring and modelling of pollution and its effects on the coastal ecosystem.

A Large Marine Ecosystems (LMES) Strategy for the Assessment and Management of International Coastal Waters

- A global effort under way
  - World Conservation Union (IUCN), UNESCO (IOC), other UN agencies, and the US NOAA
  - To improve the long-term sustainability of resources and environments of the world's LMES and linked watersheds.
Linkages between tropical ecosystems

**Hydrologic Systems**
- Rivers
- Groundwater
- Plains
- Mountains and Hills

**Hydrodynamic Systems**
- Reefs
- Bays
- Estuaries

**Marine ecosystems**
- Corals
- Mangroves
- Seagrasses

**Terrestrial ecosystems**
- Human subsystem
  - Habitation
  - Activities

**Goods and Services**
- Science + Integrated Management

**Environmental loads**
- Nutrients (C,N&P)
- Sediments
- Chemicals

**Impacts**
- Climate Change
- Effects of climate change

**Responses**
The Project Approach

Global Change Research Programs

Remote Sensing
Geographic Information Systems
Integrated Simulation Modelling
Field techniques

The Project
Multidisciplinary collaboration
Integrated watershed-coastal ecosystem approach

Stakeholders
Government (national and local)
Non-governmental organizations (NGOs)
Community-based organizations

Data and Information Sharing
Needs identification
Assistance in monitoring work

Logistical support
Assistance for policy formulation

Coastal Ecosystem

Data Collection
Implementation of global/regional monitoring programs

Policy formulations, coordination and implementation of programs

Extraction of products

Improved protection through monitoring and impact assessment
Project Objectives

Provide an understanding of the driving/forcing effects of socio-economically induced changes on environmental loads to the tropical coastal ecosystems.

Develop capacity building through workshops on standardized methods of processing in-situ, remotely-sensed data and environment-related socio-economic surveys.

Produce an accurate set of multi-date coastal resource information particular to needs of managing changes in the coastal zone and consistent to allow comparison.

Assess human welfare impacts of changes in coastal resource systems in terms of social costs and benefits considering different management strategies.

Achieve and apply understanding of the causes and consequences of present and future environmental change of tropical ecosystems in management decisions.

Strengthen the network of, and reinforce linkages among coastal scientists and managers thru shared expertise and resources.
Project Implementation

Data and information sharing and dissemination
(data, information and knowledge base exchange among collaborators and the public)

Collection and assessment of existing studies and relevant data
(changes in the coastal and human impacts in tropical marine ecosystems; identify information gaps)

Analysis of multi-temporal satellite images
(to detect changes in land use patterns and coastal habitats)

Assessment and analysis of changes
(changes in human and natural ecosystems considering hydrologic and hydrodynamic processes by use of physical and ecological models)

Development of a policy-relevant prognostic model
(environmental quality indicators and optimization technique to valuate resources and social priorities)

Capacity-building
(joint workshops; decision support tools suited for local management)
Remote Sensing for Coastal Environments

Basis of remote sensing for coastal environments:
- Coral reefs
- Mangrove forest
- Seagrass beds

Development of seagrass assessment & monitoring methodology using remote sensing
Expected Outcomes and Outputs

- **Impacts of changes to coastal ecosystems** in East Asia and the Pacific region as depicted in **processed multi-temporal images**
- **Standardized in-situ data collection protocol, uniform methods** for processing remotely-sensed data and socio-economic surveys
- An **integrated physical and ecological model** specific to assessment of environmental changes in tropical ecosystems
- A science-based, user-driven practical **decision support system (DSS)** suited for management concerns in coastal zone
- A group of **coastal scientists** in the region proficient in environmental change evaluation methods
- **Managers trained** in using **DSS** for tropical coastal environment
- **Documentation** and other **relevant publications** for promoting provisional and actual use of the integrated model