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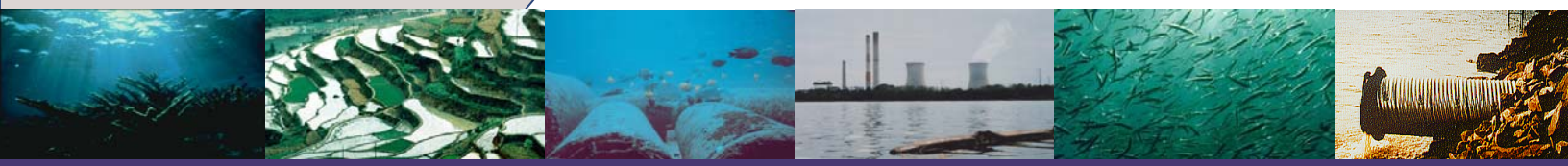
Oceans and Coasts



GLOBAL PROGRAMME OF ACTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT FROM LAND-BASED ACTIVITIES

GPA Outreach is a quarterly newsletter that helps raise awareness among a diversity of stakeholders of issues and activities relating to the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities. The United Nations Environment Programme acts as the Secretariat for the GPA. Stakeholder Forum is responsible for producing GPA Outreach.

The Challenge of Coastal Nutrient Over-Enrichment

Lex Bouwman, Netherlands Environmental Assessment Agency; and John Harrison, Washington State University

Coastal Eutrophication

The first workshop on "Coastal Eutrophication: Linking Nutrient Sources to Coastal Ecosystem Effects and Management" will be organized by the UN Educational, Scientific and Cultural Organization (UNESCO) Intergovernmental Oceanographic Committee (IOC) in Paris, France, from 2-4 February 2009. The aim of this workshop is to bring together IOC programmes and associated projects that deal with coastal nutrient over-enrichment and eutrophication. While each of these IOC programmes has independent missions and goals, their intersection would help advance common understanding of both current and future impacts of nutrient loads in watersheds on coastal water quality, ecosystem function, and policy responses.

Nutrient over-enrichment – a global issue

Nutrient over enrichment of coastal waters in marine ecosystems is an increasing global problem. The global load of nitrogen to the coastal zone increased three fold between the 1970s and 1990s, and is expected to continue to rise. In coastal waters, increased nutrients such as nitrogen and phosphorus, can cause phytoplankton and macro algae blooms, a process known as eu-

trophication. Eutrophication can lead to oxygen depletion (hypoxia) or 'dead' zones when algae die and are decomposed, thereby depleting the available dissolved oxygen. Other effects of eutrophication include the loss of subaquatic vegetation, nuisance or toxic algae that can lead to fish kills and shellfish poisoning in humans, coral reef degradation, and loss of species diversity. Globally, harmful algal blooms are considerably more widespread and frequent than they were a decade ago, and a further increase is expected in the future. While the effects of eutrophication have been documented in many areas around the world, many more exist for which data has not been compiled or is lacking. In particular, there is a need for additional information in the Asian, African, Latin American and the Caribbean regions, where eutrophication is likely to intensify.

"Land-based activities are the dominant source of nitrogen and phosphorus, and these can enter coastal ecosystems via air, surface water or groundwater."

Land-based activities: the dominant source of nutrients

Land-based activities are the dominant source of nitrogen and phosphorus, and these can enter coastal ecosystems via air, surface water or groundwater. Key sources of anthropogenic nutrients include: agriculture (through fertilizer leaching and runoff from agricultural fields, animal manure from concentrated livestock operations, and biological nitrogen fixation by leguminous crops); aquaculture; wastewater discharge from sewage and industry; and atmospheric deposition. Enormous advances have been made over the past several years with respect to global models for estimating nutrient export to the coastal zone.

Over the last decade a number of global, regional and national initiatives have identified and addressed the issue of nutrient enrichment to the coastal zone. The Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA) is one of them, as it is the only intergovernmental programme that addresses the inter-linkages between freshwater and the coastal environment. Several UNESCO-IOC programmes and activities address issues related to nutrient loading, coastal effects or coastal management:

"Several UNESCO-IOC programmes and activities address issues related to nutrient loading, coastal effects or coastal management."

- Global NEWS (Global Nutrient Export from Watersheds), which deals with current global nutrient export to the coastal zone and future scenarios.
- GEOHAB (Global Ecology and Oceanography of Harmful Algal Blooms), which focuses on the occurrence of harmful algal blooms.
- ICAM (Integrated Coastal Area Management), which deals with management for addressing various problems in the coastal area, including those associated with changing nutrient loads and ratios.
- GOOS (Global Ocean Observing System), which is a permanent global system for observations, modeling and analysis of marine and ocean variables to support operational ocean services worldwide.
- LME (Large Marine Ecosystems), which concentrates on pollution, habitat loss and overfishing in linked watersheds, marine resources, and coastal environments.
- LOICZ (Land-Ocean Interactions in the Coastal Zone), which studies the changes in the biology, chemistry and physics of the coastal zone.

Linking nutrients and coastal management

The issue of linking nutrients and coastal ecosystem effects forms a clear intersection of these programmes. The workshop will bring together key persons from the above IOC programmes and associated projects, and additional participants with specific expertise as needed. One expected outcome of the workshop is the establishment of a Steering Committee that will further refine the goals, terms of reference, information needs, additional expertise and resources required for this project, and a workplan outlining the steps to integrate the programmes and further the

modeling tools. The project will be coordinated by Lex Bouwman (Netherlands Environmental Assessment Agency, Bilthoven, the Netherlands) and John Harrison (Washington State University, Vancouver, US). The main product resulting from this integrating project will be an assessment tool including global databases at various scales for use by policy specialists from developed and developing regions to use in the evaluation and implementation of current and future policies to improve coastal water quality.

Lex Bouwman, Netherlands Environmental Assessment Agency, Bilthoven, the Netherlands

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From the Editor

Sediments loaded runoff following heavy rain (photo courtesy of ICRAN)

The key to addressing coastal nutrient problems is understanding that they come from activities in the watersheds that feed coastal streams and rivers. The majority of the nutrient pollution flowing into the sea can be attributed to agriculture, primarily runoff of dissolved nitrogen and phosphorus from fertilizers applied to agricultural fields, golf courses and lawns. Most of the remainder comes from sewage treatment plant discharges, septic system leaks, industrial discharges, and even deposits from the air of nitrogen released by the combustion of fossil fuels or in vapors from fertilizers or manure. Considering that land-based activities are the dominant source of nitrogen, the GPA, as the only intergovernmental programme that addresses the inter-linkages between freshwater and the coastal environment, is uniquely placed to tackle and raise awareness of these threats.
This issue of the *GPA Outreach* focuses on nutrients and their impacts on marine and coastal ecosystems. We feature a number of articles that demonstrate the range of management issues that this problem raises, and the need for approaches which, while addressing specific sectoral impacts directly, also recognize the need for integrated management approaches. Lex Bouwman, Netherlands Environmental Assessment Agency, the Netherlands, and John Harrison, Washington State University, US, present the upcoming workshop on “Coastal Eutrophication: Linking Nutrient Sources to Coastal Ecosystem Effects and Management.” Secondly, Nicola Barnard, Senior Programme Officer, ICRAN, describes the impacts of land-based pollution on the Mesoamerican Reef. Finally, Morgane Danielou-Doumbouya, International Fertilizer Industry Association, provides an overview of the fertilizer industry’s efforts to reduce the negative impacts of fertilizer production and use on the marine environment.

Alice Bisiaux
GPA Outreach Editor

Impacts of Land-based Pollution on Coral Reefs: A Watershed Analysis for the Mesoamerican Reef

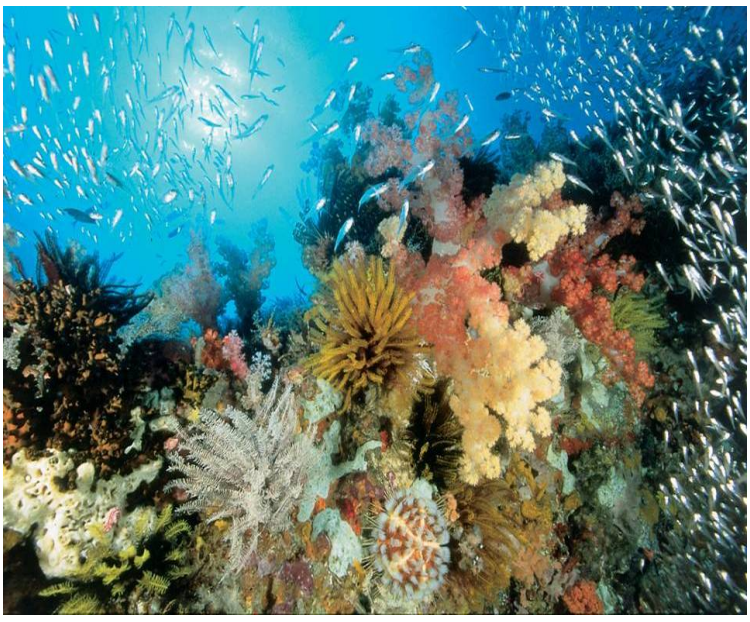
Nicola Barnard, Senior Programme Officer, International Coral Reef Action Network (ICRAN)

The alteration of natural landscapes for development, road construction, or agriculture can have adverse impacts on coral reefs through the increased delivery of sediment, nutrients and other pollutants to coastal waters. The erosion of agricultural soils, particularly on steep slopes and areas prone to intense precipitation, can produce sediments in coastal waters that block the light needed by corals for essential photosynthesis (or in extreme cases lead to physical smothering of colonies), while pollution from agricultural nutrients and fertilizers can promote the growth of massive algal blooms that deplete oxygen and light availability, and impede coral growth.

The regular release of small amounts of chemicals and sediments through land runoff, inadequate waste disposal, and poor sewage treatment can have subtle, but ecologically significant effects for coral reefs; affecting the reproductive physiology of both coral and fish species to produce viable young, and reducing the strength of coral skeletons by altering metabolic processes. Such effects have damaging implications for the continued provision of critical goods (e.g. food) and services (e.g. storm protection) by the coral reef ecosystem, upon which many human populations depend.

"The chronic effects of poor management of waste disposal and the activities of industry, agriculture, cities, towns, households and gardens are a major concern for the health of coral reefs across the globe."

The chronic effects of poor management of waste disposal and the activities of industry, agriculture, cities, towns, households and gardens are a major concern for the health of coral reefs across the globe. Certain model estimates indicate that 22% of the world's coral reefs are threatened by land-based pollution. Some scientists also believe that the apparent increase in coral disease over the last 10 years may be linked to high levels of nutrients and sediment from the land that allow diseases to thrive in warming coastal waters. Appropriate land use practices in erosion-prone areas are essential for watershed management to minimize the transport of sediment, nutrients and other pollutants to coral reefs.



Coral reef (photo courtesy of ICRAN)

Shared by Mexico, Belize, Guatemala and Honduras, the Mesoamerican Reef stretches over 1000 km and is the largest continuous reef in the Western Hemisphere. In the Mesoamerican region, over 300,000 hectares of land is allocated to banana, oil palm, sugar cane, citrus, and pineapple crop production. Fertilizer and pesticide residues used by farms, as well as eroded sediments drain through rivers and streams, and enter coastal waters along the Mesoamerican reef.

In 2004, the International Coral Reef Action Network (ICRAN) launched an ambitious regional initiative – the

Mesoamerican Reef Alliance (MAR) project - to promote the economically and environmentally sound management of the Mesoamerican reef. Through the ICRAN MAR project, the World Resources Institute partnered with UNEP-World Conservation Monitoring Centre and WWF to produce information and tools to: link patterns of land use within watersheds to the impacts on coral reefs; and identify reefs at greatest risk of degradation, watersheds most vulnerable to erosion, and those watersheds which contribute the most sediment and pollution to coastal waters (see Figure A for an example output of the analysis).

The tools were adapted to forecast potential trends, evaluate different policy or development options, and facilitate improved land management within the region. The models and diagnostic tools, which provided region-wide results indicative of the overall pattern and magnitude of erosion and nutrient, and sediment delivery across the region, were used to help educate and encourage key stakeholders to adopt a suite of “better management practices” to reduce their impacts on the coastal and marine resources.

Through technical trainings for the application of the analysis, and the formation of partnerships with agro-industry partners to reduce the presence of priority pesticides in the project area’s marine environment, and to control soil erosion from major commercial agricultural sectors, positive contributions have been made towards reducing the contamination threats to the Mesoamerican reef, which will continue beyond the life of the ICRAN MAR project.

Nicola Barnard
Senior Programme Officer, ICRAN

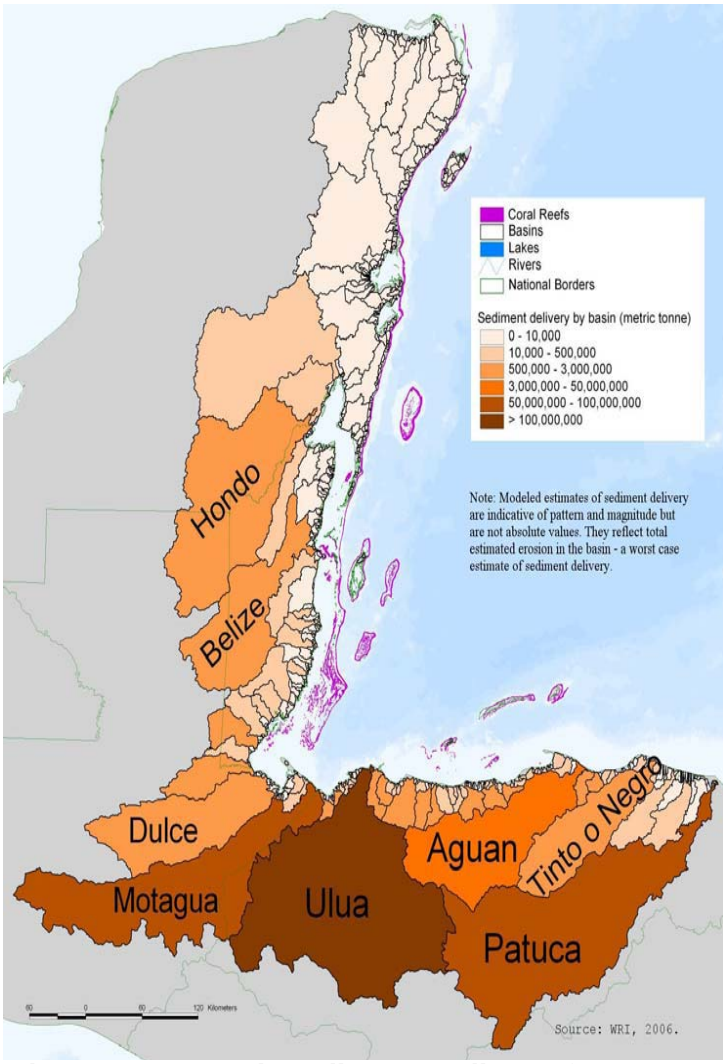


Figure A. Annual Sediment Delivery from MAR Watersheds

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Nassau grouper (photo courtesy of ICRAN)

Reducing Nutrient Losses to Marine Ecosystems

By Morgane Danielou-Doumbouya, International Fertilizer Industry Association

Nitrogen is a vital element for life on Earth. Plants need nitrogen because it stimulates root growth and crop development, promotes protein content, and improves the uptake of other essential plant nutrients. In most natural systems, “reactive” or "fixed" nitrogen is the most limiting factor in plant growth. This finding led to the development and rapid adoption of nitrogen-based fertilizers during the 20th century, such as urea and ammonium nitrate. The use of synthetic fertilizers has contributed to the dramatic increase in crop yields, which has allowed countries to sustain their ever-increasing population.

Excess of nutrients can lead to eutrophication

When nitrogen is applied to crops in the form of animal manure or synthetic fertilizers, not all of it is taken up by plants. The rest may be retained in the soil, or lost to the atmosphere and ground or surface waters. Excessive concentration of nutrients may contribute in certain marine ecosystems to eutrophication. This phenomenon has a plurality of causes, some of which are anthropogenic such as agricultural runoff and lack of, or poor, wastewater treatment. When excessive nutrients are carried through freshwater ways and reach the marine ecosystems, they accelerate plant growth leading to algal blooms, oxygen depletion and sometimes fish kills. Eutrophication occurs mostly in semi-enclosed marine systems, such as the Baltic Sea or the Gulf of Mexico, because of the physical barriers that limit free exchange of seawater between these systems and the open ocean.

“Eutrophication occurs mostly in semi-enclosed marine systems”

Fertilizer Best Management Practices

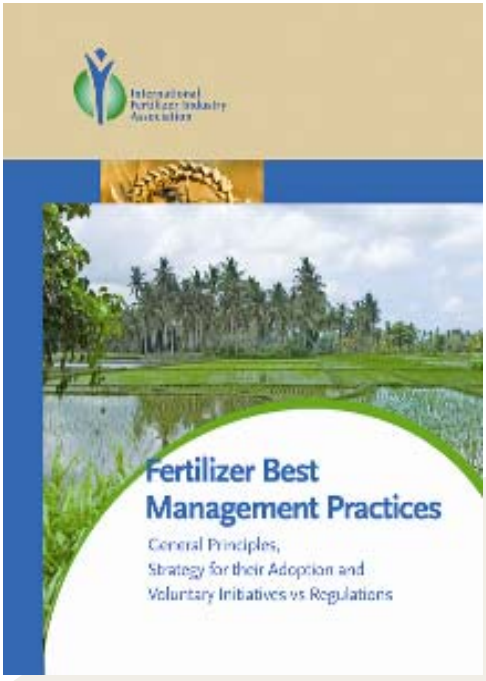
To address this important environmental concern, the fertilizer industry is working consistently with farmers to reduce its environmental footprint. On the production side, companies are improving operational practices, investing in effluent control, reducing the emissions to air, land and water, and restructuring production plants. On the consumption side, the industry is promoting education on the safest and most efficient techniques for using fertilizers with farmers’ associations, industry and government organizations. This strategy aims at optimizing nutrient use efficiency to reduce losses. Fertilizer Best Management Practices (FBMPs) have been developed by the fertilizer industry, research institutions and farmers organizations for achieving these objectives. FBMPs encompass some of the following principles:

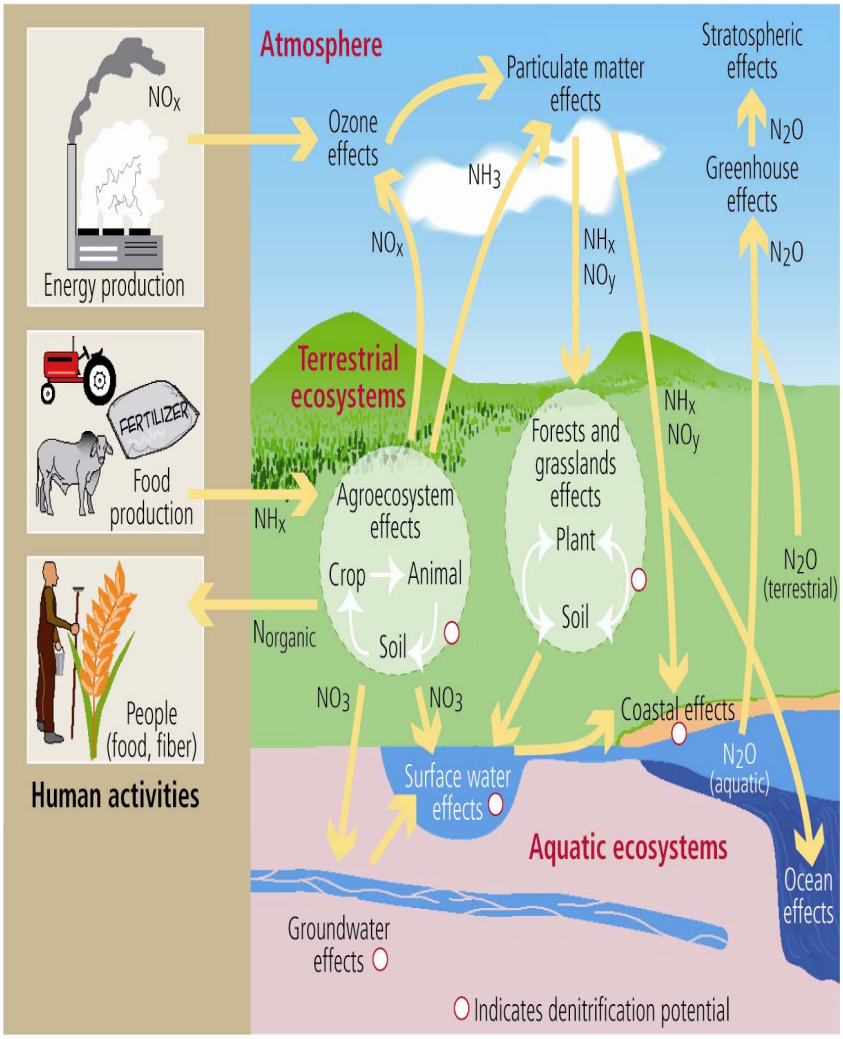
“The fertilizer industry is working consistently with farmers to reduce its environmental footprint.”

1. Organic and manufactured nutrient sources should be used in an integrated manner, i.e. farmers should start by recycling on-farm sources of nutrients (such as manures and crop residues) and then complement them with manufactured fertilizers.
2. Fertilizer use should be adapted to crop- and site-specific conditions. There is no one-size-fits-all solution. “Best” is a relative term, not an absolute judgment.
3. The right product(s) should be applied at the right rate, time and place. Among others, this means that all nutrients should be provided in the ratios required.

Any measure aimed at reducing nutrient losses through one pathway (e.g. through nitrate leaching) should not result in increased losses through other pathways (e.g. through ammonia volatilization or through denitrification). FBMPs are meant to maximize crop uptake and minimize total losses.

The International Fertilizer Industry Association is currently elaborating a global framework to foster the development and deployment of





The "Nitrogen Cascade": sequential effects of reactive nitrogen forms in the environment (IFA, 2007; adapted from Galloway *et al.*, 2003)

site- and crop-specific FBMPs. The initiative also aims to define indicators to measure the performance of FBMPs.

To support greater nutrient use efficiency, the industry recommends policymakers to:

- Fund research to better understand the most appropriate practices for various crop rotations under different agro-climatic and socio-economic conditions.
- Ensure that robust extension services exist so that farmers are exposed to recent practical research outcomes. Participatory research also strengthens farmers' capacity to influence the research agenda and to continuously fine-tune their practices.

Provide timely access to a wide range of fertilizer grades so that farmers can make the best choice for their particular situations.

Morgane Danielou-Doumbouya

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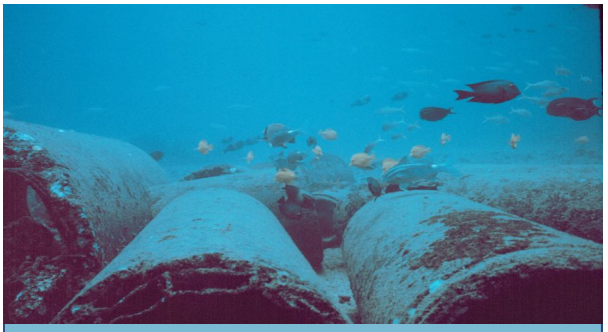

About Stakeholder Forum

Stakeholder Forum for a Sustainable Future's mission is to inform, influence, promote, and advance the implementation of sustainable development. Stakeholder Forum fulfils this mission by developing and facilitating multi-stakeholder processes that engage stakeholders in the development and implementation of sustainable development policy. To support multi-stakeholder processes, Stakeholder Forum also undertakes activities related to capacity building, training, and policy development.

Stakeholder Forum is delighted to continue its partnership with UNEP/GPA to undertake outreach and communicate the activities carried out by the UNEP/GPA Coordination Office and its partners.

For more information please visit ***www.stakeholderforum.org***

East Asian Conference Tackles Water Use and Pollution Reduction

The East Asian Seas (EAS) Congress 2009 carries the theme: *"Partnerships at Work: Local Implementation and Good Practices."* The Congress will highlight the role and various actions undertaken by international, national and local stakeholders, and the resulting impacts that contribute to the attainment of environmental objectives and targets at the community, country and global levels, with a particular focus on the seas of East Asia.

Two of the Congress 2009 workshop themes are "Water Use and Supply Management" and "Pollution Reduction and Waste Management." These workshops are a follow through on topics discussed during the EAS Congress 2006 session on Local Government Financing for Water, Sewage and Sanitation, which were co-organized by UNEP/GPA and the World Bank. The 2009 Congress will provide an opportunity to learn about: on-the-ground good practices that have been developed and demonstrated with respect to national and local government policy; innovative technologies and approaches to reducing the discharge of pollutants and improving water quality; and effective partnership arrangements involving governments, the private sector, communities and donors.

The EAS Congress 2009 is hosted by the Government of the Philippines, organized by Partnerships in Environment Management for the Seas of East Asia (PEMSEA) and the Philippine Department of Environment and Natural Resources. It will be held on 23-27 November 2009 in Manila, the Philippines.

More information: www.pemsea.org/eascongress

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About the GPA

The GPA was adopted in 1995 by 108 Governments and the European Commission in response to the increasing threat to the marine environment from human activities on land. The GPA is designed to be a source of conceptual and practical guidance for national and/or regional authorities for devising and implementing sustained action to prevent, reduce, control and/or eliminate marine degradation from land-based activities.

The UNEP/GPA Coordination Office, located in Nairobi, Kenya, supports the implementation of the GPA by: promoting and facilitating the implementation of the GPA at the national level and the regional and sub-regional levels; and playing a catalytic role with other organizations and institutions in the implementation of the GPA at the international level.

For more information please visit: ***www.gpa.unep.org***

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