# Abstracts from All Speakers of Scientific Forum, WOW2009

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## Session I: Impacts of Global Changes on Estuary Ecosystems

**Chair: Prof. Ekko C. Van Ierland,** Wageningen University, the Netherlands
**Rapporteur: Magdalena Zaras,** Xiamen University

### Addressing Impacts on Estuarine Systems Including from Climate Change in an Ocean Governance Framework

By Gunnar Kullenberg
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**Basic features and significance of estuaries**

The estuary as a transition between the inland world of freshwater and the ocean retains some of the characteristics of both freshwater and marine environments. The estuary is trans-boundary; on one hand being influenced by up-land conditions and activities there, and by conditions in the adjacent coastal sea and ocean while on the other, influencing conditions vice-versa. The estuarine ecosystem performs several vital functions. The estuary is an important nursery ground. There are many estuarine benthic species but few purely estuarine fishes. Estuaries are classified on basis of geo-morphology, as drowned river valleys; bar-built estuaries; fjords; deltaic formations; or on basis of their salinity and density distributions.

**Socio-economic importance, uses and abuses**

The socio-economic importance of estuaries relates to most human activities including settlements and urbanisation, food production, transport, sewage and waste disposal and recreation. Impacts of human actions on the estuarine system include those due to: changes in river inflows and transport of terrigenous material and of nutrient balances; pollution, land-reclamations, urbanisation, constructions of ports, marinas and other infrastructure; destruction of habitats, loss of sea grass beds, mangroves, wetlands, tidal flats and beaches, leading to increased erosion, induced subsidence, loss of parts of the estuary, particularly deltaic formations, and active reshaping of shorelines by the sea. Biodiversity, wild-life, birds, and migratory species are disturbed or lost. All will be exacerbated by climate change.

**Expected climate change and potential consequences**

The IPCC 2007 concludes that warming of the climate system is unequivocal with evidence from observations of increases of average air and ocean temperatures, wide-spread melting of snow and ice, decrease of Arctic sea ice; and rising global average sea-level. An average warming in the range 1.5-3°C can be expected over this century relative to 1980-1999. The current annual sea-level rise is 3-4 mm. Studies of Large Marine Ecosystems show significant effects of warming, with temperature increases in many systems higher than the expected range. Examples of global impacts of warming include: 30% of species at increasing risk of extinction for 1-3°C increase and most coral reefs bleached; about 30% of global coastal wetlands lost for a 3-5°C increase; large

humanitarian concerns due to increased coastal flooding and impacts on Asian and African mega-deltas; strong negative effects on fisheries from impacts on coastal systems as mangroves and salt-marshes.

**Management, ICM and ocean governance**

Recommendations of management actions with respect to maintenance of estuarine and low-lying coastal systems in context of climate change threats include: control of coastal developments, land-reclamations, ground-water exploitation; zonation into high-, medium-, low-risk categories; evaluation of cost-effectiveness of shoreline protection; use of satellite imagery for observation of impacts of sea-level changes; research for new data and modelling support, to address key vulnerabilities. These all fit within an ICM scheme. However, the ICM efforts must then include the climate change challenges, take into account the vulnerability of key systems to climate and related changes, and the long lead time for implementation of most adaptation measures.

Adaptation and mitigation are both needed. Adaptation is a dynamic process, just as ICM, with capacity to achieve it closely coupled to social and economic development. Ocean governance in the framework of UNCLOS contains integration and comprehensiveness, on basis that the problems of ocean space are closely inter-related and need be treated as a whole. The scope of ocean governance as defined by UNCLOS was extended to the coastal and adjacent land areas, where the majority of the population lives, through the seven additional instruments adopted by UNCED 1992 and subsequently, including conventions on climate change and biological diversity.

Through these developments the efforts at the coast become linked to the regional and global ocean governance framework. This is of significant importance in context of management and maintenance of estuarine systems e.g. with respect to: climate change. With each signatory to the UNFCCC, countries will be obliged to promote sustainable management of their coastal and marine ecosystems, marine biodiversity, and economically important migratory species. With each state signatory to the UN Fish Stocks Agreement, countries will be obliged to ensure compatibility of conservation and management measures for their EEZ with those for adjacent high-seas areas. They will have to regulate their shipping as obliged by the increasing role of the Port State Control convention. Application of these instruments will also ensure reaching the marine targets of the WSSD 2002 which is of great importance for estuarine ecosystems.

## Connecting the Issues of Global Change to Estuarine Management through Science——A Case Study Focused on the Chesapeake Bay Estuary, USA

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Coastal ecosystems are exhibiting signs of stress on a worldwide basis. The ultimate driving forces at the root of this mounting stress are global changes in the earth's climate and human induced land use changes. While fisheries exploitation is also an important agent of stress in coastal ocean ecosystems, the sustainability of the world's fisheries is arguably under greater threat from the

combined effects of climate and land use changes which threaten fisheries habitat through the warming and eutrophication of coastal waters. While global change is of great concern to scientists and governments, public support to confront global scale natural resource problems is usually initiated when society's expectations for ecosystem services, such as fisheries production and potable water provision, go unmet at local or regional scales. Here we utilize the Chesapeake Bay, one of the largest, most productive, and best studied estuarine ecosystems in the world, as a model to investigate how global scale problems can effect estuarine systems, and how science play a role in informing management options and initiating changes at an ecosystem level.

## The Littoral & the Wetlands Need New Laws to Manage the Effect of Climate Change

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**1 Global aspect**

One of the difficulties to adapt the International Laws Sea in a context of Climate Change (C.C) come in the fact to include the local specificities of the Regions in the global process.

Beyond the fact to separate the territories in two geographic categories: Continental and mainlands, there is some local aspect including the ecosystems which is in relationship with his population which lives from the sea resources. In this case, we will speack about "Geosystem" (concept founded in 1960 by the ***Russain V° SOCHAVA*** and expend later in France by ***N° BHEROUTCHACHVILI & G° BERTRAND*** in geography.

The nature of the aquatic ecosystems which is concerned by the sea level: the coast (littoral), the coral reef, mangrove Photo 1-2, swamp slattern, permafrost, is directly in contact with the sea and represents a source of food and one space of reproduction for many spaces.

Photo 1-2.

*Photo 1. Mangrove of Guadeloupe (Grand Cul de Sac Marin. The fauna living with the red mangrove (Paletuvié) photo SIMEON Jean-Luc, April 2009.*

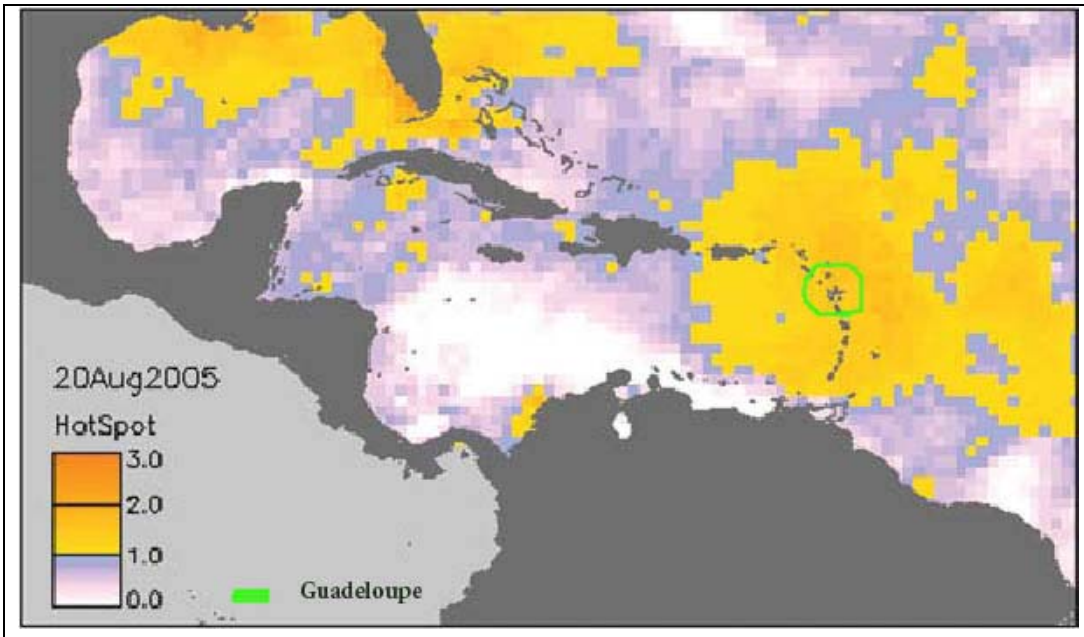
*Photo 2. Mangrove of Guadeloupe (Grand cul de sac Marin, photo SIMEON Jean-Luc, Avril 2009*

In the Caribbean's, particularly in Guadeloupe, we receive the call on whales and turtles from the seasons. The disappearance of some littorals will to be a tragedy for their equilibrium and the cycle of reproduction with all consequences on the oceans.
If the continent get less pressures because of the bigger potential of the evapotranspiration (coming from soil, the fauna, the forest and the lacks), the mainland because f their geographic situation (tropical) surrounded by water.

**2 Local impact of climate change on the sea**

It's not pertinent to build laws for short environmental and economic time. In 2005, the south of USA, Florida and the Caribbean's Islands was to undergo of the bigger climatic anomaly of the science story "Claude BOUCHON, Oceanologue from the Team Dynécar in Guadeloupe, interview 2008". Because of one higher temperature over 29°C degrees of the sea surface temperature from May to November 2005 *Image 1*, from 29°C to 32 °C degrees, we lost 40 % of our corals in 2006.

Image 1. Wilkinson C, Souter D, Status of Caribbean coral reefs after bleaching and hurricanes in 2005, p° 9.




*This image from mid-August shows a dramatic expansion of two HotSpots with temperatures 2ºC to 3ºC in excess of the summer maximum covering large parts of the Northern Caribbean including Florida, the Flower Garden Banks in the Gulf of Mexico and just touching Cuba. The HotSpot in the Atlantic has expanded alarmingly to cover all the islands of the Lesser Antilles; and there is a small HotSpot over Colombia and Guadeloupe.*

The fishing represents a very important incoming, the richness of the coral reef also one important touristic potentiality. This is a very good relevant example of the incapacity of our Region to face up to this anomaly and to the incompetence of our national legislation to take measures to prevent those sorts of disasters in the future.

**3 To change scale**

The Ocean is one extension of the coast and one part of the coral reef, to adapt the laws of the sea and to take up the challenge of Climate Change we have to change scale and to incorporate new civic values and another dimension, the "fellow participation". There are no International laws, that mean "no universal thrust in human law", because all countries are not equal front of the natural resources and the "Human Rights" and there is one thrust, each one have to take care of his citizens. It's often a question of priority to take some important decisions regarding the climate change. For some countries, the more urgent is to give his population foods, for other richer, that will be to developing their economy or to preserve their standard of living for the more rich. The laws have to be adapted depending the region, with the consent of the populations. The implication of the local population is one assurance of success of any policies. Therefore, we need other tools to educate them, new program to be reactive and project to protect the sensible areas.

**4 Managing the law of the littoral from tomorrow**

SMISD (Siméon Management & Innovation in Sustainable Development) is the company who propose today one very innovative approach of management of the costs, the wetlands and the coral reefs, the concept of "**Urban ecosphere**". The principal of this studded is to used the natural potential of the aquatic ecosystems to manage his equilibrium, the "Biotechnology" by the control of the Chain foods (chaines trophiques). In fact, we know that some plants have the capacity to absorb some pollution, to regulate the needed in Oxygen O2 and nitrate NO of the aquatic areas. The fauna have the same capacity to regulate the development of his biodiversity. The algae and the planktons have on every important role in those processes.

The coast is actually the first place of Business and Exchange of foods, material and goods. The danger for those seaports is not just the sea level, but the changing of Biodiversity which will develop because auf the stress for the estuaries, because of the climate change. In fact we will need other planning plans, new concept of managing the littoral in harmony with the Biodiversity which will change and could become a source of disease and risk for the commerce. How will react the rest of the world, if tomorrow they have some doubt about the viability of the seaports of their partner of yesterday.

But actually, this concept will not be able to adopt because of the laws which did not take in account some inevitable changing: Sea level, acidification of the sea, warmer of the sea, lost of coast and wetlands with very dangerous risk for the health (disease), disasters (lost of littoral and cities), the lost of beach (tourism), of coral reefs. Then, actually in Europe, it's not allowed to transform the actual protected areas because of a policy of preservation. But we have to be aware that those sensible territories, mainlands and lands with Littoral; like China *image 2*, France, USA will to be the first which will disappear if we didn't think about the alternative to give them other functions.

In the 60th years, the « *Program Biologic International* » gave a dynamic to build some new

methods of approach for the management of the Ecosystems but today we have more informations about the dangers in relationship with the climate change and the **uncertainties**.


*Image 2, The Seaport of China. P. Tourret, 2006.*

**Conclusion**

What is urgent to do ?

—In any council or international law projects which depend on the future of the environment, the scientists didn't have just to be consultants, but they have to take part of the decisions.

—It's urgent to allowed the scientists and the engineers to make some experiments to propose new allocations of used and management of the coast, the wetland and coral reefs.

—The laws concerning the coast (littoral), the wetland and the sea have to be more reactive and flexible to respond of the urgencies.

—It's necessary to build some tools, elaborate some protocols of management of the **uncertainties** in climate change to help the states and the regions to take decisions very quickly.

## Session II: Watershed Resources and Environment Management

**Chair: Mr. Jokab Branit,** Project Director, Stockholm International Water Institute (SIWI)

**Rapporteur: Josh Paglia,** Communication Officer, Stockholm International Water Institute (SIWI)

# Restoring the Water Quality of Lake Mälaren ----An Integrated Watershed Approach Benefitting Stockholm and Surrounding Waters

Jan Lundqvist[1]

Chair, Scientific Programme Committee for the World Water Week in Stockholm

**Purpose**

The purpose of the presentation is to provide details of how the Swedish water and environmental degradation reached critical levels by the beginning and mid 1960s and how this serious impediment to a stable development and quality of life has been reversed in important respects. Significant challenges remain, e.g. non-point pollution and new types of problems emerge, e.g. from chemicals. Cities and economic activities located near the coast deserve special attention. Because of their downstream position, they are exposed to the consequences of upstream activities. At the same time, they affect the coastal zone and marine environment relatively much, due to their size and geographical location. Most of the environmental policies and legislation were formulated and implemented from the 1960s and onwards. The process may be seen as comparatively smooth and as an example of the "Swedish model" with quite a positive outcome. It is relevant to mention that strong interests were skeptical and resisted the change that was required. In retrospect, there is consensus that the development that was pushed forward, through legislation, research findings and through media and the concern among the public has been successful and benefits have been enjoyed by various interests in society (industry, citizens, etc.). New production technologies (usually referred to as BAT – Best Available Technology), more comprehensive treatment of waste water and monitoring and evaluation programmes are concrete aspects of this change. As in many other contexts, the change is also very much the result of social, economic and political circumstances, barriers and drivers.

The presentation will include main features of Swedish water and environmental policy and provide details about the changes in Stockholm and the watershed surrounding the capital, which is located on the eastern coast of Sweden and facing the Baltic.

**Environmental externalities is an old problem**

Environmental degradation has passed through many phases. Water pollution and the fact that water is often a carrier of pollutants to water courses, inland waters and coastal zone and the sea is a common denominator. During the pre-industrial period, severe pollution problems were experienced in terms of poor sanitation, early manufacturing, pre-industrial energy, and transport systems. These problems mainly affected people locally, i.e. where they lived and worked. Outbreaks of cholera in Stockholm, the capital city of Sweden, and Gothenburg, second largest city (currently about 0.7 million) killed a large number of people in mid 19$^{th}$ century.

Water and environmental degradation must be analyzed in systems perspective in order to

1 This report has been produced in collaboration with Mr Anders Berntell, Mr Jakob Granit and Mr Andreas Lindström, SIWI and Dr Gunilla Brattberg, Stockholm Environment Institute and Ms Ulla-Britta Fallenius, Swedish EPA

understand the environmental externalities of human activities and the interplay with natural processes. What is positive for some, in some areas may be negative for other groups/interests and often in downstream areas. Introduction of bathrooms and WC in the 1920s, for instance, led to severe eutrophication in receiving waters and oxygen depletion, foul smell and health hazards. In the late 1930s, the popular swimming contests that were held in Stockholm were no longer allowed to continue due to health risks.

With the gradual growth of the industrial and urban society, the sources and types of pollution changed and similarly the geographical spread and impact. Water and environmental pollution and degradation caused by growth in economic sectors (industry, agriculture, forestry and energy) are of another sort and magnitude as compared to the impact from households mentioned above. (Today, the main impact from households refers to the consumption of goods and services and the inappropriate disposal of waste).

Improvement of water and environmental quality has been most noticeable in and around urban agglomerations, for instance, Stockholm and Lake Mälaren, which surrounds Stockholm. Since many years drinking this water directly from lake, in the middle of the capital is quite safe.

**Strategy to combat pollution**

The combination of an integrated environmental legal system, effective from 1969, and a collaboration between the private sector (industry), monitoring authorities, market related incentives and an increasing consciousness among the consumers, pushed by the media, paved the way for new water quality treatment technologies and plants, BAT (Best Available production Technologies) in industrial production.

A number of circumstances have contributed to a remarkable improvement is water and environmental quality in Sweden:

--the integrative character of the legislation,

--principle for permits to industries/economic enterprises,

--the role of competition between industries and variation in regulation between countries

--how the control and monitoring of emissions is taken care of by the industry itself,

--industry had to finance technical and other improvements themselves; municipal treatment plants were subsidized from national government, and

--the role of committed individuals and actions when “time is ripe”.

In my presentation, I will focus on some of the main drivers and barriers and how progress can be associated with these.

**Reluctance and resistance**

Like in other countries, there was a noticeable resistance and opposition from economic sector representatives. Negotiations between authorities and the industry were common, conflicts occurred and there was a reluctance to adopt a progressive environmental strategy in many industries. It is, however, also true that there have been cases where individual industries or activities have played a progressive role. Size of industry and context of competition are among the circumstances that are important in the behavior of industries.

Examples will be given from forestry/paper-pulp industry, which is located in various parts of Sweden but where a remarkable improvement has taken place (see Figure 1). Another example that may be used to illustrate the strategy refers to the reduction in the spread of mercury from dentists, which has been a considerable problem in agglomerations, e.g. Stockholm (Figure 2).

**Strategic benefits besides water and environmental improvements**

It is important to look at the benefits that came in addition to the environmental improvements. One significant aspect is a strengthening of the competitiveness of industry and an improved image or brand of industries as well as cities. In hindsight, also the skeptics acknowledge the changes that they previously were reluctant to adhere to. The noticeable improvement in ambient water and environment quality was achieved through technological progress, which is important in a competitive context and in strengthening the image of a brand.

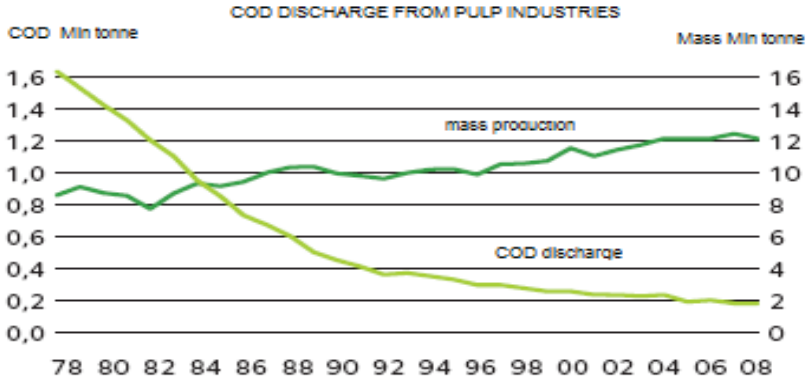



Figure1. *Graphs show COD discharge levels (million tonnes) and mass (pulp) production (million tonnes) variations over time. Source: (Swedish Bureau of Statistics), SCB, 2008*

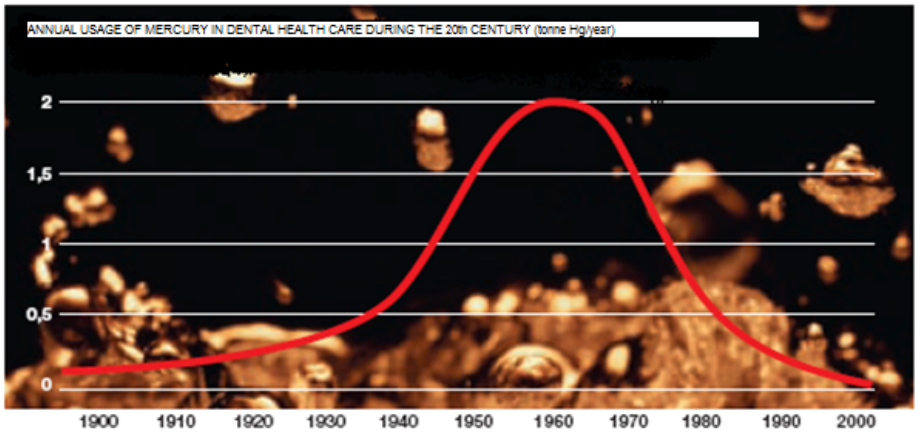



Figure2. *The graph shows the annual usage of mercury in dental healthcare in the Stockholm region during the 20th century. Notable is the considerable and drastic decline of levels during the period when intense debates on amalgam usage flared up and the continued decline as legal frameworks subsequently were put in place.*

**Assessing the multiple values of water and environmental policies**

Identification and assessment of various types of values that are at stake if water and environmental degradation are allowed to continue unabated and what values can be created from a successful policy have been made. These kinds of assessments are naturally extremely difficult to make. The remarkable restoration of the Lake Mälaren, the main water source for water supplies to Stockholm, has generated multiple benefits. It is a most significant recreation area in Sweden and attraction for tourists, from Sweden and abroad. Both in terms of recreational value and in a more concrete sense, the monetary and other values are significant. Total value has been estimated to be in the order of 40 billion SEK and the concrete values for industry and agriculture are in the order of 2 to 3 billion SEK each (Lindström, 2009).

# Integrated River Basin and Coastal Area Management Approach to Managing Bays: The Case of Manila Bay, Philippines[1]

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The Philippines faces one big challenge of effectively managing its natural resources particularly in areas of coastal and freshwater resources. The issue of mismanagement of these resources emanated from the current experiences of the country particularly the persistent and recurring problems relating to extensive flooding in low lying areas; water pollution; potable water scarcity; destruction of marine resources and habitats; decimation of fish catch; watershed degradation; and siltation and sedimentation of rivers, lakes and bays. Apparently, these problems are inter-connected and anthropogenic in nature but the compounding effect of climate change will make the adverse environmental impact worst. The aspect of flash floods and other river basin –related disasters which the country is experiencing due to inclement weather as a result of climate change must be properly addressed through effective Disaster Management and Preparedness, Climate Change adaptation and mitigation.

The Manila Bay serves as an important resource for the country because of its strategic use as the central shipment points of its export to the world markets, the central seat of the national government, home to high biodiversity communities of flora and fauna, and locations of great cultural and historical heritage of the country, and the catalyst of growth and development. The Manila bay catchment basin which constitutes a total of 17,000 km² watershed areas contributes 55% of the country's Gross Domestic Product. Because of its vital values to the country, the bay and its influencing watersheds must be properly managed and sustainably developed to preserve the long term interest of the country of achieving environmental integrity and socio-economic development.

The government policy direction to address these problems rests on its capacity to set in place an effective and unified governance, and workable institutional arrangement anchored on *Integrated River Basin and coastal Area Management Framework*. This framework was the result of a harmonizing strategy of the recent government policy initiatives in Integrated Coastal Management and River Basin Management as well as by adopting the PEMSEA's common framework for Sustainable Coastal Development. The scheme presents a useful guide for the national and local governments to promote sustainable development initiatives and programs in the Philippines with key areas of competence addressed in the governance component of the framework, namely: Policy, strategies and action plans; institutional arrangements; legislation; public awareness and information management; sustainable financing and capacity development.

[1] [1]Paper presented during the International Scientific Forum on World Ocean Week, Xiamen, Fujian Province, People's Republic of China, November 5-8, 2009.

# The Health Costs Associated with Harmful Algal Blooms: The Case of Florida Blooms of Karenia Brevis

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Harmful algal blooms (HABs) are known to be a significant natural hazard in Florida, one that is potentially increasing in both frequency and geographic scope. Florida HABs occur annually in the Gulf of Mexico as blooms of *Karenia brevis*. Due to the production of natural neurotoxins, called brevetoxins, these particular HABs can result in fish kills and mortalities to marine mammals and sea birds. Brevetoxins also may be aerosolized and transported by winds from the marine locus of a bloom to the coast and as much as one mile inland. Exposure to Florida red tide toxins may cause acute, subchronic, and chronic respiratory disease in humans.

It is important to estimate the socio-economic costs of *K. brevis* blooms for two reasons. First, the scale of the costs will help decision-makers assess the scale of potential policy responses. Second, the incidence of costs (who is affected) will enable decision-makers to target policy responses more effectively.

The objective of our study was to develop estimates of the economic costs of human respiratory illnesses that arise as the consequence of *K. brevis* blooms. We developed a statistical exposure-response model to express hypotheses about the relationship between respiratory illnesses and bloom events. We estimated the model with data on Sarasota Memorial Hospital emergency department (ED) visits, *K. brevis* cell densities, and measures of pollen, pollutants, respiratory disease, and intra-annual population changes. We found that lagged *K. brevis* cell counts, low air temperatures, influenza outbreaks, high pollen counts, and tourist visits helped explain the number of respiratory-specific ED diagnoses.

We found that blooms of *K. brevis* lead to measurable economic impacts in Sarasota County. An average estimate of the costs of cases treated in Sarasota County is on the order of $200,000 per year. The costs-of-illness of emergency room visits are a conservative estimate of the total economic impacts, however. In the future, estimates of the scale of economic impacts should be used to help make rational choices about appropriate ways of responding to the hazard in order to ameliorate its effects.

**Session III: Integrated Watershed and Estuary Management-Scientific Support**
**Chair: Prof. Gil Jacinto,** Marine Science Institute, University of Philippines
**Rapporteur: Jonathan Vause,** Xiamen University

## Scientific Basis for Integrated Assessment and Management of the Jiulong River Watershed-Xiamen Bay Water Pollution

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The river-estuary-coastal system is largely influenced by the climate change and the anthropogenic activities. The Jiulong River watershed -Xiamen Bay, located at Southeast China, has experienced rapid population growth, economic development and urbanization, accompanied by increasing water pollution and eutrophication problem. In this study, an integrated analysis was applied using long term data (1978-2007) of water flow and quality to assess how rain fall and land use change effected the special and temporal variation of water quality from the watershed to the Bay. The historical data showed that changing land use and external nutrients input from human activities in recent 30 years was a key driver of water degradation. The decreasing N/P values are observed ($P$<0.01) in Jiulong River runoff due to more chemical P fertilizers applied to cash crops land since 1990s and high phosphorous excreta discharge from proliferating livestock (swine). The changes in N and P export pattern from upstream systems might be closely connected with the recently widespread eutrophication and harm algal bloom (HAB) in Xiamen Bay. Additionally, physical–chemical alterations due to climatic events, such as stormwater discharge, flooding, droughts, and elevated temperatures are also critical. Agricultural nonpoint source pollution (NSP) input from the watershed through Jiulong River presented a large threat to Xiamen bay. Studies of NSP were conducted for the Jiulong River watershed with focus on the pollution sources, spatial distribution, transport pathway and fluxes estimation.

Based on the research results, the effective measures to control the water pollution problem are proposed. From the viewpoint of the integrated coastal management, reducing the anthropogenic nutrients input by a more efficient use of fertilizer and manure during the growing season (nutrient management), and trapping storm runoff in wetlands during the wet season (hydrological control) offer the key to eliminate nutrients loss and water pollution in this region. Control of both N and P discharge and management of low flow (ecological flow) is essential to mitigate eutrophication problem (HAB) in the Xiamen Bay. A GIS-based Jiulong River Watershed Information System was developed with the goal of information sharing and decision making for water pollution management.

World Summit on Sustainable Development (WSSD 2002) highlighted the integrated management from hilltops to oceans. The multidisciplinary and ecosystem approach can be a fundamental tool for future management of the Jiulong River Watershed -Xiamen Bay-Coast area. Long-term collaborative monitoring and modeling of environment dynamics are essential for developing realistic, ecologically sound, and cost-effective management strategies for the whole river-estuary-coastal system which impacted by both anthropogenic and climatic perturbations.

**Keywords**: nonpoint source pollution; water quality; eutrophication; management; Jiulong River

## Increasing Anthropogenic Nitrogen Inputs to the Watershed and DIN Exports from the Changjiang River Under changing human pressures

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We estimate the inputs of nitrogen (N) to the watershed and exports of dissolved inorganic nitrogen (DIN) from the Changjiang River to the estuary for the period 1970-2003, by using the global NEWS-DIN model. Modeled DIN yields range from 260 kg N $km^{-2}yr^{-1}$ in 1970 to 895 kg N $km^{-2}yr^{-1}$ in 2003, with an increasing trend. The study demonstrated a varied contribution of different N inputs to river DIN yields during the period 1970-2003. Chemical fertilizer and manure together contributed about half of the river DIN yields, while atmospheric N deposition contributed an average of 21% of DIN yields in the period 1970-2003. Biological N fixation contributed 40% of DIN yields in 1970, but substantially decreased to 13% in 2003. Point sewage N input also showed a decreasing trend in contribution to DIN yields, with an average of 8% over the whole period.

We also discuss possible future trajectories of DIN export based on the Global NEWS implementation of the Millennium Ecosystem Assessment scenarios. Our result indicates that anthropogenically enhanced N inputs dominate and will continue to dominate river DIN yields under changing human pressures in the basin. Therefore, nitrogen pollution is and will continue to be a great challenge to China.

**Key words**: nitrogen; input; export; the Changjiang River; human activity; scenarios; DIN model

## Influence of Seasonal and Periodic River Discharge Fluctuations On the Biogeochemistry of the Delaware Estuary

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The estuary of the Delaware River and Bay is one of the largest and most urbanized estuaries in the United States of America. It serves as a major drinking water supply to about 5% of the US population, one of the largest shipping ports in the country, and has significant municipal and industrial activities. The river discharge to the Delaware Estuary is dominated by the Delaware River and the subtributary Schuylkill River. High spring discharges control the estuarine hydrology and set up conditions supporting a major spring plankton bloom. Lower discharges in the summer months normally cause the estuary to be well mixed; a situation that may be changing with climate change. The balance between the watershed and urban anthropogenic inputs in the tidal river control nutrient distributions throughout the estuary. Distributions of dissolved inorganic carbon, dissolved organic carbon, and particulate carbon are strongly influenced by fluctuations in discharge. Examples from the Delaware Estuary are provided with the suggestion that patterns and controls in other urbanized estuaries be re-evaluated.

## Session IV: Integrated Watershed and Estuary Management-Policies and Approaches

**Chair: Prof. Huasheng Hong,** Xiamen University
**Rapporteur: Laura E. Higa**, Xiamen University

### New Approach towards Integrated Watershed and Estuary Management: Combining Concept and Activity on *Sato-Umi* and *Sato-yama* in Japan

Osamu Matsuda
Professor Emeritus, Hiroshima University

To the field of coastal management in Japan, a concept of integrated coastal management (ICM) has been officially introduced very recently through establishment of the Basic Ocean Law in 2007 and the following planning of the Basic Ocean Plan in 2008. This new policy includes comprehensive management of watershed and coastal waters beyond the border of administrative sectors relating to the management of forest, river, land, agriculture, coastal environment, port and harbor etc. However, implementation of ICM based on the Basic Ocean Plan is making very little progress mainly due to strong vertical system (bureaucratic sectionalism). On the other hand, activities of citizen and NGOs/NPOs which connect functions of forest, river and sea have made a remarkable progress. Among these, combining activity of *Sato-umi* and *Sato-yama* is one of promising approaches towards the implementation of ICM in the private sector. *Sato-yama* and *Sato-umi* can be both defined as a dynamic area that inter-relates people and nature in agriculture, forestry and fisheries. Compared to *Sato-yama* which is pretty well known as traditional sustainable land use and landscape in Japan, *Sato-umi* is relatively new concept which indicates coastal sea under the harmonization of sustainable wise use with conservation of appropriate natural environment and habitat conditions. *Sato-umi* should provides higher biological diversity as habitat and higher biological productivity as fisheries ground. Recent official systems and local activities on *Sato-umi* will be presented and some case studies of combining activities of *Sato-umi* and *Sato-yama* in the Seto Inland Sea area towards a new type of integrated coastal and watershed management will also be presented.
**Keywords:** *Sato-umi*, *Sato-yama*, integrated coastal management (ICM), environmental management, resource management, sectionalism

### From the Mountains to the Seas ——the Integrated Watershed and Estuarine Environmental Management Practices in China

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The links between watershed and estuary are not only the complex nature ecological processes but also the integrated management regimes. Since the actions of reducing marine environmental degradation caused by land based activities promoted by GPA, the departments of marine management, environmental protection, and water resources have jointed to establish a new collaboration of pollution control and ecological restoration from watersheds to estuaries. Some recent approaches embodied in national policies such as the “the Interim Examine Rule of

Pollution Control for Key Watersheds". On the other hands, two major national level environmental protection focused on marine environmental protection, The master plan of Bohai Sea Environmental Protection and the pollution control plan of middle and lower reaches of Yangzi river have been formulated in past few years, both of them paid more attentions on the links between watershed and estuary than ever before. In additional, the cooperation framework between marine management and environmental protection departments has been discussed and the joint gross control of pollution load is one of the key contents of the framework. In some updated national and regional policies and plans, the integrated watershed and estuarine environmental management will be stressed more and more with the new trends of industrial development in Chinese coasts.

## China's Watershed and Estuary Management: Policies and Practices

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Ecosystem based management of coastal and marine area increasingly directs our attention to developing innovative approach which considers river basins, estuaries and their associated marine habitats as a whole, namely dealing with upstream and downstream impacts of a water system as a whole. In1996，China Ocean Agenda 21 called for integrated land and sea management approach, setting up the target to mitigate pollution by 2000 and to secure good environmental quality by 2020 in key estuaries. In 2000, the National Ecological Environmental Protection Programme noted environmental degradation upstream of the country's major rivers, e.g. Changjiang River and Huanghe River, and required the establishment of inter-provincial management of key watershed ecosystem functional zones.

In 2007, to arrest ecological deterioration in the country's major functional zones, a comprehensive watershed management approach was emphasized, including multiagency mechanism, cross sector action programmes, investment initiatives and broad based participation by communities and general public. In the same year, the National 11$^{th}$ 5-Year Environmental Protection Programme took a further step in watershed management by requiring the development of target based responsibility system, water quality inspection at the provincial interfaces, ecological damage compensation scheme and integrated water resource use programmes. In 2008, State Ocean Development Programme 2010-2020 called for watershed/catchment management, requiring that management of upstream activities on land should be based on the assessed impacts downstream in the adjacent seas. In 2009, the state economic reform programme required the establishment of initial water rights system.

Despite efforts made as discussed above, operational framework and mechanisms for addressing ecological interconnections and upstream-downstream impacts of river basins, estuaries and their associated marine habitats are still lacking. For any success in the current effort to arrest the on-going coastal and marine ecological degradation, a cross jurisdictional, multi-sector and multidisciplinary approach for managing coastal water systems must be put in place.