by Rodolfo Quevenco

SUSTAINABLE MANAGEMENT OF COASTAL WATERS

A profile of the history and levels of coastal pollution in the Caribbean emerges

Five years is but an instant in the course of centuries recorded by the science of ocean sediment core sampling. But for the marine scientists gathered in Monaco in Spring 2011, the last five years yielded a treasure trove of data on the study and understanding of coastal pollution in the Caribbean.

The scientists represented countries sharing the coastal resources of the Caribbean Sea — Colombia, Costa Rica, Cuba, Dominican Republic, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, and Venezuela. Joined by experts from the IAEA, Spain and its Environment Laboratory in Monaco, they met in a special session on the Caribbean during the International Symposium on Isotopes in Hydrology, Marine Ecosystems and Climate Change Studies.

The session aimed to assess results of a regional project using nuclear techniques to measure the paths of coastal pollution in the participating Caribbean countries. First launched in 2007 under an IAEA Technical Cooperation project (RLA/7012), the project involved taking sediment core samples in all 12 countries, and analyzing these samples to determine the trend and history of pollution from heavy metals and organic contents for the last 100 years to support decision makers' appropriate environmental management decisions. Equipment and training were provided under the project to strengthen the analytical capabilities of participating countries' scientific institutions.

To date, about 6000 data points have been generated from the analysis of the sediment cores submitted by the participating countries. This information, including the trend of mercury pollution analyzed in the sediments, is the first-ever comprehensive results reported in the area.

There are similarities across the region and common pollution trends. For example:

- The coastal areas in the Caribbean are mainly used for tourism, fishing, industry and commerce, seaports, and as shelter for marine biodiversity;

- Coastal pollution has been steadily rising and results mostly from domestic sewage discharges, industrial waste dumping, residue from oil and other fossil fuels, shipping and port activities, hurricanes and other natural, agricultural runoffs, and deforestation and soil erosion;

- The most common types of coastal pollution result from high concentrations of heavy metals (lead, mercury), inorganic elements (cobalt, chromium, zinc, nickel), and organic pollutants (pesticides and polynuclear aromatic hydrocarbons).

Colombia

The Bay of Cartagena is one of Colombia's major waterways. It is a hub for tourism, for fishing and for industry. It also has one of the largest ports in the Caribbean and a manufacturing base for hundreds of small and medium factories.

Pollution in the Bay of Cartagena can be attributed to domestic sewage discharges; industrial dumping; leachate landfills; and sediments from the Canal del Dique.

Built over 300 years ago to connect Magdalena River to the Bay of Cartagena and the islands of Rosario and Barbacoa, Canal del Dique is considered to be the major source of sediment discharge for the bay. Its impact has been catastrophic for the bay's ecosystems, leading to the existing coral reefs' destruction, as well as of all sea grass. Dating tests indicate an increase in the sedimentation rate in recent years, due most likely to changing land use and climatic events affecting the canal watershed.

Across the Caribbean, pollution by heavy metals, including mercury, is causing increasing concern about its effects on tourism, clean beaches, and fishing. The presence of mercury in fish can be a health issue. This fisherman in Nicaragua relies upon clean water to catch fish that are safe for him and his family to eat.

(Photo: D.Sacchetti/IAEA)

Mercury pollution is also evident in Cartagena Bay, according to the analysis presented, with high concentrations detected in the deeper sediment layers.

Efforts are invested in ensuring the canal's navigability, but not the sustainability of the ecosystem. Dredging can further mobilize mercury present in sediments, thus emphasizing the need and importance of heavy metal pollution control in Cartagena Bay.

Cuba

The Bay of Havana is Cuba's major waterway and gateway to its capital city. The coastline is densely populated and includes a large number of industries that dump their sewage into the water. An oil refinery and the sewage system built as part of industrialization and urbanization have contributed to oil and organic pollution in the bay.

Sedimentation rates show an increase from 1890 to 1980 with peaks attributed to severe weather events that have hit the area. From 1990 there has been a reduction of sediment accumulation rates, coinciding with efforts to reduce socio-economic activities and implement sound pollution reduction measures.

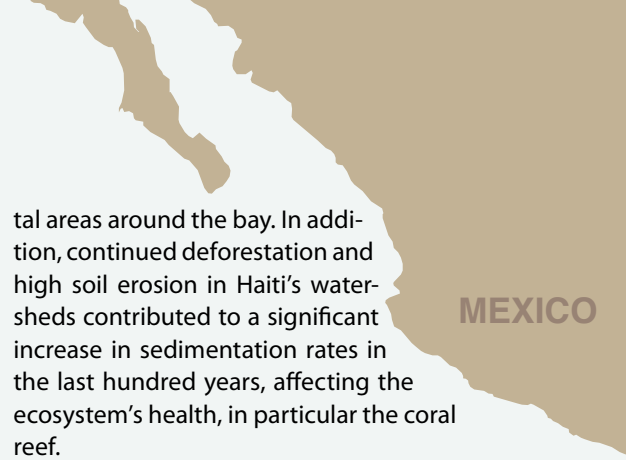
Overall, measurements continue to indicate pollution levels are higher than values prior to values from the 19th century but that management measures implemented in the bay since 1990 have helped restore the natural flow of sediments in the marine ecosystem.

Data collected have made it possible to understand the evolution and current state of pollution, and demonstrate the impact of rehabilitation programs to restore the environmental quality of the ecosystem.

Dominican Republic

Huge volumes of agricultural pollutants and industrial and municipal waste make their way into Rio Haina from industrial areas in the basin and from the city of Santo Domingo. The country conducted its first studies to assess the extent of the contamination in the mid-90's. From 1995 onwards, a recovery program was implemented to reduce the effects of pollution. Some improvements have already been reported.

Analysis of the sedimentation at Rio Haina indicate peaks during periods of extreme weather events, for example, strong hurricanes that struck the area in 1940, 1945, 1979 and, again, in 1998.



While recorded levels of organic and inorganic pollutants are low, there is an increased trend in the presence of lead, arsenic and other organic pollutants in the area.

Pesticide pollution — from DDTs — fluctuated in correlation with their use in farming activities, decreasing from the 1980s onwards as use of these pesticides were gradually discouraged.

Guatemala

Amatique Bay is a semi-enclosed body of water along the eastern coast of Guatemala hosting a complex ecosystem of coastal lagoons, swamps, marshes, river systems and channels that connect protected waters and the adjacent continental shelf. Fishing, tourism, shipping and marine conservation are among the main activities in the bay. Coastal and marine tourism alone accounts for 2% of Guatemala's gross domestic product; tourist visits have steadily increased through the years.

These activities are believed to contribute to contamination, in terms of leachate from solid waste; industrial effluent discharges; agrochemical runoffs and domestic sewage. However, it is soil erosion and deforestation that has been identified as the main environmental problem in the Amatique Bay.

According to a 2006 environmental profile of Guatemala, the country lost 11% of its forest area in the last 10 years, resulting in increased sedimentation rates in the bay area.

The continuous growth in sedimentation rates increases the vulnerability of fragile reef systems in the Atlantic region of Guatemala, and could directly impact the fisheries of the region.

Increased traces of heavy metal pollution have also been detected, but this has been attributed more to increased sedimentation rather than the level of industrial activity.

Haiti

Port-au-Prince Bay acts as a natural harbour for Haiti's like-named capital city. It hosts much of the country's industrial activities, such as loading docks, fuel storage, food processing, cement manufacturing, and metal processing, which constitute the major sources of pollution for coastal areas around the bay. In addition, continued deforestation and high soil erosion in Haiti's watersheds contributed to a significant increase in sedimentation rates in the last hundred years, affecting the ecosystem's health, in particular the coral reef.

Although industrial activity in Port-au-Prince Bay is limited, the generation of solid and liquid waste dumped into the bay — estimated at 1500 tonnes per day — resulted in a steady increase of heavy metals in the water, particularly lead and mercury. This represents a potential danger to public health from the consumption of marine organisms.

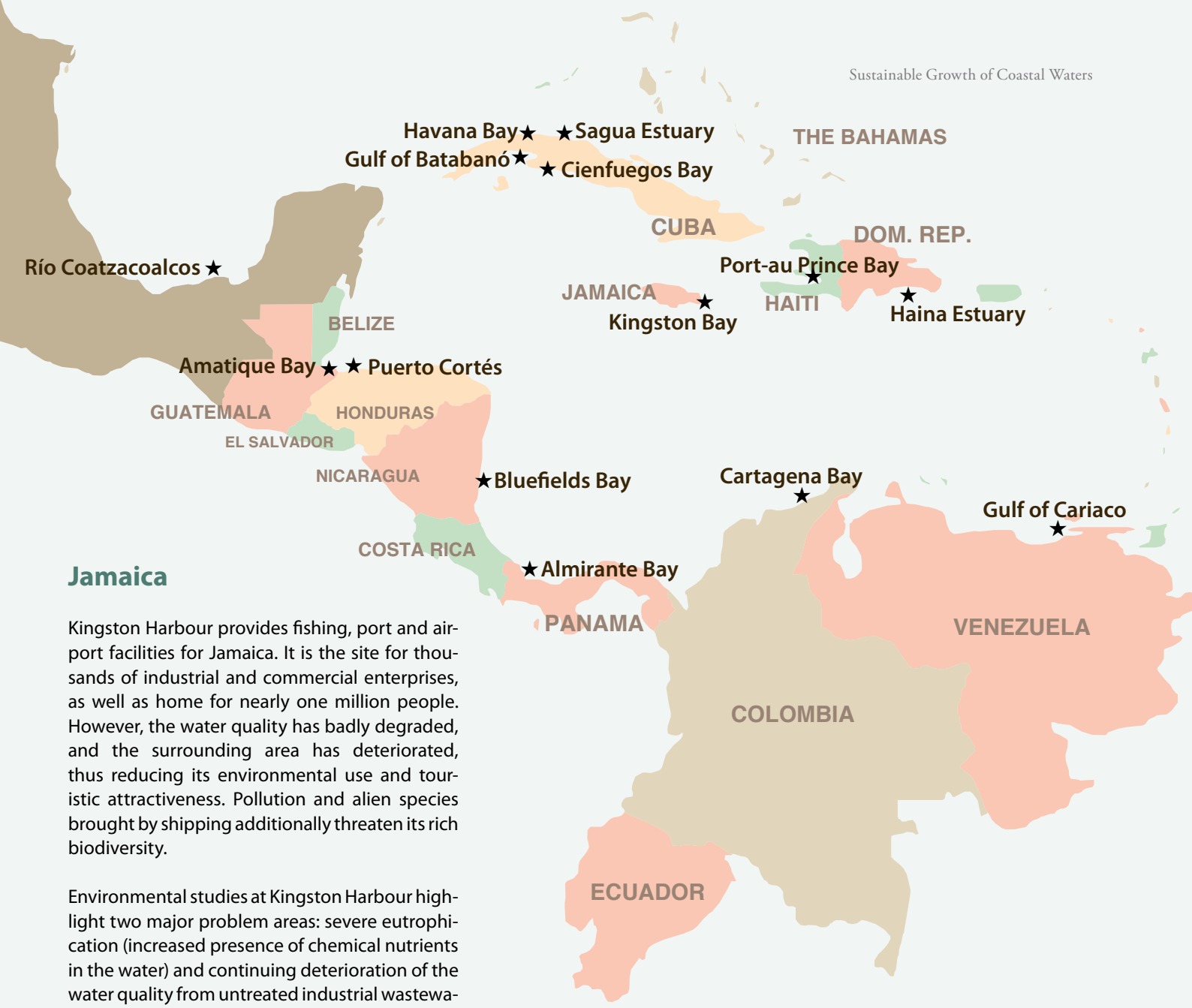
Information and data gathered so far on the evolution and state of pollution in the bay is expected to serve as baseline for evaluating policies and coastal management programmes to be established.

Honduras

The bay in the coastal city of Puerto Cortes in Honduras is the site for its fuel and mineral storage industries, fertilizer plants, and textile manufacturing. Central America's largest port – a hub for cargo vessels and luxury cruise ships – is also located along the bay. These activities, coupled with rapid population growth, constitute the main sources of pollution in the bay area.

At the same time, the high rates of erosion in the region, prolonged flooding of the coastal zone, and uncontrolled disposal of urban waste have contributed to increased sedimentation in the coastal areas. Hurricanes' seasonal passage aggravates the situation, resulting in increased pollution load and heavy metals discharge into the marine environment. The rate of sedimentation has tripled in Puerto Cortes in the last 50 years, and is expected to double its current rate in the next 20 years if left unchecked.

At the current rate of sedimentation, Honduras expects that the frequency and cost of dredging the harbour area may increase in the near future. Urgent measures may also have to be taken along the upper basins of the rivers Ulua and Chamelecon to control soil erosion.



Jamaica

Kingston Harbour provides fishing, port and airport facilities for Jamaica. It is the site for thousands of industrial and commercial enterprises, as well as home for nearly one million people. However, the water quality has badly degraded, and the surrounding area has deteriorated, thus reducing its environmental use and touristic attractiveness. Pollution and alien species brought by shipping additionally threaten its rich biodiversity.

Environmental studies at Kingston Harbour highlight two major problem areas: severe eutrophication (increased presence of chemical nutrients in the water) and continuing deterioration of the water quality from untreated industrial wastewater, disposal of agrochemicals and sewage, and an increased sedimentation rate in Hunts Bay caused by the Portmore Causeway, a bridge connecting Portsmore to Kingston.

Higher levels of polynuclear aromatic hydrocarbons have also been detected since the 1980s.

At the same time, high levels of metals were found in some sediments. The experts advise that the government should take this into account in coastal management efforts, and should also consider studying the uptake of metals by marine biota.

Mexico

The Coatzacoalcos River is the third largest river in Mexico. The industrial corridor built along its banks is home to about 65 petrochemical plants including the Lazaro Cardenas refinery, the oldest in the country. Waste water from industrial processes and expanding human settlements have dramatically altered the environmental profile of this important river basin.

Dating measurements using lead-210 showed that an increased rate in sedimentation and associated pollutants began to appear with the rapid urban growth and industrial expansion between 1970 and 1990. The increase in average sediment accumulation rates is most likely a result of soil erosion caused by changes in land use to support industrial and urban development in this area.

Increased oil pollution is also evident in the river estuary. Concentrations of organic pollutants in core sediments point to the burning of fossil fuels as a probable cause. From 1980 onwards, heavy metal concentrations in the area have reached levels that could pose a risk to marine biota.

Juan Pablo Parra of the Instituto de Investigaciones Marinas y Costeras (INVEMAR) laboratory in Colombia, recovers sediment from the seabed to check it for pollutants. After extracting a sample from the ocean floor, Parra will use nuclear techniques to identify contaminants and reconstruct the pollution sources.

Parra received training in using nuclear techniques to analyse sediment through a program supported by the IAEA's Technical Cooperation Programme.

(Photo: D.Sacchetti/IAEA)

The experts recommend a program of periodic checks, including measures to control the amount of urban and industrial effluent going into Coatzacoalcos river and its tributaries.

Nicaragua

The Bluefield Lagoon in the south Atlantic autonomous region of Nicaragua is an ecological haven for a variety of marine life and ecosystems. It provides a natural habitat for fish, crustaceans and marine species of great commercial interest. However, rapid population growth in settlements around the lagoon, and increased activities in fishing, forestry, and agriculture are threatening the balance of this delicate ecosystem.

The lagoon is also the main tributary of the Escondido river, which carries an estimated 11.6 billion cubic metres of sediment and river flow each year. Moreover, the devastation from Hurricane Joan in 1988 almost completely destroyed the basin and added significantly to sediment build-up.

Analysis of lead-210 dating and other environmental indicators have helped Nicaragua evaluate changes in the sedimentary process and identify possible causes. They also indicate trends of increased level of inorganic pollution in the last 100 years.

Nicaragua will be using knowledge gained from these analyses to replicate the study in other coastal ecosystems in Nicaragua with similar conditions, and even extend the study to inland water bodies.

Panama

A major economic activity in Almirante Bay in the province of Bocas del Toro, Panama, is the processing of bananas for export. Bananas have been grown in the area for over 100 years; it is an agricultural activity noted for its high dependence on agricultural chemicals and fertilizers and for increased cargo ship traffic to the local seaports.

This major industry thus accounts for the bay's increased pollution by organic chemicals and hydrocarbons. Another source of contamination emanates from the settlements along the Bay of Almirante. The absence of adequate treatment plants means waste-water, solid waste and sewage are deposited untreated directly into the bay or nearby rivers. In the last decade, the increasing the number of passengers who travel, for tourism, to Colon Island via water taxis, has exacerbated this situation.

These factors, combined with the bay's topography that inhibits the water's active exchange with the open sea, and the deforestation of the mangrove forest, have resulted in increased levels of environmental degradation of the marina in the Bay of Almirante.

Each of these country reports stress that data on the trends in heavy metal and organic pollution gathered for the last 100 years will be a useful tool for decision makers in crafting strategies for sustainable coastal management.

The Next Steps

The project on the sustainable management of the Caribbean Sea is scheduled for full completion in 2012.

Until then, follow-up training on the use of lead -210 for dating sediments and a review meeting for all counterparts are still foreseen. More important are strategies to make these reports available — in full and concise form— to as wide an audience as possible. The results will be presented at an inter-governmental meeting of the United Nations Environment Programme in the Caribbean for higher-level dissemination.

Strategies to further support Caribbean countries in developing and sustaining their individual capabilities for environmental monitoring and management should thereafter be developed to lend meaning to these valuable scientific results.

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Counterpart Institutes

The following national institutes participated in the regional project for sustainable coastal management of the Caribbean:

- Instituto de Investigaciones Marinas y Costeras (INVEMAR), Colombia (Institute of Marine and Coastal Research)
- Universidad de Costa Rica (UCR), Costa Rica (University of Costa Rica)
- Instituto Costarricense de Acueductos y Alcantarillados, Costa Rica (Costa Rica Institute of Aqueducts and Sewage Systems)
- Japdeva, Costa Rica
- Ministerio de Ciencia, Tecnología y Medio Ambiente, Cuba (Ministry of Science, Technology and Environment)
- Universidad Autónoma de Santo Domingo, República Dominicana (Autonomous University of Santo Domingo)
- Ministerio de Energía y Minas (MEM), Guatemala (Ministry of Energy and Mines)
- Empresa Portuaria Quetzal, Guatemala (Quetzal Port Enterprise)
- Ministère de l'environnement, Haïti (Ministry of the environment)
- Secretaria de Recursos Naturales y Ambiente (SERNA), Honduras (Secretary of Natural Resources and Environment)
- National Environment and Planning Agency, Jamaica
- Universidad Nacional Autónoma de México, México (National Autonomous University of Mexico)
- Universidad Nacional Autónoma de Nicaragua, Nicaragua (National Autonomous University of Nicaragua)
- Autoridad de Recursos Acuáticos de Panamá, Panamá (Authority for Aquatic Resources of Panama)
- Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT), Spain (Centre for Energy, Environment and Technology Research)
- Universidad del Oriente, Venezuela (University of the Orient)