

**CORPORATION FOR THE SUSTAINABLE DEVELOPMENT OF THE  
ARCHIPELAGO OF SAN ANDRÉS, OLD PROVIDENCE AND SANTA  
CATALINA**

**STUDY OF ENVIRONMENTAL IMPACT, TOURISM AND OTHER ACTIVITIES  
ON COASTAL MARINE RESOURCES AND HABITATS**

**SAN ANDRÉS ISLAND, JANUARY 2000**

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## **EVALUATION OF THE IMPACT OF TOURISM AND OTHER COASTAL ACTIVITIES ON MARINE AND COASTAL HABITATS AND RESOURCES**

### **INTRODUCTION**

In 1953, the Archipelago of San Andres, Old Providence and Santa Catalina, especially San Andres Island, showed accelerated development of tourism and the commercial sector due to its having been declared a free port. The construction of the main infrastructure to supply the needs of this model (airport, electric generation plant, roads and hotels) changed the environmental and cultural physiognomy of the islands.

Tourism on San Andres Island increased in importance, soon becoming the main source of economic development. Poor planning of hotel infrastructure and public services such as water supply, sewage system, sanitary fill, road system, etc., and the use of limited natural resources produced and continue to produce a series of environmental impacts.

Among the most serious impacts are the occupation of coastal areas, overexploitation of subterranean waters, inadequate disposal of solid and liquid waste, and intervention of habitats, especially mangroves. In view of the situation, today the sustainability of the ecosystems, natural resources and environment which not only support tourist activity but are crucial to the survival of the inhabitants of the Archipelago is endangered.

This study is presented as a fundamental component of the project presently being carried out by CORALINA called “Adequate Management of Marine Resources and Conflict Solution in Insular Ecosystems”, financed by the European Union with the participation of the International Center for Island Technology (ICIT) of the Heriot Watt University of Scotland, the Marine Biology Institute of Crete (IBMC) in Greece, and the Charles Darwin Scientific Station (CDRF) in the Galapagos Islands.

The present document develops the following objectives:

1. Identification of environmental threats
2. Identification of affected environmental components
3. Determination of a scale of values by means of a matrix, in order to determine the most relevant impacts on environmental and marine ecosystems produced by tourist activity
4. Study alternatives for the development of tourism in the Archipelago.

## **OBJECTIVES**

1. To identify and evaluate the environmental impact of the tourist industry on the islands of San Andres, Old Providence and Santa Catalina, and detect possible environmental threats to the future development of the sector.
2. To identify interactions and conflicts between tourism and conservation interests in terms of the utilization of resources and socioeconomic benefits.

## **LEGAL FRAMEWORK**

The development of tourism increased greatly after the creation of the free port which, as an additional attraction to that of the natural beauty of island scenery, offers easy acquisition of merchandise at reasonable prices. (Gallardo, Law 47 of 1993).

**The following regulations have been issued to foment investment in the tourism sector:**

- Decree 2966 bis of 1953, which legalized the existence of the free port so that the inhabitants of the islands could import and export merchandise without paying any tax or duty.
- Law 127 of 1959, which exempted hotels, restaurants, apartment buildings and industries established or to be established in the territory of San Andres and Old Providence from payment of income tax and complementary taxes for a period of ten (10) years.
- There are also other decrees such as Decree 3448 of 1983, that regulates and promotes these activities by establishing incentives for the development of frontier zones.
- Decree 470 of 1986 grants additional incentives for the development of the tourist industry in the region, declaring the territory to be the Special Intendency of San Andres, Old Providence and Santa Catalina, Special Tourist Development Zone.
- Article 19 of law 47 established the tax that must be paid by tourists and temporary residents for the use of the public tourism infrastructure.
- Decree 2762 of 1991 adopts measures for population density control in the Department Archipelago of San Andres, Old Providence and Santa Catalina. Article 14 decrees that persons who visit the Archipelago Department of San Andres, Old Providence and Santa Catalina as tourists must obtain a tourist card.
- Article 37, paragraph 2 of Law 99 of 1993 permits the establishment of the Archipelago of San Andres, Old Providence and Santa Catalina as a biosphere reserve. The Board of Directors of CORALINA will coordinate the national and international actions required to comply with this legislation.
- Given the importance of tourism and the transcendental role of tourist services in the promotion of sustainable development, CORALINA is carrying out the ENVIRONMENTAL STAR (“Estrella Ambiental”) Project with the hotel sector.

## **2 AREA STUDIED**

The Archipelago of San Andres, Old Providence and Santa Catalina is located in the Western Caribbean Region ( 12° 32’ N and 81° 43’ W) 800 Km. From the Colombian coast and 150 Km. From Nicaragua (IGAC, 1986). It is composed of the islands of San Andres, Old Providence and Santa Catalina, keys, banks and low lands. The entire

Archipelago extends lengthwise in a Northeast – Southwesterly direction and covers a total area of 52.5 sq. Km. (San Andres – 26 sq. Km. , Old Providence – 17.2 sq. Km., Santa Catalina – 1 sq. Km., banks and small islands 8.3 sq. Km.), and a territorial sea of 350.000 sq. Km. (Gallardo, 1993). This area covers 10% of the Caribbean sea (Potter, 1999).

FIGURE 1. Location of the Archipelago of San Andres, Old Providence and Santa Catalina Islands

## 2.1 CLIMATE

The Archipelago of San Andres, Old Providence and Santa Catalina is located in the intertropical zone. The climate is warm and humid and is influenced both by the geographic location of the islands and the physiographic characteristics such as the **alisian wind action** which blows in from the northeast. The average annual rainfall is around 1.850 mm. Its distribution is monomodal with a dry period between January and May and a wet period between June and December (IDEAN<sup>1</sup>). Hurricanes and tropical storms can produce rains of more than 200 mm./day between the months of August and November. The average temperature fluctuates around 27.0°C. Average relative humidity is over 80% and calculation of evapo-transpiration potential by different methods varies between 1.400 mm and 2.000 mm. Per year (IDEAM).

## 2. DESCRIPTION OF TOURIST ACTIVITY IN THE ARCHIPELAGO

Tourism and commerce are the fundamental elements of Archipelago economy, the source which generates capital and employment and the foundation for development since 1953, year in which the free port was created.

### 2.1 TOURIST INFRASTRUCTURE

Due to the need to increase hotel capacity for receiving business men coming to the free port, primarily from continental Colombia, there was a rapid. Low quality development of infrastructure. By 1955, the Archipelago already had a total of 141 establishments (hotels, cabins, hostels, residence halls, apartments, condominiums, etc. ) and a complementary infrastructure on the island of San Andres of 238 establishments of different types (restaurants, bars, discotecs, car rentals, motorcycle rentals, bicycle rentals, water sports, tourist agencies, boat cooperatives, taxi cooperatives, centers for evening entertainment, among others). From 1996 on, there has been a reduction in the number of these establishments: 219 in 1997 and 189 in 1998.

A total of 61 establishments have been identified on the island of Old Providence: restaurants, motorcycle rentals, bicycle rentals, horse rentals, tourist agencies, tour agency, handicraft shops, bars, ice cream parlors, boat service, taxis, airlines and tourist information office (Table 1, figure 2).

### 2.2 ENVIRONMENTAL DIAGNOSIS OF THE TOURISM SECTOR

<sup>1</sup> Hydrology, Meteorology and Environmental Studies Institute.

The large-scale tourism established on the Archipelago, especially on the island of San Andres, has totally transformed the environmental and cultural physiognomy of the islands.

The demands of tourist activity on the Archipelago are the source of conflicts resulting from environmental and social impacts. The construction of the main infrastructure, such as the airport, the electric energy plant, road and hotels, had a strong, destabilizing effect on the natural environment (Figure 3).

FIGURE 3. MASS BALANCE OF THE TOURIST INDUSTRY ( Source. Paper: “Cleaner Production in the Hotel Sector. Cartagena. April 1998. CORALINA)

Tourists		Waste water
Importation of non-returnables		Solid water
Tourist vehicles	TOURIST ACTIVITIES	Occupation and degradation of beaches
Fuel for electric energy	PROCESSES WITHIN SYSTEM	Deterioration of landscape
Arrival of workers		Atmospheric pollution
Importation of food		Deterioration of urban spaces
Importation of merchandise		Impact on biodiversity
Construction materials		Impact on strategic ecosystems
Money		Hydrocarbons
		Social and cultural impact
INPUT TO SYSTEM		OUTPUT FROM SYSTEM TO ENVIRONMENT

## 2.2.1 AIRPORT AND AIRLINES

### 2.2.1.1. Physical Presence

The Sa Andres airport is located on the north and of the island in a north-west direction. The runway was built on one of the northern part of the island's most extensive wet lands and one of the island's most environmentally important interior habitats, especially as a resting place for migratory birds from North America. Today, airport installations on San Andres occupy an area of approximately 483.000 sq. m. . The main building consist of three floor distributed in the following manner:

- First floor: passenger reception (arrival and exit) and security

- Second floor: Waiting room and boarding, shops and restaurants
- Administration and radar control

The runway is 2,380 meters long and 40 meters wide. Six (6) national and three international airlines operated out of the airport. One (1) airline is in operation on Old Providence Island (Figure 4)

Old Providence Island's airport is located on the mid-central eastern side of the island. It is composed of two buildings connected by a bridge-like passageway. The main building houses a restaurant, two offices and a waiting room and the adjoining building houses three offices. The runway is approximately 1.000 meters long and 25 meters wide (Figure 5). As in San Andres, it was built directly on top of a wetland area. Of course, the impacts produced were not as serious as those on San Andres. Basically, due to the size of the project and to Old Providence's topographical limits, Mcbean Mangrove, the most important part of the wetland area was not touched.

Figure 4. Location of the San Andres Island Airport

#### **HUMAN SETTLEMENTS ON SAN ANDRÉS ISLAND**

Legend scale	Date	Map N°

Figure 5. Location of the Old Providence Island Airport.

**HUMAN SETTLEMENT ON OLD PROVIDENCE ISLAND**

Legend scale	Date	Map N°

## 2.2.1.2 Input

**Number of Tourists**

Over the last few years, the Archipelago of San Andres, Old Providence and Santa Catalina has become Colombia's main tourism center. It has lost its importance for international tourism due to low quality of infrastructure and lack of promotion of these islands on that market. In 1991, the Colombian government established an open economy for the country, a situation which has had a negative impact on the islands' economy and on the quantity and quality of visiting tourists. National buyers now prefer to purchase directly on the continent and a kind of "all-included" tourism has become predominant. This type of tourism is characterized by low purchasing capacity, low demand for diversified quality of tourism services and careless, non-friendly behavior toward the environment on the part of tourists. We find a pronounced reduction of tourists movement on the Archipelago between 1995 and 1998: 70% (Table 2). Of the total number of tourists visiting the

Archipelago, daily, it is calculated that approximately 40 passengers arrive in off season and 100 in tourist season.

**Table 2. Volume of national and international tourists that visited the Archipelago in 1995, 1997 and 1998.**

Year	National tourists	International tourists	Total
1995			
1997			
1998			

Source: Departmental Planning Office, Departmental Secretary of tourism, Chamber of Commerce, Civilian Aviation (Aerocivil).

#### - Water Supply

Average daily water consumption at the airport is approximately 25 cubic meters. Presently, there are three water supply systems, an aqueduct network with a storage capacity of 85 cubic meters, system for collection of rain water and water supply by tank cars.

The Old Providence Island airport water supply comes from two cisterns with total rain water storage capacity of 35 cubic meters. There is also a pump driven system to send water to the sanitary units located in the two buildings.

#### - Electric Energy Supply

San Andres and Old Providence Island airports are mostly supplied by the island's electric power system. They also have emergency generating plants (450 and 320 KWA on San Andres and 320 KWA on Old Providence) that begin to operate wherever there is a break in the supply of electric current in the sector, in order to guarantee continuity of airport operations.

### 2.2.1.3 OUTPUT

#### - Liquid Waste

The San Andres Island airport is connected to the existing sewage system. Waste water produced by the various activities is discharged into the system, as well as the waste produced by the airplanes that land on the island. Presently, this waste water does not undergo any treatment process and is dumped directly into the sea on the western side of the Island.

For the disposal of liquid waste, Old Providence Island airport has three small septic tanks which empty into a common tank beside the control tower.

#### - Solid Waste

Solid waste produced at the airport comes mainly from the on-board services of the airplanes, bathrooms, boarding zone, passenger desk area, runway area, patios, passenger arrival area, shops and cafeterias. This waste is characterized as having the following composition: Food, paper and cardboard, glass, metals, among others. Volume is approximately 5.6 cubic meters/day.<sup>2</sup> It is temporarily stored in a room located on the south side of the installations and from there it is taken to the Island's open air garbage dump. The production of solid waste at the Old Providence airport is calculated at 0.5 tons/day. This waste, as in San Andres, undergoes no selection process and/or recycling, and is taken from there to the municipal open air garbage dump.

- Noise

The increase in noise level is the result of airplanes landing and taking off. This produces some irritation, mainly disturbing rest and the development of activities that require concentration. Level of emitted sonorous pressure are found to be in the range of 75 to 113 decibels. On Old Providence, the situation is complicated by the proximity of the runway to Mcbean Lagoon National Park, one of the principal wetlands on the island and rest area for migratory birds.

- Oil Residue

Maintenance of the emergency power plants at the San Andres airport carried out tri-monthly, generates approximately 61 gallons of used oil which is stored in drums to be given away. There is no adequate system for the disposal of this waste on the Island.

## 2.2.2. HOTELS

### 2.2.2.1 Physical Presence

The number of hotels presently located on the Island of San Andres, according to information from the office of statistics of the Secretary of Tourism, is 51 with approximately 6.892 beds. Complimentarily, there are other types of establishments and non-official hotels, which together total an estimated 95 establishments and 8.960 beds. Direct employment for approximately 3.200 persons has been created in the manner. The average monthly percentage of hotel occupancy in 1995 was 57.9%, in 1996, 52.4%, in 1997, 62%, and in 1998, 58% (Figure 6).

### Figure 6. Location of Hotels on San Andres Island

Legend scale	Date	Map N°

Source: Departmental Planning Office

Given the existing environmental natural and cultural characteristics on the Islands of Old Providence and Santa Catalina, tourists activity is directed towards ecological tourism and is entirely for rest and relaxation. Presently, there are a total of 46 establishments dedicated completely to housing tourists and distributed in the following manner: tourist lodgings (27), native homes (15), cabins (4). There are 330 rooms and 760 beds. (Figure 7).

Figure 7. Location of Hotels on the Island of Old Providence and Santa Catalina.

Legend scale	Date	Map N°

#### 2.2.2.2 Input

##### - Construction Materials

Due to the pressure on the islands to develop as a tourist and commercial center, an infrastructure to respond to that demand had to be built. Thus, a series of public construction works were carried out, such as the dragging of the San Andres Lagoon, Hooker Bay, Deep Bay, Low Bay ( presently Mar Azul Hotel) and Cocoplum Bay. Later, the filling in of several places along the northwestern coast. The material from dragging was used for the fill and construction of some of the infrastructure for tourism (Kielman,

1999). All of these activities produced repercussions, destabilizing natural resources, many nursing or “de cría” areas for marine species were destroyed, leaving no possibility for recovery.

To supply the present demand for building materials, it is necessary to import them from continental Colombia and countries such as Costa Rica, in spite of there being a legal decision prohibiting new construction on San Andres Island until a waste water disposal system and a residual water treatment system are installed there.

#### - Private Generation of Electric Energy

Electric energy is a very important resource for the hotel sector since its activities are developed around this service. The majority of hotels have their own generating plants in order to guarantee continuous service and reduce operational costs. The commercial sector and the hotels consume 60% of the total energy produced (55.044 Kw.) on San Andres Island.

#### - Water Supply

Water supply in this sector comes from deep wells, desalinization, tank cars, storage of rain water and bottled water. It is estimated that 50 hotels have their own wells, a total extraction flow of 8.24 liters/second and a user's demand of 289 liters/day/second.<sup>3</sup> with a daily permanent population of 4.550 persons and an average stay of four days, the total demand per day may be calculated at 1.315 cubic meter/day.

### 2.2.2.3 Output

#### 3 Underground Water Management Plant for San Andres Island 2000-2009. CORALINA

#### - Liquid Waste

Presently, San Andres does not have efficient sewage and residual water treatment system coverage. The existing system has only been installed for the 6% of the total capacity for the island, serving the northern zone where the majority of tourists, commercial and hotel activities are located. The hotels located in this area dump their waste water into the sewage system which empty directly into the sea with no type of process.

There are also three (3) hotels located in the rural area of the island. Over the last three years the hotels installed their own residual water treatment system suspending discharges into the mangroves and subsoil. The impact previously generated is in the process of remediation.

Considering the lodging capacity in number of beds (8.960) and the percentage of occupancy (58%), it is estimated that the discharges dumped by this sector is 233.85 Kg./day.

- Solid Waste

The Archipelago has no adequate system for the handling of solid wastes. These are disposed off in the municipal open air garbage dumps. It is estimated that San Andres produces around 80 tons/day of waste during tourist season, and Old Providence produces 3.4 tons/day. A large percentage of this waste is generated by tourism and commercial activity, and is composed mostly of cardboard, plastic and non-returnable as non-biodegradable bottles.

- Used Oil

The maintenance of hotel generating plants produces a total of 185 gallons/month of used oil. This value was calculated by CORALINA through the process of gathering environmental information on the Archipelago. This waste is disposed of at the dump. In some cases, it is used to immunize wood or in the manufacture of bricks.

- Noise

Electric generators are operated by this sector in order to reduce operational costs and in order to offer continuous services to clients. These plants do not have adequate noise reduction systems. Levels range between 75 and 80 decibels to a distance of 15 meters.

#### Emissions

The operation of emergency plants produces a series of contaminating emissions, such as CO<sub>2</sub>, soot and SO<sub>2</sub>. The amount of discharges emitted into the atmosphere by these sources is not known; neither is the air quality in the area of influence due to the fact that these parameters are not presently being monitored.

### 2.2.3. LAND TRANSPORTATION

#### 2.2.3.1. Physical presence

##### Roads

Road infrastructure on San Andres consists of a 32 Km. Long highway circling the island . This highway connects with other lesser roads communication with the interior of the island and, in some instances, crossing from north to south or from east to west.

The total length of all existing roads is 116.03 Km., of which 75% are paved, 20% unpaved and 5% projected. In general, 15% of roads are in good condition, 25% in regular condition, and 60% in bad condition. Transportation on the island has a high vehicle density, private vehicles representing 85% of total (12.799), while public transportation vehicles and official government vehicles represent 13.6% (2.052) and 1.4% (193)<sup>4</sup> respectively (Figure 8).

Figure 8. San Andres Island Road System.

Legend scale	Date	Map N°

4 Departmental Government of the Archipelago of San Andres..., IBID, pag. 97.

Old Providence has a 17Km. Long road that completely circles the island. This road was partially rehabilitated in 1999. There are no roads crossing the island as in San Andres. The circular or main road connects with 4 minor road. Santa Catalina only has a small brick-paved wall approximately 100 meters long, along the southeastern side of the island (Figure 9).

The road infrastructure of the island facilitates access to the majority of the sites of touristic interest on the Archipelago.

**Figure 9. Old Providence Island Road System**

Legend scale	Date	Map N°

## Tourist Sites

There are approximately 24 sites of interest for tourists on San Andres and Old Providence Islands, distributed over different areas, in acceptable condition and with their respective access roads. Many of these are not exploited and are potential tourist attractions. (Table 3). Table 3. Identified Tourist Sites on San Andres, Old Providence and Santa Catalina Islands.

### 2.2.3.2. Input

In order to offer land transportation for tourists, San Andres has the following automotive services: three taxi cooperatives, “trains” (3). There are also 15 car rentals and 22 motorcycle rentals. On Old Providence, there are 39 taxis and 6 motorcycle rentals.

### 2.2.3.3. Output

#### - Used Oil

An estimated 42.052 gallons/year of oil is used by this sector. It is handled inadequately, usually being dumped on the ground.

## Noise and Emissions

The vehicles offering land transportation service in the Archipelago have been in use for a long time and have not received optimum maintenance. This facilitates the production of noise and the emission of gasses from combustion. These pollutants have not yet been qualified.

## 2.2.4. WATER TRANSPORTATION

There are several places on San Andres offering boat rental and trips to different places of tourist interest in the marine area. For example: cruises around the bay, ecological tours, cruises in sailboats, trips to the cays (Albuquerque, Bolívar), trips around the island, sports fishing, and underwater observation.

On Old Providence, water transportation is offered by hotels and dive shops. There is boat service to the cays, a trip around the island and transportation to deep sea diving areas.

### 2.2.4.1 Input

Water transportation services on San Andres include four establishments for the rental of boats, ten for tourist transportation and one boatmen’s cooperative.

#### 2.2.4.1. Output

Water transportation activity produces wastes such as hydrocarbon spills in the sea and impacts on marine ecosystems because of the boats passing.

#### 2.2.5. DOCKS AND MARINAS

##### 2.2.5.1 Physical Presence

San Andres has a total of 29 docks, three (3) of which classify as marinas offering fueling services to ships, aquatic “motorcycle” and boats (Figure 10 and 11). There are also four spurs located on then eastern side of the island.

There are 32 docks on Old Providence, five concrete platforms and four spurs. The majority of these structures are located on the western side of the two islands (Old Providence and Santa Catalina). They are small structures, basically for tourist service and Artisanal fishermen. The municipal dock, located on the north side of Old Providence is the largest of the structures.

Figure 10. Location of the Docks and Landings on San Andres Island.

Legend scale	Date	Map N°

Figure 11. Docks and Landings on Old Providence and Santa Catalina Islands.

Legend scale	Date	Map N°

#### 2.2.5.1. Input

Wood is the material commonly used for the construction of docks and marinas. In some cases, there is a combination of wood and cement. These materials, although it is possible to acquire them locally, are imported from the continent or from neighboring Central America countries.

##### - Fuels

On San Andres, there are three marinas offering to supply fuel. The volume depends on the capacity of the marina and the number of ships services. Nene's Marina can service some 60 ships, and the Nautical Club some 18. The volume of gasoline handled can surpass 7.000 gallons/month (Table 4)

Table 4. Volume of gasoline used at the marinas.

NAME	NO. OF BOATS	VOLUME OF OIL	VOLUME OF GASOLINE Gallons/month
Nene's Marina	60	291	7000
Nautical Club	18	41	1000
Tonino's	30	3	7080

#### 2.2.5.3 Output

##### Fuel

The marinas, because of the services they offer, are sources of polluting oils which are discharged into the sea. The volume of (septinas) produced by the boats is difficult to quantify. However, in a study carried out by CORALINA, it was estimated that in 1996, the production of waste oils was 600 gallons/month.

## Solid Waste

The production of solid waste in the San Andres marinas is characterized by its high content of non-biodegradable material such as cans, plastic bags, bottles for oil, among others. In some cases, these are thrown into the sea.

### 2.2.6. WATER SPORTS

#### 2.2.6.1 Physical Presence

On San Andres, several water sports are offered, such as windsurfing, jet ski, surf board, sailboating and diving. Figure 14 and 15 show the diving areas of the two islands. (Table5). On Old Providence, there are four dive shops: Sonny Dive Shop, Sirius Center Dive ShoOld Town Dive Shop and Old Providence Diving Center.

Table 5. Places to rent and practice water sports on San Andres Island

Legend scale	Date	Map N°

Figure 12. Old Providence and Santa Catalina Diving Sites

Legend scale	Date	Map N°

Figure 13. San Andres Island Diving Sites

Legend scale	Date	Map N°

### 2.2.6.2 Input

#### Number of Tourists

There are no records kept by the establishments to help determine the exact number of persons participating in water sport activities. The dive shops on San Andres keep a list of clients, allowing us to estimate the number of tourists who come to dive annually: some 4000 divers (Table 6.).

Table 6. Relation of number of clients per dive shops/year in San Andrés

NAME	NUMBER OF DIVERS PER YEAR
Blue Life	250
Buzos del Caribe	1500
Aquamarina	250
Sharky Dive Shop	900
Divers Dream	750
TOTAL	4150

### 2.2.6.3 Output

#### Used Oil

The volume of sentinas? Produced by vessels and aquatic scooters is difficult to quantify due to the nature and site of disposal (the sea). This waste is a serious source of pollution for the marine ecosystems, particularly because the boats pass over shallow marine grass areas and interior part of coral reefs.

## 2.2.7 Nightlife

### 2.2.7.1 Physical Presence

San Andres has 15 establishments, including bars and discotechs that offer entertainment at night. The majority of these establishments are located in the northern section of the island,

near the hotels or sometimes inside them. On Old Providence, there are two main bars. However, there are also some isolated establishments, especially those located on the beaches and which sometimes offer musical programs and bonfires for tourists.

#### 2.2.7.2 Input

##### Electric Energy

These establishments use the electric supplied by the electric power companies. The majority of them have emergency plants which are also located in the hotels.

##### Water Supply

Water is supplied from several sources such as tank cars, wells, stored rain water, and is also purchased from bottling companies. The demand is related to the number of customers, a value which is not constant.

#### 2.2.7.3 Output

##### Liquid Waste

Liquid waste produced by this activity is qualified by the production calculated for hotels.

##### Solid Waste

The characteristics of the waste produced by this activity include a large amount of glass, cans, and plastics, much of which, as in the case of the establishments located on the beach, is thrown away in the same area. This waste is also produced during the night: tourists and others throw it into the sea and onto the streets or beaches.

##### Noise

The activity of these establishments produces noise which, in some cases exceeds permitted limits (45 decibels at night), affecting the tranquility and enjoyment of a healthy environment for neighbors.

### 2.2.8 COMMERCE

#### 2.2.8.1 Physical Presence

This activity is carried out in the northern section of San Andres island. 2.798 commercial establishments are registered. This activity increased parallelly with tourism after the declaration of San Andres as a Freeport. Nevertheless, with the establishment of a national open economy in 1991, this sector registered a decrease in regards to volume of income, sales, employment, number of establishments, imports and exports.

According to San Andres Statistical Yearbook, the balance of foreign trade and commerce is a negative indicator, imports decreasing 18% from \$81 million to \$66 million. The importation of food stuffs represents 30%, electric appliances represent 16%, with an elevated reduction at the end of the last decade ( that is to say, before the open economy, a reduction of 43%).

On Old Providence, since ecological tourism is the prevalent type of tourism, there is no development such as that on San Andres.

### 3. ENVIRONMENTAL BASELINE

#### 3.1 PHYSICAL COMPONENT

##### 3.1.1 Geological and Geomorphological Components

The Archipelago of San Andres, Old Providence and Santa Catalina is of volcanic origin, as are the great majority of oceanic islands. Stratigraphically, the island of San Andres consist of rocks of calcareous origin from the Tertiary Period. Two formations define it lithologically and morphologically: the San Luís Formation from the Pliocene Period (Tsl) and the San Andres Formation from the Miocene Period (Tsa).

The islands of Old Providence and Santa Catalina are formed primarily by volcanic rocks from the Pleistocene and, on a lesser scale, by reef limestone from the Plio-Pleistocene, and non-consolidated deposits. The central part of the island of Old Providence is composed mainly of andesitic and riolitic lava flows. (Tv) surrounded by patches on volcanic conglomerate, all interstratified (Tcgv). Toward the northeastern and southwestern extremes, there are small outcroppings of basaltic olivinic lavas (Tvb) and, in the latter sector, reef limestone that could be correlated with the upper part of the San Andres Formation (Tmsa).

##### 3.1.2 Hydrology

Water supply on San Andres Island comes from underground sources such as the San Andres aquifers in the valley of the Cove stream, the main hydrographic basin on the island, with an extension of 3 Km, formed over a limestone base belonging to the San Andres Formation. The island of Old Providence has a seasonal fresh water supply from sources such as Fresh Water Bay, Bowden, Lazy Hill, Spine, Provision Ground, among others. Nevertheless, two main systems of water supply are used by the hotel sector in Fresh Water Bay area where most of the hotels are located. These are the storage of rain water in cement cistern built directly by the hotels and the Fresh Water Bay Reservoir and the spring of the same name.

### 3.2 BIOTIC COMPONENTS

#### 3.2.1 Terrestrial Flora and Fauna

## Fauna

The main fauna found on San Andres are invertebrate, especially arthropods (crustaceans, arachnids and insects), the principal consumers of the vegetation.

There are black crabs, *Gecarcinus ruricola* and *G. Lateralis* of marine origin and reproduction but as adults in the arboreal vegetation on the western side of the island. The variety of land animals is low due to biogeographic reasons. The structuring of trophic networks is lax, limited specialization being attributed to limited competition and to control by predators (Marquez, 1987).

As for reptiles, there is a turtle species, three species of serpents and six species of lizards. These are considered to be primary consumers. For example, the hicootea turtle, *Geochelone carbonaria*; the iguana, *Iguana iguana*; and various kinds of small lizards.

Birds make up the most representative group of vertebrates: 18 resident species and 76 migratory species, including 2 endemic species and various endemic subspecies. Identified migratory species include Caradriformes, Ciconiformes, Falconiformes and Pelacniformes (Bond, 1980 and Hilty, 1986).

## Flora

The vegetation of San Andres and Old Providence can be considered as transitional forest, between dry and humid up to 20 meters in height, with few epiphytes and a scarce herbaceous and bush stratum. According to Gentry, Old Providence forests are among the best conserved in the Caribbean, with remain of primary forests. Their concentration of species per unit of area (more than 60 in 1.000 sq. meters) indicates that it is an important center of Caribbean biodiversity (Marquez, 1996). In synthesis, the vegetation of these islands is an interesting mixture of Antilles and continental flora but more related to the later. As such, it is more important to conserve (Gonzalez, 1995). Besides having uncommon floristic diversity, it is more varied than that of many other islands in the Antilles. Presently, bush is the predominant coverage and is found both on the high and low parts of the island. The most developed forest covers only 7% of the insular territory.

Beach and coastal vegetation is basically composed of sea grape (*Cocoloba unifera*), coconut (*Cocos nucifera*), and other lesser beach vegetation dominated by *Suriana maritima*, *Tournefortia ganapalodes*, *Complaya trilobata*, *Impomoea alba*, *Sesuvium portulacastrum* species. A great portion of these have been removed to make way for the tourist activities on "clean beaches".

### 3.2.2 Marine Fauna

Studies carried out in various section of the island of Old Providence indicate that the greatest number of fauna are invertebrate. The large amount of organic material found on some areas of the beaches contributes to the high density of gastropod mollusks. Species of the Neritidae family have also been reported (Mayor of Old Providence, 1995.)

Various species of herbivorous vertebrates such as fish of the Scaridae family and sting ray juveniles and invertebrates such as crusteans of the Callianassa, Clibanarius genera, and numerous equinoderms are common in the phanerogam fields.

The species found in some type of anthropic (presion?) are the spiny lobster (*Pamulirus argus*), the spade conch (*Strombus gigas*), the milky cobo? And some fish of the Lutjanidae and Serranidae families ( Old Providence Mayor's Office, 1995).

### 3.2..3 Marine Ecosystems

The Archipelago's oceanic reef is one of the most extensive and productive reef system in the Western Hemisphere and includes two barrier reefs bordering the islands of San Andres and Old Providence. The Old Providence Island barrier reef is 32 Kilometers long and covers an area of 255 sq. Km., one of the longest reefs in America (Geister, 1997). The first 400 meters, starting from the coastline, are characterized by sandy substrates extending into extensive fields of thalassias, *Halimada* and *Avrainvillea* that are displaced by communities of octocorals and sponges. At a depth of 1.500 meters the first patches of coral are found, sometimes formed by colonies of massive corals, especially *Montastrea Anularis*, *M. Cavernosa*, *Porites Clavaria*, *Euismlia Fasstigiata*, *Dendrogyra Eylindrus*, *Porites Porites*, *Agaricia Agaricetes*, *Helijoseris cucullada*, as well as incrusting corals such as *Madracis. Decactis*. The area is classified as one of protected waters due to the great diversity of species found there (Von Pral, 1985).

On San Andres Island, between the insular coast and the Little Reef, there is a depression 200 meters long and some 250 meters wide with depth that vary from 0.5 to 2 meters, known as the shipping canal because it is an obligatory route for boats and other water vehicles. This depression is covered mostly by sand and fragments of coral on which extensive fields of *Thalassia testudinum* and *Cymodoce manatarum* have developed.

## **BARRIER REEF- SAN ANDRES ISLAND**

Figure 14. San Andres Island Barrier Reef.

Legend scale	Date	Map N°

Figure 15. Old Providence and Santa Catalina Barrier Reef.

Legend scale	Date	Map N°

### 3.2.3 Marine Grass

The marine grass beds of San Andres Island covers an area of approximately 5.062.400 sq. Km., distributed principally along the northeastern coast of the island, and a small patch along the western coast, formed by mixed patches of *Thalassia testudinum* and *Syringodium filiforme* on the east coast and one monospecific patch of *Syringodium* on the western coast. (Angel, 1998).

Three species of marine grasses are found in Old Providence Island: *Halodule wrightii*, *Syringodium filiforme* and *Thalassia testudinum*. On Santa Catalina Island, *Thalassia testudinum* and *Syringodium filiforme* are found. Total extension of marine fields of grass is 13.995.000 sq. m.

The accompanying flora in these fields include: *Halimeda opuntia*, *H. Discoidea*, *H. Monile*, *Penicillus pyriformis*, *P. Dumetosus*, *Caulerpa sertularoides*, *C. Mexicana*, *C. Curpresoides*, *Dasycladus Vermicularis*, *Avrainvillea* sp., *Udotea* sp., *Anadyomene stellata*, *Riposephalus Phonis* and *Padina Jamaicensis*. Among the associated fauna we find fish of the Gobiidae, Grammatidae, Haemulidae, Luthjanidae, Myliobatidae, Scaridae and Sphyrnaeidae families; crustaceans such as *Panulirus* sp., lobsters and *Calinectes* sp., jaibas. The most predominant mollusks belong to the gastropod and bivalve classes, and in lesser amounts we find equinoderms such as sea cucumbers and erisos (Gonzalez, 1999).

The majority of these ecosystems are located in shallow waters where boat traffic affects their normal development.

### Figure 16. ECOSYSTEMS-GRASSES, MACROALGAE AND FIELDS OF SAN ANDRÉS ISLAND

Legend scale	Date	Map N°

**Figure 17. ECOSYSTEMS-GRASSES, MACROALGAE AND FIELDS OF OLD PROVIDENCE AND SANTA CATALINA ISLANDS**

Legend scale	Date	Map N°

### 3.2.4 Mangroves

According to Chapman (1976), San Andres mangroves correspond to coralline island salt water mangroves, receiving little fresh water influence. Six (6) areas are considered large mangroves, five (5) of them located on the east coast, and another small one to the south along the western coast: Hooker Bay- Bahía Honda (50.49 hectares), Cocoplum (62.31 hectares), Salt Creek (4.33 hectares), Sound Bay (18.76 hectares), Smith Channel (18.84 hectares), and Cove (2.29 hectares) for a total extension of 157.02 hectares.

These forests are mainly composed of *Rhizophora mangle*, *Avicennia germinans* and, to a lesser degree, of *Laguncularia racemosa* and *Conocarpus erectus*.

Old Providence Island has the following distribution: Mcbean Mangrove (30 hectares), Southwest Bay (3.6 hectares), Old Town (3.4 hectares), Manchineel Bay (1.5 hectares), Jones Point-Town and Santa Catalina?? ( Taylor, 1994). Predominant species are *Avicennia germinans* and *Rhizophora mangle*. In some areas individual *Laguncularia racemosa* trees are found and very rarely *Conocarpus erectus* trees.

Figure 18. San Andres Island Mangrove Forests

Legend scale	Date	Map N°

Figure 19. Old Providence and Santa Catalina Island Mangrove Forests

Legend scale	Date	Map N°

### 3.2.5 Beaches

San Andres beaches are characterized by white sands, the large quantity of algae deposited there (Sargassum and Dictyopteris) (Cabrera, 1982), and a large amount of live vegetation consisting of vines (principally *Ipomea pes-caprae* L.) and dense, leafy coconut groves, especially on the northern, northeastern and southeastern side of the island (Dau, 1998, pers. Com.).

On San Andres, we find sandy beaches located on the northern and eastern sides, rocky beaches on the western side and the "canto rodado" ? tothe southeast. Among the most important for tourists are Sprat Bight, Sound Bay, Rocky Cay Beaches and the Johnny Cay and Haines Cay islets.

The islets are one of the most important tourist attractions on San Andres Island, 200.000 persons/year visit them. This creates pressure on all of their ecosystems.

On Old Providence and Santa Catalina islands, we find Alan Bay, Fresh Water Bay, South West Bay, Manchineel Bay, Old John Bay and Fort Bay beaches.

Figure 20. Location of Old Providence and Santa Catalina Beaches

Figure 21. Location of San Andres Island Beaches.

### 3.3 Socioeconomic Conditions

#### Recent Demographic Processes in Colombia and the Archipelago

The 1993 National Population and Housing Census gives an approximate population of 37.5 million inhabitants, of which 69% inhabit municipal centers and 31% the rest of the municipal territory (Table 7).

Table 7. 1973, 1985 and 1993 Colombian and Archipelago of San Andres, Old Providence and Santa Catalina Adjusted Censuses, distributed by municipal centers and the rest of the municipal territories.

COLOMBIA POPULATION				ARCIPELAGO OF SAN ANDRÉS, OLD PROVIDENCE AND SANTA CATALINA POPULATION		
YEAR	TOTAL	MUNICIPAL CENTER %	THE REST %	TOTAL	MUNICIPAL CENTER	THE REST %
1973	22.862.118	59.25	40.74	22.983	64.10	35.90
1985	32.495.400	65.55	43.45	43.685	74.70	25.30
1993	37.581.000	68.97	31.03	61.040	70.36	29.64

Source: DANE. Seminar "Demography, Environment and Development", San Andres Island, Sept. 10-12, 1997.

The population of the Archipelago of San Andres registered in the census was approximately 61.000 inhabitants, a figure representing 0.16% of the total population of the country. Approximately 70% of the population of the Archipelago is located in population centers (settlements) and 30% in the rest of the territory. Of the total inhabitants of the Archipelago, 4.300 reside in Old Providence and 200 in Santa Catalina.

The 52.5 sq. Km. Insular area of the Archipelago represents no more than 0.0043% of the total area of the country. While the average density for the country in 1993 was 32 inhabitants/sq. Km., the average density for the Archipelago was 1.152 inhabitants/sq. Km., if this density is considered only in relation to the populated islands of San Andres, Old Providence and Santa Catalina, the density increases to 1.386 inhabitants/sq. Km.. Given the unequal distribution of the population among the main islands, the density for San Andres Island is 2.272 inhabitants/sq. Km. Thus, the average density for the township of Old Providence and Santa Catalina would be 230 inhabitants/sq. Km. For 1993.

On the other hand, while the period for population duplication in Colombia, according to the annual population growth rate (1.82% for the intercensus period 1985-1993), would be every 38.1 years<sup>5</sup> for the Archipelago, the population, the population would double every 16.6 years according to the annual growth rate (4.19%) registered for this section of the country during the same intercensus period (Table 8). With this annual growth rate, by the year 2.009 the Archipelago would have 122.000 inhabitants and by the year 2.000 the population would be 72.000 inhabitants.

<sup>5</sup> The world average for population duplication is now 43 years.

Table 8. Population growth and duplication time for the population of Colombia and the Archipelago of San Andres, Old Providence and Santa Catalina, 1973-1993.

PERIOD		COLOMBIA			ARCHIPELAGO			
YEAR	TOTAL	MUNICIPAL CENTER	THE REST	POPULATION DUPLICATION TIME (YEARS)	TOTAL	MUNICIPAL CENTER	THE REST	POPULATION DUPLICATION TIME (YEARS)
1973-85	2.93	3.77	1.53	23.7	5.35	6.62	2.43	13.0
1985-93	1.82	2.45	0.51	38.1	4.19	3.44	6.17	16.6

Source: DANE: Seminar "Demography, Environment and Development", San Andres Island, Sept. 10-12, 1997.

Immigration has been one of the determining factors in population growth, especially on San Andres Island.<sup>6</sup> For 1951, 267 persons born in other Colombian departments were registered as entering the islands.<sup>7</sup> This corresponds to a participation of 8% in the total population. Thus, migrations for that year represented an increase of 14% in the total population.

Additionally, the participation of the total population of San Andres Island in the total population of the Archipelago has increased progressively and in an accelerated manner: in 1951, it represented 66%, in 1964 87%, in 1973 89%, in 1985 90% and in 1993 93%.

### 3.3.2 ECONOMY

#### Behavior of Gross National Product (GNP)

The use given to the gross national product (GNP) is presently being questioned as a measure of the degree of development of a region or a country, especially when this measure does not recognize the deterioration of the environment and the exhaustion of natural resources that have occurred to produce "the material goods and services of society" in a given period of time.

It has been estimated that GNP growth (measured in constant prices for 1975) on San Andres and Old Providence was negative during the period of open economy, 1991-1994 (Table 9).

Table 9. GNP value and growth rate (millions of pesos at constant prices, 1975) for the Archipelago of San Andres, Old Providence and Santa Catalina.

6 For greater detail in this aspect, see CORALINA, San Andres Island : Population Diagnosis, by Rafael Estrada Majía, San Andres Island March 1997.

7 Institut de Sociologie de L'université Libre de Bruxelles. Etude d'Aménagement Intégré Archipel de San Andres et Providence, Colombie. Bruxelles, 1973. Pags 125 et 127.

8 DANE. Síntesis Estadística San Andres y Providencia. Bogotá, 1984. Pag. 5.

YEAR	GNP Value	GROWTH RATE
1991	2.390	
1992	2.213	-7.40
1993	2.183	-1.35
1994	1.912	-12.41
EXPONENTIAL AVERAGE		-7.17

Source: DANE, Seminar "Demography, Environment and Development" San Andres Island, Sept. 10-12, 1997. Quoting DANE, Departmental Accounts and Calculations, CORPES- Atlantic Coast.

With the initial warning, it is to be noted that for the 1985-1993 period, the GNP per capita growth rate for San Andres was -3.46<sup>9</sup>. This means that the real income of the population decreased, surely as a result of the population growth rate that, as mentioned previously, was more than 4% a year for this period. The negative GNP per capita value for the Department is explained by both the increases in population and the negative behavior of GNP growth value.

### Productive Sector Dynamics

In spite of the tourism and commercial sectors being the most dynamic in the island economy (including that of capital investment), only in 1996 did the electric power sector succeed in temporarily displacing investment in these sectors. Also, there are various indicators that these two activities are facing a "collapse". The following are some of the behavior indicators for the tourism sector:

- Reduction in the number of commercial flights, the number of flights decreasing from 30 flights daily in 1995 to less than half that number in 1997, and the number of passengers arriving yearly decreased from 412.612 in 1995 to 397.891 in 1996. To June 1997, there had been an 11% decrease in number of passengers arriving for that year (167.536 passengers) as compared to the previous year.
- As far as total number of persons entering Colombia: between 1991 and 1993, there was a yearly average of 312.200 visitors, not including "border tourism", of which 5% (16.600) visitor destination was San Andres. Of the total for San Andres, 14.400 were foreign visitors and 2.280 were Colombians residing outside the country (ethnic tourism)<sup>10</sup>. On subtracting ethnic tourism, San Andres remained with a yearly average of 10.2% foreign tourism for that period, occupying third place after Bogotá (60.6%) and Cartagena (11.5%).

Although there is no study permitting an estimate of the total annual monetary resources produced by national tourism to San Andres, these resources are possibly some \$400 billion Colombian pesos per year (approximately US\$300 million), a sum distributed

<sup>9</sup> MANJARES, OP. Cit . Pags. 9 and 10.

<sup>10</sup> Source: Ministry of Development, Study on Competitivity in the Tourism Sector, Summary Report on the First Stage, August 1996, Table N° 3

between airline costs and utilities, tourism intermediaries and local tourism and commercial establishments (hotels, bars and restaurants, transportation and other recreational and tourism activities). By the way, tour packages are financed and the payment capacity of a large number of tourists, it would seem that only a small part of these resources come directly from local establishments through payments to commerce and for tourism services.

Information published by the Caribbean Tourism Organization on 32 countries in the region reports an income of US\$12.7 billion per year in the tourism sector. Comparing these figures with estimates for San Andres, the type of tourism developed on the Archipelago would seem to be quite inexpensive (Table 10).

Table 10. Information on receptive tourism and reasons for travel persons arriving in San Andres between 1988 and 1992.

Reason for trip	Year	Average

Source: Table N°6, Competitivity Study...

Although tourism in the Caribbean has been undergoing a crisis of excessive offer over the last few years, other aspects in San Andres also help depress tourism even more: the reduction in number of flights and of foreign airlines, reduction of Colombian spending due to the economic crisis of the last few years and the image associated with San Andres as offering low level tourism and tourist services<sup>11</sup>.

According to the value given to the factors defining receptive tourism Competitivity in the above-mentioned study, San Andres is at a great disadvantage in relation to the principal tourist destinations in Colombia such as Bogotá, Cartagena, Cali, Medellín, Santa Marta and Barranquilla. In other words, San Andres requires much work in order to be able to offer competitive tourism in spite of the fact that San Andres offers some advantages compared with other tourism centers in the Caribbean area of Colombia. For example, it is a "prototype of a Caribbean island with all the ingredients of landscape, golden beaches, turquoise sea, Jamaican style music and a predominantly black, physically attractive, English -speaking community"<sup>12</sup>.

The Islands have three disadvantages as an alternate destination for tourism in Colombia: a) location in the extreme interior of the Caribbean, "opposite to sotavento", which is the leading territory for Caribbean small islands tourism and the favorite area for private navigation and cruises.

<sup>11</sup> Manjarres, Memories of Seminars...

<sup>12</sup> Ministry of Development, Study on Competitivity in the Tourism Sector. Report on the Caribbean Coast Cluster. Santa Fe de Bogotá, October 1996. Pag. 131. Also consult "Strategic Competitivity Plan for the Tourism and Commercial Sectors", a study complementary to the previous one

It is also situated to the extreme west of the Greater Antilles, the leading group of large island where the principal tourist centers and landing sites for the principal international commercial airlines are located; b) the San Andres model of tourism that has been maintained as a reference for the Colombian "domestic market" since the creation of the already obsolete "Freeport" model ; c) other factors such as the monopoly, on both islands, of transportation in the hands of small businessmen which impedes the implementation of more adequate means of transportation; the predominance, in San Andres, of a traditional type of commerce without innovation and with poor customer services. But, in general, these apparent disadvantages can be converted into strengths if the future of tourism to San Andres is considered from another perspective - as an unexplored site for international tourism in the Western Caribbean.

### 3.3.3. PUBLIC SERVICES

#### 3.3.3.1 Aqueduct

Water is supplied on San Andres Island from deep wells located mainly in the Cove Valley. Presently, only 8 of the 32 wells are in use. The water supply system covers 80% of the population. Nevertheless, the supply is not continuous: an average supply of one time a week for approximately 3 hours.

The island's deficient potable water supply is extreme since it is estimated that it can only adequately supply the demand of approximately 30.000 inhabitants (PMAS, 1999). This situation has caused the population to explore other alternatives of water supply, mainly the storage of rainwater in cisterns, a traditional practice of the native population of the islands. Other alternate systems also include the purchase of water from tank trucks and the construction of private wells, which is, in the case of the hotels, the most widely used alternative in association with desalinization plants.

#### 3.3.3.2 Sewage System

The San Andres Island sewage system only serves 8% of the island, while 64% use septic tanks and the rest have no formal disposal system. 28% of the installed septic tanks do not fulfill the basic technical requirements for this type of treatment system, mainly in regards to the minimum distance of the bottom in relation to the water level. Inadequate handling of these systems, as well as their absence, has in some cases produced serious problems such as the contamination of subterranean waters.

The water conducted through the sewer system is dumped directly into the sea with no type of treatment, thus endangering sea water quality. The continuous contamination of these water sources is endangering not only the development of tourism on the island but also the health of the population since underground waters are contaminated with enterobacteria from the septic tanks filtering through the subsoil. Environmental contamination by untreated wastewater is also seriously affecting the beaches.

Old Providence Island has no sewage system, wastewater being disposed into inadequate built septic tanks or by direct discharge into the sea through pipes.

### 3.3.3.3 Disposal of Solid Waste

The final disposal site on both islands is an open garbage dump, similar to those in other parts of Colombia, the only difference being that there is a greater amount of recoverable products such as cardboard, plastics, bottles, cans, metals and even automobile bodies.

Garbage disposal without adequate technical conditions adversely affects natural resources, underground waters, air and health through the proliferation of vectors.

### 3.3.3.4 Electric Energy

Electric energy on the Archipelago is produced by diesel generation. The capacity on San Andres is 55.044 Kw. and 3.400 Kw. On Old Providence. The commercial and tourism sector consumes 60% of the energy produced.

## 4 ALTERNATIVES

### 4.1 NO ACTION

The "no action" option includes no construction of water and sewage systems, non-implementation of a plan for the handling of solid waste; non-construction of infrastructure for the development of tourism; no initiation of programs for the reasonable use of natural resources, social and economic development policies directed towards population control and rational occupancy of the territory. The non-realization of these actions will result in the deterioration of the Archipelago, both environmentally and socio-economically.

The manner of utilization of coastal areas, or "open regime systems", presently in effect on the islands has not allowed for real planning as regards both the magnitude of the activities being carried out and the space involved. These activities are mainly: water sports and tourist transportation and recreation on the beaches and the keys. The consequences are reflected in the many conflicts arising between the users of common resources, especially the beaches on San Andres and the internal areas of the bay, or those areas designated for boat traffic. Sensitive areas warrant protection such as the shallow reefs within the Lagoon, the mangroves, marine grasses, etc., are not taken into account when these activities are being carried out. This situation is not only endangering to economic sustainability of these activities but is also impacting other productive sectors such as the fishing enterprises.

In this sense, if clear short term and medium term actions for management of coastal areas are not put into effect, tourism as well as other activities on the island will continue to be affected. Aspects that favor the collapse of this sector due to water pollution (the sea, underground waters) and land pollution with its related impacts on health and ecosystem components; the accumulation on poor handling of domestic and dangerous wastes; high

demands on natural resources accompanied by intensive use of water and electric energy; and the uncontrolled growth of urbanized areas occupying highly productive farm lands.

#### 4.2 SUSTAINABLE TOURISM WITHIN THE CONTEXT OF A BIOSPHERE RESERVE

The Archipelago must simultaneously and strategically bring about a change in the modality and style of the tourism presently predominant, especially on San Andres Island. This chance should be directed away from a tourism based on high consumption of limited natural resources towards a tourism that reduces consumption to sustainable limits. Massive affluence of tourists distributed unevenly over time, with low consumer capacity, should be reduced to levels below the load capacity of services and resources, and efforts should be redirected towards a tourism willing to pay to conserve, maintain and enjoy the landscape and to recognize the environmental costs that their activity produces. This is a task that requires a change of conscience and of attitude on the part of both tourists and tourism enterprises (Mow, 1998).

As one of the objective of its Action Plan 1998-2000, which we have called "... A clean print in the Archipelago...", CORALINA has proposed designing actions directed towards all of those persons, enterprises or entities that wish to carry out productive, commercial or service activities in the Archipelago so that their location, use of resources and handling of the environment will be compatible with the use potential of natural resources, with the fragility of ecosystems and the mitigation of negative impacts caused by such activities (Mow, 1998).

In this sense, CORALINA is designing two proposals directed towards producing new foundations for sustainable tourism. On the one hand, we have begun a program jointly with island hotel management in order to create a dialogue and long term activity directed towards achieving the changes in business management necessary for sustainable tourism. This project is called "Environmental Star" and is presently in the process of designing a high quality academic proposal to be included in the tourism training program presently offered by the San Andres Island's Technological Institute - INFOTEP. The Marine Protected Area Project will produce guidelines for the use and exploitation of marine resources. Then, we will continue to develop actions for tourists and residents in order to initiate changes in favor of sustainable tourism: water-saving campaigns, and campaigns regarding handling of garbage, type of consumerism, maintenance and preservation of beaches and preservation of the environment in general (flora, fauna, land).

#### 4.3 Impact Analysis of Alternatives

On making a general analysis of impacts produced by each of the alternatives, sustainable tourism was selected because it is one of the Archipelago's environmental policies. The impacts are obviously reduced by this management alternative for tourism (Table II), especially by the resulting economic and environmental benefits. It is expected that once sustainable tourism is developed, the ecosystems degraded through massive tourism will have the opportunity to recover due to changes in or reduction of use.

Table II. Analysis of impacts produced according to "No Action" and "Sustainable Tourism" for the Archipelago of San Andres, Old Providence and Santa Catalina.

ACTIVITY	ALTERNATIVA 1. NO ACTION	ALTERNATIVE II. SUSTAINABLE TOURISM
Airport and Airlines	95% are national flights for mass tourism and "all-included" package tours	A select tourism, both national and international, interested in preserving the environment.
Hotels	The present infrastructure remains. Residual waters and solid waste is "dumped". No policies for saving water and electric energy.	Improvement of present infrastructure. Policies for saving water and electric energy. Conditions established for adequate handling of solid and liquid waste.
Land Transportation	The present road structure remains. Increase in emission of pollutants.	Improvement of road infrastructure. Improvement of air quality Foot-paths for ecological tourism are built.
Water Transportation	Continued impacts on marine ecosystems (coral and grasses). Persistence of conflicts between users of marine areas.	Special management areas are established for the protection of corals and marine grasses. Areas are designated for each activity.
Docks and Marinas	No control on dumping.	Handling of waste produced. Control of anchoring areas. Establishment of routes for docks.
Water Sports	No areas specifically designated for activities, creating conflicts among users of marine ecosystems (coral and grasses).	Areas are designated for each sport with adequate indications. Protective areas are recovered. Improvement of transportation and underwater areas attractive to tourists.
Nightlife	Continued problems with noise. No other alternatives for entertainment.	New entertainment alternatives are developed.
Commerce	Reduction of imports. Sales diminish.	New expectations are created, increasing imports and sales.

## 5 ENVIRONMENTAL INTERACTION AND EVALUATION OF IMPACTS MATRIX

## 5.1 ENVIRONMENTAL INTERACTION MATRIX

To facilitate the process of impact evaluation in this study, a control list was used that includes scales or hierarchies of impacts of the alternatives of each of the environmental factors under consideration. A six point scales was user: positive, zero, insignificant, minor, moderate and major impacts (Table 12). Tourist industry impacts, both on San Andres island and Old Providence and Santa Catalina were evaluated according to the different activities identified in the development of the sector on the islands (Tables 13 and 14).

Table 12. List of categories selected for the analysis of environmental impacts in the tourist sector on the coastal and marine habitats and resources.

Scale	Environmental Effects	Social Effects
Positive	Earnings used for the conservation and handling of the environment. Recovering from or remedying environmental damage.	Inhabitants gain economic benefits from this activity (example: employment, increased GNP, improved infrastructure, improved standard of living).
0 Zero	No effect	No effect
1 Insignificant	Possibly there will be no physiochemical alteration of Habitat but some individuals of the local populations will suffer from non-lethal short-term disturbances.	On the short-term (hours or days), there will be disturbances for other users of the resource but no effect on the subsistence or quality of life for the local population.
2 Minor	On the short-term, environmental effects can create disturbances in the habitat and populations in specific areas but long-term effects over large areas can not be foreseen.	On the short-term inconveniences or small problems might affect subsistence or the quality of life for the local population.
3 Moderate	Short-term disturbances will occur to local communities through the impacts to the population with repercussions on associated populations or populations distributed over extensive geographic categories.	Periodic medium-range (a few years) impacts on the quality of life or subsistence of the local population, or a constant short-term disturbance, affecting both subsistence and quality of life.
4 Major	Long-term changes both in population, habitat or ecosystems affecting the integrity and reproduction, and welfare of both the species and habitats involved.	Impacts on the population will result both in long-term effects on subsistence or quality of life of local populations. As the effect is also observed on renewable natural resources, there will be evidence of a reduction in the commercial and subsistence use of the same.

Table 13. Environmental Interaction Matrix (San Andres Island)

COMPONENTS	ELEMENT	IMPACT	ACTIVITY
GEOSPHERIC	EARTH	Disposal of solid waste Erosion of beaches Hydrocarbon spill and disposal Disposal of dangerous waste Extraction of sand, changes in beaches	Airport and airlines Hotels Land transportation Water transportation Docks and Marinas Water sports Nightlife Commerce
	LANDSCAPE	Disposal of solid waste Demand for use of marine areas Extraction of rock, gravel (canteras)	
HYDRIC	UNDERGROUND WATERS	Alteration in physiochemical and biological quality of water Disposal of dangerous waste Disposal of solid waste Extraction volumes	
	SEA	Alteration of physiochemical and biological quality of water (sewage)	
BIOTIC	LAND FLORA AND FAUNA MARINE FLORA AND FAUNA	Loss of flora and fauna Degradation of habitat Loss of marina flora and fauna Degradation of habitat Dumping of sewage Land fills	
	MARINE GRASSES	Hydrocarbons spills Dumping of sewage Boat traffic	
	CORAL REEFS	Anchoring of boats Dumping of hydrocarbons Anchoring of boats Contact with corals Dumping of hydrocarbons Dumping of sewage Boat traffic	
ATMOSPHERIC	NOISE	Noise production (electric plants, Motor driven boztx, airplanes)	
	AIR QUALITY	Emission of gasses (electric plants, vehicles)	

SOCIOECONOMIC	HUMAN	Cause of conflicts Risk to human health On economic benefits Creation of employment Increase standard of living.	
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Table 14. Environmental Interaction Matrix (Old Providence and Santa Catalina Islands)  
( The same as table 13 except that a) **Surface Water instead of Underground Waters:**

**Alteration of physiochemical and biological quality of water (sewage and solid waste)**

**b) Marine flora and Fauna only includes the first two impacts.**

**c) There is a new category after BIOTIC COMPONENT called SPECIAL HABITAT which additions the ELEMENT of MANGROVES with the following impacts: Disposal of Solid Waste, Occupation of areas, Dumping of sewage, Degradation of habitat. There is an additional impact for Marine Grasses: Dragging.**

## 5.2 LAND AND LANDSCAPE

Solid waste produced by tourism inadequately disposed of like all other waste produced in the Archipelago is dumped in the open air without any type of control causing a series of impacts such as: esthetic deterioration, devaluation of land due to the dumping and accumulation of solid waste, contamination of the subsoil and underground waters through the migration of lixiviates producing uncontrolled emissions and proliferation of vectors.

Contamination of the soil is due to the indiscriminate dumping of all types of untreated waste. Among waste produced by this sector, especially by the hotels, we find mainly substances used for cleaning, acids, batteries, etc.

## 5.3 EFFECTS ON THE HYDRIC COMPONENT

### 5.3.1 Underground and Superficial Water

The vulnerability of pollution of the aquifer of San Andres is related to the poor disposal of solid waste, dumping of hydrocarbons and the overexploitation of water resources.

The hotel sector creates the greatest pressure on the aquifer. The extremely high demand for supply, water consumption being the double of that of the residential sector. This produces pollution through the intrusion of marine water, the poor handling of liquid and solid waste creates variation in the physiochemical quality of the water.

On Old Providence Island, surface water currents are altered through the disposal of solid waste. These are produced not only by the tourist sector but also through the erosion of stream beds due to poor building practices and the deforestation of the stream banks which also increase sedimentation in the sea.

### 5.3.2 The Sea

On San Andres Island the majority of the hotels are connected to the sewage system which discharges untreated waste water into the sea. This directly affects the quality of the water column increasing turbidity (sediments), suspended solids and bacteria. There is also a high concentration of nutrients and reduced salinity of waters near point of discharge and drains.

Recreational activities. (degrading of landscape and water quality in beaches areas), tourism, fishing and public health are also affected by the polluting discharges.

On Old Providence Island, marine water quality is affected through the dumping of sewage. An increase in organic matter, nutrients, sedimentation is observed at points of discharge.

## 5.4 EFFECTS ON THE BIOTIC COMPONENT

### 5.4.1 Land Flora and Fauna

San Andres Island fauna is affected by tourism activities through degrading of habitats, poor disposal of solid waste, hydrocarbons and occupation of areas.

On Old Providence, due to ecological type o tourism, the flora and fauna have not been greatly disturbed. The most important pressure on flora and fauna is the inadequate disposal of solid waste.

### 5.4.2 Marine Flora and Fauna

Bentic and pelagic flora and fauna are affected through the dumping of waste water, hydrocarbons, the degrading of habitats. The degradation of habitats affects the quantity of distribution, diversity and reproductive potential of the species.

## 5.5 EFFECTS ON SPECIAL HABITATS

Some areas of mangrove have been affected through the dumping of hydrocarbons, causing the death of propagulos, intervention of the rate of infiltration of pores and a delay in the normal development of mangrove trees. On the other hand, associated fauna are affected by this pollutant and the dumping of garbage. The disposal of solid waste affects the esthetic value of mangrove forests.

On Old Providence, Mcbean Park mangroves is impacted because of the activity of the airport ( production of noise) which affects associated birds and by poor disposal of solid waste.

### 5.5.2 Marine Grasses

On San Andres Island marine grasses are affected by several sources such as boat traffic in shallow areas: the propellers destroy grass morphology and increase sediment in the water, thus, directly influencing photosynthesis processes of the vegetation.

Spilling of sentinas into the sea reduces capacity for photosynthesis and also produces death and affecting the fauna associated with the habitat.

The discharge of sewage into the grasses produces a high degree of epiphitism in algae on the leaves. This interference with their normal development and their capacity for photosynthesis due to the great amount of boat traffic and jet ski over the grasses also have impacts on the associated fauna as a result of noise production.

On the Island of Old Providence, the grasses are affected by the dumping of waste water, situation that s on San Andres produces a series of alterations such as an increase in algae and the eutrofication syndrome. Discharges of sediment by sediment.

### 5.5.3 Coral Reefs

According to the document entitled "The impact of recreational activities and discharge of waste on the reefs of San Andres and ideas on the handling and solution for the reduction of impacts", the greatest contact with corals is produced by diving fins(50%), diving equipment (35%) and hands (15%).

Of 689 registered contacts, only 18% caused minor damage and 15% caused major damage.

The impact of anchoring activity on the two islands has not yet been qualified. Nevertheless, due to the absence of buoys for anchoring and the intensive development of recreational and sports diving activities, impacts on coral and soft sea bottoms has been observed.

The impact produced by discharge of waste water and hydrocarbons in reef areas is reflected in the increase of the alga population, the migration of associated species and in some cases, the death of corals.

The large-scale, non-specialized diving carried out on both islands also affects corals through mechanical rupture on contact with the divers.

### 5.5.3 Beaches

For several reasons, beach conditions on the island have changed substantially over the last decades. Some of the factors that have most motivated these changes are: The initiation of tourism on the island , which has led to the need to implement the building of infrastructure such as the road which circle the island, build over existing beach areas and the laying down of which did not follow the well -planned design. On the other hand, there was the generalized use of coral sand for the construction of infrastructure for tourism. Also, there was a pressure to occupy greater areas of beach, both for tourism and for urban expansion,

thus reducing the vegetation covering beaches. The main changes in the physical condition of our beaches are due to human activity and lack of planning for the development of the island.

Island beaches are not very great in extension and therefore can not withstand great pressure on their load capacity.

A study carried out in 1998 recommended that load capacity for use of Old Providence beaches for tourism should be:

Fresh Water Bay Beach: 120 persons

South Wets Bay Beach: 225 persons

Manchineel Bay Beach: 260 persons

Allan Bay Beach: 40 persons

## 5.6 EFFECTS ON THE ATMOSPHERIC COMPONENT

### 5.6.1 Noise

The emission of sound produced by airplanes and electric plants produces on punctual impact of short duration on inhabitants near the source of emission.

Land transportation vehicles that are not in optimum condition produce lineal, continuous noise when in motion, affecting population near their routes.

Boat motors and jet ski affect fauna associated to marine grasses and coral reefs.

### 5.6.2 Air Quality

Although there are several sources of polluting emissions such as electric plants and automobile vehicles, studies carried out show that the air quality has not been seriously affected. The amount of pollution by these sources is not known.

Old Providence Island has the advantage that tourist industry development is limited and sources of emissions few. Therefore, the quality of air can be considered optimum.

## 5.7 EFFECTS ON THE SOCIOECONOMIC COMPONENT

### 5.7.1 Human

On both island, water sports have been observed to produce a series of conflicts with the other users of the marine area: conflicts between divers and fishermen, between boats carrying tourists to the keys and persons practicing water sports.

Tourist activities positive impacts on the creation of employment, commercial service opportunities, increase in standard of living, income from abroad, public taxes.

## 6. ENVIRONMENTAL MANAGEMENT

The management plan for the tourism sector should be oriented towards sustainable development. The development of management practices should be supported by environmental legislation, commercial incentives, trained personnel and a program director.

The operational areas identified for the formulation of good user practices are:

- Handling of waste (solid and liquid)
- Use of water
- Use of energy
- Maintenance services
- Recreation
- Public/social interaction

### 6.1 HANDLING OF WASTE

#### 6.1.1 Handling of Solid Waste

- Reducing packaging through: buying bulk supplies, using dispensers for liquids, eliminating wrapping when possible.
- Not using disposable plates, glasses and utensils.
- Implementing a recycling program.
- Acquiring products that can be recycled.
- Assuring good storage of perishable products.

#### 6.1.2 Handling of Liquid Waste

- Eliminating the use of detergents containing phosphates.
- Redesigning the waste water (sewage) system when possible in order to reduce the volume available in order to facilitate the recycling of "grey" water.
- Using wash water to irrigate grass and other green areas.

### 6.2 USE OF WATER

- Using showers and faucets with little strength.
- Using faucets with timers.
- Using toilets with low water volume.
- Using automatic valves in public areas (public toilets and showers for beach goers)
- Information guests of the need to save water and by providing alternatives.
- Reducing the amount of towels, suggesting to the guest that he must not change towels so frequently.
- Washing only when there is a full load.
- Designing laundries so that water used for rinsing one load be utilized as wash water for the next loads.

- Carrying out periodic inspection of the water pipes in order to reduce escapes.

### 6.3 USE OF ENERGY

- Using sensors to control room lights.
- Installing timed switches where possible.
- Using fluorescent light bulbs for lighting.
- Routine maintenance of electric equipment, especially refrigerators and air conditioners.
- Development of energy saving practices.
- Adoption of orientation sessions and signs to persuade the guests to practice in the energy saving program.

### 6.4 MAINTENANCE OF INSTALLATIONS

- Developing a maintenance program for electronic equipment and refrigeration units.
- Employing appropriate personnel for maintenance of the programs, including the monitoring and review of the system for the disposal of sewage.
- Repairing of equipment in areas far from beaches.
- Planning species of grass resistant.

### 6.5 RECREATION

- Training of tourist guides in relation to natural resources and impacts of the activity and the providing of orientation to guests on each activity /tour.
- Reducing impact on beaches due to overuse.
- Not anchoring in coral reefs areas.
- Not dumping sentinas or sewage into the sea.
- Disposing of solid waste in container put out for that purpose.
- No operating jet ski or other motorized equipment in bathing areas.

### 6.6 SOCIAL/PUBLIC INTERACTION

Some social impacts caused by tourism can be reduced through the employment of management plans. For example by:

- Developing procedures for conflict solution for users of the resource, including access to beaches.
- Promoting collaborative efforts between tourist guides/hotels and community management.