F I N A L R E P O R T

THE FORMULATION OF THE NARIVA SWAMP MANAGEMENT PLAN

AUGUST 1999

Prepared for the

MINISTRY OF AGRICULTURE, LAND AND MARINE RESOURCES

by

TECHNICAL ADVISORY SERVICES

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FINAL REPORT

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Executive Summary

The Institute of Marine Affairs (IMA) was contracted by the Government of Trinidad and Tobago through the Ministry of Agriculture, Land and Marine Resources (MALMR) to prepare a comprehensive management plan for Nariva Swamp. This forms part of a wider study that includes an Environmental Impact Assessment (EIA) of agricultural activities in the Biche/Bois Neuf area (Block B) of the swamp and their impacts on the entire wetland.

The objectives of this management plan were informed by technical components through short baseline studies conducted over a ten-month period. The components were in the following disciplines:

- *Aquatic Fauna*
- *Water and Sediment Quality*
- *Toxicology*
- *Hydrology, Soils, Machinery and Roads*
- *Geology*
- *Wetlands Ecology*
- *Socio-economics*
- *Rice Agronomy*
- *Economics*
- *Land-use*
- *Public Education*
- *Legislative Control*

The Draft National Environmental Plan was used as a guideline to design the Management Plan for Nariva Swamp. It was stated that wetlands must be carefully managed to sustain their ecological and socio-economic value.

The Nariva Swamp Management Plan should be premised on the following objectives:-

- *To manage the natural and physical resources efficiently and sustainably*

- *To balance development efforts and environmental conservation for sustainable fulfilment of the basic needs of the people*
- *To safeguard national heritage, giving due respect for the rights of local communities*
- *To mitigate adverse impacts of development projects and human activities*
- *To integrate environment and development through appropriate institutions, adequate legislation, economic incentives and public resources*
- *To adhere to the Precautionary Principle*
- *To incorporate, as far as possible, the participatory decision-making process*
- *To introduce a system of shared responsibility within the existing and forthcoming framework*
- *To ensure that a high level of public awareness is maintained as regards the exploitation, conservation, preservation and enhancement of available resources*

The destruction of Nariva Swamp has been documented in the past by the Wildlife Section of the Forestry Division of the MALMR. It was pointed out that the Cabinet, on recommendation from the Wildlife Section, agreed that Trinidad and Tobago should become a Contracting Party to the Convention on Wetlands of International Importance Especially as Waterfowl Habitat. Nariva Swamp was designated Trinidad's Ramsar Site in an attempt to protect its rich biodiversity.

The swamp was placed on the Montreux Record in 1993 and the following year the Trinidad and Tobago Government made a request to Ramsar to apply the Monitoring Procedure. The final report from Ramsar in 1995 stated that further action was needed if Nariva was to be removed from the Montreux Record. There was also a recommendation that there was a need to do a study of the hydrology and hydraulics of the area to guide its conservation and wise use.

The issues facing the management of Nariva Swamp are essentially those related to environmental quality, resource exploitation, and institutional and organisational frameworks to implement government policies. The system is

currently managed by multiple organisations, both Government and private, and efforts have not been successful for a variety of reasons. Inadequate and ineffective legislation, as well as limited human and financial resources are among the constraints.

The Management Plan adopts sustainable development as its motto and has as its presiding goal:

Sustain the ecological character / integrity of the Swamp with special reference to its hydrology.

The objectives include:

- *Sustainable utilization of natural resources as defined by their assimilative and regenerative capacities.*
- *Protection and preservation of key elements of the system's biodiversity.*
- *Development of socio-economic activities so as to maximise the benefits derived from the swamp.*
- *Protection of traditional and customary rights of resource users from the local communities, where these do not compromise the ecological integrity of the Nariva Swamp.*
- *Prevention of activities that negatively impact on the socio-economic, physical and ecological integrity of the swamp.*

The proposed land-use plan involves zoning the Nariva Swamp. This is aimed at sustaining the ecological character of the system, while attempting to minimising conflicts in land-use. Activities to be facilitated are:

- *Agriculture*
- *Aquaculture*
- *Fishing*
- *Hunting*
- *Eco-tourism*
- *Recreation*
- *Human Habitat*

- *Scientific Research*

With respect to rehabilitation and protection, recommendations include:

1. *Protection of the mangrove forest fringing the eastern boundary of Nariva Swamp.*
2. *Protection of the freshwater marsh, palm swamp and freshwater swampwood.*
3. *Rehabilitation of approximately 2050 ha of Blocks B and C, and fireburnt areas.*
4. *Implementation of awareness and public education programs for local residents and resource users.*
5. *Formulation of the Nariva Management Agency (NMA), which will be responsible for rehabilitating designated areas on the advice of the Forestry and Wildlife Divisions of the MALMR.*
6. *Characterisation of protected areas by species, quantities and area of cover of vegetation types.*
7. *Encouragement of scientific research aimed at achieving a better appreciation and understanding of the complex relationships within such a system.*

The proposed budget for the restoration of designated areas is TT$3,500,000. The budget proposed for the recommended research is calculated at TT$240,000/year.

For fishing and aquaculture, the following recommendations are made:

1. *Fishing activities will be encouraged to take place only in areas identified for that purpose.*
2. *Fishing seasons will be determined based on the biology of the target species and the resource will be exploited both commercially and recreationally, based on a permit system.*
3. *Research studies will be undertaken to determine the maximum sustainable yields of the fish stocks, the carrying capacities of different fishing areas and the importance of these fisheries to the economic and cultural well-being of the stakeholders.*

4. *Identify fishing methods with minimal negative impact on flora and other fauna within the system.*
5. *Use available knowledge of soil and water to identify the most suitable areas for aquaculture.*
6. *Identify species that are technically and commercially feasible to culture.*
7. *Design and implement an aquaculture water management program.*
8. *Train farmers in aquaculture and fish handling techniques.*
9. *Encourage research to improve production.*

The proposed budget for the fisheries component of this program is TT$240,000, while that of the aquaculture program is TT$470,000.

For the purposes of agriculture, a solution of an optimal combination of crop and eco-tourism enterprises was sought. Watermelon was identified as the crop with the greatest potential for the Nariva Swamp. Rice is not included in the optimal solution, as the economics of its production in Trinidad does not justify its production in Nariva Swamp. The total net revenue to be gained from this optimal solution is TT$15 million, compared to TT$8.2 million net revenue for small farmers in Block A and Kernahan.

The solution suggests that Block B should not be used for agriculture, as Block A and Kernahan can accommodate all agricultural activities in the area. Recommendations include:

1. *Identification of agricultural zones.*
2. *Selection of suitable crops for land and water conditions.*
3. *Improvement of irrigation infrastructure and techniques.*
4. *Provision of security of tenure of lands for farmers.*
5. *Improvement of soil fertility in accordance with crop requirements and soil type.*
6. *Reduction in use of toxic pesticides and adoption of safer chemicals.*
7. *Adoption of an Integrated Pest Management (IPM) strategy.*

8. *Implementation of awareness and public education programs for the farming communities identifying the roles available to members to achieve the objectives of the Management Plan.*

Apart from the designation of zones, the strategies for the successful management include:

- *Implementation of the land-use plan.*
- *Minimisation of pollution of waterways.*
- *Conducting of meetings, seminars and study tours to improve community awareness.*
- *Television and radio programs to improve public awareness and appreciation.*
- *Encouragement of the development of a local eco-tourism industry using a budget of TT$135,000.*
- *Formulation of an acceptable code of conduct for tourists.*
- *Implementation of a fire management program.*

The projects for implementation are listed with their respective costs:

- *Public awareness program for stakeholders-TT$510,000*
- *Program to police areas towards stated objectives-TT$900,900*

The recommended legal and institutional framework for the management of Nariva Swamp is intended to eliminate difficulties and problems arising from inadequacies of the existing framework. The design includes:

- *An institution responsible and accountable for achieving the management objectives*
- *A suitable decision-making process*
- *Participation of relevant parties.*

On the issue of enforcement, the following activities are mandatory:

- *The gathering of information on failures to implement*

- *Initiation of progressive dispute settlement, adhering to overall plan objectives*
- *Ultimate implementation by punitive measures.*

A number of documents relevant to the management of wetlands in Trinidad and Tobago and other countries were reviewed, out of which the following recommendations were formulated:

1. *The policy related to the management of the area should be clearly stated. The newly drafted National Wetland Policy should be fully adopted.*
2. *Legislation should be enacted to implement this National Wetland Policy.*
3. *The National Parks and Wildlife Authority, the body responsible for managing the Nariva Swamp Protected Area, should appoint the Nariva Management Agency (NMA) to implement the Nariva Swamp Protected Area Management Plan (NSPAMP).*
4. *A Consultative Committee, comprising stakeholders of the Nariva Swamp Protected Area, should be appointed.*
5. *The NMA should be responsible for monitoring and managing all activities in the Nariva Swamp Protected Area in accordance with the NSPAMP.*
6. *The NMA shall ensure that all operations and activities in the Nariva Swamp Protected Area are in accordance with the NSPAMP.*
7. *The NSPAMP must not derogate from the National Parks and Other Protected Areas Bill, the new Conservation of Wildlife Bill, the Environmental Management Act (EMA) or other enactment relating to environmental planning affairs or any general policy statement issued under this Act.*
8. *The NMA should be guided by the dictates of the National Wetlands Committee in its management of the Nariva Swamp Protected Area.*
9. *The Nariva Swamp Protected Area should be afforded additional protection by having it declared an "environmentally sensitive area".*
10. *The NMA shall ensure that all rules and regulations are properly implemented and enforced.*

11. Regulations listing offences should be made by the Minister of Agriculture, Land and Marine Resources on the advice of the National Parks and Wildlife Authority and implemented and enforced by the NMA.

Proper management of human activities and natural processes within the swamp will have positive impacts on the biophysical environment. The declaration of protected areas will reduce areas for exploitation, while rehabilitation of fire burnt areas will restore habitats.

It is also anticipated that the establishment of the National Parks and Wildlife Authority may solve the jurisdictional conflicts that occurred in implementation of the Statelands Act, Forests Act and Conservation of Wildlife Act.

The effectiveness of the Management Plan must be reviewed and evaluated periodically to ensure the relevance of the management objectives to the changing environment. The National Parks and Wildlife Authority and the Nariva Management Agency will be responsible for this evaluation and that of subsequent management plans and budgets.

1.0 INTRODUCTION

1.1 BACKGROUND

The Institute of Marine Affairs (IMA) was contracted by the Government of Trinidad and Tobago through the Ministry of Agriculture, Land and Marine Resources (MALMR) to prepare a comprehensive management plan for Nariva Swamp. This forms part of a wider study that includes an Environmental Impact Assessment (EIA) of agricultural activities in the Biche/Bois Neuf area (Block B) of the swamp and their impacts on the entire wetland.

Nariva Swamp is the largest and most diverse wetland ecosystem in Trinidad and Tobago. It is located on the east coast of Trinidad between 10^{o} 30'N and 10^{o} 22'N latitude, and 61^{o} 01' W and 61^{o} 06'W longitude, covering an area of approximately 7,000 ha (Figure 1.1).

The Nariva Swamp was listed as a Wetland of International Importance and its entry into the Montreux record signalled international recognition of the importance of the preservation of its biodiversity. Wetlands are described as transitional between terrestrial and aquatic ecosystems that perform critical functions in ecological systems. Such systems protect coastlines, export nutrients to the sea, build land by entrapping sediments and provide nurseries and important wildlife habitat for various species. The importance of these wetland resources are also recognised for their socio-economic value as well as for their ability to act as industrial sinks for carbon dioxide emissions and as sources of revenue from the bioprospecting of pharmaceutical industries.

Research undertaken by IMA can determine the environmental conditions needed to maintain the wetland. This document is evidence that such an approach is being implemented and the completed technical reports provide baseline data, against which the success of future managerial endeavours may be evaluated. While the importance of the scientific evidence is not being undermined, it should be noted that all scientific studies, conclusions and predictions contain an element of uncertainty. This may be a fundamental property of the science, or due to the limitations of accuracy and precision inherent in contemporary methodologies. The latter is related to the duration and details of the study.

FIGURE 1.1: LOCATION MAP OF THE NARIVA SWAMP ILLUSTRATING WETLANDS AREAS

In designing this management plan, the following components informed the general objectives and strategies outlined below:

- Aquatic Fauna
- Water and Sediment Quality
- Toxicology
- Hydrology, Soils, Machinery and Roads
- Geology
- Wetlands Ecology
- Socio-Economics
- Rice Agronomy
- Economics
- Land Use
- Public Education
- Legislative Control

1.2 GOALS AND OBJECTIVES

Managing such a diverse ecosystem calls for policy integration within the institutional infrastructure both at the national and international level. In this regard, it was thought that in designing the Management Plan for Nariva Swamp the focus should reflect consideration for the national strategy for the protection of wetlands, as given in the National Environmental Plan (NEP). Therein it was stated that wetland areas must be carefully managed to sustain their ecological and socio-economic value through:

- Commitment to a goal of no further loss of wetlands
- Preserving representative examples of all wetland types in the country by including them in a system of protected areas.
- Instituting mechanisms for the restoration of degraded wetlands as far as possible to their original state.

- Development of demonstration models of wetland conservation and sustainable wetland use on publicly owned areas as a promotion of understanding of its importance and incentive to private landowners.

- Active partnership of the Government, private owners, interest groups, etc. in co-operative activities that promote wetland conservation.

Following a study of this and other initiatives affecting the governance of wetlands, it was decided that the Nariva Management Plan should be premised on the following overall objectives:

- To manage efficiently and sustainably the natural and physical resources. "Sustainable resource use", as taken from the NEP, indicates that natural resources and ecosystems should be used within the limits of their assimilative and regenerative capacities.

- To balance development efforts and environmental conservation for sustainable fulfilment of basic needs of the people.

- To safeguard national heritage, giving due respect for the rights of local communities.

- To mitigate the adverse impacts of development projects and human actions.

- To integrate environment and development through appropriate institutions, adequate legislation and economic incentives, and public resources.

- To adhere to the Precautionary Principle, that is, if there are threats of serious irreversible damage. Lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

- To incorporate as far as possible the participatory decision-making process, i.e. the involvement of stakeholders in environmental management decision-making, which is critical to the acceptance and successful implementation of environmental policies, programs and plans.

- To introduce a system of shared responsibility within the existing and forthcoming institutional framework. This is in recognition that the management of the environmental conditions for human health constitutes

a shared responsibility requiring co-operation and co-ordination among public and private sector levels.

- To ensure that a high level of public awareness is achieved with regard to the exploitation, conservation, preservation and enhancement of available resources.

1.3 TERMS OF REFERENCE

The Terms of Reference for the Nariva Swamp Management Plan were provided by the MALMR. The related items of the Scope of Works as defined in the Terms of Reference are set out below.

(i) A Management Plan for the Nariva Swamp and its areas of influence. Information obtained from short-term baseline studies will be used as data inputs for the plan, including the development of a Geographical Information System (GIS) for the area. The GIS will be used for the assessment of various scenarios of interventions affecting the wetland.

(ii) The development of a Monitoring Plan to monitor the impacts of the recommended activities of the Management Plan.

(iii) A description of the environment, both physical and ecological.

1.4 SCOPE OF WORKS AND DURATION OF STUDY

In order to achieve the stated objectives, short-term baseline studies have been undertaken in the area. These studies were conducted over a period of ten months to provide information on the biological, hydrological, physico-chemical, socio-economic and economic conditions (biophysical and human components) of the Nariva Swamp and surrounding areas. The data and information obtained were used to identify a management goal and related management objectives.

1.5 HISTORY OF MANAGEMENT INITIATIVES

The history of the Nariva Swamp has been documented in the past by the Wildlife Section of the Forestry Division of the MALMR. In 1993, an issue paper on *Historical Perspectives on Habitat Destruction in the Swamp* stated that the jurisdiction over the biological resources of the Nariva Swamp falls under two principal pieces of legislation, the *Conservation of Wildlife Act*, Chap. 67:01 and the *Forests Act*, Chap. 66:01 of the laws of the Republic of

Trinidad and Tobago. Also relevant to the protection and management of the biological and other resources of the swamp are the *State Lands Act*, Chap. 57:01 and the *Fisheries Act*, Chap. 67:51. Several different agencies have jurisdiction over the Swamp but their boundaries are not always clear-cut, resulting in overlap.

The paper also stated that the Bush Bush Wildlife Sanctuary was proclaimed a Prohibited Area in September 1989 under the *Forests Act*, regulating entry into, and removal of flora and fauna from the area through a permit system under the authority of the Director of Forestry. It further went on to state that in 1991, Cabinet agreed to the 1990 recommendations of the Wildlife Section that Trinidad and Tobago become a Contracting Party to the Convention on *Wetlands of International Importance Especially as Waterfowl Habitat* (Ramsar, 1971). Cabinet also designated the Nariva Swamp as the country's Ramsar Site in an attempt to protect the rich biodiversity of this wetland.

Citing negative impacts resulting from human intrusion into the area, several management recommendations also came out of this publication. These included the following:-

- Removal of all squatters from the ecologically sensitive areas of the Swamp
- Regeneration of low-lying areas of the Swamp
- Rehabilitation of the Nariva Mayaro Windbelt Reserve and highlands of the Bush Bush Wildlife Sanctuary
- Application of remedial action where changes to the hydrology of the Swamp have occurred
- Provision of adequate resources from the Government to patrol and enforce the law to prevent further encroachment into sensitive areas
- Preparation of a management plan to allow for zoned activities in the Swamp
- Resolution of the jurisdictional issues relevant to the Swamp and redrafting of the *Conservation of Wildlife Act* to give full authority to the Trinidad and Tobago Ramsar Management Authority.

At the Kushiro Conference in 1993, the Government of Trinidad and Tobago requested the inclusion of Nariva Swamp in the Montreux Record, a list of

Ramsar sites in need of priority conservation attention. In 1994, there was a request from the Government to Ramsar to apply the Monitoring Procedure. This was followed by a visit to the swamp by a three-member Ramsar team accompanied by representatives and officials of government agencies, NGOs, local associations and villagers. Fieldwork was conducted over an eight-day period and a report prepared.

The final report (Ramsar, 1995) stated that further action was needed if Nariva was to be removed from the Montreux Record. The report also cited several problems resulting in lack of coherent conservation and socio-economic development policies for the area. It indicated that there should be no further loss of the Nariva Swamp to agriculture and farming, and that any planned activities should consider and adhere to the wise use concept and be restricted to areas of least impact to the ecological character of the site. It also strongly recommended, among other things, the preparation of a management plan, an economic valuation and an environmental impact assessment of activities in Block B. Among other recommendations were the need to do a study of the hydrology and hydraulics of the area to guide its conservation and wise use, a revision of the boundaries and conservation categories, and community participation, training and co-operation.

The report named the *Forests Act*, the *Conservation of Wildlife Act* and the *State Lands Act* as governing the management of wetlands in Trinidad and Tobago. It identified the jurisdictional issues that led to inadequacies in effective management of the area and made mention of the *Environmental Management Act* and the institutions that should participate in the management of Nariva Swamp. A number of problems affecting the proper management of the swamp were identified, these being inadequate funding, not enough trained personnel and lack of co-ordination among institutions. The latter has since been alleviated somewhat with the establishment of the National Wetlands Committee, which was identified as a major role player for effective management.

Zoning has been a part of the management process of Nariva Swamp in the past. Block A was, and still is, designated for agriculture including short crops and rice cultivation. Kernahan, to the south, is occupied by squatters who are in the process of being regularised and who cultivate the land with rice and short crops. Apart from the Bush Bush Wildlife Sanctuary, entry to which is based on a permit system, all other areas of the swamp were open access.

The rest of this report is presented in the following categories:

Section 2: Biophysical and Human Environment

Section 3: Management Issues

Section 4: The Management Plan

Section 5: Regulatory and Administrative Framework for the Nariva Management Agency

Section 6: Impacts of Nariva Management Plan

Section 7: Management Plan Evaluation and Revision

2.0 BIOPHYSICAL AND HUMAN ENVIRONMENT

2.1 INTRODUCTION

The Environmental Assessment was done in order to capture baseline data for the Nariva Swamp. The data gathered during these studies was used together with historical data for the swamp to inform the design of the management plan for the area. The studies conducted also identified that the swamp should be managed in a holistic manner to include the biophysical and human factors. This requires the managers of the swamp to have an in-depth understanding of its human and biophysical components, and interactions among the components (Figure 2.1). A system is a set of components or parts working together to accomplish the objectives of a whole (Churchman, 1979). Identification of the systems boundary requires an understanding of the external and internal elements of the systems. In this case, the system boundary for the Nariva Swamp is identified by a circle. The components and resources that make up the Nariva Swamp are represented within the systems boundary. Resources and components interact within the system and this is represented by arrows showing the types of interactions. The external environment can influence the system. These external factors are represented outside the systems boundary and arrows show any interactions that can possibly take place.

Managing the system involves the following considerations:

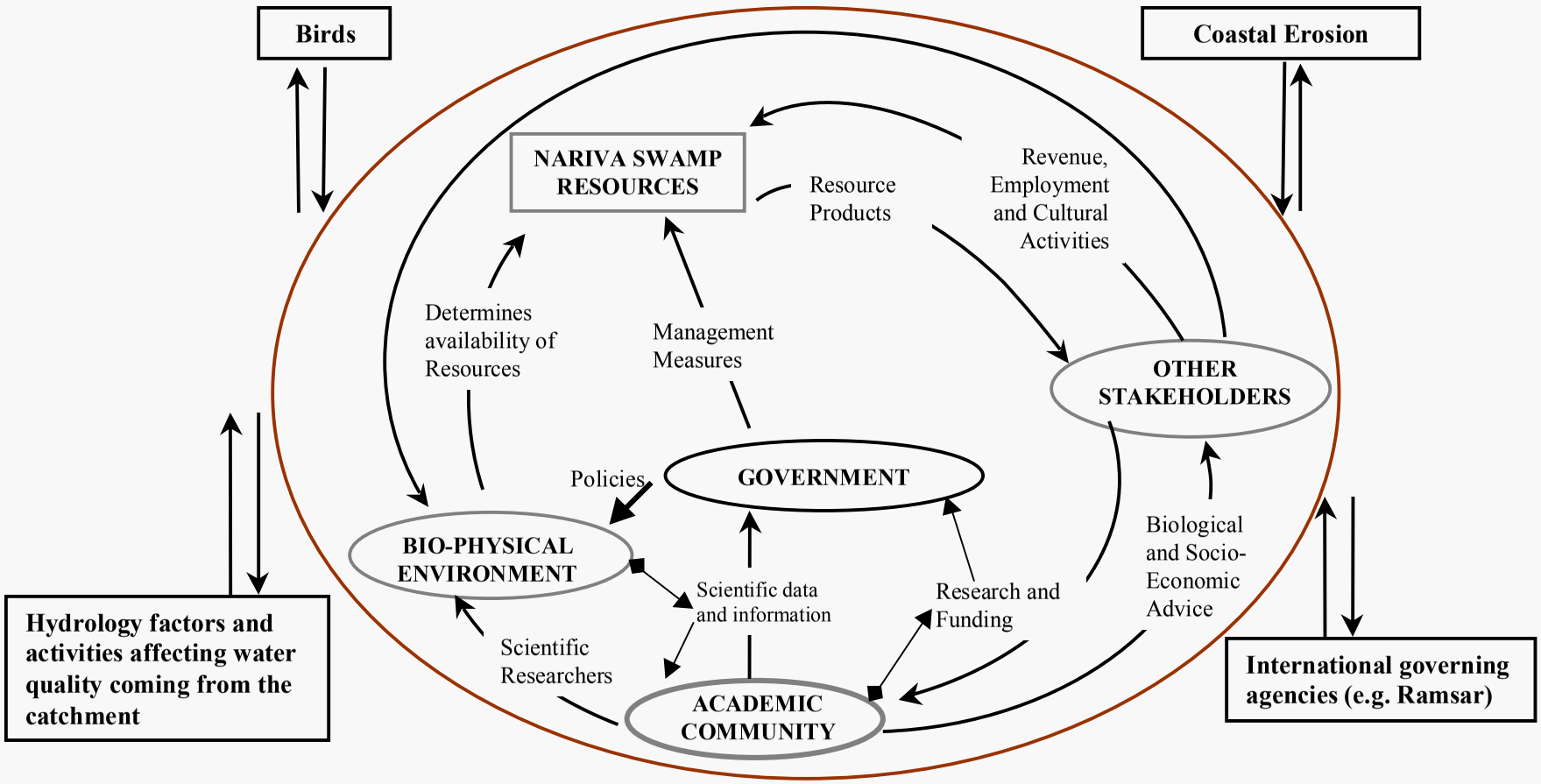
- Goals of the system
- The system's environments
- Use of resources

These are represented within the system's boundary.

This chapter captures the present understanding of these components and their interactions. Figure 2.1 represents a simplified version of this understanding.

2.2 GEOGRAPHICAL LOCATION

Nariva Swamp (Figure 1.1) is situated along the east coast of Trinidad between 10^{o} 30'N and 10^{o} 22'N latitude, and 61^{o} 01' W and 61^{o} 06'W longitude, covering an area of approximately 7,000 ha. It is a low-lying freshwater swamp situated in a topographic depression between



Bio-physical Environment:

- **Flora and Fauna**
- **Geology and Soils**
- **Hydrology**
- **Water and Sediment Quality**

Other Stakeholders:

- **Farmers and Fishermen**
- **Residents in communities in and around the Swamp**
- **Hunters**
- **Non-Government Agencies**
- **Tourists**

FIGURE 2.1: SIMPLIFIED SCHEMATIC DIAGRAM OF THE COMPLEX INTERACTIONS AND RELATIONSHIPS BETWEEN MAJOR COMPONENTS WHICH CONSTITUTE THE NARIVA SWAMP

Manzanilla Point and Radix Point. It is bounded on the east by the Cocal Sand-bar, on the north and west by the south-eastern flanks of the Central Range and on the south by a region of low-lying undulating terrain (Figure 2.2).

2.3 CLIMATE

The Nariva Swamp experiences a tropical climate with two seasons, a dry season from January to May and a wet season from June to December. Average annual temperature is 26^{o}C, with a seasonal variation of approximately 2^{o}C to 3^{o}C. Mean annual rainfall varies from 2000 mm to over 2800 mm in the catchment (Water and Sewerage Authority, 1990). Wet season rainfall for the Nariva catchment varies from 2296 mm in the upper catchment to 1968 mm on the eastern border of the swamp. Corresponding dry season rainfall data are 426 mm and 656 mm, respectively (Berridge, 1981). Most of the rain falls from June to December, and is typically of the torrential shower type (OCTA, 1967). The mean monthly relative humidity is high, ranging from 73% in April and May to 93% in June, with an annual mean value of 83%. The relative humidity approaches saturation at night. The mean annual sunshine duration is 7.3 hours per day.

The mean annual measured water loss from evaporation is 1636.8mm, while the estimated water loss through plant leaves (evapotranspiration) is 1496.3mm (Nariva Technical Report - Hydrology section IMA, 1998).

2.4 PHYSICAL FEATURES

The Central Range is the dominant topographic feature in this region (Figure 1.1). It is a broad, dissected upland trending northeast to southwest, rising to a maximum elevation of 307 m above sea level at Mt. Tamana. From an elevation of 207 m at Mt. Harris, the range's southeastern flanks slope 8^{o} to 20^{o} to the southeastern to elevations of 20 m. From here the ground slopes less than 2^{o} eastward across the broad swamp depression. More than 90% of the swamp is below 5 m in elevation (Ramcharan, 1980). Several elevated areas, occupying approximately 10% of the swamp occur in its eastern section. These elevated areas extend from the north-northwest to the south-southeast rising to a maximum elevation of 40 m at the mud volcano at Bois Neuf Hill. Several remnant sandbars (with elevations in excess of 10 m) including the Cocal Sandbar make up the rest of the elevated areas of the swamp (Bacon *et al.,* 1979). The southeastern flank of the Central Range is the source of the 8 rivers which flow into Nariva Swamp. These rivers flow from elevations as

FIGURE 2.2: NARIVA SWAMP LAND USE, 1998

high as 150 m in a southeasterly direction along a steep gradient, delivering water into the lowland to the east.

2.5 GEOLOGY AND SOILS

Regional Geology

The Nariva Swamp forms the southern shoulder of the Central Range of Trinidad (Barr, 1981). The swamp represents the eastern landward extension of the Naparima Fold Belt and the northeastern end of the Southern Basin (Paul and Rampersad, 1981) (Figure 2.3). The swamp is bounded by the Central Range on the north and west, the Balata Anticline on the south and Cocos Bay on the east.

Geology of the Nariva Swamp

The Nariva Swamp deposits lie above the Upper Tertiary basement rocks, consisting predominantly of interlayered and lens-shaped swamp clay and peat deposits with minor sands. These deposits are interrupted at the eastern end of the swamp by several sub-parallel remnant sandbars, which trend approximately northwest to southeast. The swamp is separated from the Atlantic Ocean by the youngest of these sandbars, the Cocal. The bedrock geology of the Nariva area is given in the Geology section of the Nariva Technical Report. The Holocene swamp deposits represent the latest stage in the process of land formation (Suter, 1960).

Data on the bedrock geology of the swamp is based on a review of geologic descriptions of Trinidad done by Kugler (1959) and Suter (1960). The shallow geologic structure of the bedrock materials underlying the swamp appears to be similar to that of the rocks in the Naparima Fold Belt and Southern Basin, that is they consist of several tightly-folded anticlines and synclines, which trend east-northeast. Mud volcanoes are associated with these structures.

Four formations occur below the Holocene deposits in the Nariva Swamp. In order of increasing age they are the Upper Lengua Formation, the Lower Brasso formation, the Lower Cipero Formation and the Nariva Formation.

Surface Soils

Two recent studies were done on the classification of the soil types in Nariva:

Brown and Bally (1970) mapped eight soil types in the Nariva Swamp and a more detailed study was done by NEDECO (1983), which also described eight

FIGURE 2.3: REGIONAL GEOLOGY OF THE NARIVA SWAMP

soil types. The former is given in Table 5.1 in the Geology section of the Nariva Swamp Technical Report, IMA 1998. The general characteristics of these soils as described by NEDECO are summarised in Table 2.1 and illustrated in Figure 2.4.

Some characteristics of ripened and less than ripened clays are presented in Table 5.2 in the Geology section of the Nariva Technical Report.

TABLE 2.1: GENERAL CHARACTERISTIC OF SOILS OF THE NARIVA SWAMP (AFTER NEDECO, 1983)

Soil Classification	Soil Description	Location	Comments
High Lying Soils (H)	Mature clay soils	Foothills of Central Range immediately west of the swamp	
Ripened Clay Soils (Cr)	Clay soils, which are 3/4 ripe and over 80cm or more from the surface	Western border of the swamp in the north and south sections (34% of Nariva Swamp occupying 24.4 km^2)	Suitable for mechanised agriculture
Less than Ripened Clay Soils (Cu)	Clays, which are 1/2 to 3/4 ripe and over 80cm or more from the surface	Fringe the ripened clay to the east (7.9 km^2)	Unsuitable for agriculture
Peat Soils (P)		Central section of the swamp (24.8 km^2)	Unsuitable for agriculture
Sandy Soils (S)	Light and medium textured soils	Beach bars and lagoons (2.6 km^2)	
Mangrove Soils (M)		West of the Cocal and along the banks of the Nariva River (3.5 km^2)	Unsuitable for further development
Excessively Drained Soils (Sd)		Concentrated on the Cocal Sandbar (4.5 km^2)	
Waterlogged Soils (Sw)		Lagoonal areas west of the Cocal Sandbar (4.9 km^2)	

FIGURE 2.4: SOIL MAP OF NARIVA SWAMP

Sub-Surface Soils

Northwestern Swamp Region

This area consists of a sequence of organic clays, organic silts and silty clays, with peat lenses, underlain by a sequence of inorganic silty clays and clayey silts. These soils and their properties are described in detail in the Geology section of the Nariva Technical Report.

A thick mottled zone exists in the upper 2.6 m of the region of Block B and is probably reflective of the seasonal variation in water levels in the block. The greater thickness of the mottled zone in the south of the region may be related to the reported dry season practice by large-scale rice farmers of draining water from the Bois Neuf River into the north of Block B. The greater stiffness of the mottled zone relative to the underlying soils was reflective of the drier nature of the zone at the time of the investigation (dry season). The mottled zone may be interpreted as the original depositional surface, on which the Nariva Swamp clays have been deposited. It may represent the pre-Holocene ground surface.

Southern Swamp and the Cocal Sand Ridge Regions (East)

The southern section of the swamp consists of light and dark grey sands, which lie above grey organic and inorganic clays. The light and dark grey sand sequence was also encountered on the Cocal sand ridge. Light brown sand forms the cover of the Bush Bush Hills, and is underlain by blue-grey clay. These soils and their properties are described in the Geology section of the Nariva Technical Report.

The soils are highly plastic and suggest a marine origin of the older clays. The younger clays appear to be marine clays that were subsequently exposed to a swamp environment, at which time organic soils were deposited. The blanket sands and the Bush Bush sands are also indicative of a marine origin. The presence of peat in the topsoil and the underlying blue grey clay suggests that the Bush Bush sequence was exposed to a waterlogged environment in its geologic past.

2.6 SURFACE AND GROUNDWATER HYDROLOGY

The hydrology of Nariva Swamp is the most critical factor in determining the character of the swamp and its capacity to support the existing flora and fauna.

The drainage pattern of Nariva Swamp is illustrated in Figure 2.2. The hydrology of the swamp can be divided into three components -

- freshwater inflow from the western catchment area,
- retention capacity and fluctuations in the water level in the swamp basin and
- outflow of water through the Nariva River.

The Nariva Swamp, like other swamps, is exposed to seasonal cycles of flooding and drying. Flooding results from torrential rainfall as the hydrology of the swamp does not allow rapid drainage. The low elevation of the swamp and the impeded outflow by the Cocal tend to cause water to be retained in the swamp basin during the wet and dry seasons. Losses of water from the basin occur mainly through evaporation (1636.8 mm/yr.), evapo-transpiration, i.e. water loss from plants (1496.3 mm/yr.), as well as by rivers.

Freshwater Inflow from Rivers into the Swamp

The drainage basin has an area of about 461 km^2 and receives an average of 2619 mm of rainfall per annum (WASA 1990). Input of freshwater takes place through river inflow and direct rainfall. Many of the rivers that flow into the Nariva Swamp originate from the Central Range and enter the western part of the swamp (Table 2.2). Towards the southern end, the major river flowing towards Nariva Swamp is the Navet River, which has the largest watershed. The Navet Dam is located at the upper reach of the river in the Central Range. This dam retains most of the water that could have flowed into the Nariva Swamp and is used to satisfy domestic and industrial water requirements in Central and South Trinidad. A detailed description of the drainage pattern and hydrology of the swamp is given in the Surface Water and Hydrology section in the Nariva Technical Report.

The water flowing into the swamp comes mainly from the Bois Neuf River, which is equivalent to the overflow discharge of the Navet Dam (Table 2.3) and discharges into the Jagroma Cut and the Petit Poole Cut, into which most of the rivers in the western catchment empty. All the freshwater input into the Nariva Swamp is conveyed to the marsh swamp through the Bois Neuf River and Jagroma Cut and to the Nariva River through the Petit Poole Cut.

The Jagroma Cut forms the boundary between Blocks A and B and flows eastwards, discharging into the marsh swamp. The Petit Poole Cut supplies

TABLE 2.2: MEAN DISCHARGE RATES FOR RIVERS FLOWING AROUND BLOCK A OF THE NARIVA SWAMP (AFTER AGRISTUDIO, 1992)

Month	**Petit Poole (*S = 7.22 km^2) M^3/s**	**m^3**	**Cuche (S = 7.22 km^2) m^3/s**	**m^3**	**Canque (S = 7.22 km^2) M^3/s**	**m^3**	**Jagroma (S = 48 km^2) m^3/s**	**m^3**
Jan	0.122	325983	0.311	833469	0.215	575211	0.463	1239819
Feb	0.073	177395	0.187	453562	0.129	313022	0.279	674692
Mar	0.035	93860	0.090	239980	0.062	165620	0.133	356980
Apr	0.059	151793	0.150	388103	0.103	267846	0.223	577319
May	0.146	390422	0.373	998225	0.257	688916	0.554	1484900
Jun	0.220	569355	0.562	1455719	0.388	1004651	0.835	2165441
Jul	0.398	1064936	1.017	2722813	0.702	1879125	1.512	4050295
Aug	0.428	1145612	1.094	2929085	0.755	2021481	1.627	4357133
Sep	0.366	948029	0.935	2423909	0.645	1672838	1.391	3605663
Oct	0.567	1519276	1.450	3884464	1.001	2680827	2.157	5778298
Nov	0.633	1640745	1.618	4195035	1.117	2895165	2.408	6240285
Dec	0.473	1265883	1.208	3236592	0.834	2233704	1.798	4814562
Year	**0.293**	**9246004**	**0.750**	**2364006**	**0.517**	**1631497**	**1.115**	**3516555**

*Catchment area

irrigation water into Block A through the Main Irrigation Control Unit. The Petit Poole and Jagroma Cut channels were artificially constructed to convey drainage water arising from the western rivers from the Central Range away from the Plum Mitan Rice Scheme (Block A).

TABLE 2.3: OVERFLOW DISCHARGE FROM THE NAVET DAM INTO THE BOIS NEUF RIVER (1968 - 1994)

Month	Mean Discharge		80% Probability Discharge		20 % Probability Discharge	
	$m^3 s^{-1}$	m^3	$m3 s^{-1}$	m^3	$m^3 s^{-1}$	m^3
Jan	0.55	1459728	0.15	401760	0.77	2062368
Feb	0.21	512870	0.06	145152	0.30	725760
Mar	0.12	332121	0.03	80352	0.17	455328
Apr	0.15	388800	0.02	51840	0.19	492480
May	0.45	1205280	0.06	160704	0.58	1553472
Jun	1.88	4872960	0.66	1710720	2.68	6946560
Jul	2.32	6211210	1.27	3401568	3.16	8463744
Aug	2.92	7828963	1.90	5088960	3.80	10177920
Sep	2.17	5624640	1.38	3576960	2.84	7361280
Oct	2.43	6505834	1.00	2678400	3.44	9213696
Nov	3.09	8004096	1.79	4639680	4.15	10756800
Dec	2.78	7443274	1.33	3562272	3.88	10392192
YEAR	**1.59**	**50389776**	**0.80**	**25498368**	**2.16**	**68601600**

Retention Capacity and Water Level Fluctuations in the Swamp Basin

The Nariva wetland exists because run-off from the Central Range is prevented from reaching the sea freely by the Cocal Sand Bar (Bacon, 1996). The soils of the catchment are predominantly clays and marls with low overall permeability and slow hydraulic conductivity. These soils have very limited aquifer potential and tend to permit only very slow-moving groundwater flow. Hence most of the rainfall in the catchment area flows as surface run-off, (with exception at the start of the wet season when dried out surface soils are replenished), into the streams and rivers, with losses through evaporation (1636.8 mm /yr) and evapotranspiration (1496.3 mm/yr).

Mean depth, cross-sectional area and flow rates were taken for several of the rivers at varying times during the study period. Monitoring from the Petit Poole Cut indicated that during November in the wet season, after a major rainfall event, most of the swamp fields including Blocks A and B were flooded. As the dry season progressed, the Petit Poole Canal experienced gradual reductions in water depth. Flow rates ranged from 3.22 m^3/s in November to almost zero in the dry season. The water level in the marsh swamp tends to be at equilibrium with the water level in the canal. The flora

and fauna in the swamp basin are adapted to these seasonal changes in the water level. Some species are dependent on these changes for the completion of their life cycle. Other species migrate into the swamp to take advantage of the nutrient and food influx induced by the flooded conditions.

The mean water depth in the Jagroma Cut during the wet season was 3.22 m. At this level, it floods and the discharge flows into the swamp. During the dry season, this mean depth is reduced to less than half, during which time there is little flow into the swamp as it is retained in the channel. The Bois Neuf River only has appreciable flow during the wet season, as it is dependent on overflow from the Navet Dam, which is located upstream.

Outflow of Water from the Nariva Swamp

After inundation by floodwater during the wet season, the excess water drains off from the swamp to the Atlantic Ocean through the Nariva River located on the east and running almost parallel to the coastline. The water flow into the Atlantic Ocean is slow during the wet season. During the dry season water flow is predominantly negative, that is, there is usually a net inflow of water from the ocean into the river. It is expected that there is some natural salt-water intrusion during the dry season, with a transition zone under estuarine conditions. This is kept in check by the natural hydraulic pressure of the groundwater 'head' flowing down the gradient, from the swamp to the ocean.

Some of the water from the swamp, particularly from areas around Bush Bush, drains into the Bush Bush Canal from where it discharges into the Nariva River and to the sea. The Cascadura River also contributes to draining the swamp. Flows of the Nariva River, Bush Bush Canal and the Cascadura River were monitored during the wet and dry seasons. The flow parameters measured for these rivers are presented in Table 2.4.

TABLE 2.4: FLOW PARAMETERS MEASURED FOR OUTFLOW RIVERS OF THE NARIVA SWAMP

River	Date Sampled	Water Area (m^2)	Mean Depth (m)	Mean Velocity (m/s)	Flow Rate m^3 /s)
Nariva River	20 Nov 1997	241.7	3.2	0.14	33.8
	6 Dec 1997	164.9	2.18	0.02	3.3
	27 Dec 1997	139.08	1.84	0.015	2.1
	27 Jan 1998	202.9	2.69	0.079	16*
	7 Feb 1998	195.8	2.59	0.069	13.5*
	17 Feb 1998	157	2.08	0.022	3.5
	3 Mar 1998	149.5	1.98	0.02	3
	28 Mar 1998	164.9	2.18	0.02	3.3
Bush Bush Canal	27 Jan 1998	0.55	0.28	0.18	0.1
	7 Feb 1998	0.29	0.15	0.02	0.01
	17 Feb 1998	0.62	0.32	0.21	0.13
	3 Mar 1998	0.57	0.29	0.2	0.11
	28 Mar 1998	0.65	0.33	0.22	0.14
Cascadura River	20 Nov 1997	2.13	0.4	0	0
	6 Dec 1997	1.4	0.26	0	0
	27 Dec 1997	1.02	0.19	0	0
	27 Jan 1998	0.42	0.08	0	0
	7 Feb 1998	0.21	0.04	0	0
	3 Mar 1998	1.02	0.19	0	0
	28 Mar 1998	1.03	0.19	0	0

* All measurements made at low tide

2.7 WATER AND SEDIMENT QUALITY

Water Quality

The parameters measured in this study were investigated in order to get baseline environmental conditions under which the flora and fauna of the swamp exist. Samples were collected during the wet and dry seasons to capture any seasonal variations. The study indicated that water temperatures and pH were characteristic of similar tropical systems.

There was some evidence of saltwater intrusion at the mouths of the outflow rivers, the Nariva River, the Bush Bush Canal and the Cascadura River, during the dry season. The extent of the intrusion into the swamp was not determined in this study and requires further investigation.

Generally, the dissolved oxygen content of the waters of the study area was lower than 5 mgl^{-1}, the lower limit recommended for freshwater aquatic life in environmentally sensitive areas.

This implies that aquatic life may be under some stress or are adapted to low levels of dissolved oxygen in their habitat. The quantities of total dissolved solids and suspended solids in the waters sampled within the study area are within limits to render the water suitable for livestock watering and for aquatic life.

Of concern are the levels of lead recorded at the eastern stations. These were found to exceed recommended levels for the protection of aquatic life. Most waters sampled within the study area during the 1997 wet season and the 1998 dry season contained levels of lead greater than the relative risk comparison values (human) based on non-cancer exposure endpoint.

Sediment Quality

The sediments were found to be slightly acidic during the 1998 dry season and ranged from acidic to slightly alkaline during the 1997 wet season. The silty-clay and clay sediments appear to be richer in organic material (% Total Organic Carbon) than the clayey sand along the eastern fringe of the swamp. The study suggests that much of the nitrogen content of the sediments can be attributed to organic matter. The inorganic nitrogen content of the sediments existed predominantly as ammonium ions during the 1998 dry season and mainly as nitrite ions during the 1997 wet season. During the study period, the total phosphorous content appeared to be higher during the dry season.

Within the study area, Absorbed / Adsorbed Petroleum Hydrocarbon (AAPH) levels were highest along the eastern border of the Nariva Swamp. This may be accounted for by intrusion of saltwater in the area and the large number of offshore drilling activities.

During the study period, trace metal concentrations recorded for all sediments investigated were considered to be non-toxic to humans, based on non-carcinogenic exposure endpoints. Mercury levels were found to exceed the sediment criteria for ecological endpoint evaluations (where adverse response is noted in 5% of observations with estuarine sediments). Lead and copper concentrations recorded in this study also approached these criteria, indicating a need for "more extensive, site-specific assessment" of the trace metal content in the study area.

In general, trace metal levels along the eastern border of the swamp were lower than within the swamp, with the exception of lead.

DDE, a major residue of the pesticide DDT, was detected in the sediments of the study area at levels exceeding the sediment criteria for ecological endpoint evaluations (adverse response noted in 5% of observations with estuarine sediments). In general, higher concentrations were recorded during the dry season of the study period. This may be attributed to decreased dilution and increased absorption/adsorption during the dry season. No commonly used organophosphorous pesticides were detected in these sediments.

There is need to conduct further studies and monitoring of the chemical content of the sediments of the swamp. More site-specific sampling can be conducted to confirm the results of the chemical analyses done for the study area.

2.8 ECOLOGY

The Nariva Swamp is characterised by a wide range of habitats and high biodiversity. Its rich flora is the result of the hydrology of the swamp and its undulating topography. Several pockets of land with specific conditions, mean water level, soil texture and composition support different types of vegetation and provide a wide range of microhabitats for its associated fauna. Many of these organisms are highly adaptive to the specific conditions associated with their habitat.

Flora

Nariva Swamp is dominated by four wetland vegetation types; mangroves, freshwater marsh, palm swamp and freshwater swampwoods (Figures 2.5 and 2.6). Evergreen seasonal forest is also found in the swamp and is prevalent along the length of the swamp on the western side. Distribution of vegetation types is illustrated in Figures 2.5 and 2.6. There are five reserve areas lying around the periphery of the swamp. However, these are populated by the larger vegetation types, which favour drier soils.

Mangrove forests are restricted to the eastern coastal boundary, fringing the Nariva River Lagoon where brackish water conditions occur for part of the year. The estuarine mangal (3.51 km^2) consists of a typical *Rhizophora-Avicennia-Laguncularia* mangrove association and comprises six mangrove species. These species are commonly called the Red mangroves (*Rhizophora mangle, R. harrisonii, R. racemosa*), the Black mangrove (*Avicennia*

COLOUR CODED KEY FOR FIGURES 2.5 AND 2.6

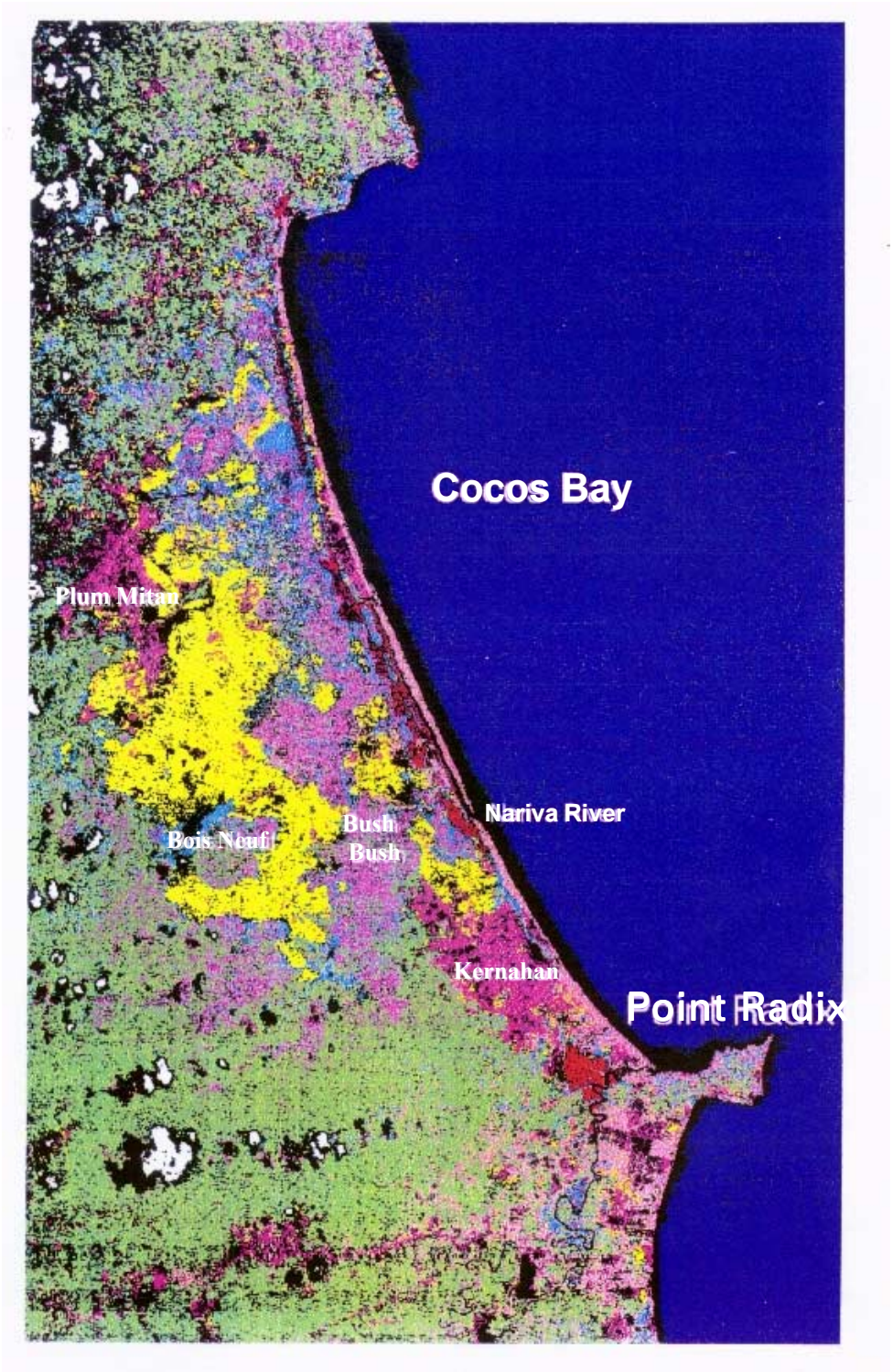


FIGURE 2.5: SATELLITE IMAGE OF NARIVA SWAMP 1986

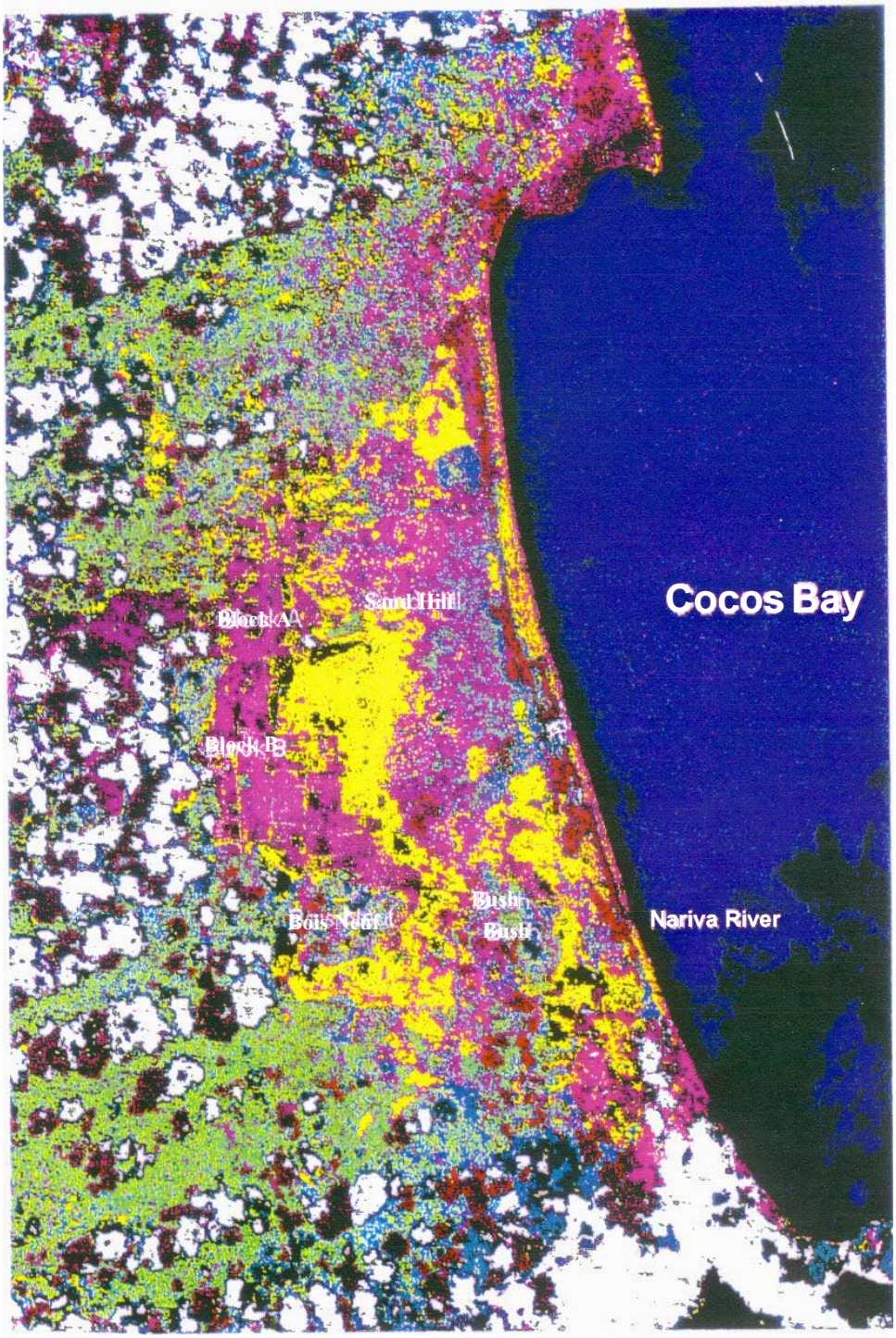


FIGURE 2.6: SATELLITE IMAGE OF NARVIA SWAMP 1992

germinans), the White mangrove (*Laguncularia racemosa*) and the Button mangrove (*Conocarpus erectus*). The mangal contains many large mangrove trees (over 20 m tall and >2 m in girth). Mangrove forest has been felled to facilitate the construction of bridges in the area. It was noted that the Red mangroves can also be used to supply bark to the tanning industry.

However, at present, the mangal appears to be healthy.

Freshwater marsh is the dominant vegetation type of Nariva Swamp, occurring in the northern, western and southern regions. They consist of floating and rooted species and provide primary habitat and rich feeding grounds for several types of animals, including waterfowl species, some rare and endangered species and abundant insect species. Within the last decade, the areas occupied by freshwater marshes have been significantly reduced, impacting heavily on the availability of habitats for many animals. Clearing was done mainly for rice farming in Biche (Block B), Plum Mitan and Kernahan, including some parts of the Bush Bush Wildlife Sanctuary.

Agricultural practices have resulted in the proliferation of some species of floating vegetation, both foreign and exotic, which can potentially clog waterways and irrigation channels and cause the reduction and loss of many populations of resident species.

The burning of the vegetation by fishermen to increase their access to the inland fishing areas has also contributed significantly to the loss of the swamp marsh vegetation. The freshwater marsh community can be considered severely damaged.

Palm swamp communities consisting of Royal/Palmiste palm, Moriche palm and Roseau palm occur on the eastern side of the swamp. Negative impacts upon the palm swamp community have been significant over the years and it is the smallest vegetation type in the swamp.

Palms were cleared for pasture, consumption and rice cultivation. Decrease in the palm community as well as over-harvesting by poachers has caused the populations of some macaw species (the Blue Macaw, the Gold Macaw and the Red-Bellied Macaw) to become almost eliminated from the swamp. The palm swamp community can be described as severely damaged.

The freshwater swampwoods occur in association with palm swamp and freshwater marsh communities (Nariva Technical Report -Flora and Non-aquatic Fauna, 1998). These are scattered in the northeast and in the low-lying

areas in the central east regions of the swamp and consist of some large tree species, which are adapted to the inundated conditions. There has been reduction in the spatial extent of these communities resulting from felling for rice farming. The community can be described as greatly modified and showing signs of damage.

Evergreen seasonal forests occur in the higher elevated areas of the swamp (>10 m) on the remnant sandbars and in the forest reserves. The forest consists primarily of hardwoods, including many fruit-trees, and can be characterised as a **Crappo-Guatecare** association (Beard, 1946). It has been reduced as a result of human activities, particularly with respect to habitat destruction to facilitate agricultural cultivation, including that of marijuana, selective logging of commercial species and fires. Loss of forests at Nariva has had significant down-stream effects on animal populations that depend on this particular ecosystem for food and shelter. The green parrot, which normally inhabits these forests, feeding on the fruit, has become a pest in the nearby agricultural plots. There are not sufficient feed trees to support the alternative populations, hence their feeding ecology has changed and adapted to existing food sources.

Wildlife and Forest Reserves

Lying around the periphery of the swamp basin are five reserve areas. These are:

- Manzanilla Windbelt Forest Reserve (occupying area of 0.44 km^2 (Alleng, 1997)).
- Brigand Hill Forest Reserve.
- Central Range Forest Reserve (approximate area of 162.5 km^2 (IMA, February 1998)).
- Ortoire Nariva Forest Reserve (approximate area of 25 km^2 (IMA, February 1998).

These reserves account for 4.5% of land use in Nariva Swamp but cover mainly areas outside of the swamp basin.

- Located in the south of the swamp and extending across from the west to the east is the Bush Bush Wildlife Sanctuary (15.4 km^2), accounting for 21% of the swamp basin area.

Non-Aquatic Fauna

As in most wetlands, the fauna of the Nariva Swamp depends almost entirely on the integrity of the vegetative systems for their survival. This wetland, with its varied physical characteristics, its variety of wetland ecotypes and plant species, and its overall high productivity, provides a wide range of niches supporting numerous animal species including birds (avifauna), mammals, fish, amphibians, reptiles and invertebrates (Table 2.5).

Avifauna

Nariva Swamp provides a wide range of habitats and food resources through its varied topography and vegetative ecotypes. The wide variety of habitats and abundant food allow the sufficient complexity in the niche i.e. part of resources utilised by that species, and many of the organisms are quite specialised in their habits.

The bird life in the swamp is extremely rich and diverse. Of more than 400 bird species recorded in Trinidad and Tobago, 287 are found in the coastal wetlands (Ramcharan and ffrench, 1988) with the largest number occurring at Nariva Swamp. A further 28 species were observed in addition to Bacon's 176 (Bacon *et al*., 1979), including 25 waterfowl species. More than half the birds occurring at the Nariva Swamp are breeding or non-breeding residents, with migrants from North and South America.

Field observations made by the Wildlife Section during March to December 1997, indicated only about 100 species present at the swamp. The reductions in the numbers of bird species in particular reflect the decline in the integrity of the swamp, as they are usually good indicator species (Nariva Technical Report- Flora and Non-aquatic Fauna, 1998). The substantial reduction in species diversity may have been caused by habitat destruction, as many of these species require specialised habitats.

TABLE 2.5: NUMBER OF ANIMAL SPECIES BY CATEGORY RECORDED AT NARIVA SWAMP (Source: Bacon *et al*., 1979)

Category	Number of Species
Protozoa (microscopic)	15
Crustacea	11
Insecta	213
Arachnida (spider)	28
Mollusca (snails, conch etc	15
Pisces (fish)	33
Amphibia (frogs)	19
Reptilia	39
Aves (birds)	176
Mammalia	45
Total	**594**

Mammals

There are forty-five species of mammals listed in the swamp, the more common ones being the bat, deer, wild hog, the Red Howler Monkey, the Capuchin Monkey, squirrel, tree porcupine, armadillo, agouti, anteater and the West Indian Manatee. The monkeys and the manatee are of special interest for conservationists as they are endangered species. The monkeys have been affected by the loss of their habitat and food trees. The manatee is especially susceptible to ecological changes in the swamp as its range for foraging is dependent on the water levels, and it is defenceless against most predators. Many of these species are either rare or endangered, and for many others the Nariva Swamp is a refuge habitat, as they are not found anywhere else in the country in the numbers as at Nariva.

Reptiles, Amphibians and Invertebrates

Morocoys and lizards, including the large matte, were found mainly in the forested areas of Bush Bush, while snakes (including the Giant Anaconda, which is endangered) are both terrestrial and aquatic. Caiman are widespread throughout the swamp in open waterways. Large numbers of nesting iguanas are found on Sand Hill. The only amphibians observed are frogs and toads. Insects are the dominant invertebrates but there are some crustaceans, such as the mangrove and fiddler crabs, and molluscs, particularly the black conch.

Human impact on the biota of the swamp has been predominantly negative. Fires have severely affected the populations of black conch, and pesticides and herbicides used in rice farming may have adversely affected the invertebrate population by killing the organisms directly or through sub-lethal effects including the bio-accumulation of toxins. However, the most detrimental human impact has been habitat destruction, which limits the feeding range, food availability, the genetic exchange between separated populations and the behavioural patterns of the animals.

Aquatic Fauna

The aquatic system of Nariva Swamp is very diverse, supporting several species of fish, molluscs, crustaceans, frogs, turtles, one caiman species, aquatic snakes, invertebrates and plankton. Insects dominate the aquatic ecosystem, which provides a habitat for many of the life stages of most of these species. The aquatic fauna is especially important as it includes several food species such as the cascadura (*Hoplosternum littorale*), the black conch (*Pomacea urceus*), oysters (*Crassostrea rhizophorae*), crabs (*Cardisoma guanhumi* and *Ucides cordatus*), coscorob (*Aequidens pulcher*) and guabine (*Hoplias malabaricus*). An active aquarium trade exists in Trinidad, but there is little collection of species from Nariva for this purpose. The aquatic flora itself is very rich and each community type can support different faunal associations.

The black conch is dependent on the hydrological pattern of flooding and drying for the completion of its life cycle. It aestivates in the dry season, during which time its young are incubated and spawned. The hatchlings emerge as soon as the rainy season starts (Lum Kong and Ramnarine, 1988). The cascadura is also dependent on the seasonal changes of water levels in the swamp. It spawns during the rainy season, with peak activity in July. The flood waters of the rains afford dispersal and increased foraging of these two species.

The endangered sea cow (*Trichecus manatus*) inhabits the aquatic environment of Nariva Swamp. The population is small (25-30) and is distributed mainly along the Nariva River channel. Threats to the manatee include habitat alteration, pollution, human harassment, range restriction from drying out of waterways and natural threats such as red tides and diseases.

Species Diversity

The number of species in any area, estuarine or freshwater, is highly variable. However, diversity is high and compares favourably with other wetlands as indicated by the Simpson's Index of Diversity (Nariva Swamp Technical Report- Flora and Non-aquatic Fauna, IMA, 1998).

The harvesting of cascadura and conch from the natural population (wild stock) constitutes a major source of income for a significant portion of the local residents.

However, as noted in the FAO study in 1985, the sizes and numbers of cascadura had started to decrease. Plans have been suggested for proposed aquaculture ventures in the less productive areas of the swamp for the rearing of cascadura and conch (FAO, 1985) as there is a ready market for the products. Thus far, however, no definite stock assessment of the existing population has been done.

2.9 SOCIO-ECONOMIC

The main villages within the socio-economic study area are Plum Mitan, Biche and Kernahan/Cascadoux.

Plum Mitan and Biche are both located on the north western side of the swamp, while Kernahan/Cascadoux is located to the south east of the swamp.

All the communities are composed mainly of persons of East-Indian decent who are predominantly Hindu. The resources of the swamp are used for religious and cultural purposes. The populations of Plum Mitan and Biche are between 2000 and 3000 persons, with Kernahan being a much smaller community of roughly 400 persons. These populations have fluctuated over the last thirty years and have displayed distinct patterns of immigration and emigration.

The main socio-economic activities in the communities are agriculture, fishing (both freshwater and marine), hunting and livestock grazing. In addition, the communities that live in close proximity to the swamp also depend on it for a variety of products (fruit, palm, mangrove bark and fuelwood) and utilise the rivers and other watercourses for domestic and recreational purposes (Wahab, 1997).

The area is affected by regional and national economic trends.

Unemployment has increased over the years and there has been a tendency towards self-employment. The generally low standard of living of most of the local population is reflected in their low per capita income. Earnings tend to be less than the national average, with the proportion of persons earning the lowest levels of income being considerably higher than the national percentage.

The socio-economic studies revealed that generally, the infrastructure in the area is below national standards. There are deficiencies in the supply of potable water, electricity (especially in Kernahan), telephone services, health, transportation and educational facilities. The area is accessed through five main roads and two secondary roads.

Major land use in Nariva and its immediate environs include:

- Residential
- Agricultural
- Natural vegetation and Wildlife Sanctuary and reserve areas
- Recreational
- Archaeological (eight sites in study area)
- Burnt areas (five sites at the time of study)

Details of land use are described in the Socio-economic section of the Nariva Technical Report, IMA 1998.

Agriculture

The majority of the area is owned by the State and there are two agricultural schemes, for which leases must be obtained from the Lands and Surveys Division, Ministry of Agriculture, Land and Marine Resources.

Agricultural lands extend through Blocks A and B located along the western half of the swamp and to the south and southeast through Block F and Kernahan respectively (Figure 2.2). Block B was previously used for large-scale rice farming and is now fallow. Block A is used for small-scale rice farming and the cultivation of short crops (tomato, watermelon and cucumber). The cultivation of these short crops poultry rearing and livestock farming are practised in Kernahan. Coconut plantations are located along the eastern

coastal fringe of the swamp. Agriculture accounts for approximately 20% of the swamp basin, covering 14.54 km^2 area.

Rice Farming

All management plans proposed for Nariva Swamp before and during the 1980s have suggested that the area be drained and used for agriculture. Rice farming was therefore a fostered activity. However, conflict arose when non-resident rice farmers displaced traditional smaller rice farmers from Block B and further restricted access into the area. Conflict also arose between the farmers because of their farming practices and use of the resources of the swamp.

The large-scale rice farmers who entered the swamp and stayed for an extended period were members of three main families. They were from a different religious and socio-economic background, which was another point of contention. The entry of these farmers was characterised by more negative impacts than positive ones (Nariva Technical Report- Socio-economic section, IMA 1998).

The main communities impacted by the large-scale rice farmers were Plum Mitan and Biche.

Kernahan to the south was not directly affected by the activities of these farmers. However, its location in the swamp and its dependence on it make the socio-economic conditions of this community an important consideration in the formulation of the management plan.

The major problems noted by residents in all three communities were unemployment, praedial larceny within the swamp, lack of secure land tenure, the growth of illegal crops (marijuana), and lack of local infrastructure and basic amenities such as schools, health, transportation, water, electricity and telephone services.

3.0 MANAGEMENT ISSUES

3.1 INTRODUCTION

This chapter highlights the issues related to human use of the natural resources of the Nariva Swamp. It identifies the needs of various users of the swamp resources and indicates some of the conflicts associated with their activities.

The issues facing the management of Nariva Swamp can be divided into overlapping categories: environmental quality, resource exploitation, and institutional and organisational issues. These categories overlap because individual issues often involve aspects of all categories. Environmental quality issues deal with changes in the natural state of ecosystems such as threats to rare and endangered species, loss of habitats and water pollution. Resource exploitation issues are those that involve utilisation of natural resources such as fish, forest products, land or water. Institutional and organisational issues relate to the organisational mechanism and strategy used to implement government polices.

Nariva Swamp is currently managed by multiple organisations (government and private), at times working independently of each other toward multiple objectives, some of which conflict with each other. The environmental quality issues result from natural events, from human use of the swamp resources and the failures of organisations with responsibility for managing various aspects of Nariva Swamp. For example, one effect of the El Niño climate pattern was the excessive drying out of the Swamp, which increased its susceptibility to fires. These fires are further facilitated by the activities of farmers, fishermen and hunters as they exploit the resources of the swamp. Additionally, the strategies used by Non-Government Organisations, Forestry and Wildlife Division and the Land Administration Unit have not been successful in preventing or minimising the negative impacts of fires. These organisations are constrained by inadequate legislation governing the use of swamp resources, as well as limited financial and human resources available for managing and implementing their activities.

3.2 ENVIRONMENTAL QUALITY ISSUES

The overriding environmental quality issue is the ability of Nariva Swamp to maintain its ecological integrity, given increasing demands for consumption and development of its resources. The swamp is predominantly a freshwater system, the integrity of which is influenced by:

- The Cocal Sandbar on the East Coast, which acts as a dam, keeping some areas of the swamp permanently inundated with freshwater. It also acts as a physical barrier between the freshwater system and the ocean.
- Its hydrology, which is maintained by water from rivers within the watershed, rainfall and groundwater supply.
- Its varied habitats and multiple niches reflected in its high bio-diversity.

Importance of the Cocal Sand Bar to Nariva Swamp

The Cocal Sandbar is an important component of the swamp's ecological character. It functions primarily as an impoundment, preventing major outflow of freshwater to the sea, thereby damming freshwater within the drainage basin. The presence of the sandbar is therefore key to maintaining the inundated nature of the basin.

The sandbar forms a permeable interface between freshwater and saltwater. The hydraulic head, created by the discharge of large volumes of water down a gradient from the watershed to the sandbar, limits the inward movement of saltwater into the marsh from the sea.

The other major function of the Cocal Sandbar is as a physical barrier to the swamp, protecting it from the effects of coastal processes and high winds particularly during storm surges and tropical storms.

Interventions that are likely to affect the Cocal Sandbar

The sandbar forms part of the eastern coastline of Trinidad and is subjected to the high energy of the Atlantic Ocean. Coastal erosion is thus a major concern with regard to its management. Additionally, sea level rise can gradually result in the submergence of the sandbar, threatening its functionality as a barrier to salt water intrusion. Increased wind and wave energy during large storms or tidal waves can result in erosion or removal of the sandbar. This removal would increase the vulnerability of the swamp to physical damage by the effects of tropical storm surges.

Removal of vegetation from the sandbar can negatively affect its nature by increasing its exposure to climatic elements and removing the stabilising effect, which (coconut) tree roots have on the sandy lithology.

Removal of the Cocal Sandbar, either gradually by erosion or sea level rise, or catastrophically by natural disasters, can result in a change of the ecological character of the Nariva Swamp. This would result in significant increases in the inflow of salt water into the swamp, causing the loss of a large reserve of fresh groundwater.

The resulting change in the quality of water stored in the swamp basin, from freshwater to salt water conditions, would affect the biodiversity of the swamp.

Importance of Hydrology to the Nariva Swamp

The distribution and quantity of water (the hydrological regime) are critical for the development of a swamp ecosystem. The hydrological pattern, the flora and fauna are the factors determining the existence and character of Nariva Swamp. The flora and fauna that have colonised the area are definitive in their ecological characteristics, as they are adapted to the specific soil conditions and hydrological regime.

This swamp receives water from rivers within the watershed and from direct rainfall. Water from the swamp is lost through rivers, evapotranspiration and evaporation. During the rainy season, supplies of freshwater to the swamp exceed its holding capacity, resulting in flooding of surrounding areas. The supply is less than the holding capacity during the dry season, resulting in drying out of large areas of the swamp. Other areas of the swamp remain permanently inundated with water during the dry season, while yet others are nourished from groundwater sources. The latter areas are suitable for short-term agricultural production. Areas not nourished from groundwater sources can become potential fire hazards. The seasonal changes in hydrology have implications for the fauna and flora of the swamp as they have adapted to these conditions. Some animals, like the black conch and several fish species, depend on the seasonal changes of the hydrology for the completion of their life cycles.

Interventions affecting the hydrology of Nariva Swamp

The hydrology of the swamp has been significantly altered as a result of agricultural and residential activities. Alterations to the hydrology include

construction of channels and small-scale dams, pumping of water and diversion of rivers. These changes were made to ensure a supply of water for agriculture during the dry season. For example, large-scale rice production in Block B required tapping water from the marsh swamp by pumping from Jagroma Cut into the man-made irrigation channels. This resulted in further drying out of swamp areas. Channels were also constructed to facilitate transport of rice from Block B to the ocean. This channel may have contributed to salt-water intrusion further into the swamp than occurred naturally. During the wet season, excess water from the rice fields was pumped into the marsh swamp resulting in increased flooding of other areas of the swamp.

Proposed developments for the use of the resources of Nariva Swamp will include similar interference on the existing hydrology. Additionally, natural events like storm surges, tidal waves and coastal erosion can have significant impact on the hydrology of the swamp. These natural events can reduce the Cocal Sandbar's ability to retain water within the swamp.

Interventions which impacted on Nariva Swamp

Changes to the hydrology of the swamp have resulted in drying-out and flooding of new/additional areas. Flooded and dried-out areas adversely affect the integrity of the swamp through both short and long term loss of floral and faunal habitats. These losses are compounded when the dried-out areas are subjected to increased incidence of fires. Fires have already adversely affected the extent and distribution of the freshwater swampwood and palm swamp vegetation communities. Additionally, the loss of vegetative cover exposes the bare soil to erosion through drying and cracks from the shrinkage of the clay soils.

Changes to the natural drainage pattern, through channelization, have reduced the swamp's ability to recharge its groundwater supply. The water table is fairly low toward the eastern coastal border (Geology Technical Report) because of deprivation of water from the swamp and inhibited recharge. This can facilitate salt-water intrusion into the freshwater system via the ground water system or through outflow channels and this would further compromise the integrity of the Nariva Swamp ecosystem.

Habitat and Biodiversity

The biodiversity of the Nariva Swamp defines its character and integrity. The flora consists of a wide range of species that aggregate into several community types. The hydrophilic floating vegetation is critical to the faunal assembly in the ponds on which they are found. Gallery forests, which are located on the areas where the land is sufficiently elevated as to permit reasonably 'dry' conditions for the growth of large trees, provide food and shelter for many birds and mammals. Marshlands retain nutrients and biomass and allow the rapid recycling of nutrients. These processes are essential and exclusive to the swamp as a dynamic ecosystem.

The importance of habitats, niches and biota to the Swamp

The Nariva Swamp contains flora and fauna which define its character and integrity. These offer services that are essential and exclusive to the swamp as a dynamic ecosystem. It is a refuge habitat for the endangered manatee. The swamp is used as an eco-tourism site. Palm-swamp vegetation provides a habitat and food for the monkeys, the rare Blue and Gold Macaw and the Red Bellied Macaw. The biota of the swamp perform important environmental functions towards the maintenance of other systems such as the coastal zone and offshore fisheries, in a state that is desirable.

Man's interventions, which have affected the biota of the Swamp

Large sections of Nariva Swamp have been cleared for agricultural purposes. These include Block A, Block B and Kernahan, which have very little of their natural vegetation intact. The palm-swamp vegetation has been reduced to the extent that what has remained does not provide adequate food and shelter for the animals dependent on it. The loss of several feed trees from the forests through selective extraction for forestry has caused species like the green parrot to become pests in nearby agricultural areas.

Extensive clearing of the marsh swamp vegetation has resulted from indiscriminate burning of the swamp in order to gain access to the fish stocks in the interior. Burning is disastrous to the ecology of the swamp. The swamp’s vegetation provides nesting and breeding habitats for over 250 species of migrant and resident bird species, many of which have specialised habitat preferences. It also provides food through its associated fauna of aquatic and non-aquatic insects and macro-invertebrates. There is evidence that the numbers of species of migrant birds and wildfowl that were previously

sighted in the swamp have decreased. This has been attributed to the changes in habitat and food availability resulting from the destruction of the natural vegetation of the swamp.

Slash and burn practices used in agriculture, burning of swamp vegetation to access fish resources, logging and squatting all contribute to habitat destruction. These impact most on the many species for which the swamp provides a refuge habitat, especially the rare and endangered species such as the manatee, the anaconda, the deer and the wild hog. Foraging or migrant animals such as deer and waterfowl are particularly endangered as their habitat is far-ranging. Reduction of their foraging range can threaten their survival.

Altering the natural conditions of the swamp has effected some changes on the competitive capabilities of indigenous organisms that inhabit the swamp. It has promoted conditions that are suitable for other species and has fostered the introduction of exotic species.

Rice farming has attracted flocks of thousands of dickcissels (*Spiza americana*), which fly in from South America to feed on rice, a main component of their diet. The altered waterways have resulted in conditions which favour the proliferation of several new species of water plants, for example, several *Sorghum* species. These plants have become pests in the swamp as they occlude the waterways and irrigation channels. The results of these and other ecological changes, have not been fully documented and are not fully known.

Changing the plant species composition as well as the abundance of certain species can alter habitats for the plants themselves. The giant aroid, though scattered throughout Trinidad, is rarely found in large stands except in the swamp. Rare plants, which are as yet under-exploited or undiscovered and which have potential commercial value, may be lost easily through practices that promote habitat destruction.

Encroachment on the mangrove forests through logging and clearing for agriculture and squatting affects the level of nutrient recycling capability of the swamp. It has resulted in increased exposure of the coastline to erosion and incidence of wind damage of adjacent inland areas.

Increased human presence and interference in the swamp, from activities such as eco-tourism, can affect the behaviour of the animals in the swamp. Animals that have negative experiences with humans (such as hunters) tend to learn and react to any further exposure to humans. This has been noted in the

behavioural changes that have taken place with monkeys at Nariva Swamp. The Trinidad Regional Virus laboratory personnel noted during their stay at Nariva Swamp (1950's and 60's) that the monkeys were shy. This contrasts sharply with 1998 reports that the monkeys often display aggressive behaviour by throwing fruit and twig missiles at onlookers.

The effects of future interventions to the swamp

If activities in the Nariva Swamp continue to occur these will result in further alteration and destruction.

The following activities are likely to continue to affect the swamp in the future:

- Bird catching
- Increased levels of agriculture
- Construction of more drainage canals
- Increased fishing
- Increased levels of eco-tourism
- Hunting

The activities outlined above have various negative impacts on Nariva Swamp that will result in further alteration and, if activities continue, complete destruction. Further clearing of land for agricultural purposes, for bird catching, logging and hunting will result in loss of natural vegetation, which is already sparse especially in the Block A, Block B and Kernahan areas. The destruction of natural vegetation will also reduce the shelter, protection and foraging areas that habitats provide for animals in the swamp. Furthermore, reduced swamp vegetation will increase accessibility into the swamp. Increased human traffic into the swamp may further the depletion of many animal species.

3.3 RESOURCE EXPLOITATION ISSUES

Mangrove Forest Conversion

The Nariva Swamp contains the most diverse flora and fauna among wetlands of Trinidad and Tobago. Changes to the mangrove forest are influenced by both natural and anthropogenic activities. Man exploits many of the resources

found in the swamp and inappropriate utilisation of the flora and fauna has caused alteration of the swamp's ecosystem.

Agricultural activities such as commercial rice farming, marijuana cultivation and small-scale farming have been responsible for altering extensive areas of vegetation in the Nariva Swamp. Large areas of freshwater marsh communities, freshwater swamp-wood and palm swamp have been cleared of natural vegetation to provide land for farming. These alterations have also resulted in the swamp conditions favouring the growth of marsh vegetation and weed species, such as *Sorghum*, in areas where the vegetation has been cleared. The proliferation of these grasses in areas where they were once absent can cause drastic ecological changes to the swamp, affecting many animal species dependent on the vegetation for habitat and food.

Fuelwood, charcoal and building wood are often obtained from the evergreen seasonal forest and the mangrove communities that exist in the swamp. Activities such as logging have been taking place for approximately 25 years and have resulted in habitat destruction of the evergreen seasonal forest. Cutting of mangrove trees for charcoal, fuelwood and extraction of tannins has also resulted in the damage of mangrove communities. This has significant downstream effects on animal populations that depend on this particular ecosystem for food and shelter. It has also resulted in alterations to the processes and functions of the swamp.

The cutting of trees for food also destroys vegetation in the Nariva Swamp, the destruction of the palm swamp community being a prime example. Palm trees are cut down to utilise the palm hearts during religious ceremonies. In addition, the trees are also cut down to capture nestling birds such as macaws and parrots for the pet trade. These activities resulted in further reduction of habitats for various bird species, particularly the Blue and Gold, and the Red-Bellied Macaw.

Improper Agricultural Practices

Nariva Swamp has been used for agricultural purposes for many years. Originally, rice, on a small scale, and short-term cash crops were grown on small plots of land. In 1986, some of these plots were taken over by large-scale rice farmers.

Clearing of land has caused loss of habitat for many animal and plant species that are specific to the swamp, adversely affecting the overall integrity of the

swamp. The large-scale rice farmers as well as marijuana plantations have also contributed to loss of habitat for many plant and animal species.

Large and medium-scale rice farming are deleterious to the soil found in Nariva Swamp. Land preparation for rice cultivation destroys the structure of the soil and as a result rice cannot be rotated economically with dry crops on the same land.

Large and medium-scale rice farmers utilise large quantities of pesticides, insecticides and fertilisers in the fields. Although commonly used pesticides were not detected in the water, herbicides and fertilisers can affect the water quality of the rivers and streams in the swamp. In the case of herbicides, it was documented that those used in the swamp were toxic to animal life. Fertilisers, when used in large quantities can lead to nutrient enrichment, which is not uncommon to wetlands. Nutrient enrichment coupled with the hydrology of the swamp can eventually lead to eutrophication, resulting in hypoxia or even anoxia, which can be deleterious to some aquatic life.

Herbicides and pesticides used in the swamp can negatively affect several invertebrate populations by either killing organisms directly or by causing sub-lethal effects including the bio-accumulation of the toxins. If consumed by organisms from higher trophic levels, there is the possibility of bio-accumulation of these poisons along the food chain.

The rice farmers utilise large quantities of water, especially during the dry season. The water used for rice farming is obtained from the swamp itself.

The utilisation of large quantities of water coupled with the cutting of channels to drain the fields have major implications for the hydrology of the swamp. Cutting of channels has resulted in salt-water intrusion into the swamp especially during the dry season. Changes in the hydrology of the swamp cause drying out during the dry season, which facilitates the spread of fires.

Overfishing and Destructive Fishing

One of the major economic activities is the collection of cascadura and conch from the swamp. There exists no data on the size or health of existing population of these species. Additionally, no system exists to capture data on current levels of catch and the related effort. Accounts from fishermen indicate that catches of cascadura have declined significantly over the years. This suggests a possible reduction in population size. However, this needs to be researched.

Fishing techniques employed to catch cascadura include those that are detrimental to the health of the resource. At present, fishermen catch fish by damming the canals and draining them to concentrate fish in one area.

The males and the eggs are also removed from the nest during the breeding season and this practice contributes to the reduction in stock numbers and its ability to replenish itself.

Removal of males alters the sex ratio and reduces the overall reproductive potential of fish stocks. Removal of eggs also reduces the number of potential recruits, which will grow and reproduce. Both of these factors affect the size of future stocks. Size selectivity of the fishing method used for cascadura may also affect the genetic structure of the population.

Illegal Hunting

Illegal hunting has been taking place in the Nariva Swamp for many years. The majority of animals hunted depend on the forested areas primarily for food and shelter. Loss of habitat to agricultural activities has resulted in easy accessibility to the forested areas. The reduction in habitat has also resulted in isolated pockets of forest, restricting free movement of land-based animals. These factors make animals more accessible to hunters.

Hunters often ignite fires to scare animals out of their habitats. Uncontrolled fires can result in further loss of food and shelter for animals. Loss of feed trees during fires has resulted in animals invading agricultural areas and being killed by farmers.

Reduction in animal populations also impact negatively on the germination and distribution of seeds. Certain seeds cannot germinate unless the protective outer coating is broken down during passage through the gut of animals, for example, the agouti.

As a result of the deterioration of the Nariva Swamp, the habitat of many rare and endangered species, such as the manatee, has been reduced. Habitat reduction is a primary threat to the ability of these species to maintain viable populations. Many of these endangered animals are protected by law. However, poaching activities further decrease animal numbers.

3.4 INSTITUTIONAL AND ORGANISATIONAL ISSUES

Adoption of Management Plan

The major potential impediment to the effectiveness of this management plan will be the failure to formally adopt and implement it. Developments in the swamp have been a mixture of controlled (Plum Mitan Rice Scheme) and uncontrolled (Block B rice farms and Kernahan agricultural establishments) events. The rapid expansion of the Block B rice farms, prior to 1996, threatened to change the character and integrity of the swamp and to permanently reduce its long term economic contribution. This was clear evidence of the need to follow a good management plan. It is therefore important that the process for review, adoption and implementation of the management plan be transparent and finite.

Inadequacy of Legislative Framework

The *State Lands Act,* Chap. 57:01, the *Forests Act,* Chap. 66:01, the *Fisheries Act,* Chap. 67:51 and the *Conservation of Wildlife Act,* Chap. 67:01 are the principal pieces of legislation, which were relevant to management of the swamp resources and activities related to access and use of these resources. The first two Acts refer to vegetation and wildlife conservation measures. However, only mammals, reptiles and birds are considered "wildlife". These Acts therefore are insufficient to facilitate conservation of amphibians, fish and invertebrates.

Section 3 of the *Conservation of Wildlife Act* provides for the establishment of Game Sanctuaries, in which it is illegal to hunt. This same section also provides for the regulating of hunting. As a further measure to protect wildlife, Sec. 7 of the Act prohibits hunting during the closed season, which according to the Fifth Schedule, runs from April 1 to September 30. The Act, in addition, makes provision for Game Wardens and Honorary Game Wardens who are given *inter alia* the powers of search and seizure. Wardens may require any person suspected of contravening the Act to produce for inspection any animal in his possession or any licence or permit issued to him under the Act. Wardens may also seize among other things any animals, guns and dogs found in the possession of such person. Very importantly, wardens are given the power to arrest without a warrant.

The *Conservation of Wildlife Act* has proved to be inadequate in preventing illegal hunting in the Nariva Swamp, including hunting in the closed season,

hunting in the Bush Bush Wildlife Sanctuary and the hunting of protected animals, birds and cage birds. One of the reasons given for this is the insufficient number of Wardens operating in the Nariva Swamp (Nadra Gyan, Wildlife Section, MALMR). The mass acreage of the Nariva Swamp renders the policing of this area inadequate with such a limited number of enforcement officers. This Act therefore suffers from one of the problems faced by the *State Lands Act* and the *Forests Act,* that is, insufficient enforcement. Additionally, the *Wildlife Act* does not provide for the protection and management of wildlife habitat or for the direct prohibition of activities leading to the loss of habitat.

Lack of Government Agency Interaction

The *Forests Act* also provides for the establishment of forest reserves on State lands and gives Forest Officers the authority to arrest and bring charges against those who commit offences on these reserves. This authority does not extend to State lands in general, which is the province of the Commissioner of State Lands. This has helped to perpetuate squatting and its detrimental effects in the Nariva Swamp. In 1954, the Nariva Windbelt Forest was declared a reserve. However, there was evidence of encroachment from illegal farming activities.

Enforcement action against squatters is referred to the State Lands Section, Land and Surveys Division, previously of the MALMR, but now in the Ministry of Housing and Settlement, which does not undertake active management of wetlands. Administrative responsibilities for wetlands fall directly under the jurisdiction of the Forestry Division. However, the Forestry Division's role is limited to patrols and wildlife data collection.

Inadequate Extension and Low Public Awareness

Public education and awareness provide stakeholders (users, managers and regulators) of the Nariva Swamp with the knowledge and information necessary to understand, appreciate and recognise their role in managing the swamp as a natural resource. This requires interaction with farmers, hunters, eco-tourists, educators, government officials, non-government organisations and residents. The lack of interaction among these stakeholders results in conflicting situations.

Educational facilities in surrounding communities, such a venue for meetings and to house educational materials on Nariva Swamp, are inadequate.

Kernahan suffers from a lack of a community centre or nearby primary school. Many young children are deprived of a secondary education and instead practise farming to assist their families. The Ministry of Community Development offers courses to members of surrounding communities. However, most of these courses do not address environmental or sustainable resource use issues.

In many instances there is a lack of knowledge with respect to the resources of Nariva Swamp. As many teachers come from outside the Nariva area, they are also not aware of the Nariva environment and therefore are not able to pass on this knowledge. In addition, some elders encourage the younger people to move from the community and this results in disinterest in the community/environment among the youth.

Transport and communication links are often absent in many of the communities in the Nariva area. These links are necessary to support services for community educational initiatives, as well as to access schools in other communities. If transport and communication links are improved, village representatives and councillors can play an important role in gaining attention from government representatives to alleviate the existing problems.

Ineffective Law Enforcement

In spite of the *State Lands Act* and its clear dictates, the digging and removal of soil from Nariva without licences took place. Squatting encroachment upon State lands and the spoil and injury to wood and forests on State lands occurred. Although large-scale rice farmers occupied Block B, no grant of State lands was issued under the public seal of Trinidad and Tobago and registered by the Registrar General under the Real Property Ordinance.

This occurrence was a clear indication of the lack of or ineffective, enforcement of the *State Lands Act*. It also shows that the policy with respect to the development of the Nariva Swamp was not clear or if it was, it was not implemented in accordance with the existing legislation.

The mass acreage of the Nariva Swamp renders the policing of this area inadequate with a limited number of enforcement officers. The *Conservation of Wildlife Act* therefore suffers from one of the same problems faced by the *State Lands Act* and the *Forests Act,* that is, ineffective enforcement.

Socio-Economic Inequalities

The socio-economic issues discussed in this section are related to communities surrounding Nariva Swamp (immediate socio-economic impact area). The immediate impact area includes Plum Mitan, Biche, Kernahan and Cascadoux as well as the settlements on the Naparima-Mayaro southern boundary road.

The main socio-economic issues hinge on unsustainable resource exploitation and conflicts in resource use. These stem from the lack of local amenities, few viable local livelihood options and the increase in the population, all of which have implications for the impact on the Swamp.

The difficulties in accessing transportation to commercial and recreational centres and a historic linkage to the area's resources may exacerbate this potential impact. Should choices remain limited, the options that may be pursued include out-migration of skilled persons, escalated resource-use and escalated cultivation of marijuana.

There is multiple land use in the Nariva Swamp area. The agricultural sector includes production of rice, coconuts, poultry farming and short crops such as watermelon and cucumbers. The major crop which dominated the agricultural sector is rice grown in Block B, Block A and Kernahan. The natural resources of the swamp are also used for hunting, fishing, eco-tourism, scientific research, aesthetics, recreation and residential activities within the Swamp. As a result of the multiple land uses of the Nariva Swamp and immediate environment, there are often land and human use conflicts.

In the last ten years the population in the Biche, Plum Mitan and Kernahan communities increased. The slow down in the national and regional economies of the last ten years contributed to the out-migration from urban areas and the net increase in population in these communities. This increase in population resulted in increased demands on the natural resources in and around the communities. The demands on the resources of the swamp continue to increase with additional demands from persons from communities from Central and Southern Trinidad.

Employment levels have dropped and this has resulted in an increase in migration as well as an increase in illegal operations taking place. The majority of people are self-employed, mainly as farmers and fishermen. There is a lack of support for small businesses even though skills training has been provided.

Sustained collective approaches to problem solving are also lacking, with collective action being short term and motivated by issues which are seen as of immediate importance by the communities. There are a small percentage of people working in the Government Public Service. The related activities aimed at satisfying these demands have resulted in conflicts between community members and regulatory officers (Police, Forestry, Wildlife and Statelands officers).

Marijuana cultivation in the area has been blamed for a perceived out-migration of persons from Biche with young families and no vested interest in the area. In Plum Mitan the lack of local job opportunities has resulted in the out-migration of people from this area.

The standard of living in these communities is generally below the national average. This leads to reliance on the resources of the swamp to supplement existing food stores and water supplies, as well as a source of recreation. The amenities present in Biche, Plum Mitan and Kernahan areas are inadequate. Water is often not pipe-borne. The main water source for Kernahan is truck borne. In Plum Mitan water is accessed from a spring. In 1990, more than half the households in Biche and Plum Mitan had access to electricity. Existing health facilities and services are inadequate to meet the needs of the population. There is one health centre located in Biche, which offers a doctor's service once per fortnight and nursing facilities on a daily basis. The nearest county hospital is in Sangre Grande. However, transport is limited, especially at night. Toilet facilities were severely limited for all three communities. The vast majority of the households use pit latrines, which can contribute to contamination of waterways as well as the spread of water borne diseases. Public transport does not provide a satisfactory service. At present, there are no adult services by the Public Transportation Services Corporation (PTSC) because of past market failures. The PTSC has arranged a maxi taxi service for secondary school children but not for primary school children.

Conflicts exist among commercial hunters, recreational hunters, marijuana growers, Non-Government Organisations (NGOs) and rice growers. The recreational hunters accuse commercial hunters of hunting in the closed season and using highly effective yet unsustainable hunting methods. The trap guns set up to protect illegal marijuana plantations are dangerous to the hunters and their hunting dogs. Rice-growers are alleged to have cleared forested areas previously used to conceal marijuana plantations, thus creating conflict with marijuana growers. NGO personnel object to the expansion of large-scale rice

farming activities at the expense of the natural swamp habitats, resulting in conflicts with large-scale rice farmers. Conflicts existed between the large-scale rice farmers, traditional farmers and small-scale fishermen over access to Block B and the changes in the water regime because of adjustments in the hydrology.

Economic Issues

This study has indicated that the production of rice in Block B of Nariva Swamp was not viable to the local or national economy. This activity was determined to have been financially viable to the farmers (net income of approximately TT$2.4 million) because of Government subsidies, guaranteed wholesale prices and markets, non-payment of taxes on income and not having to pay the cost of permanent environmental damage to the swamp (valued at TT$110.5million). Considering these factors, the activity was not viable to the economy of Trinidad and Tobago. The overall subsidy for land rent, water and price of paddy was TT$6,641,863/annum. Additionally, the quantity of rice produced was at best marginal to the national food supply. Employment opportunities generated were low (approximately 194 persons/year) and did not benefit the work force. There was no identifiable increase in local business activity related to rice farming.

Other agricultural and fishing activities were marginally economical, with net income of approximately TT$8.5million/annum. This does not consider the subsidy for infrastructure, unpaid land rents nor cost of permanent damage to the swamp ecosystem. These farmers and fishermen did not benefit from input subsidies, guaranteed markets or prices. These activities however provided employment for families (546 persons), facilitated the establishment and maintenance of secondary business units (garden supplies, variety stores, etc.). Additionally, these activities contributed to the survival of surrounding communities. These activities, though small-scale, have a greater multiplier effect in the community and the national economy than large-scale rice farming.

Economic activities proposed for Nariva Swamp must be economically viable, of benefit to surrounding communities and have tolerable impacts on the Swamp ecosystem.

SUMMARY OF THE MANAGEMENT ISSUES OF NARIVA SWAMP

General Issues	Specific Problem	Causes and/or Problem Description
Resource Exploitation	Un-sustainable fishing practices	• Conch and cascadura are taken from ponds and canals in the swamp. There has been no assessment of standing stock. Therefore the sustainable yield is not known. • One method used to harvest cascadura is by the Garapatcha Trap. The stream is fenced across its width so that fish swimming down stream are funnelled into the trap. This method is neither species nor size selective. The unwanted species are discarded and juvenile cascadura are caught. Guarding males are also removed from nests and even the eggs are harvested.
	Improper agricultural practices	• Altered hydrology of the swamp because of construction of irrigation canals and channels. Diversion of the vital water, which normally flows into the swamp, during the dry season into the excavated channels for use in the rice fields, resulted in lowered water table on the coastal area of the swamp, making it vulnerable to salt-water intrusion through the ground water and outflow rivers.
Damage to flora of potential value		• Clearing of land for cultivation and for increased access by setting fire to the vegetation. During the dry season, when the swamp is especially dry, these fires can easily get out of control and there are few avenues for amending this situation. • Rice farmers do not allow fishermen to fish in their fields. This limits fishing access in the swamp. • Rice farming is best suited to the inundated soils of Nariva. Where the water table is relatively close to the surface, short crops can be grown during the dry season. However, the two types of agriculture cannot be practised economically on the same land as their requirements for land preparation are different.

SUMMARY OF THE MANAGEMENT ISSUES OF NARIVA SWAMP (CONTINUED)

General Issues	Specific Problem	Causes and/or Problem Description
	Cultivation of illegal crops	• Some areas of Nariva Swamp are used for the cultivation of marijuana. These plots are hazardous for visitors, hunters and farmers in that they are protected by trap guns and non-law-abiding citizens. • Prevalence of marijuana cultivation blamed for perceived out-migration of young persons with families with no vested interest in the area.
Socio-economic issues	Social problems	• Unemployment, insufficient involvement of youth in agriculture, praedial larceny and gender issues. • Approximately 50% of the locals earn less than $500 per month. The rice produced as the main crop is classified as third grade and fetches low prices. • Differences in the socio-economic background of the local communities and the large-scale rice farmers instigate conflict of interest. • Perceived contamination of the waterways and land from chemical use in the large rice plantations and the altered hydrology, affecting knowledge of the distribution of fish and other wildlife.
Acknowledging the rights of local communities where these are conducive to the wise-use		• Failure of community co-operatives linked to internal community conflicts, an individualistic approach to problems and the tendency for people to work together to deal with problems reactively, rather than proactively. • Traditional small-scale farmers pushed out of lands they have occupied for over 40 years to be displaced by large-scale rice farmers and delayed land-regularisation procedure.

SUMMARY OF THE MANAGEMENT ISSUES OF NARIVA SWAMP (CONTINUED)

General Issues	Specific Problem	Causes and/or Problem Description
	Inadequate infrastructure	• Infrastructure is lacking in the Nariva area. Many small farmers cannot afford to take their produce out of the locality to larger markets like POS. It is too expensive and there are too few transport vehicles in the area and fishing permits, though free, are expensive to access. • Inadequate health facilities, too few beds, limited opening hours and limited access to medicine. • Limited access to primary and secondary schools because of a lack of transport facilities and the distance from such institutions. • Scarcity of dry goods in the area as a direct result of poor infrastructure and limited access to surrounding towns. • Lack of a rice-drying facility, which may improve the quality of rice produced. • Main domestic water source is truck-borne, especially during the dry season. Housing and toilet facility standards are generally low. Electricity, telephone and other amenities are scarce.
Institutional and organisational issues	Insufficient and overlapping regulation	• The existing legislation was not designed for the protection of the swamp environment and all of its inherent resources. There is also a lack of enforcement of certain laws, especially those governing squatter lands and forestry.
	Lack of interaction among government agencies and the NGO's.	• Jurisdictional problems in administering responsibilities among different organisations.
	Ineffective law enforcement	• Lack of enforcement because of limited personnel and financial resources. Wildlife protection laws only encompass mammals, birds and reptiles, but not amphibians, fish and invertebrates, which are a significant proportion of the wildlife in the swamp.

SUMMARY OF THE MANAGEMENT ISSUES OF NARIVA SWAMP (CONTINUED)

General Issues	Specific Problem	Causes and/or Problem Description
Environmental quality	Loss of wildlife habitats	• Considerable loss of palm-swamp vegetation, contributing to the elimination of two species of macaw and parrot from the swamp. • The destruction and clearing of the vegetation has resulted in isolated pockets of forest with few corridors. These isolated pockets do not facilitate ready movement between wildlife populations because of their spatial distribution. Restriction of the contact between the populations will decrease the gene pool of the species and thus decrease adaptability potential.
	Loss of mangrove forests	• There has been reduction of the mangrove cover because of clearing for the wood and for residential purposes. • Mangroves play a critical role in the purification of water entering the marine system. They also protect the coastline from erosion and the immediate coastal area from wind damage from storms that may disrupt the Cocal Sand Bar, which is critical to the maintenance of the wetland.
	Tourism-related problems	• Potential conflict of use, as development of facilities such as a base camp in the swamp may have major impacts on the immediate environment. Also, the carrying capacity of the swamp for this industry is not known and has to be further investigated.

4.0 THE MANAGEMENT PLAN

4.1 INTRODUCTION

This management plan was designed to ensure that the Nariva Swamp is managed in a sustainable manner. The primary objective is to promote the wise use of the swamp and its resources. The approach therefore allows for the economic development of the swamp, without compromising its ecological integrity. This in turn should result in economic and other gains to the various stakeholders of the swamp.

This management plan will:

- Identify policies which will deal with the issues identified in Chapter 3.
- Design management strategies to help solve the problems existing and anticipate conflicts in implementation of the overall objectives.
- Identify areas where the prospective strategies can be successfully applied.

4.2 MANAGEMENT GOAL AND OBJECTIVES

Adopting sustainable development as the motto and encouraging every opportunity to save marginal areas of the swamp through wise and sustainable use, the presiding goal is to:

Sustain the ecological character / integrity of the swamp with special reference to its hydrology.

In achieving this goal, the overall objectives are stated as follows:

- Sustainable utilisation of natural resources (living and non-living). Sustainable resource use may be defined as use of natural resources within the assimilative and regenerative capacities. **The principal focus of this concept is the meeting of basic human needs in the long term.** Thus the concept includes:

    1. *Meeting basic human needs for food, health, shelter, clothing, income and leisure through use, transformation and distribution of natural resources.*
    2. *Incorporating the imperatives of environmental sustainability into planning, organisation and management of that process of meeting basic human needs.*

3. *Satisfying social and political needs of citizens through their involvement in public policy-making for, and management of, a community's resources or global resources.*

4. *Ensuring equity in distribution of product benefits within and between nations, and ensuring economic security in the present and the future (Cropper 1994).*

- Protection/preservation of key elements of the biodiversity of Nariva Swamp. Such a system will be designed to ensure that the swamp is sustainably utilised in keeping with the principles established above.

- Design socio-economic activities in such a manner as to maximise the benefits that could be derived from Nariva Swamp and thus facilitate development of the management area and ultimately Trinidad and Tobago.

- Protection of traditional and customary rights of resource users within the local community, where these do not compromise the ecological integrity of Nariva Swamp. Traditional resource users would include community residents who have farmed, fished and hunted in the swamp for one or more generations.

- Prevent activities that negatively impact on the socio-economic, physical and ecological integrity of the swamp.

4.3 PERMITTED USES AND USERS

The proposed land-use action plan involves zoning Nariva Swamp. The main objectives are to sustain the ecological character of the swamp, to minimise conflicts in land-use for natural and human-induced ecosystems and to permit sustainable use of the swamp resources. Activities to be facilitated are:

- Agriculture
- Aquaculture
- Fishing
- Hunting
- Eco-tourism
- Recreation

- Human habitats and supporting infrastructure
- Scientific Research

The resources of the swamp should be accessible to all citizens of Trinidad and Tobago. In this plan, emphasis will be directed towards satisfying the resource needs of residents from communities in the study area. This strategy is an internationally acclaimed strategy for participatory management, the justification being that**, the local community plays an integral role in the policing, implementation and required enforcement of management initiatives.** Costs associated with enforcement may also be reduced as one of the major subjects being controlled is informed of the strategy and also given the responsibility of control. Additionally, traditional techniques for resource-use, identified as sustainable to the overall objective, will be encouraged.

4.4 ACTION PLANS

Policy Framework: Land-use zonation should be consistent with existing laws, regulations, sustainability and time-honoured traditions. Zoning will be used to avoid overexploitation of common property resources.

The policies and plans that are formulated for resource management should:

- Encourage wise use of resources in both the natural and human environments.
- Discourage the overexploitation and inappropriate utilisation of resources.
- Reduce conflicts among different exploitation practices.
- Rehabilitate resources identified as overexploited or significantly impacted.
- Encourage and facilitate the involvement of stakeholders in the management of resources.

The management policies should be acceptable to stakeholders (fishers, farmers, etc.) to gain their co-operation in implementation of this plan. They

should include projects on education and alternative livelihood.

Policy Recommendation: In designating land-use zones, resource-user needs must match available resources while maintaining the integrity of the swamp.

Classify beneficial uses of waterways and set appropriate surface and ground water quality standards to guide these uses. The land-use zones identified in this plan could be used to direct potentially polluting land uses away from critical areas.

Promote awareness and appreciation among government officials, NGOs and local residents, regarding the ecological and socio-economic values of the swamp.

Develop territorial use rights for stakeholders (fishermen, farmers, residents, tour guides, etc.). This will provide stakeholders with an opportunity to manage or participate in management of target resources and related habitats in their assigned areas, at their expense and for their benefit.

4.5 MANAGEMENT STRATEGIES AND ACTIONS

There are seven managerial strategies being introduced that are deemed necessary for the efficient, effective and sustainable development of Nariva Swamp. The plan may exhibit some divisiveness in its institutional mission by appropriating responsibility for some actions which are repeated in various projects and strategies. This should be used as indicators of their managerial importance and their repetition in the various categories contain subtle differences in approach and content that should not be undermined. Indeed, many of the strategies reflect similar project requirements necessary for their success.

Some strategies contain projects for implementation of specific activities necessary for the success of the particular strategy.

4.5.1 STRATEGY 1: DESIGN A LAND-USE ZONATION SCHEME FOR THE SWAMP WITH THE FOLLOWING ZONES

This strategy requires a design for a land-use zonation scheme in the swamp. Particular objectives are stated for these zones and the activities prescribed towards these objectives.

There are seven proposed zones, three of which consist of areas in different geographical locations. The zones are shown in Figure 4.1 and located as follows:

Zone 1 Preservation of Natural Vegetation

Area 1a: The area along the coastline of Cocos Bay, from the 38 mile-mark to the 50 mile-mark at Cascadoux Road.

Area 1b: The area to the west of Block B and the Bush Bush Wild Life Sanctuary, within the confines of the Proposed Management Area Boundary.

Area 1c: The Sand Hill area to the southeastern end of Block A.

Zone 2 Re-establishment and Conservation of Natural Vegetation

Area 2a: The area from the northwestern boundary of the wetland, to the northeastern Buffer-Zone boundary of the Bush Bush Wild Life Sanctuary.

Area 2b: The wetland area to the southeast of the Bush Bush Wild Life Sanctuary Buffer-Zone boundary, bounded to the south by Zone No. 7, (Human Habitat and Agriculture).

Zone 3 Re-establishment and Preservation of Natural Vegetation

The Bush Bush Wild Life Sanctuary and its 200 m Buffer-Zone boundary.

Zone 4 Fishing

Area 4a: The eastern and southern areas of Block B.

Area 4b: The area to the south of the Bush Bush Wild Life Sanctuary Buffer-Zone boundary.

FIGURE 4.1: PROPOSED MANAGEMENT AREA SHOWING DESIGNATED ZONES

Zone 5 Aquaculture

The northwestern area of Block B.

Zone 6 Agriculture

The Block A area.

Zone 7 Human Habitat and Agriculture

The area to the southeast of the Proposed Management Area, bounded to the north by Area 2b, (Re-establishment of Natural Vegetation).

Zones 1 to 3 Conservation of Natural Vegetation

At present, approximately 1540 ha of natural vegetation is protected in the Bush Bush Sanctuary. This area contains swampwood and evergreen forest vegetation. For the long-term conservation and enhancement of the vegetative diversity of the swamp, it is recommended that increased areas containing other vegetative types be protected. These areas will be managed as habitat areas providing home and protection of flora and fauna.

These areas should only be used for research and observation of flora and fauna. Where plants of genetically important economic value are discovered, those areas should be treated as high priority areas for conservation.

Present data and understanding of the relationships among vegetative types, and between vegetative types and other aspects of the swamp are not complete. Therefore, these actions would be guided by the precautionary approach, which is consistent with the overall objectives of the plan.

1. Protect the mangrove forest fringing the eastern boundary of Nariva Swamp (Zone 1a). This measure is additionally necessary to help maintain coastal protection in the Cocal Area. This vegetative type is currently classified as healthy.

2. Protect the freshwater marsh vegetative. Changes in land-use to large-scale rice farming and the

accompanied hydrological changes have resulted in the proliferation of new vegetative associations. These associations are more susceptible to fires during the dry season. Freshwater marsh vegetation is currently classified as severely damaged.

3. Protect the palm swamp vegetation. This vegetative type, which occurs in a few small communities, is currently classified as severely damaged. It is the habitat of macaws and parrots. Two areas have been recommended for protection.

4. Protect the freshwater swampwood vegetation. This vegetative type is currently classified as greatly modified and showing signs of damage.

5. Rehabilitate approximately 2050 ha of Block B, (Zone 4a), C and fireburnt areas. Swampwood along the southern border of Blocks B and C, palm communities along the eastern boundary of Block B and freshwater marshes in Block B were destroyed for rice farming. It is recommended that these vegetative types be rehabilitated, especially in Block C and along the eastern and southern borders of Block B. If the hydrology of Block B is restored to its state before large-scale rice cultivation, the marsh swamp will regenerate itself. Palm and swampwood communities have to be reforested.

6. Implement an awareness and public education program for residents in surrounding communities and for present and future resource users. This program should identify:

    - The values and functions of the various vegetative types to the integrity of Nariva swamp.

    - The roles available to them in the management process and in the achievement of management objectives.

- Enhance relations with the NMA, Forestry and Wildlife Divisions of the Ministry of Agriculture, Land and Marine Resources (MALMR).

7. The Nariva Management Agency is to be given the responsibility for rehabilitating designated areas. The NMA must be guided by advice from Forestry and Wildlife Divisions of the MALMR in planning, implementing and monitoring this rehabilitation exercise.

8. Protected and rehabilitated areas should be fully characterised by species, quantities and dimensions of vegetative types. This baseline information would be utilised to set specific management objectives, against which a monitoring program would be designed and implemented.

9. Encourage scientific research to better understand:

   - The relations among vegetative types,
   - Their roles as habitats to various species (floral and faunal),
   - The importance of other aspects of Nariva Swamp (hydrology, soils, etc.) to its continued existence.
   - The total economic value of the swamp
   - Wise economic use of the swamp's resources.

PROJECTS FOR IMPLEMENTATION

These projects are designed to address land-use management issues and to implement the strategies and actions described above. Costs are calculated based on prices and values quoted in the Nariva Draft Technical Report – Economic Aspects (IMA, 1999).

Project 1: Rehabilitation of Vegetation in Blocks B & C and Fire Burnt Areas

Background: Freshwater marsh communities are the dominant vegetative types in Nariva Swamp. However, within the last decade or so there has been extensive damage to these communities. In Block B, Plum Mitan and Kernahan, freshwater swamp vegetation was converted to rice fields. There was also some encroachment into the Bush Bush Wildlife Sanctuary. In fact, it was estimated that approximately 1200 ha of freshwater marsh in Block B was converted to rice fields.

This change in land-use has resulted in conditions that favour the growth of floating marsh vegetation. The rapid proliferation of these vegetative associations, combined with drainage of the land by artificial channels, may have contributed to favourable condition for fires. The freshwater marsh communities can be described as severely damaged.

Objectives: This two-year project has the following objectives and benefits:

- Restoration of vegetative cover in Blocks B & C and in fire burnt areas.
- Restoration of previous flora and facilitation of the return/re-colonisation of previous fauna.

Description: Areas selected for restoration will show how swamp vegetation can be rehabilitated using community and State labour as well as appropriate technologies.

Funding for this project is expected to come from donor agencies.

Phasing of Activities:

1. Begin a public education exercise that focuses on:
    - The values and functions of the vegetative types to the ecological integrity of the swamp.
    - The value of the vegetative types to local residents.
    - The need to restore vegetative types in particular areas.

2. Review studies of swamp restoration and devise a framework for rehabilitation as well as systems of restoration.
3. Publicly announce which areas will be restored.
4. Set up community restoration units.
5. Create a detailed workplan, budget, working area, manpower and time schedules.
6. Design and implement a monitoring program.
7. Implement all activities according to a detailed workplan and monitoring program.

Agencies and Administration:

The lead agency should be the Wildlife Section of the Forestry Division of MALMR. IMA and UWI will act as consultants and follow up the action plan. Restoration units will be recruited from surrounding communities on a voluntary or paid basis.

Budget: The budget is calculated at the rate of TT$ 2,500/ha.

According to the land-use zonation map, approximately 1400 ha, excluding fire burnt areas in the marsh swamp, which would rehabilitate themselves given ideal conditions, will be restored at a total cost of TT$3,500,000.

Project 2: Encourage Research to Characterise the Ecology of Selected Areas of Nariva Swamp, to Improve Understanding of Linkages within the System and to Determine Sustainable Resource Exploitation Levels.

Background: Coastal wetlands are ecologically complex systems with many linkages. Because of the sensitive nature of this ecosystem, any degree of interference can cause marked changes in the environment. Studying areas in coastal swamps can be very challenging because of the complex nature of linkages present in these systems. Adequate detailed ecological studies in the swamp have not been done and data is lacking. The data, which this project proposes to collect, should provide a comprehensive

understanding of the biophysical and interspecific relationships in the protected areas. This data can be utilised to make informed management decisions on levels of resource use in the swamp.

Objectives: This five-year project has the following objectives and benefits:

- To carry out a detailed inventory of flora, fauna and physical environment for each of the protected areas.
- To understand linkages within the system.
- To determine sustainable levels of resource exploitation.
- To promote the generation of sound data, which would be applicable in management of the remainder of Nariva Swamp.

Description: All protected areas and selected exploited areas would be part of this study.

Funding for this project is expected to come from donor agencies, government, private sector enterprises, and universities and other research organisations.

Phasing of Activities:

1. Selection of research team.
2. Review of previous studies to identify available data.
3. Identification of data gaps. Data to fill these data gaps would be collected.
4. An inventory on the flora and fauna will be carried out.
5. A physical description of the protected area will be completed. Data collected for this project should be incorporated into a GIS. This will include baseline studies with emphasis on the protected areas:
    - Water and Sediment Quality
    - Geology
    - Hydrology

6. Description of existing relationships in protected areas
7. Design and implementation of a monitoring program for the protected areas.

Agencies and Administration:

The lead agency should be the Wildlife Section of the Forestry Division of MALMR.

IMA and UWI will act as consultants and follow up the action plan.

Budget: The budget is calculated at the rate of TT$ 240,000/year

Zones 4 & 5 Freshwater Fishing and Aquaculture

Cascadura and black conch are the two main commercially exploited fish species in Nariva Swamp. An open access approach (*any individual is permitted to fish*) is currently used to manage these fishing resources. Fishing is permitted throughout the year. The biology and culture methods of these two species are known (Lum Kong 1986; de Souza and Gabbadon 1985, 1989, 1991, 1992). **However, information on the current size and health of local populations of these species is not known.** Currently, aquaculture is practised at a subsistence level, with the possible exception of one small commercial operation.

The strategies identified in this plan are informed by the need to manage all aspects of the present fisheries. These fisheries will be classified as commercial, subsistence and recreational. Fishing activities will be encouraged in 4a and 4b areas in the natural environment and aquaculture establishments.

1. Identify areas where commercial or recreational fishing for cascadura and conch will be permitted.
2. Identify fishing seasons based on the biology of the exploited species. It is recommended that fishing for these species be permitted only during the identified season.
3. Identify stakeholders who will be permitted to fish commercially. Persons living in Manzanilla, Plum Mitan,

Biche, Kernahan, Cascadoux and Otoire communities will be given priority access to fish resources with tradeable permits.

4. Identify stakeholders who will be permitted to fish recreationally. It is recommended that all interested persons be permitted.

5. Research studies will be conducted to establish management targets for each fishery. These will include:

   - Stock assessment studies to establish maximum number of fish to be extracted per season, while maintaining the ecological integrity of the swamp.

   - Carrying-capacity studies will be conducted to establish targets for the number of persons permitted to fish in any particular area.

   - Socio-economic studies will be conducted to identify the stakeholders involved in each fishery and their respective roles. These studies should also identify the importance of these fisheries to the economic and cultural well-being of these stakeholders.

6. Identify fishing methods which minimise the capture of by-catch species or sizes. These methods should have negligible negative impacts on other fauna or flora in the swamp. Additionally, the methods should not be detrimental to other human activities in the swamp. It is recommended that only fishing methods which satisfy these criteria will be permitted in the swamp. New methods must be tested for these criteria prior to approval for use. All other methods will be banned.

7. Use soil maps and hydrology to define areas for aquaculture development.

8. Identify species which are technically and commercially feasible for culture. It is recommended that only species indigenous to Nariva Swamp be cultured. These include

cascadura, black conch, fresh water prawns and ornamental fishes for the aquarium trade.

9. Design and implement an aquaculture water management program in harmony with the overall management goal of maintaining the ecological integrity of the swamp. It is recommended that the source of water for aquaculture projects will be clearly identified and sustainable. Tapping this water source must not alter the hydrology of the swamp. It is further recommended that sources of water pollution including improper discharge of aquaculture pond water will be identified and appropriate mitigatory measures implemented and maintained.

10. Train farmers in semi-intensive aquaculture techniques.

11. Encourage research to enhance efficiency of production such as improvement of breeding stock, and prevention and control of disease.

PROJECTS FOR IMPLEMENTATION

These projects are designed to promote the sustainable utilisation of the fisheries resources without disrupting the ecological balance of the fish biodiversity of the Nariva Swamp.

Project 1: Determination of the allowable fishing effort for the cascadura fishery.

Background: The open access management policy has resulted in the unlimited harvesting of fish stocks and the removal of nest-guarding males and eggs. Several fishing techniques, some of which have resulted in habitat destruction, are employed. To utilise this fish resource at a sustainable rate, the status of the existing cascadura population must be known for the level or degree of exploitation to be determined. Without any form of control, continued exploitation of cascadura could result in decreases in the population to such an extent that it could no longer sustain itself. This may result in a crash that may be detrimental to the ecological balance of the system. Controlling the fishing effort is not an easy task, particularly as some methods used by the fishermen are not standard, but rather

designed by the fishermen to suit the terrain. Information on fishing units and the pattern of fishing are therefore required for effective management planning. Education and public awareness of the ecology of the swamp are particularly important, as co-operation for enforcement is necessary for effective management.

Objectives: Fishing of the cascadura stock is to be restricted to Zones 4a and 4b. This project aims to determine optimum fishing effort for the designated areas. A hatchery will be developed to help re-stock wild populations if necessary and to provide fry for aquaculture. The benefits will be the long-term availability of stable fish stocks.

Description: The project is a fisheries management plan to determine the standing stock of the cascadura population in the Nariva Swamp and the fishing effort for the designated area. Financing for this project will come from bilateral aid programs and Government.

Phasing of Activities:

1. Compile existing data on cascadura for the Nariva Swamp. The data should include the biophysical characteristics of the fish habitat and fish ecology.
2. Characterisation of the cascadura fishery by a fishery census in terms of the number of fishing units, fishermen, types of fishing methods, catch landings, current fishing effort and sale distribution.
3. Assessment of optimum fishing method.
4. Stock assessment of the cascadura population and determination of the optimum fishing effort.
5. Socio-economic assessment of the coastal villagers and their perceptions of fishing.
6. Update of fishing legislation and fisheries management policies to include inland fisheries.
7. Development of cascadura hatchery for re-stocking of juveniles if necessary.

Agencies and Administration:

The lead agency will be the Fisheries Division, MALMR. Additional support from the IMA and UWI, funding agencies and monitoring agencies.

Budget: The budget for this project is calculated at $240,000.

Project 2: Subsistence/Semi-intensive Culture of the Cascadura and the River Conch.

Background: Reduction of catches of both these species, the destructive fishing methods employed to catch cascadura and habitat destruction have made it necessary to exploit these resources without causing undue ecological damage and/or reduction of the fish biodiversity. Existing commercial aquaculture ventures involving cascadura and the availability of the required technology may be capitalised on for supply to both foreign and domestic markets. Moreover, effluent water from aquaculture may be used for irrigation purposes in agriculture.

Objective: To develop an aquaculture program in the designated area to provide food sources as well as a means of generating income for the stakeholders, without overexploitation of the wild stock of these two fishery resources.

Phasing of Activities:

1. Feasibility study for the culture of cascadura and the river conch. This would include the determination of the main areas in the designated zone for aquaculture, the level of culture (subsistence or semi-intensive), source and availability of water, production design (pond construction, hatchery design, stocking densities, feeding regimes, harvesting protocol) and marketing strategies.

2. Public education on the importance of aquaculture to all relevant stakeholders.

3. Framework for the implementation of an aquaculture policy in designated areas, adhering to National policy on aquaculture. This may also address issues of land ownership/leases and the impact of possible stakeholders.

4. Training of stakeholders in aquaculture through extension services of Government agencies such IMA, Fisheries Division, MALMR and Sugarcane Feeds Center.

5. Production

6. Marketing

7. Research on improving production through manipulation of the life cycles of the two species, refining of feeding regimes, and disease prevention and control.

8. Research on other species indigenous to the swamp for culturing, such as freshwater prawns.

9. Development of Hatchery Facilities - The life cycles of the cascadura and black conch are synchronized with seasonal changes of the swamp's surface hydrology. The intention of establishing a hatchery to produce juveniles of these two economically important species is primarily to provide stocks for the proposed Aquaculture project. It will also serve to overcome the potential effects of the alteration of the hydrology, destructive fishing practices, overfishing and high levels of predation. Egg masses of both species will be brought into the hatchery, hatched and reared until juvenile when they will be released into the swamp. There will be no attempt at genetic manipulation. This release of juveniles will be done only if found to be necessary after a stock assessment of these resources in the swamp is undertaken.

Agencies and Administration:

The leading agency will be the IMA. Additional support from the Fisheries Division, MALMR and funding agencies.

Budget: The budget for this project is calculated at $470,000

Zone 6 Agriculture

Background: The economic analyses of alternative agriculture/non-agricultural options available to Nariva Swamp provided an optimal solution of resource use. This solution gives the optimal combination of crop and eco-tourism enterprises for

Nariva Swamp. The crop enterprises include ochroes, bodi, pumpkin, watermelon and squash. Watermelon is the crop with the greatest potential for the Nariva Swamp. Rice is not included in the optimal solution. Although it is a swamp crop, the economics of its production in Trinidad does not justify its production in Nariva Swamp.

The Total Net Revenue to be gained from implementing the optimal solution is approximately TT$15 million, which is greater than the estimated net revenue from crops of TT$8.2 million for small farmers in Block A and Kernahan.

Fishing activities are included in the optimal solution since it is expected that these activities will take place on the 1264 hectares of land (of a total of 2442 hectares) in Block A, Block B and Kernahan that have not being used in the optimal solution. It is also expected that agricultural activities on the 1178 hectares may allow some fishing activity to take place.

The optimal solution suggests that Block B should not be used for agricultural activities, as the total hectarage required for agricultural activities can be accommodated in Block A and Kernahan.

Specific agricultural projects will not be identified in this report. It is recommended that all farmers submit detailed project proposals for their proposed activities. The NMA can facilitate this process through NGOs or the traditional financial institutions. The following activities to be co-ordinated by the NMA are suggested:

1. Identify areas for agriculture production. Existing areas under agriculture include Kernahan, Cascadoux and Block A. It is recommended that agriculture be restricted to these areas.

2. Select crops according to land and water capabilities. The traditional experiences of farmers in using the flood drying-out period to produce crops should be understood and implemented where feasible.

3. Improve irrigation for agriculture activities, especially rice production.

4. Provide security of tenure to farmers by assigning rights and ownership to present users of the land.

5. Improve soil fertility in accordance with crop requirements and soil type.

6. Minimise the use of pesticides and herbicides. Use toxicology tests to select products which have minimal impacts on the biophysical and human environments.

7. Implement an awareness and public education program for farmers about:

   - The importance of the various habitats to the integrity of Nariva Swamp.
   - The likely effects of agriculture activities on the ecological integrity of the swamp.
   - The roles available to them in achievement of the management plan objectives.
   - The enhancement of relations with the NMA, Forestry and Wildlife Divisions of the MALMR.

The possibility of introducing water buffalo into marsh areas can be explored. They would tend to enhance nutrient levels and increase fertility of the area. Historically, cattle have been reared successfully in the swamp but their presence caused problems with food crop agriculture. If this idea is to be entrained, the water baffalo must not be allowed to roam freely, but should be restricted to specific areas.

Zone 7 Human Habitat and Agriculture

Background: At present, residential communities exist in Kernahan and Cascadoux. Additionally, temporary residential structures have been established in Blocks A and B to facilitate farming. The following recommendations are intended to harmonise human residential issues with the management goal and objectives:

1. Provided roads, water, electricity, telephone and waste disposal facilities. To areas designated for residential communities. Drainage within these communities will be designed to be harmonious with the overall hydrology of the swamp.

2. Provide security of tenure to residents by assigning rights and ownership to present users of the land.

3. Define a buffer zone between residential communities and protected habitats.

4.5.2 STRATEGY 2: IMPLEMENT LAND USE PLAN

Cocal Sandbar

The Cocal Sandbar is a critical element in the sustainability of the wetland and provides a physical barrier to the free loss of water from the area to the sea. In this regard, the integrity of the sandbar must be maintained to ensure the continued existence of the swamp. This can be achieved by stabilization of the sand along the bar by planting suitable species, for example Sea Grape *Coccoloba uvifera*, along the beachfront.

The Manzanilla-Mayaro Road runs along the sandbar and is maintained by the Ministry of Works and Transport, whose portfolio also includes responsibility for coastal protection against erosion. Plans are being formulated by the Ministry to deal with the areas most prone to erosion. The proposed NMA must highlight the need for the Ministry to address this specific problem with urgency. The NSMA should also be consulted on any proposed activity that may compromise the integrity of the physical barrier formed by the sandbar.

Watershed Management

The Nariva Watershed provides water to the Nariva Swamp and is vitally important to the existence of the wetland. Its management therefore cannot be divorced from that of the swamp. The windbelt forest reserves that are located in the watershed are protected areas. Of concern are those areas which are not protected and which lie within the watershed and are either occupied as human habitat or frequented for various uses. The agencies currently responsible for the

management of the Nariva Watershed are the Water Resources Agency and the Forestry Division of the MALMR. Environmental quality guidelines developed by the Environmental Management Agency (EMA) with respect to human habitat and economic activities in this area should be strictly adhered to and enforced. This is to ensure provision of suitable water to the Nariva Swamp. There should be consultation with the NSMA on any activity which may alter the water regime of the area either in quantity or quality.

Saltwater Intrusion

The potential problems of saltwater intrusion into the swamp should be addressed to some extent by refilling the drains excavated by the large-scale rice farmers in Block B and surrounding areas. These drains include a connecting channel between irrigation canals in the rice-growing areas and the Bush Bush Canal. There was also a shunt from the Bois Neuf River used to divert water northwards to augment the supply to the rice paddies during dry season.

The prevention of pumping water from Jagroma Cut during the dry season would serve to restore the groundwater hydrology of the area and would lessen the likelihood of subterranean saltwater intrusion by maintaining a freshwater head.

Saltwater intrusion would thus be limited to the channel of the Nariva River during the dry season. This is acceptable, since this area is used as a habitat and nursery area by juvenile marine fish species as evidenced by the findings of the study.

*****PostScript:** The channels were partially filled by the MALMR subsequent to these recommendations.*

Bush Fires

It must be borne in mind that during the period of the study, the dry season was unusually dry, a reflection of the El Niño weather phenomenon. This, coupled with the changes in the swamp's hydrology brought about by the activities of the large-scale rice farmers, provided ideal conditions for fires.

The restoration of the surface hydrology and the presence of a watersheet over the marsh areas would render conditions adverse to

fires. These, together with an approach of participatory management by the users of the swamp, would provide a good measure of control of fires in the swamp. These users should be aware of the implication of uncontrolled fires on the ecology of the swamp. Through training programs, they should also be made aware of plans and systems for dealing with uncontrolled fires and their respective roles in getting such fires under control.

Contingency measures must be put in place in case of emergencies. It is suggested that the NSMA could become part of existing plans for coping with disasters, in particular uncontrolled fires in southeast Trinidad. This would involve discussions with the private sector companies with fire-fighting capabilities to deal with such emergencies.

Marketing the Zonation Plan

It is important that the Zonation Plan be marketed to all stakeholders to secure their commitment to its effective implementation. The following actions are recommended to achieve this:

Actions:

1. Make public announcements regarding the importance of the land-use plan.
2. Encourage the co-operation of concerned local residents, government agencies and NGOs in the implementation of the land-use plan.

4.5.3 STRATEGY 3: MINIMISE POLLUTION OF WATERWAYS

The following actions are intended to detect and negate activities which result in intolerable pollution of the waterways:

Actions:

1. Design, cost, obtain approval for and implement a pollution monitoring and control program for the waterways to maintain predefined water quality standards.
2. Inform users (farmers, fishermen, tourists, etc.) about the objectives and their respective roles in maintaining water quality of an acceptable standard.

4.5.4 STRATEGY 4: CONDUCT A SERIES OF MEETINGS, SEMINARS AND STUDY TOURS, TO IMPROVE STAKEHOLDER APPRECIATION OF THE MANAGEMENT OF THE SWAMP AND SOCIO-ECONOMIC ACTIVITIES WITHIN THE AREA

Strategies 4 and 5 are intended to co-ordinate all activities aimed at improving public appreciation for Nariva Swamp. Public awareness and education projects identified earlier should be co-ordinated under this strategy. However, these projects should be evaluated under their respective strategies as well, to ensure these objectives are achieved. The following actions are meant to supplement projects identified earlier.

Actions:

1. Conduct meetings and seminars in communities in and around Nariva Swamp to disseminate information on management of the swamp and socio-economic activities within the area.
2. Facilitate seminars organised by local residents for better information dissemination and knowledge transfer.
3. Conduct study tours for local residents to visit protected and utilised areas to facilitate understanding of swamp ecology and related socio-economic activities. Identify beneficial and negative impacts to swamp ecology and humans.
4. Evaluate and assess the meetings and seminars for effectiveness in disseminating and transferring of information and knowledge.

4.5.5 STRATEGY 5: CONDUCT A SERIES OF TELEVISION AND RADIO PROGRAMS IN CO-OPERATION WITH LOCAL AND NATIONAL MEDIA TO IMPROVE PUBLIC APPRECIATION OF THE MANAGEMENT OF THE SWAMP AND SOCIO-ECONOMIC ACTIVITIES WITHIN THE AREA

Actions:

1. Co-ordinate the development of environmental information.

2. Produce a series of television and radio programs identifying the benefits of the Nariva Swamp to the ecology of Trinidad and of management of human and natural activities to ensure that the swamp's integrity is maintained.

3. Ensure that these programs are broadcast on a regular basis.

4. Evaluate and assess these broadcasts for effectiveness in disseminating and transferring the related information and knowledge.

4.5.6 STRATEGY 6: ENCOURAGE AND FACILITATE THE DEVELOPMENT OF LOCALLY OWNED AND CONTROLLED SMALL-SCALE ECOTOURISM INDUSTRY

Ecotourism is recommended as one of the permitted activities which can provide value from accessing Nariva Swamp resources. It is recommended that the NMA facilitate the development of community organisation to achieve this objective. The following actions are recommended:

Actions:

1. Identify individuals from the local communities who are knowledgeable about the swamp.

2. Organise seminars and training opportunities for prospective tour guides in specific areas.

3. Facilitate advertisement of locally available tour guides to target groups and individuals.

4. Educate local communities about the value of the swamp to them as tour guides.

Project: **Design and Implement a Program to Train and Certify Tour Guides.**

Background: The eco-tours to Nariva Swamp take place regularly but with very little input from agencies concerned with the swamp's resources. Local residents are not generally used to conduct tours. Their knowledge, skills and advantages conveyed by their proximity are thus lost, as is the potential to develop an

alternative to currently unsustainable resource-use practices. Tour guides presently access training from external agencies such as the Small Business Development Corporation.

Objectives: This one-year project has the following objectives and benefits:

- Provision of skills to support alternative resource base projects.
- Promotion of the need for preservation of the ecological character and integrity of the swamp.
- Greater control and regulation of tour impacts.

Description: The eco-tours should be conducted using local residents and others who are qualified under this program. This would help to ensure that correct knowledge is imparted and the best practice of tour entry and observation of the swamp's ecology is followed.

Funding for this project is expected to come from donor agencies.

Phasing of Activities:

Assess training and skills needs for existing tour companies.

1. Assess existing training programs to determine their levels of compatibility with the goals of the park, their ability to provide the necessary training and skills, their size, strengths and weaknesses.
2. Where existing programs are deemed both successful and suitable, develop a park certification program for graduates and an advanced training course for the trainers.
3. Where existing programs are unsuitable or undersized, develop a park-run training and certification program based on the assessment of existing programs and training needs.
4. Create a detailed workplan, budget, working area, manpower and time schedules.
5. Implement all activities.
6. Design and implement a monitoring program.

Agencies and Administration:

The lead agency should be the Forestry and Wildlife Divisions of MALMR. Community/Resource User groups, NGOs and existing tour companies will act as advisors and monitoring agents, and will inform and follow up the action plan.

Budget: The budget is calculated at the rate of TT$135,000.

4.5.7 STRATEGY 7: FORMULATE AND PUBLICISE ACCEPTABLE CODES OF CONDUCT FOR TOURISTS

The implementation of this strategy is presented in a project format:

Project 1: Design and Implement a Public Awareness Program for Stakeholders

Background: Stakeholders (farmers, fishermen, hunters, residents, etc.) have little formal knowledge about the ecology of Nariva Swamp and its importance to the biophysical and human environments. The exceptions are a few scientific researchers, government officers and officials from some non-government organisations. Commitment and participation of stakeholders is a prerequisite for successful implementation of a management plan and achievement of the plan's goal.

Objectives: Design and implement an awareness and public education program for residents in surrounding communities, present and future resource users, and resource managers. This one-year program should identify:

- The importance of the various vegetative types to the integrity of Nariva swamp.
- The roles available to stakeholders in achievement of the management objectives.
- Enhance relations with the Nariva Management Agency, Forestry and Wildlife Divisions of the MALMR.

Description: Public relations and public education consultants will design and test the implementation of the awareness and education program. A team of advisors from local communities, Forestry

and Wildlife Divisions of the MALMR, UWI, IMA and NGOs will guide these consultants.

Funding for this project is expected to come from donor agencies and government agencies.

Phasing of Activities:

1. Set clear objectives for the public awareness and education program:
    - Target audience.
    - Messages to be communicated.
    - Methods to be used to communicate these messages.
    - Identify persons to present the program.
    - Methods to monitor and evaluate the success or shortcomings of the program.
2. Create a detailed workplan, budget, working area, manpower and time schedules.
3. Design the public awareness and education program.
4. Test the program.
5 Train persons to implement the program.
6. Design and implement a monitoring program.
7. Implement program activities.
8. Evaluate the program and incorporate recommendations.

Agencies and Administration:

The lead agency should be the Information Division. Forestry and Wildlife Divisions of MALMR, Community/Resource User Groups, IMA, NGOs and UWI will act as advisors and follow up the action plan.

Budget: The budget is calculated to be approximately TT$510,000.

Project 2: Design and Implement a Program to Police Areas towards stated objectives.

Background: Traditionally, there have been a number of activities which have been detrimental to the ecological integrity of the Nariva Swamp. These include agricultural activities such as large-scale rice farming and short crop production, squatting, marijuana cultivation and other illegal activities. These and other activities have resulted in the alteration of extensive areas of vegetation in the swamp. Further, because of the increased number of resource users and uses, it has become necessary to police areas of the Nariva Swamp towards the stated objectives.

Objectives: This two-year project has the following objectives and benefits:

- Discourage the over-exploitation and inappropriate utilisation of resources.
- Encourage the wise use of resources according to the zone management plans.
- Minimise policing costs by using existing and indigenous knowledge and concern for the resources of the swamp.
- Monitor the implementation of the zone management plans.

Description: Activities that utilise the resources of the swamp will be checked and monitored regularly to ensure that they are in accordance with the wise use of the resource and are not prohibited activities. In the latter case, action will be brought against the perpetrator. The severity of the penalties enforced will vary according to criteria such as the number of prior offences and the level and extent of inappropriate resource use.

Funding for this project is expected to come from donor agencies.

Phasing of Activities:

1. Clearly identify permissible activities for the designated areas.

2. Design a system of fines and penalties for resource offences in conjunction with the impacted communities and other interested stakeholders.

3. Build on the proximity of the communities and their familiarity with the swamp by expanding the honorary game warden program in terms of numbers recruited from impacted communities and the levels of remuneration.

4. Rationalise and co-ordinate the surveillance and policing programs, both government and non-government, carried out in the Nariva Swamp. This would include field programs that involve forestry officers, game wardens and honorary game wardens.

5. Create a detailed workplan, budget, manpower and time schedules.

6. Implement all activities.

7. Design and implement a monitoring program.

Agencies and Administration:

The lead agency should be the Forestry and Wildlife Divisions of MALMR. Community/Resource User groups and NGOs will act as advisors and monitoring agents, and will follow up and inform the action plan.

Budget: The budget is calculated at the rate of TT$900,900.

5.0 REGULATORY AND ADMINISTRATIVE FRAMEWORK FOR THE NARIVA MANAGEMENT AGENCY

The recommended legal and institutional framework for the Nariva Management Agency are being put forward with a view to eliminating the difficulties and problems that arose as a result of the inadequacies of the existing framework (Figure 5.1). It is intended that the ambiguities and vagueness of the past which caused duplication of efforts, usurpation of functions and other such discrepancies, resulting in weak or no enforcement, would be conquered. The framework is designed to facilitate the overall objectives of the plan. The design (Figure 5.2) includes:

- an institution responsible and accountable for achieving management objectives;
- a suitable decision-making process;
- participation of relevant parties.

Technical measures and strategies include the gathering of information necessary to design solutions that would enable mutual cooperation and assistance between stakeholders. On the issue of enforcement, the following activities are mandatory:

- the gathering of information on failures to implement;
- initiation of progressive dispute settlement, adhering to the overall objectives of the plan;
- ultimate implementation by punitive measures.

Based on the review of the advisory reports, policies, plans, laws, regulations and other instruments pertinent to management of wetlands in Trinidad and Tobago, particularly the Nariva Swamp, and of the policies, plans, laws and regulations and other instruments used by other countries for the management of their wetlands, as well as the findings of other components of this project, the following recommendations are outlined for the management of the Nariva Swamp.

1. The policy related to the management of the Nariva Swamp should be clearly stated so as to leave no doubt as to which activities should be undertaken and the manner in which they should be carried out. The recently drafted National Wetland Policy should be adopted officially and

FIGURE 5.1: EXISTING INSTITUTIONAL AND ADMINISTRATIVE FRAMEWORK FOR NARIVA SWAMP

FIGURE 5.2: PROPOSED INSTITUTIONAL AND ADMINISTRATIVE FRAMEWORK FOR NARIVA MANAGEMENT AGENCY

all activities undertaken in Nariva should be in keeping with that policy. Mechanisms should be put in place to ensure that this policy is properly implemented with respect to the Nariva Swamp, thus ensuring its wise use and the conservation of its rich biodiversity in accordance with the Ramsar, CBD and other relevant Conventions.

2. Legislation should be enacted to implement this National Wetland Policy. It is therefore recommended that the new *National Parks and Other Protected Areas Bill* (1998) and the *Conservation of Wildlife Bill* (1998) be made law as soon as possible. These two Bills contain the necessary provisions that would assist in the protection of Nariva and other protected areas. They not only seek to protect the species of plants and animals, but also their habitats. They have as their basis wise use and sustainable management, as required by the National Wetland Policy and International Conventions to which Trinidad and Tobago is a Party. Additionally, the establishment of a National Parks and Wildlife Authority as the implementing agency under both Bills should solve the problems of jurisdictional conflicts which resulted in the inadequate enforcement of the State Lands Act, the Forests Act and the Conservation of Wildlife Act.

3. The National Parks and Wildlife Authority to be established under Sec. 3 of the National Parks and Other Protected Areas Bill is the body responsible for managing the Nariva Swamp Protected Area, so designated under Sec. 19 of the Bill and described in the Second Schedule of the Bill. It should appoint a body, the NMA, pursuant to Sec. 5(2), which shall be responsible for implementing the Nariva Swamp Protected Area Management Plan (NSPAMP) for the management of the Nariva Swamp Protected Area. The National Parks and Wildlife Authority should appoint a Park Manager who would head this Agency.

4. A Consultative Committee, comprising the stakeholders of the Nariva Swamp Protected Area should be appointed. The Park Manager should take into consideration the views of this Consultative Committee in the implementation of the NSPAMP.

   The Consultative Committee should include the Park Manager and representatives of:

   - The Forestry Division
   - NGOs - Pointe-à-Pierre Wildfowl Trust

- Village Councils in the Nariva Area
- Fishermen
- Small-scale Rice Farmers/Short-crop Farmers
- Research Institutions
- Eco-tourism Operations

5. The Nariva Management Agency should be charged with the responsibility of monitoring and managing all activities in the Nariva Swamp Protected Area in accordance with the NSPAMP.

6. The Nariva Management Agency shall ensure that no operation or activity is undertaken by any person in the Nariva Swamp Protected Area unless that operation or activity is in accordance with the NSPAMP.

7. The NSPAMP must not derogate from the National Parks and Other Protected Areas Bill, the new Conservation of Wildlife Bill, the Environmental Management Act or any other enactment relating to environmental planning affairs or any general policy statement issued under this Act. In addition, it must not affect any existing agreement or arrangement entered into between the National Parks and Wildlife Authority and any landowner.

8. The Nariva Management Agency should be guided by the dictates of the National Wetlands Committee in its management of the Nariva Swamp Protected Area.

   This Nariva Management Agency should comprise:

   - A Park Manager and the Consultative Committee
   - Public Education Officers
   - Patrol Officers/Park Rangers
   - Such other personnel as may be required

9. The Nariva Swamp Protected Area should be afforded additional protection by having it declared an "environmentally sensitive area" and the species therein "environmentally sensitive species" under the EM Act. The NMA would then have to ensure that any rules and regulations developed for environmentally sensitive areas or species would be applicable to the Nariva Swamp Protected Area.

10. The Nariva Management Agency shall ensure that all rules and regulations made for the proper management of the Nariva Swamp Protected Area are properly implemented and enforced.

11. In particular the Nariva Management Agency shall ensure that:

    a. EIAs are carried out for all activities to be conducted in the Nariva Swamp Protected Area.

    b. Traditional activities of local communities in the Nariva area, particularly those which are deemed to be not harmful to the Protected Area, are recognised and given due consideration

    c. Programs are developed to promote public awareness and education so as to enable meaningful public participation in all matters related to the management of the Nariva Swamp Protected Area

    d. Information pertinent to management of the Nariva Swamp Protected area is disseminated

    e. The public is notified of development plans for the Nariva Swamp Protected Area

    f. Scientific research is undertaken in the Nariva Swamp Protected Area

    g. There is an exchange of information on matters related to the Management of the Nariva Swamp Protected Area among itself and other authorities locally, regionally and internationally

    h. Residents of local communities and other interested parties are trained so as to enable them to assist and participate in the management of the Nariva Swamp Protected Area

12. In addition, the following regulations should be made by the Minister on the advice of the National Parks and Wildlife Authority and implemented and enforced by the NMA:

    a. No person shall pollute or cause to be polluted any water, stream, well, dam, reservoir or watercourse entering into or in the Nariva Swamp Protected Area

    b. No person shall occupy and use any land in the Nariva Swamp Protected Area without permission for cultivation or other purpose

c. No person shall take, destroy, wilfully injure, disturb or interfere in any manner any protected animals or nest egg of any animal in the Nariva Swamp Protected Area without written permission from the NMA.

d. No person shall carry out any formal research or collect any object, specimen, plant or animal life in the Nariva Swamp Protected Area without written permission from the NMA.

e. No person shall hunt in the Nariva Swamp Protected Area without written permission from the NMA.

f. No person shall light, use or maintain fire other than that used for domestic purposes in an area designed for that purpose in the Nariva Swamp Protected Area without written permission from the NMA.

g. No person shall carry out any operational mining, boring or extraction in the Nariva Swamp Protected Area without written permission from the NMA.

h. No person shall discharge or have in his possession in the Nariva Swamp Protected Area any air rifle or other firearm, spring gun, sling, bang stick, spear gun, harpoon or other weapon, which is potentially harmful to the wildlife or structure of the Nariva Swamp Protected Area.

i. No person shall in the Nariva Swamp Protected Area:

- park a conveyance in any place other than a place designated for that purpose;
- park a conveyance in such a manner as to obstruct or cause danger to other persons; or
- abandon a conveyance or leave it in a position, condition or in such circumstances so that it appears to be abandoned.

Conveyance has the meaning given it in the National Parks and Other Protected Areas Bill and a conveyance shall be deemed abandoned if it is left unattended for a period of forty eight hours or more.

The penalties for committing these offences should be in accordance with the National Parks and Other Protected Areas Bill and the Conservation of Wildlife Bill.

Figure 5.1 demonstrates the existing institutional and administrative framework. While this particular chart may seem clear in the delineation of responsibility, its simplicity is deceptive. The Forestry Division of the MALMR exercised responsibility *inter alia* for the present Wildlife Section, National Parks Section, State Lands Section, and Land and Surveys Division. Such a vast array of responsibility inevitably led to jurisdictional uncertainty within and amongst these departments. These issues came to light in the *Jabar Case* and ultimately led to the expulsion of the rice farmers from the swamp. The Lands and Surveys Division has since been moved to the Ministry of Housing and Settlement. Recognizing the importance of the proper delineation of responsibility, the proposed institutional and administrative framework is represented in Figure 5.2.

Figure 5.2 adopts the proposed National Parks and Wildlife Authority as the primary agency with overall responsibility for the implementation of the management plan. The NMA will report to this authority that is ultimately answerable to the Minister. Comprising the NMA is the Park Manager, the Consultative Committee, Patrol Officers (which may include game wardens), Education Officers, other officials of Government and representatives of interest groups. The framework therefore suggests an institution responsible for management, a suitable decision-making process and the participation of relevant parties.

6.0 IMPACTS OF NARIVA MANAGEMENT PLAN

6.1 ENVIRONMENTAL QUALITY

Management of human activities and natural processes within the swamp towards the goal of sustaining its ecological integrity will have significant positive impacts on the biophysical environment.

The declaration and maintenance of recommended protection zones will reduce the habitat areas of the swamp available for exploitation and therefore subjected to stress.

The rehabilitation of fire burnt areas, Block C and areas of Block B to pre-rice farming hydrology and vegetation should contribute to the gradual re-establishment of flora and faunal habitats.

Selected economic activities must be in harmony with environmental objectives. These activities must be monitored for the duration of their project lifetime to minimise negative impacts on the biophysical environments.

It is important that the NMA monitor activities within the watershed to influence the quantity and quality of waters entering the swamp.

Additionally, monitoring of coastal processes on the East Coast is essential to ensure the continued integrity of the impounding sandbar.

6.2 RESOURCE EXPLOITATION

Proper management of the swamp resources will allow for sustained use of these resources and increase the returns from such use.

In some cases, for example fisheries, the plan will facilitate increased and healthier stocks, as well as increased production for consumption.

In other cases, for example palm forests, the plan calls for reduction in exploitation levels and accessible areas.

It is expected that in the medium to long term (5-10 years), these actions will result in increased production from smaller areas of the swamp. Additionally, it is expected that through research and rehabilitation of areas, production opportunities harmonious with sustaining the swamp's ecology will increase.

The recommended aquaculture activities require a water management plan. This plan must ensure that the hydrology is restored to its natural state. It may

also make provisions for monitoring the quality of water entering the marshes from this activity.

The expansion of eco-tourism activities requires adherence to a code of conduct aimed at providing continued enjoyment of the swamp's resources. Persons should avoid activities that may have long term effects on behavioural patterns, composition of flora and eminent communities.

6.3 SOCIO-ECONOMIC IMPACTS

Management of the swamp's resources is expected to lead to positive socio-economic impacts, especially in the medium to long term.

The termination of commercial rice growing activities should stop the conflict among large-scale rice farmers and between large-scale rice farming and other stakeholders. The Government however will have to deal with the negative impacts of this decision on the large-scale rice farmers.

- The provision of land tenure for plots in Block A and Kernahan will provide farmers from the surrounding communities with security of tenure for their properties. This has generally led to improved land-use when implemented in other communities. Improved land and water uses are a necessary pre-requisite for increased productivity from the land.

- The switch from rice farming to the crops identified in the recommended option: watermelon, cucumbers and bodi will result in increases in financial returns per hectare. These crops will require less water per hectare compared to rice during the dry season. Additionally, they will employ more community personnel than rice production. This, along with spin-off indirect benefits, will serve to increase distribution of benefits from use of the swamp's resources, community cohesion and sustainability.

- Stakeholders from the communities will be involved in a co-management approach to the planning and management of the swamp. This would allow for local and traditional knowledge and expertise to be utilised in its management. It also serves to highlight the vested interests which the community has in achieving the objectives to the plan.

- Increased publicity of issues should increase the political will and lobbying power of the residents of the area in their efforts to improve the conditions under which they live. Improved health and education facilities and amenities such as water, electricity and telephone should be forthcoming.

With improved infrastructure and increased people-participation in conservation efforts in the swamp, there would be a shift away from direct dependence on the resources of the swamp as the sole source of income. Interests of younger residents will be stimulated in fields such as eco-tourism and scientific research.

The objectives of the plan may be met with adversity initially, as its role imposes tighter regulations on uses of resources from the swamp. Consequently, the Nariva Management Agency has to ensure that its policies and regulations are in accordance with the needs of the local population. The proposed consultative committee should include personnel trained in environmental management and socio-economics. This should ensure that management decisions are made with some foresight on future implications and impacts.

The NMA should have well-established protocols for the stakeholders to bring any concern, grievance or suggestion that they may have to the attention of the agency for consideration. This may facilitate the integration of the interests of the stakeholders. This promotes a holistic approach to solving problems relating to resource use.

6.4 INSTITUTIONAL AND ORGANISATIONAL IMPACTS

Enactment of the suggestions made for the new National Parks and Other Protected Areas Bill (1998) and the Conservation of Wildlife Bill (1998) would provide for the protection of the swamp, its organisms and their habitats. Recommendations have been made for an institutional and administrative framework for implementation of the plan.

It is anticipated that the establishment of the National Parks and Wildlife Authority may solve the jurisdictional conflicts that occurred in implementation of the *State Lands Act, Forests Act* and *Conservation of Wildlife Act.*

6.5 FINANCIAL IMPACTS

The cost of implementing this plan can be categorised as:

- Cost associated with the establishment and operation of the NMA.
- Cost associated with the design of projects.
- Cost associated with implementation of approved projects

- Cost associated with monitoring activities and environments.

It is recommended that Government be responsible for co-ordinating the establishment of the NMA. It is further assumed that existing allocations within various Government Units for activities in Nariva Swamp will be reallocated to the NMA. The new expenditure items will relate to funding the Park Manager and Administrative Secretary positions, and appropriate office accommodation. The education and patrol officers will be seconded from existing units with responsibility for Nariva. In the initial period, these will be supplemented by stakeholder assistance funded from external sources. It is expected that by the third year of the plan, fees will contribute significantly to financing the NMA's recurrent budget. A suggested budget for establishment and annual operation of the NMA is included in Appendix.

Design/development of projects related to rehabilitation and enhancement of environments to recommended status should be funded by Government and grants from local or foreign sources. Education and awareness for target groups should also be funded from similar sources. Investors should fund projects aimed at providing financial and economic returns. This funding could be through personal funds, loans or grants. Implementation of approved projects will be funded through a similar approach.

It is expected that the NMA will fund all activities related to monitoring activities or environments. For economic activities, investors are expected to fund monitoring activities associated with their investments.

7.0 MANAGEMENT PLAN EVALUATION AND REVISION

The effectiveness of the Management Plan must be reviewed and evaluated periodically to allow management objectives to be relevant to the changing environment. It is recommended that this plan be reviewed during the first six months of the fifth year of implementation. Annual plans and reviews will supplement this five-year review.

71. RESPONSIBILITY

The MALMR and the Nariva Management Agency should be responsible for the evaluation of this and subsequent management plans and budgets. The Nariva Management Agency should also be responsible for the annual reviews and subsequent annual plans.

7.2 REVIEW, AMENDMENT AND SCHEDULE

The Manager of the NMA will submit reports to the National Parks and Wildlife Authority. The review should account for the achievement of stated objectives and targets, and relate these to achievement of the Plan Goal.

The annual review should take place in the tenth month of the operational plan. It should identify successes of the current plan and the reasons for these achievements. It should also identify limitations of the current plan and reasons for non-achievement. The review should suggest approaches to improve implementation and achievement of objectives for the next plan.

The annual plan should be completed and approved in the eleventh month of the operational plan. Preparations for plan implementation (implementation strategies and resource acquisitions) should be made during the succeeding month of the operational plan.

The five-year review and evaluation should begin in the fourth month of the fifth year of this plan. The review should suggest approaches to improve implementation and achievement of the goals and objectives for the next plan. It is recommended that a two-stage public consultation process be part of this review. Stage one will be a review of the existing plan and receive suggestions for the proposed plan. Stage two will review the proposed plan. These consultations should be organised by the NMA.

The National Parks and Wildlife Authority is responsible for final approval of subsequent plans. This approval should be granted by the ninth month of the

fifth year. This would allow for integration of the new five-year plan with the annual planning process.

8.0 SCHEDULE OF ACTIVITIES

IMPLEMENTATION SCHEDULE FOR NARIVA MANAGEMENT PLAN

ACTIVITIES	Year 1	Year 2	Year 3	Year 4	Year 5
Establishment of Nariva Management Agency					
Project: Adoption and implementation of National Wetland Policy					
Enactment of the National Parks and Other Protected Areas Bill (1998) and the Conservation of Wildlife Bill (1998).					
Establishment of the National Parks and Wildlife Authority.					
Establishment of the Nariva Management Agency (NMA).					
Allocation of Funds for the Functioning of the NMA.					
Appointment of a Park Manager.					
Appointment of Persons to the Consultative Committee.					
Appointment/Secondment of staff to the NMA.					
Provision of Office and Office Equipment for NMA.					
Securing Funds for the Implementation of Projects.					
Design and Implement Land - Use Zonation Scheme					
Project: Rehabilitation of Vegetation					
Public education exercise.					
Devise framework for restoration.					
Set up and maintain community restoration units.					
Design and implement a monitoring program.					
Project: Characterise Ecology of Selected Areas					
Identify research objectives.					
Prepare research proposal.					
Secure project funding.					
Select research team.					
Conduct research.					
Report findings.					
Design and implement a monitoring program.					
Project: Determine Allowable Fishing Effort for the Cascadura Fishery					
Characterise existing fishing effort.					
Estimate existing populations.					
Determine market sizes.					
Determine and establish acceptable fishing methods.					
Recommend and update existing fish management policies.					
Estabish and maintain a hatchery.					

IMPLEMENTATION SCHEDULE FOR NARIVA MANAGEMENT PLAN

ACTIVITIES	Year 1	Year 2	Year 3	Year 4	Year 5
Design and Implement Land - Use Zonation Scheme (cont'd) Project: Subsistence/Semi-intensive Culture of Cascadura and Conch					
Determine areas for culturing species.					
Design and implement public education and training programmes.					
Design framework for implementation of aquaculture policy.					
Request project proposals from prospective farmers.					
Select and facilitate implementation of projects.					
Encourage research to support economic and financially viable production of these and other acceptable species.					
Project: Enhance Agriculture Production					
Determine areas for agriculture.					
Design and implement public education and training programmes.					
Design framework for implementation of agriculture policy.					
Request project proposals from prospective farmers.					
Select and facilitate implementation of projects.					
Encourage research to support economic and financially viable production of acceptable crops and practices.					
Project: Enhance Human Habitat Areas					
Determine areas for human habitat.					
Design and implement public education and training programmes.					
Design framework for implementation of human habitat policy.					
Request project proposals from prospective residents.					
Select and facilitate implementation of residential projects.					
Facilitate the provision of adequate infrastructure and services.					
Project: Protection of Cocal Sandbar					
Stabilisation of soils through plants eg. Sea Grape.					
Secure collaboration with Ministry of Works and Transport to maintain coastal protection against natural forces.					
Establish systems to ensure consultation with any organisation or individual involved in activities which will impact on the integrity of this sandbar.					

IMPLEMENTATION SCHEDULE FOR NARIVA MANAGEMENT PLAN

ACTIVITIES	Year 1	Year 2	Year 3	Year 4	Year 5
Design and Implement Land - Use Zonation Scheme (cont'd) Project: Management of Nariva Watershed					
Secure collaboration with Forestry Division, Water Resources Agency and The Environmental Management Agency to ensure continued and adequate supply of quality water from this watershed.					
Establish systems to ensure consultation with any organisation or individual involved in activities which will impact on the integrity of this supply of water.					
Project: Minimise Saltwater Intrusion					
Re-establish topography and drainage system to pre-1985 conditions.					
Secure collaboration with MALMR and Ministry of Works and Transport to maintain hydrology.					
Establish systems to provide approval based on consultation with any organisation or individual involved in activities which will impact on the integrity of this hydrological system.					
Project: Minimise Bush Fires					
Re-establish topography and drainage system to pre-1985 conditions.					
Secure collaboration with MALMR and Ministry of Works and Transport to maintain hydrology.					
Establish and maintain systems to secure stakeholder/community participation in fire prevention and extinguishing uncontrolled fires. This includes participation in existing plans for fire-fighting in south east Trinidad.					
Design and conduct training programmes for communities.					
Project: Market the Zonation Plan					
Secure collaboration with all related community personnel, Government Organisations, and Non-Government groups in implementation of the landuse and zonation plans.					
Design and implement public awareness and training programmes to assist in securing this collaboration.					

IMPLEMENTATION SCHEDULE FOR NARIVA MANAGEMENT PLAN

ACTIVITIES	Year 1	Year 2	Year 3	Year 4	Year 5
Minimise Pollution of Waterways					
Project: Establish Water Quality Standards for Water Entering, Remaining and Exiting the Swamp.					
Project: Design and Implement a Water Monitoring Programme. This plan will vary based on the location of approved activities.					
Improve Public Appreciation for Nariva Swamp, its Management Objectives and Strategies					
Coordinate the development of information packages.					
Select appropriate media to communicate information.					
Communicate information to various target groups.					
Review information strategy and modify where necessary.					
Encourage and Facilitate the Development of Community-owned or Controlled, Ecotourism Industry					
Identify groups or individuals from surrounding communities to receive training in various aspects of ecotourism in Nariva Swamp.					
Coordinate the delivery of training to interested or selected groups.					
Facilitate promotion of community tour operations and guides.					
Formulate and Implement Acceptable Codes of Conduct for Visitors					
Review of Management Plan					

9.0 REFERENCES

Alleng, Gerard, P. 1996. The Integration of Remote Sensing Imagery with GPS Data, for the Purpose of Improving the Demarcation of Boundaries within the Nariva Wetland, Trinidad and Tobago, Final Report, The Pan-American Health Organisation (PAHO).

Alleng, Gerard, P. 1997. Coastal Wetlands in Trinidad and Tobago - Status and Trends, Institute of Marine Affairs.

AGRISTUDIO. 1991. (Hydrology) Feasibility Study for Rehabilitation of the Plum Mitan Rice Scheme. Annex N1 - Detailed Pedological Study. 27pp.

AGRISTUDIO. 1992. (Hydrology). Reconnaissance Study - Final Report. Feasibility Study for the Rehabilitation of Plum Mitan Rice Scheme. 66pp.

Bacon P. R. *et al*. 1979. Studies on the Biological Resources of Nariva Swamp, Trinidad. Occasional papers No. 4. Department of Zoology, U.W.I., St. Augustine. 455pp.

Barr K. H. 1981. Geological Outline. In: Cooper St. G. C. and Bacon P. R. (eds.). The Natural Resources of Trinidad and Tobago. Edward Arnold, 233pp.

Berridge C. E. 1981. "Climate ". In: Cooper St. G. C. and Bacon P. R. (eds.). The Natural Resources of Trinidad and Tobago. Edward Arnold, 233pp.

Black J. A. 1977. (Water and Sediment). Water Pollution Technology. Reston Publishing, 260pp.

Churchman, C. W. 1979. The Systems Approach. Dell Publishing, New York.

Cropper, A. 1994. Perspectives on Sustainable Development Planning for Development in the Caribbean. Implication for Research and Training D. Pantin and A. Mohammed (ed) Workshop Proceedings, Port of Spain.

de Souza, G. and Gabbadon P. 1992. Cascadura Farming from Hatchery to Production. 1992. Institute of Marine Affairs Aquaculture Series - 2. Institute of Marine Affairs, Trinidad. 27p.

de Souza G and Gabbadon, P. 1991. Fingerling Production of the Cascadura *Hoplosternum littorale* Hancock 1828. IMA Technical Working Paper, Institute of Marine Affairs, Trinidad. 10p.

de Souza G and Gabbadon, P. 1989. Feeding Studies of Cascadura Fry *Hoplosternum littorale* Hancock 1828 Under Experimental Conditions. IMA Research Report, Institute of Marine Affairs, Trinidad. 14p.

FAO Mission. 1985. Aquaculture potential in the Nariva Swamp, Trinidad, WI. Report on an FAO Mission conducted in March, 1985. 49pp.

Gabbadon, P. and de Souza G. 1985. The Freshwater Conch *Pomacea urceus* (Muller) as a Potential Culture Species for Trinidad and Tobago. In Proc. 38th Annual Gulf and Caribbean Fisheries Institute.

Government of Trinidad and Tobago. Exploratory Well Files, Cascadoux #1 Dominion Oil Limited, Ministry of Energy and Energy-based Industries.

Government of Trinidad and Tobago. Exploratory Well Files, Tampa #1, Dominion Oil Limited, Ministry of Energy ad Energy-based Industries.

Institute of Marine Affairs (IMA). 1998. Environmental Impact Assessment of the Nariva Swamp (Biche Bois Neuf Area) - 2nd Progress Report, Ministry of Agriculture, Land and Marine Resources, February, 1998.

Institute of Marine Affairs (IMA). 1998. Environmental Impact Assessment of the Nariva Swamp (Biche Bois Neuf Area) - Final Report, Ministry of Agriculture, Land and Marine Resources, July/October, 1998.

Institute of Marine Affairs (IMA). 1998. Legislative Control - Technical Report for the Formulation Plan of the Nariva Swamp, Ministry of Agriculture, Land and Marine Resources, November 1998.

Institute of Marine Affairs (IMA). 1999. Aquatic Fauna - Technical Report for the Formulation Plan of the Nariva Swamp, Ministry of Agriculture, Land and Marine Resources, January 1999.

Institute of Marine Affairs (IMA). 1999. Economic Aspects – Draft Technical Report for the Nariva Management Plan, Ministry of Agriculture, Land and Marine Resources, April 1999.

Institute of Marine Affairs (IMA). 1999. Geology - Technical Report for the Formulation Plan of the Nariva Swamp, Ministry of Agriculture, Land and Marine Resources, January 1999.

Institute of Marine Affairs (IMA). 1999. Wetland Ecology - Technical Report for the Formulation Plan of the Nariva Swamp, Ministry of Agriculture, Land and Marine Resources, March 1999.

Kairi Consultants Limited. 1998. National Parks and Watershed Management Project – Watershed Areas: Development of Watershed Management Plans and Related Studies, Final Report, December 1998.

Kugler, H. 1959. Geological Map of Trinidad. Petroleum Association of Trinidad, Basel Switzerland.

Lum Kong, A. 1986. Aspects of the Biology of the River Conch *Pomacea urceus* (Muller 1774). M.Phil Thesis, University of the West Indies, St. Augustine, Trinidad 162 pp.

NEDECO. 1983a. Phase 1 Investigations on the Development of the Nariva Swamp. Final Report, Vol. 1. Ministry of Agriculture, Lands and Food Production, Port of Spain, Trinidad. 42 pp.

NEDECO. 1983b. Phase 1 Investigations of the Development of the Nariva Swamp. Final Report, Vol. II - Annexes A and B. Ministry of Agriculture, Lands and Food Production, Port of Spain, Trinidad. 114pp.

NEDECO. 1983c. A summary and Review of Previous Studies of the Nariva Swamp, Technical Note #4, NEDECO, Arnhem, The Netherlands.

Overseas Technical Co-operation Agency (OCTA). 1967. Agricultural Development Project for the Nariva Swamp in Trinidad and Tobago – Reconnaissance Report. Overseas Technical Co-operation Agency, Government of Japan. 84 pp.

Paul, A. and Rampersad, M. 1981. A review of the Geology and Hydrocarbon Potential of the Nariva Swamp Area, South Trinidad. Ministry of Energy and Energy-based Industries Internal Report. 13 pp.

Ramcharan, E. K. 1980. Flora History of the Nariva Swamp, Trinidad. Thesis submitted for the Degree of Doctor of Philosophy. Department of Biological Sciences, U.W.I. Trinidad. 135pp.

Russel, E. W. 1966. (Water and Sediment) Soils Conditions and Plant Growth. 9th ed. London: Longman. 687pp.

Suter, H. H. 1960. The General and Economic Geology of Trinidad, B.W.I. 2nd ed, London: HMSO. 145 pp.

Water and Sewerage Authority. 1990. Explanatory Notes, Hydrological Maps of Trinidad and Tobago. Water Resources Agency, Republic of Trinidad and Tobago.

WHO. 1996. (Water and Sediment) Guidelines for Drinking-water Quality. Second edition, Vol 2. 973pp.

APPENDIX I

ESTIMATES OF EXPENDITURE FOR THE PROPOSED INSTITUTIONAL AND ADMINSTRATIVE FRAMEWORK FOR NARIVA MANAGEMENT AGENCY

COST

This section contains an estimate of the costs attached to the establishment of a Management Agency for the Nariva Swamp within the Ministry of Agriculture, Land and Marine Resources. This estimate covers rental of premises, office equipment, furniture, salaries and allowances over a five-year period. All costs are calculated on an annual basis.

OFFICE PREMISES

The recommended option with respect to office premises would be to add another building to the Government office located in the Block A area. An alternative option is to rent office space in the Plum Mitan community. The Property Management Unit (PMU) of the Ministry of Public Administration and Information would be the agency responsible for finding and negotiating for such premises.

The PMU's policy is to pay at the rate of TT$3.00 to TT$3.50 per square foot per month (TT$37.50 per square meter) for office space which it rents. Taking this as a guide, the annual cost of renting office space is estimated to be TT$57,078.00.

TABLE (1): ESTIMATED BREAKDOWN OF COST OF OFFICE SPACE RENTAL

ROOM DESCRIPTION	AREA	COSTINGS
Park Manager's Office	100 sq. ft(9.3 sq. m)	100 sq. ft @ TT$3.50 per sq. ft = $ TT350.00
General Office Space to be divided into cubicles for 8 members of staff	48 sq. ft (4.5 sq. m) per person	384 sq. ft @ TT$3.50 per sq. ft = TT$ 1344.00
Rest rooms (2 toilets and 2 showers)	300 sq. ft (28 sq. m)	300 sq. ft @ TT$3.50 per sq. ft = TT$1,050.00
Reception area (and general space)	150 sq. ft (14 sq. m)	150 sq. ft @ TT$3.50 per sq. ft = TT$525.00
Conference Room	225 sq. ft (21 sq. m)	225 sq. ft @ TT$3.50 per sq. ft = TT$787.50
Kitchenette	200 sq. ft (19 sq. m)	200 sq. ft @ TT$3.50 per sq. ft = TT$ 00.00
TOTAL COST		**TT$4,756.50 * 12 months = TT$57,078.00**

OFFICE EQUIPMENT, FURNITURE, GOODS AND SERVICES

An information system should be established to co-ordinate and facilitate the activities of the NMA. The network should consist of one server with six additional computers, 2 lap top computers, printer and basic software such as Microsoft Office and a statistical package (Table 2). It is expected that other officials and representatives of various interest groups of the NMA will provide their own computer and software capabilities.

TABLE 2: COST OF EQUIPMENT FOR INFORMATION SYSTEM

ITEM	COST ($TT)
Seven computers	84,000.00
Two laptop computers	30,000.00
Power supply	4,000.00
One printer	3,500.00
Software	10,000.00
Upgrade of software	2,500.00
Maintenance (10% of cost)	13,400.00
Total	**147,400.00**

Other office equipment includes desks, filing cabinets, bookcases, chairs, tables, internet services, a facsimile machine, air conditioning and security equipment. In addition, minor equipment, office supplies, kitchen appliances and washroom facilities (Table 3). The furniture branch of the Ministry of Works and Transport should provide furniture. A telephone system with at least 3 direct lines would also be necessary. Goods and services would include consumable items and a wide range of small items used during the course of office work.

Since the NMA would be part of the Public Service, it is envisaged that the procurement of the above-mentioned items will be acquired through the tendering process of the Central Tenders Board.

To determine the level of consumption of goods and services of the NMA, the expenditure detailed in the establishment of the proposed Watershed Management Division (Kairi Consultants Ltd., 1998) was reviewed because size of the organisation is similar. This is estimated at **TT$350,000 per annum.**

Costs estimates for the required furniture and appliances were done on the basis of an average of current market prices.

TABLE 3: COST OF OFFICE EQUIPMENT

ITEM	COST (TT$)
10 Desks	10,000.00
1 Executive chair	1,500.00
19 Junior executive chairs	19,000.00
1 Conference table	5,000.00
4 Bookcases	4,000.00
4 filing cabinets	4,800.00
1 Fax machine	3,000.00
Telephone system	3,500.00
Air conditioning units	21,436.00
Security system	10,925.00
1 Refrigerator	5,000.00
1 Microwave oven	1,500.00
Washroom facilities	6,000.00
Kitchen utensils	2,000.00
Total	**97,661.00**

SALARIES AND ALLOWANCES

All positions of the NMA are Public Service posts, with the exception of security personnel. The annual salaries for core staff of the NMA are estimated at TT$529,824.00 (Table 4). An additional TT$96,768.00 is required for security personnel.

TABLE 4: BREAKDOWN OF SALARIES FOR CORE STAFF

POST	MONTHLY SALARY	ANNUAL SALARY
Park Manager (this post is assumed to be equivalent to that of a Director within the Public Service)	Salary Range 65 TT$7,910.00 (1988 Public Service Salaries)	TT$94, 920.00
Education Officer	TT$4,500.00 * 2	TT$108,000.00
Patrol Officer (this position is assumed to be the equivalent of a Forester IV)	TT$4,000.00 * 6	TT$288,000.00
Clerk Stenographer III (to be Administrative Assistant)	Salary Range 26C TT$3,242.00	TT$38,904.00
Security: 1 Baton Guard/Dog	TT$12.00/hr. x 672 hrs. TT$8,064.00	TT$96,768.00
TOTAL		**TT$626,592.00**

ALLOWANCES AND INCENTIVES

The total allowances granted are travelling and upkeep for all professional staff at an estimated cost of TT$1,000.00 * 9 * 12 = **TT$108, 000.00**

TRAINING

It is assumed that initial training will be provided. This is budgeted at **TT$100,000.00** per year for the first two years.

VEHICLE PURCHASE

Three vehicles will be purchased for field observation and patrols. Exemption of Valued Added Tax and Purchase Tax is expected. Estimated cost is **TT$450,000.00.**

MISCELLANEOUS

The miscellaneous expenditure is estimated at 5% of the estimates, exclusive of salaries and allowances, review and vehicle purchase. The total is **TT$36,000.00** (adjusted to the nearest thousand).

FUNDING

Funding for the implementation of the projects outlined under the Nariva Swamp Management Plan should be vigorously pursued (including external funding) and should be one of the main responsibilities of the Park Manager.

REVIEW

An external review of the activities of the NMA should take place after 5years from its inception. The estimated budget for this is **TT$100,000.00**

SUMMARY

A summary of the cost of operation of the Nariva Management Agency is provided in Table 5 for a five-year period. Operations are expected to cost **TT$6,206,511.00.**

TABLE 5: SUMMARY OF ANNUAL COST OF NATIONAL MANAGEMENT AGENCY OVER A FIVE YEAR PERIOD

ITEM	YEAR					TOTAL
	1	2	3	4	5	
Office Space Rental	$57,078.00	$57,078.00	$57,078.00	$57,078.00	$57,078.00	$285,390.00
Information System Network	147,400.00	10,000.00	0.00	0.00	0.00	157,400.00
Goods and Services	350,000.00	200,000.00	200,000.00	200,000.00	200,000.00	1,150,000.00
Furniture	97,661.00		0.00	0.00	0.00	97,661.00
Training Fund	100,000.00	100,000.00	0.00	0.00	0.00	200,000.00
Salaries	626,592.00	626,592.00	626,592.00	626,592.00	626,592.00	3,132,960.00
Allowances and incentives	108,000.00	108,000.00	108,000.00	108,000.00	108,000.00	540,000.00
Vehicle Purchase	450,000.00	0.00	0.00	0.00	0.00	450,000.00
Review	0.00	0.00	0.00	0.00	100,000.00	100,000.00
Miscellaneous	36,000.00	18,400.00	12,900.00	12,900.00	12,900.00	93,100.00
Total	**$1,972,731.00**	**$1,120,070.00**	**$1,004,570.00**	**$1,004,570.00**	**$1,104,570.00**	**$6,206,511.00**