EAS Congress/WP/2010/05

eas Congress 2009

Theme 1

Coastal and Ocean Governance

WORKSHOP 5: THE SCIENCE IN ECOSYSTEM-BASED MANAGEMENT

25 November 2009

Coastal and Ocean Management Institute
Xiamen University

PML | Plymouth Marine Laboratory

Plymouth Marine Laboratory (PML)

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The East Asian Seas Congress 2009

"Partnerships at Work: Local Implementation and Good Practices"

Manila, Philippines
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Theme 1: Coastal and Ocean Governance
Workshop 5: The Science in Ecosystem-based Management

25 November 2009

Co-Convening Agencies:
Coastal and Ocean Management Institute, Xiamen University; and
Plymouth Marine Laboratory

Chairs:
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ADOPTING AN INTEGRATED, ECOSYSTEM-BASED MANAGEMENT APPROACH TO ADDRESSING CHALLENGES IN MARINE ECOSYSTEMS

The coastal and marine environment of East Asia is confronted with similar, if not more complex, management challenges as many other regions in the world. Ecosystem-based management (EBM) is widely advocated as a way of coping with multiple simultaneous pressures that are causing a decline in the state of the marine ecosystems. EBM requires a *sound science* supporting an adaptive management framework, undertakes *integrated assessments* to inform management decisions and to regulate multiple human pressures and *coordinate and integrate* national and international monitoring programs.

Management efforts in the region should be, therefore, geared toward the adoption of an integrated, EBM approach and capitalize on the availability of scientific knowledge and technological advances from within and outside the region, including experiences in engaging wider participation of stakeholders in the scientific process.

This report presents the highlights of the papers presented in the Workshop on the Science in Ecosystem-based Management, including the conclusions and recommendations drawn from the discussions. It covers, in particular, the key initiatives and experiences in integrating science into policy and management decisions. It also discusses innovative approaches to monitor ecosystem changes due to human interventions, identify effective strategies for knowledge transfer, packaging and communicating scientific information to support policy formulation. It also illustrates how various programs that adopt an ecosystem-based approach, which takes into account ecosystem knowledge and uncertainties, transboundary influences and balancing societal and environmental objectives, have contributed to promoting interdisciplinary research, which is essential for sustainable development of coastal seas.

PART 1: INTEGRATING SCIENCE INTO POLICY AND MANAGEMENT DECISIONS

There is growing global consensus, that responsible stewardship of the oceans and coastal ecosystems should have an ecosystem basis and that system integrity should be maintained. EBM requires knowledge base, implying the need for both *in situ* and remotely-sensed observations. A suite of ecological indicators that can be applied to serially detect changes in the ecosystem are required to aid EBM. Such indicators can be used to provide an objective, concise and cost-effective description of ecosystem status. The ideal characteristics of ecological indicators for the pelagic ecosystem are presented in Box 1.

Box 1. Ideal characteristics of pelagic indicators (Platt and Sathyendranath, 2008).

1. Represent a well-understood and widely-accepted ecosystem property.
2. Quantifiable unambiguously in standard units.
3. Measurable rapidly at low incremental cost.
4. Repeat frequency compatible with intrinsic time scale of properties under study.
5. Measurable at a variety of scales.
6. Possibility to create long (multi-decadal) time series.

The Partnership for Observation of the Global Oceans (POGO) contributes to the requirements for EBM observations by promoting reliable and sustained ocean observations to describe the state of the oceans, understand how they function and how they might respond to global changes and to help predict their future states. Remote sensing, which meets the requirements of speed, resolution, repeat frequency and cost-effectiveness was presented as an important tool to develop ecological indicators of the pelagic system that are useful for EBM. For instance, some ecological indicators that can be developed from remotely-sensed data on ocean color deal with the seasonal cycle of phytoplankton biomass, production and loss terms, annual production, new production, ratio of production to respiration, spatial variances in phytoplankton biomass and production, spatial distribution of phytoplankton functional types, delineation of ecological provinces and phytoplankton size structure (Platt and Sathyendranath, 2008).

In contrast to monitoring ecosystem changes at the global scale, community-based monitoring (CBM) has been advocated in Thailand through the Tsunami Impacts in Laem Son Project. The CBM was advocated as a low-cost alternative to monitor and protect the environment since high quality and high resolution scientific monitoring

Box 2. To be useful community-based monitoring needs:

1. Clear purpose and integration with policy drivers;
2. Scientific validation;
3. Formal process for training, data collection, synthesis and feedback;
4. Awareness at government level of its limitations; and
5. Recognition that it does not replace scientific monitoring.

may be costly at the national and local levels. The project aimed to determine the extent of recovery from the 2004 tsunami in terms of biodiversity and ecosystem function by training local scientists and communities to measure changes in intertidal biological assemblages. Box 2 presents some elements that need to be considered for CBM to be effective. The study suggested that the value of CBM can be maximized if it is linked to existing data, data is collected by government employees and the academe, with national or regional scale data centers, and that routine scientific monitoring be conducted in areas where disturbance is greatest. It was also mentioned that government buy-in is needed to establish continuity and enthusiasm.

The integrated concept of humans-in-nature called social-ecological systems, where interactions occur at multiple temporal and spatial scales within a given ecosystem, is applied in the river-coastal stream of Siak River Basin in Indonesia, a 300-km long river that traverses five municipalities in Riau Province and drains into Malacca Straits. The river-coastal stream is ecologically connected and changes to this connectivity would affect the adaptability of the social agents related to the ecosystem. Siak River is impacted by pollution and other forms of environmental degradation, which have influence on the social system, particularly in terms of livelihood development of fishers along the area. The study provided examples on the capacity of the fisher communities in the Siak River Basin in adapting to the changes in the social-ecological system. Identification of best policy options that are designed to achieve sustainability of the Siak River Basin is the ultimate goal of the initiative as well as understanding the need for integration in the context of integrated coastal management (ICM).

The complementarities and divergence of two management approaches and frameworks, EBM and ICM, in terms of concept, limitations and application with special reference to the experiences in East Asia were explored. ICM and EBM complement each other in terms of operational modality where both adopt an integrated and ecosystem-based management approach to managing the living resources and protecting ecosystem functions and services. They differ, on the other hand, in terms of priority, focus,

Box 3. ICM implementation in Xiamen, China.

1. First cycle: new legislation, strategic environmental management plan, pollution reduction
2. Second cycle: sea use zoning, habitat restoration
3. Third cycle: transboundary issues including upstream pollution
4. Effective involvement of scientific expert group
5. Demonstration site for 10 additional ICM sites in China

outcome and area coverage. For instance, EBM focuses on ecosystem protection and management by taking the entire ecosystem such as the management of large marine ecosystems. ICM on the other hand may start with a small geographical scale within the administrative boundary of a local government and gradually scale up to cover a wider geographic area or ecosystem. Regardless of these differences, the application of these management approaches is necessary to ensure a comprehensive approach in addressing environmental (including ecosystem) concerns at the local level as well as in large bays, gulfs and coastal seas. The experiences of Xiamen, PR China, illustrated the application of ICM in the first and second cycles and moving towards EBM on the third cycle (Box 3). The role of national policy in ensuring that integration of local ICM programs with national and regional EBM programs was highlighted.

The following are the conclusions and recommendations drawn from the discussions.

Conclusions

- Ecological indicators are an essential component for developing ecosystem-based approach to environmental management.
- Community-based monitoring can be a useful, cost-effective means for collecting data, but needs to be scientifically validated, have statistically rigorous design and harmonized methodologies.
- Lack of long-term, systematically obtained data and scientific capacity hampers implementation of EBM in East Asia.

Recommendations

- Advocate the universal adoption of environmental indicators readily derived from satellite-based earth observations.
- Promote community-based monitoring programs using harmonized methodologies in order to create national and regional networks.
- Request national governments to incorporate specific ecosystem based goals and targets into ICM through national strategy and action programs to provide a basis for pragmatic policy implementation.

PART 2: INNOVATIVE APPROACHES AND METHODOLOGIES

A range of tools, innovative approaches and methodologies are available to facilitate detection of ecosystem changes, identify the causative agents and assess whether the management interventions are effective.

A critical review was conducted on the advantages and disadvantages of using various biomarkers/ bioindicators in environmental management in Hong Kong. Emphasis was made that many biological indicators have been successfully used in a cost-effective way in North America, Europe, Australia and New Zealand. Applications of biomonitoring in Asia, however, was said to be extremely limited. The experience of Hong Kong in developing 13 biomarkers/bioindicators that can be readily used in practical monitoring was highlighted (Box 4). It was proposed that countries in the Asian region should accord high national priorities to adopt and validate some of these biomarkers/bioindicators for use in their monitoring programs, so as to improve their cost-effectiveness and relevance to environmental management.

Box 4. Application of biomarkers for different management purposes.

I. Identify exposure to certain chemicals
- EROD, (Ethoxyresourufin-O-deethylase) in fish liver

II. Monitor spatial and temporal changes in pollution
- Body burden of metals and trace organics in barnacles and mussels

III. Provide early warning to environmental deterioration
- Fin erosion of fish
- Epidermal hyperplasia/papilloma of fish
- Condition Factor (CF) of fish
- Hepatosomatic Index (HSI) of fish
- Gonadosomatic Index (GSI) of fish
- Lysosomal integrity of mussels
- Imposex of gastropods

IV. Indicate occurrence of adverse ecological consequences
- Diversity indices
- Log normal distribution
- ABC (Abundance Biomass Comparison)
- Multivariate statistics of species composition

- Identify exposure to certain chemicals
- Monitor spatial and temporal changes in pollution
- Provide early warning to environmental deterioration
- Indicate occurrence of adverse ecological consequences.

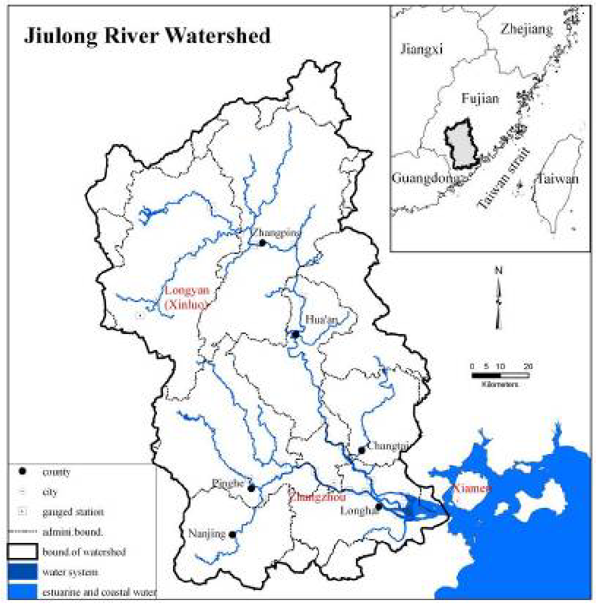
In Singapore, coastline modifications over the last 40 years have resulted in the reduction of its many coastal habitats. The remaining ones are situated within intensively-used waters that support one of the world's busiest ports and one of the largest oil refineries. The need to monitor Singapore's coastal resources is therefore very critical. Monitoring of Singapore's coastal environment has shifted from traditional monitoring of reef condition to biocriteria monitoring. Monitoring reef conditions considers the status of corals; whether they are improving or declining. Biocriteria monitoring on the other hand examines whether the environment is improving or declining above or below acceptable levels. Singapore's effort was highlighted in developing more robust, scientific monitoring tools that are designed to improve management responses to pressures. Current directions in biocriteria monitoring in the country looks at a variety of tools in the monitoring toolbox framework to determine limits of various coastal receptors, such as corals, for instance, to a variety of stressors (Box 5). The requirements of a scientifically sound monitoring program were

Box 5. Scale of impact classification currently adopted for projects in Singapore.

- **No impact:** No change to the quality or functionality of the receptor will occur
- **Slight impact:** Changes may be recoverable once the stress factor has been removed
- **Minor impact:** Changes unlikely to have any secondary consequences
- **Moderate impact:** Changes are expected to be locally significant
- **Major impact:** Changes are likely to have secondary influences on other ecosystems

emphasized. Future direction is focused on improving biocriteria development through primary research and expanding it to other coastal habitats.

A study in Xiamen, PR China, showed the benefits of conducting an integrated analysis of nitrogen pollution and eutrophication using long-term data to illustrate how human activities have influenced the river-estuary-coastal system. The study aimed to quantify the nitrogen sources including riverine input, atmospheric deposition, urban runoff and manure/sewage discharge to the Jiulong River watershed-Xiamen Bay, and to analyze the nitrogen spatiotemporal patterns and associated mechanisms. The Jiulong River watershed is an important source of water for drinking, agricultural and industrial uses. The study employed monitoring, modeling and application of GIS in estimating the nitrogen flux from various sources. The study showed that riverine input from Jiulong River watershed, is about 30% of total input, and dominated the nitrogen sources in the estuary-coastal system. The study also considered the relationships between nutrient loadings and occurrence of harmful algal blooms as well as the influence of climate-induced variations in hydrology. The results of the study recommended targeted management in specific spatial and temporal scales under an integrated river basin and coastal area management framework.



The following are the conclusions and recommendations drawn from the discussions.

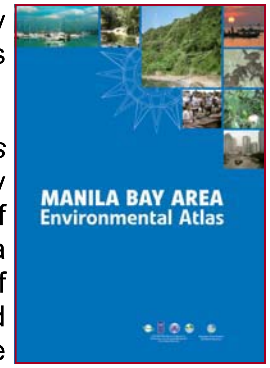
Conclusions

- Holistic monitoring programs should include biomonitoring (biomarkers, biocriteria), together with physical and chemical parameters.
- There are already clear signs of the impacts of global change on tropical ecosystems.
- Eutrophication due to nutrients derived from the watershed is a serious problem in the coastal zone of the East Asian Seas.

Recommendations

- Incorporate biological monitoring and, where appropriate, the use of biomarkers and biocriteria in environmental monitoring programs.
- Indicators should be adaptable and appropriate to changing climates.
- Recognize the need to integrate watershed and coastal monitoring programs and environmental management practices.
- A mechanism for regular inter-calibration and inter-comparison exercises needs to be considered at both national and regional scales.

PART 3: KNOWLEDGE TRANSFER AND COMMUNICATION



Making information visible means providing accurate and quality information to stakeholders in a timely manner and format that is understandable by the end users.

The impacts of the *Manila Bay Area Environmental Atlas* (Philippines) in terms of serving its purpose of providing quality information to stakeholders in the Bay area and facilitate attainment of their shared vision were reviewed. The environmental atlas has been a useful source of information for enhancing the awareness of stakeholders on the natural resources, and engineered structures, and the status of the environment of the Manila Bay Area. Aside from the textual information provided, the map-based information has been very useful in enhancing the appreciation and understanding of the stakeholders on the existing natural, social and economic features as well as threats in the area. The Atlas has also contributed in improving the performance of the various agencies and local governments in policy formulation, planning, decisionmaking and monitoring. Box 6 presents some examples on how the information in the Atlas was utilized for improved planning and policy formulation including identification of programs and projects that are designed to contribute to the overall management of the Bay. The mechanisms to sustain the Atlas in terms of updating the data and facilities as well as strengthening the Manila Bay Information Network responsible for developing the Atlas were discussed.

Box 6. Applications of Manila Bay Area Environmental Atlas.

- Integrating land and water in the planning process;
- Integrating climate change, and natural and anthropogenic hazards in planning and management;
- Developing various projects to implement the Manila Bay Coastal Strategy;
- Cleanup operations of illegally established structures in the Manila Bay;
- Strengthening the environmental impact assessment process by mapping environmentally critical areas; and
- Suitability assessment for establishing mangrove plantations.

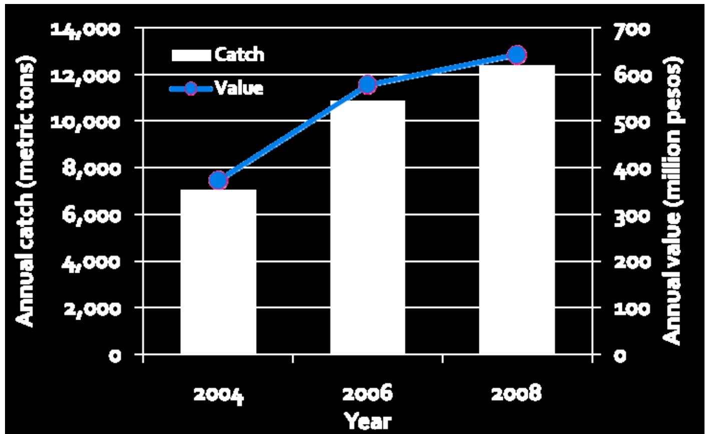
In addition to the Manila Bay Area Environmental Atlas, another key document that facilitates the protection and management of Manila Bay is the Operational Plan for the Manila Bay Coastal Strategy. To aid in measuring the progress and outcomes of implementing the operational plan, an integrated environmental monitoring program (IEMP) was developed by an inter-agency technical working group. The monitoring tasks were grouped into two main areas: biological-ecological parameters, which address the structure and functions of Manila Bay as an ecosystem (species and populations involved) and physico-chemical parameters, which characterize the physical and chemical conditions of the bay. The working group prepared a plan that is cross-sectoral, addressing major impact areas, uncertainties and data gaps as identified in the Manila Bay Refined Risk Assessment developed in 2002, and building on existing

Box 7. Characteristics of the Manila Bay Integrated Environmental Monitoring Program

- Inter-agency
- Cost sharing
- Data sharing
- Multidisciplinary
- Cross-sectoral
- Inter-linked with other initiatives
- Includes the resources and its physico-chemical environment
- Five-year implementation, review and assessment process
- Addresses special concerns

monitoring efforts of the different agencies (Box 7). The process of developing the plan, its components and the highlights of the pilot study to field test and refine the IEMP was described including lessons learned, challenges and future directions.

In terms of fisheries management in the Philippines, the technical support provided by the Fisheries Improved for Sustainable Harvests (FISH) Project in Danajon Bank (Philippines) to local governments and a broad base of stakeholders in developing and implementing ecosystem-based fishery management (EBFM) through capacity building, constituency building, and policy improvement was presented. Control mechanisms that were put in place to bring about changes in the exploitation patterns among resources users include, among others: establishment of marine protected areas (MPA) that will form a network of MPAs, species-specific management (spatial and temporal close season), gear restrictions and size limits, registration and licensing, zoning of fishing and water use activities, and cross-cutting activities in information, education, communication (IEC); policy improvement; and fisheries law enforcement. The project is expected to result in an increase in fish stocks by 10% in 2010 over the 2004 base period. The EBFM approach of the project is incremental and interventions were initially focused on four municipalities and currently being expanded to cover the rest of the seventeen municipalities constituting the Danajon Bank Double Barrier Reef system. One key aspect, which is considered crucial in the success of the EBFM initiative, is matching the spatial range of the ecosystem with the governance system.



Volume and value of catch
- 7,037 mT (2004) – 12,370 mT (2008): increase by 76%
- 690 (2004)- 1,600 (2008) kg/fisher/yr
- Equivalent to an increase of 19% per annum

The importance of using numerical modeling to determine the changes in the hydrodynamic conditions of Xiamen Bay covering the period 1938-2007 and how it provides information to management, particularly those related to optimizing restoration projects in the coastal areas, was shown. The cumulative impacts of reclamation activities in Xiamen Bay were presented using available information for 1938, 1984 and 2007. It was shown that the average tidal velocity and tidal flow capacity decreased by about 40% and 20% in the Western and Eastern Seas, respectively, if compared to 1938 data. This was attributed to the large-scale reclamation and dyke constructions, which started in the 1950s to cater to transportation, agriculture, harbor and airport and real state development. Based on the model, it was predicted that the hydrodynamic conditions in both seas could recover to the conditions in 1972 after completion of several environmental restoration projects in 2011 (Box 8).

Box 8. Proposed environmental restoration projects in Xiamen for completion in 2011

- Open the Gaoji dyke with an 800 meters bridge
- Open Maluan dyke, Xinglin dyke and Dongkeng dyke by 200, 250 and 700 meters, respectively.
- Dredge the deposited mud in Western and Eastern seas to the level of low slack tidal

The following are the conclusions and recommendations drawn from the discussions:

Conclusions

- Stakeholder involvement is essential for collecting fisheries data.
- Measuring and communicating the gains from intervention projects needs to translate scientific information into financial and economic terms.
- Long-term data sets are essential in defining changes due to human activities and climate change.

Recommendations

- Include socioeconomic data in monitoring assessment procedure.
- Communicate outputs from scientific research (data, assessment reports, publications) to stakeholders (policymakers, civil society, educators, etc.) in appropriate user-friendly language and formats, including public access by Internet.

Workshop on the Science in Ecosystem-based Management

Chairs:

- **Prof. Stephen de Mora, Chief Executive, Plymouth Marine Laboratory (PML), UK**
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Presentations:

Session 1: Integrating Science into Policy and Management Decisions

Introduction to the Science in Ecosystem-based Management
Prof. Stephen de Mora, Chief Executive, Plymouth Marine Laboratory, UK

Ecosystem-based management and the requirements for a knowledge base of observations
Prof. Trevor Platt, Executive Director, Partnership for Observation of the Global Oceans (POGO) Secretariat, PML, UK

The impact of tsunami on marine ecosystems on the coast of Thailand: some implications for coastal zone management
Mr. Michael A.Kendall, Plymouth Marine Laboratory, UK

Ecosystem-based management (EBM) and integrated coastal management (ICM): Divergence and complementarity
Prof. Xiongzhi Xue, Coastal and Ocean Management Institute (COMI), Xiamen University, China

Linking socio-ecological adaptability in the context of integrated river basin, coastal and ocean management: the case of Siak Riau Basin, Riau Province, Indonesia
Mr. Luky Adrianto, Center for Coastal and Marine Resource Studies, Bogor Agricultural University, Indonesia

Session 2: Innovative Approaches and Methodologies

The use of biomarkers and indicators for marine environmental management
Ms. Doris W.T. Au, Department of Biology and Chemistry, City University of Hong Kong

Leveraging on science to manage and monitor Singapore's living coastal resources
Ms. Karenne Tun, Department of Biological Sciences, National University of Singapore

Nitrogen pollution and eutrophication problem in the Jiulong River Watershed – Xiamen Bay: Management Implications
Ms. Chen Nengwang, COMI, Environmental Science Research Center, Xiamen University, China.

Session 3: Knowledge transfer and communication

Making invisible information visible: Impacts of the Manila Bay Environmental Atlas
Ms.Bresilda M. Gervacio, PEMSEA

Promoting interdiciplinary reseach: Integrated environmental monitoring program of Manila Bay
Ms. Elvira Z. Sombrito, Philippine Nuclear Research Institute, Philippines

Towards ecosystem based fisheries management: The Danajon Bank story
Mr. Nygiel Armada, FISH Project, Philippines

Hydrodynamic changes of Xiamen Bay (1983-present) and management implications
Prof. Huasheng Hong, State Key Laboratory of Marine Environmental Science, Xiamen University, China