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"Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand"

LAND-BASED POLLUTION IN THE SOUTH CHINA SEA

UNEP/GEF

Regional Working Group on Land-based Pollution

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First published in Thailand in 2007 by the United Nations Environment Programme.

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Cover Photo: Sewage system draining to communal cesspit on land, and domestic solid waste forming marine litter, Batam. Dr. Vo Si Tuan.

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Page 2	Solid Waste Littering a Coral Reef in Van Phong Bay, Viet Nam – Dr. Vo Si Tuan
Page 3	Algal Bloom as a Result of Nutrient Enrichment in Ca Na Bay, Viet Nam – Department of Science and Technology, Binh thuan Province
Page 4	Fish kill in Hainan Province, China – SEAFDEC
	Marine Litter Discarded in a Coastal Fishing Village, Batu Ampur, Indonesia –.Dr. Vo Si Tuan
Page 7	Compost Production from Organic Wastes in Batam Village, Indonesia – Dr. Vo Si Tuan
Page 7	Villagers with Locally Produced Compost Ready for Sale in Tanjung Riau Village, Batam, Indonesia – Mr. Noviandra

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This publication has been compiled as a collaborative document of the Regional Working Group on Land-based Pollution of the UNEP/GEF Project entitled *"Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand."*

For citation purposes this document may be cited as:

UNEP, 2007. *Land-based Pollution in the South China Sea.* UNEP/GEF/SCS Technical Publication No. 10

OVERVIEW OF REGIONAL LAND-BASED POLLUTION CONCERNS AND ACTIONS IN THE SOUTH CHINA SEA

INTRODUCTION

Geographical setting

The South China Sea is located in the Indo-West Pacific between the Pacific Ocean on the East and the Indian Ocean on the West, and has an area of 3.447 million square kilometres and a maximum depth of 5,245 meters in the Manila Trench. It is situated in the region between 3° South and 26° North latitude and between 100° and 121° East longitude. The South China Sea is surrounded by nine countries: China, Viet Nam, Cambodia, Thailand, Malaysia, Singapore, Indonesia, Brunei and the Philippines and contains many islands, including Hainan in the Northwest. Most of the islands are found to the South and East in Indonesia, the Philippines, and Malaysia where hundreds of smaller islands, atolls, submerged reefs and banks are also located. The northeastern sub-basin occupies about fifty percent of the total area of the South China Sea and includes a deep zone with abyssal plain, deep trenches and submerged peaks or guyots. There is an extensive continental shelf bordering the northern and western shores where pollution and contamination problems tend to be more prevalent than in the insular southern and eastern portions of the sea.

The South China Sea is connected to the Pacific Ocean by the Taiwan, and Bashi, Straits; to the Sulu and Celebes Seas by the Mindanao and Balabac Straits; to the Indian Ocean via the Straits of Malacca; and, to the Java Sea by the Kalimantan and Gaspa Straits. The Bashi and Malacca Straits are the most important in terms of the exchange of water between the South China Sea and other water bodies. The South China Sea receives freshwater input from many rivers, and the combined discharge from the Mekong, Pearl, Red and Chao Phraya Rivers is more than a billion cubic meters per year. The largest rivers draining into the South China Sea include the Mekong and Red Rivers in South and North Viet Nam, and the Pearl River in Guangdong Province, China. Discharges from these rivers, including land-based contaminants, influence the distribution of marine habitats and resources in the South China Sea.

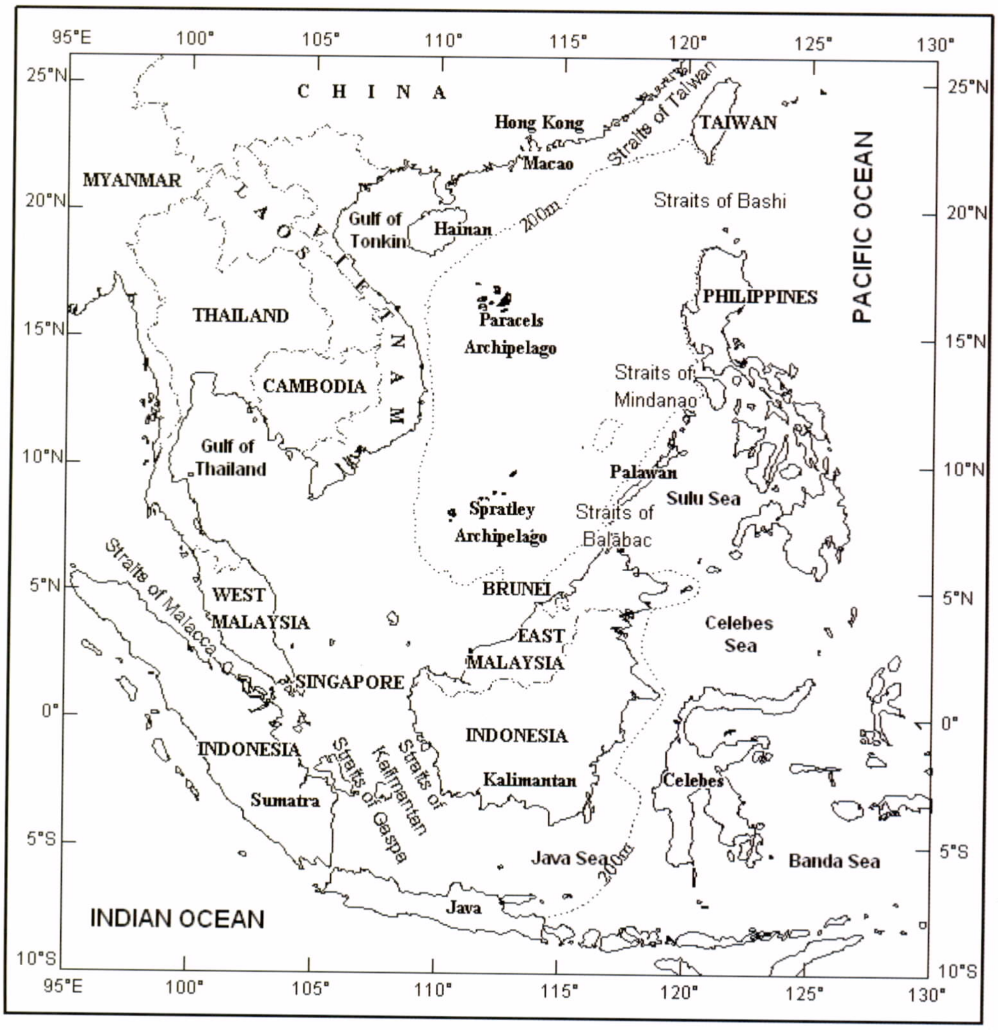

Figure 1 The South China Sea and Surrounding Areas.

The South China Sea is located in the monsoon belt of Southeast Asia with two monsoon periods: the Northeast monsoon from November to March in the winter, and the Southwest monsoon from June to August is in the summer. The two inter-monsoon seasons between April and May and between September and October are transitional periods of unstable wind direction and speed. The South China Sea is influenced by typhoons which originate both inside the South China Sea and outside in the Pacific Ocean. Typhoons mainly affect the coastal areas of Taiwan, China, the Philippines and Viet Nam, and typhoon surges from 3.2 to 3.6 metres have been recorded in China and Viet Nam.

The tides of the South China Sea are complex in comparison with most other seas or ocean areas since there are four different tidal regimes within the basin. Semidiurnal tides only occur in the Taiwan Strait and northern Viet Nam; diurnal tides dominate in the Gulf of Tonkin, and the Gulf of Thailand while both irregular diurnal, and semi-diurnal tides are found elsewhere in the basin, the latter predominating in coastal areas of southern China, Southern Viet Nam, Eastern Malaysia, Northwest Kalimantan and in the Bashi Straits. Maximum tide level at Minjiang (China) is 7.2m; Hong Kong (China) 2.7m; Cua Ong (Viet Nam) 4.7m; Sihanoukville (Cambodia) 1.8m; Bangkok Bar (Thailand) 1.2m; East coast of Malaysia 3.5m; Singapore Straits 3.6m; Sarawak (Indonesia) 5.4m; and Manila (Philippines) 2.2m. (Hydrographic Office, 1994).

As a consequence of the monsoons; the water exchange between the South China Sea and neighbouring water bodies; and the bathymetry of the South China Sea marine basin, there are two types of residual currents in the South China Sea. During the Southwest monsoon the main current flows in a Southwest-Northeast direction along the coast of Viet Nam, and from the Malacca and Kalimantan Straits to the Bashi and Taiwan Straits, resulting in the development of clockwise currents in the southeastern portion of the South China Sea, the Gulf of Thailand, and the Gulf of Tonkin. During the Northeast monsoon, the main current also flows along the coast of Viet Nam, but in an opposite, Northeast-Southwest direction. This is strengthened by currents from the Sulu and East China Seas, resulting in an anticlockwise current in the Gulf of Thailand and the Gulf of Tonkin. Currents are generally stronger in winter than in summer, except in the Gulf of Thailand.

Demographic and economic context

The countries bordering the South China Sea are some of the most densely populated and with the fastest growing economies in the world. It is estimated that more than 270 million people live in the coastal zone of the South China Sea'. Land-based activities are therefore the main source of contaminants and pollutants in coastal waters. Approximately 70% of contaminants entering the South China Sea are derived from coastal rivers, and include agricultural and urban run-off, industrial discharges, and discharges from ports and harbours. Coastal aquaculture is a significant and growing source of contamination, discharged directly, while inputs via groundwater have not been measured. The major categories of waste discharged into the South China Sea include domestic sewage, industrial and agricultural wastes, mining and construction wastes including sediments and mine tailings. Ship-based sources of pollution are a minor contributor to pollution problems in the South China Sea, but may have severe impacts when large volumes are released such as during major oil spills, and are significant in areas such as the Straits of Malacca where substantial volumes of shipping are concentrated during their passage from the Indian Ocean to the South China Sea.

Figure 2 Solid Waste Littering a Coral Reef in Van Phong Bay, Viet Nam.

Land-based sources of pollution

- ***Domestic sources:*** The total population of the nine countries bordering the South China Sea in 2003 was 1.716 billion people, of whom around 600 million were located in the coastal catchments of the South China Sea. Sewage and domestic wastes, including liquid and solid wastes are major pollutants of coastal waters. A large proportion of domestic waste in the South China Sea region is discharged directly or indirectly via rivers to the sea without proper treatment. It is estimated that the populations of countries bordering the South China Sea generate one million metric tonnes of sewage per year. The low level of sewage treatment has led to serious concern with regard to organic and nutrient pollution in the South China Sea. The high organic and nutrient content of untreated sewage leads to eutrophication, the occurrence of red-tides, and harmful algal blooms in localised areas of the coast. The consequences of this include anoxia of bottom waters, resulting in fish and benthos mass mortality. Declines in seafood quality, and public health hazards may result from build up of toxins in maricultured seafood, particularly shellfish derived from phytoplankton in the red tides and harmful algal blooms. Domestic wastes may also introduce pathogenic bacteria, viruses and protozoa to the marine environment which can be taken up by shellfish and reintroduced into the human food chain.
- ***Industrial sources***: These include liquid, solid and gaseous wastes from coastal factories involved in the manufacturing and processing of building materials, textiles, paints, food, minerals,

and hydrocarbons. Most factories employ obsolete technology and processes and the waste waters discharged into the South China Sea are normally untreated or only partially treated. These wastes contain significant amounts of heavy metals, oil and organic matter which can be toxic to marine organisms.

Figure 3 Algal Bloom as a Result of Nutrient Enrichment in Ca Na Bay, Viet Nam.

- ***Port and harbour sources:*** The South China Sea carries an enormous volume of marine transport and numerous ports and harbours have been constructed over recent decades to support international, regional and domestic maritime transport. Major wastes from ports and harbours include toxic compounds released from antifouling paints, such as tributyltin (TBT), and oil discharged from ships. Tributyltin is an effective biocide and is toxic to marine organisms at concentrations as low as one nanogram per litre. Ballast water often contains high concentrations of crude oil, which is toxic to marine organisms. It may also contain exotic organisms.
- ***Agricultural sources:*** The countries bordering the South China Sea have a substantial agricultural base. Large and increasing quantities of pesticides and chemical fertilisers are used in the region. Improper handling and application of pesticides and fertilisers has caused pollution of ground water, nearby rivers and coastal waters of the South China Sea. Fish and shellfish are extremely sensitive to pesticides, especially chlorinated hydrocarbons (e.g., the $96hLC_{50}$ value of aldrin to fish is 1 μg/L). Intensive animal husbandry is now a growing source of nutrient and organic matter contamination in the coastal waters of China, Viet Nam, Thailand and Malaysia.
- ***Mining sources:*** The mining of coal, minerals and building materials on land can contaminate the aquatic environment. Mining wastes include the chemicals used in the extraction and primary processing of minerals, low pH water from mine settlement ponds, sediments eroded from mining areas, and heavy metals leached from mine tailings dumps and spilled during transport. Dust from Vietnamese coal mines for example has degraded coral reef and seagrass habitats in coastal waters and sediments from mining have smothered coral reefs in the Philippines.
- ***Marine aquaculture sources:*** The aquaculture sector has developed rapidly in Southeast Asia over recent decades, largely in response to increased global demand for fish and shrimp products. China is the world's largest aquaculture producer much of it freshwater, whilst Thailand, Viet Nam, Indonesia and the Philippines are also amongst the world's most important aquaculture producing countries. The major pollution problems caused by aquaculture include the discharge of faecal matter from ponds and cages, which is typically high in organic matter, nutrients, and suspended solids, and contamination from antibiotics and other drugs added to the water to treat fish and crustacean diseases. The exposure of acid sulphate soils during excavation of shrimp farm ponds and the subsequent run-off of low pH water to coastal waters during rainfall events is also an issue of concern.

Figure 4 Marine Litter Discarded in a Coastal Fishing Village, Batu Ampur, Indonesia.

Contaminants and pollutants in the South China Sea

Land-based contaminants enter the marine environment through either point sources such as ports, harbours, and industrial complexes or through non-point sources such as rivers or groundwater that contain agricultural run-off, liquid domestic wastes and brackish-water aquaculture contaminants. Suspended solids are mostly derived from land-clearance, logging, coastal construction and the conversion of mangrove forests for other uses. Nutrient loads are mainly derived from untreated domestic wastes from coastal cities or urban areas discharged directly into coastal water bodies or rivers with minimal levels of treatment. Fertilisers, pesticides and herbicides in farming practices are also known to enter coastal waters of the South China Sea via run-off and leaching. Increased suspended solids and nutrient loads impact the productivity of marine ecosystems with suspended solids reducing light penetration and hence photosynthesis and enhanced nutrients increasing primary productivity. Concentrations of ammonia, nitrite, nitrate, and orthophosphate, are increasing and exceed the ASEAN Marine Water Quality Criteria in many locations. Increased inputs of nutrients apparently correspond to the observed frequency of red tides and harmful algal blooms.

The Pearl River estuary in the People's Republic of China is essentially a black river as the result of significant increases in organic pollutants, including nitrogen and phosphorus. Discharges to the South China Sea from the Pearl River estuary are not only high in nutrients but also cause very high Biological Oxygen Demand (B.O.D.)

Figure 5 Fish kill in Hainan Province, China.

Compared to suspended solids and nutrients, oils, heavy metals and persistent organic pollutants (POPs) pose an immediate threat to both living resources and marine ecosystems of the South China Sea. Oil and grease pollution from land-based sources contributes about 50 % to the total oil pollution in the marine environment. The threat of oil pollution to the marine environment and resources is even greater when there are no laws or limited law enforcement. For example, in Cambodia and Viet Nam there are no regulations pertaining to the discharge of ship wastes, with most waste engine oil being discharged directly into coastal water bodies. Similarly, concentrations of oil and grease, mercury, and phenols exceed ASEAN Marine Water Quality Criteria in many coastal water areas of the South China Sea due to weak regulations and minimal monitoring and enforcement.

Based on several studies conducted in the coastal waters of the South China Sea particularly in Thailand, the Philippines, Viet Nam, Malaysia and Indonesia it has been found that concentrations of heavy metals such as mercury (Hg), Arsenic (As) and lead (Pb) have tended to increase over the past two decades. These heavy metals have potential negative impacts on the health of marine living resources and humans who consume seafood products. Sound and strategic actions are needed at all levels of government and by stakeholders to curb heavy metal pollution and accumulation in sediments and biota in the hotspots.

	Water	Sediment	Biota
Cambodia	8	3	3
China	102	>9	none
Indonesia	100	none	none
Malaysia	128	none	none
Philippines	9	25	3
Thailand	170	50	15
Viet Nam	22	22	none
Total	539	>109	21

Table 1 Numbers of Coastal Water Monitoring Stations in the South China Sea.

REGIONAL COLLABORATION IN ADDRESSING LAND-BASED POLLUTION PROBLEMS

Over the past three decades several regional projects concerning marine pollution have been implemented by various organisations in the South China Sea region. These projects have produced useful information for marine pollution research and monitoring at the regional level and have also built capacity in the participating countries for marine pollution monitoring and management.

The Intergovernmental Oceanographic Commission Sub-commission for the Western Pacific (IOC/WESTPAC) has initiated several regional projects dealing with marine pollution research and monitoring, including an assessment of marine pollution from river inputs which resulted in a regional network of river monitoring systems to monitor nutrients inputs to the Western Pacific Ocean. This network extended over a wide geographic area from Russia in the North to Australia in the South and Fiji in the East. Two inter-calibration exercises were carried out as part of the project and training courses on analytical methods were organised for technicians and scientists from water quality laboratories within the region. The data generated from the project was transmitted to the Responsible National Data Centre for WESTPAC (Japan Oceanographic Data Centre, JODC), and relevant papers were published in the proceedings of the IOC/WESTPAC Scientific Symposia.

During the implementation of the global International Mussel Watch Project, IOC/WESTPAC initiated a mussel watch project to monitor pollutants such as heavy metals and pesticides in the WESTPAC region. A regional network was established, and training courses were organised. During the implementation of the project, reference materials prepared by the National Environment Research Institute, Japan were introduced to and used by the project. However, due to technical difficulties monitoring activities were only carried out in a few participating countries. The project established a mussel watch monitoring network within the region, and trained scientists from regional laboratories.

A third activity was an assessment of pollutants from atmospheric deposition in the WESTPAC region during which some attempts to monitor the deposition of metals (Japan) and organic compounds (PAH, in Thailand) were made. The major findings of the project indicated that the inputs of nutrients to the sea via atmospheric deposition could be as significant as those from river inputs. The results of the surveys in the Yangtze River and Yellow River supported this phenomenon.

Following the United Nations Conference on Environment and Development (UNCED) held in 1992, the Intergovernmental Oceanographic Commission of UNESCO developed the Global Ocean Observing System (GOOS). The Intergovernmental Health of the Oceans Panel, co-sponsored by IOC and UNEP, prepared a strategy for monitoring and prevention of marine pollution. The HOTO Strategy provided scientific guidelines for marine pollution monitoring and prevention, and managing the impacts on human health. The Strategy considered not only the chemical aspects of the pollution problem, but interdisciplinary approaches were proposed to the governments and scientists engaged in the respective activities.

Following the adoption of the Global Programme of Action for the Protection of the Marine Environment from Land-based Pollution (GPA/LBA) in 1992, the Regional Programme of Action for Implementation of the GPA/LBA was adopted in 1996, by the Coordinating Body for the Seas of East Asia (COBSEA[1]). Implementation of the Regional Programme of Action has been carried out since then, including preparation of regional review, organization of relevant workshops and training courses. The primary focus of COBSEA has been on the sources of marine contamination and pollution.

The Partnerships in Environmental Management for the Seas of East Asia commenced as a GEF project in 1992 and has subsequently grown and extended its operations to cover sixteen countries in East Asia. The main objectives have been to build national and regional capacity to implement Integrated Coastal Zone Management Programmes; to reinforce and establish a range of functional networks; and to strengthen national capacity for developing integrated coastal and marine policies as part of the state policies for sustainable socio-economic development.

ACTIVITIES OF THE SOUTH CHINA SEA PROJECT

Networking under the South China Sea project

The Regional Working Group for Land-based Pollution (RWG-LbP) established in the first meeting held in Bangkok, Thailand, 3-5 April 2002, is comprised of seven Focal Points from the participating countries[2], two Regional Experts, and one member from the Project Co-ordinating Unit (PCU). The government designated Focal Points were contracted to provide 25% of their time to the project under the Memoranda of Understanding signed between UNEP and the Specialised Executing Agency within which the focal point worked. The RWG-LbP links to other regional working groups and two regional task forces one for Economic evaluation and one for Legal Matters.

At the national level, the national co-ordinators or focal points were responsible for convening regular meetings of a national land-based pollution committee or working group. National working groups for land-based pollution were developed in all participating countries, and were Chaired by the National Focal Points. A total of 126 individuals representing sixty six separate national institutions were members of these committees which ranged in size from eight to twenty six members. A total of 12 institutions or agencies with expertise in various aspects of land-based pollution were sub-contracted at the national level to assist in the completion of tasks in the MoU signed with UNEP.

Regional Information Base for Land-Based Pollution Management

A problem identified during the development phase of the South China Sea Project was that, while many valuable data sets on land-based pollution were available within the region, the sharing of this information was restricted by weak data management systems in most countries. Limited cross-sectorial integration between government ministries and departments involved in marine environment and natural resource management was also identified as a key constraint in improving the information base for the management of land-based pollution of the South China Sea. In response to this, national and regional meta-databases were compiled to enable the sharing of data about existing pollution data sets (i.e., metadata). During the period from 2003-2007, a total of 226 meta-data entries on land-based pollution data sets have been contributed to the regional online meta-database for the South China Sea (http://metadata.unepscs.org) by Cambodia (12), China (27), Indonesia (13), Thailand (28), and Viet Nam (146).

The Regional Working Group on Land-Based Pollution also worked during the preparatory and operational phases of the South China Sea Project to collate data for inclusion in a regional GIS database on: the coastal impacts of pollution (ambient water quality/sediment quality); the impacts of pollution on human health; pollution loading from key rivers draining into the South China Sea basin; and land-based activities in coastal catchments of the South China Sea. However, despite the large number of water quality (539), sediment quality (99), and biota monitoring stations (21) in the South China Sea and Gulf of Thailand, very little information relating to data collected at monitoring stations was contributed to the regional GIS database by the countries (61 data sets in total). A total of 35 datasets relating to the impacts of pollution on human health, and 68 data sets relating to pollution loading from river catchments, were compiled at the regional level over the 5 years period to 2007.

Hot spot characterisation and priority ranking

The target for the land-based pollution problem is to set and maintain region-wide water quality standards and water quality objectives which will assist in maintaining the health of coastal ecosystems. In order to achieve this goal the project has adopted the marine water quality criteria adopted by the

[1] *COBSEA = The Co-ordinating Body for the Seas of East Asia, an intergovernmental forum of, presently 10 member countries, established by UNEP in 1981 and designated by the then 5 member countries as a means to execute the East Asian Seas Action Plan (UNEP, 1981) COBSEA was at that time congruent with the ASEAN Expert Group on the Environment (Para 36 of UNEP, 1981).*

[2] *Cambodia, China, Indonesia, Malaysia, Philippines, Thailand and Viet Nam.*

Association of South East Asian Nations (ASEAN) and the biological and sediment quality standards used in the People's Republic of China for use in characterising potential regional "pollution hot spots", the term which has been proposed for use within the framework of the UNEP/GEF project as follows:

"A limited and definable area in which there are prevailing environmental conditions attributable to anthropogenic activities that adversely affect, or threaten to affect, human health, threaten ecosystem functioning, reduce biodiversity and/or compromise resources and amenities of economic importance in a manner that would appear to warrant priority management attention"

The procedures employed in characterising pollution hot spots in this project partially benefited from work conducted within the preparative (PDF-B) phase of a UNEP/GEF project on the Russian Arctic. However, the refinement and augmentation of these procedures within the South China Sea project have substantially enhanced their potential replicability. The criteria for ranking hot spots were agreed by consensus and a total of 17 hot spots were characterised using the ranking system agreed at the second meeting of the RWG-LbP (UNEP, 2002).

In categorising the magnitude of the problems the "*impact on the marine environment*" was evaluated in terms of impacts on: water quality; sediment quality; biological samples; changes in living marine organisms; and affected marine communities. Ambient water quality was itself defined in terms of: nutrients; faecal coliform bacteria; heavy metals and dissolved oxygen concentration.

Ranking of the impacts resulting from contaminants in the South China Sea marine basin suggests that the reduction in water quality is apparently the major concern, followed by biological impacts which are less well demonstrated and thirdly contamination of sediments. In terms of the contaminants themselves the most widespread and severe problems resulted from enhanced nutrient inputs whilst heavy metals were found to be a significant problem in biological samples, and sediments of certain hotspots. The results form a sound basis for selection of pilot activities addressing regionally significant impacts of specific contaminants in hot spots of the region and capacity building.

Pilot activities

In evaluating potential pilot activities it was recognised that the resources available to the project were insufficient to rectify all pollution problems at even one pollution hot spot. The focus was to identify potential pilot activities that would serve as replication models addressing particular types of land-based pollution rather than to attempt the cleanup of individual sources or an entire "hot spot".

As part of this evaluation a "causal chain analysis" was conducted. A causal chain analysis is a recommended GEF tool used in the identification of the causes of change in environmental state, the level or scale of threats at a particular site, and the alternative points of intervention, along the chain of cause and effect. Optimally, all causes are identified and quantified and the potential benefits of intervention at any one point along the chain are evaluated, where possible through some form of cost benefit analysis. The causal chain therefore is used to provide an objective basis for deciding between different types of intervention at a particular site.

On the basis of proposals and their ranking by the regional working group it was agreed that the proposals for the construction of an artificial wetland in the Ling Ding Yang sub-catchment of the Pearl River estuary (China) and for Batam (Indonesia) were recommended to the Project Steering committee for support.

The Batam Pilot Site

The Municipality of Batam covers an area of 1,570.35km² located between 00^0 55' – 01^0 55'North and 103^0 45' – 104^0 10' East, bordered by the Singapore Straits to the North, the Bintan Utara Sub-District in the East, the Senayang Sub-District in the South, and Moro Sub-District in the West. In 2003 the population was 562,661 persons, 268,431 (48%) male and 294,230 (52%) female. Total population growth from 1990 to 2000 was 12% and over the period 2002-2003 it reached 5.5%.

Batam is located at a crossroads of international trade and is considered a major centre of economic development in Indonesia. Significant increases in investment across all sectors but particularly in commerce, industry, tourism, and real estate has occurred as a consequence of its proximity to Singapore and has resulted in negative impacts on the environment and resources.

Coastal and marine habitats and the environment of Batam city as a whole have degradation as a consequence of increased population and demands on marine resources of residents following achievement of higher living standards. This has led to overexploitation of resources, increase of domestic and industrial wastes, and physical destruction of coastal habitats. The major land-based pollution problem in coastal waters adjacent to the City is contamination from heavy metals and nutrients.

In term of pollution management, the Agency for Market and Sanitation of Batam City is responsible for the management of domestic waste. Usually, domestic solid waste from markets and the settlements in Batam are dumped in temporary sites prior to composting, burial or, burning. The Environment Impact Management Agency (Bapedalda) is in overall charge of environmental management with responsibilities for monitoring, control and supervision of natural resource use and environmental impact analysis.

With the support of the pilot project, a multi-sectorial management board was established that will be maintained beyond the life of the project. This body not only co-ordinates the pilot activity but also integrates the work of related entities in the planning and implementation of activities for the sustainable development of the entire city. A rural village outside Batam City was selected for trialling a communal septic system and management of the solid wastes.

In managing the solid wastes in this village the project organised waste collection, storage and treatment at the village. Two hundred plastic rubbish bins were provided for collection of solid wastes separated into organic wet materials and non-organic dry wastes. The organic wastes were gathered in a temporary waste management site and used to produce compost. Around 300-400kg of compost is produced per month from organic waste. The product is used as fertiliser in the village and provides an additional source of income. Non-organic waste is transported for disposal at the solid waste dump site of the city.

Figure 5 Compost Production from Organic Wastes in Batam, Indonesia.

The project has worked closely with local communities in Tanjung Riau village in order to address environment problems caused by domestic waste. Ten systems of communal septic tanks were installed each providing for the needs of for 8-10 families. One third of householders of the village are now connected to such systems and plans are in hand to replicate this system elsewhere.

The activities in domestic waste management have not only improved sanitary conditions in the village but have also proved helpful in enhancing awareness and generating support from the local community for environment management. The management board has encouraged replication of the practices in domestic waste management in Tanjung Riau village as part of the policy of environment management of the city.

In addition the pilot activity has further promoted the adoption of the SUPER and PROPER programmes of Indonesia that were introduced in 2002 with respect to reduce heavy metals discharged from industry. Through activities executed by the pilot project, awareness of industrial sector enterprises regarding waste management has improved significantly and compliance in reducing the heavy metal content of waste water has been enhanced. Involvement of industrial enterprises in environment management in Batam serves as a good example for wider dissemination and adoption.

Figure 6 Villagers with Locally Produced Compost Ready for Sale in Tanjung Riau Village, Batam, Indonesia.

The database on environment status and management in Batam city has been developed to include all data obtained by surveys and monitoring made by environment sector during recent years, and also data collected through the monitoring programme of the industry parks. This database is a helpful tool for environment management of the city: as a means to verify changes in environment state; and to assess the effectiveness of the SUPER and PROPER programmes in terms of reductions in heavy metal contents in waste water discharged from industrial enterprises of the city.

Modelling the impacts of nutrient inputs from land-based sources

As part of the overall work of the project on the impacts of land-based pollution a model was developed to evaluate the sensitivity of coastal ecosystems to changes in nutrient flux from land via rivers. The model is based on the relationship between chlorophyll and nutrient concentration and was developed by SEA START RC using river runoff data and remote sensing information of monthly chlorophyll concentration in the surface waters of the South China Sea (UNEP, 2007a).

Marine water along the Philippine coast from Luzon to the Palawan Islands were found to have the highest assimilative capacity and this part of the South China Sea is never likely to become eutrophic. However, this does not apply to the potential eutrophication of bays and estuaries that were not the focus of this model. The Gulf of Thailand was also found to have a high assimilative capacity while areas with low assimilative capacity include for example the southern cost of China, central Viet Nam, Peninsular Malaysia and the Straits of Malacca (UNEP, 2007a).

The region now has a tool and trained people in each country to undertake modelling of different scenarios of nutrient inputs to coastal waters. The model can be run to estimate the monthly 'effective' loading of total nutrient from any catchment, as point or non-point loading. The model output in chlorophyll equivalent units can be converted to nutrient elements, such as N, using a Chlorophyll to nutrient ratio. The model can be used to simulate the monthly responses of the chlorophyll biomass in any area of the South China Sea (at a resolution 0.1° x 0.1°) to different loading scenarios and to estimate the maximum monthly load of nutrient from any selected catchment that would ensure the chlorophyll-defined biomass remains under a pre-defined limit.

Valuing the Impacts of Land-based Pollution

The Regional Task Force on Economic Valuation has developed a framework for the valuation of land-based pollution impacts on coastal habitats that includes:

- A checklist of the impacts of land-based pollution on coastal habitats, specifying types of pollutants and their specific impacts on the four major habitats [mangroves, coral reefs, seagrass, and wetlands];
- A Framework for valuing the impacts of land-based pollution on the four habitat types, categorising the various specific impacts in the checklist into three categories, i.e., productivity, amenity, and human welfare;
- Procedures to undertake valuation of impacts of land-based pollution on the four habitat types, in which valuation techniques, indicator of measurement, data needed, and notes and assumptions were described for each specific impact identified in the checklist and framework.

The impact checklist, the framework, and the procedures for valuing the impact on the coastal habitats have been reviewed and checked by the members of all Regional Working Groups during the sixth round of meetings.

In general impacts resulting from land-based pollution either cause reductions in production of specific resources which can be measured in terms of losses in market value; in loss of ecosystem services resulting from ecosystem level impacts; and economic losses resulting from illness of individuals eating contaminated seafood. Detailed procedures for the economic evaluation of these impacts in terms of applicable valuation techniques for: productivity, amenity value, and human welfare are provided in the guidelines for economic valuation (UNEP, 2007b).

THE STRATEGY FOR FUTURE ACTIONS TO ADDRESS LAND-BASED POLLUTION

Countries bordering the South China Sea are experiencing problems with pollutants such as nutrients and organic wastes in their coastal waters. These contaminants are derived mainly from sewage and agricultural discharge and if left unmanaged could lead to eutrophication, decline in living resources, and impacts on human health. Current land-based pollution management practices differ between countries.

Most countries have environmental laws which require the establishment of standards and enforcement to ensure compliance. In order to meet standards and regulations stipulated under the law, structural facilities like waste water treatment plants are required, yet often the financial resources to invest in such infrastructure are lacking.

All countries in the region require an Environmental Assessment (EIA) prior to initiating a major development project and all have programmes to increase environmental awareness, and educate the public regarding environmental issues. In addition, monitoring of pollution discharge points and water quality monitoring is also currently undertaken by all countries.

Although these management practices are in place some countries lack the capacity to enforce the Environmental Acts due to limited budgets and manpower. Private sector waste producers generally do not have treatment facilities resulting in a low level of compliance with standards stipulated under the law.

Monitoring programmes for some countries involve extensive numbers of sites, but the data collected are not used appropriately, being used merely for the publication and dissemination of annual and environment quality reports.

In order to address the key challenges and weakness in land-based pollution management, the RWG-LbP, in its seventh meeting, suggested the adoption of targets for land-based pollution including the setting and maintaining of region-wide water quality standards and water quality objectives which will assist in maintaining coastal ecosystem health.

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