CHAPTER 4

ENVIRONMENTAL DESCRIPTION

CONTENTS

77
'78)

Chapter 4

ENVIRONMENTAL DESCRIPTION

The Republic of El Salvador is located in the Southwest part of Central America. Using Geodesic notation, the country is located on the North latitude between the parallels 13° 09' and 14° 27' and on the West longitude between the meridians 87° 41' and 90° 08'.

The area of the country amounts to approximately 21,000 km^2. The natural landscape with the unique geomorphologic and anthropomorphic characteristics is related to the particular climatic conditions.

The total approximate area of the Torola river basin is 1,575 km^2, some 35.4% of this area equivalent to 557 km^2 are located in Honduras, the remaining 64.6 %, or 1,018 km^2, in Salvadorian territory. The approximate total river length (77km) runs inside El Salvador. The average width of the river is 20m and the difference between the maximum and the minimum elevation is 327m. The measured slope along the river ranges between 1/100 and 1/200.

The Project is located in the lower part of the Torola river basin. The area of the Project include land from the Municipalies of San Luis-La Reina, Carolina, and San Antonio del Mosco, all pertaining to the department of San Miguel". The river basin is located on the Northeast part of El Salvador. The river basin is enclosed on the North latitude between the parallels 13° 42' and 14° 05' and on the West longitude between the meridians 87° 47' and 88° 29'. The layout of the project at a scale of 1:25,000 is shown in Figure 4.1.

The environmental description of the Project comprises only the areas that will be directly affected by the construction ("Area de Influencia Directa" ADI). The areas that will be required for the construction of the Project including the temporary facilities and the future reservoir are described in Chapter 3.

The areas and other elements that will be indirectly influenced by the Project have been designated as AII "Area of Indirect Influence" The AII includes areas in the jurisdiction of three different Counties or " Municipios". These areas will be described in detail.

The areas including, the Torola river basin, the river channel downstream of the dam as well as the incorporation of the Torola River to the Lempa River and the "Central 15 de Septiembre" all the way down to the delta of the river at the Pacific Ocean, will be described in a general fashion.

4.1 Physical Environment

In the context of the Physical environment, the components that will be analyzed are: the soil, the water, and the climate.

4.1.1 Soil

A reference will be made in regards to the soil main components.

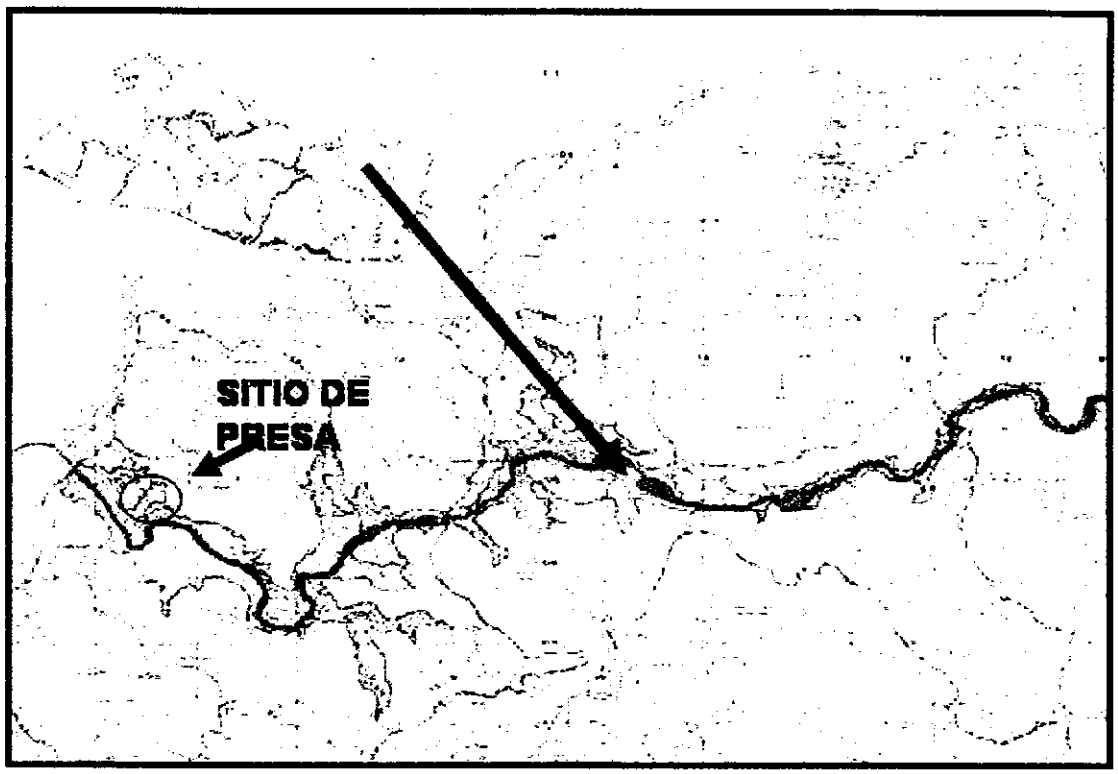


Fig. 4.1 General Project Layout
(Source: El Chaparral Feasibility Study)

a) Geology

The geologic strata found in the basin of the Torola River were formed by volcanic action during the tertiary and quaternary eras. The stratus composed of volcanic and pyroclastic rocks. The Morazan formation is the geologic unit found at the Project site. The Morazan formation is composed of Tuffaceos breccias and basalt. The exposed sediments, sand and gravel, in the riverbed are deposited mainly in thin layers.

In the reservoir area, the dominant formation is the Morazan Formation that was initially formed during the tertiary era but contains sediments of the quaternary era.

The basaltic rock is solidified lava that is characterized by having its hard and fragile components mixed together. This condition favors the development of internal cracks that in turn increases rock permeability. In general, all the natural cliffs found in the reservoir area are composed of this type of basaltic rock. There are two types of basaltic rock, the hard dark-gray and the reddish one of fragile condition. The hard dark-gray, named basalt is composed mainly of plagioclase and pyroxene, the fragile one is named andesite and is composed of plagioclase and biotite.

Along the right hand side of the dam, there is a cliff that is composed of dark-gray rock layers interbedded with brown-reddish portions. Due to the fact that some of the rock interfaces, dark-gray / brown-reddish, happen to appear in a gradual way along the river bed and in some core samples, it is then assumed that both are formed out of solidified lava/basaltic rock. One of the portions appeared brown-reddish when it was exposed to the weathering action. Some of the portions of the basaltic rock

that look like agglomerate constitute an intermediate phase between the tuffaceous breccias and the agglomerate.

The Geologic map of the project area is shown in Figure 4.2.

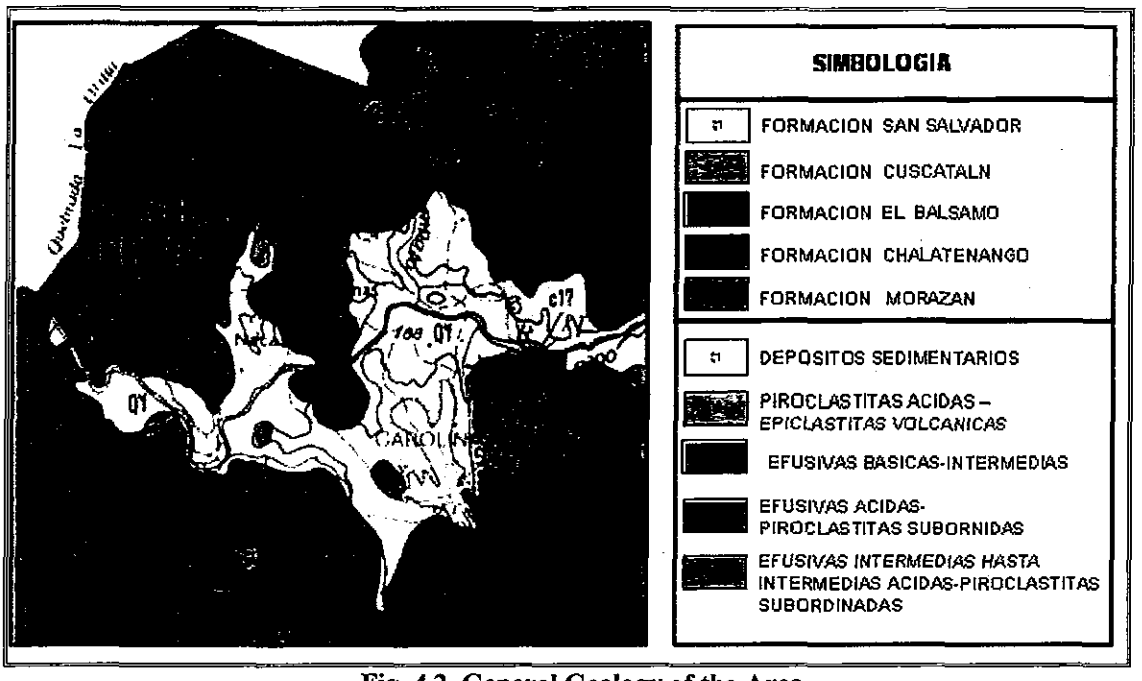


Fig. 4.2 General Geology of the Area
(Source: Geologic Map of El Salvador IGN-CNR)

b) Geotechnical Features

The outcrops of volcanic flows that exist around the project site, particularly in the areas designed for the construction of the diversion dike and the related works are of the type of basaltic-andesitic composition. The quality and soundness of these rocks make them an excellent material for the foundation of the structures.

In regards to the brown-yellowish tuffs found in the vicinities of the reservoir and the gray-led colored ones observed along the walls of the exploration pits, they are stable, impervious and a suitable material for compacted earth structures.

c) Sismicity

El Salvador is located within the fire belt of the circum-pacific region. This is one of the zones with the highest seismic activity in the world, the majority of seismic activity from 80 to 85% are originated by the plate subduction action of Cocos and Caribe.

The seismic activity inside the national territory of El Salvador is produced by the tectonic settlement, the volcanic and/or by the magma movement. The seismic activity generated by this phenomenon is of less magnitude than the movements originated by the subduction of the Continental plates; however, they are of higher intensity due to the fact that they occur at relatively shallow depth.

The record of earthquakes of magnitude greater than 6.0 monitored within a radius of 200km from an epicenter fixed around the Project site is shown in Table 4.1

The figure, 220, was established as the maximum seismic acceleration. This figure was obtained from earthquakes records using statistics analysis. It is applicable to the Project site for any return period. It was also used as a base to calculate the seismic coefficient for the analysis of stability of the dam.

d) Physiographic Features

Within the basin area of the Torola River, there are mountains with relatively gentle slopes and few flat areas. The dam site is located in an area where the Torola River has a straight stretch 1.5km long and 30m wide. The average elevation for this stretch is estimated as 133 masl.

At elevation 180 masl there are intermittent terraces that form gentle slopes. The stretch between the riverbed and the terraces is a zone that features very steep slopes. The existence of high cliffs is also an important feature found in this area.

In the area above the terraces, gentle slopes characterize the land. On the right hand side, along a stretch of about 150m, there are three hilltops with elevation ranging from 200 masl to 240 masl.

There is a gullied land of about 40 degrees that goes between the riverbed upward to an elevation of 220 masl with no terraces at all. The hilltop at elevation 230 masl increases in height up to a point located at some 400m from the river.

On the left hand side of the dam site, there are terraces located at approximately 185 masl.
From the riverbed up to the ADI terraces the land slopes very steep with an average angle of 70 degrees measured from the horizontal plane.

The surface slope of the terraces is very gentle ranging between 5 to 20 degrees. At the back of the terraces there is a rock wall with a slope of about 30 degrees.

e) Edafology

The soil groups that are present in all the zone where the Project is located are those that correspond to the "Latosoles arcillo rojizos" and "Alfisoles" they are the characteristic material found in areas with hills and mountains of abrupt topography. The predominant rocks that are found in this area are: lava and pyroclastic material with cemented stone-size grains.

The soil type observed on the surface over the Project site consists of a clayed soil with rock fragments or stones that can be found only to a very shallow depth. This type of soil is found together with abundant rock outcrops. The potential for agricultural exploitation is low to very low. Only a few areas could be cultivated by using modern methods. Most of the existing farming in this area corresponds to subsistence level. The recommended use will be for cattle grazing and forestry.

Tabla 4.1 Datos históricos sobre eventos sísmicos en la zona del proyecto

	Año	Mes	Día	Longitud	Latitud	Magnitud	Epicentro (km)	Profundidad (km)
1	1915	9	7	-89	14	7.5	71.3	80
2	1921	3	28	-87.5	12.5	7.1	177.4	30
3	1926	2	8	-89	13	7	118.8	30
4	1931	2	7	-87	13	6.1	175.5	100
5	1931	8	25	-89.5	12.5	6	195.8	30
6	1932	5	22	-90	14.2	6.3	181.5	80
7	1932	6	20	-89	12.5	6.3	166.7	80
8	1934	3	7	-87.7	13.2	6.4	102.2	30
9	1934	12	3	-88.7	15	6.4	130.7	30
10	1939	7	8	-88	12.5	6	156.1	90
11	1939	12	26	-88.2	13.2	6.3	75.7	75
12	1941	11	16	-88.5	13.2	6.1	75.5	80
13	1944	10	2	-89.7	14.5	6.6	161.4	160
14	1946	6	24	-89	14.7	6.3	115.5	260
15	1951	5	6	-87.8	13	6.6	113.3	30
16	1951	5	6	-87.8	13	6.4	113.3	96
17	1951	5	7	-87.8	13	6.3	113.3	30
18	1951	8	2	-87.8	13	6.1	113.3	33
19	1951	8	3	-87.8	13	6.3	113.3	33
20	1951	8	3	-87.8	13	6	113.3	33
21	1954	?	19	-87.5	12.5	6.7	177.4	30
22	1955	?	4	-87	13	6.4	175.5	30
23	1955	4	26	-89.5	13.5	6.6	130.3	60
24	1958	6	27	-88.5	13	6.3	97.3	60
25	1959	5	3	-87.5	12.5	6	177.4	100
26	1961	4	12	-88.9	13.2	6.2	94.5	122
27	1961	5	23	-87.3	12.7	6.6	172.5	138
28	1976	2	4	-89.1	15.32	7.2	179.3	5
29	1976	2	8	-88.47	15.57	6	188.4	5
30	1978	5	31	-87.17	12.77	6.5	177.3	76
31	1978	12	6	-89.63	13.15	6.4	159.4	33
32	1982	1	12	-87.58	13.17	6.4	113.8	6
33	1982	6	19	-89.33	13.32	7	122.1	81
34	1982	7	2	-89.28	13.07	6.2	134.2	64
35	1983	7	18	-87.18	12.67	6	183.8	86
36	1985	10	12	-89.72	13.15	6.2	167.2	41
37	1986	10	10	-89.12	13.83	6	82.4	7
38	1993	6	12	-87.53	13.25	6.2	112	217
39	1995	5	21	-87.93	12.13	6	197.2	51
40	1995	6	14	-88.37	12.13	6.7	191.9	25
41	1996	7	22	-88.72	13.08	6	95.2	61
42	1996	12	10	-88.93	12.52	6	162.1	33
43	1996	12	14	-88.78	12.73	6.1	133.8	33
44	1996	12	17	-88.92	12.47	6	166.5	33
45	1996	12	19	-89.97	13.05	6	196.9	33
46	1997	5	15	-89.78	14.47	6	168	274
47	1997	8	24	-89.58	13.55	6	137.3	139
48	1997	11	9	-88.82	13.85	6.6	50	176
49	1997	12	18	-88.73	13.83	6.3	41.1	182
50	1999	4	3	-87.63	13.17	6.3	109.9	36
51	2001	1	13	-88.67	13.05	7.4	96.6	60
52	2001	1	14	-88.58	13.12	6.1	86.7	48
53	2001	1	15	-88.78	13.18	6	88.8	67
54	2001	1	15	-88.58	13.08	6.2	90.2	74
55	2001	1	16	-88.6	13.02	6.1	97.8	44
56	2001	1	16	-88.7	12.98	6.1	104.8	62
57	2001	1	25	-88.88	12.92	6	119.8	33
58	2001	2	2	-88.97	12.82	6.1	133.9	54
59	2001	2	7	-88.93	13.22	6.2	95.4	63
60	2001	2	13	-88.93	13.67	6.7	66.4	10
61	2001	2	17	-88.92	13.07	6	107.6	33
62	2001	2	28	-88.83	13.28	6.3	82.8	65
63	2001	3	16	-88.7	13.13	6.2	89.4	48
64	2001	3	18	-87.4	12.53	6.1	180.3	95
65	2001	3	29	-88.93	13.08	6.2	107.1	33
66	2001	5	8	-88.78	13.6	6.1	55	10
67	2001	7	7	-87.52	12.43	6	182.8	79
68	2001	9	18	-88.77	12.98	6	107.6	62

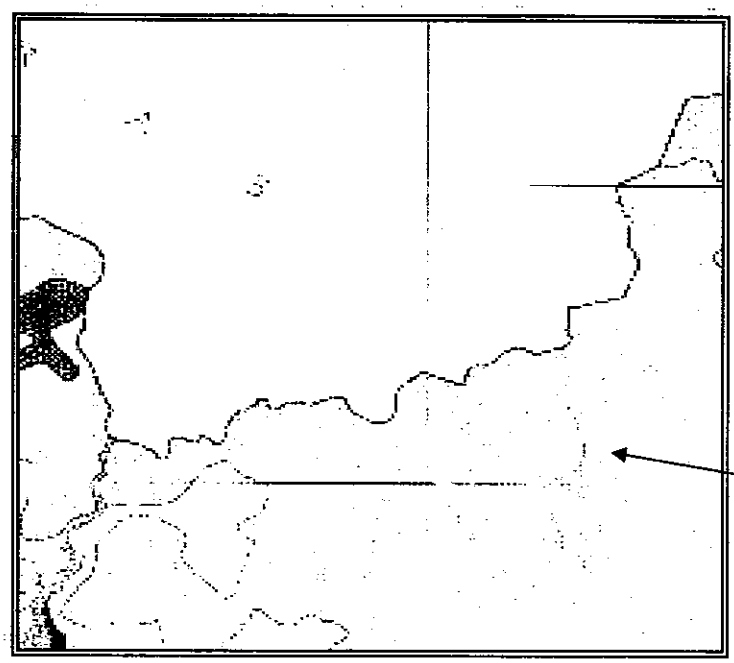


Fig. 4.3 Type of Soil in the Project Area
(Source: Atlas of El Salvador CNR – 2000)

f) Potential Use of the Soil

The potential use of the soil is an expression that indicates the production capacity in such a way that the soil can be used with the lowest possible deterioration.

The soil classification used in El Salvador is the same used by the Department of Agriculture and Soil Conservation in the United States. Only some modifications related to interpretation and in other cases limitation in some parameters have been introduced. Such modifications take in account the particularities of the country.

Under this system the land is divided in eight classes, I to VIII, as described below.

i) Land suitable for farming with use restrictions. Increasing from class I to class IV.

ii) Land with limited use nor suitable for annual farming, but for permanent farming. This classification goes from V to VII. Class VIII is not suitable for agricultural farming.

Soils classified as class VII are found in the majority of the areas under study. These soils have severe restrictions in regard to the intended use. They are not suitable for farming, but only for lumber exploitation. Figure 4.4 shows the soil classes over the Project area.

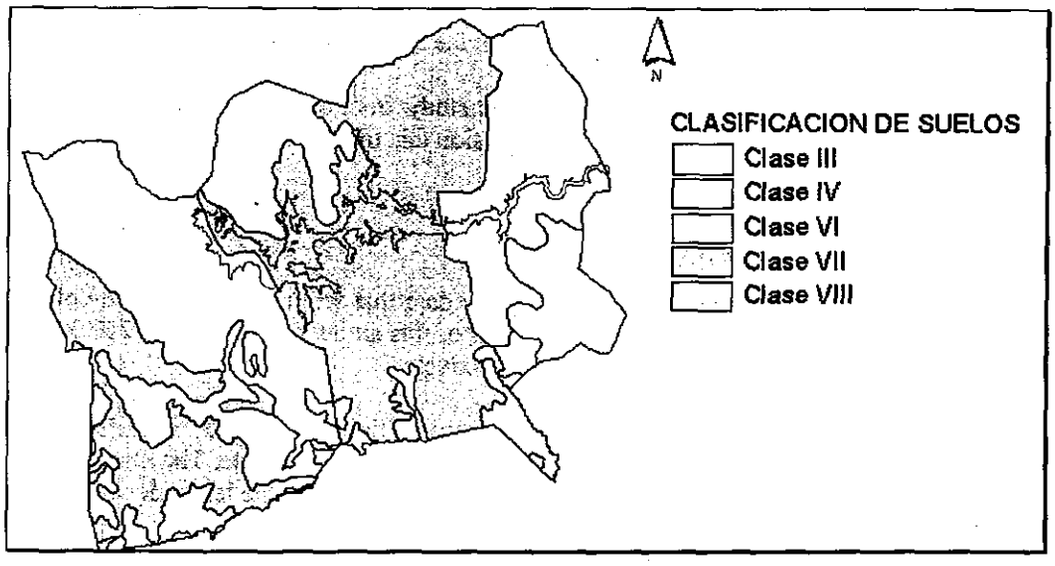


Fig. 4.4 Soil Classification in the Project Area
(Source: Ministerio de Medio Ambiente y Recursos Naturales. Sistema de Información Ambiental)

g) Current Use Soil

Generally speaking, the current use of the soil over the entire area corresponds to cattle pasture and basic grain farming (G. B.) However, natural forest and bushes are still present in small areas along the riversides. These areas are shown in Figure 4.5

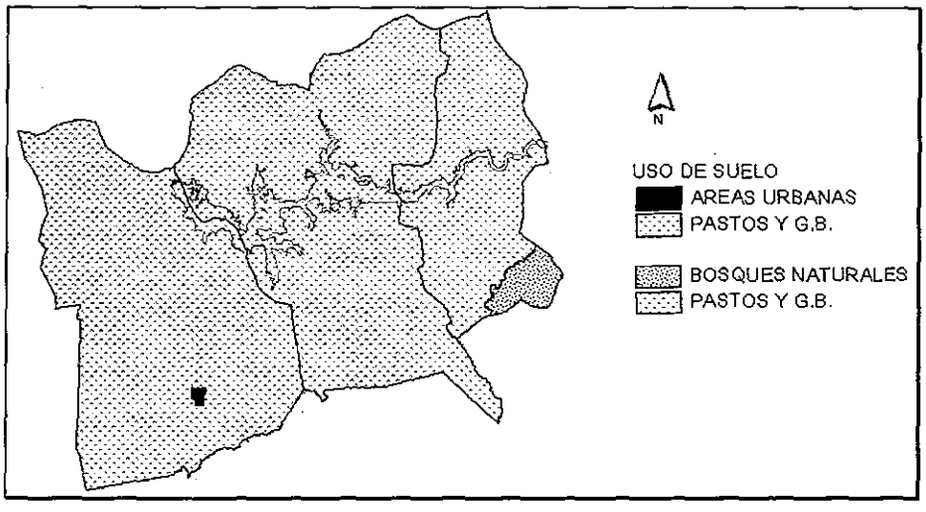


Fig. 4.5 Current Use of Soil
(Source: Ministerio de Medio Ambiente y Recursos Naturales. Sistema de Información Ambiental)

h) *Erosion Problems and Stability of slopes*

Erosion is a well-known phenomena in El Salvador. The main reason for this problem is the intense deforestation activity. This phenomena is triggered during the rainy season, when the storm water hits

the soil free of vegetation and drags it away to the drainage systems and to the lower land. The transported soil is finally deposited in the reservoirs or in the sea.

Independently of the erosion phenomena, the geologic study from aerial photography and the field surveying over the Project area have come to the conclusion that there are no significant risk in regards to erosion nor with the stability of natural slopes.

i) Construction Materials

The current design includes the construction of a gravity dam that will require the supply of 340,000 m^3 of aggregates to be used in concrete production. Out of this amount, there will be 250,000 m^3 and 90,000 m^3 required for coarse and fine aggregates, respectively.

One deposit of basaltic rock suitable for concrete aggregates has already been identified. Another deposit containing gravel and sand was located 2km upstream of the dam site. The alluvial deposit is well distributed on the right side of the upstream part of the river and on the left side along the lower part of the river.

During the dry season, the aggregates deposit is situated 3m above the level of the river. On the surface, there are abundant rounded boulders ranking from 20cm to 50cm in size. The boulders material was identified as basalt.

At the top of the bank at both deposits, the massive basalt is exposed; this indicates that the thickness of the sand and gravel deposits is relatively small.

To the left side of the lower zone, there is another terrace that is extended along one stretch 100m wide and 5m above the river level. This terrace is also covered by a deposit of sand and gravel. Figure 3.6 shows the location of the construction material deposits.

The volume of sand and gravel was estimated using seismic refraction surveys and drill holes. In addition, samples were taken from a test pit in order to perform laboratory analysis.

The volume of sand and gravel in the river channel was determined using the data logs from the drill holes. The final estimate was adjusted by comparing the thickness of the sediment deposits in the river versus the similar ones identified in the drill holes.

The total area of the sand bank that was surveyed is 90,000m^2. This area is the result of adding 50,000 m^2 that is the area of the bank deposit along the right side of the river (500m long * 100m wide) and 40,000 m^2 that is the area of the bank deposit along the left side of the river (400 m long*100m wide)

The thickness of the deposits of sand and gravel in the river channel was determined by using seismic refraction surveys performed close by the drill holes and the test pits. The information was confirmed by the data collected from drill holes and test pits.

The average thickness of the sand and gravel deposits that was determined from all the seismic lines resulted in 4m. The calculated volume using the same method was 360,000 m^3.

j) Sedimentation

The volume of sediments was estimated by analyzing the data recorded at the Osicala station the data analyzed corresponds to the periods of record elapsed from 1996 to 1980 and after 1998.

For purposes of calculation, the density of sediments was adopted as 1.25 ton/m^3 for the suspended sediments and 1.5 ton/m^3 for the bottom load.

The data given in table 4.2 shows the results of the calculations. At the dam site, the specific volume of sediments is 700 (m^3/km^2/year). This is a reasonable figure if compared with the data recorded in the reservoirs located along the Lempa river, moreover, the calculation procedure has 95% probability.

Table 4.2 Specific Sedimentation (m^3/km^2/year)

Sediment	Weight (ton /km^2/year)	Specific Gravity (ton/m^3)	Volume (m^3/km^2/ year)
Suspended	695	1.25	556
Bottom	174	1.50	116
Total	-	-	672
Adopted Volume	-	-	700

4.1.2 Water

a) Hydrographic Network-Physical Characteristics

The surface hydrology in the Project area is governed by the Torola River and its tributaries. They are comprised of rivers, creeks and gullies of relatively short length and low flow. Most of the creeks in the area respond only to seasonal flow.

Based on the cartography at scale 1:50,000, the following are the rivers (R) and creeks (Q) located on the Southern side of the Torola River from West to East: Q. Santa Catarina, R. El Riachuelo, R. Carolina, Q. Grande, R. El Riachuelo, Q. El Achotal, R. Los Jobos, R. Las Vegas, Q. Camposanto, R. Carolina, , Q. Aguas calientes, R. Gualpuca, R. Grande, R. La Mestiza, R. Osicala, Q. El Salto, Q. Honda, Q. El Cordoncillo, Q. El Terrero, Q. El Carrizal, Q. La Quebradona, R. Chiquito, Q. El Rodeo, Q. El Pelón, Q. Algodón, Q. El Limón, Q. El Rusio y Q. La Ermita. Located on the Northern Side of the Torola River from West to East: Q. de la Casa Quemada, Q. El Carrizo, Q. Valle Nuevo, R. Champato, Q. La Ceiba, Q. El Zapotal, Q. Las Anonas, R. Araute, Q. El Obrajito, Q. La Montañita, Q. Achotales, R. de La Joya, R. Sapo, Q. El Arco, Q. La Hacienda, Q. El Salto, Q. de Nicanor, Q. Copante, Q. El Conde y R. San Antonio.

Principal tributaries in the river section intervening with the project in the right bank are: R. El Chaparral, Q. El Zapote, R. Chapate, Q. El Llano, Q. El Zapotal and R. San Diego. In the left bank, there are: R. El Riachuelo, Q. Campo Santo, R. Carolina and R. El Riachuelo. The surface hydrology in the basin is shown in the Figure 4.6-1.

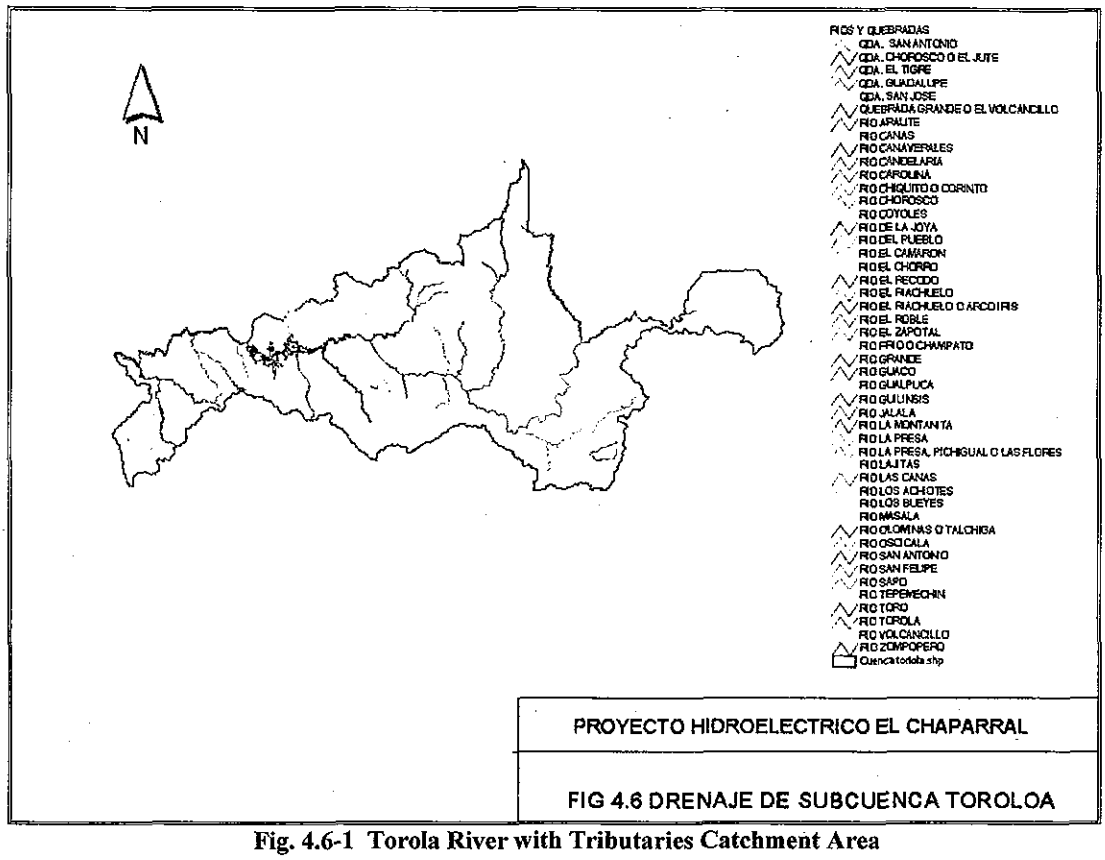


Fig. 4.6-1 Torola River with Tributaries Catchment Area

b) Flows

Based on the historical data for the period of 1942 to 1997 collected at the Osicala hydrometric station, the average flow for the Torola River has been established as 30.00 m^3/s. The pertinent data is sown on Table 4.3.

Table 4.3 Recorded Flow of the Torola River in m^3/s. Years 1942 to 1997

Osicala													Annual
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Maximum	8.7	6.5	11.5	15.0	117.0	174.1	97.2	115.7	200.1	157.0	95.0	8.0	83.82
Minimum	1.9	1.4	0.9	1.0	1.7	15.2	1.4	4.9	20.1	10.2	4.4	3.0	5.51
Average	4.3	4.1	4.7	6.7	38.4	65.9	31.7	42.5	88.9	56.6	10.7	4.9	30.00

Source: Hydrology Study by HARZA, 1998.

c) Minimum Flow

Minimum flow is a concept of paramount importance when considering the ecological aspects involved in a hydroelectric project. This is referred to the minimum water flow that is required to maintain the animal life in the river stream as well as to assure the minimum water supply that is needed by the population who live and work downstream of the Project. The concept of minimum

flow implies that the operation of any given generating plant shall not affect or limit the water flow that is required to assure the livelihood and activities that already exist downstream of the Project.

According with the data recorded at the Osicala station, the minimum flow recorded in the past of the Torola river has been 0.9 m^3/s in March. However, in order to assure the aquatic life as well as the required water supply for the population and the social activities downstream of the dam, a minimum ecological flow of 2 m^3/s shall be maintained continuously, which exceeds the value of minimum historical record.

d) Geothermal Water

An outflow of thermal water is located at both sides of the river, North of Carolina City.
According to investigations undertaken by CEL, the thermal water from the mentioned source does not represent an important energetic source; however, the water is used by the people as a thermal bath installation with the supposed beneficial medicinal properties.

4.1.3 Climate

The climatic conditions of the region are originated by the integration of a series of meteorological phenomena that is typical in Central America. There are instability waves, tropical trade winds as well as the influence of the inter-tropical convergent all of which are associated with rainstorms.

El Salvador is located inside the tropical zone right through equatorial. The country is occasionally hit by the migrating anticyclones from the North. These systems produce streams at a great scale with the Northeast trade winds that meet the trade winds from the Southeast. This latitudinal movement of the pressure systems originates climatic conditions at certain time of the year. The result is the dry season that goes from November to April, and the rainy season that goes from May to October. The two seasons are separated by transitions in which the period from June to September presents the higher precipitation 300 to 500mm. The historic records show that the annual precipitation over the basin ranges from 1,200 to 2,900 mm.

Sunny days are the predominant weather condition during the dry season, with the eventual occurrence of wind at velocities ranging from 30 to 50 km/h. In the mountain regions the wind can d reach velocities in excess of 150 km/h.

From the period of December to January, the cool air brings the coolest time of the year this condition occurs when the wind has subsided

The rain varies a great deal throughout the year, from year to year, and during the rainy season.

In consideration of the elevation El Salvador has three well-defined climatic zones:

- From 0 to 800 masl: Tropical lowland or Savanna
- From 800 to 1,200 masl: Tropical mid altitude
- From 1,200 to 2,700 masl: Mountain climate (Alpine)

The area that is influenced by the project pertains to the zone of Hot tropical Sabana or Hot land. This is because it includes lands with elevation ranging from 140 to 460masl.

a) Temperature

There are no meteorological stations in the area of the Project, for this reason, it was necessary to correlate data from other meteorological stations with similar geographic location.

The temperature does not vary very much along the year. The average daily at the lower lands varies from 25°C a 30°C, at the high lands, the temperature varies from 19°C a 23°C.

According with data obtained from the San Francisco Gotera station, which is located at 250 masl. The average yearly temperature in the lower lands is 26.4°C. The highest temperature along the year is experienced from May through July. Some recorded temperatures in this period are: 27.9, 28.6, y 27.4°C. The average minimum temperature in a yearly basis is 25.5°C reported in the month of December.

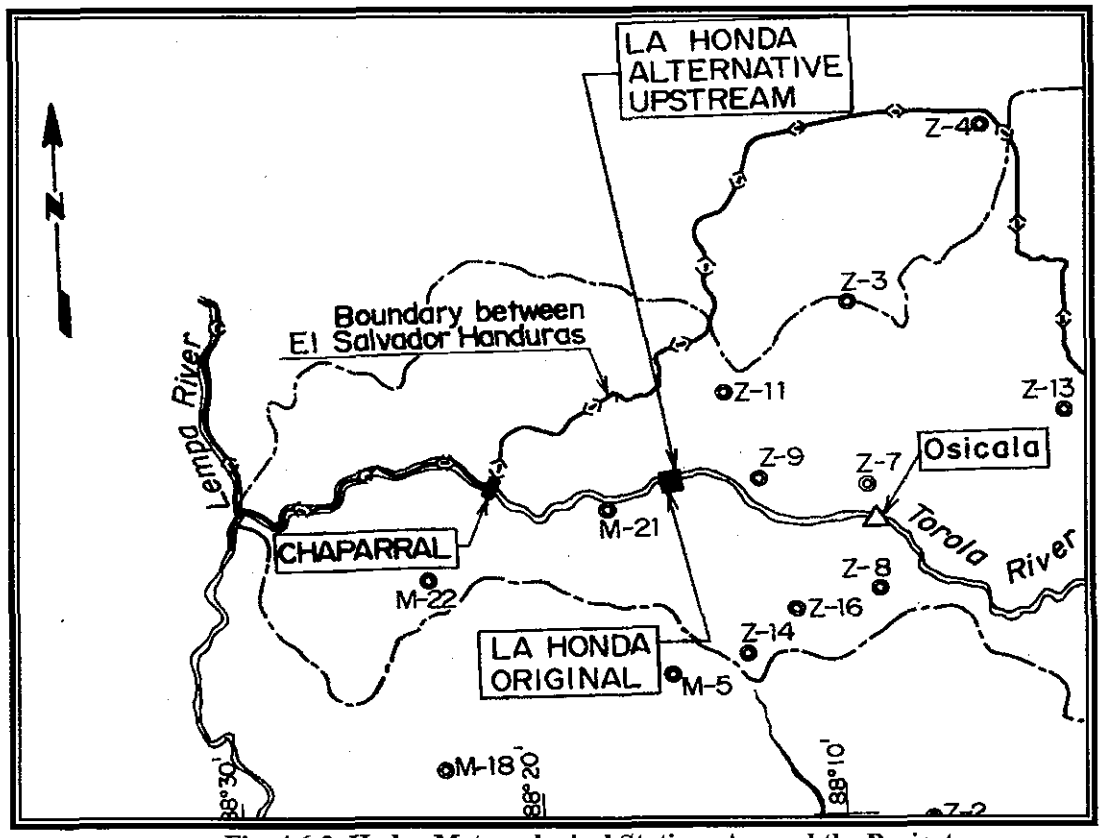


Fig. 4.6-2 Hydro Meteorological Stations Around the Project
(Source: Feasibility Study of the Hydroelectric Complex Over the Rio Torola Hydroelectric, J-Power. Dec. 2003)

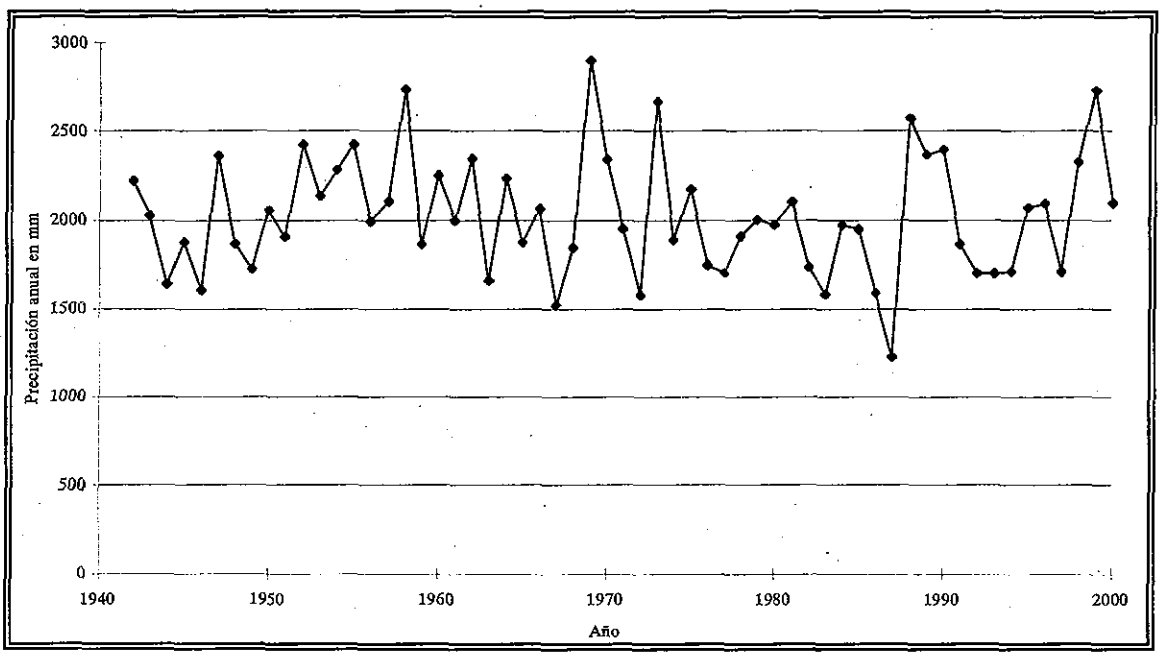


Fig. 4.7 Historical Variation of Precipitation in the Ocicala Region
(Source: El Chaparral Hydroelectric Project Feasibility Study)

El Salvador is located in the climatic belt of the tropics. This region is characterized by almost having the same thermal condition the year round (The temperature variation during the day exceeds the yearly variation). Table 4.4 shows the zone under study where the temperature ranges from 25°C a 30°C.

Table 4.4 Average Temperature in °C

Station	Month												Year
San Fco.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Gotera	25.8	26.5	27.9	28.6	27.4	26.0	26.3	25.9	25.3	25.4	25.6	25.5	26.4

Source: Salvadoran Almanac- MA – 1990

b) Relative Humidity

The average yearly Relative Humidity is 66%. However, there are two different periods that coincide with the rainy and dry seasons respectively. The maximum relative humidity of 80% occurs in September and November. The lower percentage 50-60% is reported from December through February. See Table 4.5.

Table 4.5 Relative Humidity Monthly Average in Percentage

Station	Month												Year
San Fco.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Gotera	56	52	56	58	69	75	70	74	80	79	69	59	66

c) Evaporation

Table 4.6 shows the average evaporation for both tank class A (E_T) and lake (E_L)

Table 4.6 Average Evaporation in mm

Station		Months												Year
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
San Fco.	E_T	186	188	222	225	197	167	185	190	181	165	149	177	2232
Gotera	E_L	134	133	155	156	147	130	139	139	139	125	113	133	1645

Source: Salvadoran Almanac-MAG – 1990.

d) Potential Evapotranspiration

The potential evapotranspiration in the Project area has been assumed to be similar to that recorded at the San Francisco Gotera meteorological station. See data in Table 4.7.

Table 4.7 Average Potential Evapotranspiration

Station	Month												Year
San Fco.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Gotera	157	160	194	199	188	166	181	172	150	145	141	133	1,986

Source: Salvadoran Almanac-MAG – 1990.

e) Precipitation

In the area of the Project, the maximum precipitation occurs from June through September. The monthly precipitation average is 363 and 401 mm for June and September respectively. The annual precipitation varies from 1,200 a 2,900 mm.

The data used for the precipitation analysis was obtained from 9 pluviometric stations (5204, M-21, M-22, U-070, Z-03, Z-05, Z-07, Z-08, Z-12 and Z-13). Figure 4.6-2 shows the location of these stations. Figure 4.7 shows the historical variation of the precipitation in the zone.

4.2 Biological Environment

A team of scientists and specialists in investigated the biological environment: wild fauna, wild vegetation, water quality, aquatic life, socio-economic aspects, historical and cultural patrimonium and paleontology. The specialists were supported by technical personnel that were of great help to ensure a thorough inspection during the field surveys. The knowledge acquired from the field surveys was used to develop the appropriate methodology for every subject.

In order for the investigation to be representative of the environmental conditions existing in the zone, the fieldwork was performed from October through December. The intention was to obtain the data by the end of the rainy season as well as the period of transition from the rainy-dry period to the beginning of the dry season.

4.2.1 Flora

The investigation was to include all the aspects related to the existing vegetation that would be living in the area of influence of the Project.

a) Vegetation

The study of the vegetation was undertaken by means of field reconnaissance together with the use of cartographic prints at scale 1:25,000 and aerial photography.

A 10 km stretch for the ADI was defined along the river channel. The stretch was divided in 36 square lots of 25 m by 25 m side. Knowing the area of one single lot (625 m^2) the total calculated area amounted to 22,500 m^2.

The vegetation as observed all over the area, especially in ADI, is scarce, composed of small boscage apecies and dispersed trees among areas of basic grain cultivation. The only place where dense vegetation is found is along the riverbanks. There are also some small areas covered with forest of the gallery type. This type of vegetation is found along the riversides and at the intersection with the river tributaries as it is shown in Photo 4.1 and 4.2.

Photo 4.1 Scattered Vegetation

Photo 4.2 Gallery Type Forest

In the ADI, the population of trees is comprised of the following species: "conacaste negro" (*Enterolobium cyclocarpum*), "conacaste blanco" (*Albizzia caribea*), "ceiba" (*Ceiba pentandra*),

"volador" (*Terminalia oblonga*), "madrecacao" (*Gliricidia sepium*), "jiote" (*Bursera simarouba*); "quebracho" (*Lysiloma divaricatum*), "almendro de río" (*Andira inermis*), "aceituno" (*Simarouba glauca*), "caoba" (*Swietenia humilis*), "caulote" (*Guazuma ulmifolia*), "copinol" (*Hymenea courbaryl*), "salamo" (*Calycophyllum candidissimun*), "laurel" (*Cordia alliodora*), "chilamate" (*Sapium aucaparium*), "pito" (*Eritrina berteroana*), "maquilishuat" (*Tabebuia rosea*), as well as small trees and bushes. According to the life zone classification system of Dr. Holdridge, these species are characterized by the Subtropical Rainy Woods (bh-ST) which is located from 0 to 1,700m

The flora composition was determined after considering the following aspects: Strata,-in regards to trees, bushes and grass-, Ecological conditions of the endangered species (using the official endangered species list published by MAG, CITES and the UICN). See Tables 4.9 and 4.10.

In the tree strata, 60 species were registered and included in 32 families. The Leguminous family is the one that has the largest number of species, 16, representing 27.12 % of the total. Table 4.9 shows the list of registered trees.

The rest of the registered vegetation, pertaining to the bush and grass strata, was considered as a whole. This is because 61 species were registered considering the fact that they represent the vegetal coverage over the entire area of the project.

Table 4.12 lists 10 species that have been identified as crops. The classification is based on the extensive coverage and the socioeconomic importance of the crops in the area.

It was observed that there are large areas that are covered with natural grass. Some of the predominant grass species are: "zacate jaraguá" (*Hypharrennia ruffa)* y "zacate barrenillo" (*Cynodon dactilon).*

The number of individuals found in each lot determines the density of the vegetal coverage. It was found that the maximum number of individuals per lot is 40 and the total number is 22. Figure 4.8 shows the behavior related to the density or abundance of species of vegetative nature.

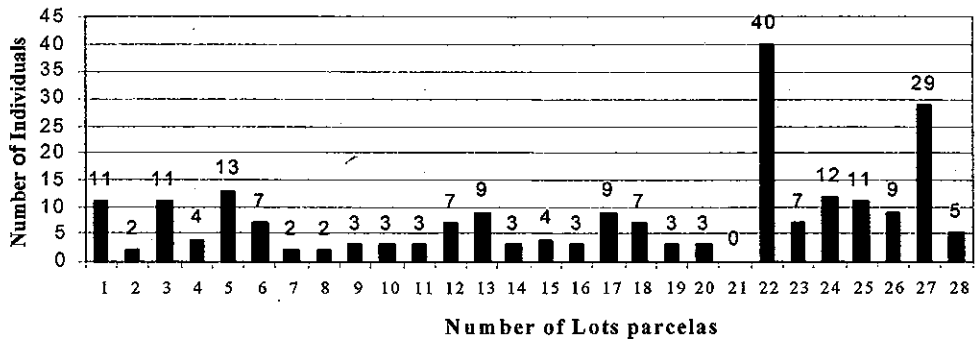


Fig.4.8 Number of Individuals per Lot

Figure 4.9 shows the quantity of registered species per lot, which determines diversity of the species.

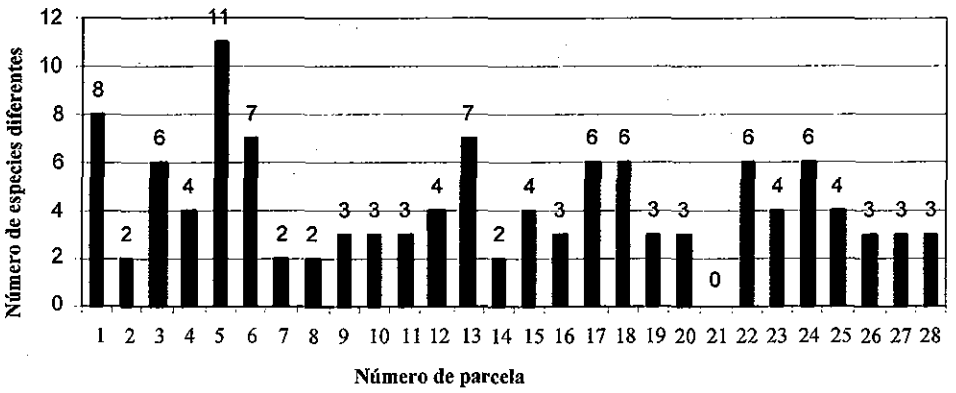


Fig.4.9 Number of Species per Lot

The field surveying that was undertaken on the tree population included the following methodology: the diameter of the trees was measured to the height of the chest (DAP). The height of the most representative as well as the ones of economic importance was estimated.
It was found that the greater number of individuals (130) was in the rank smaller than 40 cm of diameter. Only 3 individuals were found with diameter larger than 1 m. See Table 4.12.

b) Use of Vegetation

Among the tree population that exists in the Project area, there are some species that can be used for the specific purposes of: lumber, rural construction (wood planks), fencing (wood posts) and firewood. Moreover, most of the forest species are of multiple beneficial use. The trunk and the heavy branches can be used as lumber while the rest of the biomass can be used as wood fuel or firewood.

The execution of the Project contemplates the extraction of the present biomass in the area of the future dam and reservoir. The intent of this activity will be, in the first place, to take advantage of this very valuable resource, the wood, and secondly, to remove the vegetative cover from the future flooded area. The latter is because, if the organic material remains in a flooded area, it would decompose and become a polluting agent.

In addition to the dispersed vegetation in the area, six small areas of natural forest were identified, constituted mainly by gallery forest, in where the main tree species were identified, with emphasis in those of greater commercial importance by the quality of the wood.

From the field survey, the following are the findings: 26 trees "conacaste negro" with an average DAP of 55.47cm and diameter larger than 111.10 cm; 8 mahogany trees with 37.81cm DAP and diameter larger than 66.81cm; 7 "ceiba" trees with 68.53cm DAP and diameter larger than 80.21cm; 10 "laurel" trees with 25.43cm DAP and diameter larger than 29.28 cm.

A plan for the exploiting the existing biomass will be prepared. The work to be undertaken include: a detailed inventory indicating the location, quantity, and volume of extractable wood, with emphasis on the species of greater commercial importance. This information will allow to determine the costs of exploitation that will be depend upon: a) types of species, b) grow (diameter and height), c) main use, d) Access facilities for its extraction, e) market price of the wood, and, f) volume of wood to be extracted for the purposes of: lumber, tree trunk, and firewood.

Table 4.9 Flora Composition of the Arboreal Strata

No.	Common Name	Scientific Name	Family	Ecological State and/or Characteristic
1	"aceituno"	*Simarouba glauca*	Simaroubaceae	primary vegetation
2	"almendro de río"	*Andira inermis*	Leguminosae	Typical of gallery forest.
3	"amate de parra"	*Ficus hemoleyana*	Moraceae	Typical of gallery forest
4	"amate de río"	*Ficus insipida*	Moraceae	Typical of gallery forest
5	"anona poshte"	*Annona cherimola*	Annonaceae	endangered
6	"arbol de pan"	*Artocarpus communis*	Artocarpaceae	scarce
7	"barillo"	*Calophyllum brasiliensis*	Gutiferae	scarce
8	"barredero"	*Trichilia havanensis*	Meliaceae	scarce
9	"cabo de hacha"	*Luehea candida*	Tiliaceae	scarce
10	"caoba"	*Swietenia humilis*	Meliaceae	VU/UICN - A/CITES/MAG
11	"carao"	*Cassia grandis*	Leguminosae	scarce
12	"castaño"	*Sterculia apetala*	Sterculiaceae	scarce
13	"caulote"	*Guazuma ulmifolia*	Sterculiaceae	scarce
14	"cedro"	*Cedrela odorata*	Meliaceae	VU/ UICN - A/CITES/MAG
15	"ceiba"	*Ceiba pentandra*	Bombacaceae	scarce
16	"cenícero"	*Phithecellobium saman*	Leguminosae	scarce
17	"chaperno"	*Lonchocarpus minimiflorus*	Leguminosae	EP/UICN - A/CITES/MAG
18	"chichipate"	*Sweetia panamensis*	Leguminosae	scarce
19	"chilamate"	*Sapium aucaparium*	Euphorbiaceae	scarce
20	"conacaste blanco"	*Albizzia caribea*	Leguminosae	scarce
21	"conacaste negro"	*Enterolobium cyclocarpum*	Leguminosae	scarce
22	"copinol"	*Hymenea courbaryl*	Leguminosae	Rare
23	"flor amarilla"	*Cassia biflora*	Leguminosae	Frequent
24	"flor de mayo"	*Plumeria rubra*	Apocinaceae	Frequent
25	"guachipilín"	*Diphysa robinioides*	Leguminosae	scarce
26	"guarumo"	*Cecropia peltata*	Moraceae	Secondary vegetation indicator
27	"guayabo"	*Psidium guajava*	Myrtaceae	Cultivated and/or wild
28	"higo de montaña"	*Clusia mexicana*	Clusiaceae	scarce
29	"güligüiste"	*Karwinskia calderonii*	Rhamnaceae	scarce
30	"jiote"	*Bursera simouruba*	Burseraceae	Common
31	"jocote jobo"	*Spondias mombin*	Anacardiaceae	Cultivated
32	"jocote pitarrillo"	*Spondias purpurea*	Anacardiaceae	Wild
33	"laurel"	*Cordia alliodora*	Borraginaceae	Common
34	"madrecacao"	*Gliricidia sepium*	Leguminosae	scarce
35	"mango"*	*Mangifera indica*	Anacardiaceae	Wild and/or cultivated
36	"mangollano"	*Pithecellobium dulce*	Leguminosae	frequent
37	"maquilishuat"	*Tabebuia rosea*	Bignoniaceae	frequent
38	"marañón"*	*Anacardium occidentale*	Anacardiaceae	Cultivated
39	"morro"	*Crescentia alata*	Bignoniaceae	Not much frequent
40	"mulato"	*Triplaris melaenodendrum*	Polygonaceae	scarce
41	"nance"	*Byrsonima crassifolia*	Malpighiaceae	scarce
42	"naranjo"*	*Citrus sinensis*	Rutaceae	Cultivated
43	"papaturro"	*Coccoloba caracasana*	Polygonaceae	endangered
44	"pepenance"	*Ximena americana*	Olacaceae	Rare
45	"pepeto de río"	*Inga fagifolia*	Leguminosae	frequent
46	"pintadillo"	*Piptadenia constricta*	Leguminosae	scarce
47	"pito"	*Erithrina berteroana*	Leguminosae	frequent
48	"pochote"	*Alchornea latifolia*	Euphorbiceae	rare
49	"quebracho"	*Lysiloma divaricatum*	Leguminosae	frequent
50	"roble"	*Quercus peduncularis*	Fagaceae	scarce
51	"ronrón"	*Astronium graveolens*	Anacardiaceae	Rare
52	"salamo"	*Calycophyllum candidisimum*	Rubiaceae	frequent
53	"sincuya"	*Annona purpurea*	Annonaceae	Scarce wild and/or cultivated
54	"sunza"	*Lycania platypus* *	Chrysobalanaceae	Cultivated, scarce
55	"tecomasuche"	*Cochlospermum vitifolium*	Cochlospermaceae	frequent
56	"tempisque"	*Sideroxylon capiri var. Tempisque*	Sapotaceae	Rare
57	"toronja"	*Citrus medica* *	Rutaceae	Cultivated
58	"uña de gato"	*Celtis iguanae*	Ulmaceae	scarce
59	"uña de gato"	*Smilax coriaceae*	Liliaceae	scarce
60	"volador"	*Terminalia oblonga*	Combretaceae	scarce

EP/UICN: Endangered Specie..Red list UICNVU/UICN: Endangered Species Vulnerability, Red list UICN
A/CITES-MAG: Endangered Specie in El Salvador, CITES-MAG

Table 4.10 Flora Composition of the Shrub and Grass Strata

No.	Common Name	Scientific Name	Family	Ecological Condition and/or Characteristic
1	"cincuya"	*Annona purpurea*	Annonaceae	Rare
2	"cojón"	*Stemmadenia obovata*	Apocynaceae	Frequent
3	"cuchamper montés"	*Macroscepis congestiflora*	Asclepiadaceae	Scarce. Ligneous twig
4	"chupa chupa"	*Arrabidaea mollisima*	Bignoniaceae	Scarce. Ligneous twig
5	"achiote"*	*Bixa orellana*	Bixaceae	Cultivated and /or wild
6	"copalío"	*Bursera graveolens*	Burseraceae	EP/CITES-MAG
7	"pitahaya"	*Opuntia cochenillifera*	Cactaceae	scarce
8	"chupamiel"	*Combretum fruticosum*	Combretaceae	Woodish liana, common
9	"capulín"	*Muntigia calabura*	Eleocarpaceae	Common
10	"tempate"	*Jatropha curcas*	Euphorbiaceae	Abundant in fences
11	"aguja de arra"	*Xilosoma intermedium*	Flacourtiaceae	Endangered
12	"ishcanal"	*Acacia hindsii*	Leguminosae	Common
13	"pata de cabra"	*Bauhinia aculeata*	Leguminosae	Frequent
14	"casco de de venado"	*Bauhinia ungulata*	Leguminosae	Frequent
15	"flor amarilla"	*Cassia biflora*	Leguminosae	Frequent
16	"sambrán"	*Senna reticulata*	Leguminosae	Frequent
17	"izote"*	*Yuca elephantipes l*	Liliaceae	Common
18	"manzanita"	*Malvaviscus arboreus*	Malvaceae	Rare
19	"cirín"	*Miconia argentea*	Melastomataceae	EP/CITES-MAG, Rare
20	"quitacalzón"	*Guarea glabra*	Meliaceae	Rare
21	"guayabo"	*Psidium guajava*	Myrtaceae	Cultivated and/or wild
22	"guayabillo"	*Psidium molle*	Myrtaceae	Scarce
23	"huiscoyol"	*Bactris major*	Palmae	Scarce
24	"sangre de toro"	*Bocconia arborea*	Papaveraceae	Rare
25	"cordoncillo"	*Piper tuberculatum*	Piperaceae	Secondary vegetation indicator
26	"santa maría"	*Piper umbellatum*	Piperaceae	Secondary vegetation indicator
27	"iril"	*Coccoloba floribunda*	Poligonaceae	Endangered
28	"irayol"	*Genipa americana*	Rubiaceae	Endangered
29	"huesito"	*Ixora floribunda*	Rubiaceae	Rare
30	"crucito"	*Randia pleiomeris*	Rubiaceae	DD/UICN
31	"limón"*	*Citrus aurantifolia*	Rutaceae	Cultivated
32	"huevo de gato"	*Solanum hirtum*	Solanaceae	Frequent
33	"horquete"	*Solanum verbascifolium*	Solanaceae	Frequent
34	"chichicaste"	*Urera baccifera*	Urticaceae	Common
35	"cinco negritos"	*Lantana camara*	Verbenaceae	Frequent
36	"albahaca de gallina"	*Ocimun basilicum*	Lamiaceae	Cultivated and/or wild
37	"amatillo"	*Raunwolfia tetraphilla*	Apocinaceae	Wild. common
38	"begonia"	*Begonia plebeja*	Bignoniaceae	Wild common in humid environment
39	"bijagua"	*Bihaia latisphata*	Musaceae	Wild common in humid environment
40	"campanilla"	*Ipomoea spp*	Convolvulaceae	Climbing liana, common.
41	"chiltepe"	*Capsicum baccatum*	Solanaceae	Wild, common
42	"pico de pato"	*Amphilophium molle*	Bignoniaceae	Liana. Frequent
43	"come mano"	*Cissus syciodes*	Vitaceae	Wild, scarce
44	"epazote"	*Chenopodium ambrosiodes*	Chenopodiaceae	Wild common in determined places
45	"escobilla"	*Sida acuta*	Malvaceae	Wild, abundant
46	"flor de muerto"	*Tagetes microglossa*	Compositae	Wild and/or cultivated
47	"frijolillo"	*Senna occidentalis*	Leguminosae	Wild, frequent
48	"jaraguá"	*Hypharrennia ruffa*	Poaceae	Wild, abundant
49	"lengua de vaca"	*Phitecoctenium echinatum*	Bignoniaceae	Climbing liana, frequent
50	"epacina"	*Petiveria alliaceae*	Compositae	Wild, common
51	"dormilona"	*Mimosa púdica*	Leguminosae	Wild, common
52	"mozote"	*Bidens pilosa*	Compositae	Wild, common
53	"mora"	*Solanum nigrum*	Solanaceae	Wild, scarce
54	"nixtamal"	*Paullinia pinnata*	Sapindaceae	Wild, rare
55	"pico de guara"	*Syngonium podophyllum*	Araceae	Wild, humid environment, frequent
56	"pan caliente"	*Gronovia scandens*	Loasaceae	Climbing liana, abundant
57	"pié de zanate"	*Adianthum princeps*	Pteridaceae	Wild, humid environment, frequent
58	"cuculmeca"	*Dioscorea Salvadorensis*	Dioscoriaceae	EP/CITES-MAG
59	"quequeishque"	*Xantosoma spp*	Araceae	Wild, humid environment scarce, darkness
60	"tabaquillo"	*Richardia scabra*	Rubiaceae	Wild, scarce
61	"suelda con suelda"	*Anredera vesicaria*	Polypodiaceae	

DD/UICN: Classification not possible due to differences in data, International red list UICN.
EP/CITES-MAG: Endangered in El Salvador CITES-MAG
**cultivated*

97

Table 4.11 Registry of Species Used as Crops

No.	Common Name	Family	Scientific Name	Ecological Condition and/or Characteristic
1	"maguey"	*Amaryllidaceae*	Agave sisalana	Cultivated
2	"piñuela"	*Bromeliaceae*	Bromelia karatas	Cultivated in fencing, frequent
3	"flor de muerto"*	*Compositae*	Tagetes sp	Cultivated
4	"frijol"	*Leguminosae*	Phaseolus vulgaris	Cultivated
5	"guineo" **	*Musaceae*	Musa spp	Cultivated
6	"ajonjolí"	*Pedaliaceae*	Sesamum indicum	Cultivated
7	"arroz"	*Poaceae*	Oriza sativa	Cultivated
8	"caña de azúcar"	*Poaceae*	Sacharum officinarum	Cultivated
9	"maíz" **	*Poaceae*	Zea mays	Cultivated
10	"maicillo" **	*Poaceae*	Sorghum vulgare	Cultivated

* Wild specie currently cultivated in one of its varieties

* * Bush like appearance but of herbaceous consistency.

Table 4.12 DAP Ranges and Estimated Height

DAP	No. of Individuals
Less than 40 cm	138
Between 40 and 60 cm	66
Between 60 and 90 cm	15
Greater than 100 cm	3
Height	**No. of Individuals**
Less than 10 m	130
Between 10 and 15 m	46
Between 15 and 20 m	41
Greater than 20 m	5

4.2.2 Fauna

To investigate the fauna, direct observations were made through extensive visits to the Project area. This was done by observing and looking for nests or "talchinoles" of species such as parrots among others. Identification of species was accomplished by differentiating the type of nest such as hanging "chiltotas" nests and other typical nests. Also, species were identified when heard or seen flying, resting in trees, singing, or when their tracks were encountered. In addition, an indirect investigation was made by interviewing the local people. Through the investigations, it was possible to define five vertebrate groups, that is, mammals, birds, reptiles, fish, and amphibians.

a) Mammals

The studies reveal the presence of 19 species of mammals. This group was determined to be the most critical of all. According to the official endangered species lists from MAG, CITES, and UICN, several national species were found to be in danger. Of the total registered species in the country, 6 are listed as threatened species and 5 are listed as endangered or close to extinction. These species constitute the most vulnerable group due to the fact that they have been subjected to reduction of natural habitat caused by agricultural and other farming activities, and high exposure to both natural and sport hunting.

Table 4.13 presents a list of mammals found in the Project zone. The table provides scientific name, animal family and its ecological situation.

Hunting practices mostly affect species such as the deer, and the "tepezcuintle", which are used for consumption. There is also live trapping of wild animals for commercialization or for use as pets.

b) Birds

A total of 54 species of birds were found constituting 23 families. Of these species, 19 are classified as threatened, 5 are considered endangered. Thirty-two of them are identified as residents, one as resident with temporary migration, 2 as temporary migrants, one as temporary resident, 2 as migratory, and two as extinct. For two species, it was not possible to identify their status.

Table 4.14 shows a list of the observed birds and their ecological situation according to the list of endangered species.

c) Reptiles

Twenty species of reptiles were identified. The most predominant was the snake family with a variety of seven species. There also some alligator species identified. These are the alligator or cocodrile *Crocodylus acutus*, which was found in certain places along the river. From the reptile species, five are classified as threatened, and four as in danger of extinction. This information is found in Table 4.15.

d) Amphibians

Table 4.16 shows seven species of amphibians.

In total, 100 species of animals were registered of which 19 correspond to mammals, 54 are birds, 20 are reptiles, and 7 are amphibians. Figure 4.10 shows their proportional relationship of the vertebrates.

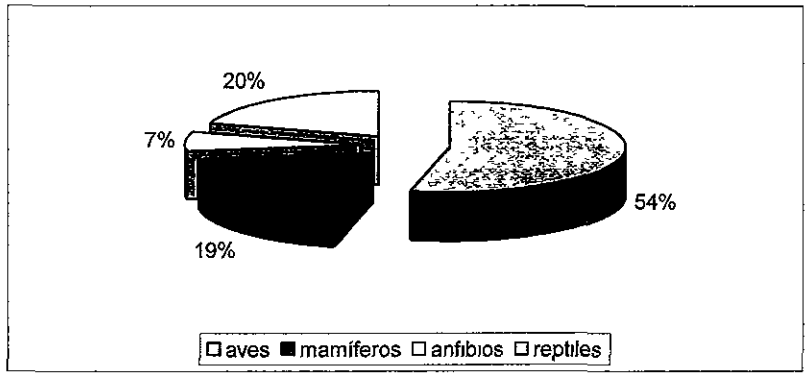


Fig. 4.10 Proportion of Families

Table 4.13 Species of Mammals Found and/or Reported in the Project Area

No.	Common Name	Scientific Name	Family	Status
1	"ardilla gris"	*Sciurus deppei*	Sciuridae	
2	"comadreja"	*Mustela frenata*	Mustellidae	A/CITES-MAG
3	"conejo montés"	*Sylvilagus floridanus*	Leporidae	
4	"cotuza"	*Dasyprocta punctata*	Dasiprocidae	
5	"cusuco"	*Dasypus novemcinctus*	Dasyprocidae	A/CITES-MAG
6	"gato cervante" / "zorro"	*Urocyon cinereoargentus*	Canidae	A/CITES-MAG
7	"gato zonto"	*Herpailurus yagouaroundi*	Felidae	EP/CITES-MAG
8	"mapache"	*Procyon lotor*	Procyonidae	
9	"perro de agua" o "nutria"	*Lutra longicaudata*	Mustellidae	EP/CITES-MAG
10	"pezote"	*Nasua narica*	Procyonidae	A/CITES-MAG
11	"puerco espín"	*Coendus mexicanus*	Erethizontidae	
12	"tacuazín blanco"	*Didelphis marsupialis*	Didelphidae	
13	"tacuazín negro"	*Philander oprossum*	Didelphidae	
14	"taltuza"	*Geomys grandis.*	Geomydae	
15	"tepezcuintle"	*Agouti paca*	Dasyprocidae	EP/CITES-MAG
16	"venado cola blanca"	*Odocoileus virginianus*	Cervidae	A/CITES-MAG
17	"venado rojo" o "cabrito"	*Mazama americana*	Cervidae	EP/CITES-MAG DD/UICN
18	"zorrillo lomo blanco"	*Mesoleucus*	Mustellidae	EP/CITES-MAG
19	"zorrillo rallado"	*Spirogale putorius*	Mustellidae	A/CITES/MAG

EP/CITES-MAG· Endangered in El Salvador CITES-MAG
A/CITES-MAG: Threatened in El Salvador, CITES-MAG

Table 4.14 Species of Birds Found in the Project Area

No.	Common Name	Scientific Name	Family	Status
1	"gorrión"	*Aimophila rufescens*	Emberezidae	A/CITES/MAG
2	"colibrí canela"	*Amazilla rutila*	Trochilidae	Resident
3	"guara"	*Ara macao*	Psittacidae	Extinct
4	"chocoyo"	*Aratinga conicularis*	Psittacidae	A/CITES/MAG
5	"garzón"	*Ardea herodias*	Ardeidae	A/CITES/MAG
6	"catalnica" o "perico "	*Brotogeris jugularis*	Psittacidae	Resident
7	"garza garrapatera"	*Bubulcus ibis*	Ardeidae	Resident
8	"gavilán zarado"	*Buteo magnirostris*	Accipitridae	A/CITES/MAG
9	"azacuán"	*Buteo swainsoni*	Accipitridae	A/CITES/MAG
10	"gualcachía"	*Campylorhynchus rufinucha*	Troglodytidae	Resident
11	"jilguero"	*Carduelis notata*	Fringillidae	A/CITES/MAG
12	"martín pescador"	*Ceryle torquata*	Alcedinidae	EP/CITES/MAG
13	"pájaro león"	*Ciccaba virgata*	Strigidae	Resident
14	"codorniz"	*Colinus cristata*	Odontophoridae	Resident
15	"urraca"	*Colocitta formosa*	Corvidae	Resident
16	"paloma morada"	*Columba flavirostris*	Columbidae	Resident
17	"tortolita común"	*Columbina passerina*	Columbidae	Resident
18	"tortolita rojiza"	*Columbina talpacoti*	Columbidae	Resident
19	"zopilote"	*Coragyps atratus*	Cathardidae	Resident
20	"pijuyo"	*Crotophaga sicirostris*	Cuculidae	Resident
21	"pishishe"	*Dendrocygna sp.*	Anatidae	Resident
22	"tordo cantor"	*Dives dives*	Emberezidae	Resident
23	"carpintero lineado"	*Drycopus lineatus*	Picidae	EP/CITES/MAG
24	"tijereta"	*Elanoides forficatus*	Accipitridae	A/CITES/MAG
25	"talapo"	*Eumomota superciliosa*	Momotidae	Resident
26	"eufonía"	*Euphonia spp*	Thraupidae	Resident
27	"halcón"	*Falco sp*	Falconidae	Temporarily Resident
28	"lislique"	*Falco sparverius*	Falconidae	A/CITES/MAG
29	"aurora"	*Glaucidium brasilianum*	Strigidae	Resident
30	"guás"	*Herpetotheres cacchinnans*	Falconidae	Resident
31	"chiltota"	*Icterus galbula*	Emberezidae	Resident
32	"paloma rodadora"	*Leptotila verreauxi*	Columbidae	Resident
33	"gavilán blanco"	*Leucopternis albicollis*	Accipitridae	EP/CITES/MAG
34	"mosquerón picudo"	*Megarynchus pitangua*	Tyrannidae	Resident
35	"cheje o carpintero común"	*Melanerpes aurifrons*	Picidae	Resident
36	"corta cabezas"	*Miscratur semitorquatus*	Falconidae	EP/CITES/MAG
37	"torogoz"	*Momotus momota*	Momotidae	Resident
38	"garza morena"	*Nyctanassa violacea*	Anatidae	Temporary migratory
39	"pocuyo"	*Nyctidromus albicollis*	Caprimulgidae	Resident
40	"chacha común"	*Ortalis vetula*	Cracidae	Resident
41	"tecolote"	*Otus cooperi*	Strigidae	A/CITES/MAG
42	"plátano asado"	*Piaya cayana*	Cuculidae	Resident
43	"calandria"	*Piranga sp*	Emberezidae	Migratory
44	"cristo fue / chío"	*Pitangus sulphuratus*	Tyraniidae	Resident
45	"clarinero" o "zanate"	*Quiscalus mexicanus*	Icteridae	Resident
46	"dichosofui"	*SaltatoraAtriceps*	Emberezidae	Resident
47	"arrocero"	*Spiza americana*	Cardinalidae	Migratory
48	"vencejón collarejo"	*Streptoprogne sonaris*	Apodidae	Extinct
49	"tangara aliamarilla"	*Thraupis abbas*	Thraupidae	Resident
50	"arriero"	*Troglodytes rufociliatus*	Troglodytidae	EP/CITES/MAG
51	"zenzontle"	*Turdus grayi*	Muscicapidae	Resident
52	"chonte"	*Turdus grayi*	Turdidae	Temporary migratory
53	"pájaro" gancho (torreja) "	*Tytira semifasciata*	Tyraniidae	Resident
54	"paloma ala blanca"	*Zenaida asiatica*	Columbidae	Resident, migratory temporary

EP/CITES-MAG: Endangered in El Salvador CITES-MAG.
A/CITES-MAG: Threatened in El Salvador CITES-MAG

101

Table 4.15 Reptile Species Found and/or Reported in the Project Zone

No.	Common Name	Scientific Name	Family	Status
1	"iguana"	*Iguana iguana*	Iguanidae	EP/CITES/MAG
2	"garrobo"	*Ctenosaura similis*	Iguanidae	Not Determined
3	"lagartija"	*Sceloporus spp.*	Anguidae	Not Determined
4	"tenguereche"	*Basiliscus vittatus*	Gorytophanidae	Not Determined
5	"masacuata"	*Boa constrictor*	Boidae	A/CITES/MAG
6	"coral"	*Micrurus nigrucinctus*	Elapidae	A/CITES/MAG
7	"cotina de 3 rayas"	*Stenorrhina freminvillei*	Colubridae	Not Determined
8	"bejuquilla"	*Oxibelis fulgidus*	Colubridae	EP/CITES/MAG
9	"zumbadora"	*Masticophis mentovarius*	Serpentes	Not Determined
10	"tortuga terrestre"	*Rhinoclenmys spp.*	Kinosternidae	Not Determined
11	"tortuga de caja"	*Kinosternum scorpioides*	Kinosternidae	A/CITES/MAG
12	"víbora castellana/cantil de agua"	*Agkistrodon bilineatus*	Viperidae	EP/CITES/MAG
13	"tamagás"	*Bothrops godmani*	Viperidae	Not Determined
14	"salamanqueza"	*Sceloporus malachitus*	Lacertilia	Not Determined
15	"geco casero"	*Phyllodactylus tuberculosu*	Gekkonidae	Not Determined
16	"cantil"	*Gonatodes fuscus*	Viperidae	Not Determined
17	"corredor pintado"	*Ameiva undulata*	Teiidae	Not Determined
18	"corredor "rayado"	*Cnemidophorus motaguae*	Teiidae	A/CITES/MAG
19	"mica"	*Spilotes pullatus mexicanus*	Colubridae	A/CITES/MAG
20	"cocodrilo" "lagarto"	*Crocodylus acutus*	Crocodylidae	EP/CITES/MAG VU/UICN

EP/CITES-MAG: Endangered in El Salvador CITES-MAG
A/CITES-MAG. Threatened in El Salvador, CITES-MAG
VU/UICN: Species vulnerable to extinction, international red list UICN

Table 4.16 Species of Amphibians Found in the Project Area

No.	Common Name	Scientific Name	Family	Status
1	"tepelcúa"	*Dermophis mexicanus*	Gymnophionidae	Not Determined
2	"sapo"	*Bufo spp.*	Bufonidae	Not Determined
3	"rana"	*Engystomops spp.*	Leptodactilae	Not Determined
4	"salamandra"	*Bolitoglossa spp*	Plethodontidae	Not Determined
5	"sapo"	Bufonidae	***Bufo spp.***	Not Officially determined
6	"rana"	Leptodactlidae	***Engystomops spp.***	Not Officially determined
7	"salamandra"	Plethodontidae	***Bolitoglossa spp***	Not Officially determined

4.2.3 Aquatic Life

In order to explore and learn the condition of the aquatic life in the river, three sampling zones were established. The goal was to determine the abundance and diversity of aquatic species as well as the level of productivity. The three places were (1) Carolina, (2) Vado Nuevo, and (3) Nuevo Edén de San Juan in which, using the appropriate measurement tools, samples of aquatic organisms were taken. With this, the goal is to establish a representative base of current conditions to be used for comparison of future studies. The areas are shown in Figure 4.15.

The following groups of organisms were studied:

a) Plankton, miniscule water animals considered the components of phytoplankton and zooplankton

b) Benthos, of Insect Classification, which was studied using larva from aquatic insects

c) Nekton, belonging to fish and crustacean

In general, the river presents environment characterized by rapids and fast streams or "chorreras" with abundance of rocks of different sizes. In addition, there are pools or areas with slow water flow.

The Carolina site is located half way along the river length that will be affected by the Project. Immediately after that, there is a site of thermal waters, which mix with the river at that point.

The Vado Nuevo site is located 1.5 km down river from the dam site. This is a pool area. This area was chosen for its proximity to the dam site in which it is possible to obtain a constant flow of 2 m^3/seg when the dam is in operation. The river water will be altered in its physicochemical composition due to the changes in volume and velocity of the flow that will result from the periodic supply, during hours of generation, of stored water.

The site Nuevo Edén de San Juan is located approximately 21 km from the dam site immediately at the convergence of the Torola River with the Lempa River, and it constitutes the lower zone of the River. This site is also a pool that is characterized by a sandy bottom. The information gathered in this site will also be compared with data from future collected samples, and this will be used to determine the level of environmental aquatic recovery in the lower end of the Project.

a) Collection of Samples

Samples were collected at five different times and at each one of the sampling locations. The samples taken are:

i) Plankton samples: For the gathering of plankton organisms, a 10 μ diameter Wildco net was used. This net was passed through the water pools and held in rapids for about 15 minutes. The collected samples were given different treatment accordingly in order to study different aspects. For observing structures, the organisms were left in their natural state. For the identification of micro algae, the samples were preserved in a 10% formalin solution and neutralized with a salt solution of borax.

ii) Benthos or macro invertebrate samples: These are aquatic insects. A manual search in different habitats was performed. For instance, under rocks, in leaf beds, and in the sand. Samples collected were preserved in a 70% alcohol solution. The crustacean group was qualitatively analyzed.

iii) Nekton or vertebrates such as fish, crustaceans and muscles samples: Different methods were used for fishing and capture of this group. The analysis was both qualitative and quantitative emphasizing the dimensions of diversity and size of captured species.

b) Identification of Aquatic Organisms

For purposes of identification among the organisms of each community, a taxonomical code was used. The codes of Husted (1959), Palmer (1962), Prescott (1970), Bourrelly (1972, Bold & Wynne (1978), Needham & Needham (1978), and González de Infante (1988) were used for micro-algae. Codes from Edmonson (1959), Westphal (1977), Pennak (1978), Jahn ***et. al.*** (1981) and Patterson (1996) were used for zooplanktons. For aquatic insects, codes from Merrit & Cummins (1978), Pennak (1978), Lehmkuhl (1979), Needham & Needham (1978) were used. For ecological representation, a list of threatened and endangered species from UICN (2003) and CITES / MAG was used.

Each one of the groups of planktons were counted and separated according to their taxonomical category of gender when it was possible. In the case of aquatic insects, it was for the most part

possible to determine the level of order as well as family. This was possible because insects have different stages of growth and they were rarely found in the pre-adult stage.

c) Results from the Aquatic Life Study

Based on the field observations and the composition of species, there were no findings of peculiar differences of statistical significance from season to season and from sampling site to sampling site. Thus, for the rest of the statistical analysis, the three sampling zones were treated globally.

With the exception of fish and crustacean, 131 aquatic species were found. Of these, 79.4 % correspond to plankton with 71 phytoplankton and 33 de zooplankton, 9.9 % correspond to benthos are made up of insects with 12 species, represented by larva and a type of crustaceans. 10.7 % corresponds to 7 species of fish, 3 reptiles, 3 amphibians, and 1 mammal. Figure 4.11 shows the relationship between plankton, benthos, and nektons.

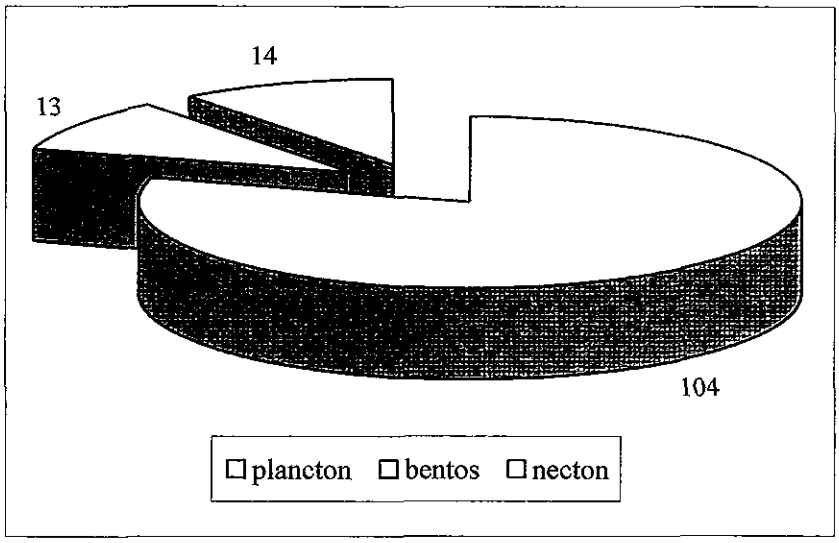


Fig. 4.11 Aquatic Life Diversity

i) Communities of plankton

In this group species of phytoplankton and zooplankton are registered.

■ Phytoplankton

With respect to the algae group, it is confirmed that they are adapted to withstand forces given their elongated shape. The algae were divided in 5 taxonomical groups, from which Cryophyte was the one that exhibited a larger number with 36 species. Next was Chlorophyte, or green algae (Verde), with 19. Then they follow in respective order Cyanophyte or green-blue (azulverde) algae, Euglenophyte or tailed-algae (Euglenas), and finally Pyrhophyte or Dinosaur-tailed algae (Dinoflagelados). These results appear in Figure 4.12

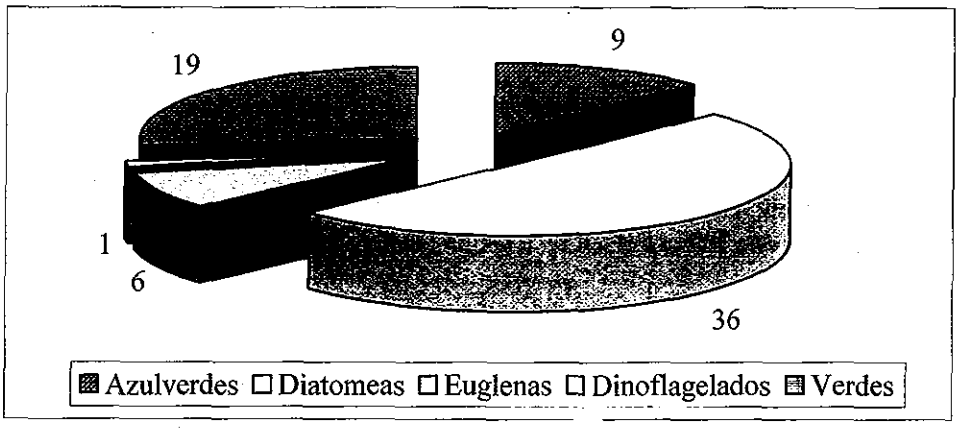


Fig. 4.12 Distribution of Phytoplankton Species

When comparing data about the microscopic algae, it was observed that between the Vado Nuevo and Carolina sites, Vado Nuevo had greater diversity, and Vado Nuevo de San Juan exhibited medium relative diversity. This difference is explained as a result of the environmental diversity that the distinct habitats presented. Vado Nuevo presents the most stability for the establishment and development of populations.

ii) Zooplankton

Zooplanktons are represented by 5 Phyla, with the most numerous being Phyla Ciliophora or o filament Phyla, with 14 species. Next is Phyla Sarcodinos or amebas with 10 species followed by Phyla Flagellate or tailed with 4 species. Next follow Rotifera, or Rotators, with 4 species, and Gastrotrich or gastrotrich with only 1 specie. This is shown in Figure 4.13.

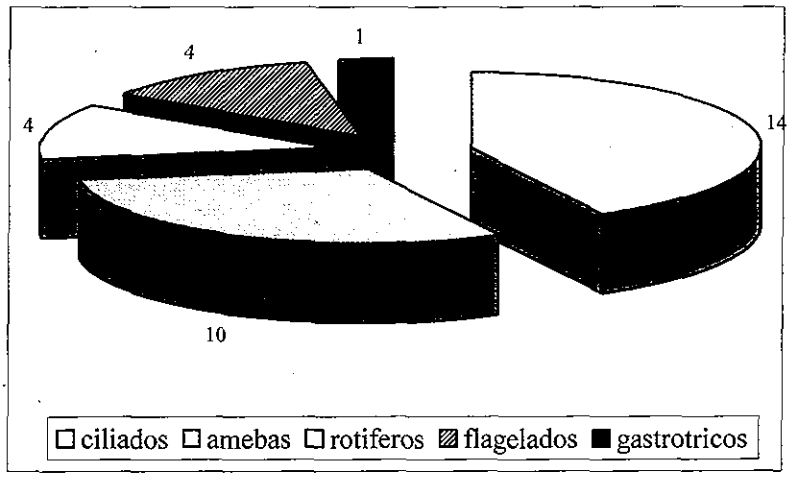


Fig. 4.13 Distribution by Zooplankton Groups

The plankton population, known as primary producers, plays an important role in the equilibrium among the rest of the aquatic organisms. This is because they constitute the base of the food chain in the transformation of solar energy in organic chemical energy, which is indispensable for the survival of the other groups.

With respect to the Protozoon and Zooplankton population, the Carolina and Vado Nuevo sites show similar results in terms of diversity as well as abundance. This is due to the availability of food in both places. Nuevo Edén de San Juan is relatively different due to the differences in its aquatic environment.

ii) Benthonic Population

In the Benthonic population, seven different groups of aquatic insects were studied, being the most prominent the Dipteral group in which flies and mosquitoes were the most common species. These are represented by 4 families. Other groups include Ephemenoptera and Trichoptera, represented by 2 families each. The rest of the groups were represented by only one family. The crustaceous group in the only one characterized by a single gender, as seen in Figure 4.14

Insects in the area are an important indicator of the availability of organic materials and water, and thus, the quality of the water. Furthermore, the presence of insects guarantees the presence of dissolved oxygen in the water. More importantly, since insects consume plankton, they help diminish the existence of microorganisms that cause diseases for human beings such as the sacordinos and amebas.

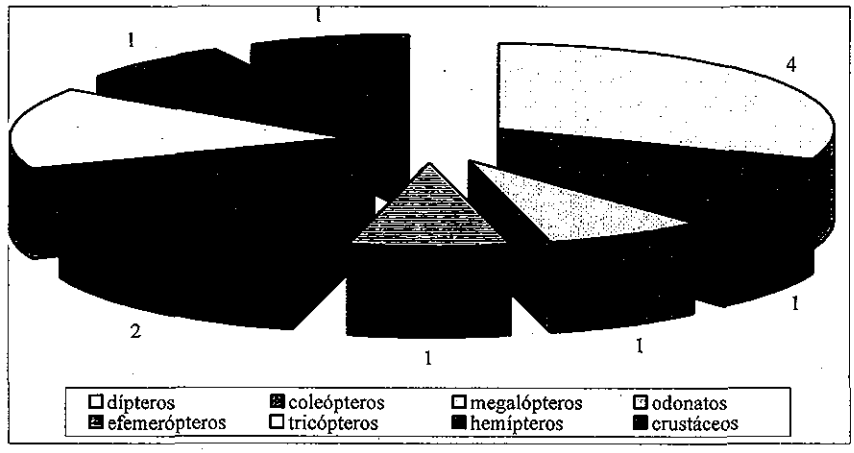


Fig. 4.14 Distribution by Benthic Groups

The benthonic population was analyzed through the observation of insects captured in the Carolina and Vado Nuevo sites, whose results are similar. Vado Nuevo exhibited greater diversity and minor diversity than the Carolina site.

iii) Nektonic Population

The study done in the nektonic population was maily composed of the family of fish, crustaceans and mollusks, finding in the group of fish the greater diversity. A lists of registered planktonics and benthonic organisms appear in Attachment 1.

- **Fish**

An investigation was carried out on aquatic macro fauna, that is, large organisms like fish, crustaceans and mollusks, in four sites along the river: a) in the site known as Poza Agua Caliente, located in the upper part of the future reservoir; b) in the site Carolina, located in the middle area of the future reservoir; c) at the dam site, and d) in the Poza de la Mula, in Vado Nuevo, 1,5 km down stream from the dam site. The location of the sampling sites appears in Figure 4.15.

In the sites a and c, during an average of 45 minutes per site, and by means of the use of manual nets with mesh of 1 cm known as "atarrayas", two fishermen fished in areas of pools as wells as rapids. In site c, in addition to the "atarraya", a fixed net of 3 cm of web know as "trasmayo" was used. This net was placed cross-sectionally in the river during 12 hours. This was done between 8:30 a.m. and 3:00 p.m.

■ **Results**

1. Poza Agua Caliente: No captures were made of any macro-fauna specie.
2. Site Carolina: Using the "trasmayo" the following were captured:

-	1 plateada	10 cm in length
-	1 guapote tigre	13 cm in length
-	2 mojarras (burras)	8 cm average size
-	13 mojarras (butas)	7 cm average size
-	3 chimbolos	8.1 cm average size

3. Dam Site: One 13 cm long filing was captured.

107

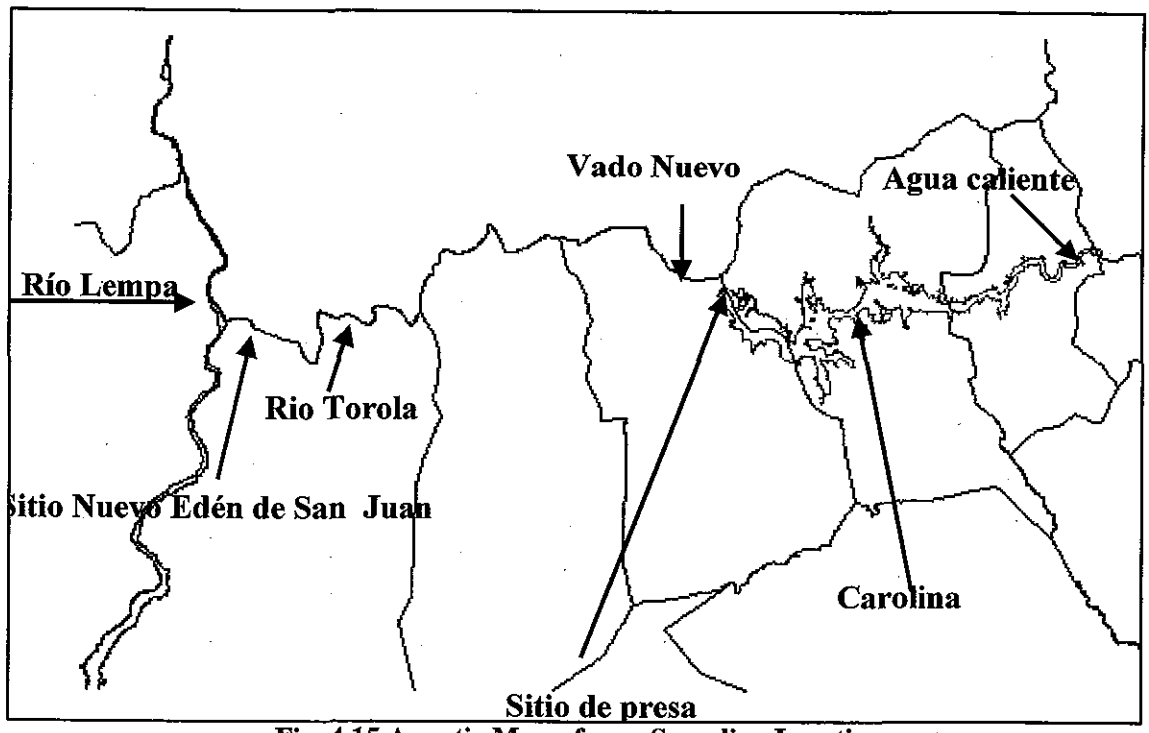


Fig. 4.15 Aquatic Macrofauna Sampling Locations

At the pond "La Poza de La Mula" in Vado Ancho, five fishermen spent 4 hours (10:00 am to 2:00 pm) doing fishing. The equipment they used was comprised of : two home made harpoons (made out of wood, elastic bands and iron bars), and two dragging nets "Trasmayos" The pond in reference is 300 m long by 30 m wide; One of the "Trasmayos" was installed crossing the river at the lower part of the pond, the other one was dragged down from the upper part of the pond. During the dragging operation, the fishermen captured the following fishes:

- 12 "tilapias" Size range: average size 25 cm - larger than 37 cm.
- 8 "bagres" Size range: average size 28 cm – larger than 33 cm
- 25 "mojarras" Size range: average size12 cm - larger than 21 cm
- 2 "guapotes" Size range: average size 19 cm - larger than 23 cm

iv) Crustacean

The sampling of crustacean organisms was done by searching their natural habitat that is, to say in crevices located underneath submerged stones. This activity was done at places with lot of stones and in places with water falls. The searching was done during a period of 45 min. One river crab "cangrejo de río" of 7 x 5 cm. in size was captured. Table 4.17 shows a list of the macrofauna organisms observed or captured.

Table 4.17 List of Fish Species recorded in the Torola River

Common Name	Scientific Name	Family	Presence During Capture
Fish			
"plateada"	***Astyanax fasciatus***	Characidae	Scarce
"chimbolo"	***Poecilia sphenos***	Poecilidae	Scarce
"bagre"	***Arius guatemalensis***	Ariidae	Scarce
"guapote tigre"	***Cichlasoma managuense***	Cichlidae	Scarce
"mojarra"	***Cichlasoma nigrofasciatum***	Cichlidae	Moderate

Common Name	Scientific Name	Family	Presence During Capture
"tilapia roja" *	***Oreochromis sp,***	Cichlidae	Abundant
"cuatrojos"	***Anableps dowi***	Anablepidae	Scarce
Crustacean			
"cangrejo de río"	***Pseudotelphusa sp.***		Scarce
Mammals			
"perro de agua" **	***Lutra longicaudata***	Mustellidae	Endangered

* introduced specie

** referenced by the local people

Generally speaking, the presence of macrofauna is scarce. There represents no significative resource for feeding of the population, because if it were the plan to capture large sized organisms (30 cm) then, it would be necessary the participation of a group of fishermen equipped with a variety of fishing equipment. The fishing must be continued for at least 4 hours. The fishing method used in Vado Nuevo is frequently used at the majority of the ponds along the river. This practice increases the rate of exhaustion of the fish resources. Figures 14.12 to 14.22 show the development of the fishing activity and the captured organisms at the sampling sites.

v) Mollusks

In the group of mollusks, only small snails with an average size of 1 cm where observed.

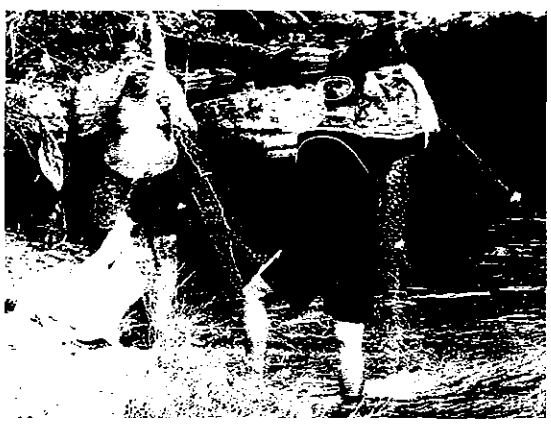


Photo 4.3 and 4.4 Installation of Dragging net" transmayo" at Vado Nuevo

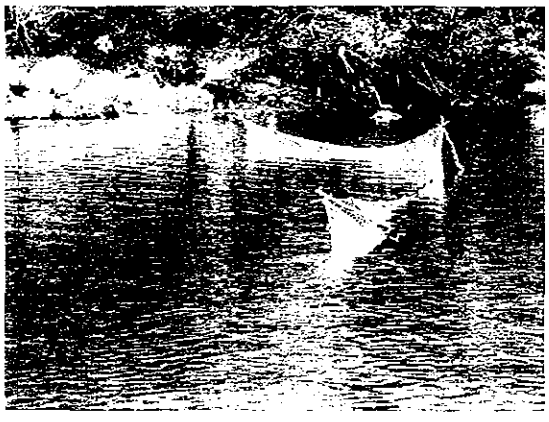


Photo 4.5 "Trasmayo" already installed

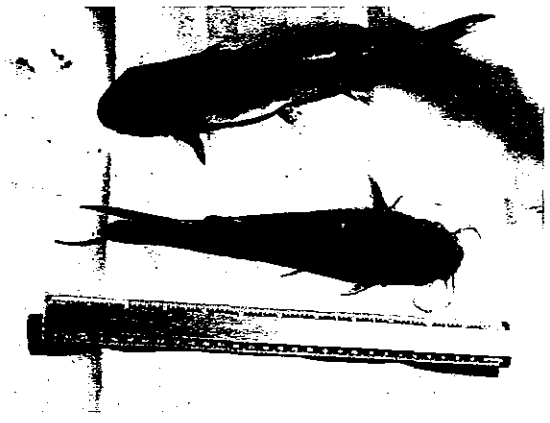


Photo 4.6 Cat fish "bagre" species

Photo 4.7 and 4.8 "tilapia" capture using harpon. "trasmayo" at the back

Photo 4.9 Captured species "tilapia", "mojarra"

Photo 4.10 Captured organisms at Vado Nuevo "guapote"

Photo 4.11 "cuatrojos" specie

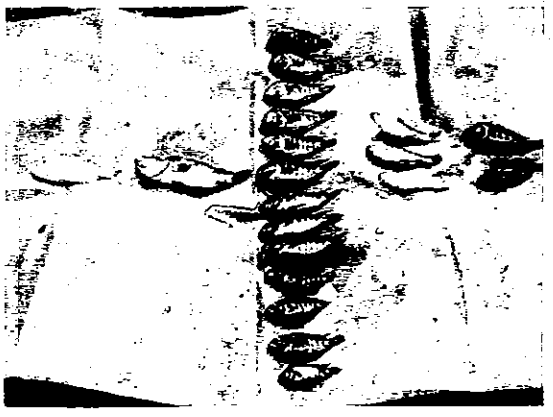


Photo 4.12 Captured organisms at Carolina

Photo 4.13 "river crab" captured at Vado Nuevo

d) Environmental Quality of the Studied River Reach

The record obtained in the samples will serve as a base for the characterization of the organisms or groups of aquatic organisms, which are considered as indicators of environmental quality.

The presence and the abundance of organisms at three monitoring stations were compared with the level existing in the river at the date the samples where collected. The relationship was established and the conclusion was as follows: The existence of organisms that are resistant to the pollution in the river is due to the fact that there is a high concentration of organic pollutants. This condition provides the nutrient that generates the ideal environment for these species to grow in those areas.

Out of a total of 71 algae species identified, it was determined that 38 species indicate the presence of organic pollutants, another 30 species were identified as indicators of clean water. The fact that these two different species are present indicates that there is a mix of different environments. The mixed water is comprised of clean water that comes from subsurface aquifers and small creeks while the polluted water enters the river stream from different sources along the river. It was determined during the investigation that the species tolerant to organic pollutant were always the larger population. However the presence of other species identified as clean water indicators was sporadic and with smaller population. See Tables 1 to 28 in Appendix A.

Twenty seven indicator species were identified in the zooplankton community. Due to the fact that the zooplankton indicators are more stringent, it was possible to identify 24 indicator species that are able to tolerate and take advantage of the high concentration of organic pollutants in the river, the remaining 3 were species indicating the mix with clean water.

The existence of high organic pollution was confirmed with the bentos community that was worked out with the community of the aquatic insects. Most of the representatives of this community are organisms that are able to tolerate the organic pollution.

The presence of more groups in the Vado Nuevo station (larger specific diversity) indicates that at the site, there are a diversity of micro environments that allows the settlement of more species, in addition, the condition of still water that exist in the area favors the proliferation of other species.

Along with the investigation, at the #2 site, it was observed the abundance of an aquatic plant (low vascular specie) represented by the *Selaginella sp algae.* This plant was not observed at the # 1 and # 3 sites. Annex 1 shows the global result of microscopic organism.

4.2.4 Water Quality

The Torola River is one of the main tributaries of the Lempa River. It begins at the North-East of El Salvador at elevation 1,220 masl The river has more than 100 km long in El Salvador were the basin has an area of 1,475 Km^2; The river channel has an average slope of 1.6 m/km. It collects the water from numerous short, low-flow tributaries. Out of them, the more representative is "El Sapo" River that discharges into another river that is located upstream of the bridge along the road to Perquin.

The water quality of the Torola River is being affected by several activities that take place over the basin. Some of these activities are laundry, personal care, use of fertilizers, use of toxic products for fishing purposes and the discharge of sewer water. One actual case is the discharge from Carolina City that goes directly into the El Rastro creek that finally discharges the polluted water into the Torola River.

The water quality was determined by taking samples from the three named locations at five different dates. The sampling process took place along the period from October to December 2001, and the analysis of the water was aimed to determine only selected parameters. The goal of the

investigation was to compare the actual data on the water with the data that will be obtained after the completion of the Project

a) Sample Management and Analyzed Parameters

- A Data Sonde Water Quality Multiprobe model Hydrolab H_2O was used for the sampling and the analysis of the following parameters: Water temperature, air temperature, turbidity, dissolved oxygen, oxygen saturation and conductivity

- The samples intended for microbiologic analysis were preserved at 4°C and transported to the lab in amber glass containers.

- The samples intended for physiochemical analysis were preserved at 4°C and taken to the lab in plastic containers.

The analysis performed on the water samples are listed below:

Physiochemical Parameters: Color, odor, water temperature, air temperature, pH, electric conductivity, turbidity, dissolved oxygen, oxygen saturation, total suspended solids, total dissolved solids, total solids, alkalinity, hardness, oxygen biochemical demand, oxygen chemical demand, nitrogen forms, phosphorous forms, total organic carbon, calcium, magnesium, sodium, potassium, chlorine, sulphate, iron, manganese, boron, oil and grease, phenols, cyanide, silica,

- Heavy Metals: Mercury, arsenic, selenium, copper, chromium, lead, barium

- Microbiologic: fecal coliforms, total coliforms.

The pH indicates that the water acidity, where 7 is neutral; with lower numbers indicating acidity and higher numbers (7 to 14) indicating alkalinity. The Oxygen Demand concentration indicates the quality of the water mass. The value 5 to 7 is considered a healthy level for maintaining aquatic life.

The electric conductivity measures total dissolved ions; it provides information about the pollution level of the water. Dissolved solids are water pollutants but, in addition they indicate the erosion level in the basin. The values of DBO represent the quantity of OD required to stabilize the organic material that enters the river. If the value of DBO is greater than the concentration of OD, then there will be a deficit of this element. That is why a value less than 8 mg/L of DBO is the lower limit for the maintaining normal aquatic life. (FUSADES, 1999 and Requena & Meyton, 1991).

b) Analysis Results

The official regulation for potable water approved in 1996 by the Consejo Nacional para la Ciencia y la Tecnologia (CONACYT) establish the limits for 29 parameters. Taking this as a base we observed that 10 out of the total of parameters analyzed exceeded the limits: pH, turbidity, iron, manganese, phosphorous, mercury, fecal coliform bacteria, total coliform bacteria measured as NMP/100 (more probable number in 100 ml), oil and greases.

For the development of aquatic life, it was found out that in Carolina nad Vado Nuevo, pH excees the average with 0.26, maximum concentration value established by EPA. As well, in Carolina, manganese exceeds in 0.03, mercury in 0.0011, selenium in 0.00009, and color in 33 units.

Regarding agriculture use, 11 parameters were investigated. The results show that the pH and total coliform bacteria exceeded the limits established by FAO regulations.

113

Based on the pollution level obtained from the analysis of 3 parameters and in accordance with the Informe de Consultoria para MAG/SEMA "Evaluación de Ecosistemas Acuáticos Contaminados" (1994. Rubio, F.), the following classification has been established for the Torola River

Class	OD (ppm)	DBO (ppm)	Total Coliform NMP/100 ml
I	More than 7	Less than 3	Less than 50
II	5 – 7	3 – 5	50 – 5,000
III	4 – 5	5 –20	5,000 – 20,000
IV	Less than 4	More than 20	More than 20,000

Where

I: Excellent quality-Potable after disinfection

II. Good quality –Potable with total treatment

III: Poor quality –could cause problems for the human consumption and other uses –pisiculture, cattle and some crops.

IV: High pollution –problems for most uses.

The following classification have been established for the stations along the Torola River

Classification of the Torola River Based on Pollution Level

Station	OD	DBO	Total coliforms
Carolina	I	II	IV
Vado Nuevo	I	III	III
Nuevo Edén de San Juan	I	II	II

Tables 4.18 and 4.19 show average data of the obtained results and Attachment 2 shows the complete results of the performed analysis.

Table 4.18 Results of the Physical, Chemical, and Bacteriological Analysis of the Torola River Water, 2001. Page 1/2

Parameter	Unit	Average Results			Maximum Acceptable Concentration			
					Aquatic Life	Potable Water		Irrigation
		Carolina Station	Vado Nuevo Station	Nuevo Edén de San Juan Station	CMC (EPA, 1998)	EEC	CONACYT (1996)	FAO
Water Temperature	°C	26.70	27.44	26.47				
Ambient Temperature	°C	31.20	29.86	26.33				
pH	Unit	9.23	9.30	8.82	6.5 to 9.0	6.2 - 8.5	6.0 to 8.5	6.5 to 8.4
Electric Conductivity	μmhos/cm	0.0101	0.0104	0.02			1,600.000	
Turbidity	NTU	27.53	19.10	2.89		4 NTU (No microbial)	1.000	
Dissolved Oxygen	mg/L	8.16	8.42	7.33	> 5			
% of Oxygen Saturation	%	104.61	104.05	150.12				
Odor		None	None	None				
Color	Pt.Co	55.40	51.00	22.67	20 mg Pt-Co/L			
Total Dissolved Solids (STD)	mg/L	105.80	117.30	145.00			1,000.000	
Total Suspended Solids (STS)	mg/L	41.10	33.70	6.33				
Total Solids	mg/L	0.00	0.00	0.00				
Alcalinity	mg/L	49.98	53.04	71.40				
Hardness	mg/L	38.28	40.45	60.57		50 mg/L		
Oxigen Biochemical Demand(DBO5)	mg/L	4.57	5.71	3.75				
Oxigen Chemical Demand	mg/L	51.76	48.05	79.73				
total Kjeldahl Nitrogen (NTK)	mg/L	3.56	3.85	3.57			1.00 mg/l	
Ammoniaa (NH3-N)	mg/L	0.15	0.26	0.10	As per PH criteria	0.5 mg/L	0.50 mg/l	
Nitrate (NO3-N)	mg/L	0.59	0.70	1.72	10.00 mg/l	50 mg/L	10.00 mg/L	
Nitrit (NO2-N)	mg/L	0.0001	0.0011	0.03	10.00 mg/l	0.1 mg/L	1.00 mg/l	
Reagent (ortho -) Phosphorous	mg/L	0.18	0.17	0.39				

CMC (EPA): Maximum Concentration Criteria (US-EPA)
EEC: Economic European Union
CONACYT: Consejo Nacional de Ciencia y Tecnología, Norma Salvadoreña
FAO: Food and Agriculture Organization of the United Nations

Table 4.19 Results of Physical, Chemical, and Bacteriological Analysis of the Torola River Water, 2001. (Page 2/2)

Parameters	Unit	Average Results			Maximum Acceptable Concentration			
					Aquatic Life	Potable Water		Irrigation
		Carolina Station	Vado Nuevo Station	Nuevo Edén de San Juan Station	CMC (EPA, 1998)	EEC	CONACYT (1996)	FAO
Total Phosphorous	mg/L	0.56	0.64	1.37		5 mg/L	0.10 mg/l	
Total Organic carbo	mg/L	4.61	3.79	4.63				
Phosphate	mg/L	0.00	0.00	0.00	0.05 mg/l		0.01 mg/l	
Calcium (Ca)	mg/L	21.15	22.01	36.62			75.00 mg/l	
Magnesium (Mg)	mg/L	8.67	10.63	23,96			50.00 mg/L	
Sodium (Na)	mg/L	6.49	7.12	12.81		75-150 mg/L	150.00 mg/L	
Potassium (K)	mg/L	1.98	2.10	4.24		12 mg/L	10.00 mg/L	
Chorine (Cl)	mg/L	0.95	0.83	3.39		25 mg/L	250 mg/l	10 meq/l
Sulphate (SO4)	mg/L	3.85	4.28	8.22			250.0 mg/l	
Iron (Fe)	mg/L	0.0735	0.29	0.18	1.00 mg/L	0.2 mg/L	0.30 mg/L	5.00 mg/L
Manganese (Mn)	mg/L	0.13	0.10	0.06	0.10 mg/l	0.2 mg/L	0.05 mg/l	0.20 mg/l
Boron (B)	mg/l	0.00	0.00	0.00	0.01 mg/l	1.0 mg/L	0.30 mg/L	0.75 mg/l
Total Coliform Bacteria	NMP/100mL	20,853	7,238	873.33		0 or MPN < 1	No detectable	5000 in 100 ml
Fecal Coliform Bacteria	NMP/100mL	13,600	6,049	206.67		0.00	No detectable	
Mercury (Hg)	mg/L	0.00254	0.001301	0.00085	0.0014 mg/L	0.001 mg/L	0.002 mg/l	
Arsénic (Como)	mg/L	0.00	0.002	0.00	0.34 mg/L	0.05 mg/L	0.01 mg/l	0.1 mg/l
Selenium (Se)	mg/L	0.0001	0.00	0.00	0.00001 mg/l	0.01 mg/L	0.01 mg/l	0.02 mg/l
Copper (Cu)	mg/L	0.00	0.00	0.00	0.013 mg/L		1.00 mg/l	0.20 mg/l
Cromium (Cr)	mg/L	0.00	0.00	0.00	0.16 mg/L	0.05 mg/L	0.05 mg/l	100.000
Lead (Pb)	mg/L	0.00	0.00	0.00	0.065 mg/L	0.05 mg/L	0.01 mg/l	5.0 mg/l
Barium (Ba)	mg/L	0.00	0.00	0.00				
Cianide (SNC)	mg/L	0.00	0.00	0.00	0.022 mg/L	0.05 mg/L		
Oil and grease	mg/L	9.40	8.5	14.00			No detectable	
Phenols	mg/L	0.00	0.00	0.00				
Sílica	mg/L	0.00	0.00	0.00			125.0 mg/l	

CMC (EPA): Maximum Concentration Criteria (US-EPA)
EEC: Economic European Union
CONACYT: Consejo Nacional de Ciencia y Tecnología, Norma Salvadoreña
FAO Food and Agriculture Organization of the United Nations

c) Eutrofication

Based on the results of OD, it can be concluded that the river has excellent qualities in the three sampling stations. In regards with the DBO, at the Vado Nuevo Station, the water is of low quality and in two remaining stations it is of good quality. In terms of the count of total coliforms at the Carolina Station, the water presents high contamination, at the Vado Nuevo Station the water is of low quality and at the Nuevo Eden Station, the water is of good quality.

As a conclusion and in accordance with the references used, the Torola River water does not fulfill the established requirements for potable water, for maintaining aquatic life or for irrigation. The general classification regarding the water quality measured in terms of pollution level is poor. This is due to the quantity of total coliforms bacteria and the total fecal coliform that is present in the water. This condition is the result of the pollution generated by the agricultural activities and the inflow of polluted water from domestic activities.


Photo 4.14 and 4.15 Sampling of bentonic organisms


Photo 4.16 Inspecting stones for insect presence

Photo 4.17 Portable sampling equipment

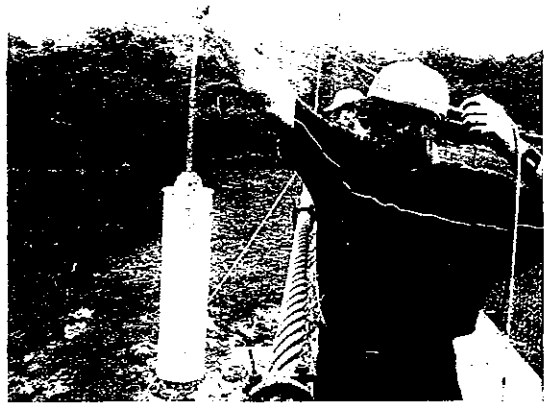



Photo 4.18 and 4.19 Sampling of water

4.3 Socioeconomic Environment

Research was conducted to understand the socioeconomic situation in the influence area of the Project, including field activities consisting of site visits and interviews with local authorities, leaders, and families living in the area of the future reservoir. The site visits permitted informing the local people about the governmental intention to execute the project and consequently to obtain particular information from each family.

Also a bibliographical investigation was made to collect statistical data related to economic and social indicators that facilitate understanding of the level of development in the zone. These indicators are tied directly to parameters related mainly to the sectors of education, health, housing, and employment.

The research shows poor indicators, especially in rural areas, as the people have to move to cities where these services are available.

With the reservoir, areas of the municipalities of San Luis de La Reina, Carolina and San Antonio del Mosco, will be flooded. In this area 89,4% of lands is used mainly for grain and grass crops, the remaining of the zone constitutes small areas with natural vegetation and unexploited land.

The execution of the Project will occupy an area of 8,6 km^2, of low agricultural productivity. The Table 4.21 shows the relation between the area to be flooded compared with the total area of the municipalities.

Table 4.21 Relation of the Area to be Flooded with the Project by Municipality

Municipality	Total Extension of the Municipality	Area to be Flooded	Relation with the Area of the Municipality
San Luis la Reina	168.18 km^2	1.3 km^2 in Cantón San Antonio.	1%
Carolina	52.92 km^2	6.78 km^2 Distributed in cantones La Orilla, Soledad Terrero, La Ceibita y Rosas Nacaspilo.	12.8%
San Antonio del Mosco	16.91 km^2	0.52 km^2 in Cantón San Diego.	3%

4.3.1 Population

The population dynamics in the three municipalities has been fluctuating, specially in the last 3 decades, due to the impact caused by the social conflict in the country, reason why the rate of population growth is remaining low, reflected by an intense emigration of the population towards other zones to the interior and outside the country, as well as through mortality.

Population data of in municipalities is presented below:

- **San Luis de La Reina**

The Municipality has an extension of 168,18 km^2. The year 2000, the total population was of 7,312 inhabitants, which represents a population density of 44 inhabitants per km^2. The urban population was 1,131 inhabitants and the rural population 6,221 inhabitants distributed in four cantons, as detailed below:

Urban Population, Cabecera municipal		1,131 habitants
Rural population, Cantones:	El Junquillo	1,923 habitants
	Ostucal	1,324 habitants
	San Antonio	1,900 habitants
	San Juan	1,034 habitants
Total		7,312 habitants

- **Carolina**

The municipality of Carolina has an extension of 52,28 km^2, for year 2000, its population was of 9,122 inhabitants, with population density of 175 inhabitants km^2. The distribution of the population appears below:

Urban Population, Cabecera municipal		2,196 habitants
Rural Population, Cantones:	La Ceibita	1,498 habitants
	La Orilla	1,228 habitants
	Miracapa	970 habitants
	Rosas Nacaspilo	2,396 habitants
	Soledad Terrero	834 habitants
Total		**9,122** habitants

- **San Antonio del Mosco**

The municipality has an extension of 16.91 km^2. For the year 2000 the population was 7,657 inhabitants, the greatest population density in the project zone. 453-inhabitants/km^2-. The urban population was 802 inhabitants and rural population 6,855 inhabitants, distributed in two cantons.

This municipality shows an expanding population profile, with accelerated growth; being considered that the present population would double in 30 years. The population of the municipality appears below:

Urban Population, Cabecera municipal		802 habitants
Rural Population, Cantons:	San Marcos	4,300 habitants
	San Diego	2,555 habitants
Total		7,657 habitants

Source for population Data: Analysis based on the following publication: Monografías del Departamento y Municipios de San Miguel, IGN, 1997.

Table 4.22 shows the total population for the three municipalities for the year 2000.

Table 4.22 Population of Municipalities in the Project's Location

Department	Municipality	Population		
		Urban	Rural	Total
San Miguel	Carolina	2,196	6,926	9,122
	San Luis de La Reina	1,131	6,181	7,312
	San Antonio del Mosco	802	6,855	7,657
Total		**4,129**	**19,962**	**24,091**

Based on topographic maps prepared from aerial photos of December of 1999 and by field reconnaissance, the existing houses and other structures in the ADI were identified, grouping them by small village in each municipality. As of December of 2003, there were 79 families who will be

120

directly affected by the formation from the dam. In addition, there is an school in the small village El Terrero, Canton Soledad Terrero de Carolina; and two small churches, the one in the small village Jocote, canton Soledad Terrero and another one in the small village Santa Clara a of the Rosas Nacaspilo, in Carolina. The distribution of the houses is presented in Table 4.23.

Table 4.23 Distribution of Houses in the Project's Influence Area

Municipality	Canton	Small Village	Houses in the Small Village	Houses in the area of influence of the Project
Carolina	La Orilla	El Cerrito	44	15
Carolina	Soledad Terrero	El Terrero	45	2
Carolina	Soledad Terrero	El Jocote	33	13
Carolina	Rosas Nacaspilo	Santa Clara	64	12
Carolina	La Ceibita	La Ceibita	30	5
Carolina	Miracapa	Vado Ancho	16	16
San Antonio del Mosco	San Diego	San Antonio	27	10
Total houses				79

In San Luis de La Reina there are no houses in the ADI.

In order to obtain data on the socioeconomic aspects of the population located in the area of direct influence, house surveys were made using the form that appears in Attachment A4. In Table A5.1, of Attachment A5, the geological location of the houses in the zone is shown.

Regarding the land area and the construction of the houses, it varies according to the economic condition of the families. I In 50% of the houses the house area is equal or less than 96 m^2 and the lot is a block equivalent to 7,000 m^2.

In relation to the construction materials of the houses, 12% are made with walls of cement blocks, 42% walls are made of unburned bricks. 40% are made of bahareque, 6% are elaborated with rustic wood. Figures A4.22 to 4.25 models of houses located in the zone are shown. Figures A6.1 of Annex 6 shows a list of family chief, grouped by houses which include two churches and a school.

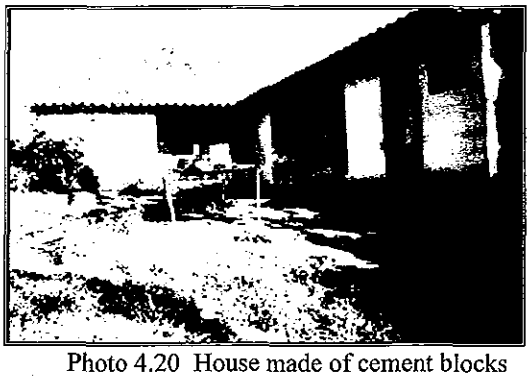


Photo 4.20 House made of cement blocks

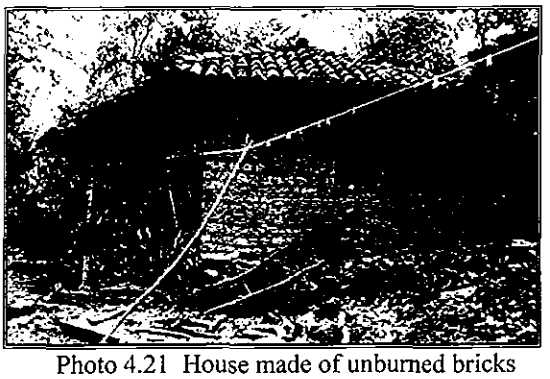


Photo 4.21 House made of unburned bricks

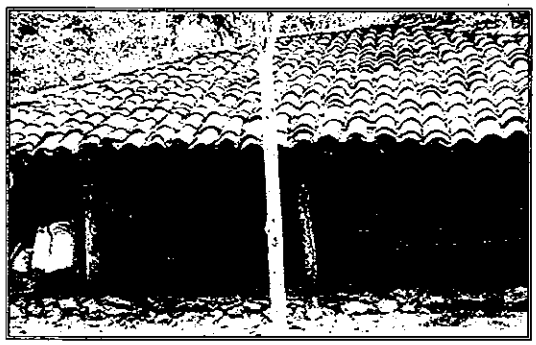


Photo 4.22 House made of bahareque

Photo 4.23 House made of rustic wood

- **Indigenous Population**

The indigenous population present in the basin of the Torola River is located mainly in the department of Morazán and is of Lenca origin. They settled down in the zone more than two thousand years ago, constituting one of the more important ethnic groups of El Salvador.
The Lencas occupied the territory located to the east of the Lempa river, which today constitutes the Eastern zone of the country, and in the department of Morazán this population was based mainly in Cacaopera. The oldest population still maintains the ancestral tradition of the natives. At the present time, the indigenous population that lived in the urban nucleus of Cacaopera has displaced itself to a rural zone. The most remarkable concentrations are in the small villages of El Copante and La Naranjera, located respectively to 5 and 8 km to the northeast of the city, in where they live in conditions of extreme poverty. Their houses have only a single room, mainly constructed with rustic materials.
Existence of indigenous population in the zone of influence of the project was not observed.

4.3.2 Education

As to the educative levels, in urban area of three municipalities, there exist high schools. In the rural area, there exixts generally the level of Sixth grade, and only in the cantons of San Diego and San Marcos of San Antonio del Mosco; in the cantons of Rosas Nacaspilo, La Orilla and La Ceibita of Carolina, and cantons of San Antonio of San Luis de la Reina, there exists Ninth grade. In the three municipalities, there are 41 schools of primary education, four in municipal heads and the rest in the cantons, as shown on Table 4.24.

122

Table 4.24 Schools in the Municipalities

Municipality	Quantity of Schools
San Luis de La Reina	**9**
• Municipal head	1
• San Antonio	3
• El Junquillo	1
• San Juan	2
• Ostucal	2
Carolina	**21**
• Municipal head	2
• La Orilla	3
• Soledad Terrero	3
• La Ceibita	4
• Rosas Nacaspilo	5
• Miracapa	4
San Antonio del Mosco	**11**
• Municipal head	1
• San Marcos	4
• San Diego	6

Source: School Survey, 2001.

- **San Luis de La Reina**

The municipality has a school population of 1,529 students, the majority is registered in the basic level and solely 55 students are in High School.

- **Carolina**

The schools of Carolina have a student population of 3,095 from first to ninth grade. High school is the municipal head only.

- **San Antonio del Mosco**

This municipality has concentrated its schooling in the levels of elementary education. However, the High school study is available by commuting.

4.3.3 Public Health

Special interest was dedicated to investigating the epidemiological conditions in the zone of influence for which the offices of the Ministerio de Salud Pública y Asistencia Social (MSPAS) in San Salvador, San Miguel, Ciudad Barrios and in the three municipalities in where the project is located were visited. The objective of these visits was to determine, using the medical statistics, the incidence of diseases in the zone, and to establish a database that serves as a reference for verification after execution of the project.

- **Access to Health Services**

The MSPAS has three main levels of health services to the population:

Health Units, Medical Health Positions, and Clinics constitute the first level, providing a direct link with the rural communities' population.

The second level are hospitals with better facilities and technical capacity, to where are referred the complex cases, which are beyond the capability of the first level. These hospitals provide basic specialty services like Pediatric, Surgery, Gynecology and Internal Medicine.

123

The third level constitutes diversified Medical Centers, where all medical specialties are available.

The population has access to these services. With the exception of emergencies, all patients must be referred from the first level. In all the municipalities of the zone of influence of the Project exists a Health Unit with a doctor, a graduated nurse or full time medical assistant. In the small village Santa Clara, Canton Rosas Nacaspilo, Carolina there exists a Medical Clinic -Dispensary-.

Complementary to these personnel there were authorized midwives, health inspectors, and administrative personnel. The complex health cases are referred to the hospitals located at Ciudad Barrios, San Francisco Gotera or San Miguel. In the zone of the project, during the decades of the 1980s and 1990s, besides the MSPAS, diverse institutions and organizations administered health services. Currently, the MSPAS is the only organization offering health services.

- **Most Frequent Illnesses**

In an annual health report provided by the MSPAS, ten primary causes of external medical consultation in the different health establishments were identified.

The percentage of people that get sick nationally, i.e. morbidity, is very similar with the percentage at a local level. This is due to the small size of the territory and the existence of environmental and epidemiologic factors such as air, water and ground pollution, malnutrition, lack of hygiene, large concentration of people, and ease of population mobility. Table 4.25 shows the most frequent causes of illness in the country.

Table 4.25 Percentage of National Morbidity, 2001

No.	Cause for Consultation	No. of Consultations	Rate per 100,000 Habitants
1	Upper respiratory Infections	1,405,273	0.28
2	Maternal child preventive consultations	508,729	0.10
3	Intestinal Parasitism	281,556	0.05
4	Diarrhea and gastroenteritis of infectious origin	262,501	0.05
5	Urinary Infections	237,852	0.05
6	Routine general medical exam	169,247	0.03
7	Acute Bronchitis	133,271	0.03
8	Mycosis	116,567	0.02
9	Routine Gynecology Exams	97,676	0.04
10	Skin Infections	85,864	0.02

Source: MSPAS. Dirección de Planificación de los Servicios de Salud, 2002.

- **San Luis de la Reina**

The morbidity in the area of San Luis de La Reina is shown in Table 4.26.

Table 4.26 Morbidity in San Luis de La Reina, 2001

No.	Cause for Consultation	No. of Doctor's Visits	Rate per 100,000 Habitants
1	Intestinal Parasitism	553	0.80
2	Acute upper Respiratory Infections	513	0.59
3	Acute Faringoamigdalitis (Sore Throat-tonsillitis)	287	0.33
4	Dermatitis	254	0.29
5	Gastritis	253	0.29
6	Intestinal Infection, poorly defined	188	0.22
7	Anxiety Disorders	174	0.20

No.	Cause for Consultation	No. of Doctor's Visits	Rate per 100,000 Habitants
8	Malnutrition	144	0.17
9	Urinary Infections	116	0.13
10	Urogenital Tricomoniasis	94	0.11

Source: SIBASI / Ciudad Barrios - MSPAS, 2001

When comparing the data of general morbidity, specifically those related to diseases of water-borne transmission, for instance: intestinal parasitism, diarrhea, and intestinal infection. and amebiasis, it was found in the municipalities under study, the rates per thousand inhabitants are practically double that of the national level, indicating that a serious problem of public health related to water pollution already exists.

- **Number of Illnesses in Carolina**

Table 4.27 presents the main causes for doctor visits in Carolina.

Table 4.27 Morbidity in Carolina, 2001

No.	Cause of Doctor Visits	No. of Visits	Rate per 100,000 Habitants
1	Intestinal Parasitism	701	0.80
2	Acute upper respiratory Infections	466	0.53
3	Acute Faringoamigdalitis (Sore Throat-tonsillitis)	295	0.34
4	Vaginal Tricomoniasis	215	0.25
5	Moderate and Severe Malnutrition	165	0.19
6	Acute Gastroenteritis	134	0.15
7	Intestinal Amebiasis	67	0.08
8	Vulvo-vaginal Candidiasis	64	0.07
9	Conjunctivitis	49	0.06
10	Gastritis	47	0.05

Source: SIBASI / Ciudad Barrios - MSPAS, 2001.

The data reported by the Unidad de Salud del Municipio de Carolina show that the illnesses of the gastrointestinal and respiratory passages most frequently affect the population in general, and are accompanied by cases of severe and moderate malnutrition.

- ***Morbidity in San Antonio del Mosco***

Table 4.28 shows the information obtained from SIBASI in Ciudad Barrios concerning the rate of persons getting sick in the area of San Antonio del Mosco.

Table 4.28 Morbidity in San Antonio del Mosco, year 2001

No.	Reasons for Hospital/Doctor Visits	No. of Visits	Rate per 100,000 Habitants
1	Intestinal Parasitism	237	0.32
2	Acute upper respiratory Infections	220	0.30
3	Moderate Malnutrition	151	0.20
4	Intestinal Infection, poorly defined	134	0.18
5	Moderate and Severe Malnutrition	95	0.13
6	Tricomoniasis/candidiasis	83	0.11
7	Acute Faringoamigdalitis (Sore Throat-tonsillitis)	79	0.11
8	Amebiasis without Swelling	64	0.09
9	Lumbago	60	0.08
10	Peptic Ulcer	46	0.06

Source: SIBASI / Ciudad Barrios – MSPAS, 2001.

125

As shown in the previous table, the information for San Antonio of the Mosco shows that the gastro-intestinal and respiratory diseases are most frequent in the population, along with malnutrition.

With respect to the occurrence of social disorder, the following was found. Alcoholic beverages are readily available and sold by vendors. This promotes promiscuity, which leads to acquiring contagious diseases, including a whole array of sexually transmitted diseases, including AIDS. The Unidad de Salud de Carolina reported the death of a woman by AIDS and the confirmed infection of her orphaned daughter. In addition, there is great mobility and frequent changing of partners, which increases the likelihood of having sexual relations without protection.

- **Epidemiology in Area of Direct Influence**

According to the epidemiologic survey administered to the population of the different areas and small villages that are within the Project area, when inquiring about the disease which more frequently affects their families and communities, 90% of the people answered Acute Respiratory Infections (ARIs). Influenza, cough and fevers are the three that affect the population the most, as shown in Table 4.29.

Table 4.29 Most Frequent Diseases in the Area of Direct Influence

No.	Disease or Illness	Cases	Percentage
1	Malnutrition	2	3.2
2	Influenza	23	36.5
3	Cough	2	3.2
4	Fever	1	1.6
5	Influenza, cough, and fever	16	25.4
6	None	2	3.2
7	Influenza and Cough	7	11.1
8	Influenza with Fever	6	9.5
9	Sinus and Allergies	2	3.2
10	Headache	2	3.2
	Total	63	100.0

Source: Socioeconomic Survey 2002.

This data agrees with the statistical data of the MSPAS, which shows that the acute upper respiratory infections are the first cause of hospital visits at the national level and the second at municipal level where the Project is located. This situation is due to the noticeable environmental contamination present, especially air pollution. As the survey reveals:

- 76.2% of families cook with wood
- 80% of families use kerosene lamps for illumination and lights
- 70% of homes were found to contain high levels of fumes and smoke in kitchens.
- 30% of families report that smoke affects and triggers their cough, allergies and eye irritation
- Almost 60% of families burn their trash, which increases the smoke in and around homes. In addition, it is very common to burn areas for agricultural activities.

- **Illnesses Transmitted by Carriers**

The very basic characteristics of a developing country with low coverage of medical services, inappropriate environmental protection, and shortage in the basic services make it very significant the risk of spreading illnesses through carriers or vectors. For this reason, a study has been done to investigate the existence of diseases such as malaria (Malaria) and dengue.

- **Malaria (Malaria)**

Malaria in El Salvador constitutes a serious public health problem according to the rates of registered departmental cases that the MSPAS reports for the year 2001. This can be seen in Table 4.30.

Table 4.30 National Cases of Malaria (per 100,000 Habitants)

Department	Rate of No. of Malaria Cases	Rate of No. of Cases by *P. falciparum* *	Rate of No. of Cases by *P. Vivax* **
Ahuachapán	6.43	0.31	6.13
Cabañas	3.90	0.00	3.90
Chalatenango	3.54	0.00	3.54
Cuscatlán	0.00	0.00	0.00
La Libertad	1.14	0.00	1.14
La Paz	26.53	0.00	26.53
La Unión	25.36	0.00	25.36
Morazán	5.16	0.00	5.16
San Miguel	**2.65**	**0.00**	**2.65**
San Salvador	0.64	0.00	0.64
San Vicente	4.91	0.00	4.91
Santa Ana	0.71	0.18	0.53
Sonsonate	18.01	0.00	18.01
Usulután	10.88	0.00	10.88
Totals	**5.66**	**0.03**	**5.63**

* *Plasmodium falciparum* ** *Plasmodium vivax*

Source: MSPAS. Unidad de Información, Monitoreo y Evaluación, 2001.

The previous table shows that the rate of cases of malaria for the department of San Miguel, which includes de areas of San Luis de La Reina, Carolina and San Antonio del Mosco, has less than 50% cases in comparison to the national rate of 5.66. According to the stratification done by the Malaria Division of MSPAS, the project zone is classified as semi-endemic, that is, intermediate in relation to the national rate.

According to MSPAS, by 2002 the data indicating the presence of malaria, which are shown in Table 4.31, confirm that the area of project El Chaparral is very endemic.

Table 4.31 Malaria Cases in Direct Influenced Area

Municipality	Thick-drop test (+)	Thick-drop test (-)	Total	Positive as per *P. falciparum*	Positive as pr *P.* vivax
San Luis de La Reina	0	0	0	0	0
Carolina	6	69	75	0	6
San Antonio del Mosco	3	10	13	0	3

Source: MSPAS. Unidad de Información, Monitoreo y Evaluación, 2002.

Table 4.31 shows a malaria tendency in the project area and the cases that have been detected are caused for the ***P. Vivax***. Over the last 9 years, no case has been caused by another species. The presence of a very low number of malaria cases detected during the last years in the project area is correlated with the MSPAS data for the year 2002, and only 10% of the blood analyses gave positive results for the ***P. vivax*** in the municipalities of Carolina, San Antonio del Mosco and San Luis de La Reina. In the country there has been registered cases transmitted by ***P. falciparum*** and ***P. malariae***.

- **Dengue**

127

The information obtained shows that the dengue cases in the project area are uncommon 1. In the last years, there has been found only one case in San Luis de La Reina.

The vectors of Dengue that have been found in the project area are the ***Aedes aegypti*** and the ***Aedes albopictus***, both are capable of producing epidemic outbreaks that sometimes can spread over a broad area. Also, the dengue serologic supervision in the department of San Miguel for the year 2001 confirmed 54 dengue cases of 319 samples taken.

4.3.4 Economic activities

The economic activities are mainly related with the basic grain agriculture and the main plant crops are: corn, beans and sorghum, and sugar cane used in the elaboration of row sugar panels. Small areas are also observed with sesame crops, Tule[1] crops and vegetables. Small sisal plantations are observed in the municipality of San Antonio del Mosco.

In relation to the municipality economic activity, it was determined that there are no settlements in the direct influence area in San Luis de La Reina. Therefore, the information presented on this topic is only for Carolina and San Antonio del Mosco, towns where there are small artisan activities. These activities are:

2 families that elaborate mats made of the tule´s fiber,
2 groceries stores,
1 workshop for the elaboration of women clothes,
1 workshop for the elaboration of raw sugar panel made from sugar canes,
1 bakery store,
1 workshop for the elaboration of tile and "adobe",
1 boat or barge located at 1 km from the hanging bridge in Carolina. It is used to transport people and domestic animals across the river. It costs US $0.23 for a person. The boat is shown in Photo 4.24.

Occupation
The main activity of the residents in the influence area of the project consists of agricultural labor. They are mainly dedicated to the production of basic grains and sugar cane and, in smaller scale, to cattle raising. Only in the urban centers, there are a certain level of commercial activities and people working in government offices.

The income of the population in the influence area comes mainly for the revenues obtained from agricultural activities. There is marked unemployment or underemployment since most of the residents own small parcels of land with a low production level. Even though there is an established minimum wage for rural areas, which is US $4.80, the daily salary oscillates between 3.43 and 4.00 US dollars for the adults.

Productivity of the land
The study area is characterized by the presence of deforested and very degraded soils, with severe restriction for use, dedicated principally to the agriculture of subsistence with average yield of 20 qq/Mz of corn, 10 qq/Mz of grain, and 18 qq/Mz of maicillo. In minor scale there also exists livestock farming. The forest resources are very deteriorated and disperse.

[1] *Tule is a fibrous plant and its roots are used to knit mats, fans, hats, etc.*

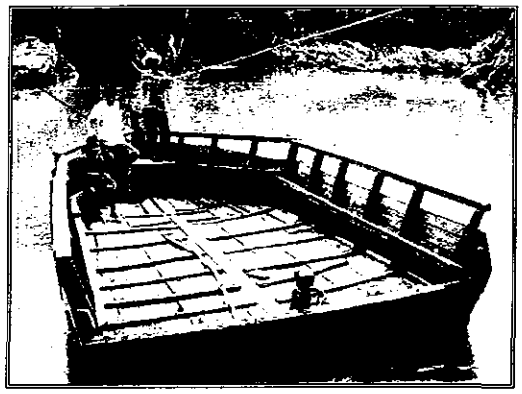


Photo 4.24 View of boat

Agricultural, Cattle and Forestry Sectors

With a relatively low production, the agricultural sector is one of the more representative sectors in the area. It is subsistence agriculture dedicated to basic grains. The cattle raising presents a relatively larger development level in the municipality of Carolina. The forest sector presents no development level since the natural vegetable cover represents the small forest areas that exist located in the riversides of the river and for diverse trees species dispersed in the area.

In the three studied municipalities, the agricultural producers can be classified as:

i) Owners. They live on their land, or adjacent to it. The property's surface varies from one fourth of a block up to more than 30 block (a block is 7,000 m^2). The 50% of the residents work in extensions of one block or less.

ii) Tenants. Sometimes they live next to the leased area and it is not very usual that they live inside the area. Most of the production is for household consumption and the scarce surplus is commercialized in direct form.

iii) Land receivers. In a minor relative quantity, people were found who work the land but they do not pay for its use and they declare it as "borrowed". This type of modality is observed among family groups whom landowner has immigrated to other places inside or outside the country.

iv) Agricultural workers. These are classified in remunerated and not remunerated. In general, they are called journeymen and live in the villages. They work for the landowners and the tenants mainly in planting time and harvesting the crops. They receive a salary that oscillates between $2.86 and $3.40 per workday. The not remunerated manpower is found inside the family group and children and women represent it.

In the cattle sector, there is breeding in small scale of cattle, horse, and pigs and poultry, with predominance in the beef and milk herds. On the average, the livestock owners possess 20 head. One Owner had more than 80 head. The pigs and poultry are raised in the back yards of the houses as much for household consumption as for local sale.

The livestock is commercialized both locally and externally. The external form includes commercialization with the neighboring country of Honduras. The livestock is usually commercialized at auctions carried out in municipal properties called Tiangues; the pigs and poultry are commercialized directly by the owners.

4.3.5 Industrial Facilities

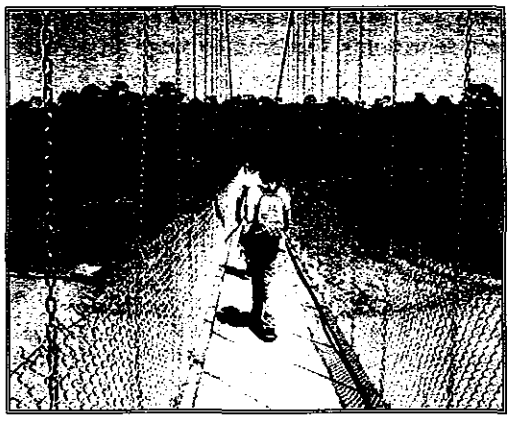
In the influence area of the project, there are no industrial facilities of any type.

4.3.6 Road Infrastructure

The highways, streets and roads represent the road infrastructure. The most important one is the paved highway that drives from Ciudad Barrios to Carolina. There are a large number of secondary roads and horses paths, most of which have difficult access during in the rainy season.

As part of the highway system, there is a pedestrian overpass bridge that is located to the north of Carolina's city. It is 135 meters long, 20 meters high and 1.5 meters wide. This infrastructure would be flooded with the execution of the project. Also there exist three vehicular paths in Carolina and one in San Antonio del Mosco, utilized during dry season when the river flow is low.

Also, along the river section there are 7 crossings used mainly in the rainy season. These are formed by a steel cable that is fastened to both riversides and some of them have a metallic structure where people seat themselves, and by a simple system they cross the river. The Photo 4.25 to 4.28 shows these crossing facilities.



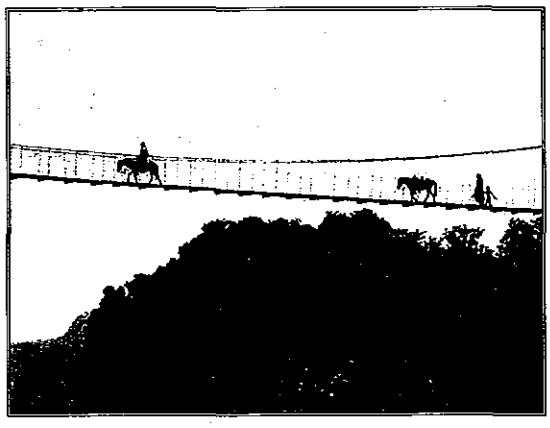


Photo 4.25 and 4.26 Partial View of the Carolina Hanging Bridge

Photo 4.27 Transit of the river by cable

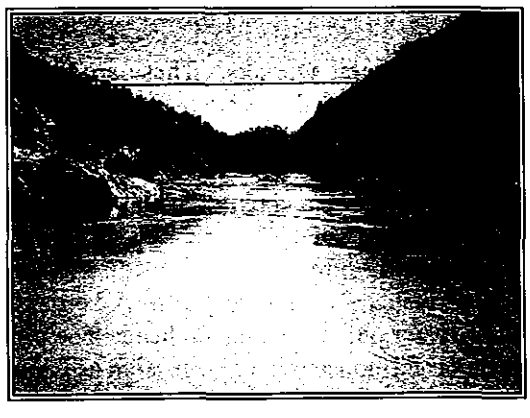


Photo 4.28 View of the river transit cable

4.3.7 Tourist and Recreational Sites

4.3.7 Tourist and Recreational Sites

Even though there are not formal tourist centers in the area, there are many visited places that are used by the population for relaxation and recreation. Among the places of interest is the section of the river located close to the bridge Carolina. Here, a structure of concrete called "malecón" (pier) has been constructed in the left riverside. This structure facilitates that tourists remain. There are thermal waters in the same area that are frequently visited for the healing properties attributed to these waters. Also, besides the many pools located in the river, there is a place called Poza de Los Lagartos in Riachuelo river, located southwest of Carolina, with touristic characteristics during the rainy season. Also there is a soccer field in Vado Ancho of canton La Ceibita. The pictures of these places are presented in Photo 4.29 to 4.32. All these sites are located in the future reservoir area.

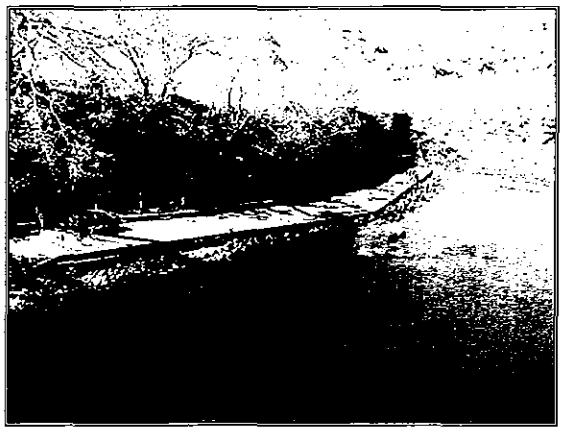


Photo 4.29 El Malecón, Carolina

Photo 4.30 Thermal Water. Carolina

Photo 4.31 Pothole in the Corola River

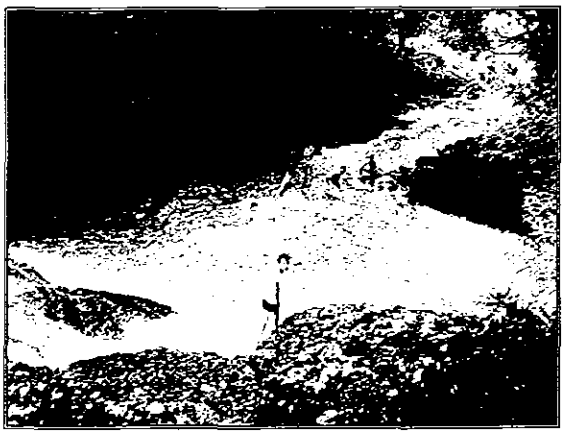


Photo 4.32 Apuzunga Pothole

4.3.8 Services

The available services in the municipalities located in the area are the following:

- **Transportation**

Due to the network of highways and streets that interconnect all the municipalities, there is a daily transportation service with buses that travel from San Miguel to the municipalities in the area. There are also transportation of merchandises and agricultural products.

- **Electricity**

The municipalities in the area are connected with lines of electric distribution of 13.2 kV from which are derived lines of 7.6 kV that extend to the rural areas. The East Electric Company (Empresa Eléctrica de Oriente) is responsible for the electric service. It has offices in San Francisco Gotera and San Miguel. The 15% of the residents count with electric illumination service in the area of direct influence.

- **Communications**

There is national and international telephone communication system in all the municipalities. Currently, cellular telephones and card telephones are used frequently. There are also Post offices in the municipalities.

Other common services are: the security of the Polícia National Civil, (Civil National Police), the Tribunal of Peace, regular bus service that connects with the cities of Ciudad Barrios, Chapeltique, Moncagua, Sesori, San Miguel and San Salvador.

Among the public buildings in the direct influence area, in the village La Pitahaya, in the north of Carolina, are found a elementary school and two churches, one in the village El Terrero of the Soledad Terrero´s canton which is located in the right bank and another in the village Santa Clara in the left bank.

- **Water and Public Health**

In the urban centers, the drinking water service is the responsibility the municipalities, except in the Carolina's city where the drinking water is supplied by the National Administration of Aqueducts and Sewer systems (ANDA). In most of the rural areas, the water is taken directly from the sources and in occasions it is taken to the houses by surface small polyethylene pipelines. In most of the cases, there is no sanitary treatment system for the wastewater.

Pit latrines are used for the final treatment of the human waste in the periphery of the cities and in relative important villages, but in general, the houses do not have latrines.

The solid waste collection service is only supplied in the urban nucleus of San Luis de La Reina. The absence of a domestic solid waste collection system constitutes a potential source of public health problems and environmental contamination.

4.3.9 Use of the Torola River

In general, the people use the river mainly to wash clothes, to bath and for recreation, as well as to fish and to let the livestock drink.

4.3.10 Public Information Dissemination for the Residents

The sectors involved in the environmental administration, from the government sectors as well as from the NGOs and the public in general, particularly the ones directly affected for the execution of the works, must be invited to participate in all development projects and mainly in the project currently studied, since their opinions help to identify potential impacts to the environment. This fosters the execution of environment-integrated designs and the social acceptance of the project. That is why it is important to create interest in these sectors, promoting information exchanges that facilitate accurate information on the importance and magnitude of the works, and at the same time to understand the concerns that the population might have.

Therefore, municipal authorities, communal leaders and the people living in the ADI were visited during the field investigations to talk to them about the extent of the project and to understand their opinions on this matter.

Taking this into account and since 2002, CEL is carrying out an information campaign about the advantages inherent in project execution. Representatives of the diverse sectors of the area have participated in a series of activities carried out by CEL.

A big number of communal assemblies have been carried out in the area. Also informative meetings in San Miguel's city and mainly, CEL has carried out visits to the Hydroelectric Power Station "15 de Septiembre", during these visits a walk is made across the district Lempa-Acahuapa. There have been visits to places where project activities are generated for the construction of the Central Cerrón Grande. It demonstrates the use of lands on a diversity of agricultural production, fishing, tourist and recreational activities. Photo 4.33 to 4.36 show the referenced activities.

Photo 4.33 Meeting with the Area Leaders

Photo 4.34 Visit to the 15 de Septiembre Plant

Photo 4.35 Observing the productive Project Lempa-Acahuapa Irrigation District

Photo 4.36 Turistic Boats Project in Santa Bárbara. Cerrón Grande

m) Land Productivity

The study area is characterized by deforested and very degraded soils, with severe use restrictions, dedicated mainly to the subsistence agriculture with average returns of 20 qq/Mz of corn, 10 qq/Mz of bean and 18 qq/Mz of sorghum. In a minor scale, there is also cattle activity. The forest resources are very deteriorated and dispersed.

4.3.11 Historical and Cultural Patrimony

The historical and cultural patrimony elements are the cultural construction that are known as the historical-architectural patrimony, together with the collections of chattels, which are important for the maintenance of the character and the domestic identity, as well as for the population's cultural formation. The particular record conservation of the human history related with customs and traditions is fundamental for the integration of the regional culture with the universal one.

Due to the importance of these resources, an investigation was made to identify and to register the components of the archaeological, historical and cultural patrimony present in the influence area of

the project. The flood risk level for a flood with the reservoir was studied and inspections were undertaken from the dam site to Vado Ancho.

The investigation was made to determine the locations with archaeological and anthropological potential, like the place called Agua Caliente located in the municipality of San Antonio del Mosco and the place called Carolina, in Carolina. In both places, excavations were carried out with a surface of one square meter and depths from 0.40 to 1 m.

There were found in Carolina indications of possible existences of objects belonging to the archaic period that goes from the 6,000 to the 2,000 years B.C. The discoveries consisted on small obsidian pieces and stone fragments that could be used in human activities. These objects are also usually found outside the influence area of the project and due to there were no constructions nor artifacts that need to be preserved, this constitutes no impediment for the implementation of the project. Nevertheless, it is advisable to carry out a detailed investigations.

The location is located in the left bank of the Torola River, 1.5 km to the north of the city. It is a flat land of approximately 20,000 m^2, with a flat slope toward the south. It consists of two mounds of approximately 20 m of diameter. The place has been and it is being altered by agricultural activities and the filler stones of the mounds are being used for fences, and part of the archaeological material, consisting in ceramic and obsidian fragments, has been removed and dispersed. Photo 4.37 and 4.38 show aspects of the archaeological activity.

It is recommended to undertake a second phase study in the site previously investigated and in another site located on the south side of the river.

Photo 4.37 Excavations in the archeological site

Photo 4.38 Material found

4.3.12 Paleontological Resources

The paleontological work was oriented to investigating and documenting the existence of fossils in the direct influence area of the project. Detailed field inspections were carried out along both banks of the river, from the dam site to Agua Caliente.

A fossil outcrop was found in a place called Vado Ancho. It consisted of calcareous, diatomite and slime that encase large quantities of fossilized invertebrates, with density in some cases of up to 30 individuals for each 20 square centimeters.

A detailed profile of the area was prepared and properly labeled samples of important elements were collected. When observing the profile, it was verified the presence of very dense materials

that seem to be very compact diatomite. Nevertheless, in spite of their density, this material fragments itself easily, being visible a superior materials stratum with gastropod inlays; these superior strata of which fossil material has been collected, are very difficult to extract and to outline. It has not been possible yet to work on them given the urgency of the discovery and the land irregularities. A detailed investigation will be made to allow correct identification of the type of material.

Most of the collected material belongs to fresh water fauna. From the sedimentation levels found, it is deduced that this material belongs to a very old water body.

Due to the discovery of this site, it should be carried out a paleontological study should be undertaken define its importance. A work plan will be elaborated for the registration of the fossil site and it will consist on carrying out excavations during the dry season since this site is inundated during the wet season. This site will be inundated by the future reservoir.

The proposed work would lead to the collection of material in the entire fossil outcrop to elaborate a general profile, facilitating the verification of the life strata found in the area.

It must be assured that this place, even if flooded, will not be disturbed by human activity unless done for scientific purposes. The use of heavy or industrial machinery to clearance trees and weeds could damage the site and should be avoided.

In the event of carrying out excavations in the places of archaeological interest, it will be known by CONCULTURA.

4.4 Generation of Gases from Greenhouse Effect (GEI)

In its 1999 "Study of Options for Mitigation of Greenhouse Gases in the El Salvadoran Energy System" the MARN estimated an emission reduction factor of 0.5 tons of CO2/MWh generated.
The electric power generation attributable to the Project, including the increase at the 15 de Septiembre Power Plant, is 232,000 MWh/year, which represents a reduction of 116,000 tons of CO2 a year, equivalent to 5,800,000 tons of CO2 during the Project's 50-year service life.

The factors to consider in generation of greenhouse gases at hydroelectric plants must include various factors such as flooded area, vegetation, climate, soil composition and age and the service life of the plant. At a reservoir short-, medium- and long-term sources can be distinguished. Among the short-term sources are emissions due to vegetation (leaves, small branches, flowers) found at the flooded site. The slow-decomposition woody material that remains at the flooded site is a medium-term source. Finally, the residual organic carbon in the soil is a long-term source.
For the El Chaparral Project the vegetation in the zone to be flooded will be removed, for which reason it is considered that reduction of generation of CO2 will be greater than what has been calculated.

Loss of CO2 Capturing Capacity

The loss of present CO2 capturing capacity in the area occupied by the Project (dam and ancillary installations) caused by the loss of vegetal coverage estimated at 25% of the occupied surface area has been determined on the basis of the fact that the vegetation consists of mixed deciduous forest (trees, shrubs and thicket). For such calculation a methodology developed by the Climate Change Intergovernmental Panel (PICC) of the CMNUCC has been used. According to that methodology the CO2 capturing capacity is 3.67 (44/12) times the carbon capturing capacity. Each hectare captures 2.6 tons of CO2e a year. The total surface area occupied is 10.2 km2, or 1,020 ha, 25% of which is 255 ha. Loss of those 255 hectares is equivalent to 663 tons of CO2e a year, or 33,150 tons of CO2 during the 50-year service life.

Increase in Capturing Capacity

The quantity of CO2 capturing due to increasing the forest coverage by planting 114 ha of mixed forest (the calculated area of reforestation in the Project) has been determined. Using 2.6 tons of CO2 per hectare a year as the capturing value, that 114 ha increase in forest coverage is equivalent to 296.4 tons of CO2 a year.

4.5 Landscape

The landscape analysis is done understanding it as an element of a series of characteristic of the environment, along with its capacity to absorb alterations attributable to the human activities.

In the landscape study, the methods coincide in the analysis of three important aspects that are: the visibility, the landscape quality, and visual fragility.

The visibility refers to the area that can be appreciated from a certain place where the topographical aspects related have great importance.

The landscape quality is valued starting from three fundamental elements:

- The intrinsic place characteristics, which are determined by physical components (soil, water) and land formations (topography, rock outcrop, water bodies); by biological components (arboreal masses and vegetation in general) perceived as three-dimensional single elements that are in contrast with the soil; and by anthropoid components determined by the man's performances, like different uses of the soil, urban centers and diverse construction.

- The visual importance of the immediate environment located at a distance of between 500 and 700 m from the observer, and

- The scenic background quality in where the object or work is will be introduced.

The fragility refers to the capacity that the medium has to absorb the introduced alterations, together with the biggest or smaller concurrence of potential observers.

Certain structures of the project like the powerhouse and the substation will be located in the low area of the river canyon, in an area that is not frequently visited by the population. Nevertheless the structures of the dam will reach an elevation that exposes them in view of potential observers, causing a visual impact. A similar situation will occur with the construction of the offices and camp.