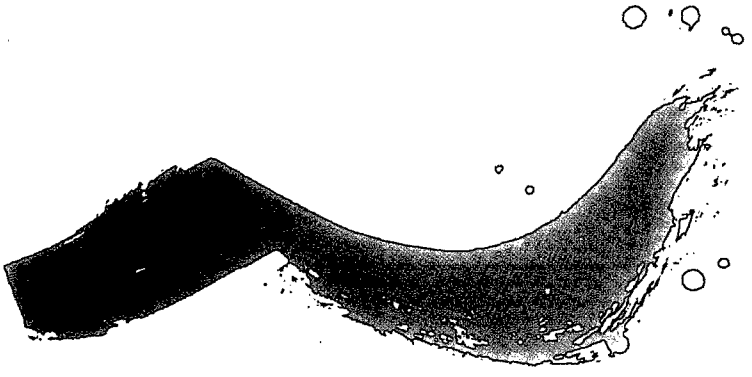
# Situation of the water resources

# in the Central American isthmus countries

Global Water Partnership
GWP - Central America



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# Situation of the Water Resources in the Central American Isthmus Countries

## Principles and Policies on Water Resources[1]

In Central America, there is a clear awareness of the importance of adopting a set of lead principles that have been drafted at important international forum as a result of a large systematization experience. (Chart 1).

## Regional Commitments in Central America

All countries of this region have a stated interest in reorganising their water resources sector. A sign of this interest is shown in the Alliance for the Sustainable Development document (ALIDES)[2], which establishes a set of political, economic, social, cultural and environmental objectives and commitments for

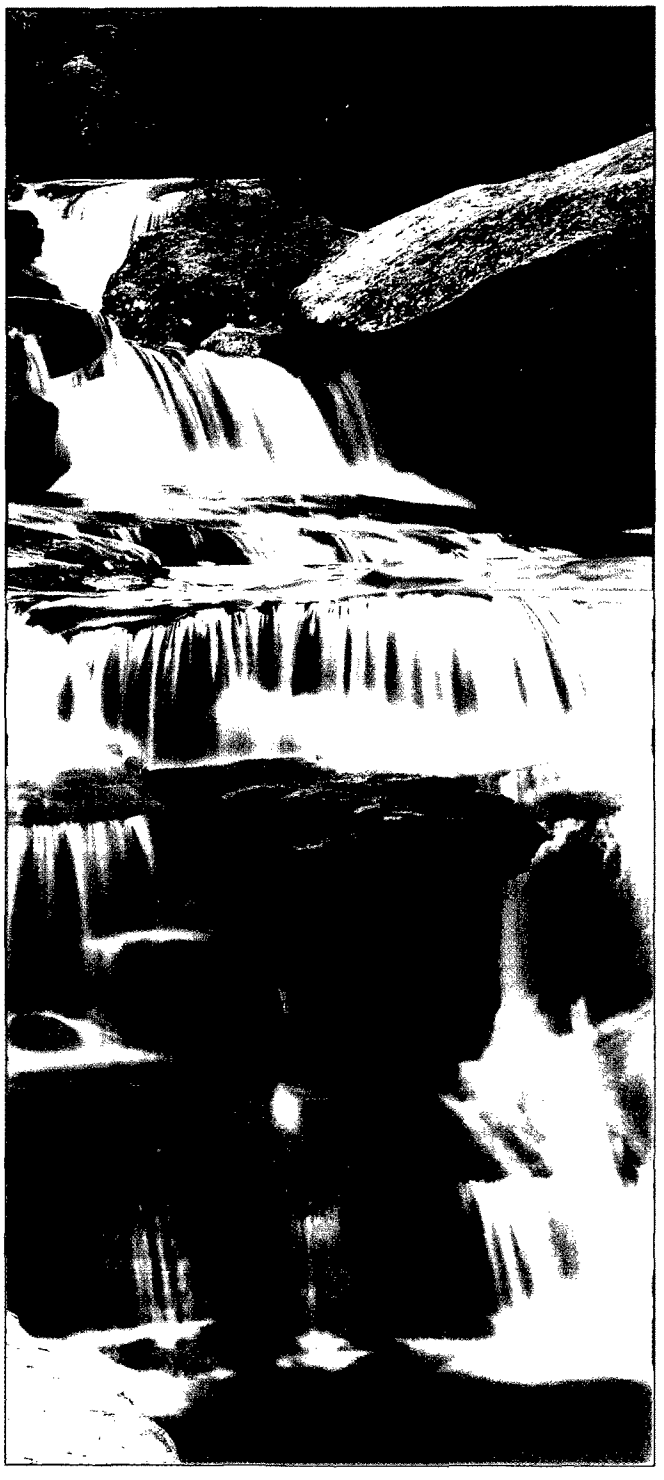


*Chart 1. Environment and Water International Principles, Dublin, Ireland, 1992.*

*Dublin Principles:*

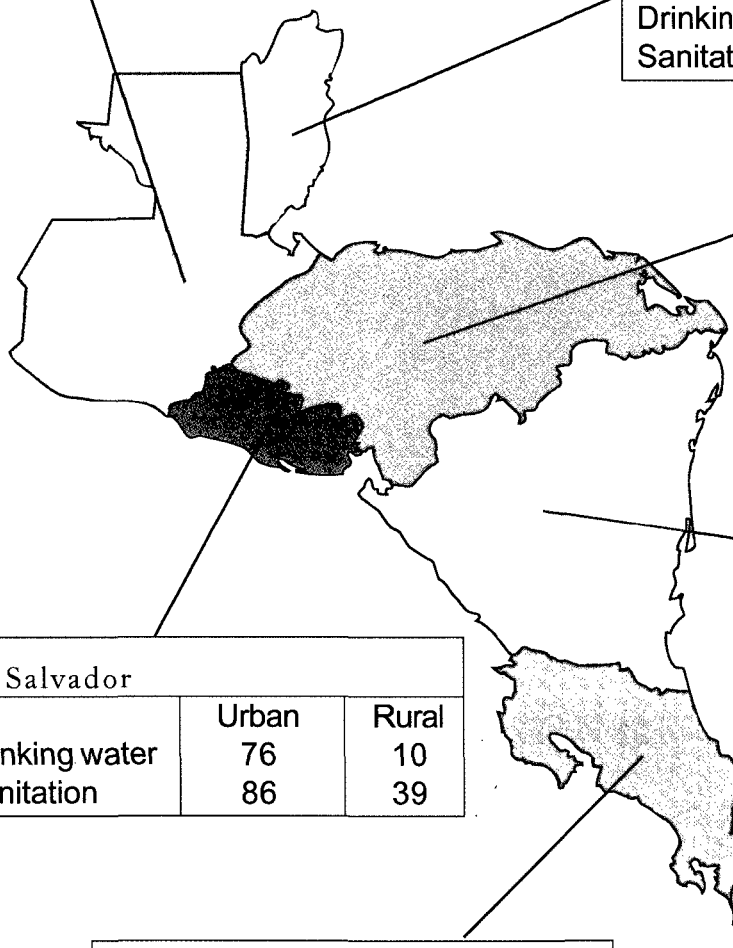
- Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
- Water development and management should be based on a participatory approach, involving all users, planners and policy-makers at all levels.
- Women play a central part in the provision, management and safeguarding of water.
- Water has an economic value in all its competing uses and should be recognized as an economic good.

[1] SICA (CRRH,CCAD, CAPRE, DANIDA) 2000: Plan Centroamericano para el Manejo Integrado de los Recursos Hídricos (PACADIRH).

[2] ALIDES: This is a regional and national strategy, aimed at turning the Central American Isthmus into a region of peace, freedom, democracy and development... (Rodríguez y Salas, 1995, ALIDES, 1994).

GWP - Central America

# Percentage of Inhabitants with Access to Drinking Water and Sanitation Services (% in 1998)



| Guatemala | Urban | Rural |
|---|---|---|
| Drinking water | 91 | 41 |
| Sanitation | 72 | 48 |

| Belize | Urban | Rural |
|---|---|---|
| Drinking water | 94 | 44 |
| Sanitation | 94 | 28 |

| Honduras | Urban | Rural |
|---|---|---|
| Drinking water | 89 | 60 |
| Sanitation | 88 | 44 |

| Nicaragua | Urban | Rural |
|---|---|---|
| Drinking water | 78 | 19 |
| Sanitation | 88 | 44 |

| El Salvador | Urban | Rural |
|---|---|---|
| Drinking water | 76 | 10 |
| Sanitation | 86 | 39 |

| Costa Rica | Urban | Rural |
|---|---|---|
| Drinking water | 100 | 84 |
| Sanitation | 100 | 93 |

| Panama | Urban | Rural |
|---|---|---|
| Drinking water | 100 | 66 |
| Sanitation | 100 | 68 |

Source: CCAD, 1998: Estado del ambiente y los recursos naturales en Centroamérica, 1998. (WRI; UNEP y UNDP, 1992: World Resources 1992-93

supporting the common future of the Central American countries. The "Commitment 39", regarding water, states:

*Commitment 39. Water:*
*To give priority to the elaboration of policies and laws concerning water resources management and preservation that include, among other issues, institutional and legal ordinance, co-ordination mechanisms among those authorities in charge of the management and administration of the resource, both for human consumption and for irrigation and generation of electricity; and, at the same time, training our pertinent authorities on the implementation of this commitment.*

On this same matter, the *"Carta Centroamericana del Agua"*, expressed by the *Parlamento Centroamericano* (PARLACEN) and drafted as a resolution of the Central American Isthmus Water Resources Integrated Management Workshop in 1994 (PARLACEN et al., 1994)[3], recommends, among other aspects, the following:

- *To consider water as a lifeblood, a source of peace and development and as publicly acknowledged good containing an economic value.*
- *To use water resources in an efficient, logical, multiplex, sequential, just, equitable and coordinated manner; guaranteeing at the same time a gradual process that ensures conservation, preservation and improvement of its quality.*
- *To recognise water as the task of a single sector that takes into account all involved actor interests, and not as one of isolated subsectors working for their own interests and without any coordination.*

In May 1996, the objective of the congress about "Assessment and Management Strategies of Water Resources in Latin America and the Caribbean" was to explore strategies that allow national institutions involved in the management of water resources to play a major role in the national and regional development of Latin American and the Caribbean. (BID and OMM, 1996)[4]

During the 1997 Panama Presidential Summit, the Central American presidents declared themselves on water issue as follows:

*"Fulfilling ALIDES Commitment 39, we recognise the work developed by regional Organizations of the water sector intended to achieve a more effective coordination on these aspects; that, with the support of these Organizations, our national authorities involved in the management, preservation and treatment of this valuable resource begin with the final assessment and approval of a regional action plan; all these actions should be carried out in a period of time which does not exceed 90 days".*

Table 1. Water Resource Availability in the Central American Isthmus

| Country | Average Precipitation p/year (mm) | Water resource per capita 1000m³/ year) | Withdrawal ($m^3$ /year/per capita) | Household Withdrawal (%) | Agricultural Withdrawal (%) | Industrial Withdrawal (%) | Hydro-energetic resource consumed (%) |
|---|---|---|---|---|---|---|---|
| Belize | 1,300 - 4,450 | 80.8 | na | na | na | na | na |
| Guatemala | 500 - 6,000 | 11.9 | 139 | 9 | 74 | 17 | 9.2 |
| El Salvador | 1,500 - 2,300 | 3.5 | 241 | 7 | 89 | 4 | 18.9 |
| Honduras | 1,500 - 3,000 | 11.6 | 508 | 4 | 91 | 5 | 15.8 |
| Nicaragua | 400 - 6,300 | 44.3 | 370 | 25 | 54 | 21 | 2.3 |
| Costa Rica | 1,300 - 7,500 | 29.8 | 779 | 4 | 89 | 7 | 4.7 |
| Panama | 1,500 - 5,500 | 57.3 | 744 | 12 | 77 | 11 | 10.7 |

*Source: CCAD, 1998: Estado del ambiente y los recursos naturales en Centroamérica, 1998.*

[3] Parlamento Centroamericano (PARLACEN), UNICEF, CRRH, CAPRE, CIUDAGUA, Guatemala 1994: Central American Isthmus Water Resources Integrated Management Workshop

[4] OMM,BID, San José, Costa Rica, 1996: Conference on Assessment and Management Strategies of Water Resources in Latin America and the Caribbean.

Supported by the Organization of the American States (OAS), the Inter-American Development Bank, the Danish Agency for International Development, among other Organizations, regional institutions such as the *Comisión Centroamericana de Ambiente y Desarrollo* (CCAD), *the Comité Regional de Recursos Hidráulicos* (CRRH), and the *Comité Coordinador Regional de Instituciones de Agua Potable y Saneamiento* (CAPRE), fulfilled the mandate of the Panama Summit Conference by developing a large participation and consultation process which ended with the resolutions presentation workshop of the *Plan Regional del Agua* (PACADIRH) held in Managua, Nicaragua, in June 1999 (SICA, 2000).

At the XX Central American Presidents Summit Conference, the PACADIRH was integrated into the *"Marco Estratégico para la Reducción de la Vulnerabilidad del Istmo Centroamericano"*[5], and the *Sistema de Integración Centroamericana* (SICA) was requested to follow the recommendations declared in the Plan. In order to implement the PACADIRH, the SICA establishes the organization recommended in the document by building a three-level structure of large regional participation (Chart 2)

*Chart 2: Organizational Structure for the PACADIRH Implementation*

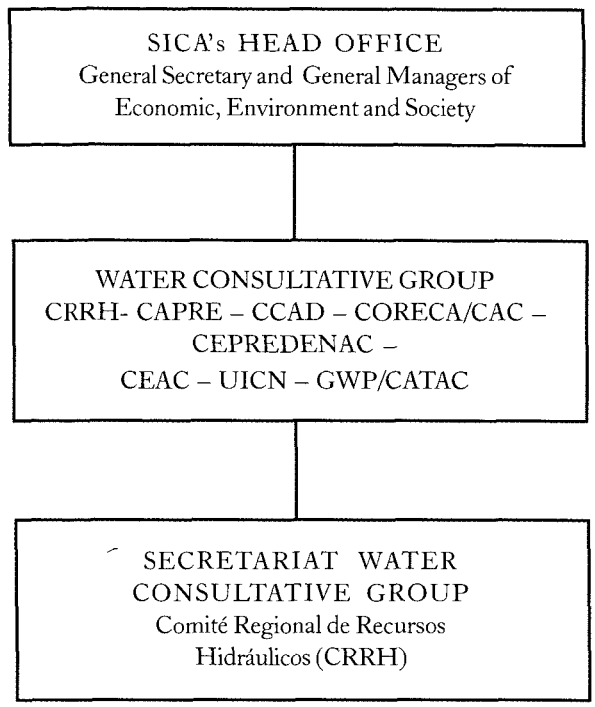
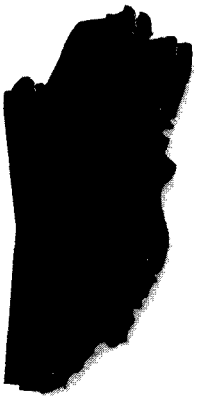



*Table 2. Central American Countries and Regional Basic Indicators (World Bank, 2000).*

| Country | Population | Population Growth | Area (km2) | (GNI/cap.) Gross National Income per capita US$ | Available Water resources per capita (1999) (m3/capita) |
|---|---|---|---|---|---|
| Guatemala | 11,000.000 | 2.6% | 109.000 | 1.680 | 12.121 |
| Honduras | 6,000.000 | 2.7% | 112.000 | 760 | 15.211 |
| Belize | 247.000 | 3.4% | 23.000 | 2.730 | 64.817 |
| Nicaragua | 5,000.000 | 2.6% | 130.000 | 410 | 38.668 |
| El Salvador | 6,000.000 | 2.0% | 21.000 | 1.920 | 2.876 |
| Costa Rica | 4,000.000 | 1.8% | 51.000 | 3.570 | 31.318 |
| Panama | 3,000.000 | 1.7% | 76.000 | 3.080 | 52.437 |
| Central America | 35,247..000 | 2.4% | 522.000 | 2021.4 | 31.064 |

[5] SICA, 1998: XX Central American Presidents Summit Conference, *Secretaria General, Sistema de la Integración Centroamericana*, Guatemala.



# Belize

Area: 23,000 km²
Population: 247.000 inhabitants
Growth Rate of Population: 3.4%
GNI / per capita: US$2.730
Water resources per capita (1999) : 64.817m³ / capita
Water withdrawal (% of water resource): 0.6%
Urban population access to an improved water source (year 2000): 83%
Urban population access to a sanitation system (year 2000): 59%
Agricultural area (% of the total area): 6.1%
Agricultural contribution to economy (% GDP-1999): 19%
Irrigated agricultural area: 3.4% of total agricultural area
Protected areas (% total area): 21%
Forest covered area (% total area, 1999): 13.000 km², 59.1%
CO2 emissions per capita (Metric tons / per cap.) 1.7 (1998)

*Belize's Statistics (World Bank, 2001)*

*Mollejon Pools*
*Photography: Courtesy of the Meteorological Service of Belize*

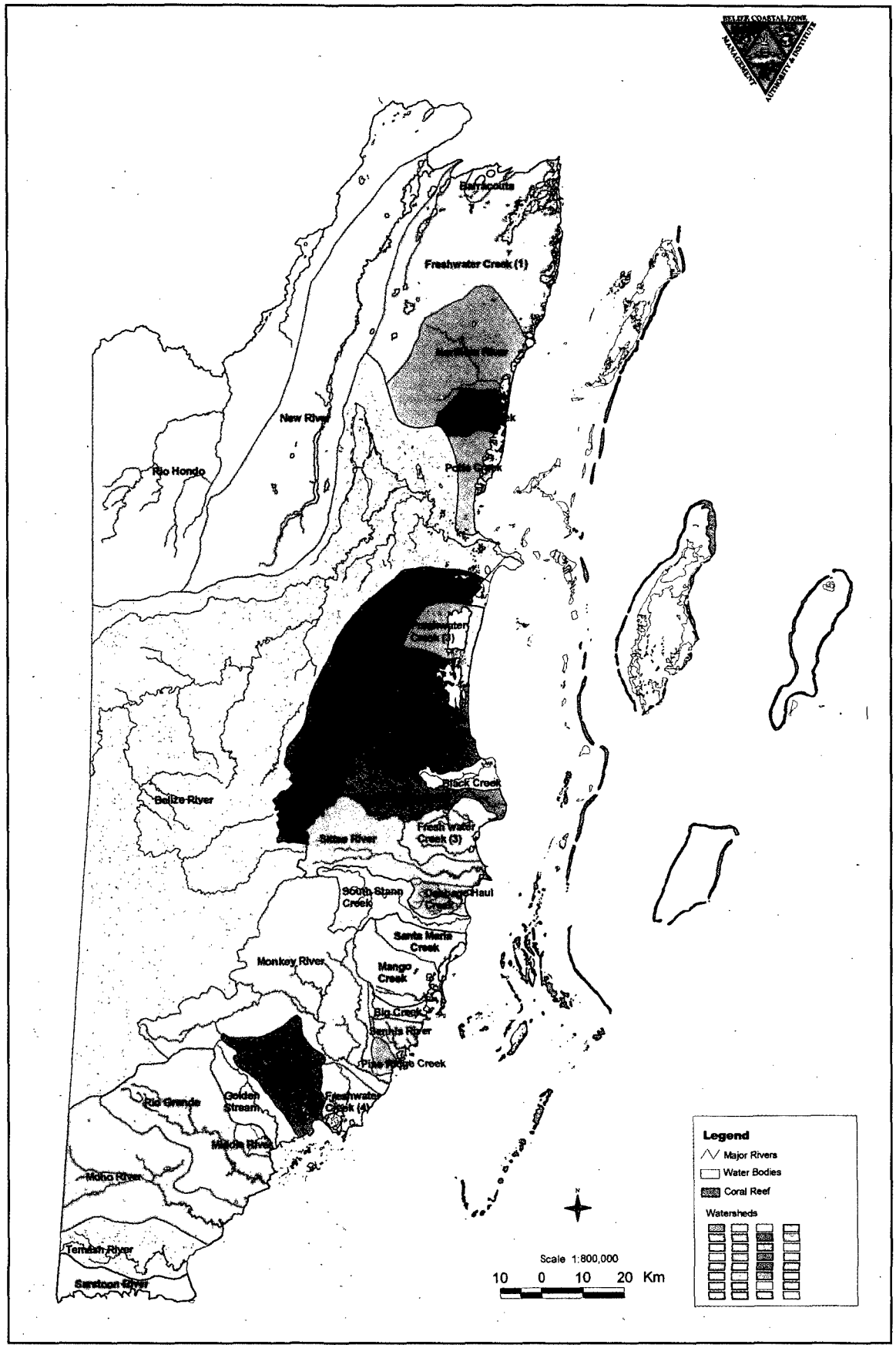
## Geographic location

Belize is located on the north-western coast of Central America, between Mexico (north), Guatemala (south and west) and the Caribbean (east). Its territory is about 23.000 km² and 8.4% of the country is covered by water.

## Climate

Belize's climate is humid subtropical, characterized by an average temperature that goes from 20°C to 31°C, a humidity rate of 80% and an annual rate of precipitation that fluctuates between 1,500 mm on the northern side of the country and 4,600 mm in the southern zone. There are two clearly defined seasons: from February to May with lower precipitation and the rainy season during the rest of the year, in which the maximum precipitation rate is recorded in July. Tropical storms and hurricanes affect the territory with an average frequency of once every five years, causing floods and considerable damage to agriculture and physical facilities (Arteaga, 1994).

# Belize Watersshed Boundaries and Major Rivers



## Demography

Belize's population is about 247,000 inhabitants. The growth rate of population is 3.4% per year, the density of population is 11 inhabitants per $km^2$ , and the birth rate was 3.5 children per woman in 1999 (World Bank, 2001).

## Economic and sustainable development indicators

The Gross National Income (GNI) per capita of Belize is US$2,730, and its economy increased by 4.5% (GDP) in 1999 (World Bank, 2001). The inflation rate of Belize in 1999 was -1.2% and the unemployment rate was 12.8%.

The agricultural area of Belize corresponds to 6.1% of the whole area, of which 3.4% are irrigated areas. The contribution of this sector to the national economy was 19% GDP in 1999. The goods and services exportation have decreased as follows: 63.8% GDP (1990), 50% GDP (1998), and 48.8% GDP (1999). Regarding importation, Belize showed the following fluctuations: 61.6% GDP (1990), 57.2% GDP (1998) and 58.4% GDP (1999).

Belize has a total forest coverage of 13.000 $km^2$, about 59.1% of the whole territory, of which about 21% is in some way under protection. Belize´s deforestation rate was 2.3% in 1999.

## Water Resources Situation

Belize and Panama are the Central American countries that have the greatest water resources capital per capita. Due to Belize's geographical location on Central American´s Caribbean (coast), its climatic conditions reach 46.817 $m^3$ per capita. This rate makes Belize one of the countries with the greatest water capital in the world, only exceeded by the African countries of Sub Sahara. From its whole water capital, Belize consumes only 0.6% for household, industrial, and agricultural uses.

Regarding Belize´s hydroelectric resources, these are subject to the characteristics of the rivers rising in the Mayan mountains, since the rest of the territory is fairly even. (Arteaga, 1994).

The drinking water consumption has increased 115% in the last 10 years, from 550,115.000 gallons in 1980 to 1,180,644,000 gallons in 1999. The increased average rate of consumption is 8.9% per year. The access of population to water improved resources was 83% in 2000. Also, the access of population to sanitation systems was 59% in 2000 (World Health Organization, quoted by World Bank, 2001.)

Belize has 16 major basins. The drinking water is drawn from rivers, wells, water tables and surface waters. Among some methods for water treatment (drinking water) are chlorination, filtration and reversed osmosis.

*New River*
*Photo: Courtesy of Lighthawk*

# Guatemala

Area: 109.000 km$^2$
Population: 11.000.000 inhabitants
Growth Rate of Population: 2.6%
GNI / per capita: US$1.680
Water resources per capita (1999) : 12.121m$^3$ / capita
Water withdrawal (% of water resource): 0.9%
Urban population access to an improved water source (year 2000): 97%
Urban population access to a sanitation system (year 2000): 98%
Agricultural area (% of the total area): 41.6%
Agricultural contribution to economy (% GDP-1999): 23%
Irrigated agricultural area: 6.6% of total agricultural area
Protected areas (% total area): 16.8%
Forest covered area (% total area, 1999): 29,000 km$^2$, 26.3%
Electric power consumption per capita: 322 KWh, 1998
$CO_2$ emissions per capita (Metric tons / per cap.) 0.8 (1998)

*Guatemala's Statistics (World Bank, 2000)*

*Icbolay River, Guatemala*
*Photography: Rocío Córdoba, IUCN*

## Description

Guatemala is located to the north of the Central American Isthmus and has an area of about 109.000 km$^2$. About 75% of its entire territory is formed by mountains covered by forests which begin with the prolongation of the *Sierra Madre* from the Mexican territory. The *Sierra Madre* branches off into two mountain ranges. The first one stretches to the northeast and forms the *Sierra de los Cuchumatanes, the Sierra de Chamá, the Sierra de Santa Cruz* and *Sierra de las Minas.* The second mountain range is formed by the *Sierra Madre*, which stretches along the Pacific coast. The *Sierra Madre* also forms the *Altiplano Central* with inter-mountain valleys, constituting the dividing line of continental waters (Arteaga, 1994)

Guatemala is divided into 10 physiographic provinces: Llanura Costera del Pacifico, Pendiente Volcánica Reciente, Cadena Volcánica, Tierras Altas Cristalinas, Tierras Altas Sedimentarias, Depresión de Izabal y del Montagua, Planicie Baja Inferior de Petén, Cinturón Plegado del Lacandón, Plataforma de Yucatán y Llanura Costera del Caribe. In addition, Guatemala has 33 volcanoes, some of them active.

## Climate

Climatic ranges can be divided from 0-600m for warm climate and average temperatures from 23°C to 26°C; from 600-1,800 m for temperate climate with average temperatures from 18°C to 23°C, and for higher elevations, over 1.800 m, temperatures are between 10°C and 17°C. The rainy season takes place from May to October, and has fluctuations from 500mm for the Northwest zone of the country to over 5.000 mm in the southern zone (Arteaga, 1994).

## Demography

The population of Guatemala is about 11,000,000 inhabitants and its annual rate of growth is 2.6%. The density of population is 102 inhabitants per $km^2$. Guatemala´s birth rate for 1999 was 4.5 births per woman. The life expectancy average of Guatemalans has increased from 61 years in 1990 to 65 in 1999 (World Bank, 2001)

## Economic and sustainable develop indicators

The Gross National Income (GNI) per capita of Guatemala is US$1.680 and its annual economic growth was 3.6% of GDP in 1999.

The agricultural area of Guatemala represents 41.6% of its whole territory, and 6.6% of this area is irrigated. The economic contribution of this sector reached 23% of GDP in 1999. Other important sectors are: trade 24.6%, manufacturing industry 13.8%, transportation, warehousing and communications 8.8% and public administration 7.4%.

Exportation of goods and services was reduced from 21% in 1990 to 19% in 1999, while importation of goods and services increased from 24.8% to 27.4% in 1999. Coffee represents the main export product with 28.3% of the total, followed by sugar with 15.2%, banana with 9.2% and cardamom with 2.8%.

The ecosystems´ wealth and diversity of this country are present in its vegetation and landscape, which in only a few kilometers varies from conifers and latifolia of temperate climates to a tropical latifoliated vegetation in the low lands. Guatemala forest coverage area is 29.000 $km^2$ which represents about 26.3% of its territory, and from this percentage, 16.8% is in some way under protection. Deforestation rate for 1999 was 1.7%.

## Water Resources Situation

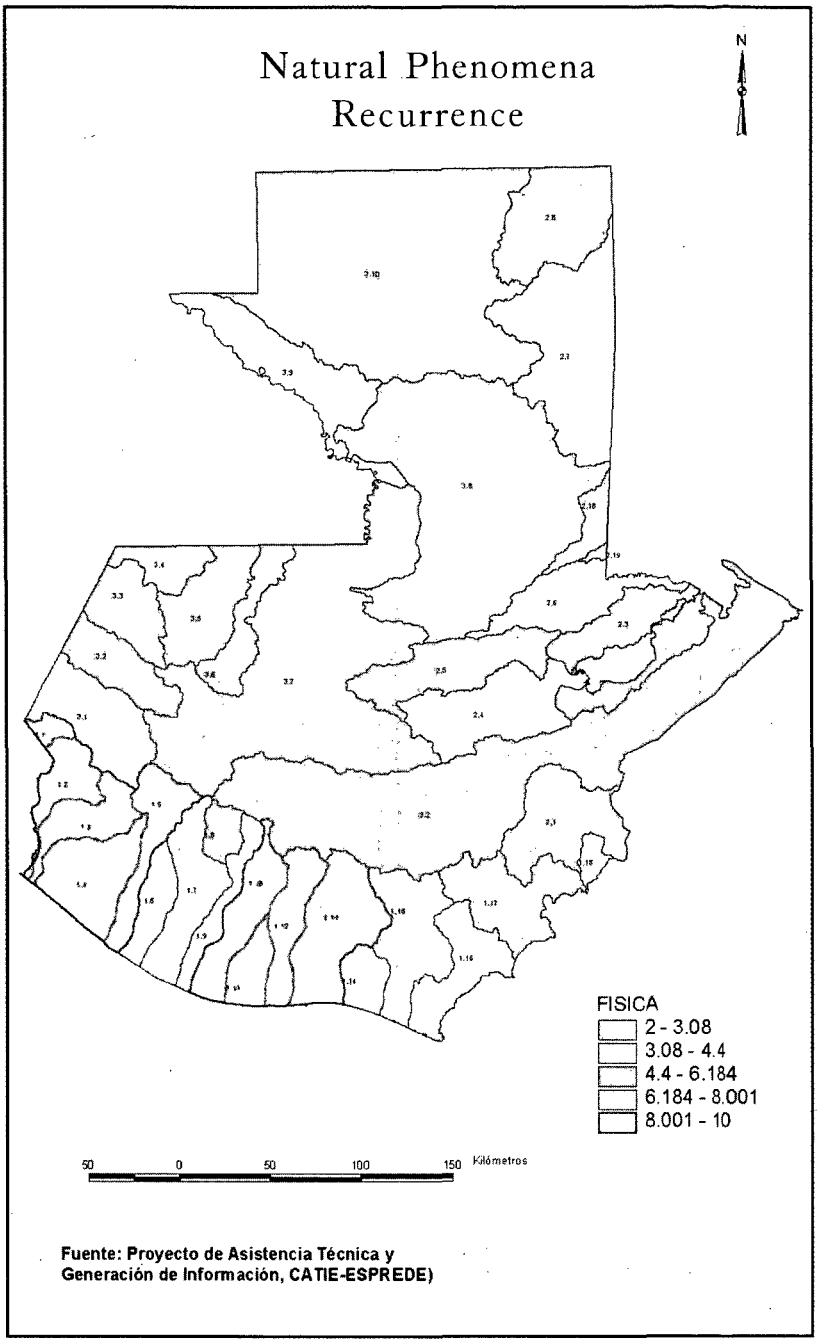
The orographic configuration divides Guatemala´s territory into the Pacific and the Atlantic runoffs. At the same time, the Atlantic runoff is divided into the Gulf of Mexico and the Caribbean runoffs. The Pacific runoff contains 19% of the total runoff, while for the Atlantic runoff is 34%, and, for the Gulf of Mexico slope, the total annual average is 47%. The most voluminous river is the Usumacinta, followed by San Pedro, Pasión, Salinas and Chixoy rivers in the Gulf of Mexico runoff; the Montagua and Cahabón rivers in the Atlantic runoff; and the Paz, Nahualate and Coyolate rivrs in the Pacific runoff. In Guatemala there are more than 300 lakes and lagoons, of which the largest are Izabal lake (590 $km^2$) and the Atitlán lake (126 $km^2$) (Arteaga, 1994).

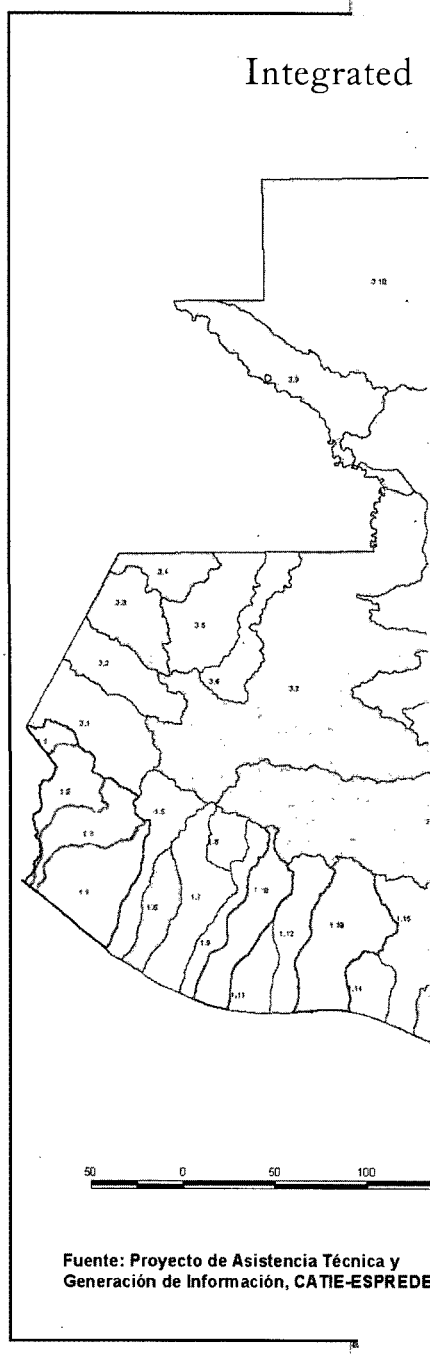
Guatemala's water capital is 12,121 $m^3$ per capita and its withdrawal for household, industrial and agriculture uses is 0.9%. The access of the urban population to improved water sources is 97% (2000). Also, the access of this same population to sanitation systems is 98% in 2000 (World Health Organization, 2000, quoted by the World Bank, 2001).

There are 27 systems of public irrigation built by the government that cover 39,536 acres (20%). Also, 158,144 acres (80%) are irrigated by private systems. The total of lands to be irrigated is 6,177,500 acres.

According to information from 1998, the electric power consumption per capita is 322 kWh. Presently, the electric capacity is 1.030 MW that basically cover the capital city and the urban areas of the country. The biggest hydroelectric power station is *Chixoy* and the country´s hydroelectric resource totals 10.891 MW.

Guatemala lacks a General Law of Water and the ownership of this resource is regulated by the Political Constitution (1985), the Civil Code (1966) and the Law

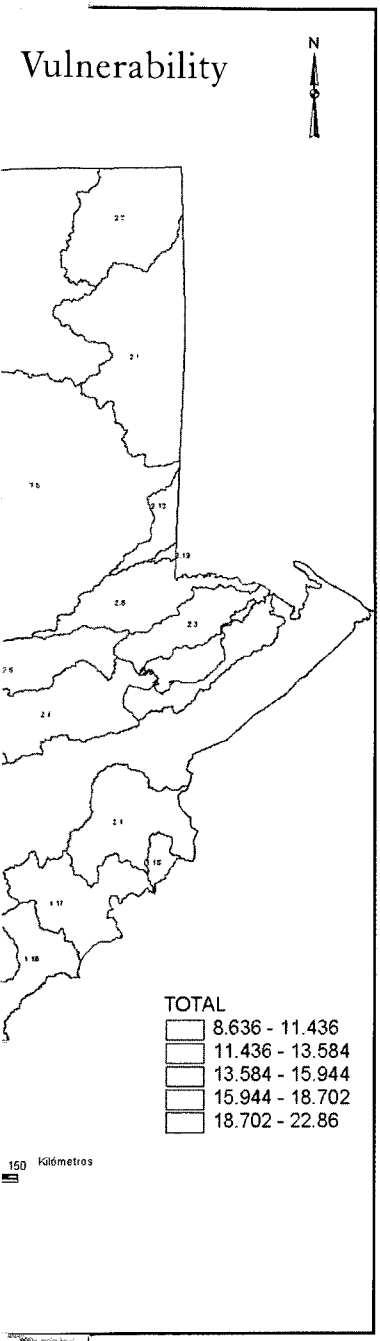


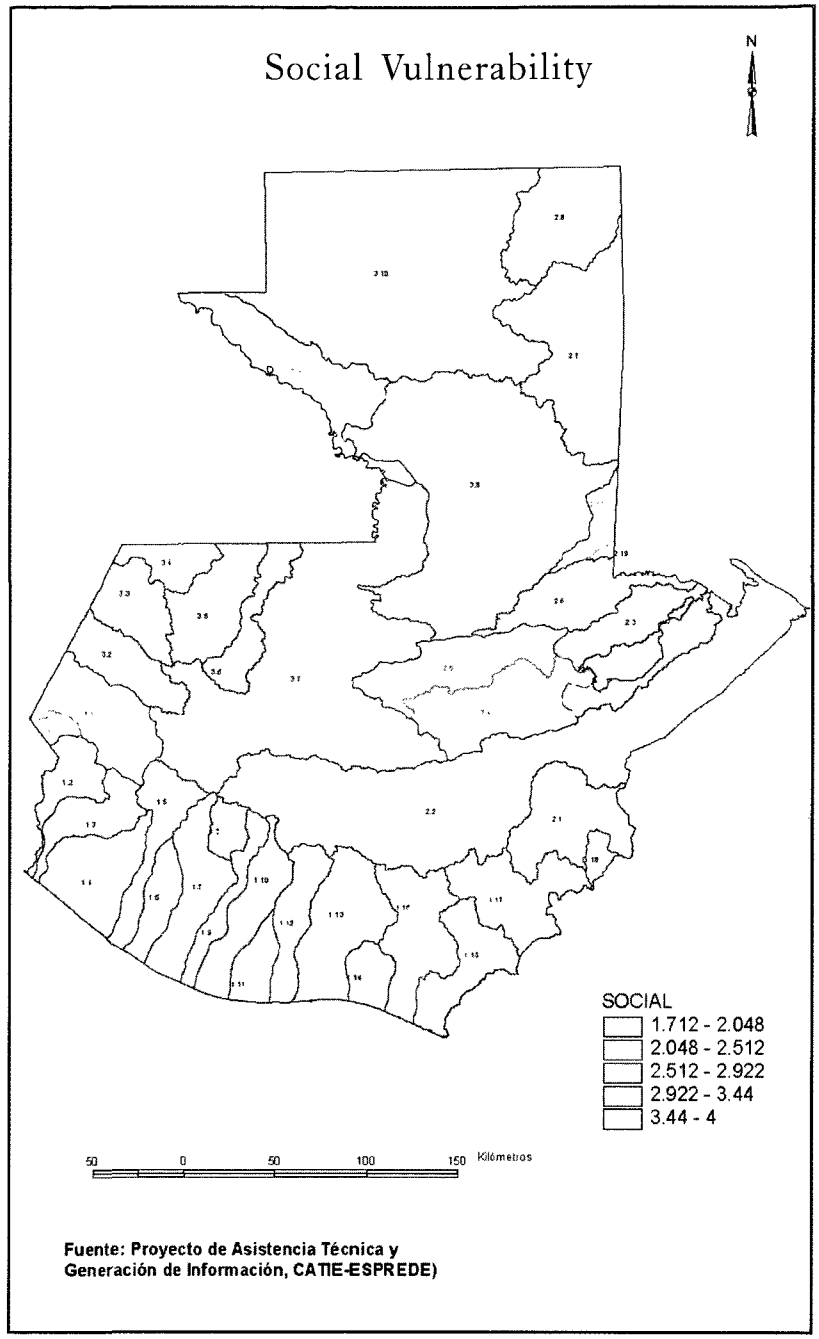




of Expropriation (1845). Water uses are regulated by different laws used by different sectors. For example, the *Instituto de Fomento Municipal* (INFOM) is in charge of drinking water and sanitation issues at the national level. The *Ministry of Agriculture, Livestock and Food* (MAGA in Spanish) leads the water policy (irrigation and hydrobiological resources) with the exception of drinking water, sanitation and hydroelectric issues, which are regulated by the *Instituto Nacional de Electrificación* (INDE).

The Ministry of Public Health's Office of Vigilance and Control is in charge of ensuring that projects fulfill the required sanitation regulations and that a water quality control program be implemented in all the country. Also, the *Comisión Nacional del Medio Ambiente* (CONAMA) oversees after the control of water quality, while the protection of water producing forests is the responsibility of the *Consejo Nacional de Areas Protegidas* (CONAP).

Research on underground waters have been carried out by the *Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología* (INSIVUMEH), the INFOM and the Japan International Cooperation Agency (JICA).




The risk to each of the 38 basins of the country has been estimated from the combination of natural threats, defined by the occurrence of natural phenomena and the environmental, economical and social vulnerability.

In summation, current water use and exploitation systems are obsolete: there are no water laws; the agricultural sector leads the water resources policies while the other sectors are regulated by their own norms; water supply for human consumption is low; there are conflicts among communities that use water for human consumption and those who use this resource for irrigation; and there is a low exploitation of water resources for irrigation and hydroelectric generation. However, there is interest in arriving at an agreement to reformulate the current system into one that promotes the integrated management of water resources. This initiative should be carried out by drafting a policy and designating a leading Organization —autonomous from the rest of the sector— that be supported by the active participation of all users.

# Honduras

Area: 112.000 km$^2$
Population: 6.000.000 inhabitants
Growth Rate of Population: 2.7%
GNI / per capita: US$760
Water resources per capita (1999) : 15.211m$^3$ / capita
Water withdrawal (% of water resource): 1.6%
Urban population access to an improved water source (year 2000): 97%
Urban population access to a sanitation system (year 2000): 94%
Agricultural area (% of the total area): 32.0%
Agricultural contribution to economy (% GDP-1999): 16%
Irrigated agricultural area: 3.7% of total agricultural area
Protected areas (% total area): 6.0%
Forest covered area (% total area, 1999): 29.000 km$^2$, 48.1%
Electric power consumption per capita: 446 KWh, 1998

*Honduras´s Statistics (World Bank, 2000)*

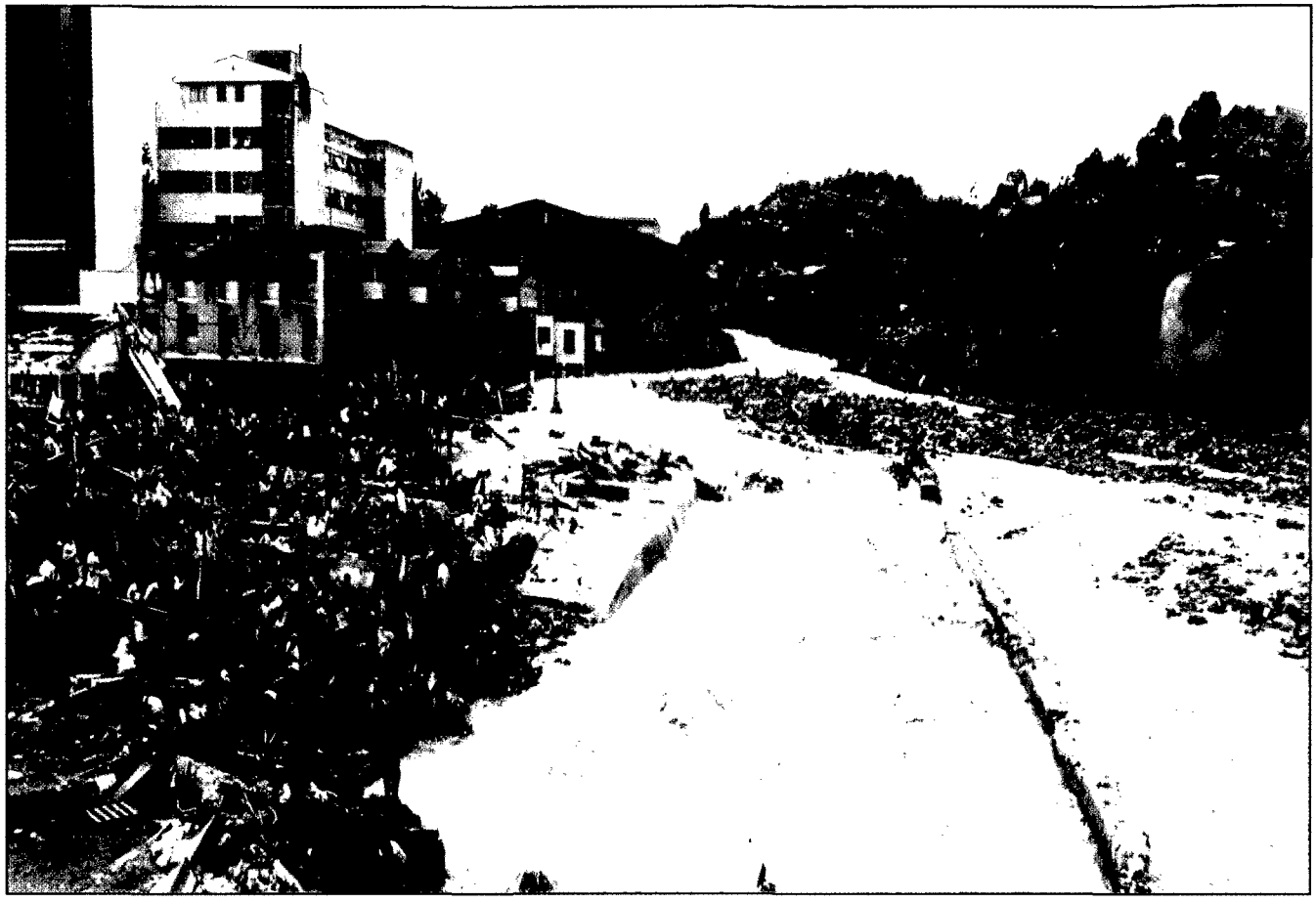
*Hurricane Mitch, Honduras*
*Photography: Jaime Valdés*

## Description

With 112.000 km$^2$, almost all Honduras´ territory is formed by mountains, except for the north coastal zone of the Caribbean and a small part that drains to the Gulf of Fonseca in the Pacific Ocean. In this country, three regions can be identified: high land, 600 meters above sea level with intermountain valleys (80% of whole territory); the valleys between 150 meters above sea level and 600 meters above sea level (16%), and the third region which is formed by even areas that have fair gradients in its coastal valleys (*Valle del Sula* and other valleys to the north, and *Valle de Nacaome* in the Pacific) (Arteaga, 1994).

## Climate

Due to its geographical location, Honduras has a tropical climate. The orography of Honduran territory plays an important role in diversifying its climate, since when this



*Hurricane Mitch, Honduras*
*Photography: Jaime Valdés*

mountain terrain interacts with the atmosphere, general circulation causes different rain systems in the Caribbean and Pacific runoffs and the inter mountainous central zone (Pastrana, 1976, quoted by Argeñal, 2000). On the Caribbean coast, it rains almost all year long. During the period of November-March inclusive, this territory is affected by colds fronts which produce a considerable number of rain storms and low temperatures. The inter mountainous zones have a climate with a precipitation system that presents two clearly defined seasons, the rainy (from May to October) and the dry (from December to March).

As occurs with the precipitation system, the thermal system is determined by the orography of the territory and by meteorological phenomena. Honduras´ warmest zone is the Pacific coastal region, for example Choluteca where, sometimes the higher absolute temperatures reach values over 40°C during the last months of the dry season. The coldest zone is the northern region where minimal temperatures are lower than 5°C, especially at the height of the mountain ranges of El Merendón, Puca Opalaca and Celaque, especially when the cold fronts affect Honduran territory, from December to March, inclusive.

## Demography

Honduras´ population is about 6.000.000 inhabitants showing an annual growth of 2.7% and a population density of 56 inhabitants per km$^2$. In 1999, birth rate was 4.0 children per woman. The average life expectancy increased from 67 in 1999 to 70 in 1999 (World Bank, 2001)

## Economic and sustainable development indicators

The Gross National Income (GNI) per capita is US$760. Honduras´ economy has fluctuated as follows: 0.1% GDP in 1990, 2.9% GDP in 1998 and -1.9% GDP in

1999. This last indicator is highly influenced by the economic effect provoked by Hurricane Mitch in October 1998.

Honduras´ agricultural area represents 32% of the whole territory, of which 3.7% is irrigated. The economic contribution of this sector was 16% of the GDP in 1999. Goods and services exports have increased from 35.4% in 1990 to 49.% in 1999. Likewise, goods and services imports increased from 39.8% in 1990 to a 56.7% in 1999. Honduras has a total forest coverage of 54.000 $km^2$, about 48.1% of its territory. From this area, 6.0% is in some way under some protection. The deforestation rate was 1.0% in 1999.

Situation of the water resources

The Honduras water capital is 15,211 $m^3$ and its withdrawal for household, industrial and agricultural uses is 1.6%. Access of the urban population to improved water sources was 97% in 2000. For this same year, the access of urban population to sanitation systems was 94%. (World Health Organization, 2000, quoted by World Bank, 2001).

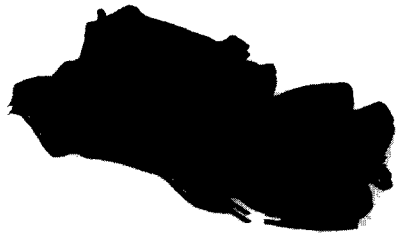
In terms of its hydrography, the territory has been divided into 19 main basins, which include the transnational ones shared with Guatemala, El Salvador and Nicaragua. The largest basins flow into the Caribbean , the most important of which are the Ulúa river (22.800 km) with annual average flows of 360 $m^3/s$, the Patuca river (23,898 $k^2$) with 407 $m^3$ p/s, and the Aguán river (10,266 $k^2$) with 182 $m^3/s$. Flowing the Gulf of Fonseca, is the Choluteca river with 7580 $km^2$ and 84$m^3/s$. Basins that flow into the Pacific are the most deteriorated and with the lower hydric wealth, representing 12% of the national territory (Arteaga, 1994).

In Honduras, the institutional and legal framework of water resources is being restructured. The objective is to promote user participation, especially through an organization that considers the basin as the resource management unit. Another objective is to establish an integral administration of those hydrographic basins with greater problems, such as the Choluteca, Chamelecón, Cangrejal and Ulúa rivers.

The goals and priorities of Honduras regarding the water resource include development of irrigation projects that cover about 39,536 acres. The private sector will be both encouraged to develop secondary, tertiary and productive infrastructure at large and small irrigation projects, by offering long term credit incentives, investment security, and technical assistance. In addition, micro irrigation and drinking water projects, using the methods of co-participation by community and Government, will be supported. All these projects will be managed by their users.

Also, to supply a population of 153.000 inhabitants of urban-marginal sectors, the capacity of the Concepción reservoir will be increased by 3.6 million of cubic metres. Furthermore, will be developed a project to increase the capacity of the secondary water conduit in marginal suburbian zones of the capital city.

In addition to these plans, the following policies and goals will be promoted: an Irrigation and Drainage Master Plan which intends over a period of 25 years to achieve the incorporation of 29,997.5 acres into agricultural irrigation in agreement with the need for increasing agricultural production for domestic consumption, exportation and development of water resources in those areas requiring lower investment. Regarding the legal framework, there is already a proposal from the Secretariat of Natural Resources and Environment to update the legislation related to water issues by giving it a modern legal, technical and institutional modern framework for the integrated development of water resources.



# El Salvador

Area: 21.000 km²
Population: 6.000.000 inhabitants
Growth Rate of Population: 2.0%
GNI / per capita: US$1.920
Water resources per capita (1999) : 2.876m³ / capita
Water withdrawal (% of water resource): 4.1%
Urban population access to an improved water source (year 2000): 88%
Urban population access to a sanitation system (year 2000): 88%
Agricultural area (% of the total area): 77.4%
Agricultural contribution to economy (% GDP-1999): 10%
Irrigated agricultural area: 4.4% of total agricultural area
Protected areas (% total area): 0.3%
Forest covered area (% total area, 1999): 1.000 km², 4.6%

*El Salvador´s´ Statistics (World Bank, 2001)*

*Laguna Llanos del Espino, El Salvador*

## Description

El Salvador (21.000 km²), is orographically divided into three regions: the mountain north region (1,200–2,700 meters above sea level) with narrow valleys and glens, *the Meseta Central* with valleys and high plateaux (800–1,200 meters above sea level) and the coastal region of the Pacific coast (0 – 800 meters above sea level).

## Climate

In the northern mountain region, average temperatures vary between 10°C to 16°C, in the *Meseta Central* vary from 19°C to 22°C, and in the coastal region of the Pacific coast the climate is warmer and humid and temperatures vary from 22°C to 28°C. The country's average precipitation is 1,180mm per year, which varies over the coastal plain zone (1,500 mm per year) and the mountain north region (2,800 mm per year). The dry season extends from November to April while the

rainy season is from May to October. 3% of the rain falls in to the dry season, and the remaining 97% occurs in the rainy season.

## Demography

El Salvador´s population is about 6,000,000 with an annual growth of 2% and a population density of 297 inhabitants per km$^2$. The birth rate for 1999 was 3.2 children per woman and the average rate of life expectancy has increased from 66 in 1990 to 70 in 1999 (World Bank, 2001).

## Economic and sustainable development indicators

The Gross National Income (GNI) per capita of El Salvador is US$1,920, and its economy has varied as followed: 4.8% GDP in 1990, 3.5% in 1998 and 3.4% GDP in 1999.

The agricultural area of El Salvador corresponds to.4% of its territory, of which 3.4% is under irrigation. The economic contribution of this sector was 10% of the GDP in 1999. Export of goods and services has increased from 18.5% in 1990 to 24.8% in 1999. At the same time, imports of goods and services have increased from 31.2% in 1990 to 36.9% in 1999.

El Salvador has a total forest coverage of 1.000 km$^2$, 5.8% of its territory, of which 0.3% is protected in some way. The deforestation rate was 2.3% in 1999.

## Water Resources Situation

The water capital of El Salvador is 2.876 m$^3$ per capita and its withdrawal for household, industrial and agricultural use is 4.1%. The access of the urban population to improved water sources was 88% in 2000. Likewise, for this year, the access of the urban population to sanitation was 88% (World Health Organization, 2000, quoted by World Bank 2001).

Hydrographically speaking, all of El Salvador´s rivers flow into the Pacific Ocean. This country can be divided into 10 small systems from which the largest and most important is the *Lempa* river basin (10,000 km$^2$) which covers a distance equivalent to 49% of the whole territory. In terms of length, this river is followed by the basins of the *Grande de San Miguel* river (2,259 km$^2$), The *Jiboa* river (1,717 km$^2$), *Goascorán* river (1,316 km$^2$, this river is shared with Honduras) and the *Paz* river, shared with Guatemala, covers 958 km$^2$ in Salvadorian territory. The artificial reservoirs of the *Cerrón Grande, 5 de noviembre* and *15 de setiembre* hydroelectric projects are all located within the *Lempa´s* river course. This river constitutes the main energy and hydric wealth of the country, which is equivalent to 72%. It is estimated that the amount of water drained from soil in the territory is equivalent to 18.000.000 m$^3$ per year, representing 33% of the total rain average. (Arteaga, 1994)

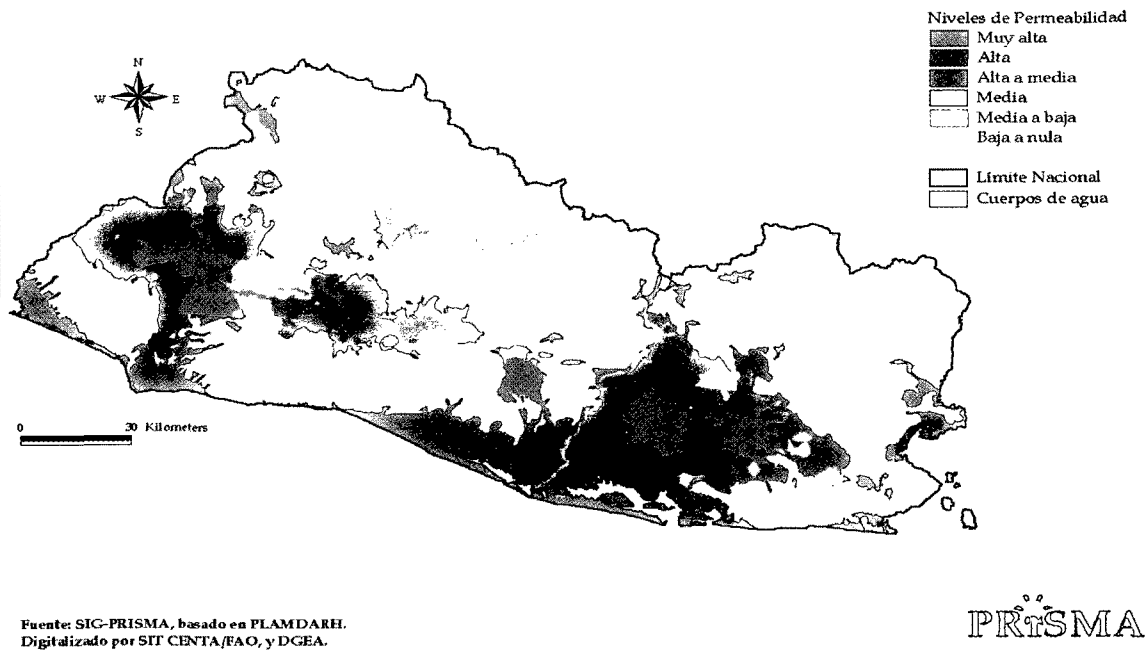
Considering the physical borders of the hydrographic basins, the area of the bordering basins represents almost 50% more of the national territory , which flow means 34% of the available water at the national level. About 28% of the *Lempa* river's water comes from Honduras and Guatemala, and 34% of El Salvador's available water comes from these two countries.

The lack of treatment of residual household, industrial and agroindustrial waters affects the quality of the country's most important water source, the *Lempa* river. Also, this river's geographic location and its flow towards the sea facilitates the distribution of pollutants in its water through the whole national territory.

| POPULATION DISTRIBUTION | |
|---|---|
| ZONE | PORCENTAGE |
| SOUTH WESTERN | 74 |
| EASTERN | 18 |
| NORTH | 8 |

| DRINKING WATER AVAILABILITY IN URBAN AND RURAL AREAS | |
|---|---|
| AREA | %OF PEOPLE WHO HAVE ACCESS TO DRINKING WATER IN ACEPTABLE CONDITIONS |
| URBAN | 55.9 |
| RURAL | 13.3 |

**Mapa Hidrogeológico de El Salvador**




Fuente: SIG-PRISMA, basado en PLAMDARH.
Digitalizado por SIT CENTA/FAO, y DGEA.

PRISMA

One of the main actions, to the future development of the water resources of El Salvador is to diminish polluting agents coming from the different uses given to water. In this way, the possibility of water as a transmitting agent of illnesses such as cholera, diarrhoea, etc. will be minimized. All of these illness represents a very high percentage of child mortality in the country.

## Water Resources Management

In El Salvador, it is not possible to talk about a coherent water management policy since the exploitations of water resources has been influenced by economic, social and political factors in different regions. Furthermore, the development model of renewable natural resources which has been used dated from the 50's and 60's when development and management were centralized.

Actually, a new policy on water resources has been proposed. Its objective is to achieve an equitable availability and sustainable exploitation of water resources, through a sustainable environmental management of the national supply, considering social and economic requirements regarding quality, quantity and distribution.

Specifically, this new policy hopes to achieve efficient availability, facilitating water resource development. This initiative will be carried out by supporting an integrated management system based on the knowledge of the occurrence and use of water (both in quantity and quality), promoting and facilitating private and communal water users´ participation in its planning, development and administration. At the same time appropriate economic value to the resource.

It is also necessary to guarantee the protection of the water bodies, aquifers and refill zones by providing the necessary legislation to promote respect for conservation and by facilitating basin management through emphasis on soil and vegetation coverage management. This will facilitate research and technology transfer and provide the necessary information and knowledge about the resources management. At the same time, this policy should achieve the sustainable use and the establishment and consolidation of Organizational and institutional improvement of the sector.

# Nicaragua

Area: 130.000 km²
Population: 5.000.000 inhabitants
Growth Rate of Population: 2.6%
GNI / per capita: US$410
Water resources per capita (1999) : 38.668m³ / capita
Water withdrawal (% of water resource): 0.7%
Urban population access to an improved water source (year 2000): 95%
Urban population access to a sanitation system (year 2000): 96%
Agricultural area (% of the total area): 62.3%
Agricultural contribution to economy (% GDP-1999): 32%
Irrigated agricultural area: 3.2% of total agricultural area
Protected areas (% total area): 7.5%
Forest covered area (% total area, 2000): 33.000 km², 27%
Electric power consumption per capita: 281 KWh, 1998
CO2 emissions per capita (Metric tons / per cap.) 0.8 (1990)

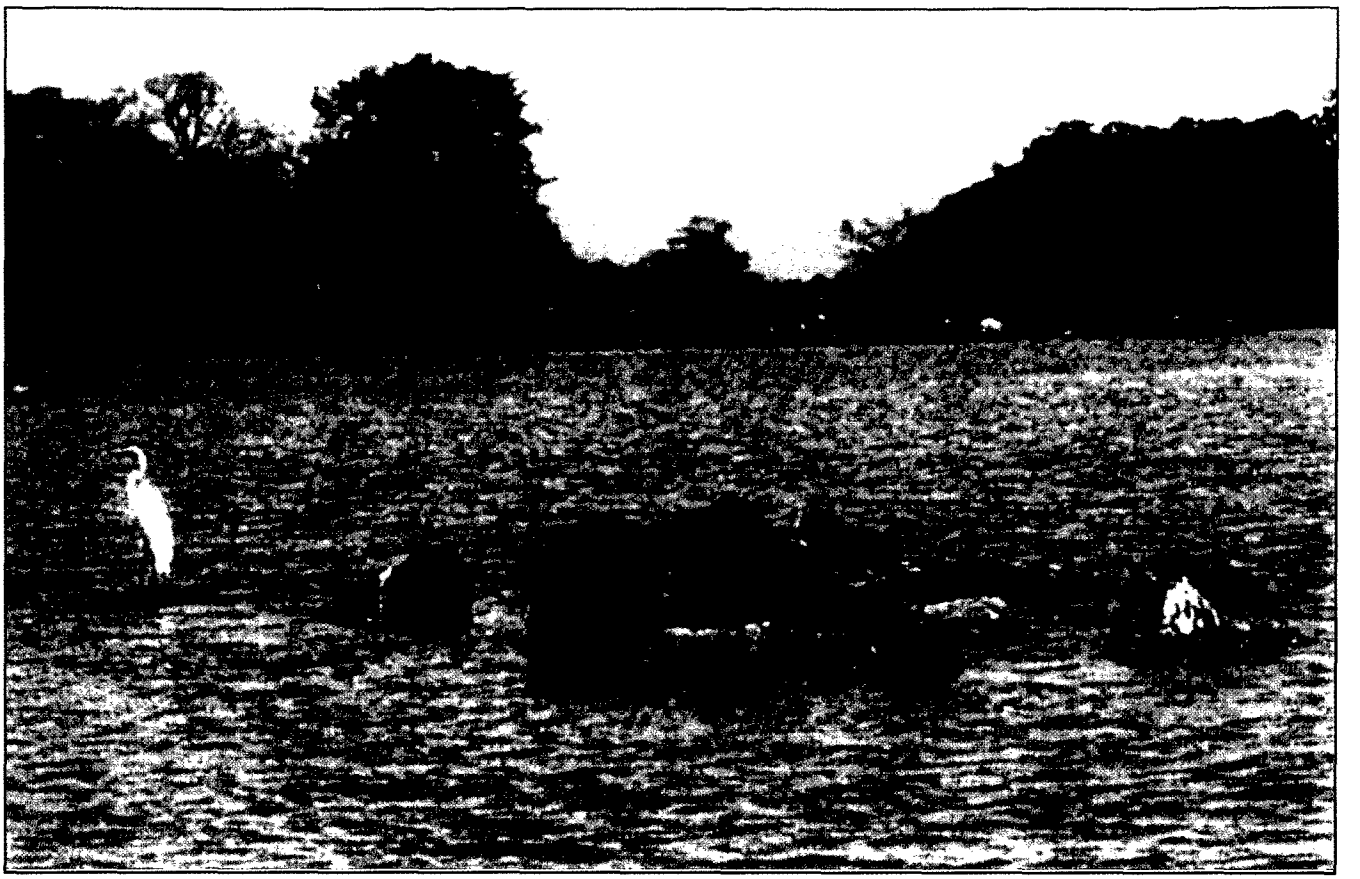
*Nicaragua´s Statistics (World Bank, 2000)*

*San Juan River, Nicaragua*
*Photography: Rocío Córdoba, IUCN*

## Description

Nicaragua, the largest Central American country, with a territory of 130.000 km², is geographically located in the middle of the Isthmus.

Nicaragua´s orography divides its territory into three regions: The Pacific (38.700 km²), a territory of small basins and rivers that cover short distances whit the highest population density. The Central region (42,400 km²) contains gradient plateaux and forms the medium and high sides of the largest basins of the rivers that flow into the Caribbean. The Atlantic region (46,600 km²) into which most of the surface resources flow.



*Lake of Nicaragua*
*Photography: Enrique Lahmam, UICN*

## Climate

Precipitation on the Pacific runoff varies from 500 mm to 1.000 mm per year and in this slope 200 $m^3/s$ are drained (4%). On the Atlantic or the Caribbean, average rain fall is 4.000 mm per year with a drainage of 5.300 $m^3/s$ (96%), making a clear difference regarding surface waters between both runoffs.

## Demography

Nicaragua has about 5,000,000 inhabitants with a annual growth of 2.6% and a population density of 41 inhabitants per $km^2$. Its birth rate in 1999 was 3.6 children per woman and the average life expectancy has increased from 64 in 1990 to 69 in 1999 (World Bank, 2001).

## Economic and sustainable development indicators

The Gross National Income (GNI) per capita is US$410, with an annual increase of the economy of 7.0% of the GDP in 1999. The agricultural area corresponds to 62.3% of the total territory of which 3.2% is irrigated. The economic contribution of this sector reached 32% of the GDP in 1999.

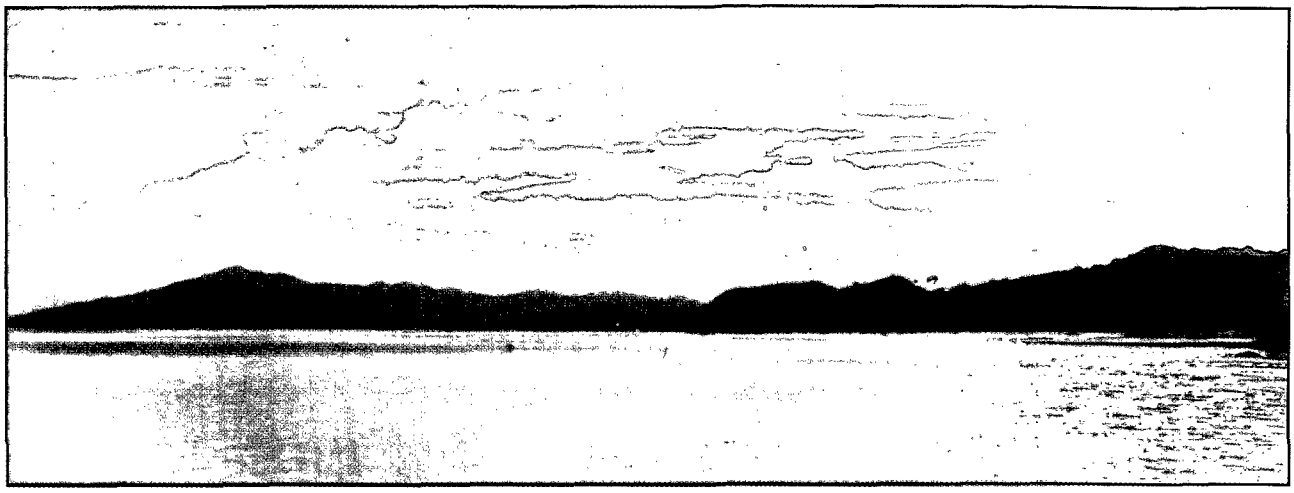
Goods and services exports have increased from 2.4% in 1990 to 33.6% in 1999. Also, goods and services imports have increased from 46.3% in 1990 to 88.7% in 1999.

Nicaragua has a total forest coverage of 33.000 $km^2$, about 27% of its territory. 7.5% of this forest is protected in some way and the deforestation rate, for the period 1990-2000, was 3.0%.

## Water Resources Situation

The water capital of Nicaragua is 38.668 $m^3$ per capita and its withdrawal for household, industrial and agricultural uses is 0.7%. The access of the urban population to water sources was 95% in 2000. Likewise, for this year, the access of the urban population to sanitation systems was 96% (World Health Organization, 2000, quoted by World Bank 2001).

Hydrographically, the country is divided into 21 basins, from which 8 flow into the Pacific (10% of the territory) and 13 into the Atlantic (90% of the territory). The Coco´s river basin (24,476 $km^2$) is shared with Honduras (21%) and the San Juan´s (41.870 $km^2$) with Costa Rica (32%). Those rivers are the most voluminous and important and



*San Juan River, Nicaragua*
*Photography: Rocío Córdoba, IUCN*

Drinking water and sanitation subsector:
The drinking water availability for the rural area is 30% and for the urban area is 70% (data of 1997). The urban population represents 40% of the total population of the country.

Power subsector:
The hydroelectric generation of power represents 25.6% of the total generation. The resources of hydroelectric power amounts to 1,767 MW. Nowadays, the generated hydroelectric power does not exceed 6% of these resources.

Irrigation subsector:
At the national level there is an area of 1,729,700 acres that is potentially irrigable located under 100 meters above sea level. Presently, 74,130 acres are being irrigated, which represents only 4% of the potential area.

Conservation subsector
As a result of erosion, sediments have been deposited in the flows and mouths of the biggest lakes, lagoons and rivers.

both flow into the Caribbean. In order of importance, there are the Prinzapolka, Grande de Matagalpa and Escondido rivers, whose basins are about 11.000 km$^2$. The rest of the hydrographic system is formed by smaller basins, lower than 3.000 km$^2$ that flow into the Pacific (Arteaga, 1994).

Electric power generation in Nicaragua represents 25.6% of the total energy generation and the consumption per capita is 281kWh (World Bank, 1998). The huge hydric capital of Nicaragua, especially in its Caribbean runoff, brings its hydroelectric energy resources to 1,767 MW. Nowadays, the generated hydroelectric power does not exceed 6% of these resources.

The institutional framework of Nicaragua´s water resources, and the functions of water use and management were laid out by laws as to the competence and attribution of an existing institutional framework. In this manner, different ministries and autonomous entities of the State fulfil the requirements established by primary laws, organic laws and other special laws related to water resources issues.

Nicaragua already has an Action Plan for Integral Water Management (PARH), the Government has not implemented. As a result, the country lacks an approved General Water Law and a Water Authority in charge of executing that law; so, in the short and medium terms, all the actions proposed at the PARH could be implemented pending political will. Inevitably, this implementation will bring about, in the long term, a rational and sustainable resource management. Based on the above, it is clear that Nicaragua is still struggling with a divided and un-coordinated management.

With respect to the legislative framework, Nicaragua's Political Constitution establishes that natural resources belong to the State patrimony and that the State has the duty to preserve and conserve them. The Constitution also indicates that the State can sign contracts for rational exploitation of natural resources when the national interest so requires. This concept confirms the State role as the keeper or manager of the national water resources.

In another context, the present Civil Code, enacted before modern concepts of integral water management, contains norms that recognize water as public property but subject to specific rules related to private ownership of land. The Civil Code establishes the right to use water resources by people who need them, prohibits the change of rivers flow, guarantees the right of way and recognizes the right of conveying water through third party properties.

In 1996, the General Law of Environment and Natural Resources was passed. This Law confirms that water is a public good and establishes the basis for water resource administration under the principle of requesting previous authorization for using these resources. This Law refers to all those issues related to its implementation and the definition of the competitive authority to a special law, the General Water Law.

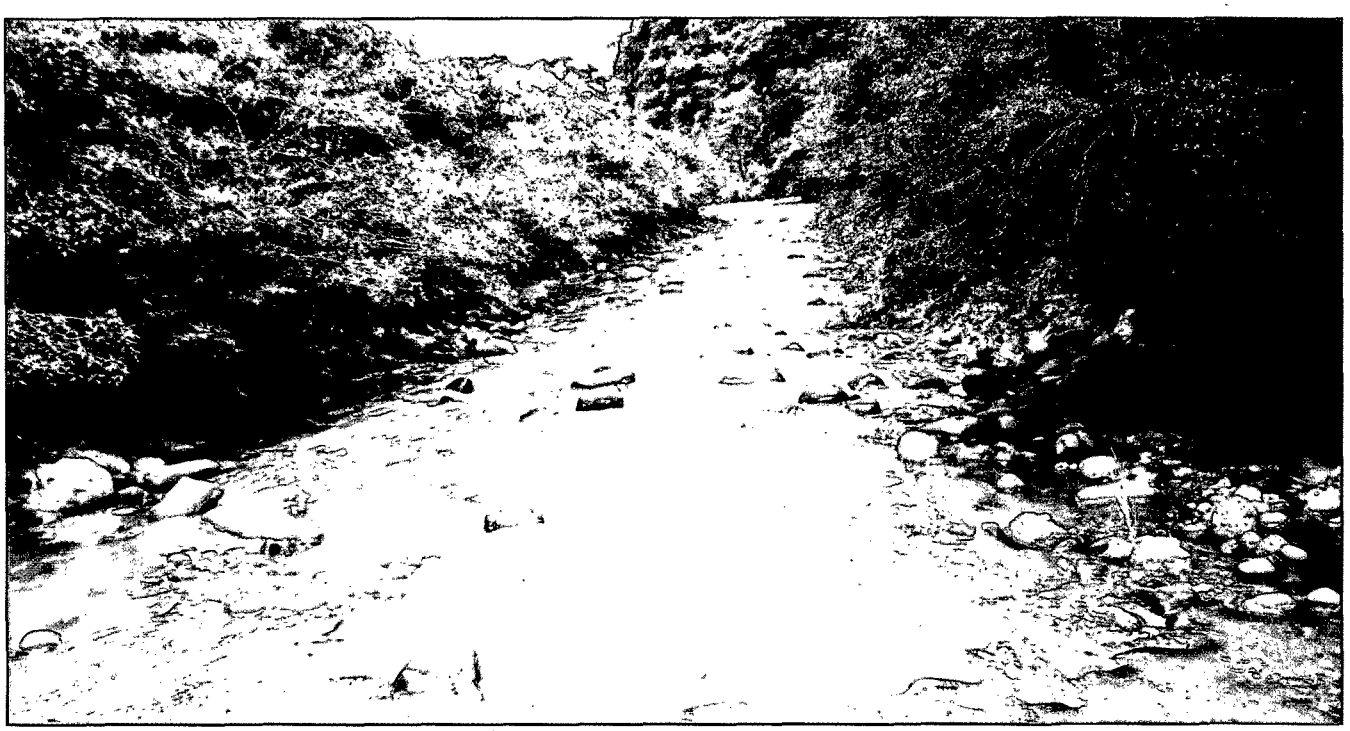
In Nicaragua, the lack of a national water policy, that highlights the way for integrated management, has provoked the present degradation of the most important water bodies of the country, both surface and underground. Also, many conflicts among small and large users remain unsolved. In the face of this problem and as a way of seeking its solution, the *Comisión Nacional de Recursos Hídricos* (CNRH) managed and monitored the elaboration of the PARH, which also included a proposal for a national water resources policy. This proposal defines the main objectives that would result in sustainable management and use of water. Likewise, this proposal establishes strategic guidelines to be applied to accomplish those objectives.

Recently, the Law of Organization, Competence and Procedures of Nicaragua´s Executive has been approved. It is expected that the proposals of this Law would carry out a substantial transformation in the governmental structure (State apparatus). Regarding water issues, it establishes a set of regulatory mechanisms that give economic value to a resource for its use, as if this resource were another row material of the production processes in which water is present. In respect to the initial project of the General Water Law drafted by the PARH, it is been revised by the CNRH to be later considered by the National Assembly for its approval.

# Costa Rica

Area: 51.000 km²
Population: 4.000.000 inhabitants
Growth Rate of Population: 1.8%
GNI / per capita: US$3.570
Water resources per capita (1999) : 31.318m³ / capita
Water withdrawal (% of water resource): 5.1%
Urban population access to an improved water source (year 2000): 98%
Urban population access to a sanitation system (year 2000): 98%
Agricultural area (% of the total area): 55.7%
Agricultural contribution to economy (% GDP-1999): 11%
Irrigated agricultural area: 25% of total agricultural area
Protected areas (% total area): 142%
Forest covered area (% total area, 2000): 20.000 km², 38.5%
Electric power consumption per capita: 1.450 KWh, 1998
CO2 emissions per capita (Metric tons / per cap.) 1.6 (1998)

*Costa Rica´s Statistics (World Bank, 2000)*



*Cartago, Costa Rica*
*Photography: J. Rivera*

## Description

The territory of Costa Rica is about 51.000 km² and it is divided into two runoffs, the Caribbean and the Pacific, and into three range mountains, Guanacaste, Central and Talamanca.

## Climate

The Pacific slope has two clearly defined seasons, the rainy season (May to November) where October is the month with the highest precipitation, and the dry season (December to April). The Caribbean runoff is characterized by the presence of a rainy season during the entire year, where December is the month with the highest level of precipitation. In this region, the humidity rate is high and there are no water deficits, even in the driest months the average rainfall reaches 200 mmm (Arteaga, 1994).

## Demography

Costa Rica' population is about 4.000.000 with a annual growth rate of 1.8% and a population density of 70 inhabitants per km$^2$. Its birth rate in 1999 was 2.5 children per woman and the average life expectancy was 77 in 1999. (World Bank, 2001).

## Economic and sustainable development indicators

The Gross National Income (GNI) per capita is of US$3.570, the highest of the region. Economy has grown from 3.6% of the GDP in 1990 to 8.0% of the GDP in 1999.

The agricultural area corresponds to the 55.7% of the total territory from which 25% is irrigated. This area is located along the regions with the highest hydric shortage, and this situation contributes to reduce losses during severe dry seasons. The contribution of this sector to the economy of the country reached 11% of the GDP in 1999.

Goods and services exports have increased from 34.6% in 1990 to 53.7% in 1999. Goods and services imports have fluctuated as follows: 41.4% in 1990, 88.7% in 1999 and 47.2% in 1999.

Costa Rica has a total forest coverage area of 20.000 km$^2$, about 38.5% of its territory. The 14.2% of this forest is protected in some way and the deforestation rate was 0.8% in 1999.

## Water Resources Sitation

The water capital of Costa Rica is 31.318 m$^3$ per capita and its withdrawal for household, industrial and agricultural uses is 5.1%. The access of the urban population to improved water sources was 98% in 2000. Likewise, for this year, the access of the urban population to sanitation systems was 98% (World Health Organization, 2000, quoted by World Bank, 2001).

Hydrographically, the country is divided into 34 basins, half of them flows into the Pacific and 17 into the Caribbean, 10 in a direct way and 7 through the San Juan river, bordering Nicaragua. The rivers with the biggest water volume are those located on the Caribbean runoff. Rivers of the Pacific slope suffer higher reduction of their flow during the dry months. For this reason, the highest percentage of water availability in the territory occurs in the Caribbean runoff. The most important basins that flow into the Caribbean are those that belong to the *Sapoa-Zapote*, *Frío*, *San Carlos* and *Sarapiquí* rivers, to the tributaries of the *San Juan* river and to the *Tortuguero*,

| | | | |
|---|---|---|---|
| Population | 4.000.000 | | 5.203.055 |
| Rate of growth | 2.15% ↑ | Rate of urban growth | 2.07%↑ |
| Urban population (1995) | 1.419.400 | Urban population ( 2020) | 2.601.528 |
| GDP (1997) | $9.258.900 | GDP per capita (1997) | $2203 |
| Area | 51.100 km$^2$ | | 70 in habitants p/km$^2$ |
| Total volume of available | 112.4 km$^3$ | Total volume of water | 9.9 km$^3$ |

| Water uses (with respect to total used volume) (2) | | Population access (1) | |
|---|---|---|---|
| Agriculture | 23.3% | Drinking water | Sanitation |
| Industry | 1.96% | | |
| Household/Municipal | 3.7% | Rural | 82.2% |
| Hydroenergy | 70.95% | | |
| Turism | 0.1% | Urban | 97.5% |

(1) Main indicators of Costa Rica, MIDEPLAN

(2) Water budget of Costa Rica: Estimation of supply and demand. Edmundo Castro, Gerardo Barrantes, June 1992.

*Reventazón*, *Pacuare*, *Chirripó* and *Sixaola* rivers (this last one bordering Panama). At the Pacific slope, the *Tempisque*, *Bebedero*, *Grande de Térraba* and *Grande de Tárcoles* river basins are the most important (Arteaga, 1994).

In general, the main problems of the national water sector are:

- An un-integrated vision of resource management, since each institution works individually.
- A divided and obsolete legal framework.
- Use of the resource without applying any concept of solidarity among users.
- A lack of knowledge about the country´ water situation. There is an absence of real knowledge about national water availability (quantity and quality).
- The water resources have not been properly valued.
- Excessive demand of water resources from productive activities which endangers water availability.
- Increasing water demand.
- There are no policies aimed at regulating a change in the use of land.

*San Carlos, Costa Rica*
*Foto: J. Rivera*

Regarding the water resources policies established at the National Development Plan 1998-2002, it consideres the following strategic objective: "To guarantee the protection of water resources intended to supply the different national development activities with water in a sufficient quantity and quality". In order to achieve this objective, the Plan proposes three specific policies containing a set of general programs and actions as follows:

1. Ordinance and planning of water use for national development.

    - To strengthen the Ministry of Environment and Energy's National Water Office as the leading institution for planning and supervising national water resources.
    - To establish the Water Resources Ordinance National Plan.
    - To draft the national strategy for water resource management and use.
    - To develop and accomplish studies about environmental impact at public and private projects that use water resources.
    - To strengthen inter institutional and civil society initiatives intended for the integral management and planning of hydrographic basins.
    - To develop a national plan to collect, dispose and treat wastewater or sewage water.

2. Include costs related to water protection into the costs of goods and services

    - To look deeply into environmental and economic studies that may determine the real value of water resources.
    - To include the actual value of water into the fees of goods and services produced and supplied by public institutions.
    - To be aware of the environmental damage cost caused by the production of goods and services in which water is used.

3. Promote the ordinance and use of sea water.
   - To draft the Ordinance Plan for using sea water and protecting ecosystems.
   - Ordinance and rehabilitation plan for the Golfo de Nicoya.
   - Management and ordinance plan for the Golfo Dulce.

It is intended, also, to continue controlling and diminishing rivers water pollution by controlling the branches that flows into them. This task would be under the charge of the Ministry of Health in coordination with the ICAA, and, at the same time, this process would involve local governments and private sector.

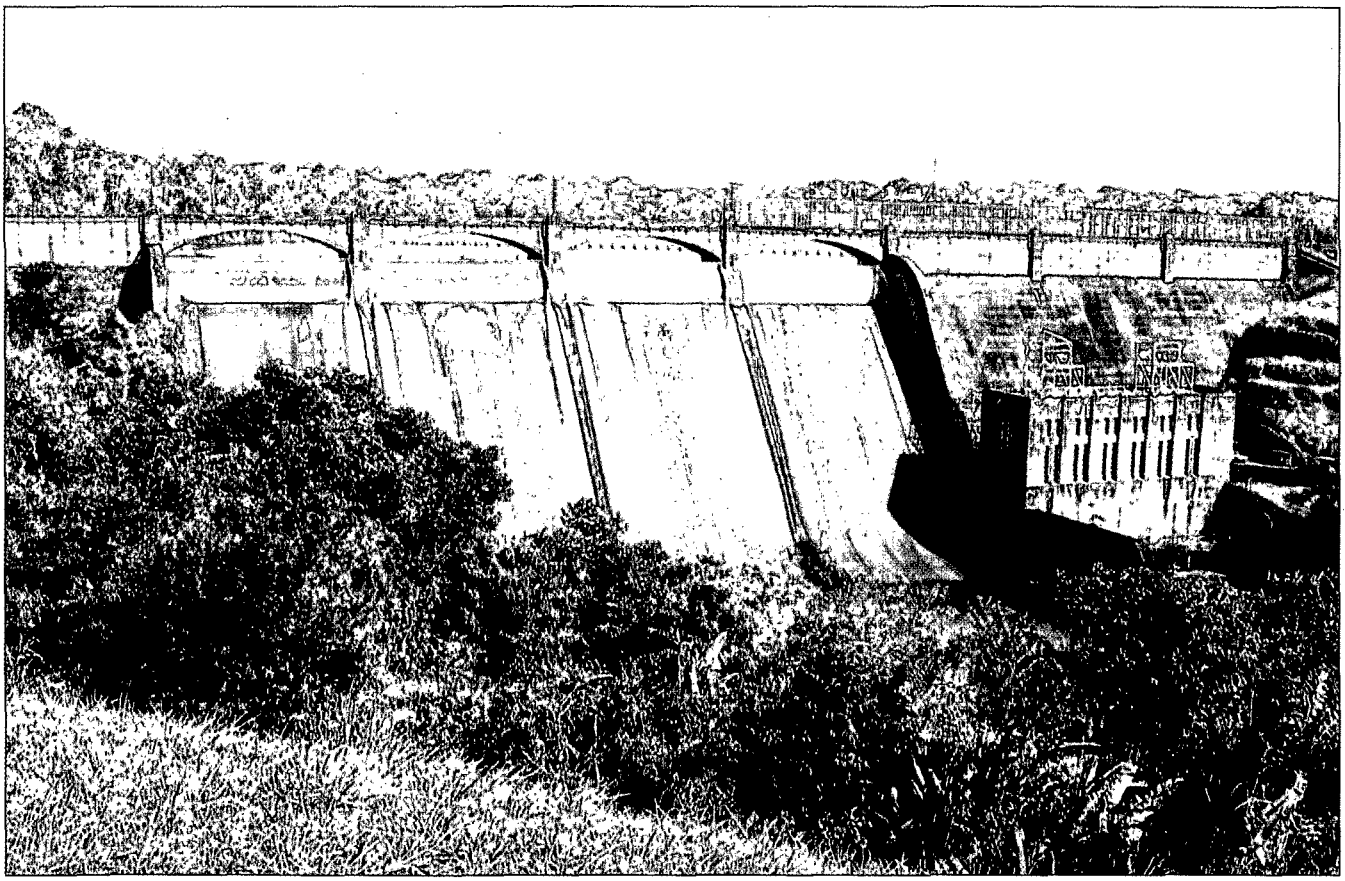
| | | | |
|---|---|---|---|
| Theoretical hydroelectric: | 25.450 MW | Total capacity installed | 1.701 MW (2000) |
| Hydroelectric economic power (that could be generated) | 10.000 MW | Hydroelectric capacity installed by ICE | 1.090 MW (2000) |
| | | Private hydroelectric power | 138,3 MW (2000) |
| Total annual production | 6.933 GWh (2000) | Total hydroelectric capacity | 1.220 MW (2000) |
| ICE annual production | 5.691 GWh (2000) | Percentage of hydroelectric production from the hydroelectric power with respect to installed capacity | 82% |
| Private generation | 1.357 GWh (1999) | With respect to actual power generation | 10% |

Source: Sectorial Office of Energy and ICE

# Panamá

Area: 76.000 km$^2$
Population: 3.000.000 inhabitants
Growth Rate of Population: 1.7%
GNI / per capita: US$3.080
Water resources per capita (1999) : 52.437m$^3$ / capita
Water withdrawal (% of water resource): 1.1%
Urban population access to an improved water source (year 2000): 88%
Urban population access to a sanitation system (year 2000): 99%
Agricultural area (% of the total area): 28.6%
Agricultural contribution to economy (% GDP-1999): 7%
Irrigated agricultural area: 4.9% of total agricultural area
Protected areas (% total area): 19.1%
Forest covered area (% total area, 2000): 29.000 km$^2$, 386%
Electric power consumption per capita: 1.211 KWh, 1998
CO2 emissions per capita (Metric tons / per cap.) 2.9 (1998)

*Panama 's Statistics (World Bank, 2000)*



*Madden dam – Alajuela lake, Panamá*
*Photography: R. Palavicini*

## Description

The territory of Panamá is 76.000 km$^2$ and it is located in the narrowest strip of the Central American Isthmus. Orographically it is formed by a mountain range that begins in *Chiriquí* volcano (3,475 meter above sea level) and crosses the country from west to east up to the eastern province of *Darién*, bordering Colombia. In this place, mountain range is called *Cordillera de San Blas* and it brings close the Caribbean . This orographic formation separates the Caribbean runoff to the north from the Pacific slope, located to the south (Arteaga, 1994).

*Bocas del Toro Archipelago, Panama*
*Photography: R. López*

## Climate

Panama is not directly affected by tropical storms and hurricanes originating in the Atlantic; however, it is severely influenced by the movements of Intertropical Convergence Zone which provokes high rates of annual precipitation resulting in an increment in the rivers flow and in the considerable hydric wealth of this country. Panama shows an annual rate of rains up to 5.000 mm in the central region and 6.000 mm in the *Península Valiente*. Also, in the Costa Rica-Panama border, at the *Bocas del Toro* and *Chiriquí* provinces, presents a night-month rainy season with an annual rate of precipitation of 7.000 mm. At the eastern extreme of *Darién* province, precipitation exceeds 4.000 mm.

Climates classified between humid tropical, fairly humid and dry are common in low plains, while in high land it is common to have climates between temperate humid to fairly humid. At the *Coclé* province and the *Península de Azuero*, also known as *Arco Seco*, the climate is dry tropical with precipitation lower to 1.500 mm per year, that characterizes this region as dry and with a shortage of surface and ground waters, compared to the abundance in the rest of the country.

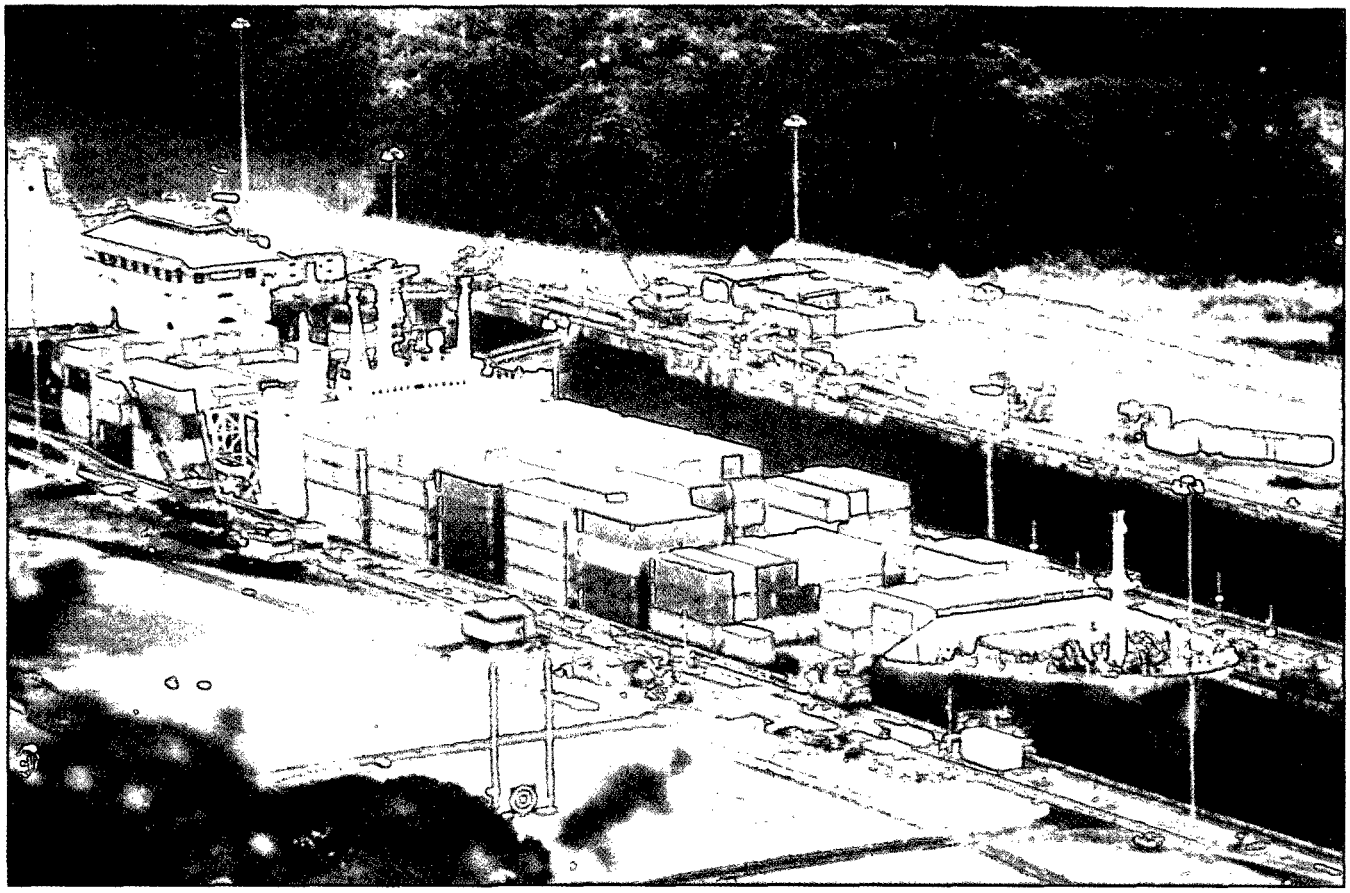
## Demography

Panama has about 3.000.000 inhabitants with an annual rate of growth of 1.7% and a population density of 38 inhabitants per $km^2$. In 1999, the birth rate was 2.5 children per woman and the average life expectancy was 74 in 1999. (World Bank, 2001).

## Economic and sustainable development indicators

The Gross National Income (GNI) per capita is of US$3,080. Its economy has fluctuated as follows: 8.1% of the GDP in 1990, 4.4% in 1998 and 3.0% in 1999. (World Bank, 2001).

The agricultural area represents the 28.6% of the total territory of which 4.9% is irrigated. The contribution of this sector to the economy of the country reached 7% of GDP in 1999. According to this information, Panama is the Central American country with the lowest dependency on agriculture as its economic base. Goods and services exportation have decreased from 38.4% in 1990 to 32.9% in 1999. Goods and services imports have fluctuated as follows: from 33.8% in 1990, 41.8% in 1998 and 41.4% in 1999.



*Canal de Panamá*

Panama has a total forest coverage of 29.000 km$^2$, about 38.6% of its territory. Of this, 19.1% is protected in some way and the deforestation rate was 1.6% in 1999.

It is important to point out that forests play an important role in regulating water evaporation, in refilling water tables, in controlling winds, erosion and sedimentation and in keeping environmental temperature in adequate levels. In Panama´s humid tropic forests, 25% of rain is retained at the top of the trees, 15% is evaporated, 25% runs over the soil surface and 35% flows into water tables, which are use as reservoirs for dry seasons. On the other hand, 40% of the water in deforested zones is evaporated, 50% runs over the soil surface and only 10% flows into water tables. According to Ligia Herrera, (CATHALAC) "the country´s forest coverage area decreased from 93% of the territory in 1800 to 70% near 1947. Later, it decreased to between 38% and 45% in 1980, with a loss estimation of 123.550 acres of forest per year. Basically, this situation owed to agricultural expansion".

## Water Resources Situation

The water capital of Panama is, like Belize's, one of the richest in the world. This capital is about 52.437 m$^3$ per capita and its withdrawal for household, industrial and agricultural uses is 1.1%. The access of the urban population to improved water sources was 88% in 2000. Likewise, for the 2000, the access of the urban population to sanitation systems was 99% (World Health Organization, 2000, quoted by World Bank, 2001).

Hydrographically, the country has 52 basins, two of them shared with its neighbouring countries, Costa Rica and Colombia. The range mountain that divide the country into two runoffs are the Caribbean (north) and the Pacific (south), these are the orographic reason by which the Caribbean is a narrower region. In this region there are 150 rivers that present small basins that runs short distances, for example: *Sixaola* (bordering Costa Rica), *Changuinola* (2.991 Km$^2$) and *Chagres* (3.315 Km$^2$) rivers. It is important to mention that the *Chagres* river flows into the Gatún lake, a very important lake for the Panama

Canal operation. The Pacific runoff comprises a territory wider than the Caribbean. It is formed by more than 330 rivers that flows into the Gulf of Chiriquí and the Gulf of Panama. In these rivers, there are 8 basins that exceed 2.000 km$^2$ and the basin of the *Tuira* river (10.664 km$^2$), the longest of the country.

To refer to the hydric situation in Panama, it is necessary to begin pointing out the relationship between water, environment and country's development. Through its history, Panamanian society has been subjected to the pluvioagriculture system. According to archaeologist Richard Cooke, there is important proof that demonstrates the use of practices of specialized agriculture (i.e. few species planted in considerable quantities) in some communities located in river holm and shore lakes and in intermountain valleys, such as *Cerro Punta, Chitra, El Valle de Antón and Cerro Azul*. Obviously, this agricultural economy of natural irrigation was facilitated by the climatic conditions resulting from the geographic location of the country —in the Intertropical Convergence Zone— and from its orographic arrangement. The mountain ranges never experienced an absence of precipitation, and the dense forests, rich in biodiversity and with a wide coverage over hills in the high basins, were extraordinary natural managers of water resources given the significant sloping configuration of the continental territory.

From the last decades of the colonial period, the water resource agriculture experienced, changes rapidly towards a critical disorder. This situation was caused by the extensive land exploitation that provoked, on one hand, the deterioration of the soil's high productivity levels and, on the other hand, confusion in the natural management of water; all of these without replacing it with a new artificial management system for rationing water. Current figures are very clear on this aspect: from the total of the country's potentially irrigable land, only 14.8% is under controlled irrigation. These lands are formed, almost as a whole, by lands used by banana companies, sugar factories and, about 14.826 acres, in rice plantations.

In the energy field, Panama counts with a hydroenergetic resource of 12,000 GWH, and only 10.7% is used. The thermoelectric production has been increased with the corresponding implications of consuming fossil fuels that provoke greater environmental impacts. The electric power rate of consumption per capita is 1.211 KWh, 1998 (World Bank 2001).

Regarding the availability of hydrometeorological information, Panama has monthly information about precipitation, temperature and flows which is collected by the main institutions in charge of these records such as the current *Empresa de Transmisión Eléctrica S.A.* (ETESA), the *Autoridad del Canal de Panamá* (ACP) and the *Autoridad Nacional del Ambiente* (ANAM).

The Centro de Investigaciones Hidráulicas e Hidrotécnicas of the Universidad Tecnológica de Panamá, with the support of UNESCO, carried out during 1988 and 1989 the Balance Hídrico del Istmo de Panamá. With this initiative, also contributed the Departamento de Hidrometeorología of the Instituto de Recursos Hidráulicos y Electrificación (IRHE), known in the present as ETESA. The Balance Hídrico used the methodology of the guideline published by UNESCO/ROSTLAC in 1982 focusing on the period between 1965 and 1982. National maps were drawn in 1:250,000 scale and the regional map used 1:2,000,000 scale. However, updating the assessment of Panama´s water resources is an urgent task, since its current hydrometeorological network does not properly cover those regions where water resources related conflicts are beginning to arise (zone known as *Arco Seco*).

Inside the institutional framework, the *Autoridad Nacional del Ambiente* (ANAM) is the national institution responsible of assigning permits for using water in the country. At the same time, the Ministry of Health and the Ministry of Agriculture play a similar role for wells drilling intended to withdraw underground waters. The Instituto de Acueductos y Alcantarillados Nacionales (IDAAN) is the responsible entity for supplying drinking water and collecting sewage waters in the main cities of the country. The generation of hydroelectric power is in the charge of the current *Empresa de Transmisión Eléctrica S.A.* (ETESA). Also, the management of waters from the basin of the Panama Canal is under the control of the *Autoridad del Canal de Panama* (ACP).

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