

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE ESTABLISHMENT OF A MARINA/SMALL CRAFT HARBOUR IN SOUTHWEST TOBAGO





**Caribbean Environment Programme
United Nations Environment Programme
CEP Technical Report No. 29 1994**

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1. Background

One of the most pressing issues with regard to the environment is linked to development. It is well recognized the need to assess the impact that a given development has on the environment in order to prevent or reduce it as much as possible or even recommend to stop it if the negative impacts surpass the expected benefits. The United Nations Environment Programme (UNEP), aware of the importance of this matter and recognizing that the Environmental Impact Assessment is a valuable technique to assess these effects, has established a Global Programme on Environmental Impact Assessment for the encouragement of governments and agencies around the world to utilize EIA's as a tool in project development.

The present Technical Report is the result of a case study undertaken by the Institute of Marine Affairs (IMA) and sponsored by the Caribbean Environment Programme of the United Nations Environment Programme within the framework of the above mentioned Global Programme. It focuses on the results of an environmental impact assessment study undertaken for the development of a marina/small craft harbour in Southwest Tobago in the Republic of Trinidad and Tobago.

2. Introduction

Early planning is the key to reducing the impact of development on the natural environment. If environmental concerns are considered concurrently with technical and economic planning of a major project, and precautions are applied from the outset of the planning process and through all phases of the project's development, it may very well be possible to develop a project and at the same time protect the natural resources of an area.

The Environmental Impact Assessments (EIA) as a tool utilized in planning to assess the potential impact that a given development has on the environment is being extensively used over the last 15 years. Its wide application clearly indicates a need to ensure that environmental considerations are included in the decision-making process.

There are many sectors where the EIA could be applied to policies, regulations and managerial practices. Some of these are energy, fisheries, agriculture, forestry, waste management, land use and health care to name but a few. In all these cases, the ecological

and social impacts of possible political, regulatory and managerial decisions should be formally, systematically, and publicly assessed to determine whether they threaten sustainable development and whether they do as much as they could to enhance that sustainability. In addition, each EIA would contribute to raising public consciousness about sustainable development goals and means. This would be a vital contribution because sustainable development cannot be achieved without stimulating public consciousness.

Problems in the EIA procedures may arise where project-specific reviews inadequately deal with issues which should be addressed in policy reviews; or when there is no environmental policy context at all for a project evaluation. Work is needed to provide a framework for environmental decision making if the EIA processes are to function as they were originally intended, that is, to review and mitigate environmental effects of proposed projects before, and not after, the damage is done. Without such a framework, this has led both in developed and developing countries to a track record of the EIA process where few projects have been rejected on environmental grounds. The planning framework should not increase the number of rejected projects in the EIA process, but should set out environmental criteria and environmentally-based land use restrictions so clearly that many conflicts never occur. It is by this addition to the planning process or act that EIAs will be able to make the contribution to sustainable development that they should make.

The requirements for EIA's of projects or plans which may have adverse effects on the human environment are today embodied in the national legislation of many countries and in a number of international agreements. However, the procedures used for the preparation of such assessments vary considerably from country to country, and at present, there is no agreement, on a global or regional level, on procedures which may lead to comparable results.

Various EIA's methodologies and approaches have been developed during the last few years. In 1990 the Ocean and Coastal Areas Programme Activity Centre (OCA/PAC) of the United Nations Environment Programme, developed and published an innovative EIA methodological approach entitled "An Approach to Environmental Impact Assessment for Projects Affecting the Coastal and Marine Environment" (Regional Seas Reports and Studies No. 122 (1990)),

This methodological approach was prepared as a response to the fact that EIAs were taking a very long time to be conducted while projects were going ahead. The problem was compounded since in a number of instances a vast amount of information needed to be collected and the cost of doing so was enormous. The methodology essentially advocates that countries become innovative in carrying out the EIA process and adapt the process to suit the realities of their situations, rather than not carry out the EIA at all. This in turn will ensure that the process itself evolves in to a more practical tool.

The approach of UNEP-OCA/PAC is limited to a narrowly defined practical and easily applicable methodology which could be used to assess or predict the environmental

consequences of projects or activities proposed for a given site. The approach utilizes analogies, therefore it is limited to projects that are unique in size or scope. The document does not cover a number of important considerations related to planning for sustainable development, such as environmental accounting; cost-benefit analysis of environmental protection measures; comparative analysis of available alternatives; risk assessment and management; physical planning etc. These considerations have been deliberately left out because it is felt that these considerations should not be mandatory to the approach to environmental impact assessment recommended in the document.

The approach for preparing EIAs for development projects affecting the coastal and marine environment considers that the EIA procedure should:

- i. be based on simple and easily understandable goals and principles;
- ii. recognize and utilize the fact that very few projects are unique in nature or size and that knowledge from analogous cases can be used in carrying out EIAs;
- iii. include monitoring of the environmental impacts as an integral part of the EIA process, which would allow for errors in the initial predictions to be observed and corrected and more knowledge of the environmental consequences could be gathered on an ongoing basis; and
- iv. require less time consuming and costly collection of site specific data.

The advantages of this approach to the EIA process are that the EIA document which is the output of the process, could be:

- i. based on existing or deducible information;
- ii. prepared within a few months;
- iii. prepared at relatively low cost; and
- iv. prepared by the professionals and public servants of developing countries with minimal training in the EIA process, which would make the heavy involvement of foreign experts unnecessary.

Since UNEP's approach on EIA is mainly based on predictions, the validity of the predictions should be verified during the construction and operational phases of the project. Therefore a follow-up monitoring programme and re-evaluation of the assessment is necessary as an integral part of the EIA process. The components of such a programme should be specified by the environmental organization which recommends approval of the

EIA document to the decision makers. The monitoring could possibly be required from the applicant as a condition of issue for authorization.

The UNEP's EIA approach considers guidelines for marinas, tourist complexes, sewage treatment plants for cities between 10,000 to 100,000 and 100,00 to one million inhabitants and a submarine sewerage outfall of a city of up to 100,000 inhabitants.

The Preparation of an Environmental Impact Assessment Document for a Marina was tested in a case study for the construction of a marina in Paphos, Cyprus; where no EIA procedure was previously practiced in this country and evolving environmental groups were suspicious of the Government's attitude to environmental questions and governmental bodies had no experience in collaboration over multidisciplinary environmental questions. The first positive effect of the procedure of EIA preparation was that interagency governmental collaboration was established and functioned well.

Public participation was for the first time formally introduced in Cyprus in connection with the presentation and evaluation of the EIA documents. A wide range of NGOs and concerned individuals participated in and were in agreement with the decisions. A decision was taken not to build the marina at the first location considered (north-west of Paphos), where it would have interfered with turtle nesting sites and bird migration routes. Instead, a location near the airport was chosen where the marina would cause considerably less environmental disturbance.

The construction of a marina under UNEP's methodological approach provided a good example for its implementation and also proved to be a successful EIA methodological resource in one case study in the Mediterranean Sea. As a result of this experience, it was decided that a similar case study should be undertaken in the Wider Caribbean and Trinidad and Tobago was selected by the Caribbean Environment Programme (CEP) for this purpose.

Environmental impact assessments in Trinidad and Tobago started in 1981 when a baseline study undertaken on the flora and fauna of the rivers, mangroves and bays of the proposed Point Lisas Industrial Estate. This was done at the request of the development company which acted on behalf of the Government of the Republic of Trinidad and Tobago. An EIA which examined the impacts of the location, construction and operation of the Industrial Estate on the ecology of the rivers, mangroves and bays; on the economy of Trinidad and Tobago; and on the human settlement areas adjacent to the estate was undertaken. Later in 1985 discussions began with the Airports Authority of Trinidad and Tobago (AATT) concerning the need to carry out an EIA for the extension of the Crown Point Airport runway, Tobago. The upgrading of the airport from domestic to international status had the potential for impacting significantly on the terrestrial and marine environment, particularly due to the potential impacts of the reclamation, which was one of the options being considered for the runway extension, and the presence of the Buccoo Reef designated to become the country's first national marine park in close proximity to the project site.

The Airports Authority gave the permission for the undertaking of an EIA study at the time funding was being released to begin the undertaking of construction activities of the project. The Institute of Marine Affairs (IMA) then found it expedient to undertake a shortened form of the predictive phase of the EIA including the baseline studies. This preliminary/predictive phase was of four months duration. It was anticipated that this shortened phase of the EIA would provide the data required for an initial assessment of the impacts of the runway extension and would facilitate the identification of specific aspects to be monitored over the entire construction phase of the project. Existing data on previous studies were included in the predictive phase of the EIA. The monitoring phase of the EIA took place over the entire construction phase of the project which was of two years duration. This innovative approach to the EIA used by the IMA closely paralleled the UNEP methodological approach to be tested.

3. Case Study

The present EIA exercise has been undertaken by the IMA and its results are presented as reported by this institution.

The results of the project study is divided into the six components as recommended by the UNEP approach:

- description of the proposed project;
- reasons for selecting the proposed site, including a short description of alternatives which have been considered;
- description of the site of the proposed project, including the natural environment and the socio-economic structures which may be affected by the project or plan on the site and in its vicinity;
- identification and assessment of anticipated or forecasted negative and positive impacts on environmental quality as a consequence of implementing the project;
- description of measures proposed for eliminating, minimizing or mitigating the anticipated adverse impacts; and
- proposed programme of monitoring the environmental impacts of the project.

3.1 *General Description of Tobago*

Tobago is located 11⁰N latitude and 60⁰W longitude. It is 300 km² in area and its resident

population is 46,654 (Central Statistical Office, 1990). Tobago, like the other Caribbean islands, experiences seasonal fluctuations in climate and displays two distinct seasons, one wet (June - December) the other dry (January - May). The prevailing wind system is the NE Trade Winds. Occasionally local variations in wind direction result in wind blowing in from the south and southwest. Eighty percent of the time winds blow from 070⁰ to 110⁰ (NE/E). Rainfall is less during the dry season and increases considerably during the wet season. Berridge 1981, states that rainfall in Tobago is highest in the northeastern end of the island, the rainfall quantities decreasing towards the southwest. Mean annual rainfall for Tobago over the years 1971 to 1991 was 1,413.2 mm. Tobago experiences minimal seasonal temperature variations. Mean annual temperature was 26.8⁰C in 1990.

Fifteen tropical cyclones affected Tobago between 1773 and 1986, four of which were hurricanes, the remainder, tropical storms. The most severe hurricane was Flora (1963) which was classified as a Category 2 hurricane.

Tobago is elongated along an ENE axis and the main mountainous landmass, the Main Ridge, runs along the length of the island. The ruggedness of the Main Ridge decreases toward the southwest and gives way to a low lying limestone platform. The flat to gentle topography of the southwestern end of Tobago (maximum elevation approximately 70 m) has made it ideal for the development of infrastructure to support the tourism industry. The international airport, the deep water harbour, the highway and numerous hotels and guesthouses are all concentrated in this part of the island. Southwest Tobago (**Figure 1**) extends from Plymouth on the north coast to Scarborough on the south coast.

3.2 Selection of Alternatives Sites

Private and public sectors indicated that there was a need for a marina/small craft harbour in Southwest Tobago to provide facilities which would be supportive of the tourism and/or the fishing industry. Several applications for outline planning permission for marinas associated with tourism development were submitted to the national planning authority (the Town and Country Planning Division) by private sector developers. On the other hand the public sector was more interested in the establishment of a small craft harbour with fuelling facilities to service the fishing industry.

The EIA was divided into two phases: Phase One was the selection of a suitable location for a marina to accommodate yachts or other boats with a deep draught; or a harbour with fuelling facilities for small craft with relatively shallow draughts such as artisanal fishing boats and the glass-bottom boats used by the reef tour operators, and Phase Two the detailed study of the bay selected as the most suitable location for a marina in Southwest Tobago.

During Phase One eleven locations in Southwest Tobago were initially considered and from these eleven locations four were short-listed based on considerations such as safety of anchorage, geology, hydrography and marine ecology. The original eleven locations were: Great Courland, Stonehaven (Grafton), Mount Irvine, Buccoo, Bon Accord Lagoon,

Milford, Kilgwyn, Cove, Petit Trou Lagoon, Little Rockly and Rockly Bays. The four locations short-listed were Great Courland Bay, Mount Irvine Bay, Buccoo Bay and Petit Trou Lagoon.

In order to select the final bay from the four short-listed locations the Geology, Hydrography, Marine Ecology and Socio-Economic characteristics of these locations were examined. The most suitable bay for the location of a marina or small craft harbour was chosen based on a comparison of the specific set of characteristics being reviewed for the alternative bays.

Based on all the site characteristics considered for the three alternative bays, Great Courland Bay was selected as the most suitable location for a multi-purpose marina for Southwest Tobago (**Figure 1**).

In terms of the Geology and Hydrographic conditions Great Courland was considered suitable due to the following:

- i. The bay is deep with depths of 15 m in the nearshore at the northern end of the bay.
- ii. The northern headland gives good protection to vessels except when the wind is N of E when a swell enters the bay.
- iii. A submerged rock close to the northern headland provides additional protection. Other than this there are no submerged rocks in the bay so that there is easy access to the bay from the sea.
- iv. The bay is moderate to high energy with waves ranging in height from 0.2 m to 1.5 m. A higher wave energy is experienced in the winter (wave height 0.6 m to 1.5 m).
- v. The land around the bay rises gently from the flat back beach area.
- vi. Coastal engineers advise that since the bay is open to swells several months during the year a marina facility will have to be protected.

Great Courland Bay (**Figure 2**) was most suitable for a multi-purpose marina based on Marine Ecological considerations because of the following characteristics:

- i. It was furthest from Buccoo Reef, to be designated the country's first national park in the marine environment. Therefore the impacts of marina construction and operations would not affect the Buccoo Reef.
- ii. The habitat present in this bay was not considered a critical habitat. It consisted of hard-bottom fauna at the northern outer area of the bay dominated by anthozoans primarily octocorals and stony corals. Generally sparse benthic biota and high turbidity conditions occurred towards the inner northern area of the bay.

Figure 2. Great Courtland Bay

- iii. The habitat was considered to be moderate in richness, that is, the total number of species presented was not considered to be high.
- iv. The habitat size and extent in the bay was considered moderate since the hard-bottom habitat was restricted to northern end of the bay at the base of the headland.
- v. The habitat was of low importance both ecologically and economically.
- vi. The habitat susceptibility to physical disturbance from marina construction and operation was considered to be low.
- vii. Habitat sensitivity to changes in water quality by pollution from the marina was considered to be high.

Based on Socio-Economic considerations Great Courland Bay was considered most suitable for a multi-purpose marina because of the following characteristics:

- i. Potential end users of the marina have identified Great Courland Bay as a suitable location for a marina for pleasure boats with a deep draught or as a small craft harbour with fuelling facilities to service the fishing community.
- ii. Basic infrastructure such as electricity, water, telephones and good roads exist within 50 m of the beach in the northern and central areas of the bay.
- iii. The presence of a large agricultural estate which could be purchased and the land used for a resort development which could be associated with the marina.
- iv. The water collection and distribution system at Courland is to be upgraded which would eventually provide an adequate water supply for the marina and an associated resort development.

Both Buccoo Bay (**Figure 3**) and Petit Trou Bay (**Figure 4**) would have required dredging and removal of parts of their respective coral reefs to provide safe access to the bay by boats with a deep draught. While Great Courland Bay could provide a naturally deep harbour. Based on these environmental considerations and under normal sea conditions Great Courland Bay would appear to be the least cost option. Therefore it should have been recommended as the bay of choice for a multi-purpose marina. However, because at certain times of year Great Courland Bay is open to swells the marina would require the construction of sea defenses such as some sort of breakwater which would make the marina at Great Courland Bay the most costly from the economic perspective, however this is not the case from an environmental point of view.

Figure 3. Buccoo Bay

Figure 4. Petit Trou Bay

Buccoo Bay was recommended as a small craft harbour to service only the reef tour operators since this activity would have been uneconomical from any of the other bays being reviewed.

It was recommended that Mount Irvine Bay (**Figure 5**) should not be considered for either a marina or small craft harbour, since this was a relatively small bay in which recreational activities such as swimming, surfing and snorkeling form the dominant activities for both foreign tourists and the citizens of the country.

It was recommended that a small craft harbour with fuelling facilities to service the fishing communities of the north coast of southwest Tobago should be located at Great Courland Bay as part of the pleasure craft marina thus making it a multi-purpose marina.

3.3 Description of Proposed Project

In order to carry out the case study it was necessary to obtain the actual project plan along with the preliminary engineering drawings. Two sources were available in this respect.

The first was a feasibility study for a small craft harbour with fuelling facilities carried out by an engineering firm for a government company. The three alternative bays considered in the study were Great Courland, Buccoo and Minister Bays (the last is not in Southwest Tobago). The second was a proposal for a marina which had been submitted by a private developer to the Town and Country Planning Division. This proposal was for Great Courland Bay.

Aspects of the private developer's proposal, that is, the feasibility of the engineering design for the marina facilities, the adequacy of the location of the land-based facilities etc. were queried by a number of public sector agencies. This proposal eventually became the subject of a planning dispute; thus, under the circumstances the use of the plans contained in the feasibility study of the engineering firm was chosen instead.

An engineering firm was commissioned to carry out a feasibility study for a facility capable of berthing and serving small shallow draught marine craft including power boats, cabin cruisers, fishing boats and reef tour operator boats; and deep draught vessels such as yachts, but it was not intended to provide a fully developed marina.

Alternative layouts were developed for each site. In developing the layouts, the engineers gave consideration to the site topography and bathymetry, marine conditions, basic layout requirements, wave attenuation and utilities. In addition, the engineers gave basic consideration to the preservation of the coastal regime and ecological conditions in the absence of any extensive investigations at the time of their study. The layouts reflect depth requirements in waters of natural depth, thereby eliminating the need for dredging and minimizing disturbances to the regime. Consideration was also given to land accessibility and availability of space for land-based facilities.

Figure 5. Mount Irving Bay

Berths were oriented to suit the characteristics of each site. Since the vessels are relatively small, minimizing the effects of wind on the vessels at the berth does not offer significant advantages. Breakwaters and harbour entrances were oriented to give maximum protection to the facility whilst at the same time affording use of the deeper portions of the protected area.

Great Courland Bay was chosen as the most suitable location for multi-purpose marina for Southwest Tobago in the site selection exercise for this case study. Therefore the two alternative marina designs for Great Courland Bay were assessed.

Due to the existing potential for conflict between the traditional fishermen in Great Courland Bay and developers of a marina, the IMA selected Alternative II (**Figure 6**) for the marina design. This was because this layout kept separate the smaller craft such as fishing boats from the larger pleasure craft. In addition the 20.0 m branch pier in the shallower side of the harbour could be easily extended further northwest into areas marginally less than 1.0 m which could provide berthing for fishing boats in their traditional mooring areas. In addition, Alternative II was selected, because the design was specific for an open pier structure which would impact less on the water circulation patterns within the northern section of the bay.

Expanded land-based facilities for the marina would have to be located at some distance from the berthing area due to the topography of the location and the existing land uses of the area. It was recommended as the location for the expanded land-based facilities of the marina, the back beach area of Great Courland Bay between the two mouths of the Courland River where adequate flat land exists for the facilities which have been adapted from an engineering design.

3.4 *Description of the Environment*

3.4.1 *Oceanography (Figure 7)*

The study showed that the water circulation of Great Courland Bay was consistently towards the east - southeast. This pattern was also repeated at 10 m depths. The study revealed no clear relationship between tidal fluctuations and circulation patterns. The conclusion did not preclude the possibility that such a relationship exists. The data was simply not sophisticated enough to reflect this.

Due to the brevity of the study, which took place at the end of the dry season, the influence of the rainy season on the circulation patterns in the bay remain unknown. It is thought that the higher seasonal discharges from the Courland River during the rainy season might alter the circulation patterns in the Bay. In addition, other forcing mechanisms originating in the offshore at certain times of year and not identified in this study may further alter the circulation patterns.

Figure 7. Great Courland Bay, Tobago. The study area is shown in the inset relative to its location on the Island of Tobago. Station locations and numbers are indicated

3.4.2. Geological and Hydrographic Characteristics

The land around Great Courland Bay is generally flat and gently sloping inland. The land north of the southern Courland River distributary has a wide backbeach area. Two rivers, the Courland River and the Black Rock River discharge into the bay (**Figure 8**). During the period 1974 - 1987 Courland River experienced an average annual mean discharge of 0.258 m³/sec. The annual mean discharge for the same period ranged from 0.151 m³/sec to 0.419 m³/sec. The suspended sediment discharge for the period 1979 - 1986 was 0.50 - 1.6 tones per day, and the maximum river and sediment discharge occurred between July and December.

High berms occur at the mouths of both rivers which control the flow of water and sediment supply into the bay. Events of high rainfall and high runoff result in the river breaking through the berm and flowing into the sea.

The study of inshore hydrography of the bay has indicated that waves approach the land predominantly from the northwest and display moderate wave and breaker heights. These conditions intensify during tropical cyclones and winter swells. Two long-shore current directions transport a small quantity of sediment per year - $3.14 \times 10^5 \text{ m}^3 \text{ yr}^{-1}$. Net longshore movement of sediment is to the south.

The beach appeared to be very dynamic, exhibiting periods of erosion and accretion. Previous work showed that high accretion rates occur on the beach at the northern, more sheltered area of the bay. The beach showed to be very mobile in the lower beach area (20 - 40 m from bench mark).

Beach sediments consisted of well to poorly sorted very fine to coarse grained sands which have a high quartz content. Offshore sediments consisted of very well to poorly sorted coarse to very fine sand. Most of the northern section of the bay consisted of muddy sand while off Courland Point the substrate was rocky (**Figure 9**).

Within the bay the seafloor sloped gently seaward, reaching maximum depths of 31 m. The bay had adequate natural depth to accommodate small to medium vessels (**Figure 10**).

Tidal variation showed to be in the order of 1.3m and fairly constant for all coastal areas. Rising tides flowed towards the southeast while falling tides towards the northwest. Rising tides resulted in slight eastward flowing eddies, while with falling tides, the opposite was true.

3.4.3 Marine Ecological Characteristics

The assessment of water quality in Great Courland Bay indicated a generally unpolluted marine environment with the exception of the northeastern corner of the Bay where sewage pollution was evident (**Figure 11**). Coliform bacteria concentrations in the

Figure 8. Physical Setting of Great Courland Bay, Tobago

Figure 9. Sediment Distribution within Great Courland Bay, Tobago

Figure 10. Bathymetry of Great Courland Bay, Tobago

Figure 11. Water Quality Sampling Sitations in Great Courland Bay, Tobago

Very high coliform bacteria concentrations were simultaneously found in river water samples close to both the northern and southern mouths of the Courland River. As only the northern mouth of the Courland River was flowing into the Bay over the duration of the study period, it is apparent that sewage is entering the marine environment of the Bay at this point and is subsequently transported southwards, parallel to shore, by predominant southwesterly longshore currents. This would account for the nutrient and coliform concentrations present in water sampled opposite the closed southern mouth of the Courland River.

Probable sources of sewage pollution in the Bay are run off from pit latrines which were the common form of human sewage disposal in Plymouth; effluent discharged from the hotel's malfunctioning sewage treatment plant directly into a stream draining into the Courland River close to its southern mouth; and run off from pig farms and pit latrines located in the drainage basin of the Courland River. Given the developments proposed for the land area adjacent to the Bay, it was likely that sewage pollution in the nearshore would escalate if proper disposal and treatment facilities were not provided.

In the present study, water quality data collected for Great Courland Bay when compared with analogous data available for other localities around Tobago showed close similarities between the data obtained from areas of the Bay away from the direct influence of river discharge and that recorded for other localities, particularly at Buccoo Reef.

The major faunal groups which characterize the ecology of the Bay comprised a benthic coral community, inter-tidal bivalve and mole crab populations on the beach, estuarine and marine fish species many of which were juveniles of commercially important species, nesting leatherback turtles and migrant and resident sea birds.

3.4.4 Socio-Economic Characteristics

In terms of land use, the Great Courland Bay area appeared to be dominated by large agricultural estates with two main settlement areas, Plymouth to the north and Black Rock to the southwest (**Figure 12**).

The main economic activities in the Great Courland Bay area were fishing, tourism and agriculture. No official data was available on numbers employed by sector. The northern area of Great Courland Bay is used as a base by some thirty fishing boats, while further south along the coast, approximately ten boats are moored close to the fishing facility on the beach adjacent to which is an abandoned fuelling facility. Next to these facilities on the beach is the Turtle Beach Hotel.

The social demographic statistics of the Great Courland Bay area including the Plymouth and Black Rock Villages indicated that there is a growing demand for employment generation. A multi-purpose marina and its spin-off activities would assist in this respect.

Figure 12. Pre-Columbian and Historic Sites in Plymouth and Adjacent Areas

Basic infrastructure such as electricity, water, telephones and good roads existed and could be upgraded. The water distribution for Southwest Tobago originated from the Courland water treatment plant. The plant had an existing capacity of 7,000 m³ per day. Plans exist to upgrade the Courland plant by 1,800 m³ per day. At present the water supply is not considered adequate on a year round basis.

4. Identification and Assessment of Potential Impacts

The problem in data collection imposed by the time constraint, the unavailability of data, or data not available in a desegregated form and gaps in knowledge did not allow for the quantification of the impacts of the establishment of a marina in Great Courland Bay. In addition, water quality standards and guidelines do not exist in Trinidad and Tobago, so that there could not be an assessment of how much the marina would cause the water quality of the selected bay to depart from the standards set. Consequently, it was not possible to use predictive analysis to fully determine the nature, magnitude, extent and significance of the impacts. Therefore it was opted for describing these impacts as determined by expert judgement, in addition to the acquired information.

The predicted impacts of the establishment of the marina on the various characteristics of the environment of Great Courland Bay are listed below.

4.1 Impacts on the Geology and Hydrography

The predicted impacts on the Marine Geology and Hydrography of Great Courland Bay were as follows:

- i. Increased run off during the construction phase caused by clearance of vegetation and destruction of berms. Increased run off will cause deposition of sediments in the nearshore areas resulting in shallowing and alteration of the nearshore bathymetry in the northern section of Great Courland Bay. The alteration of the bathymetry may result in the formation of nearshore shoals and sandbars which may be hazardous to navigation and may eventually necessitate dredging.
- ii. In the operation phase it is predicted that the breakwater will cause the alteration of the current and water circulation patterns, which in turn will affect the sediment transport and distribution patterns, and the beach dynamics. However, the information presently available does not allow for the determination of how significant these impacts will be.
- iii. Previous studies have shown there are high rates of sediment accretion occurring at the northern end of the beach in the vicinity of the proposed land-based facilities of the marina. This is due to the more sheltered nature

of this section of the bay. The presence of the breakwater will result in even more sheltered conditions, which is likely to accelerate the build-up of sediment.

- iv. If the Courland River is modified to allow discharge only through its southern mouth, the active build-up of sediment will necessitate an expensive and rigorous maintenance programme in order to keep the river mouth open.

4.2 Impacts on the Marine Ecology

The predicted impacts on the Marine Ecology of Great Courland Bay were:

- i. The Oceanographic studies have shown that the ambient water movement is in a consistent east-southeasterly direction, that is, at both surface and depths. The longshore current is predominantly to the southwest. The available data suggests that pollutants released into the bay will circulate the entire length of the bay with possible residence times in the order of several days. This means that pollutants entering the bay during the construction or operation of the marina could have adverse impacts on both the water quality and on the presence, abundance and survival of the major faunal groups in the bay.
- ii. The assessment of the water quality in Great Courland Bay indicated a generally unpolluted marine environment with the exception of the northeastern corner of the bay where sewage pollution is evident. If proper disposal and sewage treatment facilities are not put in place to prevent the marina, during its operation phase, from also adding to the sewage pollution of this part of the bay, eutrophic conditions may become evident. Indications of this already exist in that water quality results showed nutrient levels to be higher in this section of the bay.
- iii. Zinc concentrations recorded at the stations in the bay were approximately two orders of magnitude above the seawater natural concentration of zinc and slightly lower than the recommended zinc concentrations in seawater for the protection of aquatic life. Also the zinc concentrations in the sediment samples for the stations at the northeastern end of the bay were higher than concentrations found in the rest of the bay. It is predicted that unless proper waste disposal mechanisms are put in place for the boat repair facilities of the marina the zinc concentrations could be elevated to above the recommended concentrations in seawater for the protection of aquatic life.
- iv. The closure of the northern mouth of the Courland River and the permanent opening of the southern mouth will transfer the most polluted zone of the

bay further south. In particular the area of the highest concentrations of sewage pollution will now be located closer to the Turtle Beach Hotel and therefore closer to the areas where foreign and local visitors swim.

- v. The ecological importance of Great Courland Bay as a nursery area for commercial species of fish, nesting site for turtles and feeding area for sea birds would be threatened by a range of pollutants which may result from activities associated with marina development in the bay.

4.3 Impacts on the Socio-Economic Environment

The predicted impacts on the Socio-Economic Environment of Great Courland Bay were as follows:

- i. It was anticipated that an already existing conflict between the fishermen, in particular the beach seine fishermen, and the developer of the marina will escalate during the operation of the marina. These fishermen saw the marina as reducing the area of the bay in which they would normally pull their seines (nets) and thereby reducing their catch.
- ii. Some three hundred people were directly and indirectly affected by the beach seine activity and would be impacted if the catch is reduced.
- iii. The offshore fishermen also saw the marina location as a negative impact, because it would prevent them from mooring their boats in their traditional mooring area in the northeastern section of the bay. In addition, they felt that the pollutants generated by the marina will have an adverse impact on the bait fish found in the bay which they use in their fishing.
- iv. Positive impacts perceived by the fishing community were the provision of a jetty, fuel and ice.
- v. The marina was anticipated to contribute to the general trend of land use change in the Great Courland Bay area, that is, from agriculture to tourism development.
- vi. The marina would increase the demand for water and sewerage, which are already limited.
- vii. The marina was expected to contribute only marginally to the need for the provision of employment in the two settlement areas of Plymouth and Black Rock.
- viii. The marina was expected to attract a new section of the tourism market to

Tobago, namely the pleasure craft visitors.

- ix. The financial appraisal of the project has shown that it is not a financially viable venture. The project will cover its operating expenditure but not its investment expenditure.
- x. The establishment of a marina in Great Courland Bay effectively represents the change in use of part of an economic resource (the northern section of the bay) from fishing and free anchorage to paid anchorage. Many local residents benefitted from the former while the developer and foreign visitors appear to be the main beneficiaries of the marina.
- xi. Economically, this change in use appears to be more efficient in its ability to earn income and foreign exchange. However, the distribution of the benefits from the income generated would be less efficient than the benefits from the traditional use.

5. Recommendations and Mitigatory Measures

Recommendations to prevent, reduce or mitigate the negative effects of the proposed marina area are described below. However, it should be noted that water quality standards do not exist in Trinidad and Tobago and pollution control legislation only existed in a draft form. The draft Prohibition and Control of Pollution Act when approved by Parliament will provide the legal basis for the water quality standards. Monitoring of the impacts of the various activities on the environment is to be undertaken in keeping with the Act and this would go a long way in protecting the coastal and marine environment.

5.1 Construction Phase

Recommendations for the construction phase of the marina were as follows:

- i. Although it is already a common practice to undertake construction in the dry season in Trinidad and Tobago so as to minimize working days lost due to heavy rains, it was recommended that construction takes place in the dry season in order to minimize run off from the site into the sea.
- ii. The beach berms create embankments which restrict run off and they protect the back beach area from the effects of wave attack. Therefore the berms should not be removed as part of the site clearance and site preparation activities.
- iii. Sand should not be removed from the beach for construction activities. Removal of sand for this purpose could lead to severe beach erosion as was

seen in the southern section of this bay.

- iv. Clearance of the natural beach vegetation during site clearance should be minimized. Any vegetation removed during the construction phase should be replanted. Natural beach vegetation should be replanted and not ornamentals, since the natural beach vegetation has root systems specially adapted to stabilizing this type of soil.
- v. Although the possibility of closing off the northern mouth of the Courland River to provide more land space in the back beach area by filling this part of the river and keeping the southern mouth open has been suggested, it is not the recommended alternative. This alternative is not recommended because to keep the southern mouth open would require a rigorous and expensive maintenance programme, and it would shift the existing pollution zone southward nearer to the parts of the bay used for swimming by local and foreign visitors.
- vi. Care should be taken to protect and possibly integrate with the development, any archaeological and historical sites within or adjacent to the construction site.
- vii. Employment opportunities during the construction and operation phases should be given to the people of the Plymouth and Black Rock areas. In particular, all requirements for unskilled labour should be filled by people from these communities.
- viii. In the short term the Water and Sewerage Authority (WASA) will not be able to meet the water demands of the marina on a regular basis. Therefore a water tank should be constructed to hold at least two days supply of water for the land-based facilities of the marina.
- ix. Although evidence of sewage pollution exists in the nearshore of the northern part of Great Courland Bay, the marina should not contribute to this form of pollution. At the land-based facilities of the marina, sewage should be treated at least to the secondary level. If a package secondary treatment plant is installed, it will have to be built in such a way that it could eventually be linked to the proposed central sewerage system for Southwest Tobago. The effluent from the secondary treatment package plant should not be released directly into the marine environment.
- x. It is recommended that the best option is that the sewage be treated to the tertiary level and the effluent stored and used for all the marina's requirements for freshwater other than for potable water, particularly as there will be a shortfall in the supply of water to the marina by the Water and

Sewerage Authority (WASA).

- xi. If above ground fuel tanks are to be used, they must be located where there is enough room for a bounded area to be constructed around the tanks, with the bounded capacity being sized according to the tank capacity.
- xii. The breakwater should be designed in such way so as to minimize adverse alterations to wave conditions and water circulation.
- xiii. As part of the planning process, opportunities should be made possible for community participation and public consultation during the development stages of the marina, so as to address any particular concerns and conflicts which could be resolved in the short term.
- xiv. The Authorities should give serious consideration to the establishment of a museum at Plymouth to house the archaeological and historical artefacts found in the area. This museum would be for the benefit of the tourists and citizens of Trinidad and Tobago.

5.2 Operation Phase

Recommendations for the operation phase of the marina were as follows:

5.2.1 Pier and Berthing Facilities

- i. Equipment and materials adequate for the clean-up of small oil spills should be available for use on site.
- ii. The fuel pipelines should be fitted with stop-valves at intervals along their length. This would enable rapid lock off and minimize leakage into the sea in case of pipeline or fuel pump damage.
- iii. Liquid waste (including sewage) and solid waste must not be disposed of within the marina or in the Bay. Sewage pump-out facilities should be available on the pier and connected to the sewage treatment plant in the land-based facilities of the marina.
- iv. Collection and disposal facilities for fish offal should be provided.
- v. A number of berths should be allotted to the traditional fishermen of the Plymouth area free of charge so as to assist in the resolution of the conflict between these fishermen and the developer of the marina.

5.2.2 Land-Based Facilities

- i. Only the minimum lighting required for security and operation at night should be permitted, so as to minimize impacts on the nesting activities of turtles.
- ii. In the Caribbean in general and in Tobago in particular, there is a history of malfunctioning package plants due to inadequate maintenance and in turn these plants cause pollution of the marine environment. It is therefore recommended that if a secondary treatment package plant is installed maintenance staff will have to be properly trained for this purpose.
- iii. Provision should be made for solid waste to be collected and removed from the site to the nearest official solid waste disposal site in Tobago.
- iv. Oily wastes and other liquid wastes from the boat repair facilities should not be allowed to drain into the sea or the Courland River. It should be collected and stored in drums and eventually taken to the official disposal site for such wastes in Tobago.

6. Proposed Monitoring Programme

The impacts predicted above and the effectiveness of the control and mitigatory measures proposed must be evaluated during both the construction and operation phases of the marina. The monitoring programme established for this purpose will focus on the aspects of the environment described below.

6.1 Water Quality

A water quality monitoring programme should be carried out over the entire construction phase of the project and at least for the first year of the operation phase of the project. Five samplings should be done over a 30 day period for each of the sampling stations. There should be four 30 day sampling periods in a year, that is, sampling should be undertaken every three months.

Based on the results of the water quality sampling undertaken for the baseline study, the parameters that should be monitored are: salinity, turbidity, dissolved oxygen, nutrients, chlorophyll, petroleum hydrocarbons, trace metals (particularly copper, zinc and lead), total and faecal coliforms.

6.2 Benthic Organisms

Marine species found in the bay during the baseline study, could be used as indications of

the condition of the marine environment for the monitoring programme. The benthic organisms should be monitored with reference to their locations, presence and abundance recorded prior to marina construction and operation. The most suitable organism to be studied in the monitoring study would be the bivalve *Donax denticulatus* which was found in the intertidal zone in the northern part of Great Courland Bay. This organism would be significantly impacted on if the northern mouth of the Courland River is closed off. It has been recommended that sampling of this species be undertaken every three months for the entire construction period and at least for a year of the operation phase.

6.3 Physical Processes

Coastal erosion has been predicted to be one of the main impacts resulting from the construction of the land-based facilities. Beach profile monitoring should be carried out to assess beach changes during the entire construction phase and for at least one year during the operation phase of the marina. In addition to the beach profiles already present, new locations should be established on either side of the proposed construction site.

Increased sediment load into the bay may result in shallowing and alteration of inshore bathymetry. Altered bathymetry may also occur in the vicinity of the breakwater due to current changes caused by the structure. A bathymetric survey in the northern section of the bay (particularly in the inshore) should be done approximately one year after construction to determine what bathymetric changes have occurred. Results of the bathymetric survey would indicate if maintenance dredging would be required.

It has been anticipated that the presence of the breakwater will alter the hydrographic conditions of the bay. However, these alterations cannot be properly determined from monitoring because the baseline study did not provide data on wave conditions and temporal variations in currents in the outer areas of the bay. Hydrographic conditions will still have to be monitored to observe the effect of seasonal changes in wave and current conditions on the breakwater. Moreover, hydrographic monitoring will also provide important information which can be utilized in the interpretation of data obtained from beach profile monitoring.

Hydrographic monitoring must include measurement of wave and current parameters both close to shore and in the vicinity of the breakwater. The inshore (littoral) monitoring can be done concurrently with beach profile monitoring. Monitoring of wave and current conditions on the breakwater can be done once every three months for a period of one year after construction.

7. Summary of Legal and Administrative Mechanisms

The existing and proposed policies, laws, regulations and other instruments for protecting Trinidad and Tobago's environment were reviewed with a view to determining requirements for environmental impact assessments. The existing institutional arrangements for the

implementation or enforcement of Trinidad and Tobago's policies, laws, regulations and other instruments were also reviewed.

A review of EIA processes of some developed and developing countries was undertaken to see what aspects of their processes could be applicable to the Trinidad and Tobago situation.

8. Limitations of the Case Study

The most serious limitation to the case study was the amount of time available for carrying out the detailed study of the selected bay. In particular the baseline study was limited to one sampling period (one season) when it should theoretically be of twelve (12) months duration and over at least two seasons (i.e. one wet and one dry season) in the absence of analogous data. However, the time constraint was seen as an integral part of testing out the UNEP methodological approach, since very few public or private sector developers would be prepared to wait for the outcome of a baseline study of one years duration before beginning construction. Therefore, the case study was carried out within six months since it was seen as a realistic time frame.

9. Recommendations

Recommendations obtained from the Case Study which indicate the applicability of UNEP's methodological approach are set out below as follows:

- i. Analogous research data is recommended for use in EIAs whenever possible since the use of such data will be less time consuming and could reduce the cost of the EIAs. This data could be obtained by private developers and their consultants from research institutions including universities in the region.
- ii. A time frame that allows the use of data of at least two seasons (wet and dry in the tropics) is recommended for EIAs in developing countries. This should be at least six months where analogous research data exists or nine months when such data is not available.
- iii. It is recommended that different ways to reduce the costs of the EIAs should be examined before EIAs become mandatory in developing countries.
- iv. It is recommended that the EIA project team be multi-disciplinary and that at least one person in the team has had training in the EIA process so that this person could guide the rest of the team.
- v. It is recommended that the legal and administrative mechanisms be put in

place to ensure that EIAs become mandatory and that the EIA procedure is workable in developing countries.