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Project for Environmental Protection and Maritime Transport Pollution Control in the Gulf of Honduras

ENVIRONMENTAL DIAGNOSTIC ANALYSIS (EDA)

GULF OF HONDURAS

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The Environmental Diagnostic Analysis (EDA) *of the area of the Gulf of Honduras is the result of a process of identification and analysis of problems that constitute the "**current state**" of the situation.*

The EDA represents for the different stakeholders who interact at the different levels of the life dynamics of in the area of the Gulf of Honduras, the informative framework which allows Access to knowledge, sensibilization and conclusions which will be of use for decision-makers of the region to secure the development of the economies, the protection of their valuable natural resources and the progress of the inhabitants.

Image No.1: Tourism activity in Puerto Barrios, Guatemala

Source: Gulf of Honduras Project

Environmental Diagnostic Analysis (EDA)

Document No. PGH-001

Frontpage images: Gulf of Honduras Project. These present the both the natural landscape of the Gulf of Honduras as the logic of the EDA preparation process.

Inside photos: Gulf of Honduras Project. They relate to the different dynamics of the area of the Gulf of Honduras and the activities undertaken during the preparation of the SAP.

August 2011

CONTENT

Presentation

The Gulf of Honduras is part of the western Caribbean Cayman Basin. It includes Amatique Bay, the entire Caribbean coast of Guatemala, eastern coast of Honduras and the southern part of the Belize Barrier Reef. Its regional environmental problems are due to the oceanography of the water body. The prevailing direction of the currents varies with the seasons and contributes to the interconnection of waters in Belize, Guatemala and Honduras. There is a persistent counter-clockwise current along the coast, particularly off the coast of Belize. This reverse flow of coastal water is most pronounced during the summer months, when combined with the currents created by the winds. During the winter months, the trade winds can cause coastal upwelling off the coast of Honduras with its current westward along the coast.

As a result of these prevailing oceanographic wind currents, the region of the Gulf is highly susceptible to point pollution spreading over great distances in the three countries. As maritime traffic and port operations continue to increase in the Gulf of Honduras and beyond, the potential for catastrophic accidents and marine pollution increases. Furthermore, rivers flowing into the Gulf drag increasingly larger loads of sediment and pollutants, which are carried by the currents through the marine boundaries.

Consequently, the environmental protection of the Gulf, particularly the prevention and control of pollution, requires a strategic approach in which actions are directed at addressing the main sources, monitoring trends and build lasting and sustainable schemes for regional cooperation for the management of the Gulf. In this sense, in the framework of the ***Project for Environmental Protection and Maritime Transport Pollution Control in the Gulf of Honduras*** *- GEF-BID-COCATRAM-CCAD, the* **Environmental Diagnostic Analysis** *(EDA) has been developed as a result of a research process using recognized methodologies. The EDA constitutes a technical-scientific tool oriented to provide information, generate knowledge and make significant agreements in its adoption and help governments and countries involved to address identified problems on a priority, strategic and consensual basis and, from there, support measures to generate a positive change of the current conditions that are affecting the region's natural resources, reducing the causes and potential threats exerting pressure on the health of the marine system, seriously compromising their sustainable development.*

The acceptance and use of the ***EDA*** *as a tool for systematization of the reality of the Gulf of Honduras, requires and attitude of responsibility and commitment of all actors and social, economic and political sectors interacting in the dynamics of life in the area of the Gulf of Honduras. It is and should a shared responsibility of the states of Belize, Guatemala and Honduras, their governments, civil society, private sector, communication media, academia, international cooperation and of each and every men and women with conscience of the need to influence the reduction of the negative impacts caused by pollution and contribute to a better and sustainable use of natural and environmental resources available in the area of the Gulf of Honduras and thereby achieve an improvement in the quality of life of "today" and of "tomorrow".*

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Prologue

The region of the Gulf of Honduras is highly susceptible to point pollution spreading over great distances in the three countries (Belize, Guatemala and Honduras). As maritime traffic and port operations continue to increase, the potential for accidents and marine pollution increases. Likewise, rivers flowing into the Gulf drag increasingly larger loads of sediment and pollutants, which are then carried by the currents.

To contribute to the attention to the problems of the Gulf, this document on the Environmental Diagnostic Analysis (EDA) was prepared, *to constitute a tool that provides valuable insight of the biophysical and socio - economic situation of the Gulf of Honduras*. It includes, in summary, technical and scientific information produced from thorough research, which used methods to ensure the quality of results and also includes an important variety of work areas and specialties, field and laboratory analysis, data, maps and other.

The environmental diagnostic analysis covers issues related to the physical and biogeochemical framework, the framework of pollution related to water, sediment and biota, the socio-economic priority issues identified in terms of water availability, pollution, loss and modification of habitats and communities and unsustainable exploitation of marine and coastal areas, emergent problems from climate change and unsustainable development of marine and coastal areas, particular problems associated with port and maritime activities and operations, the causal chain analysis that *runs through the relations of cause - effect, associated with each priority problem from environmental and socio - economic impacts to its root causes*, the legal framework and the current status of the Gulf of Honduras.

The contents of the document is presented in a simple and orderly way, respectful of technical and scientific rigor, to facilitate understanding and encourage decision making and the execution of actions by different actors involved directly and indirectly in the dynamics of life in the Gulf of Honduras. The origin of this document is linked to the **Project for Environmental Protection and Maritime Transport Pollution Control in the Gulf of Honduras (Gulf of Honduras Project)**, executed by the COCATRAM y co-executed by the CCAD through the Regional Program Coordination Unit (URCP).

INSTITUTIONAL FRAMEWORK OF THE ENVIRONMENTAL DIAGNOSTIC ANALYSIS

Central American Commission on Maritime Transportation (COCATRAM)

COCATRAM is a specialized agency that is part of the institutions of the Central American Integration System (SICA), which is of permanent nature, and has its own directory based in Managua, Nicaragua. Legally, COCATRAM is based on REMITRAN Resolution V-3-87, establishing its constitution and operation. Members of COCATRAM are: Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama. The Directorate of COCATRAM is in charge of a Board, with the participation of public and private sector.

COCATRAM addresses matters relating to maritime and port development in Central America. Its main function is to advise the Council of Ministers Responsible for Transportation in Central America (COMITRAN) and member governments to adopt policies and decisions in order to achieve a harmonious development of the sector to meet the needs of the countries' foreign trade in terms of quality, economy and efficiency of maritime transport and ports, to protect and represent the interests of the region before interest and extra-regional bodies. In turn, COCATRAM meets the guidelines and policies issued by the COMITRAN.

Their vision is to be the leader organization in the management and promotion of maritime port policies of member countries to turn Central America into a competitive and integrated region in the international maritime trade.

Its mission is to identify, promote and support measures, policies and actions that contribute to the development of maritime trade in Central America in the framework of the regulations and standards of its competence.

*COCATRAM – with the GEF through the IDB and with member countries - has assumed the commitment to be the executing agency of the **Project for Environmental Protection and Maritime Transport Pollution Control in the Gulf of Honduras (Gulf of Honduras Project)**, within which the **Environmental Diagnostic Analysis** was developed as a management tool to ensure sustainable economic benefit of the countries of the region, protection of natural resources*

and more importantly, the benefit of the people of the valuable region of the Gulf of Honduras.

Central American Commission for Environment and Development (CCAD)

The CCAD is the body of the Central American Integration System (SICA), responsible for the regional environmental agenda. Its main objective is "to contribute to sustainable development of the Central American region, strengthening the cooperation regime and the integration for environmental management"

On December 12, 1989, the presidents of Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua, decided to sign the Constitutive Agreement of the Commission on Environment and Development (CCAD) to establish a "regional cooperative regime for optimal and rational use of natural resources in the area, pollution control and restoration of ecological balance" that ensures a better quality of life for the people of Central America. An Addendum to the Agreement in 1991 incorporated Belize and Panama. In 2005, the Dominican Republic joins the CCAD as an associated body.

It is within this institutional framework that CCAD assumes the commitment as co-executor of the Gulf of Honduras Project.

Regional Program Coordination Unit (RCPU)

To implement the Gulf of Honduras Project, the institutions responsible for it, the Central American Commission of Maritime Transportation (COCATRAM) as executing agency and the Central American Commission of Environment and Development (CCAD) as co-executing agency, with the approval of the Global Environment Facility (GEF) as a donor agency and the Inter-American Development Bank (IDB) as an administrative entity, created the Regional Program Coordination Unit (URCP), which is based in the city of Puerto Cortes, Honduras.

ºThe RCUP is the technical and administrative base driving the operation of the Project in the whole area of influence of the Gulf of Honduras. This unit has played the role of carrying out the approaches, processes and activities and achievement of results of the set of components integrating the project.

The Gulf of Honduras Project and the SAP

The Gulf of Honduras comprises a tri-national body of coastal and marine waters, including portions of the exclusive economic zone of Belize, Guatemala and Honduras. The conditions sustaining productivity and diversity of the Gulf are the same factors which, combined with human-caused elements, make the area vulnerable to maritime and terrestrial pollution. Accelerated erosion of watersheds, mainland pollution sources and inadequate environmental safety in the ports is a growing concern due to potentially negative impacts on nearby coastal ecosystems as well as on public health and economic development.

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The issue of safety of navigation is of great importance to the Gulf. The risks of collisions and groundings are significant, so the need to improve the safety of navigation, including infrastructure and communications systems, as well as updating the nautical cartography is widely recognized. The Gulf region is vulnerable to spills due to the shallow and enclosed nature of the bay, in combination with strong circular currents.

To minimize the risks of pollution in the Gulf, the ***Gulf of Honduras Project*** *was created, which is a regional initiative supported by the Global Environment Facility (GEF) through a non-reimbursable fund No. GRT / FM - 9179 – RS of $ 4.8 million, administered by the Inter-American Development Bank (IDB), which added a $ 2.4 million contribution from the participating countries: Belize, Guatemala and Honduras. The executing agency of the Gulf of Honduras Project is the Central American Commission of Maritime Transportation (COCATRAM), and the Central American Commission of Environment and Development (CCAD) as co-executing agency, through the Regional Program Coordination Unit (RCPU).*

The development objective of the Project is to contribute to the reversal of the degradation of coastal and marine ecosystems, strengthening the control and prevention of pollution from maritime transportation in the major ports and shipping routes, improving navigation safety to avoid ship groundings and spills and reduce the entry of contaminants from land-based pollution sources to the adjacent coastal and marine areas in the Gulf of Honduras.

1. Introduction

The ***Environmental Diagnostic Analysis of the area of the Gulf of Honduras (EDA)*** in summary contains information that provides knowledge of the physical, biogeochemical, socio-economic and legal of the same area. This information is the product of extensive research, using internationally recognized methodologies ensure the quality of their results,

Project for Environmental Protection and Maritime Transport Pollution Control in the Gulf of Honduras (Gulf of Honduras Project), executed by the COCATRAM y co-executed by the CCAD through the Regional Program Coordination Unit (URCP)

The EDA was prepared in the frame of the **Project for Environmental Protection and Maritime Transport Pollution Control in the Gulf of Honduras**, as part of the development of the *"Data and Information Management System, Establishment of the Baseline, Preparation of the Environmental Diagnostic Analysis (ADT) and the Strategic Action Plan (SAP)".* For the implementation of the Project, the Central American Commission of Maritime Transportation (COCATRAM), and the Central American Commission of Environment and Development (CCAD) received from the Global Environment Facility (GEF) a non-reimbursable fund, managed by the Inter-American Development Bank (IDB)

The EDA contains in general terms the following information:

- The physical and biogeochemical framework, in reference to temperature, precipitation, drainage basins, coastlines, ecosystems (coral reefs and mangroves), biodiversity, environmental sensitivity and ocean and coastal currents.
- The framework of pollution related to water quality, sediments and biota.
- The socio-economic framework focused on the main social and urban aspects, basic economy and economic valuation of coastal ecosystems.
- Priority problems identified in terms of water availability, pollution, loss and modification of habitats and communities, and unsustainable exploitation of marine and coastal areas.
- Emerging problems from climate change and unsustainable development of coastal and marine areas.
- Particular problems associated with port and maritime activities and operations.
- Causal chain analysis, which goes through the cause-effect relationships associated with each priority problem, from environmental and socio - economic impacts to its root causes
- The legal framework and current status of the Gulf of Honduras.

2. Study area

Central America is developed as a narrow continental strip whose area is approximately, 762,064 km² (0.4% of the earth's land surface). Geographically it is located between the southeastern border of Mexico and the northwest border of Colombia, surrounded by the Pacific Ocean and the Atlantic Ocean and consists of seven nations (**Table No.1**).

Table No.1 Central America: Basic Information

Country	Area (km2)	Populations (2004 Estimates)	Density (people/km 2)
Belize	22.965	253.000	11
Guatemala	108.890	11.016.173	101
Honduras	112.492	7.326.000	65
El Salvador	21.041	7.417.000	305
Nicaragua	120.254	5.342.000	44
Costa Rica	51.100	4.492.000	87
Panama	75.517	2.940.000	39

Source: Gulf of Honduras Project

The coasts of the Caribbean Sea are characterized by the presence of various gulfs and bays, among which is the **Gulf of Honduras**, the subject of this analysis.

The *Gulf of Honduras* is a large inlet of the Caribbean Sea, bounded by the coasts of Belize, Guatemala and Honduras. It is characterized by the presence of cays and coral reefs and many draining rivers as part of the western Caribbean Sea basin. It includes Amatique Bay, the Caribbean coast of Guatemala, the eastern part of the coast of Honduras and the southern part of the "Mesoamerican Reef System." This is a body of multinational marine and coastal waters, since it comprises part of the exclusive economic zones of the three countries.

The study area includes the Gulf of Honduras and the watersheds whose rivers drain into it. This area extends from Punta Izopo (Honduras) to the NW (Northwest) towards the Belize City Port, and inland along the northern limits of the basin of the Maya Mountains and of the River Sarstun and Rio Dulce in Guatemala, Motagua River on the border between Guatemala and Honduras and the Rivers Ulua, Lean, Cuyamel and Chamelecon in Honduras. This area covers approximately 68.577 km^2, of which approximately 13,779 km^2 correspond to the Gulf of Honduras, while the remaining 54.798 km^2 correspond to the watersheds associated with it (of which about 9.050 km^2 develop in the territory of Belize, about 16.302 km^2 in the territory of Guatemala and 29.446 km^2 in Honduras territory.

The western part of the study area includes the so-called **Mesoamerican Barrier Reef System (MBR),** considered one of the **"seven underwater wonders of the world"** because it represents the second largest barrier reef in the world, stretching from the Island of Contoy, North of the Yucatan peninsula, to the Bay Islands of Honduras, throughout approximately 1,000 km and spanning four countries (Mexico, Belize, Guatemala and Honduras) and two areas: the Bay of Chetumal between Belize and Mexico and the Gulf of Honduras)

The waters of the Gulf of Honduras harbor a great abundance of species, some of them threatened or in danger of extinction as well as highly productive marine ecosystems, such as beaches, estuaries, seagrass beds, mangroves and coral reefs.

Image No.2 Location of the "Mesoamerican Reef System" in the area of the Gulf of Honduras

The conditions sustaining the productivity and diversity of the Gulf, are the same factors which, when combined with economic and sociocultural elements, make the area particularly vulnerable to terrestrial pollution (sewage, solid waste disposed in the open, agro - chemicals and industrial pollutants) and marine pollution (potential oil spills and intentional dumping of ballast water and / or bilge).

The Gulf of Honduras is a maritime area of great importance for commercial trade in the region

Main port facilities

The area of the Gulf of Honduras has five main port facilities: Port City, Belize and Big Creek Port in Belize, Puerto Barrios and Puerto Santo Tomas de Castilla in Guatemala and Puerto Cortes in Honduras. It also has facilities for loading and unloading of hydrocarbons around the Port of Belize City in Belize and in the Bay of Tela, Honduras.

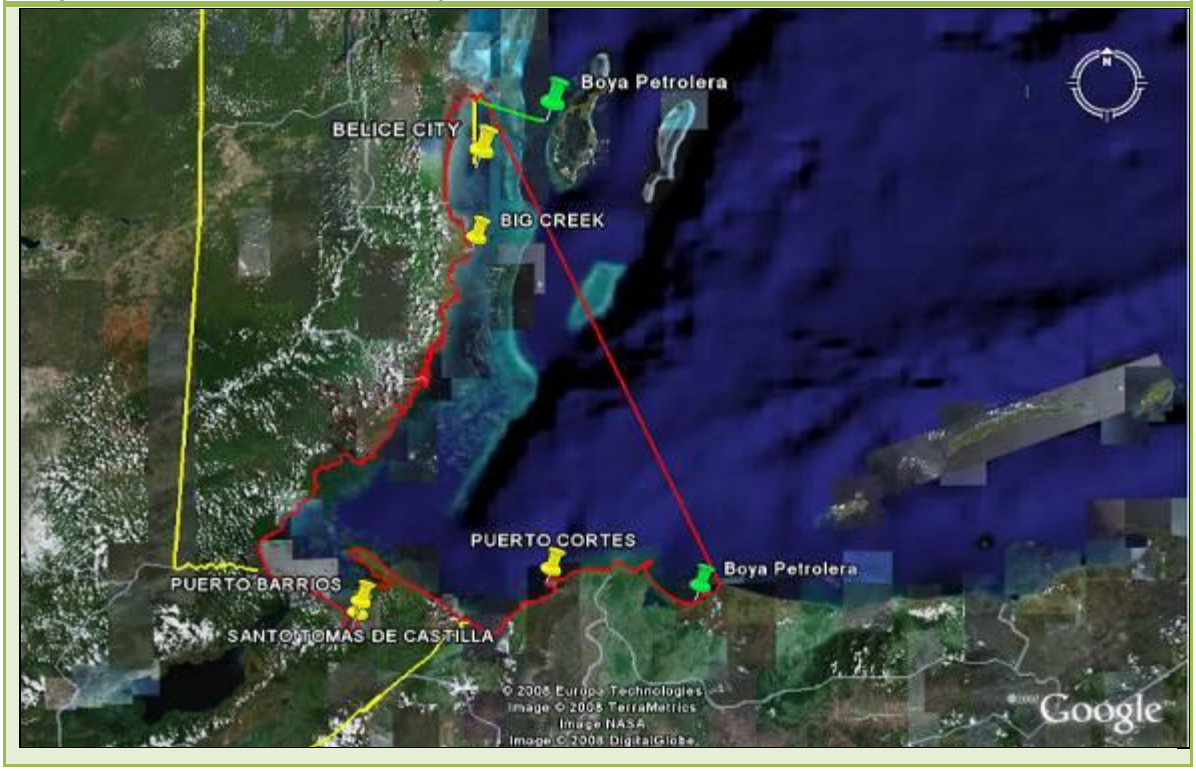
Table No.2 Movement of ships in ports of the study area

Year	City of Belize	Big Creek	Santo Tomas de Castilla	Puerto Barrios	Puerto Cortés	Tela
2001	253	No data	1.263	535	1.786	No data
2002	227	No data	1.281	570	1.742	16
2003	246	No data	1.320	508	1.792	70
2005	273	100	1.369	463	1.756	74
2005	238	110	1.365	480	1.746	85
2006	237	117	1.437	541	1.836	26
2007	256	168	1.578	564	1.909	15

From: Maritime Profile of Latin America and the Caribbean (www.eclac.org)

There are five main port facilities in the area of the Gulf of Honduras: Belize City Port and Big Creek Port in Belize, Puerto Barrios and Puerto Santo Tomas de Castilla in Guatemala and Puerto Cortes in Honduras. Also, around the Belize City Port in Belize and the Bay of Tela, Honduras there are facilities for loading and unloading hydrocarbons.

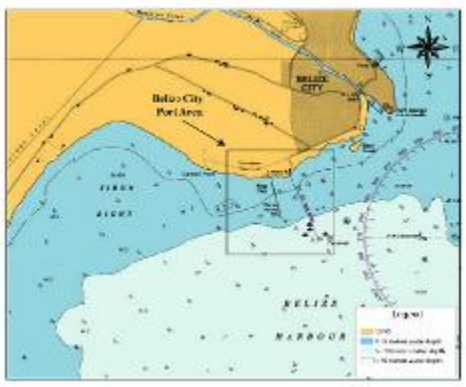
Image No.3 General location of the main ports of the Gulf of Honduras



Belize City Port

Establishment and Operation	It was built in 1978 and privatized in 2002. It is currently operated by Port of Belize Limited, which is also responsible for its environmental management.
Location and attention	It is located approximately at coordinates 17 ° 28 '43 ° North Latitude and 88 ° 12' 09 ° West Longitude. Serves all types of cargo, but gives priority to loading and unloading of containers.

Image No.4: Location of Belize City Port

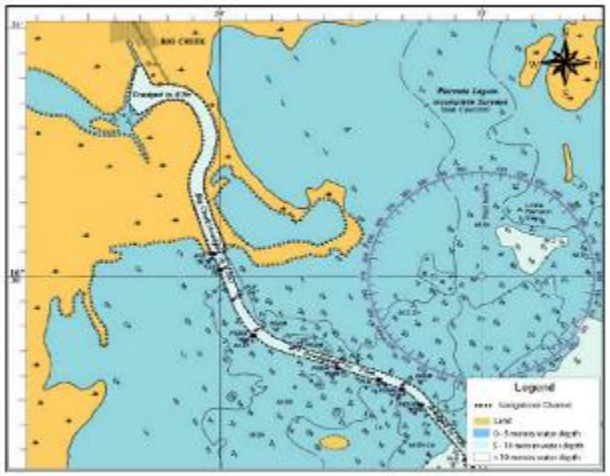


Port composition	The port consists of: a. A dock 600 meters long and 340 meters wide. b. A 67 meter long main dock with three docking structures (such as "Dolphin") and 10 meters deep. c. A 25-meter long Ro - Ro dock. d. A small dock for boats ferrying supplies coasting nearby Keys. e. A 4.600 meters long and 120 meters wide access channel, whose maintenance and beaconing is in charge of the Port Authority of Belize (at the state agency). This beacon is composed of thirty-one (31) metal markers and a set of concrete piers driven into the seabed with heights of 4.57 to 25.30 meters and equipped with lighting systems which reach to between 5 and 17 nautical miles
Terrestrial Area	a. A 6.583 square meters reservoir. b. Two storage yards and 31,000 and 19.000,000 square meters
Other characteristics	The port does not receive tankers, but at 120 meters from the main dock is the Esso Standard Oil Co. terminal which belongs to the group Exxon Mobil group, which is the sole importer of petroleum products existing in Belize. Oil tankers moor offshore through a system of mooring buoys located approximately 200 meters from the coast and at a depth of 6.00 meters. The fuel is sent to a tank park, built in 1961, through two (2) underwater pipelines. Near the port, besides the presence of Fort Street Tourism Village, there is a tourist terminal, where small boats from cruise ship passengers moor offshore, but they approach the coast through the access channel to the port of Belize. During the high season up to six (6) cruises come daily and move about 11,000 people, while during the low season up to three (3) cruises are received per week. Merchandise is mobilized in the port in containers or liquid and dry bulk. The main products exported by sea include citrus concentrate, bananas, sugar, molasses, dolomite, seafood, papaya, beans and wood. The main imported goods are fuel, dry bulk (wheat, animal feed and fertilizer), steel and finished products (in containers).

Big Creek Port (Belize)

Creation and administration	Officially called Port of Toledo, this is a small private marina built in 1990 and is administered by Banana Enterprises Limited and regulated by Belize Port Authority.
Location	It is located approximately in coordinates 16 ° 25 '50 "North Latitude and 88 ° 21' 50" West Longitude.

Image No.5: Location of Big Creek Port



Main activities	The main activities being developed are the banana industry, citrus and shrimp, although in recent years it has also become a port for import of refined petroleum products and crude oil exports.
Conformation	The port consists of: a. A dock with a length of 304.15 meters which supports up to 6.50 m drafts, and b. An access channel 2.500 meters long and 63 meters wide, 7.00 meters deep at the time of its opening (1990). The beaconing consists of six (6) lighthouses and twenty (21) buoys composed by elastomeric plastic floats with a steel towers (without lighting). This channel has been modified to prevent bending and facilitate the entry of ships into port
Land area	The land area is approximately 12 hectares and includes: a. Several yards for storing containers and general cargo. b. Two warehouses located behind the dock. c. A tank for water storage.
Other characteristics	The terminal for refined petroleum products (Petrofuel Company), where two ships come every month, has six (6) storage tanks for refined products; the crude oil terminal (Belize Natural Energy), where every fifteen (15) days comes a barge, also has facilities for storage.

Image No. 6. Aerial views Big Creek Port

Source: Gulf of Honduras Project

Port of Santo Tomas de Castilla. EMPORNAC (Guatemala)

Name and management	It is managed by the State enterprise National Port Company Santo Tomas de Castilla (EMPORNAC). It is the most important port on the coast of Guatemala in the Caribbean Sea. It handles almost half of the containers moving in Guatemala (in 2006 moved 333,816 TEUs - export and import - and 4,623,400 tons of cargo, ECLAC, 2007)
Location	It is located at approximately in coordinates 15 º 57 '08 " North Latitude and 88 º 37' 24" West Longitude, in an area with a maximum depth of 18.0 m, located in the well protected Bay of Amatique. It is a quiet-water port.
Conformation	The port has: a. A dock with 906 meters in length and 150 meters of width, with a maneuvering area of 667, 640 square meters and 11.00 meters of depth. b. An access channel 12.0 km long and 90.0 meters wide with a depth of 11.00 meters and whose beaconing is formed by: 1) four headlights (Villeda, Heredia, Cape Three Points and Ox - Tongue) consisting of 155 mm diameter lanterns on steel structures driven into the seabed, 2) nine (9) pillar type buoys (four red and five green), 3) a pillar type buoy identified as of sea or pilot, equipped with a 155 mm lantern with a range of 4.0 nautical miles, and 4) two pairs of threading steel structures (one in the water and three in land). c. A marginal dock with 914.56 meters in length and 9.50 to 9.80 meters average depth , with six (6) docks of 152.42 meters each: 1) Dock No. 1 for passenger ships, general cargo, military vessels and other , 2) Dock No. 2 for the same uses as above, plus transfer vessels, 3) Dock No. 3 for liquid bulk vessels and transshipment, 4) Dock No. 4 for container ships, multipurpose and transshipment, 5) Dock No. 5 for general cargo and multipurpose vessels, cold storage and transshipment, and 6) Dock No. 6 for a bulk liquids, chemicals and container vessels and transshipment
Land area	It has 35,071.49 square meters of covered storage and 15,833.30 square meters for uncovered storage; in addition, 93.511 square meters are prepared for storage of containers and trucks.

Image No.7: Location of Port of Santo Tomas de Castilla

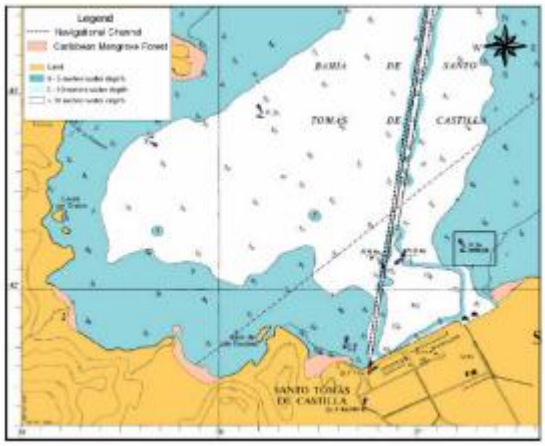


Image No.8: Aerial view of the Port of Santo Tomas de Castilla

Source: Gulf of Honduras Project

Puerto Barrios: COBIGUA (Guatemala)

Name and creation	It was built in wood in 1880, remodeled in 1924 and rebuilt in 1988 by the Guatemalan Independent Banana Company SA (COBIGUA), after near destruction by the earthquake of 1976. It is the oldest of Guatemala (in 2006 it moved 213,098 TEUs - export and import - and 1,818,900 tons of cargo, ECLAC, 2007).
Location	It is located approximately in coordinates 15 ° 44 '03 " North Latitude and 88 ° 36' 21" West Longitude and is located in the well protected and deep waters of the Bay of Amatique
Conformation	It consists of a pier - dock 304 meters long. It has four docks (two on each side) for vessels up to 9.50 m draft: those on the southern side are 144 feet long each, and those on the northern side are 190 and 66 meters in length, respectively.
Land area	Land areas have a surface of 15.000 m^2 for open air storage , to be noted that, given the type of operations, roofed areas have been eliminated to turn them into patios for open air storage
Other characteristics	For approximating to the port, the same access channel to Santo Tomas de Castilla is used to then deviate to a branch marked with two pillar type buoys (yellow) until you reach a turning basin of 100 x 280 meters.
	This is a multi-purpose port dedicated to: a) the stevedoring service for different types of ships: container ships, conventional, solid and liquid bulk carriers, general cargo, refrigerated, b) the coupling and uncoupling of containers on patios, and c) inspection and emptying and / or filling of containers with import and export goods.

Image No.9: Location de puerto Barrios

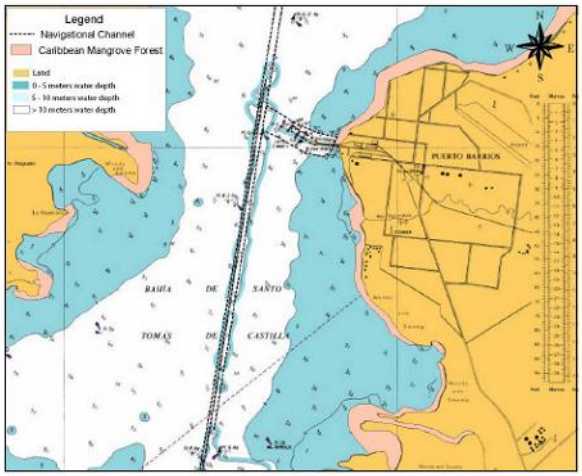


Image No.10: Aerial view of Puerto Barrios

Source: Gulf of Honduras Project

Puerto Cortés (Honduras)

Name and management	Managed by the National Port Enterprise (ENP), it represents one of the best port infrastructures in Central America (in 2006 it moved 507,980 TEUs - export and import - and 7,396,849 tons of cargo, ECLAC 2007).
Location	It is located approximately in coordinates 15 º 48 '00 " North Latitude and 87 º 57' 00" west longitude, in a well protected natural deep-water bay.
Conformation	The port has: a. A basin 900 meters in diameter and 400,000 square meters of anchoring. b. Six docks with a total length of 1157.03 meters of docks c. An access channel 1.270 meters long and 400 meters wide with an average depth of 12.00 meters. d. A cabotage dock 120 meters long and 4.00 meters average draft e. Six terminals: 1) a liquid bulk (Dock No. 1), with dockside depths of 11.30 - 13.40 meters. 2) one dedicated to the import / export of chemicals and molasses (Pier No. 1a) with dockside depths of 9.20 - 11.90 meters, and is administered by private companies, 3) the old terminal of a banana company that is sunken (Dock No. 2, where it is planned to build a new bulk terminal), 4) one for bulk solids and liquids (Dock No. 3), with depths at dockside from 11.30 - 13.40 meters and an operating capacity estimated at 1.8 tons/m^2, 5) one for general cargo and Ro-Ro type vessels (Dock No. 4), with dockside depths of 9.10 - 11.00 m and a design capacity of 4.0 tons/m^2, and 6) a container equipped with two gantry cranes (Dock No. 5), with dockside depths of 10.10 - 12.20 m and a design capacity of 4.0 tons/m^2.
Land area	Its land area has: a) closed storage areas corresponding to two warehouses covering a total area of 18,000 square meters and a cold storage of 4,100 square meters, and b) areas of open air storage reaching 296,000 square meters (of which 106,000 square meters are regarded as reserve).

Image No.11: Location de puerto Cortés

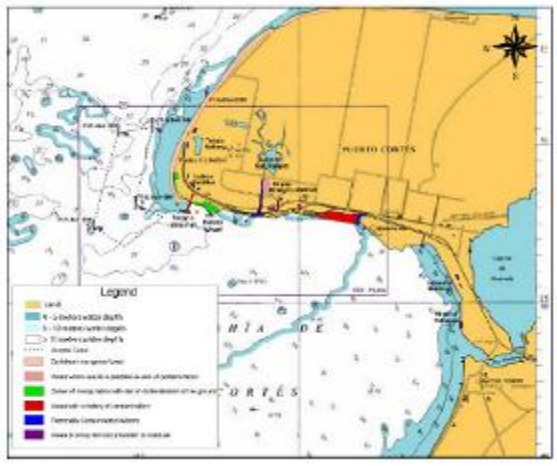


Image No. 12: Aerial view of Puerto Cortés

Source: Gulf of Honduras Project

Port of Tela (Honduras): fuel discharge facilities

Name and management	The Tela terminal is operated by the company Distribuidora de Productos del Petróleo S.A. (DIPPSA)
Location	It is located in the Bay of Tela, with average depths of around 14.00 meters
Conformation	It is formed by six mooring buoys and a PLEM (pipe line end manifold) located at 880 meters from the shoreline.
Other characteristics	Here one or two tankers operate per month to unload between 100,000 and 120,000 barrels of non-persistent oil (regular gasoline, super and aviation, diesel and kerosene).

3. General characteristics of the study area

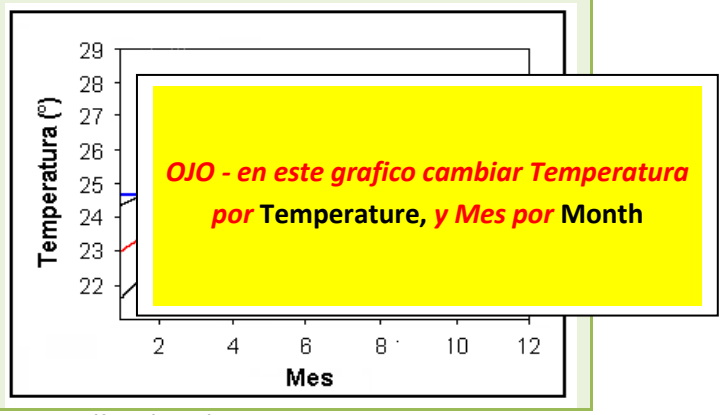
3.1 Physical and Bio- Geochemical framework

A. Temperature

The study area generally register higher temperatures along the coast, with annual averages of approximately 28 ° C (degrees Celsius) descending to about 20 ° C at higher altitudes (between 500 and 1.000 meters) according to Abt Associates Inc - Woods Hole Group (2003).

***Note**: The center line (red) on the graph represents the dominant temperature pattern and the bands represent one standard deviation. The horizontal line (blue) represents the average annual temperature (24.7 ℃).*

Image No.13: Predominant temperature regime in CA

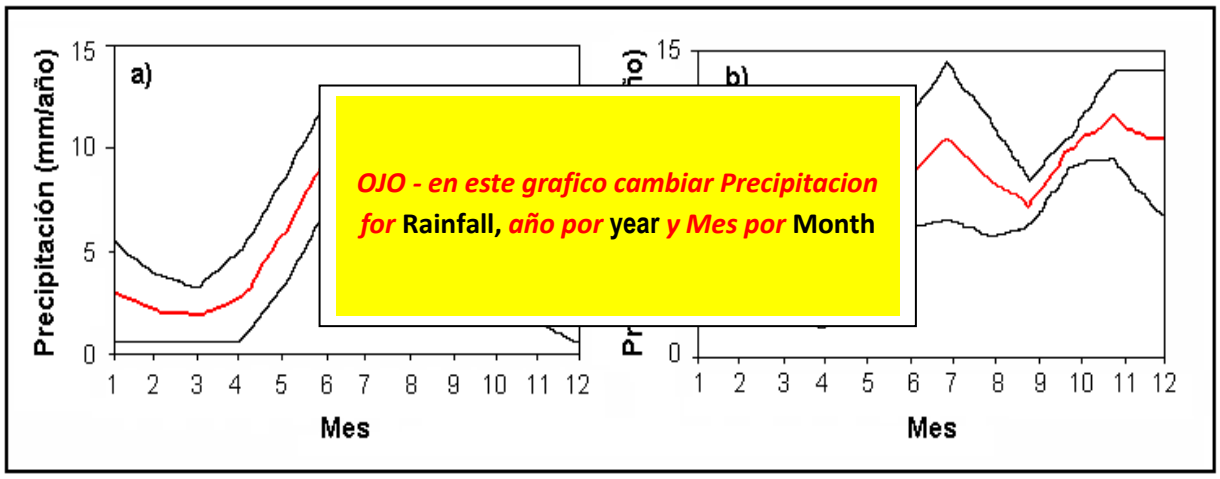


From: Alfaro (2000)

B. Rainfall or waterfall on the terrestrial surface

Two cycles of precipitation annually are identified, according to Alfaro, 2002: a) **The first cycle:** the dominant regime explained 86.7% of the total variance (Image No.14 a), observing two maximum peaks of precipitation: one in June and the second largest in September; between these months a relative minimum occurs in July-August ("veranillo", "canicula" or "mid-summer drought"). The dry season occurs during the corresponding period in the Northern Hemisphere of winter and early spring (being more intense in the Pacific region of the isthmus). b) **The second cycle**: The regime explains 8.2% of the total variance (Image No.18 b) and is located near the Caribbean coast of Honduras and Costa Rica, featuring two maximum peaks occurring in July and November, the latter being more intense than the first, two minima that occur in the months of March and September, the former being less intense than the second.

Image No.14: Dominant rainfall regime in Central America



Note: The center lines (red) represent the first (a) and second (b) dominant pattern of annual rainfall. The bands represent one standard deviation. Taken from Alfaro (2002).

There are other important facts: i) The dry season accumulates 16.4% of total annual rainfall, occurring between November and late May. It is characterized by strong winds and high values of total radiation and hours of sunlight in the lower levels of the troposphere, ii) the average start date of dominant pattern of precipitation is around 11 to 15 of May , decreasing in mid-July (from 15 to 19 July, a period known as "veranillo", "canicula" or "mid-summer drought"), iii) a second maximum of rainfall greater than that observed in June, begins in mid-September (18-22 September) and ends around 17 to 21 November.

Tropical storms and hurricanes. The Caribbean Sea is an area frequently affected by tropical storms and hurricanes which regularly cross the Gulf of Honduras between June 1 and November 30. The frequency of tropical storms increases from South to the North, resulting in twenty (20) storms per century in the area of Amatique Bay and up to sixty (60) storms per century in the NE boundary of the Gulf of Honduras (Heyman and Kjerfve, 2000).

Prevailing winds. In this tropical sea during most of the year, the winds come from the East region (from the NE to SE) at speeds between 12.0 and 28.0 km / h (Force 3 to 4 on the Beaufort scale), reaching values in the east, between 20.0 and 38.0 km / h (Force 4-5) during the months of May, June and July (NOAA, 1985). This regime of wind generates wave heights ranging from 0.50 to 1.25 meters, increasing up to 2.5 meters in the case of persistent winds with speeds between 29.0 and 38.0 km / h (Force 5). These easterly winds (known as "trade winds") respond to the presence of semi-permanent anticyclone of the Atlantic Ocean, known as Azores - Bermuda anticyclone, with stronger influence during the summer months, when located in the central region between latitudes 35 ° and 40 ° N

C. Characterization of drainage basins

The study area consists of eight (8) primary basins and totals 53,700 km^2 or 68,577 km^2 depending on the estimate made. Of these primary basins, one (1) consists of eighteen (18) subsidiary basins and is located in Belize, three (3) basins are located in Guatemala and four (4) basins are located in Honduras.

Table No.3: Main drainage basins of the Gulf of Honduras

Basin	Country	Area (km^2)	Main rivers
Maya Mountain	Belize	5,800	Sietee, Swasey, Grande, Moho
Sarstun	Guatemala y Belize	2,218	Sarstun
Dulce	Guatemala	3,485	Dulce
Motagua	Guatemala y Honduras	12,670	Motagua, San Francisco, Piteros, Canal de los Ingleses
Chamelecon	Honduras	4,350	Chamelecon
Cuyamel		2,141	Motagua
Ulua		21,230	Ulua
Lean		3,045	Lean

From: Abt Associates Inc – Woods Hole Group (2003)

Liquid and solid discharge of the tributary rivers of the Gulf of Honduras. *Few measurements have been made and existing ones are generally of short duration:*

- It is estimated that the total discharge of the Gulf of Honduras is approximately 2.200 m^3/sec (about 68.4 km^3), according to Abt Associates Inc – Woods Hole Group (2003).
- For their part, Heyman and Kjerfve (2000) estimated a total discharge of 2,400 m^3/sec (about 74.6 **km^3/year**).
- The above value is very similar to the estimation of the United Nations Food and Agriculture Organization (FAO, 1996), to the effect that the discharge is of the order of 74.0 km^3 (15.0 km^3 for rivers Belize, 16.0 km^3 for rivers of Honduras and 43.0 km^3 for the rivers of Guatemala).

The three estimates are similar, and likewise, the distribution of discharges is consistent with the characteristics of ecosystems in the region.

Table No.5 Discharge of some tributary rivers to the Gulf of Honduras

River	Country	Discharge (m^3/sec)
Sittee	Belize	32 *
Stann Creek		40 *
Swasey		27 *
Monkey		63 *
Grande		26 *
Moho		37 *
Sarstun	Belize Guatemala	160 ** 182 ****
Dulce	Guatemala	300 **
Motagua	Guatemala, Honduras	530 ** 326.5 ****
Ulua	Honduras	690 ** 1,400 ***
Chamalecon		370* 400***

Notes:
** Abt Associates Inc – Woods Hole Group (2003)*
*** Heyman y Kjerve (2000)*
**** Comision Ejecutiva del Valle del Sula (2002)*
***** Lopez Choc (2002)*

Source: From Abt Associates Inc – Woods Hole Group

Table No.6 Preliminary estimates of average solid discharge from major rivers in drainage basins of the Gulf of Honduras

River	Country	Average liquid discharge (m^3/s)	Average solids discharge (ton/day)
Stann Creek	Belize	40	1.728
Monkey		63	2.722
Grande		26	1.123
Moho		37	1.598
Sarstun	Belize, Guatemala	160	6.912
Dulce	Guatemala	300	12.960
Motagua		530	22.896
Ulua	Honduras	690	29.808
Chamalecon		370	15.084

Notes:
** According to Heyman y Kjerve, 1999*
*** Assuming and average concentration of 500 mg/l*

From: *Abt Associates Inc – Woods Hole Group (2003)*

Solid discharge estimates developed from assuming certain values of erosion potential and average concentration of suspended sediments in rivers

D. Coastline characterization

➔ **The coast of Belize** has three major subsystems: the coast, the reef system (with keys) and near-shore atolls (Foer and Olsen, 1992). The coastal subsystem, some 280 km long and a total area of 7,611 km^2, has the following formations: evergreen forests (2,192 km^2), farming systems (1.245 km^2), savanna (1,068 km2), flooded forests (930 km^2), mangroves (920 km^2), and other minor formations such as lakes or ponds (543 km^2), wetlands (187 km^2), shrublands (175 km^2) and pine forests (165 km^2).

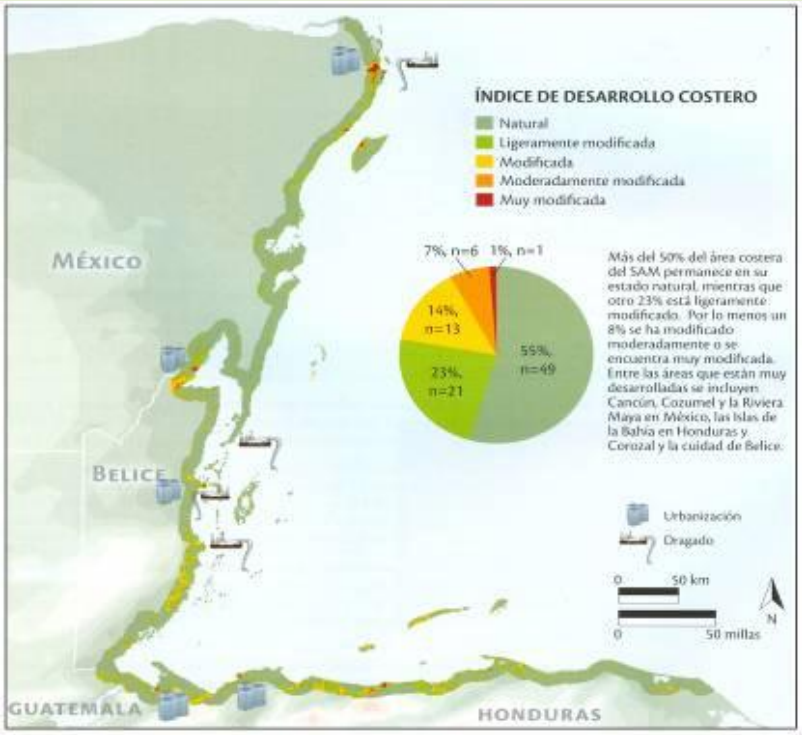
➔ **The coast of Guatemala** has a coastline with a total length of 403 km and an area of 7,365 Km2, of which one-third (1/3) corresponds to the coastline on the Caribbean Sea (Foer and Olsen, 1992). In the Caribbean, agricultural systems are the most extensive formations, followed by evergreen forests (598 km2) and swamps (471 km2). Two of the major rivers flow into the Bay of Amatique: River Sarstun and fluvial - lacustrine system formed by the Polochic River, Lake Izabal (the largest in Guatemala) and Dulce River. The presence of mangroves is limited by the nature of the soil, of limestone type (Yanez - Arancibia et al., 1994).

➔ **The coastline of Honduras** is 842 km long being the more extensive on the Caribbean Sea with about 680 km of coasts covering an area of 12,965 km2 (SERNA, 1997; OdD - UCR, 2001). In them, the agricultural systems dominate the landscape with 5.236 km2 (40.4% of the area), followed in importance

by evergreen forests (2.135 km^2), wetlands (1.395 km2) and rivers, lakes and ponds (1,324 km^2). The longest beaches are of "barrier" and "coastal plain" type, distributed from the outlet of the Motagua River (border with Guatemala) to the vicinity of the town of Tela (included in the study area), then continue in the surroundings of La Ceiba, Trujillo, La Mosquitia and the Bay Islands (all outside the study area). Also stand out the estuaries that are developed associated to the outlets of major rivers.

➔ **Importance and development of the coastal zone.** Healthy Reefs Initiative, developed in 2008 a "Coastal Development Index" (DCI) which measures the degree to which humans have altered the landscape of the coastal areas (Image # 15), and is composed of five factors:) the coastal population, b) the land area covered by large infrastructure projects (urban or agricultural), c) the amount of roads built on the coast, d) the rate of coastal population growth, and e) rate at which natural lands of the coast lands are being converted to urban lands.

Image No.15: Coastal development adjacent to the Mesoamerican Reef System



Source: From Healthy Reef Initiative (2008)

E. Characterization of ecosystems

The major marine and coastal ecosystems located along the Gulf of Honduras include, among others, coral reefs, mangroves, seagrass beds, beaches and estuaries and coastal lagoons.

⇨ Coral reefs

Image No. 16: Roatan Scenic Square Reef

Source: Gulf of Honduras Project

Coral reefs

These are shallow communities in tropical and subtropical waters with complex interrelationships between species, showing the greatest diversity of the different marine communities.

These communities live typically in oligotrophic zones, with a relatively small range of salinity and temperature, and tend to grow in temperatures and salinities near the tolerance limits of the corals conforming the reefs; and consequently are particularly sensitive to small changes in salinity and temperature.

In addition to its vulnerability to changes in salinity and temperature, reef communities are sensitive to systematic anthropogenic (tourism, for example) or accidental (oil spills, for example) effects.

➔ **Location and importance in the Gulf of Honduras**. In the Western Caribbean Sea is one of the more extensive reef systems in the world, called the "Mesoamerican Barrier Reef System", which extends from the Caribbean coast of Yucatan in Mexico to the Bay Islands in Honduras, i.e. about 22,800 km^2, which include: a nearly continuous barrier reef, 220 km long along the coast of Belize, approximately 6,000 km^2 of coastal lagoons, and over 1,000 cays. To the east of this system are three large atolls: Turneffe, Lighthouse and Glover's Reef, separated by deep water, which play a fundamental role in structuring the "reef system"[1].

➔ **Current health status**. Current health status. To know the status of the reef system, a system of five categories or variables between "*very good*" and "*critical*" was used, to qualify seven (7) key indicators that can help identify the differences existing between different sites of the reef. Thus three (3) indicators that focus on *the coral* were combined to formulate the so-called "**Coral Index**" and four (4) indicators that focus on *reef biota* to formulate the so-called "*Reef Biota Index*" (Table No. 7). Both indexes are integrated into a single index, called "Integrated Reef Health Index" (IRHA) which encompasses all the reef and ecological data, which in turn, allows mapping the spatial distribution of healthy and unhealthy reefs.

Healthy Reefs Initiative
It is a joint initiative at international level which generates tools for measuring the health of the Mesoamerican Reef System and science-based reports to support decision-making. It has developed a "Report Card" (Report Card) on ecosystem health which aims to provide timely, accurate and reliable information, on the condition of the resources of the Mesoamerican Barrier Reef System and establish the success in managing these resources.

The study sites (representative of the reef) were selected remotely from among the different types of reefs based on the maps produced by the Millennium Project for Mapping of Coral Reefs[2]. Thus, 326 sites were selected in twelve (12) regions belonging to different geomorphologic reef (shallow front, patch, pinacoid and platforms).

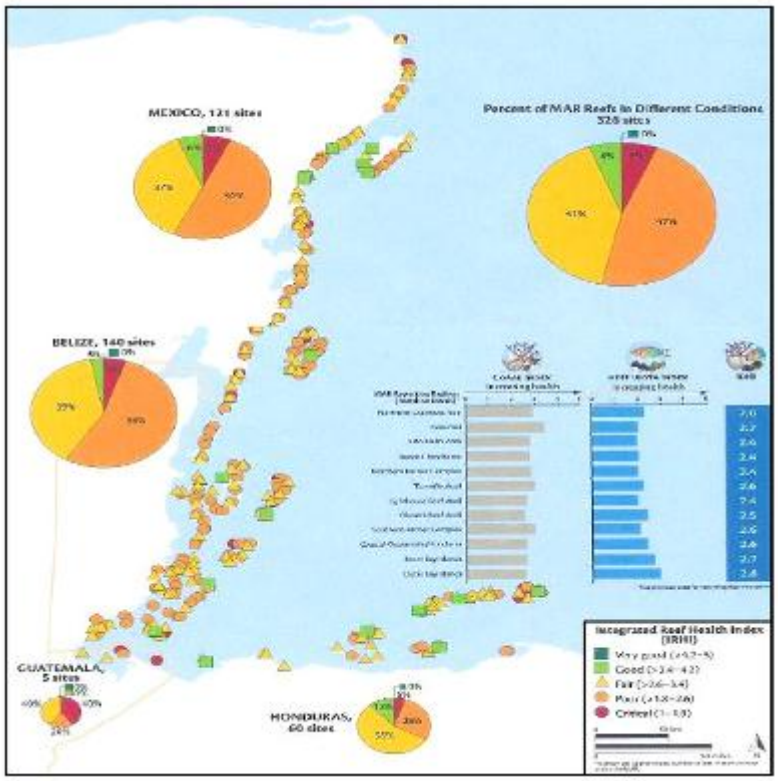
Table No.7: Central indicators of the health of the Mesoamerican Barrier Reef System

Coral Index	Reef Biota Index
Indicators	
Coral coverage: It is a measure of reef surface covered by live hard corals, which are forming the three-dimensional framework of the reef **Coral Disease Incidence:** The percentage of colonies visibly affected by disease. **Coral Recruitment:** The process by which the tiny coral larvae that are drifting adhere to the bottom and start to grow (measured as the number of recruits per square meter of reef; this is vital to recovery after a disrupting event occurs).	**Fleshy Macro algae Index:** Measures the amount of fleshy algae or seaweed that exists in the reef and is defined as the product of fleshy macro algae cover and the height of these algae. **Abundance of herbivorous fish:** Measures the biomass (total weight of fish per unit area) of "surgeon fish" and "parrot fish" which are the fish that graze on those plants most likely to cause abnormal growth of vegetation in the reef. **Commercial Fish Abundance:** Measures the biomass (total weight of fish per unit area) of fish species with commercial importance. **Abundance of Hedgehog Diadem:** Measures the density of long-spine sea urchin, a key herbivore whose role is to graze on the algae that competes with corals for the available space on the reef.
Integrated Reef Health Index (IRHI) This is the average (mean) of coralline and reef biota sub indexes. This is the most fundamental point in reef health - like the Dow Jones Stock Exchange, which is not an accurate measure of specific actions, but which is useful as an indicator of general market trends.	

From: Healthy Reefs Initiative (2008)

[1] Murray et al., 2003; World Resources Institute, 2005; Arrivillaga y Windenvoxhel, 2008
[2] See: http://eol.jsc.nasa.gov/reefs/Overview2003/ mill.htm

Image No.17: Integrated Reef Health Index (IRHI) of the Mesoamerican Reef System



Source: From Healthy Reefs Initiative (2008)

Belize Reefs

Once considered among the most productive and prosperous reefs in the Caribbean. *From about one hundred and forty (140) sites surveyed, the "Integrated Health Index Reef" corresponded to "Critical" for 5% of the sites, "Bad" for 53%, "Regular" for 39% and "Good" for only 3% of the sites.*

Guatemala Reefs

Guatemala has a limited development of coral reefs along the Caribbean coast. The best known are the carbonated banks around Punta Manabique. These are part of the Mesoamerican Reef System and are dominated by sediment-resistant corals (*Siderastrea siderea* species that form isolated communities and very small patches, according to Wilkinson and Souter, 2008). There are also some patches of coral reefs in Amatique Bay and near the outlet of the Motagua River. *Of a total of five (5) sites surveyed, the Integrated Health Index Reef corresponded to "Critical" in 40% of the sites, "Bad" at 20% of sites and "Regular" at 40% of the sites*.

Honduras Reefs

There are few coral communities (very scattered and with little level of development) on the Atlantic coast and in the vicinity of Puerto Cortes, La Ceiba and Trujillo. The only highly developed coral community is outside the study area. The discontinuous but well-developed reefs, are dominated by *Montastrea annularis* species, which predominates in terms of mass and biotic coverage in many Caribbean reefs, both fossil and living, and is highly sensitive to light, which is an important factor determining their abundance and growth (Goenaga, 1998). *Of a total of sixty (60) surveyed sites (mostly outside the study area), the "Integrated Health Index Reef" corresponded to "Critical" for 5% of the sites, "Bad" for 28%, "Regular" for 55% and "good" for 12% of the sites.*

According to Healthy Reefs Initiative (2008) "The general perception from the studies conducted is that the reef is endangered and needs immediate protection. Efforts to improve the health of the reef have achieved mixed results. On the other hand, some elements of reef health are in good condition and there are others which can be improved quickly and easily by choosing a better option for management. "

➔ **Ecosystem services.** Coral reefs have sustained human populations in the tropics for thousands of years. The main benefits can include high fish yields and revenues related to tourism as an important source of nutrition for coastal communities and a huge value as a source of pharmaceuticals. At present, sustainable fisheries from coral reefs is estimated at about 20 - 35 million tons per year. Some of the commercial species, characteristic of these systems are invertebrates such as lobster (*Panulirus argus*), conch (*Strombus gigas*), crab (*Calianactus sp*) and fish such tarpon (*Megelops atlantica*), grouper (*Epinephelus sp*.) snappers of the Lutujanidae family or saw fish of the Scomboridae family. Despite this importance, human population growth has outpaced the ability of coral reefs to produce harvestable biomass, in certain cases, overexploiting fish resources.

⇨ Mangroves

Mangroves preserve biodiversity and are home to species of mammals, reptiles, amphibians and birds, some of which are now threatened, just as numerous inhabiting species of juveniles and adult fish. Many juvenile reef fish species live in these ecosystems.

The mangrove has a marked influence on the structuring of fish communities inhabiting coral reefs. It has been observed that the biomass of fish species of commercial interest doubled when mangroves are connected to their habitat. Some authors suggest that approximately two-thirds of the fish species that inhabit tropical and subtropical seas depend heavily on mangroves. They are the main source of supply of nutrients in coastal and estuarine trophic chains[3]. These ecosystems have the ability to sequester carbon into the soil more rapidly than other terrestrial ecosystems (Chmura et al., 2003).

Mangroves of Belize

They grow in the intertidal area, covering an important dimension of the coast and can be found in an almost continuous belt along the coast. Mangrove species in general are all together: i) the red mangrove (*Rhizophora mangle*) is the most abundant and typically common, is present along rivers and their watersheds as well as on the coast, ii) the black mangrove (*Avicennia germinans*) develops mainly at sites farther from the coast, iii) the white mangrove (*Laguncularia racemosa*) is the species that is not present in many places, iv) the buttonwood mangrove (*Conocarpus erectus*) is more towards the edges of mangrove areas, particularly in the NE of Belize. Also is reported the presence of three true mangrove species and a species of association:*Conocarpus erectus* y *Acrostichum aureum*), (According to Murray et al., 2003)

Most mangroves occur on land and one fourth of these are located in more remote areas and towards the coast. In addition, many keys of platform, and particularly Turneffe Reef, have large amounts of areas covered by mangroves. The presence of the barrier reef, the gentle gradient of the coastline and the narrow tidal range are the main geographical factors that shape and control the distribution of mangroves in Belize. In addition, to a lesser degree, they are influenced by the geomorphology, soil drainage and hurricanes[4].

Belize still has large areas of mangroves, a situation associated with two main factors: a) historical low-level development pressure (associated with low population density), and b) the concentration of the population mainly around the Belize City. The mangrove is developed on the coast, along rivers, terrestrial lagoons and most of the Keys. The main rivers with mangroves are the Rivers Hondo, Belize (which forms the largest delta in the country), Sittee, Mango Creek, Manatee and Bar. There are mangroves in almost all the southern coast of Belize, especially in Placencia, Port Honduras and the edge of the main rivers such as the Deep River, Sarstun and Temash. However, during the last decade, there has been an accelerated loss of mangroves around population centers and, with the exception of strong hurricanes; impacts from human activities are the main determinants of the dimension of mangroves in Belize[5].

Mangroves of Guatemala

In 1999, according to FAO 2007, the mangrove cover in Guatemala was estimated at 17,727 ha. Mangrove species reported for Guatemala are black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*) and the red mangrove (*Rhizophora mangle*). A fourth species that grows in the region Amatique Bay is reported, the buttonwood mangrove (*Conocarpus erectus*). There is presence of mangroves in the Atlantic coast; however, it does not cover a wide swath, but is only found by and at the entrances the seaside of the rivers flowing into it. Some small areas have been reported along the Bay of Amatique and the delta of Chocon River. From the analysis of aerial photographs, about 92 km from the Caribbean coast of Guatemala are colonized by mangroves (in FUNDARY – PROARCA / APM, 2004).

Mangroves of Honduras

The species reported for Honduras are: black mangrove (*Avicennia germinans*), buttonwood mangrove (*Conocarpus erectus*) and white mangrove (*Laguncularia racemosa*). Added to these is a species not referred for Belize or Guatemala: *Avicennia bicolor*. Honduras is the country that has the highest coverage of mangroves in the region. In the Caribbean the most extensive areas of mangroves are found in Honduras and Nicaragua. In 2000, mangrove coverage in Honduras was estimated at 78,668 **ha**, covering both the Caribbean and the Pacific coasts. On the Atlantic coast there are large areas of mangroves associated with estuaries, deltas and coastal lagoons, being

[3] Lee, 1999; Abt Associates Inc – Woods Hole Group, 2003; García – Salgado et al., 2006)
[4] Murray et al., 2003.
[5] Murray et al., 2003

abundant in the Laguna de Alvarado, the Laguna de los Micos (Jeannette Kawas National Park), Laguna Negra (Tela) and the National Park Punta Izopo. However, the largest areas are in the west of the country, around lagoons, among which stands out the Lagoon of Caratasca.[6]

➔ **Ecosystem Services**. Within the ecosystem functions of these coastal forests are included the supply of fresh water and food, as well as raw materials such as resins, oils, medicines and supplies the tourism industry. In addition, the mangrove is used for aquaculture practices, whether in estuarine open water (mariculture), mainly for oysters and mussels, or in fresh water, mainly for shrimp.

⇨ Biodiversity in the Gulf of Honduras

The Central American region has high species richness with numerous cases of endemic species, being considered of high conservation priority in relation to biodiversity (Mittermeier et al., 1998). The Gulf of Honduras is home to much of the world's biodiversity, whether terrestrial or marine[7]. Mangroves, seagrasses and estuaries are areas that currently show high levels of biodiversity, and that due to intensive deforestation in other areas, represent areas of refuge for many species[8].

Belize

Within the marine biodiversity highlights the of the Cnidaria phylum invertebrates to which belong the group of corals; in turn, in vertebrates fish stand out due to their importance for the fisheries sector.

Guatemala

According to the National Council of Protected Areas of Guatemala (CONAP, 2003) there are 2,050 vertebrate species, of which 799 species are fish (estuarine, freshwater and marine), 118 species are amphibians (including 28 endemic species), 224 species are reptiles (including 18 endemic species), 695 species are birds (including one endemic species) and 214 species are mammals (including three endemic species).

In Amatique Bay there is a high degree of association between different environments and habitats which also leads to a great diversity of flora and fauna. Yanez - Arancibia (1998) reported 20 species of algae, 95 species of pelecypods and 48 species of gastropods. There are also in the area more than 113 species of birds associated with wetlands, some of which are endangered, such as the osprey, the stork and the toucan. The same applies to mammals such as the tapir and amphibians such as crocodiles.

In the protected area of Punta Manabique there are over 100 fish species grouped in 54 families, assigning this high diversity to the river discharge, salinity and oxygen concentration during the rainy season, which ultimately shapes the patterns of abundance and distribution of species. For this same area are reported several species of reptiles, including the American crocodile (*Crocodylus acutus*), boa (*Boa constrictor*), brown caiman (*Caiman crocodilus*), the hawksbill turtle (*Caretta caretta*), green turtle (*Chelonia mydas*) and the leatherback turtle (*Dermochelys coriacea*). Among the most commercially valuable fishes are mackerel, sea bass, Calala, pike, bream, pomfret, croaker and shark[9]

Honduras

It presents an exceptionally high diversity relative to its size.

- The flora is represented by 7,524 species reported, of which 170 have restricted distribution, 134 are endemic and 35 have threatened habitat (SERNA, 2007). Birds are represented by 718 species, of which 59 are under national threat and 5 are in the "Red List of the International Union for Conservation of Nature" (including the only endemic bird of Central America: *Amazalia luciae*).
- Mammals are represented by 228 species (of which 6 are endemic and 19 are under threat). Reptiles are represented by 211 species and 111 species of amphibians (of which 36 are endemic).
- Among marine and freshwater - terrestrial reptiles are recognized: a) six species of sea turtles and nine freshwater -terrestrial turtles b) two species of crocodiles, and c) a sea serpent and a freshwater snake. In addition, the green iguana (*Iguana iguana*) and the Utila iguana (*Ctenosaura bakeri*) are strongly associated with wetland ecosystems, especially along riverbanks and mangroves.
  Fish are represented by 672 species. The species of freshwater fish are grouped into 27 families and 50 genera and there is no report of any endemic fish species in the region (SERNA (2001). Insects are represented by 2,500 species (of which 14 are endemic species). Invertebrates represent the most diverse and abundant group of marine organisms of Honduras (SERNA, 2001) ; there are 537 species of invertebrates reported for the Atlantic coast, including sponges, coelenterates, ctenophores, annelids, mollusks, arthropods, echinoderms and urochordates.

[6] IDEM
[7] According to Abt Associates Inc – Woods Hole Group (2003)
[8] By Ellison (2004).
[9] Abt Associates Inc – Woods Hole Group, 2003).

⇨ Protected areas and priority conservation sites

Currently there are 159 Contracting Parties to the Convention and 1,834 wetlands, with a total area of 170 million hectares, designated for inclusion in the "Ramsar List of Wetlands of International Importance" (see: www.ramsar.org). The countries of the Gulf of Honduras have incorporated 15 sites (7 from Guatemala, 6 from Honduras and 2 from Belize) (see Table 3.8) which provides protection to the major wetlands in the region, also conferring them international status for the protection of flora and fauna linked to these sites.

Terrestrial protected areas

The International Union for Conservation of Nature (IUCN) defines protected areas as "terrestrial or marine areas specially designated to protect and maintain biological diversity and the associated natural and cultural resources, managed by means of legal tools "(IUCN, 1994).

The countries of the Gulf of Honduras have established numerous sites which are conferred some form of protection; some of them are part of international environmental protection agreements such as the RAMSAR sites and the Biosphere Reserves (UNESCO - "The man and the Biosphere " Program).

The Convention on Wetlands of International Importance (Ramsar, Iran, 1971) is an international treaty whose purpose serves as a framework for national action and international cooperation for the conservation and rational use of wetlands and their resources.

Image No.18: Scenic beauty of the Gulf of Honduras

Source: Gulf of Honduras Project

Table No.8: RAMSAR sites in countries bordering the Gulf of Honduras

Site Number	Country	Site Name	Date of Designation
946	Belize	Crooked Tree Lagoon Area	22/04/1998
1562		Sarstun Temash National Park	19/10/2005
488	Guatemala	Tiger Lagoon	26/06/1990
725		Manchon – Guamuchal	25/04/1995
813		Wildlife Refuge Bocas del Polochic	20/03/1996
1016		Punta de Manabique	28/01/2000
1599		National Park Yaxhá – Nakum – Naranjo	02/02/2006
1623		Eco-region Lachuá	24/05/2006
1667		Multiple Use Reserve Sarstun River	22/03/2007
619	Honduras	Barras de Cuero y Salado	23/06/1993
722		National Park Jeanette Kawas	28/03/1995
812		Wildlife Refuge Punta Izopo	20/03/1996
1000		Wetland System of the South Zone	10/07/1999
1254		Bacalar Lagoon	03/02/2003
1467		Lake Yojoa Sub-Watershed	05/06/2005

From: *http://www.ramsar.org/sitelist_order.pdf*

Table No.9: Biosphere Reserves in countries bordering the Gulf of Honduras

Country	Site Name	Date of Designation
Belize – Guatemala	Maya	1990
Guatemala	Sierra de las Minas	1992
Honduras	Río Platano	1980

Source: *http://www.unesco.org.uy/mab/reser.html*

Biosphere Reserves (Table 3.9) are "areas of terrestrial and coastal / marine ecosystems, or a combination of these, recognized as such at international level within the framework of the" Man and Biosphere "(MAB) of the United Nations Educational, Scientific and Cultural Organization (UNESCO)."

⇨ Environmental Sensitivity Card

a. Determination of the Environmental Sensitivity Index

Table No. 10 presents the average values of the "priority targets for conservation." These values were assigned based on the values considered in the recent publication *"Ecoregional Assessment of the Mesoamerican Reef: Marine Conservation Plan"* by Arrivillaga and Windevoxhel (2008).

The **Environmental Sensitivity Index (ESI**) was determined by an aggregate where the weight and percentage of hexagonal coverage of the different conservation elements are considered: Where there is representation of the conservation element / hexagon and Prioritization Target for conservation of the conservation element.

Table No.10. Weighting criteria used to determine the "Environmental Sensitivity Index "

Conservation Feature	Average value of the "Prioritization targets for conservation"
Reef	56.0
Mangroves	57.5
Seagrass	62.5
Sandy Beaches	37.5
Estuaries and Coastal Lagoons	47.5
Reef Fish Aggregation Sites	80.0
Manatee Habitat	71.2
Sea Turtle Nesting Sites	52.5
Seabird Nesting sites	47.5
Crocodile Nesting Sites	70.0
Whale Shark Feeding Sites	80.0
Priority Sites for Conservation (TNC)	100

Modified from: *Arrivillaga and Windevoxhel (2008)*

b. Results

The Environmental Sensitivity Index (ESI) obtained varied between 0.0 and 3.4, and consequently to establish the categories, it was considered 3.4 as the maximum sensitivity value (100%) and sensitivity values for each hexagon of quantification were re - calculated in terms of percentage. For the graphical representation ten (10) ranges were selected (Table No.11). For the interpretation the ranges presented in Table No. 12 were considered.

Table No. 11. Environmental Sensitivity Index: Ranges considered and their representation in the study area

ISA, %	Quantity of hexagons	Surface (Hectares)
>0 y <10	721	187.321
>= 10 y <20	870	226.903
>= 20 y <30	577	151.063
>=30 y <40	361	94.874
>=40 y <50	516	136.125
>=50 y <60	176	46.606
>=60 y <70	167	44.390
>=70 y <80	39	10.405
>=80 y <90	10	2.678
>=90	6	1.613
Total = 3.443 hexagons = 901.978 ha		

Table No.12. Environmental Sensitivity Index: Criteria for Interpretation

Characterization of the Zone	ISA %	Quantity of hexagons	Surface	
			Hectares	%
Highly sensitive	ISA > 70	55	14,696	1,63
Sensitive	50 > ISA < 70	343	90,996	10,09
Moderately sensitive	30 > ISA < 50	877	230,999	25,61
Low sensitivity	ISA < 30	2.168	565,287	62,67

➔ **Highly sensitive areas and sensitive areas** (with ESI values > 50%). Because of its high biodiversity, these areas would present the greatest sensitivity to the effects generated by shipping and / or coastal development. Most correspond to the "Priority Sites for Conservation" proposed by Arrivillaga and Windevoxhel (2008) or sites where there are several elements of conservation (reef fish aggregation sites, sea turtle nesting sites, sea birds nesting sites, manatee habitat sites, crocodile nesting sites and whale shark feeding sites). While these areas represent only 11.72% of the total area covered by the hexagons of quantification, highlights the location inside them of some port areas (Big Creek) and some sections of the shipping routes between major ports in the area from study.

➔ **Moderately Sensitive Areas** (with ESI values between 30% y 50%) and **Low Sensitivity Areas** (with ESI values < 30 %) show, respectively, a coverage of 25.61% and 62.67% of the hexagons of quantification. These areas correspond mostly to the coastal regions of the Gulf of Honduras where highlights the presence of sandy beaches and estuaries which constitute ecosystems that Arrivillaga and Windevoxhel (2008) assigned a low priority for conservation; this value should be re - considered as both the tourism and coastal development of the Gulf of Honduras as the increase in sea level are identified as potential causes that would affect both their physical characteristics as well as the biodiversity associated with them.

➔ **Characterization of ecosystems**. After the Environmental Sensitivity Card and Google Earth Image, a

characterization of the existing ecosystems was prepared throughout the coastline of the study area (Table No.13). It is observed that Belize concentrates 85.01% of coastal mangrove areas and 100% of seagrass; Honduras concentrates 48.31% of coastal areas with sandy beaches and Guatemala 66.96% of coastal areas corresponding to protected areas. In turn, on regards to coastal population, Belize and Honduras concentrate 44.20% and 39.95% of the areas with some type of urban development.

Table No.13. Characterization of the coastline of the study area subject of this consultancy

Country	Length						
	Coastal Lin	Mangroves	Seaweed	Sandy Beaches	Protected Areas	Urban Areas	Other populated areas
Belize	325.16 km 48.34 %	40.21 km 85.01 %	187.12 km 100.00 %	60.46 km 20.54 %	77.01 km 31.16 %	19.27 km 29.08 %	23.10 km 44.20 %
Guatemala	203.13 km 30.20 %	5.29 km 11.18 %	0.00	91.68 km 31.14 %	165.25 km 66.86 %	17.98 km 27.14 %	8.29 km 15.86 %
Honduras	144.37 km 21.46 %	1.80 km 3.81 %	0,00	142.27 km 48.32 %	4.89 km 1.98 %	29.00 km 43.77 %	20.88 km 39.95 %
Total	***672.66 km***	***47.30 km***	***187.12 km***	***60.46 km***	***247.15 km***	***66.25 km***	***52.27 km***

⇨ Ocean and coastal currents

The hypotheses of discharge (Table No.14) were defined based on the analysis of existing information on statistics of discharges. Discharges were analyzed both from accidents during navigation phase (which tend to produce discharges of large quantities of hydrocarbons) and waste produced during phases of operation in ports (which tend to produce discharges of small and medium quantities). The results of discharges in different ports follows:

Table No. 14 Characteristics of simulated discharges in the different ports

Discharge	Discharge Time	Flow of discharged product (kg/s)	Discharged product (tons)	Simulation Time (hours)
Discharge 1	11' 15''	1.5	1	24
Discharge 2	2h 30'	3	27	24
Discharge 3	9h 15'	3	100	24
Discharge 4	24h	5	435	24

From: ALATEC Ingenieros Consultores y Arquitectos – Valencia Port (2007)

Port of Belize City (Belize)
The results indicate that 24 hours after a potential spill occurred at some point outside the harbor, the coast will not be affected (even if nothing is done in that time, the potential discharge will reach the existing marine reserve in front of the city). For a potential spill produced inside the port, the coastal zone will be immediately affected, although to varying degrees (depending on the magnitude of the spill) and may vary from 3.0 km to 7.0 km.

Big Creek (Belize)
A potential spill occurred in the external point considered will not affect (in 24 hours) the nearby coastal zone and, after that time, will follow a direction distant from any point located on the coastline. However, potential discharges in the entrance channel to the port, could affect the coast. The movement of the potential discharge would occur towards the South, since the prevailing winds and currents are directed from North to South; consequently, a spill in the vicinity of the access channel to Big Creek could have very damaging effects on ecosystems and surrounding fisheries. Potential discharges inside the port also would affect the coastal edge (characterized by the presence of mangroves and habitats of manatees) and the back of the port, (where shrimp farms are located).

Puerto Barrios y Port of Santo Tomas de Castilla (Guatemala)
For the study of Guatemalan ports three points were considered: a common (approximation to port) and one in each one of the ports. In approximating to the ports, potential discharges show a similar behavior, differing only by the magnitude of the spill. Over the hours, the potential discharge tends to exit the Bay of Santo Tomas de Castilla, becoming more scattered for the smaller of the simulated discharges (1.0 tons), while in the worst case (discharge of 435 ton), the discharge would reach coastal zones (Cerro San Gil manatee reserve), even affecting areas with mangrove forests and beaches of touristic importance; however, it is noted that the potential discharge tends to move away from Punta Manabique (area of special ecological importance). The low current conditions characterizing the South Bay provoke that a potential discharge in the Port of Santo Tomas de Castilla affects exclusively the nearest coastline to the port. According to the results of the modeling, simulated spills could affect between 3.0 and 4.0 km of coastline. Meanwhile, potential discharges in Puerto Barrios tend to affect the coast located east of the Bay of Santo Tomas de Castilla and the outlet of the Rio Cacao, affecting a total of 4.0 km of coast (within 24 hours of evolution of the discharge).

Puerto Cortes (Honduras)
The two discharge scenarios studied show quite similar behavior. Both for the point outside the port, as for the inside,

the different discharges studied tend to move along the East coast of the port and the potential affectance involvement differs essentially on the type of discharge considered: a) the stretches of coast affected by discharges outside the port, reach up to 8.0 km of extension for the largest of the discharge considered and 4.0 km in the smallest, and b) the sections of coast affected by discharges in the inner harbor range between 5.0 - 6.0 km.

Image No. 19 Different forms of pollution in the area of the Gulf of Honduras

Source: Gulf of Honduras Project

3.2 Pollution framework

The current state of pollution of the of the Gulf of Honduras was identified through primary recognition monitoring ("screening"), made based on repeatability aspects and complementary of existing information on water quality, sediments and biota. A literature review of the draft document both of the ADA and other studies was also performed. The baseline is presented based on the analysis of the main background and the information obtained from the Environmental Campaign Survey conducted between 08 and 26 August, 2008.

A. Environmental campaign survey

a. Number of samples and scope

The location of sampling stations corresponds to 12 of surface water, 12 of sediments and 7 of biota. Sampling points with the codification used and the geographic coordinates and the data on dates and time of sampling are presented in the following tables.

Table No.15 Environmental Survey Campaign: Information on water and sediment sampling points

Nº	Station	Point ID	Coordinates WGS´84		Date	Time
			Latitude (N)	Longitude (W)		
1	Turneffe Reef	T Be	17º 22' 54"	87º 55' 00"	11/08/2008	7:30 – 7:40
2	Port of Belize	PB Be	17º 28´ 06"	88º 12´ 02"	12/08/2008	6:30 – 6:40
3	Big Creek	BC Be	16º 30´ 08"	88º 24´ 02"	13/08/2008	6.25 – 6.40
4	Sarstun River	SR Gu	15º 54´ 09"	88º 54´ 14"	18/08/2008	7:00 – 7:12
5	Dulce River	RD Gu	15º 49´ 31"	88º 44´ 36"	18/08/2008	8:01 – 8:20
6	Port of Santo Tomas de Castilla	STP Gu	15º 41´ 46,3"	88º 37´ 25,3"	18/08/2008	9:00 – 9:10
7	Puerto Barrios	PB Gu	15º 43´ 53"	88º 36´ 22,1"	18/08/2008	9:-35 – 9:46
8	Puerto Cortes	PC Ho	15º 49´ 47,3"	87º 57´ 12,9"	25/08/2008	10:00 –10:20
9	Laguna de Alvarado	LA Ho	15º 50´ 36,5"	87º 55´ 40,6"	25/08/2008	11:28 – 1:55
10	Motagua River	MO Ho	15º 43´ 48,4"	88º 13´ 30,9"	25/08/2008	7:34 – 7:45
11	Ulua River	UL Ho	15º 55´ 66,2"	87º 42´ 92,2"	21/08/2008	8:20 – 8:32
12	Chamalecon River	CH Ho	15º 54´ 28,6"	87º 47´ 24,3"	21/08/2008	9:35 – 9:25

Table No.16 Environmental Survey Campaign: Information on biota sampling points

Nº	Station	Point ID	Coordinates WGS'84	
			Latitude (N)	Longitude (W)
1	Gallows Point	Gallows Point	17º 61' 43.0"	88º 04' 29.0"
2	Turneffe Reef	TeR	17º 22´ 54.0"	87º 55´ 00.0"
3	Willson Key	Cayo Willson	16º 13´ 30.0"	88º 35´ 30.0"
4	Mc Bride	Mc Bride	16º 15´ 04.0"	88º 34´ 29.0"
5	Sapodilla Key	Cayo Sapodilla	16º 08´ 08.0"	88º 14´ 10.0"
6	Three Points Key	Punta Manabique	15º 58´ 08.3"	88º 33´ 14.6"
7	Puerto Cortes	PCHs	15º 50´ 17.0"	87º 58´ 45.0"

b. Matrices considered

The matrices considered were ***water, sediments and biota***.

➔ **Water matrix.** This matrix has been further analyzed because: a) it is the most easily extractable, b) methodologies for the analysis are the least expensive and c) there is diversity of equipment in the region to analyze field and laboratory parameters. However, quality data are relatively scarce and, although this matrix is a good indicator of threats to the ecosystem, a regular monitoring program has not been developed. This information gap generated the need to include the matrix.

➔ **Sediments matrix.** Sometimes presents greater utility for certain parameters, as organic molecules such as pesticides and PCBs, will be attracted by organic matter in the sediment (it is expected to find higher concentrations of these analytes in these samples). Such values can define whether or not accumulation exists, and even detect if the contamination is recent or not. The amounts found indicate, many times, the probability of finding the components in water even though these cannot be detected by common methods. This may be due to its low solubility in water or, less sensitive methods of analysis.

➔ **Biota Matrix.** *Biota* refers to the set of biological matrix. A variable is selected (fish, bivalves, other) to be considered as "biomarker." Then you need to evaluate what kind of sub-samples will be analyzed (muscle, fluids, other) and parameters to be determined. The physicochemical characteristics of the different compounds condition the matrix to be analyzed for its potential accumulation in specific sites (muscle, fluids, and others.). For the purposes of the Environment Survey Campaign conducted, the matrix "biota" corresponded to the "white grunt" fish (*Haemulon plumieri*), analyzing composite samples from the muscle and liver.

c. Determined parameters

In the selection of parameters to be monitored, it was considered:

– *The economy of the ocean - coastal region*, whose pillars are commercial and artisanal fisheries, aquaculture, agricultural production (being bananas the main export), ports and maritime transportation, storage and transport of hydrocarbons and liquid bulk cargo (including hazardous chemicals), urban development and tourism.
– *Diverse relevant characteristics of the substances to monitor and their toxicological information*. Sampling stations and the diverse parameters to be measured in the field were selected, and the analysis was performed in the laboratory. This research broadens the analysis of parameters around the presence of heavy metals in the “sediment" and "biota" matrices. Also the range of persistent organic pollutants that were analyzed was broadened.

d. Analysis of results

In the 12 sampling stations surface water and bottom surface sediments were sampled, but biota was sampled only in 7 of them These stations did not necessarily coincide with those for water samples and sediments, as the indicator organism used, the "white grunt" fish (*Haemulon plumieri*), is associated with coral reef.

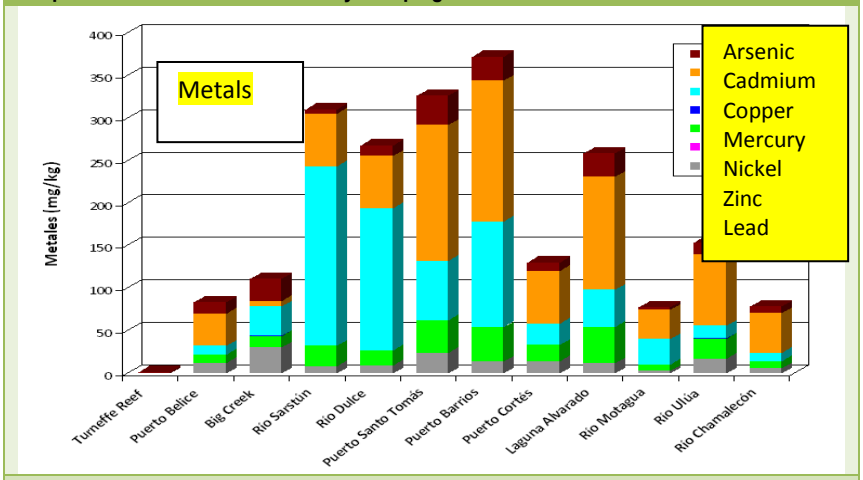
➔ **Water quality studies. Microbiological parameters** (Thermotolerant Coliforms).

The condition of this parameter is more compromised at the ports (except Puerto Cortes) (Figure No. 1). Puerto Barrios is the sampling point with the highest concentration (500 CFU/100 ml), followed by Port of Belize (with 390 CFU/100 ml) and Port of Santo Tomas de Castilla (with 250 CFU/100 ml). For high values of salinity, the concentration of thermotolerant coliform decreases, because in brackish or salt water, its half life is low, so in these cases, high counts indicates that wastewater discharge is close - in terms of time - at the time of sampling.

➔ **Studies of sediment quality**

In the **sediment matrix**, the groups of parameters monitored were **inorganic compounds** (toxic metals, Including arsenic) and **organic compounds** (PCBs, PAHs, pesticides and aliphatic hydrocarbons). Considering the textural characteristics of sediments, which conditions the capacity of adsorption of the different pollutants; sediments with higher organic load are more feasible to have presence of the monitored compounds.

Graph No.1. Environmental Survey Campaign: "Sediment" Matrix - Metals



Note: *Some values reported correspond to the limit of quantification of the analytical technique; in particular: a) all values of Cadmium, b) the value of Copper for Turneffe Reef c) the values of Mercury for Turneffe Reef, Port of Belize, Big Creek, Sarstun River, Dulce River, Motagua River and Chamalecon River and d) the values of Nickel and Zinc for Turneffe Reef.*

Source: Project Gulf of Honduras

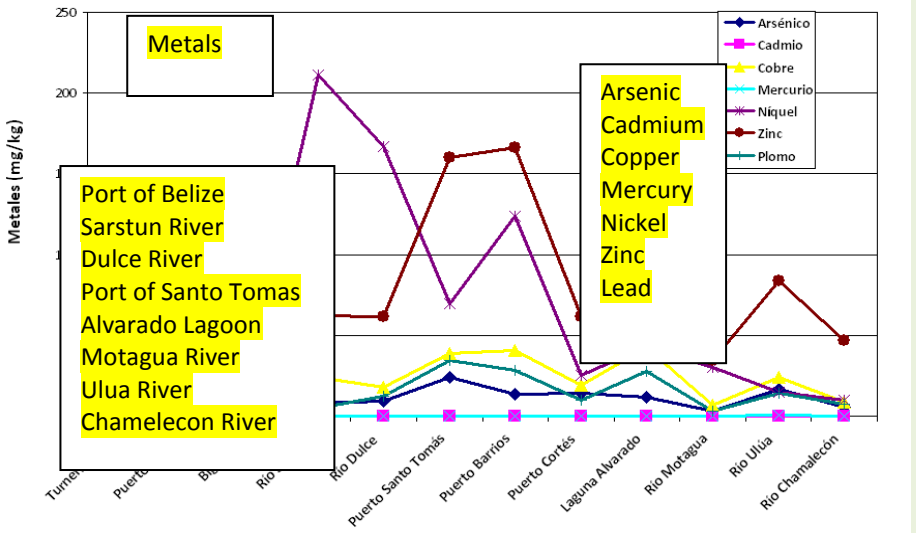
The evaluation of the data considered the so-called "threshold effect", values proposed by Canadian standards based on statistical studies using data from various studies that considered the presence of metals in aquatic environments and its harmful effects on living beings. These standards define two values: **the so-called probable effect level (PEL) and the so-called threshold effect limit (TEL)**. The highest value (PEL) indicates the ratio above which such effects are statistically frequent, while the lowest value (TEL) is the concentration below which these effects are statistically improbable. In the strip between the PEL and TEL, are the statistically occasional concentrations of metals with harmful effects.

➔ **Presence of contaminants. Sediment.**

– **Metals**

Graph No.2 and Table No.17 present the total metal concentrations per sampling point, showing that they had a heterogeneous gradient.

Graph No.2 Environmental Survey Campaign: "Sediment" Matrix - Concentrations of metals



Note: *Some values reported correspond to the limit of quantification of the analytical technique; in particular: a) all values of Cadmium, b) the value of Copper for Turneffe Reef c) the values of Mercury for Turneffe Reef, Port of Belize, Big Creek, Sarstun River, Dulce River, Motagua River and Chamalecon River and d) the values of Nickel and Zinc for Turneffe Reef.*

Source: Gulf of Honduras Project

Table No.17 Environmental Survey Campaign:"Sediment" Matrix - Concentrations of metals (expressed in mg / kg of dry matter)						
Station	**Cadmium (mg/kg)**	**Copper (mg/kg)**	**Mercury (mg/kg)**	**Nickel (mg/kg)**	**Zinc (mg/kg)**	**Lead (mg/kg)**
Turneffe Reef	<0,8	<1,3	<0,05	<1,3	<2,7	1,3
Port of Belize	<1,2	9,7	<0,078	10,1	38	13
Big Creek	<0,9	13,5	<0,058	34,6	6,4	26
Sarstun River	<0,84	24	<0,056	211	62	5
Dulce River	<1,2	18	<0,074	167	61,3	12,3
Puerto Santo Tomas	<1,4	38,5	0,2	69,5	160	34,5
Puerto Barrios	<1,1	40,5	0,2	124	166	28,1
Puerto Cortes	<0,63	18,8	0,057	25,3	61,8	10
Laguna Alvarado	<1,3	42,7	0,18	43,4	133	27,5
Motagua River	<0,6	7	<0,041	30,1	34,4	3,3
Ulua River	<0,94	23,9	0,33	14,7	83,7	14,1
Chamalecon River	<0,62	8,5	<0,043	9,7	47	7,5
Note: *The values indicated as "<x" correspond to the limit of quantification of the analytical technique*						

Source: Gulf of Honduras Project

Table No.17 shows that for the sample corresponding to Turneffe Reef Station quantifiable results were not reported for any of the metals analyzed, these results being consistent with expectations, as this is considered a "control point". It also shows that the points corresponding to the Guatemalan coast of the Gulf of Honduras (Sarstun River, Dulce River, Port of Santo Tomas de Castilla and Puerto Barrios) are those that showed higher total concentrations of metals. Then there are the sampling points for the coast of Honduras, where the Laguna de Alvarado is the sampling point with greater total concentration of metals. Finally are the points corresponding to Belize, where there is little difference in the total metals (except for Sarstun River).

As for the comparison of the concentrations of metals in sediments with values corresponding to the "probable effect threshold" (PEL) and the "threshold effect level " (TEL), it shows that, all cases are below the TEL (0.03 mg / kg), this means that they are lower than the concentration below which it is unlikely that there will be evidence of an adverse effect on biota.

– **Organic compounds**

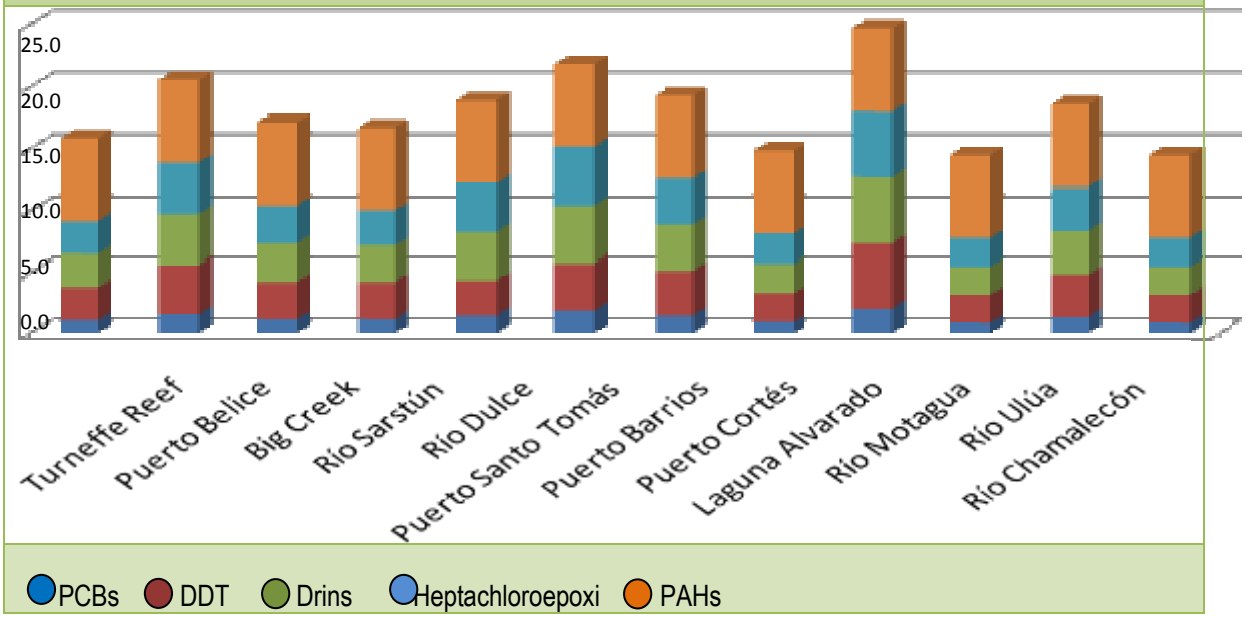
Among these organic compounds are the subgroups aliphatic hydrocarbons, organochlorine pesticides, polycyclic aromatic hydrocarbons (PAHs) and Polychlorinated biphenyls (PCBs). From the samples obtained, the highest value reported for the upper limit content of the sample was obtained at Laguna de Alvarado (2.1 µg/kg). However, all values are below the values corresponding to "probable effect threshold" (PEL) and the "threshold effect level" (TEL) which correspond to 21.51 and 188 µg/kg, respectively.

Organochlorine pesticides, did not present quantifiable results for any of the proposed subgroups; however, for the sampling points corresponding to Puerto Santo Tomas de Castilla and Laguna de Alvarado, the quantification limit reported by the laboratory analysis (4.7 and 5.3 µg/kg, respectively), does not allow to ensure that the concentration of Drina, at these points, does not exceed the guideline value which conditions the limit of quantification is greater than this value (4.3 µg/kg).

For the subgroup DDTs, all monitored points had values below the "probable effect threshold" (PEL) corresponding to 52 µg/kg. On regards to the "threshold effect level" (TEL), which corresponds to 3.89 mg / kg µg/kg, ten of the twelve sample points recorded lower values. For Laguna de Alvarado and Port of Santo Tomas de Castilla it is not possible to make conclusions, since the analytical quantification limits were slightly higher than the value corresponding to the "threshold effect level"

Since all data was reported as below quantification limit of the analysis, Graph No. 3 shows an approximation of the probable maximum concentrations of each organic compound in the sediment samples for the different sampling points. However, for visualization of the results the more conservative situation is assumed, being this that the maximum present is equal to the limit of quantification reported for each sample.

Graph No.3. Environmental Survey Campaign:"Sediment " Matrix - Hypothesis of maximum concentrations of organic compounds (µg/kg) as conservative criteria (assuming the limit of quantification as the actual value)



Source: Gulf of Honduras Project

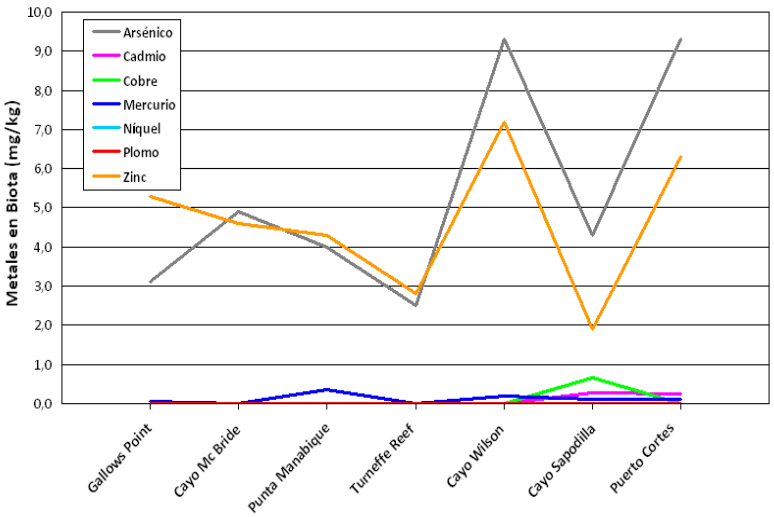
➔ **Biota quality studies**

– **Metals**

Metals measured in sediments were also determined in seven (7) biological samples corresponding to composite samples (muscle and liver) of "white grunt" fish (*Haemulon plumieri*).

The lower values for metals were registered for the samples at the "control point" (Turneffe Reef); based on the results obtained, zinc and arsenic are the metals with higher concentrations (Graph No.5 y No.6).

Graph No.4. Environmental Survey Campaign: "Biota" Matrix - Metals (mg/kg)



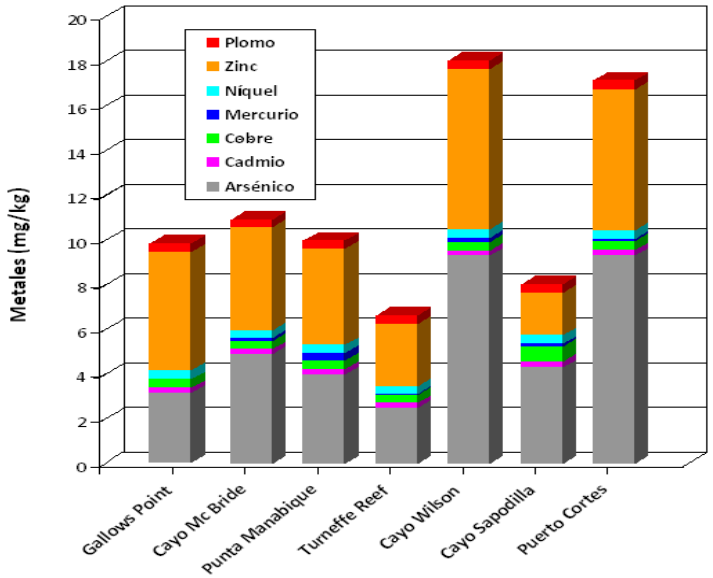
Note: Some of the value reported corresponded to the technical analytical quantification limit, in particular: **a)** the values for cadmium corresponding to Gallow Point, Mc Bride Key, Punta Manabique, Turneffe Reef and Wilson key; **b)** all the values for copper, except for Sapodilla Key; **c)** the values of mercury for Mac Bride Key and Turneffe Reef; and **d)** all the values of nickel and lead

Source: Gulf of Honduras Project

At Wilson Key and Puerto Cortthan other sampling points with concentrations of 7.2 and 6.3 mg/kg, respectively; these results are in accordance to those obtained with surface bottom sediments where also arsenic and zinc were the metals with higher concentrations.

Arsenic concentrations showed a gradient similar to that registered for zinc, showing high concentrations at the same sampling points; the values recorded in both cases were 9.3 mg / kg.

Graph No.5 Environmental Survey Campaign: "Biota" Matrix – Metals (mg/kg)



Note: *Some of the value reported correspond to the technical analytical quantification limit, in particular: a) the values of Cadmium corresponding to Gallow Point, Mc Bride Key, Punta Manabique, Turneffe Reef and Wilson Key; b) all copper values except for Sapodilla Key; c) the values of Mercury for Mac Bride Key and Turneffe Reef; an* ***d)*** *all the values for Nickel and Lead.*

Source: Gulf of Honduras Project

Punta Manabique was the sampling point with the highest concentration of mercury (0.35 mg / kg), followed by Wilson Key (0.18 mg / kg). Cadmium and copper concentrations were highest in Sapodilla Key, at 0.27 and 0.86 mg / kg, respectively. Although Wilson Key had the highest concentrations of arsenic and zinc and some mercury, the sample corresponding to Sapodilla Cay was the only one with quantifiable presence of five of the seven metals analyzed.

Given the situation described above, and considering the process of biomagnification in the trophic chain of certain pollutants, it was decided to perform an evaluation of indicative characteristic, considering the guideline values established in the Standard for Consumption of Fish, Crustaceans and Molluscs of Australia and New Zealand (ANZFA, 2000), considering only those metals that have a value guide in fish tissue.

Regulation used in the evaluation of the data

The National Oceanic and Atmospheric Administration (NOAA) of the United States, does not establish concentrations for samples of biological tissue. The Canadian Water Quality Regulations for Aquatic Life Protection sets maximum permissible concentrations of certain compounds in the tissue of aquatic organisms aiming at protecting the natural biota, as it establishes maximum levels at which no adverse effect on the development of aquatic life is expected. However, these regulations do not establish values for metals, with the exception of methyl mercury, as this is the most relevant form of mercury from a toxicological point of view.

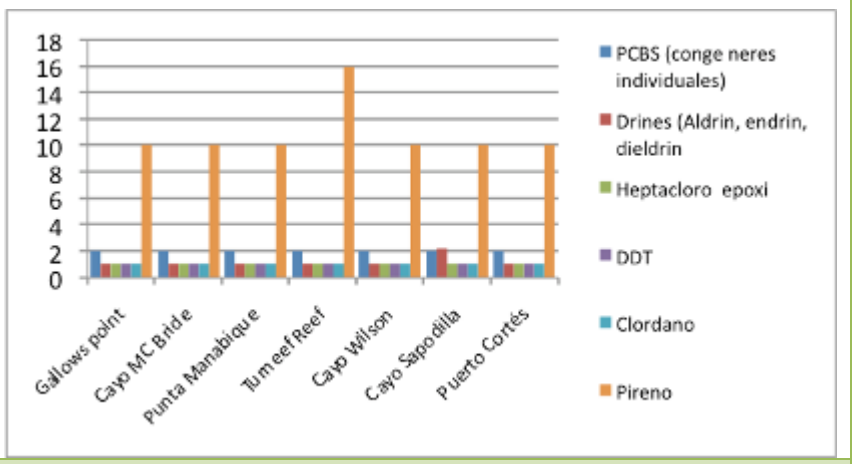
Based on regulations used for data evaluation, it is observed that for arsenic, all points are above the maximum permissible value in fish tissue to protect the health of consumers (2.0 mg / kg), being the sampling points for Wilson Key, Puerto Cortes and Mc Bride Key the more jeopardized.

For mercury, the situation is reversed, since none of the sampling sites exceeded the maximum permissible concentration for fish consumption (0.5 mg / kg); the same applies for copper, lead and zinc which maximum permissible concentrations are 2.0, 0.5 and 15.0 mg / kg, respectively.

– **Organic compounds**

For such compounds subgroups considered for the matrix "sediment" were maintained. Graph No.6 shows the probable concentrations of each organic compound in fish tissue samples.

Graph No.6 Hypothesis of highest concentrations of organic compounds µg/kg in biota, according to conservative criteria (assuming the limit of quantification as the actual value)



Source: Gulf of Honduras Project

It is observed that pentacosane is the quantifiable compound in several of the samples analyzed, being the average value 0.21 µg/kg. The results presented a fairly uniform concentration gradient, between 0.13 and 0.26 µg/kg, being the points of higher concentration Wilson Key, Cayo Mc Bride, Turneffe Reef and Sapodilla Key. The values for Gallows Point could not be considered in the assessment given that the sample has a quantification limit significantly higher than the other samples analyzed.

Table No.18 Summary of results of organic compounds in "white husky " fish tissue" (µg/kg)

Station	PCBs (individual congeners)	DDT	Drins *	Chlordane	Heptachlor epoxidexi	(individual congeners)
Gallows Point	<2,0	<1,0	<1,0	<1,0	<1,0	<10
Cayo Mc Bride	<2,0	<1,0	<1,0	<1,0	<1,0	<10
Punta Manabique	<2,0	<1,0	<1,0	<1,0	<1,0	<10
Turneffe Reef	<2,0	<1,0	<1,0	<1,0	<1,0	Pirene= 16, All others <10
Wilson Key	<2,0	<1,0	<1,0	<1,0	<1,0	<10
Sapodilla Key	<2,0	2.9	<1,0	<1,0	<1,0	<10
Puerto Cortes	<2,0	<1,0	<1,0	<1,0	<1,0	<10

Note: The values indicated as "<x" correspond to the limit of quantification of the analytical technique
The Drins include Aldrin, Endrin and Dieldrin.

e. Conclusions

The information obtained from the Environmental Campaign Survey identifies the current status of the study area. However, there is a need to implement a systematic sampling which allows collecting a series of important data, considering the possible seasonal variations to generate base information. Its evaluation will allow the implementation of actions before the environmental degradation of the system occurs, and evaluate the effects of the introduction of pollutants into the environment.

➔ **Variations in the physicochemical properties of water**. The variations in water physicochemical properties such as conductivity, salinity and total dissolved solids indicate that the water body is not homogeneous; this variation may be associated with differences of the input of the masses of water from tributary rivers, the incorporation of groundwater, differential evaporation ranges as well as the action of tides and ocean currents.

➔ **Water Quality**. The eutrophication conditions reported in previous studies does not appear to be maintained. However, it is important to highlight that none of those studied presented information of water samples of the marine area of the Gulf of Honduras; rather they were assessments of its tributaries.

➔ **Sampling point - Port of Belize**. This is the one with the highest nutrient load of all sampling points, and is also the one with the higher bacterial load, the higher concentration of quantifiable sulfur and higher suspended solids. These parameters could be showing the presence of sewage discharges. Additionally,

it is noted that sediments at this sampling point revealed no evidence of contamination by metals and organic compounds, except for the aliphatic hydrocarbon pentacosane which was found at very low concentrations and is present in diesel and gas oil.

➔ **Sampling point- Zone of influence of the Chamelecon River**. It presented loads of nutrients and coliform bacteria (although in lower concentrations), being this point, along with the sampling points corresponding to the zone of influence of the Ulua and Motagua rivers, the most compromised in terms of suspended solids.

➔ All the recorded values of metals in sediments, with the exception of cadmium, have been quantified in different concentrations and at all sampling points, being zinc and arsenic those with *the highest concentrations. The same trend was registered in the tissue samples of "white grunt" fish (Haemulon plumieri*); at all sampling points, arsenic and zinc occurred in measurable concentrations followed by mercury.

➔ **Arsenic concentrations**. Concentrations in tissue samples of "white grunt" fish (*Haemulon plumieri*) exceed, in all cases, the permissible values of the Standards for Consumption of Fish, Crustaceans and Mollusks of Australia and New Zealand (ANZFA, 2000). This contaminant may come from sewage discharges, stormwater, and industrial solid waste and leaching. It could also be transported by gases and airborne ash and deposited both in water and soil, only to be swept away by runoff from the tributary watersheds of the Gulf.

➔ **Sampling Points: Puerto Barrios and Port of Santo Tomas de Castilla**. Have recorded the highest concentration of fecal indicator bacteria as well as measurable concentrations of oils and fats. Furthermore, these points showed the highest concentrations of total metal in sediments with high values in relation to all sampling points for arsenic, mercury, zinc, copper, lead and nickel (although in lower concentrations than in other samples). These parameters are closely related to sewage discharges as well as industrial discharges and leaching from solid waste. Is noted that there were no quantifiable organic compounds (hydrocarbons, pesticides, etc.) in any of the two sampling points.

➔ **Fecal contamination fecal**. Fecal contamination evident in the sampling points corresponding to the ports, suggests that its origin is due to sewage discharges and not from ships domestic, since such pollution is not registered in Puerto Cortes, where there is an efficient treatment of domestic waste. Puerto Barrios is the sampling point with highest concentration, followed by Port of Belize and the Port of Santo Tomas de Castilla.

➔ **Main pollutants in Rivers Sarstun and Motagua.** The main pollutants found were suspended solids (which generate a reduction in light penetration in the water column, resulting in affectation of the aquatic flora), being the Motagua River the one evidencing larger problems. In the Sarstun River high concentrations of oils and fat are also observed as well as sulphided; the latter would indicate the presence of organic matter discharges that has been degraded.

➔ **Concentrations of oil, grease and orthophosphates.** The Laguna de Alvarado is the sampling point which has the highest concentration of oils, fats and orthophosphates, as well as quantifiable concentrations of mercury and higher values of copper and lead. Also were registered quantifiable values of pentacosane; consequently, the contribution of pollutants might come from discharges of sewage and stormwater (contributions from urban areas by washing of the roads and the subsequent fuel drag) as well as solid waste.

➔ **Metals. Sapodilla** Key was sampling point where the largest number of metals was quantified (cadmium, lead, zinc, arsenic and mercury) in tissue samples of "white grunt" fish (*Haemulon plumieri*). Zinc, arsenic and mercury have also been quantified in tissue samples of "white grunt" fish (*Haemulon plumieri*) for Puerto Cortes, Wilson Key and Punta Manabique.

➔ **Aliphatic hydrocarbon.** With quantifiable values in biota, was the pentacosane (which is present in most sampling points). Since its origin is diesel or gas oil, its presence could come from the engines of boats and / or may be associated with contributions from urban areas (by washing of the roads and the subsequent drag of fuel).

➔ **Tissue of "white grunt" fish (*Haemulon plumieri*).** In tissue samples no quantifiable values were registered of organic compounds such as PCBs, pesticides and PAHs, except for Sapodilla Key (where DDT could be quantified) and Turneffe Reef (where pyrene was determined, although at low concentrations).

3.3 Socioeconomic framework

A. Major social and urban aspects

a. Ethnic diversity

In Belize, Guatemala and Honduras there is an ethnic diversity which is reflected in the coexistence of cultures and languages: a) in Belize, mestizos represent approximately 50.0% of the population, Creole 25.0%, Garifuna a 7.0% and other ethnic groups 18.0%, and b) in the department of Izabal, Guatemala, the mestizo population accounts for 75.0%, indigenous population 23.0% and Garifuna 2.0%.

b. Urbanization

The three countries have low levels of urbanization, however, in the coastal zone of the Gulf of Honduras, there are some urban centers of social and economic importance: a) the City of Belize and its port (in Belize), b) Bay Santo Tomas de Castilla with the city of Puerto Barrios and the ports of Santo Tomas de Castilla and Puerto Barrios (Guatemala), and c) the Sula Valley with the city of Puerto Cortes (Honduras).

c. Other aspects

Countries	Description of other aspects
Belize	Belize City represents the most important urban and commercial center in the country. It currently has 63,700 inhabitants and has a tourist infrastructure. The tourism industry accounts for 17.0% of the Gross Domestic Product (GDP) of Belize, but urban services do not meet the demand because the city does not have an adequate system of urban wastewater treatment and 40% of the population is not connected to the sewerage system. In addition, the Belize River, source of drinking water for the city, receives - untreated - urban effluents from the city of Belmopan (the treatment plant is not operating).
Guatemala	By 2008 the total population of the department of Izabal was estimated at 364,910 inhabitants according to the National Statistics Institute, mostly concentrated in rural areas and the rest in several urban centers (Puerto Barrios, Livingston, Los Amates, Morales, sweet River, The Curtain, Modesto Mendez). Puerto Barrios is the departmental capital and port city, located on the Bay of Amatique. All urban centers including the city of Puerto Barrios have an urban infrastructure with numerous shortcomings, because they have no sanitation systems or storm drains; however, the network of potable water has been improved and expanded. The department economy revolves around port activities, tourism and agriculture. In the ports an intense economic activity is developed related to the movement of cargo and cruise tourism. Crude oil is stored in the town of Piedras Negras. Regarding the use of soil, of the total 825,000 hectares of the department, 37% is for agricultural use, 9% corresponds to water bodies and 53% for forests, bushes, flood lands and wetlands. Agricultural crop production is destined for exports (bananas, oil palm, rice) and domestic consumption (corn, beans, rubber and others). By 2006, the departmental GDP represents 4.2% of the national GDP.
Honduras	In the Region of the Sula Valley a major industrial corridor between San Pedro Sula and Puerto Corte has developed. San Pedro Sula is known as the "Industrial Capital of Honduras" and is the second most important city (after Tegucigalpa). Puerto Cortes is the third largest city and has a mega - regional port, with a large open area, which moved 8,000,000 tons of cargo and 553,000 TEUs of containers in the year 2007. It has modern facilities and has been certified by the Department of Homeland Security of the United States. San Pedro Sula and Puerto Cortes potable water and sanitation services are considered "advanced" for the country, serving as reference. In these cities over 80.0% of the manufacturing and textile industry of Honduras is installed, with a good network of road infrastructure and the Ramon Villeda Morales International Airport (San Pedro Sula) as wells as six industrial parks where an important maquila industry is developed. San Pedro Sula, Puerto Cortes, Choloma, La Lima, El Progreso, Buffalo and Villanueva, are articulated as a conurbation of the Sula Valley and provide important demographic and economic dynamism to the country. The region also develops agricultural activities which include bananas, sugar cane, plantains, oil palm, citrus fruits, pastures and grains. The economic activities of the Sula Valley represent 55.0% of the GDP of Honduras and approximately 40.0% of exports. About 20% of the Honduran population lives in the region (which is the largest labor force).

B. Basic economics aspects

a. Recent trends and current profile of the regional economy

The economy of the Gulf of Honduras is characterized by the weight of its agricultural sector (particularly for exports of bananas, coffee and sugar) and the predominance of intensive natural resource production. Similarly, the fisheries sector is important, especially for Belize.

➔ ***The tourism sector*** has developed rapidly over the past years in the three countries, becoming a sector of particular interest at country level. The greater dynamism is observed in the coastal municipalities of Belize, the coastal municipalities of Honduras (Cortes, Tela and Omoa) and the municipalities of Livingston and Puerto Barrios (Guatemala). Cruise tourism tends to grow in the region, particularly in Belize and Honduras.

➔ ***The shipping and ports sector*** represents one of the most relevant economic activities in the area. The ports of the region represent the entrance and exit of exports and imports to the respective countries (particularly Honduras). In addition, dry channel or interoceanic road connections projects are underway between the main ports of El Salvador, on the Pacific Ocean, and Puerto Cortes and Santo Tomas de Castilla (on the Caribbean Sea). The Port of Belize is the most important of the country, but since 2006, with the onset of oil export activities, the Port of Big Creek has been strongly dynamized.

➔ ***The maquila industry and diverse industrial activities*** (paper, chemicals and food products) are specifically relevant for Honduras, specifically for the region of the Sula Valley, department of Cortes.

b. Economic valuation of coastal ecosystems

Marine - coastal ecosystems of the Gulf of Honduras provide environmental goods and services of vital and high social and economic significance for the local population and the economy of the countries of the region.

The most significant ecosystems from the economic point of view are the coral reefs, mangroves, sea grasses, bays, lagoons and estuaries, and sandy beaches. They also provide environmental services with an indirect economic impact. The coral reefs and mangroves are the main habitat of the juvenile stages of many coastal and pelagic fish as well as shellfish, and also provide elements of protection in relation to coastal erosion. All offer direct economic benefits such as: International receptive and cruise tourism, fishing activities, generation of financial resources, port services to shipping and maritime transportation of people and goods, and urban development. Tourism depends on environmental quality and the existence of a natural and cultural capital along the coastal and marine zone of the Gulf and has several components that must be analyzed separately: the international receptive tourism and cruise tourism. The fishing sector also represents a key element for the local coastal community and particularly for the national economy of Belize

➔ **Results of the ecosystem "baseline"**

– The estimated **direct impact of ecosystems** is of U.S. $ 967.9 million and, due to inaccuracies in the available information, the ***average estimate*** is in the range of U.S. $ 574.4 - 1,236.1 million
– The economic contribution of these ecosystems accounts for 2.0% of the total gross domestic product (GDP) of the three countries of the Gulf of Honduras and 27.7% of coastal GDP

Table No.19. Economic contribution of coastal ecosystems

COUNTRIES		***SCENARIO***		
Belize		***Low***	***Medium***	***High***
Direct Impacts (US$)		***288.267.416***	***394.943.581***	***469.206.150***
	% of Coastal GDP	***28 %***	***39 %***	***46 %***
	% of Country GDP	***28 %***	***39 %***	***46 %***
Indirect Impacts	Tourism Indirect Impact (1,2 – 1,4)	24.185.689	42.007.318	63.639.820
	Shrimp + Accompanying (Fauna135 %)	21.447.445	22.687.706	23.927.967
	Fisheries Indirect Impact (1,2 – 1,4)	1.825.314	2.896.303	4.072.845
Guatemala		***Low***	***Medium***	***High***
Direct Impacts (US$)		***102.212.112***	***225.658.523***	***287.247.741***
	% of Coastal GDP	***7,2 %***	***15,9 %***	***20,3 %***

	% of Country GDP	*0,3 %*	*0,7 %*	*0,9 %*
Indirect Impacts	Tourism Indirect Impact (1,2 – 1,4)	8.284.069	14.618.945	22.415.716
	Shrimp + Accompanying (Fauna135 %)	5.952.906	8.025.765	25.242.193
	Fisheries Indirect Impact (1,2 – 1,4)	506.630	1.024.566	4.296.544
Honduras		***Low***	***Medium***	***High***
Direct Impacts (US$)		***183.955.947***	***347.333.845***	***479.626.268***
	% of Coastal GDP	*17,4 %*	*32,8 %*	*45,3 %*
	% of Country GDP	*1,5 %*	*2,8 %*	*3,9 %*
Indirect Impacts	Tourism Indirect Impact (1,2 – 1,4)	26.327.090	49.363.295	98.726.589
	Shrimp + Accompanying (Fauna135 %)	1.383.074	1.536.749	2.150.705
	Fisheries Indirect Impact (1,2 – 1,4)	117.708	196.181	366.077

3.4 Priority problems

A. Water availability

Overall water resource availability is variable in the countries included in the study area

Belize	Guatemala	Honduras
Surface water resources, as well as groundwater, seem to be abundant in most parts of the country, however, total resources cannot be evaluated because the existing data is limited, in particular those concerning the availability and quality of groundwater. In coastal areas and along rivers subject to tidal action and, consequently, marine intrusion from the Gulf, high concentrations of chlorides have been detected, determining that during the dry season, when fresh water recharge from rainfall is scarce, the presence of chloride affects the quality and availability of groundwater (FAO's Information System on Water and Agriculture, 2000). The United Nations Food and Agriculture Organization (FAO) estimate that the total discharge of Belizean rivers is approximately 15,000 million m^3/year. The availability of fresh water per capita is high. In 2002, renewable natural water resources were 78.8 thousand m^3/person (EarthTrends, 2003), a little less than in year 1995, when it reached 80.8 thousand m^3/person (CCAD, 1998, Belize Assessment National Report, 2003). Total water consumption reaches 95 million m^3/year, which results insignificant when compared to existing surface water resources (FAO, 2000).	According to the diagnostic report for 2006 (Strategy for Integrated Management of the Water Resources of Guatemala), the country has a supply of 97,120 million m^3 of water, with 34.28% (33,224,000 m^3) corresponding to watersheds draining to the Caribbean Sea. These values are lower when compared with water capital data presented in the report prepared by CCAD (1998), according to which it amounts to 133,280 million m^3/year, which means a water capital of 11,900 m^3/person/year. The total annual water extraction amounts to 1,557 million m^3/year, indicating that in absolute terms, there is a surplus of the resource, which in the annual water balance is due to the rains and the abundance of water resources. However, there is no proper management of this resource allowing developing and maintaining the supply requirements, both in terms of potable water and sanitation services as well as for agricultural water (IARNA, URL and IIA, 2006). The uneven distribution of rainfall and population, where most densely populated areas are in regions where water availability is low, coupled with the inefficient management of available water resources, are the main causes of the problems of water supply. Water resources are stressed up to a critical situation. In urban areas, groundwater provides most of the supply for domestic use.	There is significant hydric potential and, according to 2004 data, almost 79% of the existing resource is not used. The availability or water capital is 48,628 million m3/year, according to the Water Platform of Honduras, this amounts to about 13,500 m3/person/year, a quantity higher than the value considered as an indicator of scarcity (1,000 m3/ person/ year ; SERNA 2004). According to the FAO 2000, total water consumption amounted to 1,820 million m^3/year, so the available annual renewable water resources of Honduras are sufficient to meet consumptive water demands. In Tegucigalpa (the capital of the country) coverage of water infrastructure is 91.4%, and the supply deficit is 1.0 m3/s. The excess of unaccounted for water and an inefficient distribution explain the reason for the severe rationing, especially during the dry season. Although the situation is more favorable in San Pedro Sula, it is necessary to reduce unaccounted water and improve distribution systems. In Puerto Cortes, coverage is 93.4% and the service is 24 hours, however, due to population growth and expansion of city limits, it is necessary to incorporate new sources of supply in the short term (GEO Honduras, 2005). In the event of an increase in water demand for irrigation, some watersheds would face water shortages.iin the future. Also, other watersheds (Ulua and Chamelecon) where the annual average resource is greater than the demand, accuse have shortcomings during certain periods of the year (February to May).

B. Pollution

At global scale, the effects of the different contributions of pollutants on water quality and aquatic biota are diminished by the large dilution effect. ***At local scale***, the identification of potential sources of pollutant inputs becomes particularly important, since often, the effects on the environment are significant, affecting, particularly water quality and sediments of the coastal zone.

The Gulf of Honduras receives contributions of pollutants from both point sources (from industrial, sewage and solid waste effluents,) and diffuse pollution sources. Sewage effluents also carry pollutants from industrial activity, since sewage networks receive contributions from industrial effluents. Additionally, as a navigable waterway and as the basis for the main ports oriented to trade in the region, there are several factors associated with maritime- port activity, which contributes to the degradation of coastal and marine ecosystems.

⇨ Microbiological pollution

Excreta disposal is in most countries with low industrialization the major source of contamination of water bodies; the forms of pollution include:

- ***Point sources:*** When disposition is done through a sewage system that collects sewage liquid to concentrate them in a discharge point (with or without treatment before the discharge).
- ***Scattered sources:*** When disposition is made directly from houses to roads, drainage channels or directly into water bodies.
- ***Scattered sources through contaminated aquifers:*** When households have a system of excreta disposal by infiltration to the ground, without proper control it can result in contamination of aquifers.

In general, there is lack of sanitation coverage in all three countries. Additionally, incoming tourism by sea is important and has significantly increased over the past years (Table No.20); this has led to a growing concern about the discharge of sewage from both cruise ships and the growing number yachts. However, large ships have wastewater storage systems and comply with the Convention for the Prevention of Pollution from Ships (MARPOL), which prohibits downloading these waters within 7.0 km of the nearest land

Sanitation
"Sanitation" is understood as the environmentally safe management of excreta; it can be done either through sewage systems with appropriate treatment prior to discharge or by individual disposal systems designed and built in an appropriate manner.

However, coastal vessels and pleasure craft are not subject to the scope of MARPOL so, given the lack of wastewater reception facilities in ports of most Caribbean countries, their wastewater is discharge directly into marine waters, regardless of the distance to the coast and even in areas near coral reefs (WRI, 2005).

Table No.20. Cruise Tourism statistics in Central America (Number of tourists by country and year)

Country	2000	2001	2002	2003	2004	2005	2006	2007
Belize	58.131	48.116	319.640	575.295	851.436	800.331	655.929	624.128
Guatemala	1.454	4.058	6.430	19.254	22.454	17.975	20.522	42.000
Honduras	217.700	154.100	238.605	276.076	384.539	444.610	397.689	513.000
Other countries	391.524	484.139	577.781	690.312	782.601	931.244	1.152.474	1.335.000
Total	**668.809**	**690.440**	**1.142.506**	**1.560.937**	**2-041.030**	**2.194.160**	**2.226.614**	**2.514.000**

Source: *Sistema de Integración Centroamericano (SICA)*

⇨ Eutrophication and contributions of nutrients

Water quality with respect to their biological properties can be classified in terms of: **a)** its ***saprophicity***, which refers to the biological status of water and is determined based on the presence or absence of certain organisms (algae, ciliates, bacteria) and **b)** their ***trophicity***, which refers to the capacity of the water body to nourish aquatic organisms, according to Jerman (1987).

As for the impacts of eutrophication and nutrient contribution to ecosystems, the most important are related to loss of habitat.

Eutrophic

This used to define water bodies that have a nutrient enrichment with its consequent effects related to: **a)** the excessive growth of aquatic plants and uni-and multicellular algae, **b)** reduction of water quality associated with negative biogeochemical processes.

Eutrophication is one of the more general problems of water pollution, with adverse effects on several ecosystem processes (Agard et al., 1996, Gray, 1997; Leno et al., 2006). Eutrophication can occur in lotic or lentic systems (Ramirez and Viña, 1998) or coastal water bodies (Clark, 1996, Clarke et al., 2006).

The eutrophication of continental waters has been a major ecological problem, but the concept of marine eutrophication was initially ruled out based on the simple premise that, being relatively large and dynamic, marine ecosystem as a whole would be able to incorporate nutrients without adverse effects. It was not until the mid 80's the years that research on coastal eutrophication began to increase (Nixon, 1988). The causes of this process may be of natural origin (physical - chemical processes) but is mainly considered as an effect generated by man (anthropic process) being this the scope of this Section.

⇨ Nutrient contributions from for sewage and industrial effluent discharges

As already indicated, the discharges of inadequately treated sewage - or directly without being treated - constitute a common denominator in the study area. This way, additional contributions of organic matter and nutrients (nitrogen and phosphorus) are generated which - along with stormwater discharges, discharges of certain types of industrial waste, the increased use of fertilizers and pesticides in agriculture and leachage from waste solids - impact water quality by accelerating the process of eutrophication.

⇨ Nutrient contributions from leaching of solid waste

The deposits of solid waste in rivers, lagoons and mangroves generate as a consequence of precipitation, leaching that flows into water bodies and pollute them.

Table No.21 shows the percentage of nutrients in relation to the total load received by main water bodies in the study area as a result of leaching from solid waste. It is observed that the relative importance of nutrient inputs to streams of the tributary watersheds of the Gulf of Honduras, as consequence of solid waste leaching is relatively similar: the percentages range between 16.1% and 31.2% for BOD5, between 4.6% and 10.1% for nitrogen and between 8.2% and 19.5% for phosphorus.

Table No.21. Nutrient contributions to streams resulting from solid waste leachage (as % of the total contribution)

Watershed	DBO5 (%)	Nitrogen (%)	Phosphorus
Chamalecon	17,4	3,9	8,2
Ulua	16,1	5,8	13,1
Sarstun	29,6	6,1	14,6
Motagua	26,4	10,1	19,5
Lago Izabal -Dulce River	29,5	4,6	12,2
Belize	31,2	7,0	15,3

From: *Abt Associates Inc. – Woods Hole Group (2003)*

⇨ Nutrient contributions from leaching of agricultural products

The economy of the Gulf Coast region of Honduras is based on both commercial and artisanal fisheries and agricultural production, bananas being the main export of the region. Other important crops are citrus, pineapple, oil palm and sugar cane. In agricultural production intensive methods are used, including the use of fertilizers and chemicals whose runoff drains into water bodies, with the consequent contribution of nutrients that leads to the formation of algae and potential deficiency of dissolved oxygen.

⇨ Nutrient contributions from for aquaculture activities.

Aquaculture can become a source of pressure on the quality of water bodies when developed on site, (for its nutrient contributions). All farms take water directly from the Gulf of Honduras and the majority of discharges are made directly to it, through extended drains without prior treatment and passing through extensive mangrove areas. Additionally, overflow of the lagoons occur during the rainy season, with the corresponding nutrient discharge.

⇨ Chemical pollution

Chemical pollution of surface water presents a threat to the aquatic environment with effects such as: **a)** acute and chronic toxicity for human health and aquatic organisms, **b)** accumulation in the ecosystem and **c)** loss of habitats and biodiversity.

As possible / potential sources of water pollution from chemical are:

- ⇨ Farming activities with a significant increase in land area and intensive use of pesticides and fertilizers.
- ⇨ Maritime and port activities, the possible discharge of fossil fuels and / or chemicals and the potential losses associated with oil tankers.
- ⇨ Port infrastructure (or near ports) of bulk storage and the increase of crude oil movement in the respective installations.
- ⇨ The vessels as generators of discharges from ballast water, bilge cleaning and solid waste.

According to the Mesoamerican Reef System Project (2006), quantification of the different types of waste generated daily by "cruise ship" type boats is as follows:

- *540 m^3 of greywater from sinks, showers and laundries.*
- *113 m^3 of sewage from toilets.*
- *13.5 m^3 oily water from the bilge of the vessel.*
- *50 liters of hazardous waste (such as perchlorethylene from dry cleaners, liquid photo processing, paints, solvents, etc.).*
- *7 tons of solid waste (garbage).*

Presence of pollution:

– In ballast water (more than 1,000 m^3 of water taken at the ports is stored within the hull of the boat to balance the boat at sea), there are usually contaminants that contain exotic species that are transported by this route through the different ports.

– Toxic metals in sediment, being zinc and nickel the ones with highest concentrations detected. Nickel is dominant at the sampling points for the coast of Guatemala. In addition, arsenic was quantifiable at all points, the highest concentration of copper was found in the Laguna de Alvarado, and mercury concentrations were higher in the points corresponding to the coast of Honduras and Guatemala (and lower in Belize).

– All values for organic pollutants such as Polychlorinated biphenyls (PCBs) were lower than the values corresponding to *Threshold Effect Level* (TEL) and *Probable Effect Level* (PEL) of the NOAA guidelines (21.51 and 188.00 µg / kg, respectively).

– On regards to organochlorine pesticides, no quantifiable results were found for any subgroup, and the determination of PAHs in sediments had values 1,000 times below the Probable Effect Level (PEL) proposed by the NOAA at all points. With respect to aliphatic hydrocarbons, only pentacosane and heptadecane were quantifiable, being Port Belize and Sartsun River the sampling points with greater concentrations.

– Chemical pollution in fish tissue samples, in general, showed that Wilson Key had the highest concentrations of arsenic, zinc and some mercury, and Sapodilla Key had quantifiable presence of five (5) of the seven (7) metals analyzed.

– The concentration of arsenic in all sampling points exceeds the maximum allowable in fish tissue to protect consumer health (2 mg / kg, according to the Guidelines for Consumption of Fish, Crustaceans and Mollusks of Australia and New Zealand - ANZFA, 2000), the most compromised being Wilson Key and Puerto Cortes.

⇨ Solid waste

In general, population dynamics and agricultural and industrial activity produce solid, liquid and gaseous wastes which are mostly discharged to the environment without any treatment. Indeed, the current economic model of the study

Solid waste

Solid wastes include those that for their origin are referred to as urban / domestic, industrial, agricultural and those generated internationally, directly impacting coastal-marine ecosystems.

area, considers that the generation of waste is part of the economic process of production and consumption and this process assigns to the environment the function of source of natural resources and waste reservoir. The environment acts as a common property which is deteriorated when used as a receiver of waste, affecting the integrity of ecosystems and the quality of life.

Land-based sources and sewer overflows are a major cause of litter found on beaches and waterways in the area of the Gulf of Honduras. They affect public health, tourism, fisheries and marine life. There is information on species that have died or have been injured by debris entering the sea (as in the case of sea turtles, dolphins, sharks and corals).

Cruise ships are also an important source of contamination. A typical cruise ship generates an average of 13.5 m^3 of oily bilge water and 7.0 tons of trash per day; on the other hand, the volume of cruise ship tourism has increased notably in recent years.

Waste generated by vessels in general, is a major source of solid waste to the coastal areas.

In 2003, The Ocean Conservancy conducted a campaign called "Clean Up the Coast", which involved more than 55,000 people and over 1,200 tons of trash were removed along the 2.100 km coastline on the Caribbean Sea (WRI, 2005).

Image No. 20 Tourism activity, Puerto Barrios, Guatemala

Source: Gulf of Honduras Project

C. Loss and modification of habitats and communities

⇨ Impacts on ecosystems

The combination of anthropogenic impacts or caused by humans and the chronic stress on the coral reef ecosystem, has determined that, particularly in Belize, there is an important decline of coral cover and an increase of coverage by macroalgae, as well as a decrease in the abundance of fish associated with these ecosystems.

Hurricanes are common phenomena in the Caribbean Sea, as most of it is in their path. The region has a long history of hurricanes and storms of different intensity and with greater or lesser impact on coral reef systems. Hurricanes Haiti (1961), Fifi (1974), Greta (1978), Mitch (1998) and Keith (2000) were particularly devastating. The type of damage to the reef system depends on the location of the reef, species present and the structural complexity of the community. Some effects:

- Following the passage of Hurricane Mitch, the worst damage was found on Belize coral barrier with damage to 29% of corals in shallow areas, 5% in corals in deeper areas and nearly 80% in corals located North of Glovers Reef.
- There are other associated phenomena, such as heavy rains that increase sedimentation around reefs located close to shore and / or river outlets 2005.
- The supply of fresh water derived from the drainage basins of the region has produced the reduction of salinity, high sedimentation and high percentage of nutrients that are found in the Caribbean Sea.
- Also were reported diseases and abundance of algae associated with stress possibly caused by a combination of high temperatures on the surface of the sea (pre - hurricane) and the flow of sediment and nutrients (post - hurricane).

⇨ Impacts on biodiversity

The major threats of impact on the biodiversity of marine-coastal ecosystems are overexploitation, followed in importance by the loss of habitat.

D. Unsustainable exploitation of living resources

Artisanal and small-scale subsistence fishing highlights as it is a relatively cheap source of protein while creating jobs.

Coral reefs and especially those who are closest to the coast are an easily accessible site for fishermen; consequently reef fish are also an easily accessible prey. Moreover, the limited existing regulation on this activity has led to overfishing this resource, illegal fishing and use of inappropriate fishing gear (gill nets, trawls, traps) that can even be destructive when they are thrown on the reef.

Mangrove ecosystems also represent attractive areas for fishing, but overexploitation is an important cause of ecological destabilization of these environments.

A direct consequence of overfishing is the decrease of the average size of the various species, as fishermen are directed selectively towards larger organisms, which are those with greater reproductive success; therefore the population loses its natural ability to recruit. In this way, the fishing activity is above sustainable harvest levels and disturbs the ecological balance of the reef system. For example, removal of algae consuming fish facilitates coverage of reefs with algae, thereby reducing the coverage of live coral.

Another harmful form of overfishing related to reef fish aggregations around full moon, and more frequently between December and July, when at least 22 species of fish aggregate for reproductive purposes. At this time, fishermen extract a significant proportion of breeding individuals.

Overfishing threatens over 60% of Caribbean coral reefs; approximately one third of them are in "high" threat level and nearly 30% are at "medium" level of threat

E. Unsustainable development of marine and coastal areas

Coastal areas represent almost one fourth of Central American territory (23.3%), of which slightly less than 45.5% develops over the Caribbean Sea, nearly three fifths corresponding to the territory of Belize. Main pressures on coastal formations are derived from human activities of destruction or degradation of habitats, including the impact of land-based sources of pollution. Among the more important it should be noted:

a) The conversion of natural habitats to other uses (which affects 44.6% of the total area of the Central American coast), as well as the resulting processes of sedimentation and pollution
b) Those originating from agriculture, aquaculture and mining.
c) Human settlements (representing 0.36% of the total area of the Central American coast).
d) Tourism activity.

3.5 Emerging problems

A. Climate Change

From information covering the period 1958 - 1999 (30 stations), Peterson, 2002 observed:

- The percentage of days with very warm temperatures, maximum or minimum, increased, while the percentage of days with very cold temperatures decreased.
- The extreme intra - annual temperature range decreased.
- The number of warm days and nights increased, while the number of cool days and nights decreased
- The maximum number of consecutive dry days decreased.
- The number of heavy precipitation events increased.

An analysis of the impacts of climate change on average annual temperature and precipitation in Central America (using data from seventeen global circulation models ran under different climate change scenarios)

concluded that:

- The temperature will increase (1.0 to 2.5 °C by year 2050 and 3.5 to more than 4.5 °C by year 2100).
- The average annual rainfall will decrease (0.0 to 9.0% by year 2050 and 3.0 to 10.0% by year 2100) and the region will become drier (particularly in the months that already show that behavior).
- Changes in tropical cyclone will affect the annual rainfall totals so that extreme events (droughts and intense precipitation) will become more frequent (Borne et al. 2007).

These results indicate a significant decrease in water availability, since the increase in temperature will cause a general increase in evapotranspiration. Moreover, annual flows of rivers will decline, as will the amount of water recharged aquifer systems.

Although it is unclear in the future how the frequency, intensity, and the spatio - temporal rainfall events will change, recent research indicates the intensification of extreme events (droughts or floods). The tele - connections, such as El Niño - Southern Oscillation (ENSO) strongly affecting Central America and the Caribbean region, can also be affected in a more temperate climate (although there are strong uncertainties about the nature of such effects)

Behavioral changes of tropical cyclones, probably due to increased sea surface temperatures and changes in the dynamics of oceanic atmosphere, even though the effects are uncertain, the likely consequences would be the increase of the maximum intensity of the tropical cyclones and rainfall rates.

⇨ Impacts on human health

The impacts of climate change on human health are reflected in the increased morbidity and mortality, and specifically in acute respiratory infections, diarrhea, and vector-borne diseases (malaria and dengue). In the case of acute respiratory infections, the periods of 1960 - 1990 and 1990 - 2000 were analyzed considering the number of reported cases of disease and climatic variations for each period. During the period 1960 - 1990 they had a bimodal behavior, with a strong peak in the month of March and another that reaches its peak between the months of September and October, whereas for the period 1990 - 2000 they show a trimodal behavior.

⇨ Impacts in basic grain production

Basic grains (corn, beans, wheat, rice and sorghum) are of particular importance in Guatemala due to its cultural, socioeconomic and dietary implications for a large majority of the population and especially for the rural population, who obtains from these grains their energy and protein requirements. Since climate and its variability affect crop productivity, their future behavior (growth, development, evapotranspiration and absorption of nutrients) was simulated with mathematical models. In general, annual production simulation estimated lower annual productions relative to the baseline, and for some products, the simulations were very negative (with decreases of up to 66%).

⇨ Impacts on hydric resources

Climatic variations alter the components of the hydrological cycle and climatic parameters. Indeed, variations in precipitation and evapotranspiration change surface runoff and groundwater by increasing or decreasing the levels of water bodies like rivers, lakes and seas. Less precipitation implies a reduction of surface runoff and, conversely, increased rainfall represents more runoff into rivers. Depending on the scenario considered, less runoff is expected (resulting from the decrease in precipitation) and, consequently, a decrease of river flow, which would bring a reduction in water sources for consumption (human and animal) and irrigation, as well as increased sedimentation in riverbeds.

⇨ Impact on forestry resources

The geographical distribution of forests, their composition, characteristics and productivity are determined naturally by global and local weather conditions. Variations in temperature and precipitation play an important role in the distribution and productivity of forest stands: the temperature directly affects the biochemical and

physiological processes, while precipitation is the major input for soil moisture. Humidity and temperature directly affect the decomposition of organic matter, which affects the availability of nutrients for vegetation. The analysis of the impacts of climate change on forest resources was based on various scenarios which indicated that the most vulnerable forest species are conifer forests, which will show negative conditions that will lead to a reduction in coverage (as a result of the increase of dry zones).

B. Unsustainable development of marine and coastal

There are several projects for the development of port infrastructure and tourism in the Gulf of Honduras, such as the Expansion Project and Modernization of Puerto Cortes, the Modernization of the Port of Santo Tomas de Castilla, and the Bay of Tela Tourism Development Project (Honduras) called the Micos Beach & Golf Resort.

The National Port Company (ENPORNAC) has initiated the Project for Modernization of the Port of Santo Tomas de Castilla which envisages the creation of four new specialized terminals:

- A "Cruise Terminal". It will have the capacity to handle simultaneously two cruisers of large capacity, and port facilities will also include ground facilities for attention and comfort of tourists, as well as an ecological park and an amusement park in areas adjacent to the terminal.
- A "Container Terminal". It will cover a land area of 70 ha which include patios, industry and container consolidation centers.
- A "Liquid Bulk Terminal." Penetration docks or bay docking bay systems will be built and their ground facilities foresee, in a first phase, 35 ha for deposits and processing plants.
- A "Solid Bulk Terminal." Penetration docks will be built with a capacity of two vessels each and will count with 45 hectares of land areas for the storage and processing of specific products.

Additionally, the project will be complemented with a *logistics-industrial platform* including a complex of logistics platforms and industrial parks in free zones, which will be built on 140 hectares of land adjacent to the port.

The tourism development project of the Bay of Tela (Honduras), is a mega - hotel and tourist complex, located in an area of 312 hectares located on the Bay of Tela. The resort property is mixed and will be managed through the Tela Bay Tourism Development Company (TBDT), and is promoted by the Honduran Tourism Investment Fund (HTIF) and has the support of the Government of Honduras through the Honduran Institute of Tourism (IHT).

3.6 Particular problems associated with port and maritime activities and operations

A. Port operations

The problems associated with port operations, are summarized in the comments made by ALATEC Consulting Engineers and Architects - Valencia Port (2007) in the framework of the Project for Improvement of Environmental Management in Ports in the Gulf of Honduras.

Image No.21 Port activities

Source: Gulf of Honduras Project

B. Dredging activities

In the ports of Belize City and Big Creek there are no dredging activities. The areas for anchorage under the responsibility of Belize Port Authority correspond to areas of sandy bottoms and without presence of coral reefs.

Guatemalan ports, are located in the Bay of Santo Tomas de Castilla, were more than fifteen (15) rivers drain, bringing problems of silting (sedimentation)

associated with the contributions of these rivers. Bathymetries are performed monthly designed to test the depths in the access channel to the port of Santo Tomas de Castilla, which is shared with Puerto Barrios. Maintenance dredging is in charge of the National Port Company Santo Tomas de Castilla (EMPORNAC) and the Guatemalan Independent Banana Company SA (COBIGUA). There is no information on the volume of dredged material, nor evidence of application in the dredging work of the criteria in the London Convention with respect to the characterization of the products of dredging.

C. Navigation and maritime transportation

Environmental issues associated with shipping operations include management of:

- Hydrocarbons and hazardous materials (accidental spills of fuel and cargo as a result of accidents during shipping or transfer of such products).
- Sewage and other effluents (including ballast water that may contain hydrocarbons, hazardous and non-native organisms, and black and gray water can contain high levels of BOD 5, as well as bacteria and other components that may affect aquatic life).
- Air emissions (including, particularly, exhaust gases of the engines that contain nitrogen oxides, sulfur dioxide, hydrocarbons, carbon monoxide and dioxide as well as particulates)
- Generation and management of solid waste (including general waste generated on board ships and hazardous waste such as fluids, solvents and batteries resulting from maintenance of the vessels).

3.7 Environmental and socioeconomic impacts

Coastal-marine ecosystems offer numerous economic benefits from the point of view of local communities and from the standpoint of national and regional levels. Among the most significant, besides the generation of food resources for local communities are: a) fishery activities, b) receptive international tourism and cruise tourism, c) urban development and d) port activity (with the shipping activities associated with them).

The main priority problems with high socio - economic impacts are those associated with water availability, pollution, loss and modification of habitats and communities, non-sustainable development of marine resources and those of marine-coastal areas and, climate change. The main sectors affected are:

- The *tourism industry* through a reduction of local and international attraction sites.
- The *fisheries sector* through the reduction in catch per unit of effort, increased costs of capture and / or the loss of fisheries.
- *Basic urban services* with increasing operational costs associated with mitigation of impacts needs.
- *Sea shipping and port activity* by increasing operating costs.
- *The economy* is indirectly affected, for reasons associated with the loss of environmental services that these ecosystems provide.
- At *Social and cultural* level, associated with the conflict of uses and potential cross-border conflicts.

3.8 Causal chain analysis

From the scientific information gathered, sufficient information was available for the purposes of causal chain analysis of the priority problems identified and its consequent environmental and socio – economic impacts.

Causal Chain Analysis

The "Causal Chain Analysis," according to the GIWA methodology (Global International Waters Assessment) covers the cause - effect relationships, associated with each priority issue from the environmental and socio - economy impacts to its root causes. Its purpose is to identify the most important root causes of each priority problem, to make it subject of appropriate policy measures for correction or mitigation. This last feature must be emphasized, since the overall objective of the GIWA methodology (and, therefore, that of the Causal Chain Analysis) is to develop a conceptual framework - strategic - to identify priorities for "corrective action or mitigation" in international waters, it is for this reason that the "Causal Chain Analysis" is oriented to policies.

The methodology seeks to provide a systematic and practical approach to identify and understand the root causes of transboundary water problems and is intended that it will allow describing how the relevant components are linked to determine the transboundary water problems in a given area. The approach is based on accepted theoretical models that have been tested in several sub - regions, however, the methodology is tailored to meet the particular characteristics of the needs and circumstances of each particular case.

The core of the causal chain analysis is to recognize the root causes of human actions that impact the way in which water and related resources are used. To achieve this, the factors that determine the actions that have both direct and indirect impact on major GIWA must be identified, these factors will be the root causes.

The methodology was developed to provide practical and systematic guidelines for identifying and understanding the complexity of the causal factors that lead to transboundary water problems. The characteristics of both the required data as statistical tools to prove "causality" in a scientific way, suggest that the construction of the causal chain is an extremely difficult process, however, if the analysis is supported by information and therefore with quantitative evidence, the process will be greatly simplified.

The GIWA methodology provides a list - not exhaustive - of root causes and examples of how they can act and influence each other.

In subsequent tables is presented the first approach to identifying the causes of some of the current priority problems identified. The main contaminants observed were defined according to their concentration in the sample points into consideration in relation to the total sampling points. Additionally were considered the parameters that exceeded international guideline values. In particular consideration was the quality of the sediments, which represent the most relevant matrix for the purposes of assessing pollution, since water quality depends on several factors and especially of the dynamic factors (tides, winds, contribution from tributaries, others.). Also potential impacts from major pollutants found were established, as well as the causes that could be causing the presence of these pollutants in the rivers under study. Many of the immediate causes and root causes identified are general and not specific, as this is beyond the scope of the investigation conducted. The sectors involved and identified, are also outlined in general terms.

Table No.21: Causal Chain Analysis: Problems of water availability

ASPECT: FLOW REDUCTION

IMPACT	SECTOR/ACTIVITY
- Shortage of water supply - Conflicts of use - Greater potential for saltwater intrusion - Increased transport of contaminants to groundwater - Changes in their quality - Modification of habitat - Reduced groundwater recharge - Changes in flow	- Urbanization - Agriculture **INMEDIATE CAUSES** - Inadequate management of water resources - Unequal distribution of the population - Increased demand - Insufficient distribution - Large amount of unaccounted water - Changes in the relationship rainfall – runoff - Climate change

ROOT PROBLEM

- Lack of land use planning	- Lack of local response capacity
- Population growth	- Natural disasters
- Economic growth	- Insufficient potable water distribution systems
- Poverty	- Insufficient distribution sources
- Lack of integrated watershed management	- Insufficient water resource management

Table No.22: Causal Chain Analysis: Problems of pollution	
ASPECT: MICROBIOLOGY	
IMPACT	**SECTOR / ACTIVITY**
- Deterioration of surface water quality - Deterioration of the groundwater quality (infiltration) - Risk of disease for aquatic organisms	- Tourism - Urbanization - Ports - Agriculture - Industry
INMEDIATE CAUSES	
- Sewage water discharges - Industrial wastewater discharges - Storm water discharge - Animal waste	- Solid waste discharges from boats - Leaching from landfills and / or sanitary landfills
ROOT PROBLEM	
- Lack of land use planning - Population growth - Mismanagement of domestic wastewater - Unsustainable management of solid waste - Poverty - Mode of urbanization - Lack of local response capacity - Lack of systematic monitoring - Economic growth - Natural disasters - Lack of integrated watershed management - Lack of quality standards - Lack of scientific information - Insufficient access to cleaner production technologies	- Gaps in existing regulations - Insufficient capacity for monitoring and enforcement of regulations - Inadequate coordination of sectoral policies - Lack of coordination between levels of government - Insufficient financial and human resources - Lack of approval and implementation of contingency plans - Lack of agreement of understanding on border problems - Lack of agreement on limits of territorial waters - Lack of port environmental management plans - Lack of financial mechanisms for sustainable coastal and marine management.

Table No.22: Causal Chain Analysis: Problems of pollution	
ASPECT: EUTROPHICATION	
IMPACT	**SECTOR / ACTIVITY**
- Deterioration of surface water quality - Deterioration of quality of groundwater (infiltration) - Loss of habitat - Increased algal blooms - Presence of toxic substances in the water	- Tourism Urbanization Ports - Industrial Agriculture Aquaculture
INMEDIATE CAUSES	
- Sewage water discharge - Industrial water - Rainwater discharge (washing streets, etc.) - Animal waste - Solid wastes	- Landfill leaching or open dumps and / or sanitary landfill - Discharges from boats - Leaching and landfill of agricultural products - Aquaculture discharges
ROOT PROBLEM	
- Lack of land use planning - Population growth - Poor management of domestic wastewater - Unsustainable management of agricultural products - Unsustainable management of solid waste - Poverty - Modality of urbanization - Lack of local response capacity - Lack of systematic monitoring - Economic growth - Natural disasters - Lack of integrated watershed management - Lack of quality standards - Insufficient access to cleaner production technologies	- Gaps in existing regulations - Lack of control and policy enforcement - Inadequate coordination of sectoral policies - Lack of coordination between different levels of government (national and local) - Insufficient financial and human resources - Lack of approval and implementation of contingency plans - Lack of agreements on border problems - Lack of agreement on limits of territorial waters. - Lack of financial arrangements that make sustainable coastal and marine management - Lack of port environmental management plans - Lack of scientific information

Table No.22: Causal Chain Analysis: Problems of pollution

ASPECT: CHEMISTRY

IMPACT	SECTOR / ACTIVITY
- Deterioration of surface water quality - Deterioration of quality of groundwater - Loss of habitat - Increased mortality of aquatic organisms - Increase of behavioral dysfunctions of aquatic organisms (from toxicity and bio - accumulation) - Deterioration of quality of sediments (resuspension of contaminants in the water column and bio - accumulation in biota)	- Tourism - Urbanization - Ports - Agriculture - Maritime Transport - Industry
INMEDIATE CAUSES	
- Sewage water discharge - Industrial water discharge - Discharge of rainwater (washing of streets, etc.). - Solid waste (urban and hazardous) - Leaching from landfills of open dumps and / or sanitary landfills - Discharges from boats	- Leaching of agricultural products (pesticides) - Boat fuel residues - Port activity - Burning of solid and agricultural waste - Discharge of mining activities - Accidental spills of chemicals and petroleum or petroleum products
ROOT PROBLEM	
- Lack of land use planning - Population growth - Poor management of domestic wastewater - Unsustainable management of agricultural products - Unsustainable solid waste management - Poverty - Modality of urbanization - Lack of local response capacity - Lack of water quality monitoring - Economic growth - Natural disasters - Lack of integrated watershed management - Lack of quality standards (at local, national and / or regional level) - Lack of scientific information - Insufficient access to cleaner prodution technologies	- Gaps in existing regulations - Insufficient capacity for monitoring and enforcement of regulations - Inadequate coordination of sectoral policies - Lack of coordination between different levels of government - Insufficient financial and human resources - Lack of agreement of understanding on transboundary problems - Lack of agreement on limits of territorial waters - Lack of financial arrangements to make coastal and marine management sustainable. - Lack of awareness at the social level - Lack of port environmental management plans.

Table No.22: Causal Chain Analysis: Problems of pollution

ASPECT: SOLID WASTE

IMPACT	SECTOR / ACTIVITY
- Deterioration of surface water quality - Deterioration of quality of groundwater (by infiltration) - Loss of habitat - Increased mortality of aquatic organisms - Deterioration of the beaches - Changes in the composition of sediments	- Tourism - Urbanization - Ports - Agriculture - Industrial - Afforestation
INMEDIATE CAUSES	
- Discharge of solid waste (urban and industrial) - Discharge of rainwater (washing of streets, etc.). - Solid waste discharged into water courses - Solid waste generated by ships (cruise ships and boats)	- Solid waste generated by beach users - Solid waste from construction of coastal development - Existence of illegal dumping - Increase in waste generation
ROOT PROBLEM	
- Lack of land use planning - Population growth - Poor management of domestic wastewater - Unsustainable management of agricultural products - Unsustainable management of solid waste - Poverty	- Gaps in existing regulations - Lack of capacity for control and implementation of regulations - Inadequate coordination of sectoral policies - Lack of coordination between levels of government (national and local)

- Modality of urbanization - Lack of local response capacity - Lack of systematic monitoring - Economic growth - Natural disasters - Lack of integrated watershed management - Lack of quality standards - Poor access to clean production technologies	- Insufficient financial and human resources - Lack of approval and implementation of contingency plans - Lack of agreement on transboundary problems - Lack of agreement on limits of territorial waters - Lack of financial arrangements to make sustainable coastal and marine management - Lack of port environmental management plans - Lack of scientific information

Table No.23: Causal Chain Analysis: Loss and alteration of habitats and communities

ASPECT: ECOSYSTEM LOSS

IMPACT	SECTOR / ACTIVITY
- Loss of biodiversity - Loss of natural storm barriers - Loss of natural protection against erosion - Alteration of the bio- geochemical cycle	- Tourism - Urbanization - Agriculture - Ports - Fishing
INMEDIATE CAUSES	
- Changes in land use - Dredging and disposal of products - Natural disasters - Solid waste	- Coastal erosion - Extraction of aggregates - Over-exploitation of key species
ROOT PROBLEM	
- Lack of good management practices Population growth	- Lack of regulation - Lack of coordination (local and regional) - Modality of urbanization - Natural phenomena

Table No.23: Causal Chain Analysis: Loss and alteration of habitats and communities (Continued)

ASPECT: ECOSYSTEM MODIFICATION

IMPACT	SECTOR / ACTIVITY
- Modification of the natural productivity - Modification of biodiversity (including loss of species)	- Aquaculture - Forestry - Mining - Industry - Maritime Transport
INMEDIATE CAUSES	
- Replacement of native species by alien species - Diseases	- Eutrophication - Discharge of untreated sewage
ROOT PROBLEM	
- Insufficient definition of fishing exclusion areas (marine protected areas and areas of spawning aggregations)	- Inadequate wastewater management - Unsustainable management of solid waste - Lack of coastal management policies

Table No.24: Causal Chain Analysis: Problem of unsustainable exploitation of living resources

ASPECT: SOBREEXPLOTACIÓN

IMPACT	SECTOR / ACTIVITY
- Reduction of key species - Changes in trophic chains - Changes in the composition of biological communities	- Fisheries
INMEDIATE CAUSES	
- Gears and mechanization - Decreased level of recruitment	- Reduction of habitat - Fishing in aggregation zones
ROOT PROBLEM	
- Lack of regulation - Lack of scientific knowledge	- Lack of coordination among governments for the establishment of closed seasons and areas

ASPECT: BYCATCH	
IMPACT	**SECTOR / ACTIVITY**
- - Change in the composition of biological communities	
INMEDIATE CAUSES	
- - Gears and mechanization	- - Fish by catch in gillnets

Table No.25: Situation of transboundary rivers	
Main problems detected	
Sarstun River **Countries: Belize – Guatemala**	**Motagua River** **Countries: Guatemala-Honduras**
Water - Dissolved oxygen (above the guideline value) - Suspended solids - Oils and grease - Sulfide	**Water** - pH - Suspended solids
Sediment - Nickel (highest value guide) - Copper (TEL exceeds PE) - Pentacosane - Sulfur	**Sediment** - No high concentrations for any parameter found

3.9. Legal Framework: National Legislation

⇨ Environmental Impact Analysis (EIA)

Belize

The Environmental Protection Act (1992), the Environmental Protection Amendment Act (1998) and the Environmental Impact Assessment Regulations (1995) define Environmental Impact Assessment as *"the studies necessary to identify, predict, assess and manage the environment and impacts key social and economic development projects, policies and activities."* According to the Environmental Protection Act (1992) "*any person who proposes to undertake any project, program or activity that can significantly affect the environment will be subject to an Environmental Impact Assessment, which must be performed by suitably qualified persons, and shall submit the same for evaluation and recommendation, "* However, the Ministry of Natural Resources and the Environment, could make its own Environmental Impact Assessment and synthesize the views of the public and interested bodies

The EIA should identify and assess the effects of specific actions on humans, flora and fauna, soil, water, air and climatic factors, material assets (including cultural heritage and landscape), natural resources, ecological balance, and any other environmental factor that needs to be considered. Also, it will include measures which in the proposed development will be taken to mitigate any adverse environmental effect and a statement of reasonable alternative sites (if any) and reasons for rejection. The Environmental Protection Act (1992) establishes the legal consequences in case of default, *"any person who fails to make the Environmental Impact Assessment as required by law and regulations, commits an offense and shall be subject to a fine (not to exceed twenty-five thousand dollars), imprisonment (for a term not less than six months and not exceeding five years) or both."*

The Environmental Impact Assessment procedure includes:

a) Written notice to the Department of Environment (before making the final project design);
b) The Department will determine if it is necessary to conduct the EIA and, if it is, a revision will be made (by a committee "ad hoc") and the design and implementation of a monitoring program.
c) Once the need for EIA has been determined, the Department of Environment may, upon request of the proponent, provide guidance for the preparation of the EIA for a nominal fee. The proponent's obligations include conducting the necessary study for the preparation of the EIA and submit it within the time frame established. The EIA should include the following minimum requirements: i) description of proposed activities, ii) description of the area potentially affected (including information to identify the environmental impacts of proposed activities), iii) a description of practical alternatives, iv) assessment of the potential environmental impacts (including direct and indirect, short and long term consequences), v) description of available measures to mitigate adverse impacts to the environment, vi) identification of gaps related to the processing of above information and required.

No instruments were identified related to the control and monitoring of compliance with the obligations arising from the EIA.

Guatemala

The "Law of Protection and Improvement of the Environment" (Decree N ° 68 - 1986) states that *"for all project work, industry or any other activity which by its nature, can cause deterioration of renewable natural resources or the environment, or introduce harmful or noticeable modifications to the landscape and cultural resources of the national heritage, it will be necessary, prior to development, a study of environmental impact assessment conducted by experts in the field and approved by the commission of the Environment ".* For its part, the "Regulation for Environmental Assessment, Monitoring and Control" (Governing Agreement 23 - 2003) defines environmental impact as *"any significant changes, positive or negative, of one or more components of the environment, caused by the action of man or natural phenomena in a defined area of influence".* The EIA is carried out through a series of instruments:

a) **Strategic Environmental Assessment** which *"consists in a process of environmental assessment applied to policies and national and government plans as well as projects of transnational concern involving the generation of patterns of social-economic development with environmental impacts in their areas of influence"*
b) **Initial Environmental Assessment** must consider "the relevance of environmental impact, its location relative to environmentally fragile areas and areas with land use planning, in order to determine, as a result of the analysis, the type and characteristics of the EIA study or other environmental assessment instrument corresponding to the project, work, industry or related activity " and from which " the recommendation on the type of environmental assessment to be made by the proponent will be issued " or, where appropriate, should " determine that it is unnecessary. "

The **Study of Environmental Impact Assessment**, is "the planning tool that provides a preventive thematic analysis reproducible and interdisciplinary of the potential effects of a proposed action and the alternative practices in physical, biological, cultural and socio - economic attributes of a determined geographic area";

The **Environmental Risk Assessment** is obtained from linking the threat or probability of occurrence of a phenomenon with a specific intensity with the vulnerability of the exposed elements " and may be " of natural, geologic, hydrologic, atmospheric or technological origin also or caused by man ";

The **Social Impact Assessment**, is an evaluation and assessment process of social and cultural consequences from any project, work, industry or any other public or private activity that may alter the normal rhythm of life of populations and thus affect their quality of life "and,

The **Cumulative Effects Assessment** that "is the process of systematically analyzing and assessing environmental changes caused by the systematic combined sum of effects of the projects, works, industries, or in any other activity developed within a defined geographic area."

The Instruments of Environmental Monitoring and Control applied are:

a) Environmental Audits which constitute "the process of systematic and documented verification to assess the degree of compliance with the Environmental Management Plans and identify criteria to ensure compliance. They can be mandatory or voluntary, with the purpose of certification, registration and / or self declaration"
b) The Environmental Monitoring and Surveillance which " consists in the collection of periodic or test information to determine the level of compliance with mandatory regulatory requirements, environmental commitments or to identify the levels of pollutants in the environment" and
c) The so-called Complementary Instruments (COIs) include: i) the Environmental Commitments (which constitutes the list of actions and practices derived from Environmental Assessments and Instruments for Environmental Monitoring and Control that the General Directorate of Environmental and Natural Resources Management approves as binding for implementation of projects, construction, industry or any other action, are set by an administrative resolution, without prejudice to the enforcement of the national regulation in force), and ii) the relevant Code of Good Environmental Practices.

Steps of the Administrative Procedure: start the procedure, presentation of the environmental assessment, review and analysis, public information, opinion from other entities, request for increases, technical recommendation and final decision.

Honduras

The General Environmental Law (Decree N ° 104 - 1993) introduced the Environmental Impact Assessment (EIA) for *"projects, industrial facilities or any other public or private activity, which may contaminate or degrade the environment, natural resources or historic cultural heritage of the nation"*, stating further that *"measures to protect the environment or natural resources resulting from these assessments shall be binding on all parties in the implementation phase and during the useful life of the works or facilities "*. The Regulation of the Environmental Impact Assessment System (SINEA) defines: **Environmental Impact Assessment** as *"the process of analysis which serves to identify, predict and describe the positive and negative impacts of a proposed project, as well as to propose mitigation measures for negative impacts and a control and periodic monitoring plan "* and the **National System of Environmental Impact Assessment (SINEA)** as *"the harmonious set of institutional elements, natural or by law, technical and legal norms and regulations that determine the relationship between each one of the components and aspects required to conduct the process of Environmental Impact Assessment of economic - social policies, investment initiatives (public or private) and of established economic activities that may affect the environment. "*

The procedure for obtaining the "Environmental License" includes the following steps: registration and application, categorization of the project and preparing the terms of reference of the EIA, preparation of the EIA, EIA review and granting of the license. Once the "Environmental License" is awarded, the proponent and the Ministry of Natural Resources and Environment (SERNA) sign a "contract" by which such license is formalized and the proposer agrees to comply with all aspects contained in the final EIA report. In this contract all "control and monitoring actions" are defined, which are the "set of actions performed by SERNA, the environmental units during implementation and / or operation of a project to ensure that mitigation measures are being implemented, also verifying that no new impacts have occurred during the time the project has been in operation". Article 13 ° of the SINEA states that "state agencies (both central, departmental or municipal) will have an Environmental Unit that will work with SERNA and will be structured according to the nature of each institution and whose relationship with SERNA will be determined through an agreement."

In particular, the municipality of Puerto Cortes (included in the study area) celebrated a decentralization agreement of environmental management in March 2000, establishing an Environmental Management System composed by an Environmental Management Unit (UGA), a Municipal Environmental Commission (a a citizen participation mechanism), a System of Information and a Municipal, Environment Inspector. The UGA of Puerto Cortes is a technical-administrative office, established in 1994, that regulates and norms the socioeconomic and policy activities (publics or private) interacting with the natural resources and the environment. Its main objective is to implement the “policy” an “environmental strategy” of the municipality of Puerto Cortes, in the frame of the concept of sustainable development, contributing to the improvement of the quality of life of the inhabitants of Puerto Cortes. To that end it is conformed by the divisions of Natural Resources Management, Environmental Authorizations, Environmental Control and Monitoring, Integrated Watershed Management, Early Warning Center and Environmental Inspector.

⇨ Water management

Belize

Regulation on water and / or water resources include: i) water flows or waters above the surface of any land, ii) the flow of water or water contained in rivers, streams, creeks or other natural resources, iii) groundwater, iv) any water contained by works, improvements or operated by authorized persons, and v) any estuary or coastal waters designated by the responsible Minister. According to these regulations, water can be used in two forms: "common use" (for human needs, without the use of equipment, without changing courses or sources) or "special use" (with social or economic benefits, which includes the domestic, agricultural, hydroelectric, tourism, industry and others).

The Water and Sewerage Ordinance (1971) incorporated to the institutional organizational chart of Belize, the Water and Sewerage Authority (WASA) which has the power to implement legal measures in specific areas, to regulate polluting activities where there is need to protect water from contamination, whether or not in an water supply area, surface water or groundwater. Also, the Subsidiary Act (2001) gives Belize Water Service Ltd. (BWS) an operating license for 25 years, subject to applicable regulations and the provisions established in the License.

Wastewater. The Public Utilities Commission Act (1999) declared delivery of water and sewerage services as public service. It corresponds to indicate that "sewage" shall mean the different animal fecal waste, drainage, stables and sewage and other water subjected to domestic or industrial use. "In urban communities, waste disposal is the responsibility of local governments; when disposal methods are inadequate and cause health problems, the Ministry of Health is who should identify the problem and take corrective action. Indeed, the Public Health Ordinance (1943) states that the Ministry of Health, through the Office of Public Health and Environmental Health Department, has the following competences::

a) Monitoring of wastewater, solid and liquid waste and waste management (ensuring that they are disposed of properly and in according with public health standards to prevent environmental damage);
b) Prevention of pollution (monitoring of water pollution);
c) Monitoring of solid and liquid waste and sewage management;
d) Control over the use of chemicals, pesticides, herbicides, insecticides and industrial waste (ensuring that people using them, do it properly and without polluting the environment);
e) Criminal prosecution of public health offenders (any person or organization refusing to comply with public health laws can be prosecuted).

Health Department officials are in capacity to enter premises under the control of any citizen council or person, in order to inspect the system for water supply or sewage disposal.

The Environmental Protection Act (1992) prohibits to issue, import, discharge, deposit, or throw any kind of waste that could contaminate water resources or harm marine life.

Watersheds. The Environmental Protection Act (1992) prohibits the issue, import, discharge, deposit, or throw any kind of waste that might directly or indirectly contaminate water resources or harm marine life; it also, empowers the Minister to issue regulations to establish the types of projects, programs or activities which require Environmental Impact Assessment, also defining the procedures, contents, guidelines and other matters relevant to this assessment. These provisions have resulted in the Environmental Impact Assessment Regulations (1995) which stipulate that "the development of over 500 acres of public lands, as well as major watersheds and coastal water works will require a thorough Environmental Impact Assessment."

Guatemala

The water regime is based on the constitutional premise that all water is public property, inalienable and indefeasible, subject, in accordance with the public interest and in accordance with procedures established by law, to use and enjoyment. According to the provisions of the Civil Code, "public property" is defined as those belonging to the State or Municipalities, divided into "common public goods" and "special assets":

Wastewater discharge
The Ministry of Environment and Natural Resources (MARN) is the entity responsible for implementing the "Regulation of Discharge and Reuse of Wastewater and Sludge Disposal" (Government Agreement No. 236-2006 of May 5, 2006) that establishes "the criteria and requirements to be met for discharge and reuse of wastewater, as well as sludge disposal" and the " mechanisms for evaluation, control and monitoring for the Ministry of Environment and Natural Resources to promote conservation and enhancement of water resources "to the effect that" it succeeds in establishing a continuous process that allows to: i) protect the receiving water bodies from impacts of human activity, ii) recovering the receiving water bodies in process of eutrophication, and iii) promote the development of water resources with a vision of integrated management."

For its part, the Health Code (Legislative Decree No. 90 - 1997) states that the Ministry of Health (jointly with sector institutions, municipalities and organized community): i) promote universal coverage of the population services for excreta disposal, wastewater conveyance and treatment, ii) promote health education activities for their proper use, iii) establish sanitary standards regulating the construction of works for the removal and disposal of excreta, and iv) establish, together with municipalities, authorization, supervision and control of such works. In turn, the Code provides that:

a. Municipalities or users of the affected sub-watersheds are responsible for the construction of works for the treatment of wastewater and sewage to avoid contamination of water sources, rivers, lakes and springs, and
b. The Ministry will provide technical assistance on issues related to their construction, operation and maintenance. At the same time, it prohibits: i) the discharge of untreated sewage into rivers, lakes, streams and lakes or water bodies, whether they are on surface or underground, and ii) the discharge of pollutants from industrial of agro-industrial origin and the use of non-treated wastewater without the favorable opinion of the Ministry of Health.

The Fishery Fish and Regulation (Decree No. 1235) prohibits "the destruction of fish germs, muddy the waters in which they are submerged or throw them any material that may harm them" and "arbitrarily alter the condition of the waste waters of industries or pour into them, for any purpose, harmful materials or substances for fisheries"

Watersheds

The Protection and Improvement of the Environment Law (Legislative Decree No. 68 - 1986) establishes as one of its primary objectives "to promote initiatives aimed at the protection, enhancement and restoration of the environment" and, in particular, "the integrated use and rational management of watersheds and hydric systems. "

The Protected Areas Law (Legislative Decree N ° 4 - 1989) states that " protected areas, including their respective buffer zones, are those aimed at the conservation, rational management and restoration of wild flora and fauna, its related resources and their natural and cultural interactions that have high significance for their function or genetic, historic, scenic, recreational, archaeological and protective values, so as to preserve the natural state of biotic communities, unique geomorphologic features, water sources and supply, critical river watersheds, protected areas of agricultural land, in such way to maintain sustainable development options ", and creates the subsystem Rain Forest Conservation as a way to " ensure a constant water supply of acceptable quality to the Guatemalan community. "

The Forestry Law (Legislative Decree N ° 101 - 1996) "prohibits eliminating the forest in the upper hydric watershed covered with forest, especially those located in areas of hydric recharge to supply water sources, enjoying special protection" and consequently, these areas" will only be subject to sustainable forest management. "

The Health Code (Legislative Decree No. 90 - 1997) states that "it is the responsibility of the municipalities or the users of the affected watersheds or sub-watersheds, the construction of works for the treatment of wastewater and sewage to avoid contamination of other water sources, rivers, lakes, water springs" and that "the Ministry of Health shall provide technical assistance on issues related to their construction, operation and maintenance"

Honduras

According to the Water Use Law (Decree No. 137-1927) corresponds to the State eminent domain, inalienable and imprescriptibly, of: a) waters of territorial seas that bath its shores and islands, for the width determined by International Law, with its beaches and coves, bays, harbors, ports and other shelters used for fishing and navigation; b) waters of lakes, lagoons, estuaries, rivers and streams of constant current, and c) stormwater and underground water flowing through public lands. On the other hand, are of private property: i) the waters of streams that are born and die within a property, ii) stormwater as they run through private property, and iii) groundwater lit by the owner.

The General Environmental Law (Legislative Decree No. 104 - 1993) states that it "corresponds to the State and municipalities, in their respective jurisdiction, the management, protection and conservation of watersheds and natural water deposits, including the preservation of the elements involved in the natural hydrologic process " and that " users of water, whatever its intended purpose, are compelled to use it rationally, preventing its waste and week where possible its reuse ". Also, the Act states that are subject to special protection and control the following water categories: i) those designed to supply populations or for human consumption in general; ii) those designed for irrigation or food production, iii) those constituting natural breeding nurseries or species of aquatic flora and fauna, iv) those found in protected areas, and v) any other source of general importance.

Wastewater discharge

Under the technical parameters accepted by Honduras **wastewater** is defined as "the liquids of varying composition from domestic, industrial, commercial, agricultural, livestock, mining or other" (Technical Norm for Wastewater Discharges to Receiving Water Bodies and Sanitation; Agreement N ° 058 - 1996). According to the General Environmental Law (Legislative Decree No. 104 - 1993), such wastes must be technically treated to avoid alterations in the soil, rivers, lakes, ponds and, in general, land and maritime waters, as well as to prevent air pollution. The Act also establishes that municipalities, in consultation with the Ministry of Public Health or other technical bodies, adopt a system of collection, treatment and disposal of these wastes, including opportunities for reuse or recycling.

The General Environmental Law prohibits the location of human settlements, military bases, industrial facilities or of any other type in the areas of influence of water supply sources to populations or irrigation systems for agricultural crops for human consumption; the residues, even treated, present potential risks of pollution (corresponding to the municipalities to ensure the correct application of the norm) and, at the same time, establish as "environmental crime" the discharge of dangerous pollutants with prohibited use, or without previous treatment, in the seas of national jurisdiction (including the maritime – terrestrial zone), in water courses or inland water deposits or groundwater (including population water supply systems) or infiltrate into the soil or groundwater or wastewater wastes that cause or may cause the death of one or more persons or serious damage to human health or the ecosystem in general.

The Health Code (Legislative Decree No. 65 - 1991) states that the Executive Branch through the Ministry of Public Health and Welfare, will regulate all matters relating to the handling and disposal of excreta, sewage, wastewater and stormwater, and the surveillance and technical control over sewers and its corresponding effluent. Thus, the Environmental Health Regulation prohibits the discharge of wastewater and sewage into rivers, streams, lakes, ponds and winter streams as well as seas, estuaries, reservoirs, aquifers or other water body. At the same time, it establishes that the authority of the Health Regions or Areas, may only authorize domestic, industrial, agricultural and mining establishments, discharges of liquid waste into rivers, lakes, ponds, reservoirs, streams, creeks, streams , winter flows, as well as beaches and estuaries or seas fishing sites or fish and shrimp industry, when the treatment system for those waste fluids ensures that the discharge meets the Technical Norms for Residual Wastewater Discharges to receiving water bodies and sewage system

Thus, any individual or legal entity, public or private, generating wastewater discharges, is required to submit a monitoring plan to control the quality of the final effluent (which must be approved by the Health Authority) and exercise Quality Control (according to the indicated Norma). The application of the Technical Norms for Wastewater Discharges into receiving water bodies and sewage is the competence of the Secretary of State for Public Health, the Secretary of State for the Environment and the Secretary of State for the Offices of the Interior and Justice.

The Criminal Code establishes that commits the crime of pollution anyone who pours into surface waterways or groundwater or lakes, lagoons or sea, residues containing chemicals such as arsenic, mercury, sulfur, carbonates, sulfates or other analogous, whether they are biodegradable or not.

Watersheds

a) The General Environmental Law (Legislative Decree No. 104 - 1993) states: Corresponds to the Executive Power, through the Secretary of State for the Environment and other State Secretaries and competent decentralized institutions, the hydric ordering and

b) In order to regulate the water regime, prevent dragging of solids and help protect the reservoirs, dams, roads, agricultural land and populations against the harmful effects of water, projects will be implemented for hydric planning, which will depart from the hydrological consideration of watersheds as the unit of operation and management.

To this end, it creates the National Hydric Watershed Network which coordinates the management of hydric resources, improving its quality and quantity, in order to ensure permanent use of the resource by the population.

⇨ Solid waste management

Belize

The Environmental Protection Act (1992) defines waste as **"any liquid, solid, gaseous or radioactive material to be discharged, emitted or deposited in the environment, which when emitted or deposited into the environment in certain volumes or composition, causes alterations in the environment ".** It further provides that no person shall emit, import, discharge, deposit or discard waste that may directly or indirectly pollute water resources or destroy marine life and that anyone who commits a breach of the above offense and, therefore, will be punishable with sanctions of imprisonment and fines.

The competencies necessary for the management of solid waste for the Solid Waste Management Authority, dependency of the Ministry of Environment and Natural Resources (MERN), which has the responsibility to take the steps that it deems appropriate for the collection and final disposal of solid waste within a given service area and, upon approval of the Minister, may secure the services of a contractor in order to provide efficient collection services in specific areas. However, in practice, solid waste collection is under the responsibility of local governments of cities, towns and villages, i.e. the City Council, Town Board or the Village.

Guatemala

The Health Code (Legislative Decree No. 90 - 1997) states that: a) it corresponds to municipalities the provision of services; cleaning or collection, treatment and disposal of solid waste in accordance with the specific laws and in compliance with applicable health regulations and b) municipalities may use sites for disposal of solid waste or construction of the respective landfills, after obtaining the favorable opinion of the Ministry of Health and the National Environment Commission, which shall be made within the unextendable time limit of two months after requested. It also prohibits throwing or accumulating any solid waste in unauthorized sites, around populated areas or in locations that may produce health damage to the population, ornament of the landscape, use of inappropriate means for transportation and storage or proceed to their use, treatment and disposal, without the corresponding municipal authorization, which must take into account compliance with established health measures to prevent environmental pollution.

The Law on Protection and Improvement of the Environment (Legislative Decree No. 68 -1986) prohibits the introduction into the country for human or animal excreta, household or municipal garbage and its byproducts, sludge or sewage sludge, whether they are treated or not, and toxic waste from industrial processes containing substances that may infect, contaminate and / or degrade the environment and endanger the lives and health of the inhabitants (including chemical mixtures or combinations, traces of heavy metals, radioactive waste, undetermined acid and alkalis, bacteria, viruses, eggs, larvae, spores and zoo and phytopathogenic fungi). At the same time, the Act provides that the Government shall, technically determine the cases where the dumping of waste, garbage, debris or waste in a receiving source can be produced or permitted (according to water quality regulations).

Government Decree 234 - 2004 created the National Commission on Solid Waste Management (CONADES), responsible for coordinating and implementing appropriate technical and legal actions in the management of solid waste in the country. The commission is conformed by the Ministry of Environment and Natural Resources (MARN), which holds the presidency, the Ministry of Health and Social Welfare, the Presidential Commissioner for Local Development, the General Secretariat of Programming and Planning (SEGEPLAN), the Institute of Municipal Development (INFOM), the National Association of Municipalities (ANAM) and the Coordinator of Agricultural, Commercial, Industrial and Financial Associations (CACIF). Within this framework the National Policy on Waste Management and Solid Waste (Government Agreement 111-2005) has developed as a tool that organizes institutional actions in the theme and as joint vision of at least four basic social components: Private Initiative, the Central Government Bodies, Municipalities and Civil Organizations.

Finally, the Criminal Code provides for penalties of imprisonment for those who throw dead animals, trash or debris in the streets, in public places or where its use is prohibited or foul water sources.

Honduras

According to the Regulation of Solid Waste Management (Agreement N ° 378 - 2001), the term "solid waste" refers to those hazardous materials that are discarded by human activity or generated by nature and becomes undesirable to its current possessor by not having an immediate utility. For its part, the Health Code (Legislative Decree No. 65 - 1991) defines the generic name of "junk" as:

a) Putrescible wastes that result from cooking, handling, preparation and consumption of food;
b) Non-putrescible wastes formed by substances, fuels and non-fuels;
c) Waste produced as ash resulting from the combustion process with industrial and domestic purposes;
d) Bodies of domestic animals and of those kept in captivity;
e) Waste produced by the action of cleaning of buildings, streets and public places;
f) Waste produced in health facilities (public and private), whether contaminated or not;
g) Waste producing ionizing radiation, and
h) The use and final disposal of non-perishable or non-biodegradable solids will receive special consideration in the regulations to be established.

Altogether, the Regulations for Solid Waste Management (Agreement N ° 378 - 2001), the Health Code (Legislative Decree No. 65 - 1991) and General Environmental Law (Legislative Decree No. 104 - 1993), impose obligations to the municipalities to: a) organize, contract and assume the responsibility of the services for cleaning, collection, treatment and disposal of garbage, and **b)** adopt, for this purpose, specific measures for prevention and control of pollution as well as the techniques and technologies appropriate to their local interests, and their natural, social and economy conditions. Additionally, the General Environmental Law prohibits the

introduction into the country of radioactive toxic waste, household garbage, sewage sludge and silt and other pollutants considered harmful or, in particular, states that the Honduran territory and waters may not be used as repositories for such materials. This Regulation adopts the landfill as an acceptable method for final solid waste disposal (although not ruling out the use of other environmentally appropriate technologies) and establishes a classification of landfills according to their form of operation: a) manual sanitary landfill (which is used as a method for final disposal of ordinary waste from urban and rural populations generating less than 20 tons per day of waste), and b) mechanized landfill (to be used as a method of final waste disposal of ordinary waste from urban populations generating more than 40 tons per day of waste). Likewise, it imposes a custodial sentence to those polluting the air, soil or water with toxic fumes, excessive noise, dumping dangerous substances or disposal of hazardous products that could harm people, animals, forests or plantations.

⇨ Protected Areas

Belize

Protected Areas are managed by three different ministries (which maintain their financial and administrative independence and define their own policies): **a)** the Ministry of Natural Resources and Environment through its Forest Department is responsible for terrestrial protected areas and is in capacity to regulate, either in general form or in particular applied to a forest reserve or other areas, that related to the protection of trees and forests; **b)** the Ministry of Agriculture and Fisheries through its Fisheries Department is responsible for marine protected areas, and is in the capacity to declare extraordinary measures in a determined area within Belize fishing limits (and adjacent territory) to create a marine reserve, and **c)** the Ministry of Tourism, Civil Aviation and, which, through its Department of Archaeology, manages archaeological sites and whose director is in capacity to compel the owner, tenant, licensee or any person who is about to perform an operation that in their judgment could destroy, damage, interfere with or serve to the detriment of any historic monument, to desist of any action.

The Minister for National Park System is in capacity to declare thorough publication in the Official Gazette of the State, specific areas under any of the following figures: a) *National Park* (for the protection of species and habitat, preservation of sites of natural, research, education, tourism and / or recreation significance), b) *Reserve Area* (for the protection, research, visit, extraction control, management, and preservation of biological communities and commercial species, c) *Wildlife Sanctuary* (for the protection of species or groups of species, biotic communities or physical sites that require human management for its perpetuation), and d) *Natural Heritage* (natural sites of special interest or with unique characteristics in order to provide opportunities for interpretation, research, education and public appreciation).

Guatemala

Guatemalan legislation (Protected Areas Act, Legislative Decree N ° 4 - 1989) understands by "protected areas" (including their respective buffer zones) those aimed at the conservation, rational management and restoration of wild flora and fauna, its related resources and cultural and natural interactions, having great significance for their function or values, being these genetic, historic, scenic, recreational, archaeological or protective, in order to preserve the natural state of the biotic communities, unique geomorphic phenomena, water sources and supply, critical watersheds of rivers in the protective zones of agricultural soils, thereby to maintain sustainable development options.

For its part, the Protection and Improvement of the Environment Act (Legislative Decree No. 68 - 1986) establish that "for the conservation and protection of biotic systems (or life for animals and plants), the Executive Organism will issue the regulations regarding the following aspects: **a)** the protection of species or animal and plant specimens that are in danger of extinction; **b)** the promotion of the development and use of methods of conservation and use of wild flora and fauna; **c)** the establishment of a system of conservation areas to safeguard the national genetic heritage, protecting and preserving the special geomorphologic features, landscapes, flora and fauna; **d)** the import of plant and animal species that could damage the biological balance of the country, and the export of unique species threatened with extinction; **e)** the illegal trade of species considered endangered, and **f)** ensure compliance with international treaties and conventions relating to the conservation of natural heritage.

The National Protected Areas Council (CONAP), as the maximum steering and coordination body of the Guatemalan System of Protected Areas (SIGAP), dependent from the Office of the President of the Republic and which is chaired by the Minister of Environment and Natural Resources (MARN). This Council implements exclusively, the National Policy on Protected Areas. Protected areas are classified as national parks, biotopes, biosphere reserves, multiple-use reserves, forest reserves, biological reserves, springs, resource reserves, natural monuments, cultural monuments, scenic routes, marine parks, regional parks, historic parks, wildlife refuges, recreational natural areas, private nature reserves and other areas established for similar purposes. All of them integrate the Guatemalan System of Protected Areas (SIGAP). The official declaration of a protected area of any nature must be based on a technical study approved by the CONAP. The Criminal Code states that whoever, in contravention of statutory requirements or provisions of the competent authority, exploits, cut down or destroys, in whole or in part, a forest, afforestation, planting, public cultivation or nursery, shall be punished with imprisonment of six months to two years and a fine.

Honduras

According to the Forestry, Protected Areas and Wildlife Act (Legislative Decree No. 56 - 2007), "protected areas" is defined those that, whatever its management category, being defined by the pertinent law, for purposes of conservation and protection of natural and cultural resources, taking into consideration geographic, anthropological, biotic, social and economic parameters which justify the general interest.

The National Institute for Conservation and Development of Forest, Protected Areas and Wildlife (ICF) has the authority to formulate,

coordinate, monitor, implement and evaluate the policies related to forestry, protected areas and wildlife, and is also responsible for managing these areas. These powers may be exerted directly or by delegation. Protected areas are declared by the Executive or the National Congress, through the ICF, through motion or at the request of municipal corporations or communities in town hall meetings, and subject to technical and scientific studies that demonstrate its feasibility.

⇨ Fisheries and aquaculture

Belize

The Fisheries Department is regarded as the regulating entity with technical leadership to oversee the development of the industry; its functions include: a) the application of legislation and national policies to guide the development of the industry, b) the administration of permits and licenses for crop production, c) the provision of technical assistance to existing and potential aquaculture producers, d) environmental monitoring and compliance and, e) the application of the respective legislation.

For its part: **a)** the Coastal Zone Management Authority and Institute /CZMAI) is responsible for coordinating efforts to manage coastal resources; **b)** the Environment Department of the Ministry of Natural Resources and the Environment is responsible for leadership of the regulatory process for impact assessment and is conceptually bound to safeguard and maintain the integrity of the environment and, **c)** the Belize Agriculture Health Authority is in the process of consolidating and strengthening its functions of inspection and certification of fishery and aquaculture products (which were formerly under the Department of Fisheries).

In addition, the Principal Fisheries Ordinance Principal Act, Chapter 210, stipulates that "commercial fishing" is understood as taking, capturing, selling, reproduction or production of any fish, and at the same time, establishes the need to obtain a license, since "no person shall engage in commercial fishing, except as a holder of a valid license as a fisherman."

Guatemala

The Executive Branch through the Ministry of Agriculture is the highest authority on fisheries and related activities, exercising its functions through the Political Chiefs, municipalities and other authorities as convened. The Management Unit for Fisheries and Aquaculture (UNIPESCA) is the government agency responsible for administrative control of aquaculture.

The General Law of Fishing and Aquaculture (Legislative Decree No. 80 - 2002) and its Regulations (Government Agreement No. 223 - 2005) constitute the highest normative in the field; according to them the state promotes the development and responsible management of aquaculture (taking into consideration the Environmental Impact Assessment) and the municipalities are obligated to: a) establish, within their jurisdictions, fish nurseries of any species, and b) oversee its preservation and access to its propagation (according to the instructions issued by the Ministry of Agriculture, Livestock and Food).

Honduras

The body responsible for administrative control of fisheries and aquaculture is the General Direction for Fisheries and Aquaculture (DIGEPESCA) under the Ministry of Agriculture and Livestock (SAG), which is governed by the Fisheries Act (Legislative Decree No. 154 - 1959) and gives it the faculties for the exploitation of aquatic resources and includes the procedures and requirements for: a) to conduct river, lake and sea fishing; b) the establishment of closed seasons (permanent or temporary, general or regional), reserve zones and any other condition to ensure a rational and methodical exploitation, from the biological, medical, industrial commercial or sport; c) establishing the form of fishing to be used and their characteristics, and d) the issuance of sanitary norms and other provisions necessary to regulate the fishing industry.

⇨ Coastal Zones

Belize

Belize has a Coastal Zone Management Act (2003) that introduces the Coastal Zone Management Authority and Institute (CZMAI) whose functions include: **a)** advise the Ministry of Agriculture and Fisheries on issues related to sustainable use of coastal resources; **b)** assist in the development and implementation of programs that convert marine policies of the government in activities that contribute to the sustainable development of coastal resources; **c)** assist in developing and implementing programs and projects aimed at rooting of regional and international cooperation regarding the use of the marine environment and other related areas to the environment, **d)** review the Coastal Management Plan of Belize, **e)** to commission research and monitoring in any coastal area of any activity that could impact these areas; **f)** promote public awareness of the nature of the coastal zone of Belize and the importance of sustainable management and conservation of its resources; **g)** create guidelines for investors interested in the area (in consultation with other government agencies); **h)** cooperate with other state departments, boards, commissions, NGOs and the private sector on issues which might have impact on the development and use of coastal resources in an orderly and sustainable manner; **i)** maintaining a national reef monitoring program and monitoring programs of water quality (in collaboration with government and private sector agencies), **j)** recommend to the Minister of Agriculture and Fisheries anything else related to coastal resources.

Guatemala

The Constitution of the Republic of Guatemala states that the State exercises full sovereignty over its national territory consists of the soil, subsoil, internal waters, territorial sea (to the extent prescribed by law) and the airspace extending on them. Thus, in accordance with Article 121 of the Constitution of the Republic and with the guidelines established by the United Nations Convention on the Law

of the Sea (UNCLOS), Guatemala has sovereignty over the sea area immediately adjacent to the territorial sea, over living natural resources of the seabed and marine subsoil and on those existing in waters adjacent to the coast beyond the territorial sea which constitute the exclusive economic zone.

The Constitution and the Law of Territorial Reserves establish under "Territorial Reserve" that the State reserves the dominion of a strip whose width will be is: a) along the oceans: 3.0 km starting from the top line of the tides; b) 200 m around lake shores; c) 100 m either side of the banks of navigable rivers, and d) 50 m around water sources and springs (where the waters to supply populations are born).

The Protection and Improvement of the Environment Act (Legislative Decree No. 68 - 1986) states that the Government will look up for the maintenance of the quantity of water for human use and other activities whose employment is indispensable; therefore it will issue the provisions necessary and appropriate regulations to (among others): **a)** promote and encourage research and permanent analysis of inland, coastal and oceanic waters constituting the maritime economic zone of exclusive domain and **b)** prevent, control and determine the levels pollution of rivers, lakes and seas of Guatemala.

The Executive Branch, through the Ministry of Agriculture, Livestock and Food (MAGA) and through the Bureau of Control of State Reserve Areas (OCRET), is who has control of the Territorial Reserve Areas of the State, and also runs programs and works that are necessary for their better use and development.

Honduras

In Honduras, the General Environmental Law (Legislative Decree No. 104 - 1993) states that "marine and coastal resources" are waters of the sea, beaches, flats and coastal strip, bays, coastal lagoons, mangroves, coral reefs, estuaries, scenic beauty and living and nonliving natural resources contained in the territorial waters, contiguous zone, exclusive economic zone and continental platform. At the same time, it states that: **a)** the Executive Branch, through the Secretary of State of the Bureau of Natural Resources, in coordination with other competent institutions, may delineate protection zones of particular marine or coastal areas, which will be subject to use and management plans (for the purpose of preventing and combating pollution or environmental degradation), and **b)** the execution of civil works on the coast will be done in such way that there will be no damage to the territorial or aquatic coastline and not cause significant ecological changes, with a previous Environmental Impact Study.

3.10 Current status of the Gulf of Honduras

In short (and generalizing), population growth, lagging urban development in terms of coverage of basic services, lack of adequate land use plans, the potential expansion of agricultural activities, overexploitation of fisheries resources, the degradation and loss of biodiversity (ecosystems and species), non-sustainable development of marine and coastal areas (with major expansion projects in the tourism and port infrastructure), the effect of climate change and legal loopholes, are potential threats exerting pressure on the health of the coastal - marine system of the Gulf of Honduras (compromising its sustainable development).

The region of the Gulf of Honduras possesses valuable natural resources, which due to its disordered and non-systematized and incipient unsustainable development has compromised its own future. This leads to having levels of neglect of basic services to the population and the consequent poverty level.

Glossary

Adsorption	Process by which a porous solid (at microscopic level) is capable of retaining fluid particles on its surface after coming into contact with it.
Trade winds	Winds that blow regularly in the oceans.
Analyte	A chemical species which can be identified and quantified, this is, one can determine its amount and concentration in a chemical measurement process.
Atolls	Set of several small islands that are part of a coral reef with an interior lagoon communicating with the sea.
Beacons	Voice of nautical used in motor traffic to indicate light signals that warns the edge of the roadway or the presence of obstacles.
Beacon	It is a marker object, used to indicate a geographical location or a situation of danger.
Barrier reef	Solid structures of the relief of the seabed formed predominantly by the cumulative development of petrous corals.
Bathymetry	The study of sea deepness.
Polychlorinated biphenyls (PCBs)	A series of organochlorine compounds, which are a series of 209 congeners, which are formed by chlorination of biphenyl in different positions, 10 in total.
Biphenyl	A solid organic compound that forms from colorless to yellow crystals
Biogeochemical	Interaction between geochemical compounds and living organisms.
Biomagnifications	Process of bioaccumulation of a toxic substance.
Biomass	Organic matter originating in a biological process, spontaneous or induced, usable as an energy source.
Biota	Combined flora and fauna of a region and its form of life.
Draught	The vertical distance between a point on the waterline and the base line or keel, with the thickness of the hull included; in the case of not being included, it would be the molded draft.
Silting	Accumulation of sediments.
Congener	Any compound belonging to the same chemical family.
Consumptive	Consumed or can be consumed.
Technophores	Set of artificial means o supporting the development of human society, evolving into an analogy of the biosphere with which it interacts.
DDTs	Means: Dichlorodiphenyltrichloroethane. It is one of the most known synthetic pesticides. It is a chemical with a long history, unique and controversial.
Dock	More sheltered part of a port used to perform tasks of loading, repair or dismantling of ships.
Dilution	Reduction of the concentration of a chemical in solution.
Brackish	Containing a mixture of seawater and fresh water.
Endemic	Native to or confined to a certain region Native to or confined to a certain region disease that occurs systematically, regularly, and without any appreciable variation of affected population in a demographic segment.
Chronic stress	A natural and necessary response for survival.

Estuarine ecosystems	Natural system in coastal areas where freshwater from land mixes with seawater.
Gradient	Measurement of the slope of a curve (often a straight line).
Heptadecane	An organic compound, a hydrocarbon alkane.
Aliphatic hydrocarbons	Organic compounds composed of carbon and hydrogen, in which carbon atoms form open chains.
Ballast	On a ship, is the weight placed to counterbalance the heel or inclination.
Leachate	Liquids produced when water passes slowly through any permeable material
Mangrove	Describes both the ecosystem and the family of plants adapted to life in the intertidal zone. This ecosystem receives contributions from ocean water and inputs of freshwater, sediment and nutrients (FAO, 2007).
NOAA	National Oceanic and Atmospheric Administration (NOAA).
Organochlorine	Organic chemical compound.
PCBs	Polychlorinated Biphenyls (PCBs).
Pelagic	Fish living in open water (or very large lakes) in the surface layers or between water, avoiding or minimizing contact with the coast and the bottom.
Polycyclic	Having two or more rings of atoms in the molecule.
Pentacosane	Chemical: saturated hydrocarbons C25H52 formula found in paraffin.
Putrescible	Not Biodegradable
Human health	Considered a product of the interaction of a number of factors including human biology, environment, socio-economic activities, habits, customs and individual and collective lifestyle of the people.
Siderastrea siderea	Coral species which form colonies that can reach over a meter long. Larger colonies are generally hemispheres (domes) of smooth surface.
Tecnophores	A set of artificial means to support the development of human society, evolving into an analogy of the biosphere with which it interacts.
Troposphere	The layer of the atmosphere in contact with the surface of the Earth.

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Image No.26: Monitoring, Belize, 2008