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HAITI
Country Environmental Profile

A Field Study

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Preface

This Country Environmental Profile (CEP) of Haiti is one of a series of environmental profiles funded by the U.S. Agency for International Development (USAID), Bureau for Latin America and the Caribbean (LAC), Office of Development Resources (DR), and the USAID Mission to Haiti. The scope of work for this in-country field study was developed jointly by James Talbot, USAID Regional Environmental Management Specialist (REMS/CAR) and Robert Wilson, Assistant Agricultural Development Officer, USAID Mission to Haiti.

Marko Ehrlich was contracted as the team leader and specialists were contracted through the International Institute for Environment and Development (IIED) to prepare sector reports during January 1985. Marko Ehrlich prepared the first draft of this synthesis and analysis of status of environment and natural resources in Haiti. James Talbot and Evelyn Wilcox prepared the final draft.

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This Profile Is Dedicated To The Haitian People

Nou nan yon ti bouk pa trò lwen Pòtoprens. Bouk sa-a rele Fonrouj. Li gen yon problèm ki gro anpil: pa gen dlo. Pa gen dlo menm menm. Plant ap mouri, bèt ap mouri. Yon jou se moun ki ka mouri tou. Depi lontan lontan lapli pa tonbe. Tout bagay sèk, tout bagay tris.

Petèt se paske yo te koupe tout piebwa yo, men sa ou vle? Yo te bezwen bwa-a pou fè chabon, pou fè kay, lantiray, mèb. Epi yo te bezwen tè-a tou pou plante mayi, pou plante pwa, pou yo jwenn manje. Si yo pa travay tè-a, yo pap manje.

"Mèt Larouzé", Jacques Roumain (1907 – 1944)

TRANSLATION FROM THE CREOLE:

We are in a small town not too far from Port-au-Prince. This town is called Fond-Rouge. It has a very big problem: There's no water, none at all. Plants and animals are dying: some day, people will die too. It hasn't rained for a long time. Everything is dry, everything is sad.

Maybe it's because they cut all the trees; but what do you want? They needed the wood to make charcoal, to build houses and fences, to make furniture. And then, they needed the land to plant corn and beans, so they can have food. If they don't work the land, they won't eat.

"Masters of the Dew", Jacques Roumain (1907 – 1944).

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List of Acronyms and Abreviations*

AOP	Agroforestry Outreach Project (USAID).
ASSA	Agricultural Services, S.A.
BCA	Bureau de Crédit Agricole
BID	Banque Interaméricaine de Développement
CAMEP	Centrale Autonome Métropolitaine d'Eau Potable.
CARE	Cooperative for American Relief Everywhere.
CEP	Country Environmental Profile (Haiti).
CEPAL	Comision Economica para America Latina.
cm	Centimeters
cm/hr	Centimeters per hour.
CIDA	Canadian Agency for Inernational Development
CONADE	Conseil National de l'Eau.
CONADEP	Conseil National de Développement et de Planification.
CONAELE	Conseil National de l'Environnement et de la Lutte contre l'Erosion.
CRDA	Center for Research and Agricultural Documentation
CIMMYT	Centro Internacional de Mejoramiento de Maize y de Trigo.
DATPE	Direction d'Aménagement du Territoire et Protection de l'Environnement (Ministry of Plan).
DEP	Département d'Education Publique (Ministry of Education)
DHP	Direction de l'Hygiène Publique.
DRI	Développement Rural Intégré
DRN	Direction des Ressources Naturelles (MARNDR)
DSPP	Département de la Santé Publique et de la Population
EDH	Electricité d'Haiti
EIA	Environmental Impact Assessment
ENAOL	Entreprise Nationale des Oléagineux.
FAC	Fonds d'Aide et de Coopération (France)
FAMV	Faculté d'Agronomie et de Médecine Vétérinaire.
FAO	Food and Agricultural Organization of the United Nations.
FSR	Farming Systems Research
FY	Fiscal Year
PIB	Produit Intérieur Brut
GDP	Gross Domestic Product
GJW	G.J. White (Engineering Firm)
GOH	Government of Haiti
ha	Hectares (2.47 acres)
HACHO	Haitian American Community Help Organization
HAMPCO	Haitian American Meat and Produce Company.
HASCO	Haitian American Sugar Company
HAVITAS	Swiss International Cooperation Agency
IBRD	International Bank for Reconstruction and Development Bank
IDB	Interamerican Development Bank
IICA	Instituto Interamericano de Cooperacion para la Agricultura
IHS	Institut Haitien de Statistiques & d'Informatique.
IMF	International Monetary Fund.
INAHCA	Institut National Haitien de la Culture et des Arts.
INAREM	Institut National des Ressources Energétiques et des Mines
ISPAN	Institut de Sauvegarde du Patrimoine National.
IUCN	International Union for the Conservation of Nature and Nautural Resources
KFW	Agency for International Cooperation (Federal Republic of Germany)
km	Kilometers
km²	Square kilometers

LGL	Lalonde, Girouard, Letendre & Associates (Montréal)
l/sec	Liters per second
MARNDR	Ministère de l'Agriculture, des Ressources Naturelles, et du Développement Rural.
masl	Meters above sea level
mc	Cubic meters
mc/sec	Cubic meters per second
mm	Millimeters
m/min	Meters per minute
MEN	Ministère de l'Education Nationale.
MMRE	Ministère des Mines et des Ressources Energétiques
MSL	Marine Systems Laboratory (Smithsonian)
MSPP	Ministère de la Santé Publique et de la Population (formerly DSPP)
MT	Metric ton
NGO	Non-Governmental Organization
NMFS	National Marine Fisheries Service (U.S.A.)
NOAA	National Oceanic and Atmospheric Administration (U.S.A.)
NRC	National Research Council (U.S.A.)
OAS	Organization of American States
ODBFA	Organisme de Développement du Bassin versant du Fleuve de l'Artibonite
ODH	Opération Double Harvest
ODNO	Organisme de Développement de la Plaine de Gonaïves
ODNO	Organisme de Développement du Nord-Ouest.
ODVA	Organisme de Développement de la Vallée de l'Artibonite
ONL	Office National du Logement
OPEC	Organization of Petroleum Exporting Countries
PADF	Pan American Development Foundation
PAHO	Pan American Health Organization
PAP	Port-au-Prince
PDAI	Projet de Développement Agricole Intégré (USAID)
PEN	Section de Protection de l'Environnement (part of DRN)
PLAN	Ministère du Plan
POCHEP	Postes Communitaires d'Hygiène et d'Eau Potable
PROTOS	Project Technische Ontribtilelings Somerverling Development (Belgium)
PVO	Private Voluntary Organization
SEP	Service de Protection de l'Environnement (MARNDR)
SERA	Service d'Etude et de Recherche Agronomique (MARNDR)
SHADA	Société Haitiano-Américaine de Développement Agricole
SMCRS	Service Métropolitain de Collecte des Résidus Solides
SNEM	Service National des Endémies Majeures
SNEP	Service National d'Eau Potable
SPV	Service de Protection Végétale (MARNDR)
TPTC	Ministère des Travaux Publics, Transport, et Communications
UEH	Université d'Etat d'Haiti
UMO	University of Maine-Orono
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNICEF	United Nations Children's Educational Fund
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USOM	United States Overseas Mission (former U.S. Development Assistance Organization
VPI	Virginia Polytechnic Institute and State University
WFP	World Food Program
WHO	World Health Organization
WWF	World Wildlife Fund
YR	Year

* Since the change in government in February 1986, several reorganizations of GOH agencies have taken place. It is not possible to mention all of these changes because many are in progress at the moment. Once the provisional government is replaced by an elected one, a more comprehensive listing of GOH reorganization can be accomplished.

I

Executive Summary

INTRODUCTION

Few countries in the world face a more serious threat to their own survival from environmental catastrophe than Haiti. Overpopulated, its resources are overexploited and trends towards further environmental deterioration are apparent everywhere. The chance for reversing these trends, thereby preventing human suffering, destabilization of the country, and the further loss of development potential is diminishing daily. Much needs to be done, and quickly.

The field study for the country environmental profile of Haiti (HCEP), financed by USAID/Haiti was carried out during the first three weeks of 1985 by a team of six specialists. The purpose of the Haiti Profile is to present in one document information, data and analyses on the country's natural resource base, and highlight environmental problems and trends. Included in the report are syntheses of the relative state of the country's natural resource base, the institutional and legal aspects of environmental issues, and the socio-cultural background of the country as it affects the present state of its physical environment. Not all aspects relating to the state of the environment, such as public health, demography and energy were covered in detail due to time restrictions. A comprehensive institutional and legal sector analysis was also not possible. These may be covered in future additions to this document.

GEOGRAPHY, CLIMATE

The country of Haiti is located in the mountainous western third of the island of Hispaniola, bordered on the north by the Atlantic Ocean, to the west and south by the Caribbean Sea and to the east by the Dominican Republic (DR). Its closest neighbors are Cuba and Jamaica, the United States and the DR. (Figure I-1).

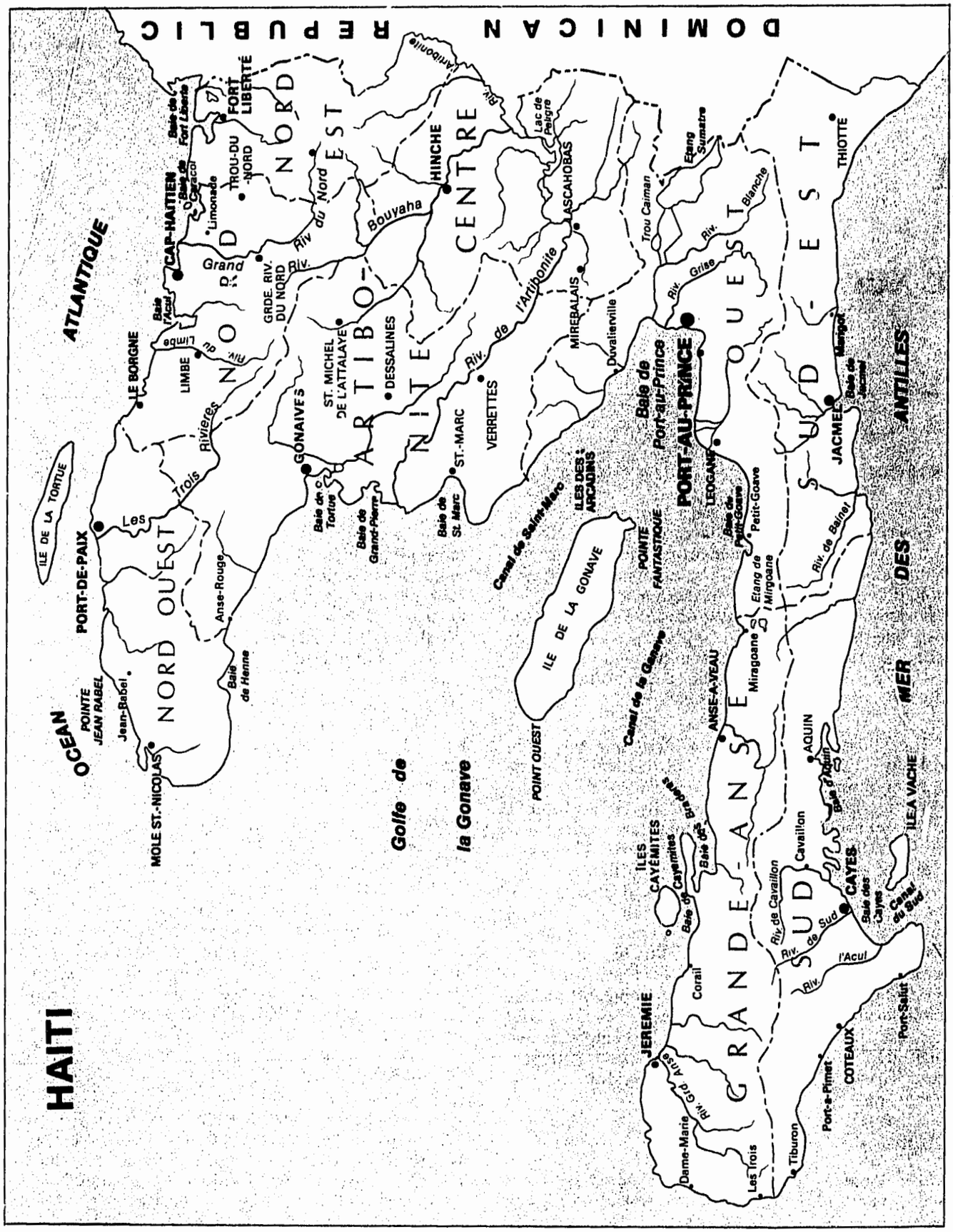
Haiti's position in the tropics and its mountainous terrain have created extreme weather conditions and temperature regimes which vary greatly with altitude. Rainfall patterns range from less than 300 mm in the northwest to more than 3,000 mm in the mountains of the southwest. Tropical storms, hurricanes, droughts and floods are not infrequent.

One of the larger of the Caribbean nations, Haiti has 27,000 km^2 of land area including four large offshore islands: La Gonave (680 km^2), La Tortue (180 km^2); Ile à Vache (52 km^2) and Grand Cayemite (45 km^2): as well as numerous smaller islands and cays.

Haiti is a mountainous country with very few plains. Two ranges, the Massif de la Hotte and the Massif de la Selle, including Pic la Selle, the country's highest peak at 2,684 meters above sea level, run in a west to east direction along the southern part of Haiti. The Massif Central gives rise to the Central Plateau with smaller mountains ("mornes") extending towards the north, south of Cap Haitien and west, along the northwestern peninsula. Approximately 63% of all lands have slopes greater than 20%, and only 29% have slopes of less than 10%.

GEOLOGY

It has been suggested that the island of Hispaniola was created by the uplifting of three major land masses and their subsequent collision over geologic time. These land masses were formed from oceanic crust, uplifted and influenced by sea level changes. Most marine terraces were exposed during the Pleistocene era. There have been no major sea level changes in



PREPARED BY WILCOX ASSOCIATES

Fig. I-1: Geopolitical map of Haiti

the last 10,000 years. In Haiti exposed rock formations are of igneous, metamorphic and sedimentary origin. The latter formations are the most abundant (80%) and are represented by limestone deposits from the middle and upper Eocene era. Where limestone formations occur, soils are relatively more fertile than those derived from rock of igneous origin which, like the soils found in the northern part of the country, are heavily weathered. Alluvial soils deposited by rivers are the most fertile and are found on the major coastal plains of Haiti and in pockets along mountain valleys.

The geologic history of Hispaniola, characterized by repeated changes in sea level, has given rise to significant local endemism (speciation unique to the area) of plant and animal species. Although species extinctions from habitat destruction have been numerous, a great number of endemic plants and a few endemic animals still remain.

HYDROLOGY

Dissected by numerous mountain ridges and flowing across two relatively narrow peninsulas, Haiti's rivers are mostly short and swift flowing. The notable exception is the Artibonite River which originates along the border with the Dominican Republic and flows for approximately 290 km. It is not surprising, therefore, to find along this river the country's major hydroelectric power generating facility (Peligre) and, on its delta, the country's major rice producing area.

Surface water is used for domestic purposes by the great majority of the people in Haiti. It also flows directly into a great number of small and large irrigation systems. In fact, four large irrigated plains constitute the country's most important agricultural areas: the Plaine du Nord, Fort-Liberté area, in the North, the lower Artibonite and Estere valleys in the center, the Cul de Sac plain in the south and the Les Cayes plain in the southwest.

Yet, the evidence is mounting that the quantity of surface waters available for irrigation is decreasing each year due to the relationship between vegetation cover and river discharge. Baseflows, which represent the water available for irrigation when storage is limited, are diminishing significantly due to continuous deforestration and loss of water retention capacity in the rivers' upper watersheds.

The second most important source of water is groundwater which already contributes significantly to the irrigation system in the Cul de Sac region. Since limestone substrate underlies nearly 80% of the nation, groundwater reserves could become the principal source of fresh water in the country in the future. This important source of water has not been mapped nor is being utilised to complement surface water and increase agriculture production through irrigation.

Both groundwater and usable surface water depend upon the capacity of watershed areas to store water and then to gradually release it into the river system and recharge the water table. The significant development potential of irrigated plains in Haiti calls for immediate action to be taken in an effort to protect and to restore the vegetative cover, and, thus, the water retention capacity of the country's major watershed areas.

LAND USE

In Haiti, not only is the most arable land already being utilized, but the total area under some form of agricultural production (more than 1,300,000 ha) is six times greater then the estimated area of «good agricultural land».

About one third of all lands are either extremely eroded, abandoned for farming, or saline and practically sterile, due to inappropriate land use practices including farming, grazing and tree cutting. The country's marginal lands are mostly found on mountain slopes. Every year cultivation of annual food crops forces other crops and grazing lands higher up the mountain and every year the steepness of the cultivated plots increases. The end result of indiscriminate tree cutting and intensification of cultivation is tremendous soil erosion. Each year the equivalent of 6,000 ha of valuable arable land are lost to erosion. Over the past forty years, estimates of remaining "good" arable land in Haiti show a consistent decline of as much as 3% per year.

Only 11.3% of the total land area of the country consists of good soils with possibilities for irrigation, mechanized cultivation and high yield potential. Much of the 31.7% of the land having good soil, but no potential irrigation is found on steep slopes subject to severe erosion. These lands are best suited for permanent tree crops such as coffee and managed pastureland. The extensive reduction of forest cover and widespread cultivation of lands unsuited for annual crop production, without even minimal attention to soil conservation practices, has led to the catastrophic state of erosion throughout the country and to the subsequent serious damage to the agricultural potential of the lowlands, both in terms of irrigation and infrastructure.

It is evident that a high percentage of all cultivated lands are being farmed beyond their carrying capacity, resulting in an escalating and potentially irreversible land degradation process. If the strategy of maintaining existing land resources, let alone improving them, is a high priority, clearly a very significant portion of Haiti's cultivated lands needs to be removed from current land use and returned to forest. In practical terms however, only the upper watershed areas of the agriculturally and economically most important plains could become the object of such a drastic resource restoration strategy.

AGRICULTURE

The production of agricultural commodities directly provides a livelihood to 72% of the Haitian population. The export of agricultural commodities accounted for 48.7% of total exports in 1983, though the contribution of agriculture to GDP in 1981 was only 31%. During the period 1970-1980, the annual growth rate of the sector averaged 1.1%. Since 1980, growth has been negative, falling by about 1%, 4.7% and 0.6% for 1980, 1981 and 1982 respectively.

Although food crops cover approximately 80% of the cultivated area, their value of production is only about one-half that of export crops, excluding sugar. The great majority of all food crops are grown by small farmers on hillside plots. The annual production cycle, coupled with the lack of any soil conservation practice, exposes most of these lands to severe erosion, decreases yields and forces the peasants to clear a new plot, burn the vegetation and start a new cycle. Demographic pressure upon a limited supply of arable land and horticultural practices which haven't changed significantly since the nineteenth century, explain the decreasing trend in per capita food production (-2% year) and the accelerating rate of land degradation in the mountains.

Only root crops and other starchy foods have followed slightly rising trends; at a slower rate however, than population growth. Rice production has also shown improvements in total yields; yet maize and sorghum production, accounting for 37% of all cropped area, has been decreasing since 1970. At the same time, per capita daily calorie supply has been reduced in the past twenty years and food imports have increased steadily over the past decade. Wheat imports, alone, account for one fourth of the negative trade balance with the USA.

Haiti's agricultural sector suffers from physical, socio-political, institutional, and economic constraints. The arable land area is very small, limited by topography and high erosion risk. Rainfall is scattered and periodically unpredictable. Natural disasters, floods, droughts, tropical storms wipe out essential income from permanent crops.

Only about half of the land situated on plains in Haiti is presently being utilized. Approximately 400,000 ha of mostly flat lands are not cultivated due to severe erosion, salinization, urbanization or lack of appropriate technology and investment. Just half the land that could be potentially irrigated is presently under irrigation. At the same time, increasing amounts of this precious land are being lost to agriculture, due to salinity caused by inadequate irrigation practices and technology.

Land holdings are small and fragmented. Seventy-one percent of all production units (generally multiple-plot family farms) occupy less than 1.3 ha, consisting of an average of three plots, and account for only 32.5% of all cultivated land. The remaining land is cultivated in larger plots including a few large holdings (i.e. HASCO) of more than 10,000 ha. Thus, although Haiti's distribution of agricultural lands appears less unequal than in most countries of Latin America, it's scattered distribution prevents the development of efficient production systems.

Production technology is very primitive, lacking essential inputs such as organic and/or chemical fertilization, soil conservation practices, crop rotation and tree cover, which might serve to increase production capacity. Government taxes and pricing policies and oligopsonistic market structures, as well as limited credit availability, weak institutional support and lack of rural infrastructure contribute to the continued decline in agricultural productivity (0.6% in 1982).

It is evident that in order to address and, ultimately, solve the multiple and complex problems affecting the agricultural sector in Haiti, a number of organizational and institutional reforms need to be implemented. Tree crops such as coffee, cocoa and fruit trees that protect slopes from erosion, increase water retention, and whose products give the country a clear comparative advantage must be promoted with production and export incentives.

Yields of traditional food crops could be improved to reduce, but not eliminate, reliance upon food imports. Hillside farming and grazing needs to be reduced by at least 30% to allow for natural recovery of water retention capacity, increased base flows and, thereby, more reliable irrigation of the plains. Large scale soil conservation/reforestation projects based on community participation in the uplands should accompany any effort and cash crops can be produced with greater efficiency and improved yields, if fertilizers and appropriate technology are applied.

To restore the agricultural sector to a point at which it can contribute substantially to the nation's self-reliance in food production and significantly add to foreign earnings, it must receive priority attention by both the public and private sectors. A coordinated agricultural sector investment policy complemented by adequate credit and tax incentives could produce tangible results over a relatively short time and in the process, become the back-bone of the country's economic growth in the near future.

FOREST RESOURCES

The forests of Haiti have long ago lost their economic significance as renewable resources, and are quickly losing their ecological function as well. However, while the economic loss could conceivably be offset, the loss of the forest ecosystem has enormous, and potentially irreversible, repercussions which affect the livelihood of millions of people.

At the beginning of the XVI Century, Haiti was mostly covered by lush forests with ecological variation defined in terms of different forest types. Since then, forested land area has been reduced drastically, and today covers only 6.7% of the total land area of the nation (approximately 185,000 ha). Almost 38% of the total forested area is represented by pine formations, which in a number of cases has been severely degraded by unmanaged exploitation, repeated forest fires and overgrazing. The single largest parcel of forest land (26,400 ha) remaining is the pine forest in the southeastern portion of the country. While the highest percent of tree cover is found in this area (Fond Verrettes), all its rivers drain into the Dominican Republic.

Of the thirty major watersheds within country, twelve were completely deforested by 1978. Thirty-six percent of the remaining forest (66,000 ha) falls within the «dense forest» category (more than 80% canopy cover) and sixty-four percent in the «open forest» category of less than 80% canopy cover. The high amount of open forest and its very fragmented distribution suggest that clearing and burning at the fringes of these parcels continues. In fact, if we assume a decrease in forest cover of only half of what has been estimated from aerial photography of two sample areas in Haiti, a 6.7% annual reduction will remove half of the remaining forest cover by 1995, and completely deforest all but five major watersheds in the nation. If the present trend continues, only the pine forest and its corresponding watershed will remain forested by the year 2008.

Reforestation programs past and present, even when successful, have proven inadequate to reverse the trend in deforestation rates. In fact, successful small-scale projects implemented by non-governmental organizations (NGOs) have only replaced less than 20% of the tree biomass cut every year for lumber, charcoal and clearing for small-scale agriculture. Yet these projects, by appealing to individual self-interest and by relying upon a decentralized and efficient tree production and distribution system, have tested and proven a successful implementation strategy by planting nearly 14 million trees in four years with about 50% survival. Key elements of this strategy can be extrapolated to make future tree planting efforts successful in Haiti.

It his highly unlikely that forest resources in Haiti will ever again be a significant economic resource. Yet if one considers that more than 70% of all energy consumed in the country comes from either firewood or charcoal; that sustained agricultural production of the plains and continuous hydroelectric output depend upon an adequate forest cover in the upper watersheds, it is evident that remaining forests in Haiti must be protected, restored and adequately managed in order to perform their ecologically critical role.

THE PEASANTRY AND THE LAND

Following a successful slave uprising against the French in 1804, Haiti emerged as a nation where 80% of its citizenry was and remains today rural freeholding and directy dependent upon agriculture for its livelihood. History shows, that during those painful years of enslavement, the descendants of today's Haiti, forced to work in their «off-time» to defray the costs of their own upkeep, successfully developed techniques of intensive food cultivation, operated a country-wide internal market system and passed rights to certain parcels of land to their children. Rights to the land and control over one's own labor, far from the centers of government, became symbols of freedom which still exist today.

Currently the Haitian peasantry is facing serious challenges to its way of life. Although the productivity of peasant agriculture has long been the mainstay of the nation's economy, a corresponding investment in the agricultural sector has yet to be made and, in fact, is declining. The combined pressures of population growth, shrinking farm sizes, soil erosion, and soil exhaustion, have led to the present situation where the majority of small farmers cannot count on even one profitable season to help them save or reinvest. Planning ahead, today's peasant is hoping to ensure the future of his children, by necessity, outside of the agricultural sector through education or emigration from the degraded hillsides.

Today, the peasant farming system is a complex pattern of land ownership, investment, and crop strategies, which vary with the economic status of each farmer. While the majority of the peasantry are landowners, the majority of them are also land poor. Some wealthy peasants can afford to invest in perennial and export crops and livestock. Most are too poor to forego even a portion of their annual crop production or income to utilize soil conservation measures or begin to establish perennial multi-year crops.

Peasant tenure is of «mixed» character where farmers generally work several plots simultaneously, under different arrangements e.g. renting, sharecropping, owning, or leasing their own land to others. The security of tenure significantly affects their attitude towards the land. Overexploitation and poor management of the resource result in land farmed by sharecroppers and others with no permanent stake in the outcome. Although a national cadastral survey is desirable in principle, under present social and political arrangements it is unlikely to lead to a more equitable distribution of lands and to tenure security.

Diverse farm strategies resulting from the great variation in climate and the highly dispersed pattern of multi-plot farm units complicate any national effort to improve farming practices. Capital shortages are the

most significant constraint on farm production and often foster destructive land use practices. Natural disasters, occuring all too frequently, force the peasant farmer to select annual crops rather than more ecologically desirable perennials such as coffee.

Land scarcity has caused the widespread destruction of Haiti's forests even though these mountainous and fragile lands are unsuitable for sustained agriculture. Although the peasants' need for new agricultural lands and their preference for fruit trees have prevailed in the past, new projects such as USAID's Agroforestry Outreach Project demonstrate that peasants will plant non-fruit bearing trees on a large scale if there is public participation and an understanding of the goals of such a project.

COASTAL AND MARINE RESOURCES

In contrast to the declining resource value of its lands and forests, the country's coastal and marine habitats appear to be in a relatively pristine state. The magnitude and ecological significance of its resources; mangrove wetlands, seagrass meadows, coral reefs and protected bays and estuaries are considerable. The mangrove forests alone cover more than 180 km^2. Well developed coral reefs fringe large stretches of coastline and offshore barrier, and atoll-like reefs and "walls" directly offshore and largely unexplored, are prized by recreational users and fishermen. Underwater landscapes are considered among the most spectacular in the world.

Fisheries export in 1982 earned 3.5 million US$, yet a similar amount is spent importing salted and dried fish each year. It has been estimated, however, that the fishery yield potential could greatly increase with the introduction of appropriate technology and adequate infrastructure. The fishing industry is predominantly artisanal in both scale and technology. Mariculture projects involving conch, shrimp and King crab have recently been proposed on a small-scale basis by Private Voluntary Organizations (PVOs). Aquaculture projects involving tilapia and carp are widely scattered around the countryside, but not fully assessed for their ecologic and economic impact.

The major constraints to improved fisheries production in Haiti are: the lack of fish in areas where artisanal fisherman have access to more productive areas, the lack of skills and proper training and a general lack of efficient fish preservation, distribution and marketing infrastructure and organization.

In general, coastal and marine resources of Haiti remain relatively unknown and underexploited. Notable exceptions are: widespread nearshore overfishing; a large export trade in coral, sea turtles, aquarium fish, shells; some clearing of mangroves for charcoal making; and the pollution of coastal waters from human and industrial wastes near the metropolitan area of Port-au-Prince.

Breeding and nesting sites of rare and endangered species in the coastal zone are almost totally unknown. Laws exist which protect these species, yet pressure upon rare sea turtles for eggs, meat and shells, as well as the hunting of shorebirds, continue unabated. At least thirteen threatened or endangered species have been identified as utilizing the mangrove wetlands and lagoons of Haiti; among them the West Indian Manatee (Trichecus manatus) and the American Crocodile (Crocodylus acutus).

Site specific species and habitat studies, as part of a coastal resources plan, could result in better management of coastal areas for the protection of rare and endangered species, as well as the enhancement of fisheries.

Marine reserves and parks, once designated within the framework of such a plan could be effectively used for both public education and research, and as fish reserves to replenish depleted fish stocks. Legal precedents in Haiti exist now for protecting and managing coastal resources. Haitian laws, especially those regulating the taking of fish and shellfish are rarely enforced, however.

Candidate marine areas worthy of protection include: the Arcadins and the Barraderes-Cayemites areas in the Golfe de la Gonave; the Ile à Vache, on the south coast; and baies de Labadie and Cadrasse on the north coast, west of Ft. Liberté.

WILD FLORA AND FAUNA

The insular nature of Hispaniola and the island's ecological diversity have resulted in a particulary rich and varied flora. More than five thousand different plants are known to exist at the present time. About two thirds of these are woody plants, trees and shrubs. They have adapted to a wide range of different environments from dry desert conditions to the permanently moist conditions of the mountainous rainforest. There are about 600 fern species and over 160 different kinds of orchids. Thirty-six percent of all plants are endemic to the island and it is probable that many plant species are still undiscovered.

Haiti is characterized by nine life zones as defined by OAS (1972). They include arid zone biomes such as cacti formations and xerophitic forest typical of the Subtropical Thorn Woodland and the Subtropical Dry Forest life zones. The most commonly represented zone is the Subtropical Moist Forest characterized by mahogany and tropical oak forests. Few representative samples of this life zone remain, however, due to its extensive use for subsistence farming. Typical of the

lower elevation mountains and ridges is the Subtropical Wet Forest best suited for the cultivation of coffee, cocoa and fruit trees. Found at higher elevations and primarily atop the Massif de la Hotte (Pic Macaya) are two characteristic high-humidity zones, the Subtropical Rain Forest and the Subtropical Lower Montane Moist Forest. Remains of these zones can still be found within the Macaya National Park in the southwestern portion of the country. The pine forest of Haiti are included in the Subtropical Lower Montane Moist Forest and in the Subtropical Lower Montane Wet Forest characteristic of the mountains in the south (Massif de la Selle) and portions of the Plateau Central. Finally, the Subtropical Montane Wet Forest is a life zone which covers only a limited area at the highest altitudes of the Massif de la Selle located on the southern peninsula.

Vertebrate fauna are well-known compared to invertebrates. A recent survey of two mountainous areas by a team from the University of Florida has found that 23 of 46 species of molluscs collected were new to science.

The island's wildlife is represented by few mammals, but a diverse population (220 species) of birds. A number of these birds are endemic to the island, such as the Laselle Thrush (Turdus swalesi), the Ground Warbler (Microligea palustris) and the Hispaniola Parrrot (Amazona ventralis). Along the Haitian coast in marshes and mangrove wetlands, the American Flamingo (Phoenicopterus ruber), as well as the Frigate birds (Frigatidae) and other shorebirds abound. Most notable, however, is the presence of the American Crocodile (Crocodylus acutus) primarily in Etang Saumatre and of two endemic and endangered rodents: the hutia (Plagiodontia aedium) and the solenodonte (Solenodon paradoxus) in the remaining remote forests of the southwest.

A number of forces, not at all unique to Haiti, contribute to mount incredible pressures upon the island's rare and sometimes unique wildland resources and, thus, upon the nation's natural heritage. The most serious threat is represented by rampant habitat destruction within all life zones of Haiti, some of which have already lost their plant and animal representatives. The second most important factor is the introduction, over the years, of many exotic species which have replaced native and often endemic species in their ecological niches. The third threat to wildlands in the country is of a structural and institutional nature. Protective legislation, although enacted, is rarely enforced, and the priority given to environmental protection has generally been very low. This lack of concern is often linked to the lack of adequate information on the interdependencies between the natural and human components of the biosphere. Finally, commercial exploitation of wild plant and animal species, whose full impact has not yet been addressed, also contributes to the loss of the country's natural heritage.

Basic information on populations, distributions and food habits of threatened and endangered wildlife in Haiti is generally very scarce. As population pressure further encroaches on the last remains of wildlife habitat in Haiti, the protection of wild fauna and flora within adequately managed reserves becomes increasingly urgent. Recent development in this direction, such as the establishment of two national parks, are encouraging signs that the preservation of the country's natural heritage is being seriously considered.

POLLUTION

The two most pressing pollution related issues in Haiti are the increasing population's need for (1) a safe water supply; (2) sanitary methods of disposing of human wastes. The Centrale Autonome Metropolitaine d'Eau Potable (CAMEP) now supplies only 60% of the Port-au-Prince area. Beyond the metropolitan area only 10% of the population have access to a safe water supply. Water-related diseases are prevalent particulary in the countryside. Children are especially affected. In 1979, diarrhea alone caused the death of 9% of the babies under one year of age (UNICEF 1984).

The vast majority of Haitians do not have access to sanitary means of human waste disposal. UNICEF reported in 1984, that 40% of the population were using latrines or septic tanks, mostly in urban areas. Operation and maintenance of these disposal methods are often deficient. Contamination of surface and groundwater from human waste and other solid and liquid wastes is increasing without sufficient means or a plan to control it. The air in Port-au-Prince contains dust and emissions from poorly inspected vehicles. Smoke from burning garbage and industrial plants add to the air pollution problem.

Haiti's population is projected to increase from an estimated 5,200,000 in 1985 to 6,500,000 in 2006, the long range planning horizon selected by the Ministry of Plan. During that period, the rural to urban areas are predicted to experience a population shift which will swell the metropolitan area of Port-au-Prince, alone, to 2,200,000 persons.

A planning process has begun which holds the promise of future improvements. The Port-au-Prince drainage program will help alleviate pollution problems emanating from stormwater. Reforestation of the upper watershed is continuing to reduce sediment loads to the city's sewers. Water resources, though not precisely known are believed adequate to meet domestic needs. Groundwater is abundant underlying the many limestone formations and easily accessible in some areas, particularly the coastal plains. Existing water supply systems are the results of investment largely by bilateral and multilateral banks and other international organizations. Progress has been made and efforts

continue to expand water supply services, but the population is growing faster than water supply development. The management of stormwater and solid waste disposal is expected to improve considerably in Port-au-Prince and other urban centers as a result of current or planned efforts, but other population problems, including air pollution from automobiles and industry in Port-au-Prince will become worse if no action is taken.

INSTITUTIONAL AND LEGAL ASPECTS OF ENVIRONMENTAL ISSUES

Despite early and comprehensive legislation designed to protect and manage the country's natural resources, Haiti's environment, lands, forests, drinking water, wildlands, and wildlife, are in serious trouble. Environmental laws, although well drawn, have not been applied and enforced. There are many repetitive laws and administrative orders which confuse and complicate their administration.

Numerous agencies, private voluntary organizations, non-governmental organizations, and international donors are involved with the environment and natural resources in Haiti. Problems caused by lack of coordination are due as much to the diverse responsibilities assigned to each public agency as to the absence of a coherent natural resource policy.

Virtually every natural resource sector has more than one primary government agency, hence there is considerable duplication of efforts and programs, as well as a kind of «territorial» jealousy. Even worse, some institutions with similar programs have little substantive interchange of information.

International donors are becoming increasingly involved in environmental conservation and management programs. In order to achieve the best results most efficiently, all efforts in the environmental arena should be placed within a coherent and unified framework, with priorities established, objectives and strategies defined, and programs coordinated and evaluated accordingly. Preparation of a National Conservation Strategy by DATPE may be a focal point for this unification of programs and policies.

STRATEGIES FOR PROTECTION AND CONSERVATION OF THE RENEWABLE RESOURCES OF HAITI

Deterioration of the countryside as evidenced by sharply declining food production, internal migration into Port-au-Prince, the high unemployment of rural emigrants, the continuing attempts at illegal international migration have all been thoroughly documented. To have any stabilizing effect at all, land conservation strategies are urgently needed now.

- Approach land conservation on a regional watershed management basis considering both environmental and socio-economic issues.
- Conceptualize projects for longer periods than the normal two to five year framework.
- Manage the upper watersheds such as the Macaya and La Visite National Parks and the Upper Artibonite Watershed.
- Encourage large-scale conservation and reforestation projects to prevent further soil erosion, particularly in the watersheds directly above significant agricultural and economically important lands.
- Incorporate local participation in land use projects.
- Consider the removal of certain hillslope cultivated lands from production, return of these lands to forest and also a relocation of inhabitants where other living arrangements can be found.
- Promote tree crops such as coffee, cocoa and fruit trees that protect slopes from erosion and give the country an economic advantage.
- Employ vegetative cover in a strip pattern alternating with cultivated crops to reduce soil erosion.

FORESTRY

- Elimate tax on imported wood products to encourage tree conservation.
- Establish price controls on lumber.
- Implement a fruit tree and fuelwood reforestation program in the mountains as well as the lowlands.
- Expand existing seedling production and outreach capabilities, to cover a wider range of land types across Haiti.
- Coordinate the efforts of donor agencies to enable the financing of a large-scale reforestration effort on private as well as state lands.
- Support the expansion of teaching and training facilities in forest resource management, with special emphasis on the development of appropriate technological packages for reforestation and soil erosion control.
- Amend legislation to protect forest resources by

exempting trees planted for harvest from current prohibitions and taxations and by prohibiting planting in zones set aside for soil erosion protection.

- Subsidize kerosene, perhaps by taxing gasoline and support higher taxes and licence fees for commercial charcoal production.

WATER CONSERVATION AND DEVELOPMENT

- Improve the water retention capacity of the country's major watershed areas by reducing hillside farming and grazing.

- Consider groundwater as a valuable resource to provide fresh water for irrigation and map its extent.
- Evaluate the groundwater resource in the lowlands. Development should not begin until proper environmental safeguards are in place to avoid salinization.

AGRICULTURE

The best strategy for maintaining agricultural production on the short to medium term, is by the more efficient use of presently irrigated lowlands and by developing additional irrigation potential. Without immediate action to manage the upper watersheds, however, soil erosion and declining soil fertility continues to minimize the benefits of irrigation projects and lowland agricultural efforts.

- Study the costs involved in developing irrigation capital, system maintenance and operation, on-farm distribution and drainage, structure maintenance and operation and land preparation. Special attention should be paid to sprinkler irrigation from wells.

- Increase agricultural production by improving farming practices to help to offset losses to small farms by removing their lands from cultivation.

- Encourage better land-use practices by making title registration papers less expensive, easier and faster to obtain. Title teams could be established and financing these initiatives within the context of a national cadastral survey should greatly benefit a long-term environmental restoration process.

- Concentrate on high valued crops to the extent that these can be consumed, processed and/or marketed. Reconsider using a significant portion of irrigated area, now in sugar cane currently being produced at a loss in terms of world sugar prices, for other crops.

- Initiate guarantees to farmers that once land improvements are made, lands will not be taken away or taxes increased.

- Develop a program to help rural communities conserve their natural resources.

THE PEASANTRY AND THE LAND

The Haitian peasantry is facing serious challenges to its way of life. Although the productivity of peasant agriculture has long been the mainstay of the nation's economy, there has yet to be a reciprocal investment in the agricultural sector.

- Consider the unique and basic characteristics of the Haitian peasant farming system in projects by external sources as well as the government.

- Continue and initiate projects which invite the peasantry to fully participate in land conservation strategies.

COASTAL MARINE RESOURCES, PROTECTION AND MANAGEMENT

Coastal and marine resources of Haiti remain relatively unknown and underexploited. Notable exceptions are widespread overfishing of nearshore reef areas and a large trade in aquarium fish, sea turtles and shells. A coastal resources plan could result in better management of coastal habitat for the enhancement of fisheries, tourism and rare and endangered species.

COASTAL ZONE MANAGEMENT

- Prepare a coastal resources plan for Haiti which would include:
  - inventories of breeding, nesting areas of threatened and endangered species; inventory and designation of critical coastal areas, e.g. habitat for commercially important fish and shellfish species, areas of unusual scenic value for present or future tourism and proposed sites for mariculture;
  - the conceptual, scientific, administrative and legal framework for decisions affecting coastal marine resources;
  - the assessment of mariculture and fisheries development schemes and recommendations as to their suitability for Haiti.

- Evaluate and designate marine reserves and parks as part of a coastal resources plan. These parks and reserves would provide:
  - areas for the replenishment of depleted breeding stocks of valuable but vulnerable fish and shellfish species that quickly disappear from heavily fished areas;
  - interpretive education for the public and private recreational users of the coastal, marine areas;

– small cooperative fisheries programs to benefit the nearby fishing villages;
– management plans for the longer range protection of the renewable resources;
– research programs to identify more precisely the ecological systems which determine continued productivity and value for recreation.

- Implement the recent (Nov. 17, 1983) amendment to Section 119 of the U.S. Foreign Assistance Act authorizing Federal executive agencies to provide assistance to countries in need of protecting and maintaining critical habitat.

FISHERIES MANAGEMENT

- Improve fisheries with a strong commitment from the government of Haiti to increase funding, staffing and extension training programs.
- Prepare fish stock assessments of potentially productive areas such as Anse d'Hainault and Môle St-Nicolas.
- Locate and organize communities and groups as production and marketing cooperatives in order to provide assistance and coordinate fish catch and distribution.
- Extend credit to such groups for the purchase of needed equipment.
- Stimulate small-scale industries related to fishing (e.g. gear manufacturing and maintenance, boat construction, fish salting and drying operations).
- Strengthen and expand marketing capabilities to ensure reasonable profits.
- Extend fish distribution networks to rural populations to increase protein consumption.
- Provide training and appropriate equipment for fishing the nearshore areas in order to avoid depletion of these resources.
- Encourage the private sector to stimulate the expansion of artisanal fishing operations through investment and more effective distribution.
- Investigate mariculture proposals carefully as part of a coastal marine resource strategy to relieve fishing pressure on natural fish stocks, especially those from nearshore coral reefs.
- Investigate the feasibility of installing artificial reefs in nearshore areas where fish stocks are declining.
- Enforce existing fishing regulations which regulate the taking of fish and shellfish.
- Assess the ecological and economic impacts of aquaculture, particularly in estuarine and coastal waters.

WILDLANDS CONSERVATION

There are incredible pressures on Haiti's rare and often unique wildland resources and thus the nation's natural heritage. The most serious threats are rampant habitat destruction, the introduction of exotic species and the lack of law enforcement.

- Establish objectives for the protection and manage-management of natural areas by adopting the IUCN World Conservation Strategy objectives.
  – maintain essential ecological process and life-support systems on which human survival and development depend;
  – preserve genetic diversity on which depends the the functioning of many of the above processes and live-support systems;
  – ensure the sustainable utilization of species and ecosystems; notably fish and other wildlife, forest and grazing lands, which support rural communities as well as major industries.
- Establish a National Park Service with the technical support of the Ministère d'Agriculture des Ressources Naturelles et du Développement Rural (MARNDR) and direct access to the Presidency.
- Establish a Natural History Museum and Botanical Gardens to become centers for research and education about Haiti's endemic flora and fauna.
- Develop a long range plan for a program of scientific research on Haiti's flora and fauna with participation of qualified scientific institutions abroad.
- Institute a program for public education concerning environmental protection and resource conservation.
- Identify and protect, within a system of National Parks and other protected natural areas, significant remains of different forest types (from mangrove to rainforest) and other major biomes, in an effort to preserve Haiti's diverse natural heritage.
- Strictly enforce those existing laws which prohibit the taking of certain endangered and threatened species.
- Assess the impacts and control the wildlife trade in Haiti.
- Stop the trade in wild orchids and tree ferns.
- Stop the trade taking place in Haiti, either illegal or legal, which is rapidly depleting populations of endangered and threatened

species such as sea turtles, certain coral, aquarium fish species, birds and reptiles.

POLLUTION ABATEMENT

The two most pressing pollution related issues in Haiti are an ever expanding population's need for (1) a safe water supply and (2) a sanitary waste disposal system. With a population projected to increase from 5,200,000 in 1985 to 6,500,000 in 2006, existing efforts to supply potable water and manage stormwater drainage and human and solid waste disposal are grossly inadequate.

- Expand significantly the water supply network to meet increasing demand, reduce losses and chances for contamination and upgrade and motivate personnel at the intermediate and lower levels through training and incentives.
- Establish a realistic code for drinking water sources and treatment guidelines which consider rural and urban socioeconomic conditions and financial means.
- Consolidate the solid and liquid waste disposal facilities at Truitier, including the construction of a primary sewage treatment facility. Move the existing and underutilized composting plant to this site.
- Improve water quality controls as well as vehicle emission inspection. Consider changes in transit pattern to reduce traffic congestion and air pollution.
- Expand solid waste collection and human waste disposal systems throughout the metropolitan area. Continue drainage improvement and the recovery of the Morne Hopital watershed, near Port-au-Prince.

INSTITUTIONAL AND LEGAL CHANGES

Almost every natural resource sector has more than one primary government agency, hence there is considerable duplication of effort. International donors, non-governmental organizations (NGO's) and private voluntary organizations (PVO's) are becoming increasingly involved with environmental programs. These public and private institutions, with similar goals and objectives, have very little substantive interchange of information and coordination and are not guided by a coherent set of priorities for natural resource management.

- Consolidate government agency authority over specific natural resource sectors, within a framework of a focused natural resource policy, to avoid duplication and policy contradictions.
- Improve communication and promote a more integrated approach to natural resource management, by establishing and Inter-Ministerial Environmental Committee with direct access to the Presidency.
- Develop priorities for future economic development based on environmental as well as economic goals.
- Perform environmental impact assessments (EIA's) for all significant development projects funded by the GOH and external sources.
- Consider an environmental management component (e.g. conservation and restoration) in the development of projects for rural development.
- Reorganize MARNDR along functional lines.

II

Introduction

The purpose of a country environmental profile (CEP) is to aggregate in one definitive document information, data and analyses on the country's resource base, focusing on the significant environmental issues and trends and to identify possible solutions to environmental problems. Specifically, the Haiti CEP objectives were to identify major areas of concern for management of Haiti's natural resources; to survey existing institutions, policies, and activities; to assess the effects of any identified problems on the environment, society and the economy; and to provide conclusions and recommendations for actions to ameliorate problematic situations.

Haiti is located on the island of Hispaniola, which is between Cuba and Puerto Rico in the West Indes, occupying the western third of the second largest island in the Caribbean (18°-20°N, 71°45'-74°-30'W). Haiti is still isolated by language and culture from most of its Spanish and English speaking neighbors.

Although materially the poorest nation is the western hemisphere, Haiti is perhaps the most distinctive and intriguing. Born of the only successful slave revolution in modern history, Haiti is the New World's second oldest Republic and has been dubbed "the most African of Afro-American countries." The Haitians are above all, a warm and gregarious people. The outsider, willing to speak to them on their own terms, in their own language of Creole or French, is richly rewarded with the opportunity to learn and appreciate the Haitian culture.

A.- GEOLOGY AND PHYSIOGRAPHY

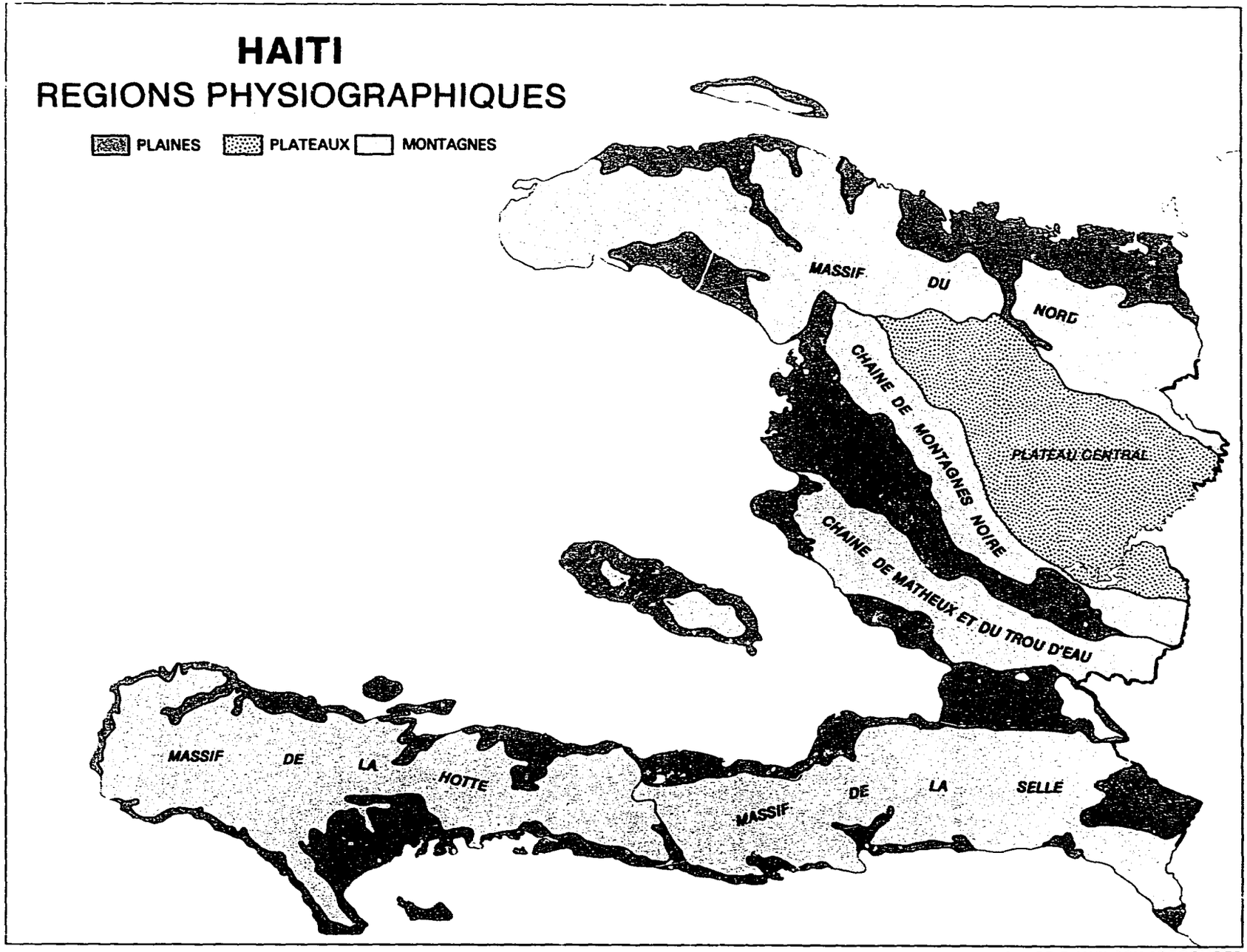
According to a recent study of the geological development and tectonics of the Caribbean islands (Maurasse, 1983), Hispaniola was formed by the collision of one small and one larger land mass during the late Miocene and early Pleistocene periods. The theory states that the smaller land mass broke off from Central America, drifted east and eventually collided with a larger land mass now comprising northern Haiti and most of the Dominican Republic. Following the impact the Plain of Cul-de-Sac and the three large saline lakes, Bois Caiman, Etang Saumatre and Lac Enriquillo were uplifted. Throughout southern Haiti the uplift of the Eocene limestone seabed created towering and rugged mountains cut occasionally by plains and steep valleys. The mountains of the north were formed by local volcanic activity.

Other authors claim that three land masses collided to form the present island of Hispaniola. Much research needs to be done to verify the geologic history. Most geologists agree that these land masses were formed from oceanic crust, uplifted and influenced by sea level changes. Marine terraces for the most part were exposed during the Pleistocene era. There have been no major sea levels changes in the last 50,000 years. Exposed in Haiti are rock formations of igneous, metamorphic and sedimentary origin. The latter formations are the most abundant (80%) and are represented by limestone deposits from the middle and upper Eocene era. Where limestone formations occur, soils are relatively more fertile than those derived from rock of igneous origin which, like the soils found in the northern part of the country, are heavily weathered. Alluvial soils deposited by rivers are the most fertile and are to be found on the major coastal plains of Haiti and in pockets along mountain valleys.

The geologic history of Hispaniola, characterized by repeated changes in sea level, has given rise to significant local endemism (speciation unique to the area) of plant and animal species. Although extinctions due to habitat destruction have been numerous, a great number of endemic plants and a few endemic animals still remain.

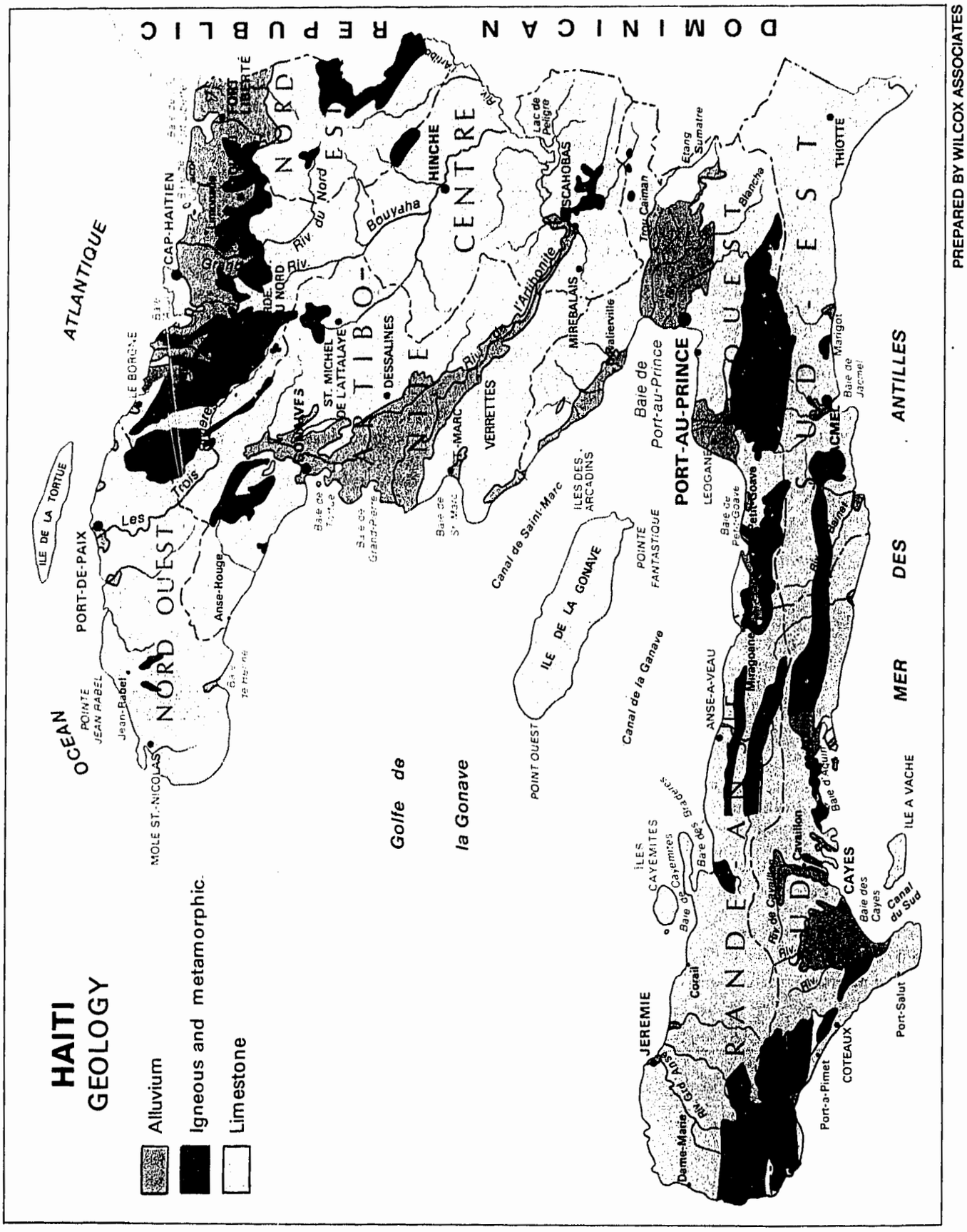
The major mountain ranges of Haiti are:

1) Massif du Nord, the northwestern prolongation of the Cordillera Central of the Dominican Republic, composed primarily of metamorphic volcanic rocks, metamorphic detrital rocks and quartz diorite sometimes covered by Limestone (max. altitude 1,200 m).



PREPARED BY WILCOX ASSOCIATES

Fig. II-1: General Physiographic Regions of Haiti


HAITI
GEOLOGY
Alluvium
Igneous and metamorphic.
Limestone
OCEAN ATLANTIQUE
DOMINICAN REPUBLIC
PREPARED BY WILCOX ASSOCIATES
NORD OUEST
NORD EST
ARTIBONITE CENTRE
GRAND'ANSE
SUD
SUD EST
GRAND'ANSE
MER DES ANTILLES
Golfe de la Gonave
CAP-HAITIEN
HINCHE
DESSALINES
ST. MICHEL DE L'ATTALAYE
GONAIVES
ST-MARC
VERRETTES
MIREBALAIS
SCAHOBAS
Lac de Peigre
Baie de Port-au-Prince
PORT-AU-PRINCE
LEOGANE
JACMEL
THIOTTE
Marigot
Baie de Jacmel
Etang Saumatre
Trou Caiman
Canal de Saint-Marc
ILES DES ARCADINS
ILE DE LA GONAVE
POINTE FANTASTIQUE
Canal de la Gonave
POINT OUEST
ANSE-A-VEAU
Miragoane
Baie d'Aquin
ILE A VACHE
Canal du Sud
Port-Salut
COTEAUX
Port-a-Pimet
CAYES
Baie des Cayes
Cavaillon
Riv. de Cavaillon
ILES CAYEMITES
Baie de Cayemites
Corail
JEREMIE
Dame-Marie
Grande Anse
Riv. du Nord
Riv. Bouyaha
Riv. de l'Artibonite
Riv. Blanche
Riv. Grande
Riv. Trois
Riv. Jean-Rabel
Riv. Les Cayes
Riv. Jacmel
Riv. Grande Anse
Riv. Cavaillon
Riv. Aquin
Riv. Saint-Jean
Riv. Petite Goave
Riv. Grande Goave
Baie de Grand-Pierre
Baie de St-Marc
Baie de Gonaives
Baie de Petite Goave
Baie de Port-de-Paix
Baie de Mole St-Nicolas
Baie de Les Cayes
Baie de Jean-Rabel
Baie de Anse-Rouge
Baie de Grande Anse
Baie de Cayemites
Baie de Cavaillon
Baie de Aquin
Baie de Port-au-Prince
Baie de Jacmel

2) Montagnes de Terre-Neuve – extending northwest from Gonaïves, composed primarily of limestone and volcanic rock (max. altitude 700m)
3) Montagnes du Nord-Ouest – along the northwestern peninsula, is composed of a thick cap of limestone above a mass of igneous rocks (max. altitude 850m);
4) Montagnes Noires, the rugged range between the central Plain and the Artibonite Valley, composed primarily of limestone (max. altitude 1,400 m);
5) Montagnes du Trou d'Eau, north of the Plaine du Cul de Sac, primarily composed of limestone and some exposed basaltic rock (max. altitude 1,520 m);
6) Chaine des Matheux, extending from St Marc to the Plaine du Cul de Sac, composed of limestone (max. altitude 1,575 m);
7) Massif de la Selle, the highest and largest mountain range in Haiti, extending west from the Dominican border about 100 km, dominates the southern peninsula. The range is about 30 km wide and composed mainly of limestone with some younger detrital rocks. It is very rugged with a maximum altitude of 2684 m at Pic la Selle;
8) Massif de la Hotte covers the southwestern part of the southern peninsula. It is rugged, steep and almost inaccessible. Composed of Eocene limestone and basaltic volcanic rocks, it features Pic Macaya, towering at 2347 meters above sea level (masl).

Pic la Selle, in the southeast, has the highest elevation in Haiti. The highest peaks in the north are much lower, with Morne Brigand near Le Borgne reaching 1147 masl. In the south central region Morne Baptist in the Chaine des Matheux and Morne Nan Puits in the Montagnes Trou d'Eau attain elevations of 1575 and 1520 m.

Exposed in Haiti are ignous, metamorphic, and sedimentary rocks. Both plutonic and volcanic rocks are found, ranging in composition from ultramafics to leucratic tonalities. The metamorphic rocks originate primarily from volcanic flows, tuffs, and limestones. The metamorphism appears to be primarily regional, with contact metamorphic effects found only locally around some intrusions. Sedimentary rocks are mainly of later Cretaceous and younger ages.

Some important facts about the geology of Haiti can be summarized as follows:

1) The origin of the land mass of Haiti is oceanic crust;
2) Volcanic activity practically ceased in Hispaniola in the late Eocene;
3) Some Upper Tertiary volcanic deposits have been reported in Haiti, and several outpourings of late Cenozoic limburgite, hornblend-augite, andesitic porphyry, and nepheline basalt occured in the southern part of the island, the ages of which are approximately the Pleistocene;
4) The high percentage of sedimentary rocks, about 80 percent, are mostly middle and upper Eocene limestones;
5) Rocks of igneous origin, about 20 percent are found where the overlying strata of sedimentary rocks have been worn away;
6) As a general rule areas of igneous rocks, or soils derived from them, coincide with areas of high rainfall where erosion has been rapid, as in the mountains of the north;
7) Mountain soils derived from limestones are more fertile then those derived from old igneous rocks;
8) Alluvial plains and pockets of alluvium in mountains are most productive since they receive yearly inputs of new materials, such as silts and gravels from natural erosion;
9) Repeated changes in sea level in the Caribbean over geologic time have provided a sufficient number of land bridges for the dispersal of plant and animal species found on the island today;
10) The subsequent permanent rise in the sea level has given rise to much local endemism of plant species, yet the basic common relationships among plant species exist throughout this biogeographic province.

B.- CLIMATE

The highly varied topography with elevations ranging from sea level to over 2680 m results in a large variability of rainfall and temperatures. These variations over relatively short distances resulting in numerous micro-climates make characterization of rainfall patterns by areas of significant size and mapping for agricultural purposes problematic.

Haiti lies in the Low Subtropical Region (18-20 degrees North latitude), not truly tropical but rather that portion of the Tropical and Warm Temperate Regions which is free of frost at low elevations above sea level and in which the temperature range is significantly wider than in the deep tropics.

An extensive chain of meteorological stations was set up in the 1920s and more have been added since that time with the result that many places have at least 40 years of precipitation data. Many other areas, however, do not resulting in the need to extrapolate frequently for planning purposes. The wettest areas for which records are available include: Bel Air (4180 mm); Sources Chaude (3410 mm); Choiseul (3418 mm); and Baptiste (3322 mm). Unfortunately, the period of record for these sites is less than six years, hence they may have been unduly influenced by anomalous precipitation events such as tropical cyclones. Holdridge's Life Zone Map of Haiti prepared for and modified by the OAS in the 1960's indicates the wettest region to lie in the Southwest in the Pic Macaya region, which could receive as much as 5000-6000 mm of rainfall, but for which no precipitation records exist.

Most precipitation is brought by the Northeast Trade Winds and to a lesser extent by winds from the east. Site specific rainfall patterns are influenced mostly by orographic (related to topography) factors. For example, high land masses such as mountains intercept this precipitation so that the highest rainfall areas are in the mountains of the north coast (near Cap Haitian) and in the southwest peninsula. In the latter case, the Gulf of Gonave serves as an additional source of moisture which feeds the hydrologic cycle.

The Central Plateau, an area of relatively high rainfall, exhibits an anomalous pattern derived from turbulence of air masses flowing in laterally to fill the vacuum in the wake of the high mountain areas. This pattern probably applies to other areas of Haiti such as in the western end of the southwest peninsula.

Convectional rainfall, e.g. thundertorms, and hurricanes, also may bring heavy local rain from any direction, depending on the relation of a given place to the path of the storm.

Although one fourth of Haiti consists of areas with annual precipitation of less than 1200 mm (Moral, 1961), most of the country receives at least 1000 mm of precipitation annually, and a subtantial portion receives at least 1500 mm. The higher elevations of the southern peninsula, northern plains and central plateau receive over 2000 mm with some areas in the southern peninsula receiving over 3000 mm. Most of the northern peninsula, the coastal plains reaching from the western tip of the northern peninsula to the Cul-de-Sac region, the lower elevations of La Gonave Island, and small areas in the extreme northeast and eastern ends of the Cul-de-Sac receive less than 1000 mm of precipitation, with some areas receiving less than 500 mm. A rough characterization of the rainfall of seven principal areas, differentiated on the basis of rainfall, follows: (Library of Congress, 1979).

- Northern plain and mountains: More than 1270 mm, with as much as 2540 mm on the higher mountains;
- Northwest: Semi-arid conditions prevail throughout the region, especially around Mole St-Nicolas (508 mm) on the extreme western end of the northern peninsula; Port-de-Paix has about 1524 mm in the mountainous areas;
- Western coast from Mole St-Nicolas to the Cul-de-Sac Plain at Port-au-Prince: Very dry with 500 to 1000 mm of rain; a semi-arid area extending back from the coast over the plain to the mountains covered with xerophytic vegetation such as mesquite, thorny shrubs, and cacti;
- The island of La Gonave off the coast has similar cover and a rainfall of about 508 to 762 mm;
- Artibonite Valley: Lower portion of the valley is a semi-arid area, but rainfall increases rapidly up the valley until it reaches a mean annual level of about 3000 mm; however, about 40 km away in the Cul-de-Sac plain, at about the same altitude, the driest area with annual rainfall of about 500 to 750 mm is found;
- Eastern part of the mainland between the two peninsulas: The Central Plateau receives about 1016 to 1524 mm of rainfall;
- Southern peninsula: Well-watered, with 1524 mm of rain or more in all parts, except the southern slope of the western end and a small area near Anse-à-Pître in the Southeast.

C.- ECONOMY / ECONOMIC DEVELOPMENT

Haiti has potential to compete more successfully in the world economy, contrary to common belief outside the country. Its physical and human resources are not negligible. The country is well within the range of the vast North American market. It has built a basic infrastructure where 15 years ago there was hardly a paved road. Almost 50 percent more children are attending school than 20 years ago.

Yet the pace of economic growth is slow compared to its potential. Haiti's economy has shifted significantly in recent decades away from traditional agriculture and towards urban dependency and its growing industrial sector. Sectors other than agriculture have grown but not sufficiently to absorb all those leaving rural Haiti. As a result, some 25,000 Haitians (0.5 percent of the population) leave their native land each year to seek employment in North America and the Dominican Republic.

Exports, imports and investments have risen markedly in the last 15 years but consumption has not increased in real terms. There is now a greater reliance on imported goods, especially food and public goods and services.

Present economic conditions are so critical that there are few peasants with surplus cash or agricultural commodities. Government policies, such as subjecting coffee, their primary cash crop, to an export tax which represents half the producer price, have made the situation far worse.

Economic problems in industry are more recent. Manufacturing output grew throughout the 70's, at a very rapid 10 percent per year but has since declined sharply, partially due to the global recession of FY 81-83 but more fundamentally, because of the consequence of protectionist polices. While there was some improvement in FY 84, which protected import substitution industries, Haitian industry is still considered stagnant. Only a fast growing export assembly subsector contributed to growth in FY 84.

Public investment, and, thus, economic growth have suffered both from less public savings and from the government's recent acquisition of five uneconomic

but major industrial enterprises. The tax base has grown slowly and unevenly, largely because of increasing exemptions. Many tax rates are too high, encouraging evasion. Meanwhile public expenditures have steadily expanded, outstripping current revenues and making the financing of the public investment program difficult, as evidenced by the government's frequent inability to meet its counterpart funding obligations for projects financed by external aid agencies.

Haiti relies heavily on external donors to finance development activities. The United States provides more assistance than any other donor; over $45 million in development assistance, food and disaster relief and Economic Support Funds in FY 84. Over 300 non-governmental organizations (NGOs) annually contribute an estimated $65 million in resources and services to Haiti's development (FAO, 1985) representing a powerful influence on the economy and the environment. Unfortunately, individual projects are not the end product of a clearly defined set of priorities based on integrated economic and environmental goals. Moreover, their composition has changed from an initial concentration on providing economic infrastructure to include social sectors, and, more recently, several major public industrial enterprises. To correct the stagnation and disequilibrium of recent years, it has been suggested that the short term priority for public policy be financial and economic stabilization, using a variety of methods; among them, tighter control of public expenditures, new tax objectives and the development of long-term financial institutions and instruments (World Bank, 1985).

In agriculture, the consensus seems to point to a concentration on farm enterprises in irrigated and rainfed zones of high production potential achieved through changes in price, trade and fiscal policy; the continued reform of the Ministry of Agriculture and its investment program and the establishment of a strong credit institution. In industry, elimination of the anti-export bias principally through a reduction of protection and actual export promotion, a restructuring of public industrial enterprises and a more realistic look at industry's infrastructure and training needs. With all these changes, however, Haiti will still have to look to substantial external financial assistance for its economic recovery.

III

Land, Water And Forest Resources

A.- INTRODUCTION

Conceptually, the problem of environment and development is how to maintain and increase resource exploitation without foreclosing future resource use options. This makes it essential to achieve compatibility between immediate, short-term needs for population support and long-term needs for a viable resource base and flexible resource use systems. The fact that physical system boundaries and the boundaries of human systems that exploit the resources seldom coincide, complicates effective resource management. Thus, there is a critical need to protect renewable resources through long-range ecological planning, including socio-economic considerations.

Development of an ecological approach to resource management must integrate physical, social, political and economic systems. To maintain the vegetation, soil, and water resources, it is crucial that human use of the environment does not sress the resource base to such an extent that degradation is either irreversible or so large as to require excessive economic inputs that exceed the potential returns (for many places in Haiti, this condition has already been reached).

Vegetation, soil and water interact in defining the natural resource base. This, in turn, determines the carrying capacity of the land for agriculture, including livestock use, and forestry.

B.- THE LAND RESOURCE

The land/soil resource base in terms of erosional/depositional dynamics is determined by precipitation (type, amount, intensity and seasonal patterns); wind (velocity, duration and direction); soil erodibility (structure and texture); topography (slope and length, especially in arid and semi-arid areas, and spatial location within the hillslope system); groundcover (vegetation density and type); and conservation practices (mulching, pasture rotation, etc...). Other factors, such as the location of the water supply (type and seasonal availability) protection against fire, livestock type and numbers, land ownership, and service infrastructure, are significant in determining an area's erosional/depositional patterns.

The texture of the soil is important. Finer soils can be set into motion and transported at lower velocities than coarse ones. While coarser soils are more resistant to erosion and have higher infiltration rates, finer soils usually have higher agricultural potential. Finer soils generally have a higher porosity (soil moisture storage) increasing their plant potential during drier periods, and producing a higher seed germination rate in most cases. Where areas are drier, bare soil surfaces exist and the texture is sand size or finer, wind potentially becomes an erosional agent as well.

Erosion rates for specific areas are determined by the interaction and magnitude of these variables. Removal of groundcover by stock overgazing, fires and farming, substantially reduces its effectiveness. In Haiti, as rural population pressures increase, and damaging agriculture practices continue, the ecological system of the soil, water and forest will continue to decline. Clearly, vegetation cover and soil properties are crucial management issues for most areas where hydrology, forestry, and agriculture are primary concerns.

Erosion

While Eckholm (1976) clearly overestimates the proportion of exposed bedrock in Haiti (50 percent), the very existence of widespread rocky outcrops in a tropical setting indicates the severity of the Haitian erosion problem. Tropical areas, under natural conditions, normally have a thick veneer of weathered material. Almost always, bedrock exposures reflect accelerated man-induced soil erosion in humid tropical areas. Generally, 90 percent of total nutrient supply is found in the upper 10 cm of tropical soils (Ewel, 1977). Almost everywhere in Haiti, this rich topsoil is gone. Additionally with the coarser subsoils commonly found in upland areas, the decreased moisture-storage

capacity of these soils produce pseudo-droughts that stress vegetation growth whenever rain does not occur frequently. Thus, with the ever declining Haitian soil resource, more and more water and nutrient supplies are required to maintain the status-quo. Unfortunately, almost no actual soil erosion data exist on a national scale. Perceptions and qualitative studies comprise the literature.

Haiti's overwhelming environmental problem is soil erosion. Despite research, legislation, erosion control and reforestation projects, indicators clearly point to an acceleration in the processes contributing to land degradation from soil erosion. Food production is declining, river regimes are becoming more extreme (Lowenstein, 1984), bedrock exposures on hillslopes are growing in areal extent (Coffey, et al. 1984), and rural to urban migration pressures are increasing (DATPE, 1984). None of these trends is surprising, since the rural population density per hectare (ha) of arable land is close to 700 (USAID, No. 1, 1984). On steep slopes (15-100 percent), as much as possible annual crop agriculture is practiced. For example, on the southern peninsula population densities over 125 per km^2 (Coffey, et al., 1984) exist on steep slopes of the upland areas. Even in the most remote mountain areas where no permanent settlements exist, land clearing occurs (Cohen, 1984).

This alteration in the land use, from forest to shifting cultivation to abandonment, sets into motion an array of dynamic socio-economic and physical events that exacerbate the trend toward a declining land, water, forest resource base. This affects not only the uplands, but also many of the high potential lowlands. With the passing of each year, the strategies that could salvage the Haitian countryside are becoming less viable.

Three direct results of soil loss need to be considered within the Haitian context: the adverse effects of soil erosion on agricultural productivity; the impact of transported sediments via rills, gullies, streams, and rivers on major engineering works (e.g. reservoirs, irrigation canals); and the impact on coastal habitats (e.g. mangrove, coral, seagras beds, fish spawning and nursery grounds).

Considering the generally degraded nature of most Haitian soils with shallow root zones, target figures for erosion control of 2 MT/ha/yr are realistic (Young, 1980) to mitigate the enormous impacts of erosion on agricultural productivity. To prevent negative impacts of soil loss on engineering works, even lower sediment delivery values than those affecting agricultural productivity are generally required. Coastal resources such as mangroves, coral reef and seagrass beds, found in areas where significantly increased turbidity is adversely affecting the resource, will benefit from the erosion control initiated for conservation of agricultural soils and protection of engineering works.

C.- THE WATER RESOURCE

Surface Water

The broken and steep landscape which characterizes most of Haiti's surfaces give rise to numerous streams and rivers. During periods of rainfall the flow of most streams is torrential and of short duration. Few rivers have permanent flow. The principal catchment areas and river systems are shown in Table III-1 There have been only limited measurements of water flows, and those generally date prior to 1940. The flow data cited usually refer to average flows. From the standpoint of agricultural use, average flows have only limited relevance to water potential because of the high irregularity of flow. This is illustrated by flow data for 31 rivers in 26 catchment basins, as provided by Harza (1979). The average annual flow for the 31 rivers is given as 274.031 mc/sec, 90 percent of which is provided by four rivers. The ten year, one month low flow, is given as 48.770 mc/sec, of which 73 percent is provided by the same four rivers. In the absence of impounding structures (the dam is the only significant one, since the physiography of most river basins does not lend itself to impoundment), much of the water goes out to sea.

Table III-1
PRINCIPAL CATCHMENT AREAS OF HAITI

The main river	Average Runoff mc/s	Length Km	Catchment Area / Km^2
Artibonite	34.0	280	6,862
Rivière de la Grande-Anse	27.0	90	556
Rivière de l'Estère	19.0	?	834
Les Trois Rivières	12.0	102	897
Rivière de Cavaillon	9.0	43	380
Grande Rivière du Nord	7.0	70	312
Rivière du Limbé	6.4	70	312
Rivière Momance	6.4	53	330
Grande Ravine du Sud	3.9	34	330
Grande Rivière du Cul-de-Sac	3.3	?	290
Rivière l'Acul	?	36	?

Source: Data from Library of Congress, Draft Environmental Report on Haiti, 1979.

Table III-2
HYDROELECTRIC POTENTIAL OF HAITI

Region	River	Site	Location	Avail. Power
	Grde Rivière du Nord	GN-47.7	18.5 km/N 85° W. Vallières	600
	Limbé	L-34.6	11.0 Km/S 15° W. Limbé	279
Nord	Caracol	Caracol	24 Km/S 24° Cap-Haitien	282
	Pte Rivière	Pte. Rivière	8 Km/W Trou du Nord	130
	3 Rivières	TR-28	13.5 Km/59° E Port-de-Paix	1,778
		TR-76	10.5 Km/ N 88° E Gros-Morne	726
	Artibonite	A-108.1	2.5 Km/N 60° E Verrettes	20,936
		A-139.9	2 Km/N 12° E Lachapelle	25,265
Trans versale		A-166.0	5 Km/N 45° W Mirebalais	11,850
		A-176.7	3 Km/N 24° E Mirebalais	16,982
	Guayanouc	GU-3.5	10.5 KM/S 76° E Thomonde	3,408
		GU-25.7	8 Km/N 85° Thomassique	2,134
	La Theme	La-1.6	Mirebalais	1,349
	Fer-à-Cheval	FC-35.8	9km/S 15° E Lascahobas	220
		Saut d'Eau	12 Km/S 83° W. Mirebalais	670
		Déluge	13 Km/S 5° E St. Marc	1,160
	Gobe	Gobe	13 Km/S 69° St. Marc	190
	Samana	Samana	8.5 Km/N 15° E Hinche	776
	Roche Plate	Roche Plate	14 Km/S 33°o E Lascahobas	2,570
	Grise	G-31.0	16 Km/S 70° E P.au.P	720
		G-41.7	19 km/S 60° E P.au.P.	379
	Momance	Momance	20 km/S 72° W P.au.P.	1,120
	Pichon	Pichon	6 Km/N 45° E Belle Anse	1,234
Ouest	Gosseline	Gosseline	11 Km/N 32° E Jacmel	13
	P. Riv. Jacmel	Bassin Bleu	6 km/W Jacmel	129
	Cavaillon	C-42.3	5 km/N 47° E Camp-Perrin	240
	G.R. de Nippes	GNIP-29.5	13 Km/S 360° W Anse-à-Veau	382
		S. du Baril	10 Kms/S 45° E Anse-à-Veau	129
	Grande Anse	GA-4.1	4 Km/S 5° W. Jérémie	1,210
		GA-35.4	20 Km/S 53° W. Jérémie	970
Sud		BD-8.6	24 km/S 49° W. Jérémie	1,060
		BG-15.4	26 km/S 59° W. Jérémie	2,460
		Voldrogue	18 km/S 4° W Jérémie	230

Source: Inventory of Hydrologic Resources (Synthesis of Hydro-electric Potential of Haiti – CIDA, April 1977.

Water potential for agricultural purposes depends on the proximity of suitable land. Estimates of this potential is variously reported, with perhaps 180,000 ha as the upper limit. Actual irrigated lands cover less than 70,000 ha in Haiti.

The water resources of Haiti have also been inventoried and characterized in accordance with hydroelectric potential (See Table III-2).

Groundwater

The foregoing refers only to surface water and does not take into account groundwater resources. There is little information on the potential availability of groundwater. Harza (1979) estimated the potential groundwater resources in 22 areas selected to be used for possible irrigation. Table III-3 summarizes these data.

Table III-3
GROUNDWATER POTENTIALS FOR 22 SELECTED AREAS

Region	Number of Project Areas	Number of Project Acquifers	Potential No. of Acquifers for which flow was estimated	Water Flow t/sec
North & North Western Region	7	13	7	500-685
Artibonite Region	2	2	–	–
Southeast Coast Region	3	5	2	399-1114
South Coast Region	5	3	2	530+
Central Plains Region	5	6	1	15-45
Total	22	29	12	1444-1844

Source Harza 1979 Final Reports: Water Resources Study for Haiti.
Area springs are lumped and counted as one potential acquifer.

Groundwater is used for irrigation in significant amounts in only two regions. Currently water is pumped for irrigation in the Cul-de-Sac area, with some 50 wells for irrigation of about 3500 ha by HASCO. An additional 19 wells are used by several cooperatives for irrigation within the region, producing a wide variety of crops. The wells were initially expected to provide water to irrigate approximately 200 ha each. In practice, however, only about 100 ha are irrigated from each well (Hauge, 1984). Groundwater for irrigation has also been developed in the Plaine des Gonaives. Pumped wells supply about 75 percent of the water for irrigation of 3000 ha, the remaining 25 percent is supplied by pumping water from seasonal flows of nearby streams.

Groundwater capital is widely used for domestic purposes in the larger towns, including the city of Port-au-Prince. Some of the principal areas in which groundwater is domestically used include the Cul-de-Sac, Leogane, Carrefour, St-Marc, Cabaret, Grande-Rivière Du Nord (Grande Rivière du Nord), Limonade, Ouanaminthe and Aquin (Library of Congress, 1979).

Availability of Rainfall for Agriculture

Figure III-1 illustrates the general pattern of rainfall throughout Haiti. Most locations have a dry period during the winter months, while the high rainfall values in October and November partially reflect the impact of hurricanes on the mean monthly values. In most years, rainfall is less than the values given on this figure for these two months. When hurricanes strike, the rainfall values are far greater than the 300 mm values. Table III-4 presents mean monthly moisture availability index values (MAI) for some selected stations.

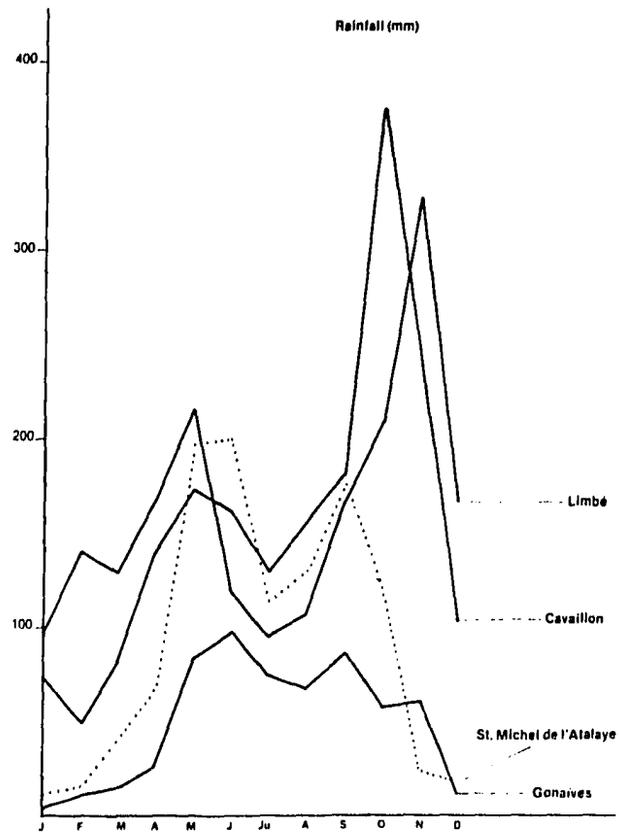


Fig. III-1: General rainfall patterns based on four selected localities.

The MAI is a useful agro-climatological index for planning purposes because it indexes relative rainfall adequacy. It is defined as PD/ETP, where PD is the 75 percent probability of monthly precipitation, and ETP is the monthly evapo-transpiration potential. An MAI value of less than 0.50 signals that dry fertilizers should not be used, as not enough moisture exists to

Table III-4
MONTHLY MOISTURE AVAILABILITY INDEX FOR SELECTED STATIONS

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Camp Perrin	0.30	0.28	0.39	0.74	1.17	0.66	0.45	0.64	1.11	1.65	0.86	0.18	1.15
Cerca la Source	0.00	0.00	0.00	0.10	0.80	0.43	0.49	0.57	0.66	0.78	0.05	0.00	0.60
Cap-Hait	0.45	0.33	0.12	0.12	0.32	0.27	0.05	0.10	0.32	0.89	1.44	0.85	0.87
Ennery	0.00	0.00	0.02	0.09	0.92	0.69	0.17	0.23	0.48	0.43	0.13	0.012	0.58
Furcy	0.00	0.02	0.01	0.15	0.55	0.64	0.67	0.93	1.48	1.62	0.45	0.00	1.11
Desdun.	0.00	0.00	0.00	0.00	0.07	0.20	0.20	0.21	0.15	0.06	0.00	0.00	0.23
Saut Mat	0.94	1.12	0.85	1.59	2.00	1.09	1.20	1.96	2.38	2.19	1.37	1.60	2.10
Soubois	0.44	0.52	0.58	1.03	1.80	0.94	0.76	0.99	1.83	1.64	0.86	0.35	1.44

Source: MAI values from: Coffey, Lewis, Hauge (1984) / Hargreaves and Samani (1983)

allow the fertilizer to become soluble and then be absorbed for plant growth. Since it detects moisture deficiencies, the MAI values are useful for first approximation determination of irrigations needs. Only when MAI values are at least 0.75 will the better soils have high enough moisture storage to prevent moisture stress. As soils degrade through erosion, a higher MAI value is likely needed. Finally, a high MAI value (> 120), generally indicates a need for drainage to prevent water logging on flat or gentle slopes.

Irrigation

Table III-5 lists the number of months that irrigation is needed, by geographical location, according to MAI values. For values between 0.50 and 0.74, supplemental irrigation would increase agricultural yields by removing moisture stress during the growing season. Because the moisture deficit in these regions is not large, a small amount of irrigation should greatly increase yields. In areas where slight moisture needs (0.50-0.75) are only during brief dry periods falling within the humid season, supplemental irrigation has proven very effective elsewhere and would be useful in Haiti. MAI values between 0.33 and 0.49 indicate greater water demands. Without irrigation under these conditions, yields are exceedingly low. Annual crops ideally should not be grown when the MAI values are in this range; not only because of low yields, but also with the poor ground cover, high erosion would likely occur. Finally, when MAI values are less than 0.33, not only is irrigation needed, but fields generally require large quantites of water when riverflows are low.

According to the information provided in Table III-5, the existing irrigation schemes that require the greatest quantites of water per area of irrigated land, are found in the Cul-de-Sac, lower Artibonite and northwest, while the irrigated areas with the lowest water demands are on the north and south coasts. Unfortunately, from an environmental management perspective, the prognosis is not favorable for irrigation expansion, anywhere, even in those areas of relatively low water demand, unless major environmental interventions are immediately initiated in the uplands of the various watersheds.

To maximize surface waters for irrigation, impoundment of water is required; yet, reservoirs can rarely be justified economically, solely for irrigation. Multipurpose use, including combinations of flood control,

Table III-5
IRRIGATION NEEDS BASED ON MAI INDEX

Location	No. of Months having MAI Values 0.50-0.74	0.33-0.49	<0.33	Months of Irrigation	Example of Irrigation Project
So. Coast of the So. Peninsula	3	2	3	8	Moreau-Funfrede
South East	3	2	6	11	Orangers
Cul de Sac	2	3	7	12	Varreux
Lower Artibonite	1	2	9	12	Artibonite dist. I-IV
Upper Artibonite	1	2	6	9	Nan Paul
North Coast	1	4	2	7	Limbé
North West	0	3	9	12	Jean-Rabel

recreation and energy production, more often than not, must be included to make irrigation feasible, using impoundment strategies. Even then, costs can only be justified if the reservoir's costs can be pro-rated over a long period of time (e.g. 100 years). In the context of Haiti's existing environment, reservoir construction is a reckless strategy. First, due to the lack of tree cover and poor land management in the upper portions of almost all Haitian river basins, sedimentation would be rapid in any reservoir. For example, Lake Peligre has lost over 30 percent of its storage capacity in less than 25 years (LGL, Vol. 2, 1981). Second, good agricultural lands along the valley bottoms in the uplands would be removed from production, reducing food-growing capacity for thousands of small famers.

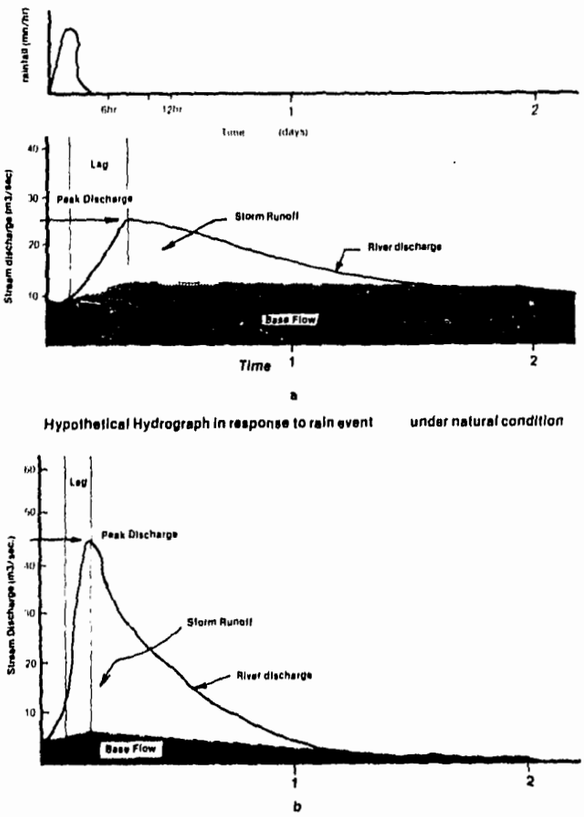


Fig. III-2: Water availability as a function of vegetative cover and river discharge

Evidence exists that the quantity of surface waters available for irrigation is decreasing each year due to the relationship between vegetative cover and river discharge (Figure III-2). Baseflows, which represent the water available for irrigation when storage is limited, are diminishing (Lowenstein, 1984). Thus, it would appear that groundwater utilization needs now to be considered, although a recent evaluation dismisses this strategy a priori, without any data analysis (LeBaron et al. 1984). Potential groundwater use, however, is being threatened by the continuing degradation of the uplands. With an ever lower percentage of rainfall infiltrating into the groundwater, recharge of groundwater must be decreasing.

Unlike other renewable resources, the groundwater resource still exists within the lowlands due to rapid runoff caused by deforestation and steep slopes. Groundwater utilization, particularly in these areas, needs to be evaluated. Development of this potential resource, however, should not begin until proper environmental safeguards are implemented. If pumping rates exceed inflow into the groundwater, the salinization of fresh water will occur. To be able to maximize pumping, interventions throughout the pertinent watersheds need to be undertaken. The linkages affecting the environmental status of water, soil and forests both in-situ and spatially, need to be considered at the onset of any proposed activity that intends to utilize groundwater resources.

Watersheds

Haiti's watersheds (river basins) include all the lands above the river-discharges to sea. All flows of energy and matter move solely in a downstream direction. The flow conditions are determined by the elevation and slope of the basin and the climate (precipitation), as well as the resistance of the soil and its infiltration characteristics (vegetative cover). Crop selection, farming practices and tree cutting also significantly affect the magnitude and stability of the river basin system, or watershed. From an ecological perspective, the uplands and lowlands within a watershed are completely inter-related, just as the physical characteristics and the socio-economic systems throughout each watershed impact one another.

The effects of soil erosion on river flow are experienced both on-site and downstream. Accelerated soil erosion upstream degrades both upland and downstream areas, such as reservoirs and engineering works (e.g. irrigation canals and sewage systems), resulting in ever higher costs for maintenance and reconstruction (Figure III-3). In addition, with lower infiltration rates resulting from existing soil loss, the flow regime and total river discharge are often permanently altered. Changes in the flow, both rate and volume, and in sediment load, complicate the management considerations of forestry, agriculture, and downstream impacts of all activities affecting the watershed. On-site and downstream impacts of all activities affecting the watersheds should be considered in both economic and environmental planning.

The amount of water (discharge) flowing through the river basin system, and the seasonal variations, are important factors in watershed management. When precipitation strikes the ground, the route that

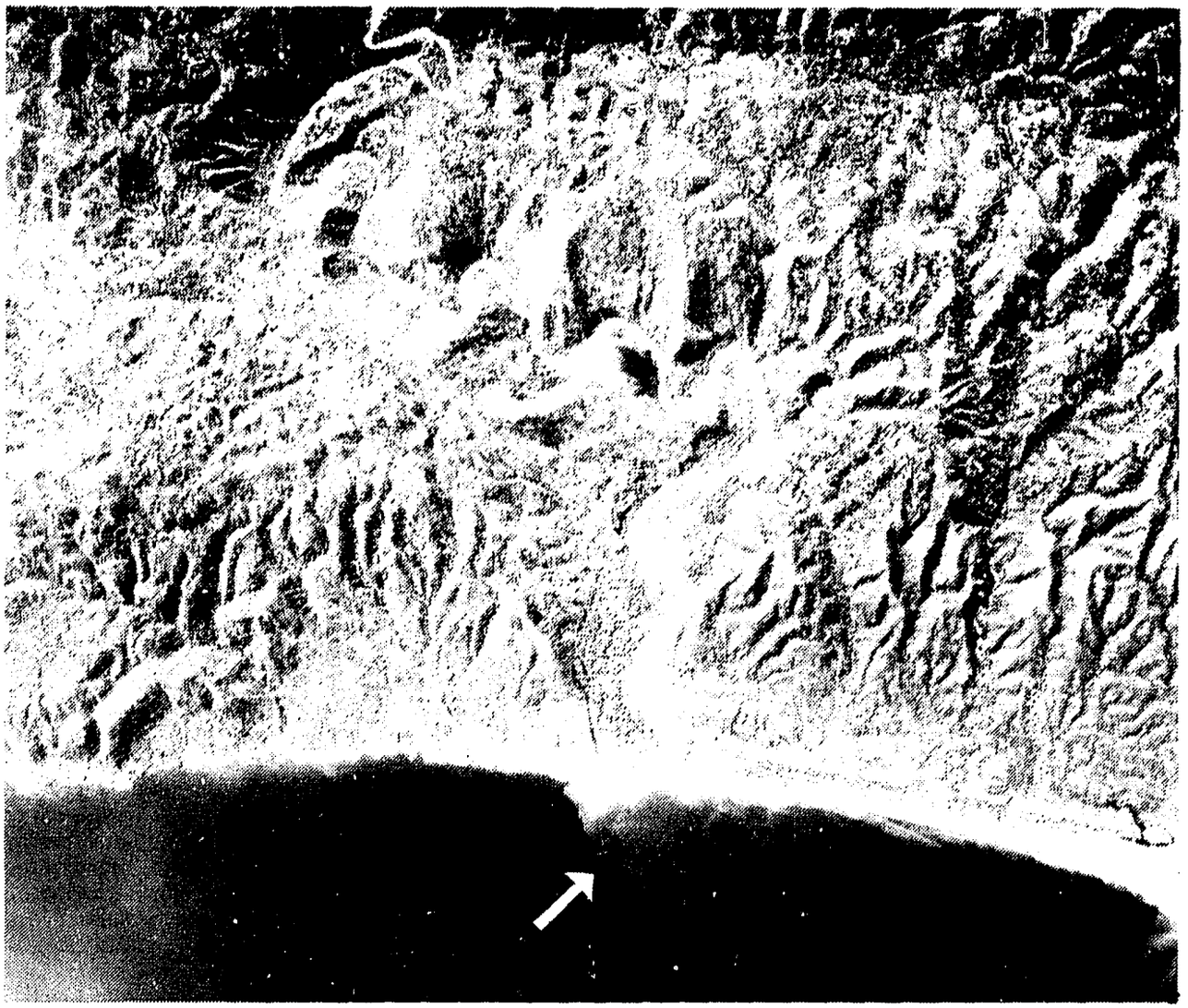


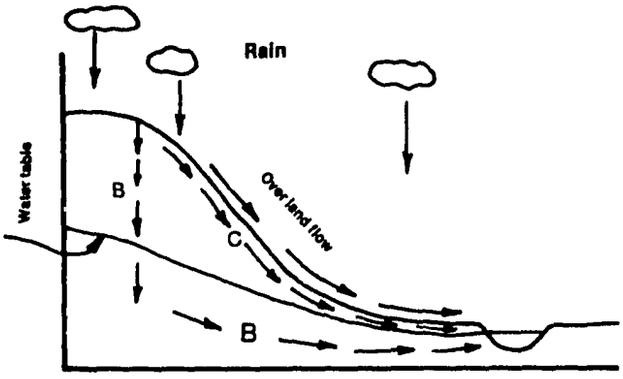
Fig. III-3: Aerial photograph (Scale 1:40,000) flown in 1978 showing terrigenous sediment input to the marine environment from Rivière Roseaux, near Jérémie (Courtesy: Service Géodésie et Cartographie)

the water takes (Figure III-4) in reaching the river channel influences the river's flow regime. Overland or surface water flows travel at the highest velocity (m/min) and reaches the channel first. Surface water, however, stops flowing shortly after the rain ends. Conversely, the rain that infiltrates through the soil and becomes groundwater, moves more slowly (cm/hr) and may take weeks or months before entering the river channel. Overland flow contributes mainly to the stormflow of a river (Figure III-2). Groundwater flow is the major contributor to the baseflow of the stream. It is the baseflow that permits rivers to continue to flow during the dry season in Haiti. Throughflow's contribution to river discharge is closer to that of the groundwater flow; however, in a humid tropical river basin, a very large proportion of the throughflow would be captured by evapo-transpiration. To a large degree, this water source represents rainfall that never enters the river system, but provides a very important source of moisture for deep-rooted plants.

When a river basin's groundcover is altered from broadleaf forest to an annual row crop such as maize, a larger proportion of the rainfall becomes overland flow; while the groundwater, and, accordingly, the baseflow, decreases. With less water reaching groundwater levels and greater volumes of water entering the river, water levels in the channel rise faster and the river system has larger peak discharges but lower recharge and baseflows. River flows also drop faster since surface water flows only continue for a short period after the rain ceases. In Haiti, with its soils and altered vegetation cover, the hydrograph illustrated for cleared lands in Figure III-2 is the typical case. It is predicted that as conditions for erosion increase, river regimes will become ever more peaked due to an ever greater proportion of the rainfall becoming overland flow.

In Haiti this trend towards more extreme flow regimes is further strenghtened by the steep slope charac-

teristics of most of the river basins. Generally speaking, those parameters that affect the hydrologic balance between overland flow and infiltration into the groundwater are more sensitive on steeper slopes than on flat lands. Thus, the destruction of the forests on fragile uplands has severely altered river hydrographs in the lowlands, the very areas in Haiti where a stable stream regime is needed most to maximize the utility of the water resource.



B = Infiltrated water that becomes ground water flow
C = throughflow – a shallow (subsurface) flow that moves within vegetal debris or the upper portions of the soil

Fig. III-4: River flow regime in relation to infiltration and through flow.

A paucity of river discharge data exists throughout the country. No systematic data collection is in operation. Almost all discharge values quoted for Haitian rivers are based on measurements dating from the 1930-1940 period. A few recent discharge values are available, based on short-term observations connected with specific projects. Since dramatic environmental changes to vegetation cover and soils have occurred during the last forty years, the often quoted values are out of date. Mean discharge values in almost all cases are probably larger since evapo-transpiration losses must be less, with the seriously degraded vegetation cover decreasing the moisture storage potential of the soils found on most slope lands (Coffey, et al., 1984).

These two changes, alone, imply that a larger percentage of rainfall enters the river system today than in years past. Unfortunately, this larger total discharge, reflected in higher mean flows, is a water resource largely lost to the surrounding seas due to the trend of more extreme flow regimes. With each passing year, the rivers and streams throughout Haiti flow more and more like torrents than stable permanent rivers. As a result, the river's use as a water supply for ever increasing population is continuously decreasing. When water is needed during the dry seasons, less is available.

Table III-6 presents the published discharge data for all of Haiti. This lack of current data represents a critical shortcoming for sensible project design of hydroelectric and irrigation schemes. The numerous feasibility studies that have been prepared for irrigation, hydroelectric and other water-related projects, unfortunately, have had to extrapolate from this no longer relevant data base. For example, the Etude de Faisabilité-Projet GU-1-Riv. Guayamouc (HQI-LGL-LMBDS, 1982) which examines the proposed dam sites to protect the Peligre lake from sedimentation, as well as to generate electrical power, is based on the 1925-1931 discharge data. The attempt to update this inadequate data base through correlation with precipitation has had to introduce error into the assessment, since the vegetation and soil attributes of the catchment basin clearly have changed between 1931 and 1982.

Watershed Management

One of the basic tenets of watershed management dictates that the soil surface be maintained in a condition that maximizes the infiltration of rainfall. Trees are crucial components in this strategy. By intercepting precipitation, a dense forest canopy reduces rainfall intensity; dead leaf matter not only protects soils from the direct impact of raindrops, but also increases the infiltration of the ground surface; the root structures of trees increase the resistance of the soil to erosion; and, the vegetation matter on the forest floor increases friction which reduces the erosional potential of surface water runoff. Overland flow of water results whenever precipitation is greater than the sum of infiltration and interception. Removal of vegetative cover from an area increases the erosional potential of an area by lowering infiltration and interception rates which increase overland flow, the major cause of erosion in Haiti. To minimize erosional potential and create a stable hydrologic regime in an area, vegetation is a crucial variable. On steep lands, permanent vegetative cover is absolutely essential to retain vital soils and contribute to a stable hydrologic regime.

The problems of bringing ecological land use planning to tropical river basins before erosion destroys too large a proportion of their soil and water resources, remain one of the major environmental challenges in the developing world (Pereira, 1973). Nowhere is this objective more critical than in Haiti. Improving land use in this country's watersheds must be one of the critical, if not the most crucial, environmental concern of the nation. All available data and surrogates, albeit very limited, indicate that despite widespread recognition of land degradation and destruction, land use practices and trends continue to lower the short-term potential productivity of Haiti's forest land and water resources, and threaten the long-term viability of the nation's natural resource base and its economy. This is not a rural or an urban problem, it is a national problem. A whole array of urban and rural needs, including water, food, building materials, energy and economic development are threatened by existing patterns of land use. More foreboding, recent evidence (Cohen, 1984; Lowenstein, 1984) points to an accele-

Table III-6
RIVER DISCHARGES

River	Site of Cleared Lands	Year	Mean Dis. mc/sec	Max. Dis. mc/sec	Min. Disc. mc/sec
Trois Rivières *	Paulin Lacorne	1965-67	13.13	527.0	2.65
	Pont Gros Morne	23-40;62-67	6.95	1,500.0	0.3
	Plaisance	25-40;62-67	0.87	193.0	0.01
Rivière Limbé*	Roche à l'Inde	22-40	4.29	458.0	0.3
Gde Rivière du Nord *	Pont Parois	22-40	3.41	9.41	–
Riv. Massacre *	Ouanaminthe	22-40	5.34	450.0	0.05
Riv. Boyaha *	St-Raphaël	22-40	3.41	9.41	–
Riv. Guayamouc *	Hinche	26-31	25.52	900.0	0.9
Riv. Artibonite *	Mirebalais	22-40	86.9	2,500.0	8.4
Riv. Artibonite *	Pont Sondé	22-40	101.4	850.0	11.1
Riv. Estère *	Pont Estère	65-67	18.76	95.3	1.85
Riv. Fer-à-Cheval*	Pont Pétion	23-31	11.85	700.0	0.73
Riv. Blanche*	La Gorge	22-40	1.97	200.0	0.65
Riv. Grise *	Amt. Bassin Gén.	19-40	3.97	475.0	0.31
Riv. Pedernales *	Anse-à-Pître	29-30	0.46	0.81	0.06
Riv. Marigot *	Peredot	28-30	2.42	79.0	0.07
Riv. de Jacmel *	Jacmel	26-31	4.67	800.0	0.12
Riv. Momance *	Amont Barrage	20-40	5.88	420.0	0.60
Riv. Côtes de Fer *	Côtes de Fer	28-30	0.27	7.5	0.0
Riv. Cavaillon *	Cavaillon	22-41	9.42	1,035.0	0.70
Riv. Islet *	Charpentier	23-31	2.52	500.0	0.66
Riv. Torbec *	Torbec	23-31	2.66	188.0	0.39
Riv. Ravine du Sud *	Camp Perrin	23-35	4.88	350.0	0.28
Riv. Gde. Anse*	Passe Ranja	25-31	26.85	850.0	0.70
Riv. Voldrogue *	Passe Laraque	28-30	6.07	60.0	0.52
Riv. Limbé #	Pont Christophe	22-30	7.1	–	0.3
Riv. Gallois #	Grison Garde	22-31	0.44	–	–0.07
Riv. Estère #	Pont Benoit	22-31	3.95	–	0.0
Riv. Bois #	Verrettes	24-31; 33,35-40	2.58	–	0.8
Riv. La Theme #	Passe Fine	23-31	4.76	–	0.64
Riv. Montrouis #	Pont Toussaint	24-30	1.84	–	0.15
Riv. Torcelle #	Messaye	22-41	1.15	–	0.0
Riv. Courjol #	Bassin Proby	22-39	1.23	–	0.3
Riv. Matheux #	Arcahaie	22-36	1.50	–	0.4
Riv. Islet #	Cayes	23-31	2.68	–	0.64
Riv. Acul	Carr. Valere	83 est.	3.7	–	–

Sources of data
* OAS, Haiti-Mission d'Assistance Technique Integree, 1972
# HARZA, Water Ressources Study for Haiti, 1979
SHELADIA Ass., Integrated Agricultural Development Project-Dubreuil, 1983.

ration in the processes of environmental destruction. Given the long history of abusive environmental activities, for all practical purposes, the undermining of the country's renewable resources has become an integral part of the nation's fabric. In practice, almost every conventional conservation strategy in the agricultural, hydrologic and forestry realms is ignored throughout the country. Ecosystems everywhere must be experiencing decreasing capacities for sustained production; yet this statement is impossible to prove at the national level, as too little data exists. Only in very limited areas, such as on the bare slopes in the uplands of l'Acul river basin (Coffey, et al., 1984), is there proof of ecosystem decline and collapse. Given the apparent poor status of Haiti's forest land and water resources, immediate action must be taken without the waiting for a complete data base.

D.- THE FOREST RESOURCE

With temperature being relatively uniform throughout the year, it is the amount and seasonal

patterns of rainfall that largely determine vegetative patterns under natural conditions in the tropics. With annual precipitation almost everywhere greater than 1000 mm broadleaf or pine forests should exist throughout 75 percent of Haiti (NRC, 1982). Only in the drier areas along the southern coast, the northwest, the northeast, the lower Artibonite, and the Cul-de-Sac Plain, should dry forest be found (OAS, 1972 – Chapter 5). This was the vegetative pattern of Haiti prior to the European colonization.

Life Zones

According to the Holdridge Life Zone Classification System, there are nine different life zones in Haiti. It is interesting to note that Holdridge devised his classification system while working in Haiti in the 1940's.

- Subtropical Thorn Woodland; represented by semi-desert conditions of only 550 mm of rainfall a year, and a xerophytic forest dominated by Cercidium praexcox, Prosopis juliflora (bayahonde) and cacti from the genera Opuntia and Cereus. This life zone is typical of the cacti formations of the northwestern peninsula.

- Subtropical Dry Forest; characterized by Phyllostylon brasiliensis, Prosopis juliflora and Guaiacum officinalis. Found at altitudes below 400 masl, this second largest life zone is highly productive where soils are deep and irrigation is available (Cul-de-Sac). On shallow soils and without water, it has typically supported sisal plantations.

- Subtropical Moist Forest; constitute the most extensive life zone in Haiti. Characteristic plants have included the mahogany tree (Swietenia mahogani), the tropical oak tree (Catalpa longissima) and the royal palm (Roystonea regia). It prevails on the Central Plateau and on the alluvial plains in the north, center and south. This zone supports the majority of subsistence farming and the cultivation of mangoes and avocados.

- Subtropical Wet Forest; the zone covering most low-altitude mountain ridges and small mountains (mornes). Its coverage is restricted to the nothern and southern coasts of Haiti and portions of the Central Plateau. It supports coffee, cocoa and rubber plantations, primarily on calcareous (limestone) soils.

- Subtropical Rain Forest; found typically at the lower altitudes of the Massif de la Hotte in the southern peninsula. This zone is not productive for farming, since it contains a shallow soil base, yet its recent exploitation for slash-and-burn agriculture indicates the extent of the population pressure on the remaining forest resources of the country. Because of heavy rainfall, it produces poor harvests and is very susceptible to erosion. Its value as wildlife habitat and erosion control far exceeds its value for cultivation of food crops.

- Subtropical Lower Montane Moist Forest; represents the zone of low altitude mountains, such as the Kenscoff area near Port-au-Prince, in altitudes ranging from 800 to 2000 masl. It is generally well suited for the cultivation of potatoes and other vegetables, if the slopes are farmed using soil conservation practices..

- Subtropical Lower Montane Wet Forest; characterized by higher rainfall than in the previous zone and includes most of the pine forest remaining in Haiti. Its use should involve the protection and sustained utilization of the pine forest (Pinus occidentalis).

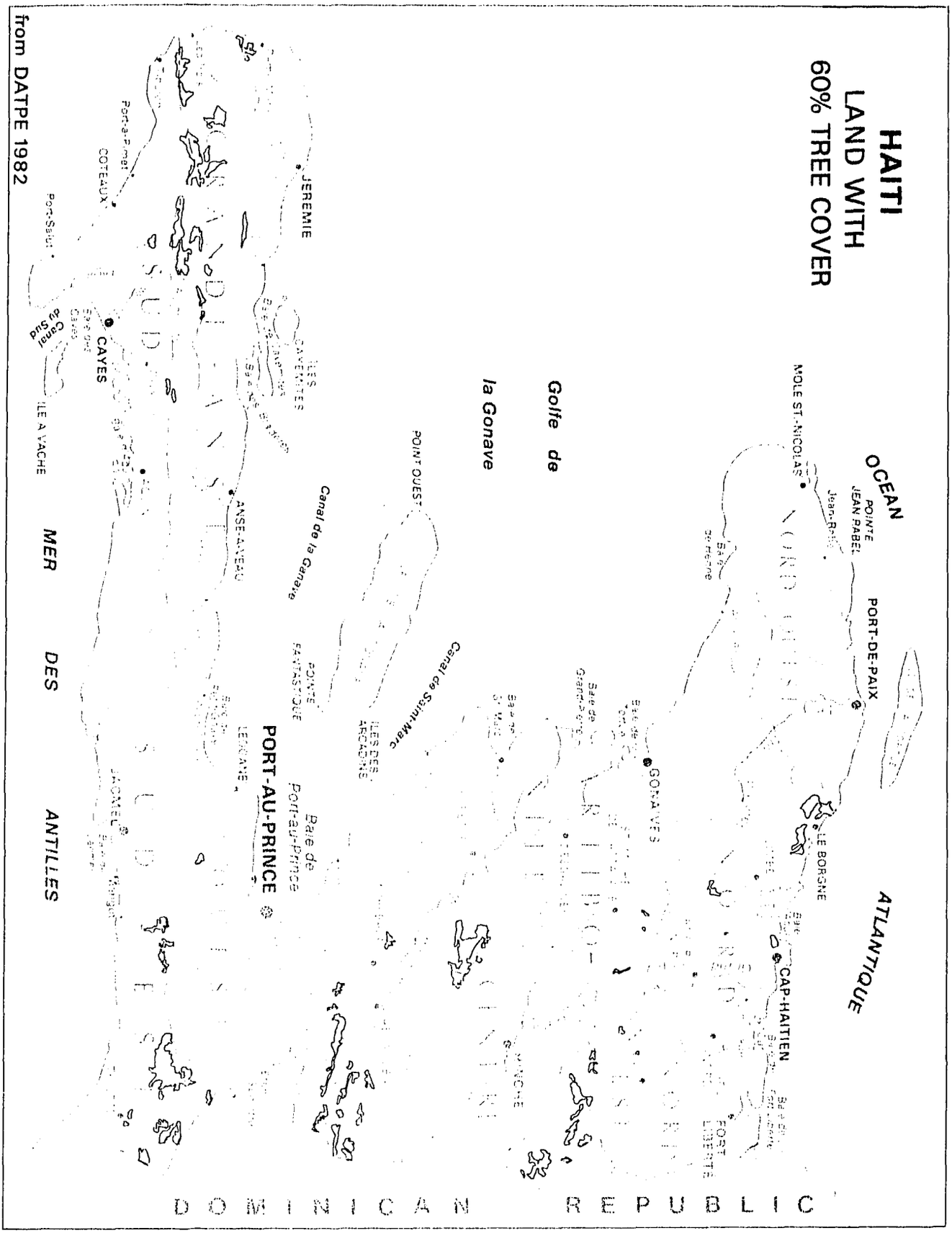
- Subtropical Lower Montane Rain Forest and Subtropical Montane Wet Forest; cover a limited area in Haiti, primarily on the slopes of the higher mountain ranges in the south (La Selle). These zones are characterized by pine forest and evergreen broadleaf forest.

Trends

Today, there is little resemblance to this potential natural landscape as described by these Life Zones. Commercial harvesting of trees, and clearing of forest for agriculture, has destroyed the natural forests. By 1954, it was estimated that only 8 to 9 percent of the land surface remained in forest (Burns 1954). In spite of numerous reforestation projects, Haiti continues to lose its last remaining forests either to land clearing for food production or tree cutting for lumber and fuelwood.

TABLE III-7
FOREST COVER BY MAJOR WATERSHEDS
(Derived from DATPE 1:250,000 maps)

River Basin	Total Tree Area (Km²)	Basin Area(Km²)	% Tree Cover
4 P.de-Paix/P. Margot	123.8	545	23
5 Limbé	16.8	312	5
6 Zone Cap-Haitien	21.1	–	–
7 Grande R. du Nord	10.0	699	1
10 Estère	25.8	834	3
11a Upper Artibonite	220.1	4,300	5
11b Lower Artibonite	431.3	2,562	17
13 Cul de Sac	12.8	1.250	1
14 Fond Verrettes	69.5	190	37
15 Léogane	1.8	650	<1
16 Sud-Est	360.7	–	–
17 Jacmel	9.5	1,220	1
20 Cavaillon	51.0	380	13
21 Les Cayes	163.3	720	23
22 Tiburon / P. Salut	52.3	540	10
23 Irois / Jérémie	41.8	365	11
24 G. Anse	117.3	556	21
25 Voldrogue/Roseaux	116.8	–	–
26 Corail / Anse à Veau	1.0	880	<1
Total	1,846.7		6.7



from DATPE 1982

PREPARED BY WILCOX ASSOCIATES

Fig. III-5: Remaining forests of Haiti: Pine and Broadleaf formations aggregated.

A very conservative estimate, based on the difference between wood products being consumed and the numbers of trees being planted and naturally regenerating, indicates that for every new tree, three are being cut or burned. Some estimates place the current ratio of trees cut and burned to planting and regeneration to be as great as seven to one. Trees are being cleared without regard for hydrologic and soils information, and not replaced where they are being cut, thus undercutting the attempted mitigation of deforestation impacts on the ecology.

Figure III-5 and Table III-7 quantify the 1978 areal coverage of broadleaf and pine forest throughout Haiti; these are parcels of forest by major watersheds falling within the dense and open forest categories and including all lands having at least 60 percent tree coverage. These data indicate that in 1978, only 6.7 percent of the country remained forested. The single largest forest parcel (264 km^2) remaining is the pine forest in the southeastern portion of the nation, while the highest percentage of tree cover is found in the Fond Verrettes (37 percent) watershed, an area where all rivers drain into the Dominican Republic.

Of the thirty major watersheds within country, twelve were completely deforested by 1978. According to DATPE (Table III-7), 9.2 percent of the country is forested; however, this includes savanna with trees as well as sparsely covered forest lands that, from an erosional or hydrologic perspective, do not function as tree covered landscapes.

Of the 6.7 percent of existing forest, approximately 36 percent (659 km^2) falls within the dense category (80 to 100 percent canopy cover) and 64 percent is in the open category (60 to 79.9 percent canopy cover). From this, it can be inferred that the areas of open forest experiencing tree clearing are likely areas of agricultural and grazing activity expansion. The highly fragmented pattern of forest cover illustrated in Figure III-5 indicates that the edges of these parcels are undergoing active tree cutting and/or burning. The majority of these remaining forest parcels are concentrated along watershed divides, covering steep and potentially highly erodible lands. As these lands are cleared, hydrologic and sediment balances within the affected river systems will be further altered.

In the northwest (Anse Rouge to Jean Rabel) and the western portion of the southern peninsula (Camp-Perrin to Roseaux and Pic Macaya National Park), Cohen (1984) documents the pattern of current land clearing. Lowenstein (1984) substantiates the negative results of the deforestation in the Pic Macaya area on the irrigation potential in the Grande Ravine du Sud of the Cayes Plain.

From 1978 to 1984, Cohen (1984) determined that deforestation in three study areas, namely degraded

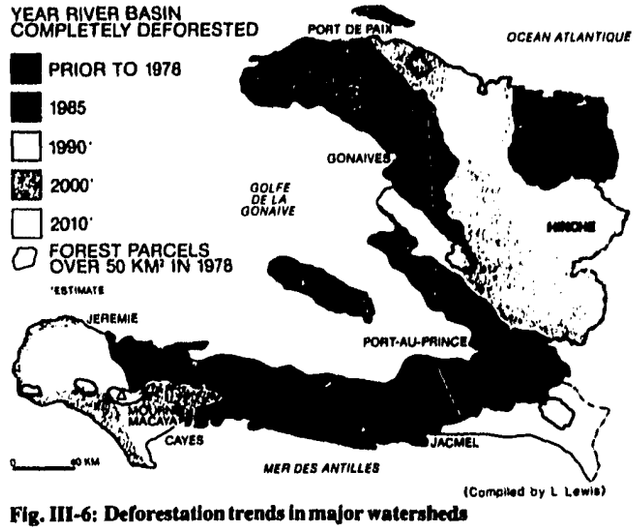


Fig. III-6: Deforestation trends in major watersheds

forest, open forest, and closed forest, ranged between 1.0 and 3.4 percent. Even more alarming, the actual decrease in closed forest area during this six year-period was 12.6 percent per year. The only environmentally beneficial vegetative cover in these humid mountainous lands apparently is rapidly disappearing.

Prospects

To estimate the future status of forest cover in Haiti, the 1978 vegetation cover (Table III-7) was assumed by the CEP team to undergo a constant decrease of 0.67 percent. Figure III-6 represents those trends and prospects. This value is conservative, since it is less than one-half of Cohen's measured rates. The demands for lands and trees should remain at least what they were between 1978 and 1984 unless spectacular changes occur in population, agriculture and industry.

If anything, the results presented in Table III-8 underestimate the severity of the problem. As is clearly evident from Table III-8, all areas of open and closed forest cover will likely be gone within fifty years unless extreme and immediate action is initiated and established. By 1990, eight, or one-half, of the river basins having forest cover in 1978, will likely be completely denuded of forest lands. One of these basins, the upper Artibonite, drains directly into Lake Peligre, which already has lost over 30 percent of its storage capacity due to sedimentation (LGL, 1981). The proposed multi-million dollar dam construction on the Guayamouc makes little sense unless the tree cutting is stopped in this area, and the lands above the proposed reservoir are immediately protected.

By the year 2008, unless current rates of tree cutting are stopped and reforestation in appropriate areas is accelerated only one river basin will have any forest cover remaining. There is no evidence, documented or otherwise, that the deforestation trend will be reduced, yet alone stopped. Clearly, new far-reaching initiatives need to be developed and implemented imme-

diately before the last vestiges of Haiti's forest is forever lost.

TABLE III-8
ESTIMATED NUMBER-YEAR DENSE AND OPEN FOREST IS TOTALLY REMOVED BY RIVER BASIN

Basin	Year
4 Port de Paix / P. Margot	1995
5 Limbé	1986
7 Grande Rivière du Nord	1981 (Gone)*
10 Estère	1982 (Gone)
11a Upper Artibonite	1987
11b Lower Artibonite	2002
13 Cul de Sac	1982 (Gone)
14 Fond Verrettes	2042
15 Léogane	1981 (Gone)
17 Jacmel	1981 (Gone)
20 Cavaillon	1996
21 Les Cayes	2008
22 Tiburon / P. Salut	1992
23 Irois / Jérémie	1995
24 Grande Anse	2007
26 Corail / Anse à Veau	1980 (Gone)

estimates based on an average decrease of 0.67%/ year of 1978 tree cover.

* gone only implies there are no stands of dense or open forest according to the DATPE, 1983 criteria that can be detected at a scale of 1:250,000.

Current and past mitigation projects have been inadequate to meet the challenge of reforestation. The integrated watershed projects, such as those undertaken in l'Acul (USDA/USAID, 1983) and Limbé (PNUD/FAO, 1984) failed, for a host of reasons. Significantly, two factors were identified: the lack of involvement of local people and the lack of perceived benefits of the projects by the local population. Once external funding stopped, the land improvment practices ceased. Planted saplings either died, were browsed by livestock, or cut by the inhabitants. Engineering works quickly went into disrepair and, once not maintained, increased land degradation. Two tree planting projects, the SHEEPA (Société Haitienne d'Etude et d'Exécution des Projets Agricoles) and the AOP (Agroforestry Outreach Project), appear to be successful in mobilizing the small farmer to plant trees for profit. The SHEEPA project is raising and selling mostly fruit trees in the eastern portion of the Upper Artibonite Valley. AOP through its three components, ODH (Operation Double Harvest), PADF (Pan American Development Foundation) and CARE, are distributing seedlings to be later used for fuelwood, charcoal, poles and eventually lumber. These projects, however, are conceptualized as income producing, not as reforestation projects (Conway, 1983; Miller and Ehrlich, 1984). Tree planting locations are selected by the farmers and in almost all cases trees are not planted in areas where the trees either maximize their role in the control of soil erosion or water conservation. In fact, the purpose of the AOP is to eventually harvest the trees. The ODBFA tree planting in the Upper Artibonite, to lower sedimentation yield into Lake Peligre, has also not been entirely planned as a reforestation project.

The continuation of the deforestation of Haiti's few remaining forest tracts, in response to both the need to expand farming into new areas to offset the decline of soil productivity in established areas, as well as to derive income from the sale of the wood, is fundamentally altering the nation's hydrologic regimes. River discharges everywhere are becoming less stable, permanent streamflows are changing the intermittent flows, while groundwater is decreasing. The magnitude of Haiti's environmental situation is evident in every region of the country. With the resource base declining everywhere, even if optimal land use strategies are immediately adopted, there is little hope that the potential productivity of the physical systems can ever return to former levels.

E.- CONCLUSIONS AND RECOMMENDATIONS

1.- INITIATE LAND CONSERVATION STRATEGIES

Today's grave environmental situation, as evidenced by the deterioration of the countryside, including sharply declining food production, internal migration into Port-au-Prince, the high unemployment of rural emigrants, and the continuing attempts at illegal international migration, has been thoroughly documented in a series of studies (e.g. Donner, 1975; Larose, undated; PNUD, 1981). To have any stabilizing effect at all, and conservation strategies are urgently needed now. The traditional conservative sectoral approach with a multitude of preliminary pilot programs that might seem prudent at first glance, is irresponsible in the Haitian context. Time is of the essence. Immediate large scale changes and investments are needed now; any alternative is defeatist. Hillslopes are being destroyed throughout Haiti, not just degraded. The natural resource base of the country is moving from the renewable resource category into a non-renewable classification.

Fortunately, previous reports and studies provide useful insights from which to develop immediate large scale land-use programs (e.g. Coffe et al, 1984; Conway, 1983; Murray, 1979; ODBFA, 1983). Therefore, it is possible to move directly toward implementation of land strategies, based upon these findings. Emphasis should be placed on projects involving systems where the greatest immediate and long-term benefits are likely to occur. Development projects concerned with environmental amelioration have to

include physical, social, economic, and institutional components; otherwise, prospects for success are negligible.

Projects will need to be conceptualized for longer time periods than the normal two-to-five year framework if there is to be any hope in reversing damaging physical and socio-economic trends.

The magnitude of land degradation both in extent and severity negate any attempt to solve the problem on a national scale, at least in the foreseeable future. A regional approach is more likely to prove successful in solving Haiti's environmental illness (Coffey, et al. 1984).

To select projects within this regional context, a set of criteria must be developed to determine priorities in selecting regional projects for strategy implementation. In the interest of immediate need, selection criteria should include those projects which preserve the potentially most productive lands. The areas, within Haiti, selected for immediate land conservation projects may not necessarily be the most productive lands today, since political considerations (such as ownership) with resulting investment practices, may be distorting production statistics.

The lands delineated by the CEP (see Figure IV-1) represent one possible set of high priority areas based on low erosion risk, arable land criteria. Other criteria should be developed to select areas which have important environmental and socio-economic implications in addition to or other than food production. For example, criteria which identify mountainous areas producing large quantities of sediment that threaten existing hydroelectric plants and other infrastructure and lowlands agricultural production should be included.

No matter which lands are identified as crucial to preserve, it is critical, at the first stage of project formulation, to identify all the critical system links that affect and interact on these lands. For example, lowlands have and likely will remain the highest priority for both international donors and the GOH. Yet irrigation projects to increase food production in the lowland areas have rarely met expectations in the past because an integrated watershed approach was not part of the planning process.

2.- FOCUS ON CAYES BASIN REGION

The Cayes Basin region appears to be a high, if not the highest, priority area for immediate program initiatives based on the criteria suggested. Previous reports (Coffey et al. 1984; Delatour et al. 1984) indicate that this area, both physically and sociologically, has potential for success. Comparative data for all of Haiti indicate that the greatest concentration of agricultural lands with low erosion risk is found here. The area becomes even more valuable because 99 percent of these "good" lands form a single continuous tract. Furthermore, climatic conditions make possible rainfed agriculture throughout the entire region, and supplemental irrigation would increase the range of crop yields, especially if fertilizers are effectively used.

Unfortunately, numerous indicators point toward an accelerating deterioration in the environmental conditions of the Cayes region. Soil erosion on the uplands (Cohen, 1984; Geter, 1983) appears to be accelerating in response to the cutting of trees and expansion of shifting cultivation. A major change in the water balance of the area due to larger peak river discharges from less water retention of soils in the uplands, and lower sustained baseflow, will limit the success of irrigation. This trend to a less stable hydrologic regime will constrain future management options throughout the entire Cayes plain.

To maintain and improve the environmental situation throughout this large area, a regional, not sectoral, approach must be developed. Lowland and upland sector planning must be integrated, and include both socio-economic and environmental considerations, if the resource base of this region is to remain and increase in productivity.

The planning issues and strategies pertinent to the Cayes Basin area can be usefully applied to other large parcels of "good land" in Haiti that have development potential at the regional scale.

3.- INCORPORATION OF LOCAL PARTICIPATION IN LAND-USE PROJECTS.

If the inhabitants are to accept the need to alter existing agricultural practices, benefits must directly and immediately accrue to the small farmer whenever innovations are attempted. Local participation of the people living on the land must be an integral part of any environmental project. Guarantees should be in place, prior to improvements, to protect the farmers from losing either their land, or having tax laws applied to negate the benefits once the land utility increases.

Because of the ecological interaction of the physical processes and the fragmented nature of land holdings throughout the countryside, local participation must be coordinated within functional areas such as hillslope and catchment units. A recent community soil conservation project, Ti Bwa (Petit-Bois) is illustrative of a successful environmental maintenance effort at the local level (Talbot, 1984; Lowenthal, 1984). Minimal development occurred, but at least land degradation was arrested. In many ways, the building of waterway channels along the hillslopes in this area illustrated the community cooperation/hillslope unit approach advocated by Murray (1979) (Figure III-7). The contour canals are now catching runoff, which reduces erosion. Their primary benfit, however, increases groundwater recharge, which permits crops (e.g. sorghum to survive. Because of the thinsoil throughout the area, crop production likely will only be able to meet the needs of the existing population demands

Fig. III-7: Building contour dry-wall to control erosion (photo WFP/Rome)

and economic development is limited in an environmental setting such as Ti Bwa. Nevertherless, this project has utilized elements that should be incorporated into any project design: (1) a perceived need of the inhabitants, (2) the integration of local inhabitants in the project, (3) benefits directly accrued to the small farmer, and (4) incorporation of legal inputs to ensure that land resource improvements do not threaten peasant security and access to the land.

The organization of the inhabitants will require on-site advisors. Both PVO and GOH participation should be incorporated into any project design. The use of agronomists appears to be particularly crucial. PVO activities need to be conceptualized beyond the normal narrow goals of these organizations. Their operations must be tailored to the needs of an environmental framework and within an integrated environmental approach.

Population pressures on Haiti's fragile lands must decrease. Thus, projects intended to improve the environment must also include components concerned with rural and urban development and family planning. If employment opportunities do not expand to absorb the excessive upland agrarian population, out-migration from the hillslope areas will occur only after the upland environments are destroyed.

IV

Agriculture

A.- INTRODUCTION

Once the richest French colony in the new world, Haiti is now the poorest country in the western hemisphere and one of the poorest in the world. With independence came a breakdown of the plantation system and the irrigation works on which it depended to a large extent. In the civil wars which followed, two processes developed, became institutionalized and are characteristic of the Haitian scene: The parcelization of land, as the freed slaves occupied land in scattered and small parcels, further subdivided by increased population pressure, led to the present state of high degree of morcelization with much insecurity of tenure. The other characteristic which became implanted in Haitian society and which persists to this day, is a lack of identification of the individual with any greater purpose than self/family survival and/or agrandissement. Out of this evolved a society in which every layer of the society exploits those which are below.

Those two characteristics of the Haitian society are the underlying causes of rural poverty and of the deterioration of the resource base which threatens to make the very survival of the society problematical. Numerous assessments of the agricultural sector have been made in which the characteristics of the sector are amply described and analyzed. The discussion to follow will focus on elements which are most directly related to the evolution of environmental changes: the resource base, the structure of the sector, production technology and productivity, the almost insurmountable task of bringing about a reversal of resources degradation and certain options which may be considered.

Haiti is a mountainous country with two parallel ridges forming the southern and northern peninsulas. An elevated area, the Central Plateau, extends southward from the northern ridge. A low lying plain, the Cul de Sac, separates the southern mountains from the Central Plateau.

Only 29 percent of all lands have slopes of less the 10 percent. Conversely, 63 percent of all lands are too steep (more than 20 percent slope) to be cultivated sustainably. When the land is deprived of the vegetative cover by slash-and-burn farming activities, it can only yield a meager crop for one season. After losing the topsoil to erosion, it becomes unproductive. The situation has already occurred on most lands in Haiti.

The FAO estimates in 1982 that the equivalent of 6,000 ha of farmland is lost to erosion each year. Given the limited amount of arable land remaining in Haiti it is evident that this loss of soil is rapidly diminishing the viability of many areas of the country to support its human population.

B.- AGRICULTURAL USES OF THE LAND

The FAO Production Yearbook (1983) divides Haiti's total land area of 2,770,000 ha into use suitability classes: (a) arable land (897,000 ha, of which 550,000 ha are suitable for annual crops, and 347,000 ha are suitable for permanent crops); (b) permanent pasture (504,000 ha); (c) forest lands (119,000 ha); and (d) other lands (1,250,000 ha). Actual land use distribution (Table IV-6) shows that 2 out of every 3 ha. of cultivated lands are found on mountains, presumably on more or less steep slopes. Thus, twice as much land is cultivated on mountain slopes than is considered suitable by the FAO (1983) for permanent crops. Moreover, considering that only a small portion of the cultivated lands on the mountains is actually used under a permanent vegetative cover (permanent crops such as coffee, cocoa, fruit trees), the soil loss from mountain lands cultivated with annual crops is enormous.

Table IV-1

DISTRIBUTION OF LAND BY USE POTENTIAL

Potential Use (2)		Land Area (km²) and % Distribution (1)				
	Land/Soil Class	**North**	**Transv.**	**West**	**South**	**Total**
Ia	Good soils with possibilities for irrigation, suitable for mechanization, high productivity potential, topography constraining	785.6 20.2 25.7	1,046.3 10.0 34.3	588.7 8.7 19.3	633.7 11.2 20.7	3,054.5 (3) 11.3 (4) 100 (5)
IIb	Good soils, not irrigable, some restriction in type of crop, small localized mechanization and irrigation possible traditional agriculture with soil conservation measures, topography a constraint, most appropriate for tree crops, pasture and forest.	1,040.4 26.7 12.1	3,712.5 34.7 43.3	2,135.0 31 24.9	1,683.9 29.6 19.6	8,571.8 (3) 31.7 (4) 100 (5)
IIIc	Mediocre soils, swampy suited for rice subject to adequate water development and management, drainage and irrigation	104.0 2.7 16.2	397.8 3.7 62.5	60 1 9	74.1 1.3 11.6	636 (3) 3.2 (4) 100 (5)
IVd	Soils suited especially for forest, localized tree crop agriculture and pastures possible. Topography constraining subject to severe erosion.	1,966.9 50.5 13.3	5,547.4 51.8 37.4	4,014 59 27.1	3,289.8 57.9 22.2	14,818.6 (3) 54.7 (4) 100 (5)

a) includes classes I and II of the USDA system
b) includes classes III, IV and VI of the USDA system
c) includes class V of the USDA system
d) includes classes VII and VIII of the USDA system

1) The country is divided into four regions for resources inventory & planning by DATPE (see figure)
2) adopted by DATPE from USDA soil capability classification
3) for each region/country the total area
4) for each region/country the percentage of the area corresponding to the respective land soil class
5) contribution of each region to area of the respective classes expressed in percentage.

The Ministry of Plan in its approach to regional planning, has divided the Haitian land area into land use classes based upon a modification of the USDA land capability classification system (DATPE, 1984). Potential uses of land in the four regions newly designated, based on that system of classification and derived from recently produced maps from 1978 aerial photography (DATPE, 1982), are given in Table IV-1.

Only 11.3 percent of the total land area or 313,010 ha is placed in the combined classes I and II, which represent few constraints for agricultural use. Much of the 31.7 percent of the land placed in the combined USDA classes III, IV and VI, consists of steep slopes subject to severe erosion and suitable only for permanent crops or pastures. The DATPE figures show a considerably larger area in classes I, II and III (combined USDA classes I through VI) than is classified as arable by the FAO. This is due to the inclusion by DATPE in its class II of much of the land which FAO classes as suitable for permanent pasture rather than as arable land.

The CEP team, using more conservative criteria (e.g. arable land with low erosion risk), concluded that the area suitable for crop production with few restrictions is in order of approximately 205,000 ha, or 7.4%. The team also concluded that the area under forest cover is greatly overstated by the DATPE figures.

According to a recent GOH document (DATPE, 1984), forty-two percent of Haiti's total land surface is actively being farmed (Table IV-2). Utilizing data derived from 1978 air photographs, a soil potential map and an erosional map were developed (DATPE, 1982). By combining the information presented on these two maps, the CEP team derived on a real dis-

Table IV-2
AGRICULTURAL LAND USE IN HAITI *

Cultivated lands	870,000 ha	31.4 percent
Shifting cultivated lands within pastures	300,000	10.8
Grazing lands	530,000	19.2
Forest lands	250,000	9.0
Non-cultivated lands	820,000	29.6
Total	2,770,000	100.0 percent

* DATPE (1984)

tribution of agriculturally "good" lands (low erosional risk under the existing Haitian agricultural system of classes I, II, III, and soils not degraded significantly by erosion A1, A2) within Haiti (Figure IV-1). Having a low risk of environmental degradation, these "good" lands have the best potential for sustaining long-term agriculture, provided that sufficient water is available.

A few basic patterns are evident from this map.

First, for a country where nearly eighty percent of the population lives in rural areas and whose livelihood is largely based on agricultural activities, there are few "good" lands (7.4%: Table IV-3) that are environmen-

Table IV-3
DISTRIBUTION OF GOOD AGRICULTURAL LANDS
(Independent of climate) and crop suitability zone

Basin (1)	Area of Good Land (Km²) (2)	Basin Area (Km²)	% Good Land	Crop Suit. Zone (4)
1. Versant Sud	10	550	2	1
2. Versant Nord	27			3
3. Trois Rivières, Port-de-Paix	41	897	5	4
4. P. Margot	18	545	3	4,5
5. B. de Limbé	32	312	10	2,4,5
6. Z de Cap-Haitien	116			3,5
7. B. de la Gde. Riv. du Nord	37	699	5	3,5
8. Zone Nord-Est	79			2,3,5
9. B. de Quinte	47	690	7	2,3,4
10. B. de l'Estère	29	834	3	1,3,4
11a Upper Artibonite (3)	324	4,300	7	4,5
11b Lower Artibonite	166	2,562	6	1,3,4
12. Z St-Marc	61	1,090	6	2
13. Z. Cul de Sac	292	1,250	23	1,2,3
14. Fond Verrettes	2	190	1	5
15. P. de Leogane	71	650	11	5
16. Z. Sud-Est	32			1,2,5
17. B. de la Gde R. de Jacmel	20	1,220	2	5
18. Bainet / Côtes de Fer	35	1,065	3	3
19. Aquin / St-Louis du Sud	48	700	7	2,6
20. Cavaillon	32	380	8	6
21. Les Cayes	251	720	35	5,6
22. Tiburon / Port Salut	20	540	4	3,5,6
23. Les Irois / Jérémie	11	365	3	6
24. Grande Anse	16	556	3	1,6
25. Voldrogue / Roseaux	16			6
26. Corail / Anse	82	880	9	3,6
27. Gde. Riv. de Nippes	20	460	4	3,4
28. Miragôane / Petit & Grand Goâve	46			3,4
29. Tortue	4	180	2	3
30. Z. de la Gonave	63	680	9	1
31. Ile à Vache < than	1	48	1	5
Total	2,047		7,4	

1) Delimitation of basins according to DATPE, 1982.
2) Area falling within Land Potential Classes I, II, III and Land Erosion Risk A1, A2; DATPE, 1982.
3) Upper Artibonite – all lands draining above Lake Peligre Dam
4) Based on Rainfed Agriculture in Haiti (Hargreaves et al. 1983).

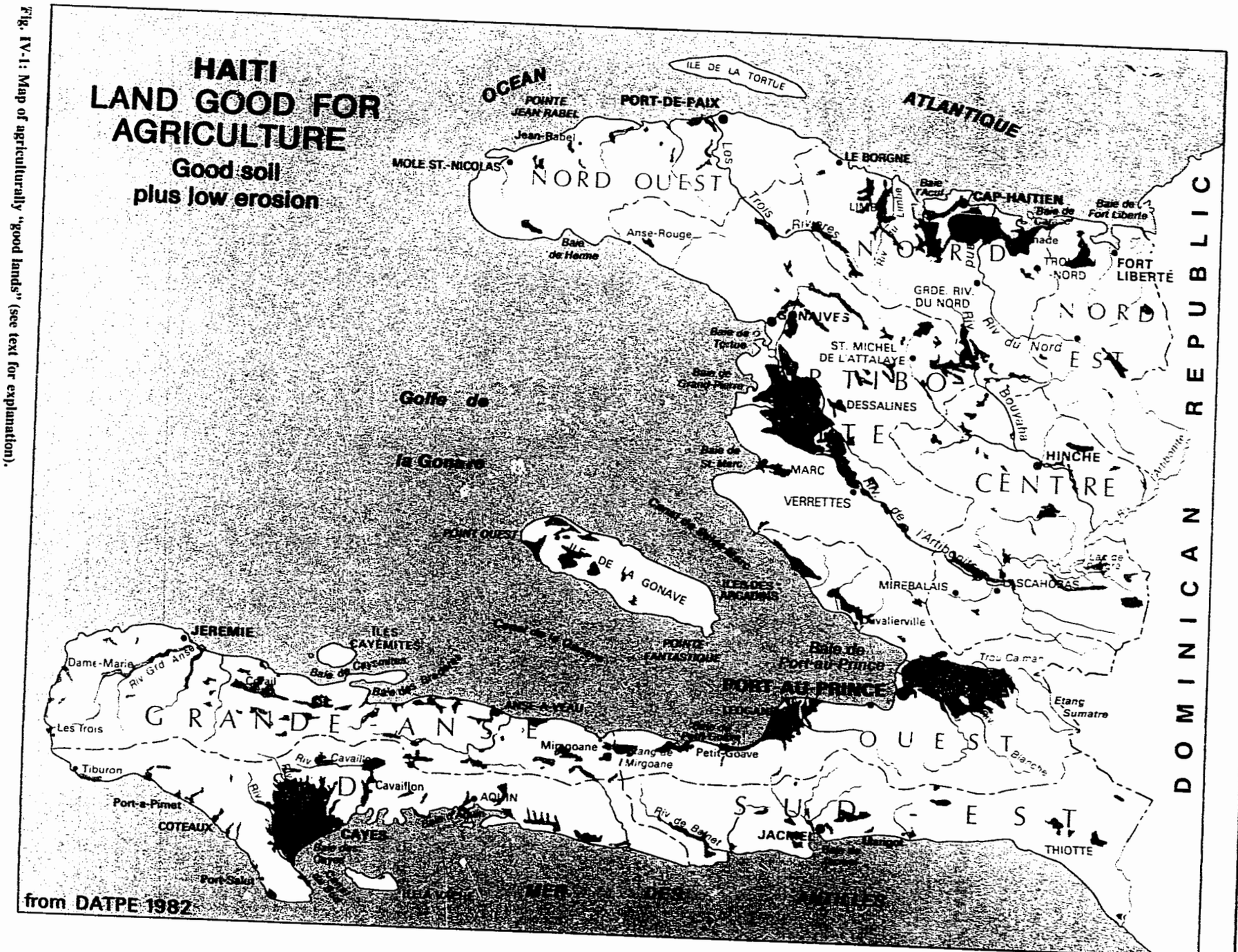


Fig. IV-1: Map of agriculturally "good lands" (see text for explanation).

tally stable under current land use practices. Second, the majority of these "good" lands are not contiguous, but in small discrete units. Third, even without considering precipitation factors in the delimitation of "good" lands, the northwest has a very restricted percentage of "good" lands for agriculture. On the other hand, the southwest peninsula, especially the Cayes Basin, as well as the zone of the Cul-de-Sac have the greatest percentage of "good" land density. Fourth, almost all large parcels of "good" lands are concentrated along the coast or found along valley bottoms that are likely to be susceptible to flooding. Fifth, if river basin divides are ignored, four large parcels of contiguous "good" lands dwarf all other parcels. These are from north to south: the lands in proximity to Cap-Haitien, the lower reaches of the Estere and Artibonite River Basins between Dessalines and St-Marc; the Cul-de-Sac lands focused on Croix-des-Bouquets; and the Cayes river basins. Sixth and finally, when combining both the "good" land factor with the crop suitability zones (Tables IV-3 and IV-4), the Cayes river Basin appears to have the best potential per unit area of land within a river basin system for rain-fed and irrigated agriculture. Appendix A provides a detailed discussion of crop suitability zones.

Table IV-5 provides data on current (based on 1978 aerial photographs) land use by type of crop, pasture or forest cover. It is clear from these figures that the land currently supporting crops is much larger in area than what the FAO has classified as agricultural land. This appears to be due to the high degree of food cultivation interspersed within the areas classed as suitable for tree crops and permanent pasture and forest.

Table IV-6 shows regional land use in relation to topography. The widespread cultivation of land unsuited for annual crop production, without even minimal attention to soil conservation practices, as well as the extensive clearing of forest cover for new lands, has led to the catastrophic accelerated state of erosion throughout the country.

C.- CLIMATE

The range of temperatures in the areas which are suitable for agriculture does not pose an important constraint on agricultural production. Yet the combination of elevation and rainfall can determine the kinds of crop produced. For example, beans are principally grown at the high elevations during the rainy season because of severe damage from disease and pests when planted in the lowlands, while beans are successfully planted in the lowlands during the dry season where irrigation is available.

Although, based on evapotranspiration data, areas with rainfall of 1500 mm or more should be able to sustain reasonable crop growth without irrigation (a substantial portion of Haiti receives at least 1500 mm/year), the considerable variation between and within seasons makes annual crop production without irrigation hazardous in all but a few favored areas. Moreover, "agricultural droughts" frequently occur under conditions of generally adequate amounts and distribution of rainfall because of the low absorption and retention capacities of the soils (NOAA, 1979). Agricultural droughts are especially severe where soil erosion has reduced the land's water retention capacity over extensive areas, such as the northwest around

Table IV-4
CRITERIA USED TO DETERMINE GOOD AGRICULTURAL LANDS

Land Classification of Soils (USDA)
Land/Soil Class
I. Excellent – Soils well drained, slope 0-2% high productivity
II. Very Good – Soils well drained, slope 2-5% good productivity
III. Good – Slopes 5p8% need erosion control, average productivity

Erosion Characteristic of Soils (DADPE, 1982)
A1 Slight erosion and low erosion potential when vegetation cover exists, primarily alluvial soils
A2 Average erosion, need soil conservation, should primarily be kept in tree or perenial vegetation.

Crop Suitability Zones (Hargreaves and Samani, 1983)

Zone
1. Arid, cultivated crops need irrigation in all months
2. Semi-arid, crops requiring 60 days or less (e.g. millets and mung beans), low potentially yields for rainfed and irrigation very useful
3. Sum-humid bi-modal rainy season, average growing season three to four months, good yields possible under good water moisture storage
4. Humid, average growing season five to six months, rainfall usually dependable, some double cropping possible.
5. Humid, Average growing season seven to nine months, some months have excessive rainfall requiring good drainage for most general crops.
6. Perhumid, average growing season ten to twelve months, situated primarily in mountainous areas, important source areas for river flows.

Table IV-5

OCCUPATION OF LAND BY USE CATEGORIES (1)

Type of Land Use		North	Transversale	West	South	Haiti
Agricultural Domain	Specialized crops	371.1	605.3	318.9	413.4	1,708.7
	Rice	42.8	316.0	46.8	63.6	469.2
	Sugarcane	126.1	NI	144.5	81.7	352.9
	Annual Irrigated	48.4	265.6	28.0	162.4	504.4
	Banana	–	0.9	42.9	12.3	56.1
	Sisal	163.2	22.8	56.1	17.6	249.7
	Vetiver	–	–	–	72.0	72.0
	Coconut	–	–	0.6	3.8	4.4
	Tree crops dominant	413.0	725.9	460.9	396.3	1.996.1
	(Food crops in	(c)267.5	(c)168.4	(c)281.5	(c)183.5	(c)900.9
	association)	145.5	557.5	179.4	212.8	1.095.2
	Tree crops sparce	846.7	1,728.6	1,094.8	861.0	4,531.1
	associated food	553.1	1,462.9	577.9	535.7	3,129.6
	crops dense	(c)293.6	(c)265.7	(c)316.9	(c)325.3	(c)1,401.5
Agro-pastoral Domain	Food crops dense tree cover open	474.7	1,629.8	962.5	979.8	4,046.8
	Food crops moderately dense in pasture and natural vegetation	438.1	1,663.2	1,437.2	837.3	4,375.8
	Food crops dispersed pasture and natural vegetation	196.8	1,777.8	564.1	319.7	2,258.4
	Extensive pasture herbaceous species dominant	305.1	1,244.9	385.0	27.4	1,962.4
Silvo pastoral Domain	Savana with trees	183.7	998.0	1,053.6	664.1	2,879.4
	Trees localized	44.8	56.1	109.1	124.9	334.9
	Trees dense	3.0	61.3	12.4	41.6	118.3
	Trees sparse	12.7	443.3	316.5	219.1	991.6
	Trees very sparse	123.2	437.3	615.6	258.5	1,434.6
	Broad leaf forest	397.3	253.6	104.1	1,064.8	1,819.8
	Dense	13.3	58.6	31.4	116.1	219.4
	Sparse	265.0	29.9	13.0	312.6	620.5
	Very Sparse	119.0	165.1	59.7	631,1	979.9
	Pine forest	94.6	74.2	252.4	52.6	473.8
	Dense	9.8	27.9	53.8	–	91.5
	Sparse	84.8	46.3	93.5	22.4	247.0
	Very Sparse	–	–	105,1	30.2	135.3
	Mangrove	49.1	43.1	17.7	61.6	171.5
				6.651.2	5,658.0	26,223.8

(1) From maps showing occupation of land established from 1978 aerial photographs. (DATPE/SEP);
NI = Not Indicated
(c) Coffee probably in association

TABLE IV-6:
OCCUPATION OF LAND IN RELATION TO TOPOGRAPHY

Region	Valleys and Plains	Low hills Mountains	Mountains	Plateau
North Region				Area: 3,831.2 Km²
(Area (Km²)	1,087.1	1,454.7	1,195.3	33.1
Specialized Crops	34.13%	–	–	–
Agricultural Domain	84.52%	53.28%	31.91%	91.24%
Agro-pastoral Domain	6.03%	25.62%	41.73%	8.76%
Silvo-pastoral domain	9.44%	21.10%	26.36%	–
Transversal Region				Area: 10,735.4 km²
Area (km²)	2,076.4	4,705.1	2,828.1	515.6
Specialized Crops	27.56%	0.30%	47.60%	
Agricultural Domain	76.91%	41.58%	30.82%	47.60%
Agro-pastoral domain	13.00%	40.15%	42.38%	23.54%
Silvo-pastoral domain	4.54%	17.52%	9.54%	34.98%
Region West Area				Area: 6,959.1 km²
Area (Km²)	805.4	2,768.4	2,365.8	711.6
Specialized crops	35.86	1.08%	–	–
Agricultural domain	79.15%	28.50%	46.59%	43.34
Agro-pastoral domain	13.00%	40.15%	42.38%	23.54%
Silvo-pastoral domain	7.85%	31.35%	11.0%	33.12%
Region South				Area: 5,776.1 km²
Area (Km²)	967.40	3,111.0	1,324.2	255.4
Specialized crops	33.37%	2.29%	–	–
Agricultural Domain	85.09%	45.94%	20.91%	47.49%
Agro-pastoral domain	2.53%	23.05%	30.32	16.13%
Silvo-pastoral domain	12.37%	31.01%	48.77%	36.38%

Source: from interpretation of aerial photography of 1978 (DATPE/SEP).

Bombardopolis, Môle St-Nicolas and Jean-Rabel.

In these areas the soils are naturally thin and have poor water absorption and retention characteristics. Once denuded of forest or grass cover, the absorption and retention capacities diminish, making crop production hazardous even under generally adequate rainfall amounts and distribution. Even with the deeper soils on the steep slopes, absorption and retention of water by denuded soils is frequently inadequate. The result of widespread clearing of vegetation is a vicious cycle of low rates of absorption, rapid runoff, erosion, still lower absorption capability, more rapid runoff and more erosion.

Although the view is frequently heard that rainfall is decreasing and droughts have increased in recent years in Haiti, this is not supported by the available data (NOAA, 1979). The occurrence of several series of drought years during the period of the late 50's to the late 70's, which was generalized throughout the Caribbean region, appear to be a cyclical phenomena. A comparison of variablity data for three periods, 1920-1937, 1938-1958 and 1958-1978, shows no significant differences or trends (NOAA, 1979). Nevertheless, a perception of increasing occurence of droughts affecting agriculture may be really due, not to natural phenomena, but because of the decreasing absorption capability of eroded lands.

D.- THE STRUCTURE OF THE AGRICULTURAL SECTOR

The amount of arable land in Haiti has been variously estimated. The figures cited usually range between 890,000 and 1,100,000 ha, with most estimates in the lower range.

Although it is generally understood that the agricultural sector is composed primarily of a large number of small farmers, there are nonetheless some sizeable holdings. A total of 178,080 ha is attributed to ten such holdings (CEPAL/FAO 1983). If one single holding of 150,000 ha is subtracted (SHADA, Société Haitienne Américaine de Développement Agricole, was granted 150,000 ha of forest lands in the early

1940's), the remaining 28,080 ha which are mostly arable, constitute about three percent of the land area classed as arable by most authorities. This land is located in the plains and occupied principally by sugar cane and sisal.

Extensive areas are attributed to the government referred to as "State lands". Little is definitively known about the magnitude and location of these holdings. They are not exploited by government, but rather rented or otherwise occupied by the local population. Much of the state lands fall in the non-arable category. There are also numerous holdings of 50 to 100 ha which are cultivated as single units; however, the total area thus occupied is very small as a percentage of the whole.

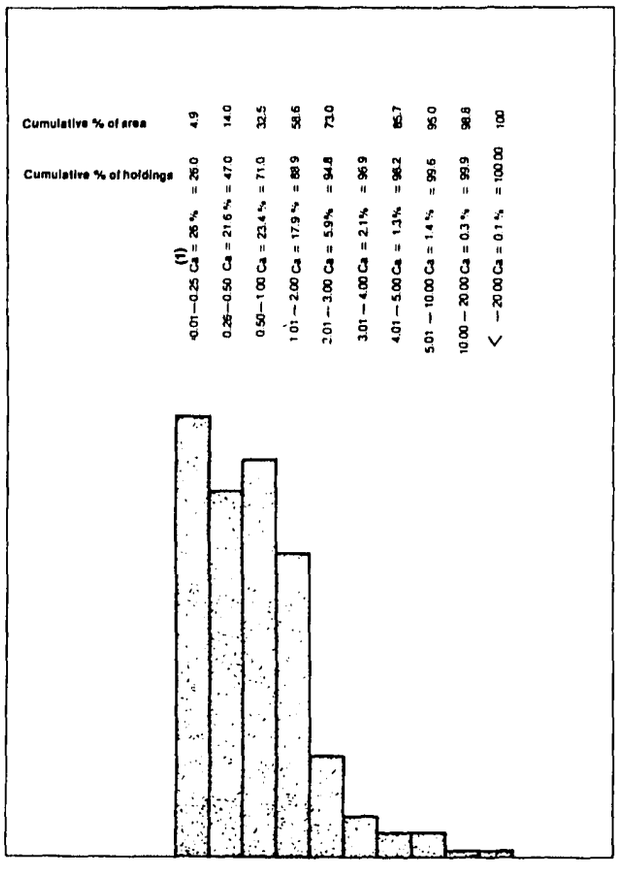


Fig. IV-2: Size distribution of cultivated holdings (CEPAL/FAO 1983) (1) 1 carreau = 1.29 ha.

Figure IV-2 provides a diagramatic picture of the distribution of cultivated holdings by size (CEPAL/FAO, 1983). The aggregate of 669,395 carreaux (863,519 ha; one carreau is equal to 1.29 ha) is represented by 616,710 production units. The degree of parcelization is clearly evident; seventy-one percent of all production units (generally family plots) occupying one carreau or less account for 32.5 percent of the total cultivated area.

The distribution by size of units, illustrated in Figure IV-2, refers to production units (family units). Since, in most cases, a production unit consists of more than one parcel of land which may be owned, rented, sharecropped or jointly farmed by several individuals with undivided interest, the degree of parcelization is greater than appears. Among holdings of 3 ha or less, 557,515 holdings averaging 0.96 ha, involving a total area of 534,142 ha., was distributed among 936,390 individual parcels. Table IV-7 shows the number of plots per farm and the size of each plot (IHS, 1973).

This feature of Haitian peasant agriculture is apparently of long standing. Data for 1950 and 1971 show essentially no change in average unit area, although the number of units and the total area involved more than doubled during this period. The Haitian farmer has evidently through the years chosen or was forced by limited resources, to limit the size of his production unit even when land was more generally available. Thus, in 1980, only 28 percent of all farms consisted of a single, continuous plot, while 47 percent consisted of non-contiguous plots at some distance from the peasant hut.

An interpretation of Table IV-8 (Anglade, 1974) shows that 59 percent of all holdings were smaller than one ha, consisted of 47 percent of all parcels of cultivated land, but occupied only 21 percent of all land cultivated. These smalls parcels supported approximately 54 percent of the peasant population.

Table IV-7
NUMBER OF PLOTS PER FARM AND SIZE OF PLOTS (1971)

Dept.	No. of Farms	No. of Plots	Plots/Farm	Avg. Plot (ha.)
Nord	106,400	200,400	1.9	0.85
Nord-Ouest	30,100	53,430	1.8	1.25
Artibonite	140,000	246,600	1.8	0.55
Ouest	177,060	312,100	1.8	0.65
Sud	163,150	305,700	1.9	0.75
Entire country	616,710	1,118,230	1.8	0.75

Source: IHS Port-au-Prince.

Table IV-8
SUMMARY STATISTICS ON AGRICULTURAL HOLDING (1971)

Land Holdings (by hectare)	No. of Holdings	No. of Parcels per Holding	Total Land (Ha)	Population	Average # of parcels per holding	Average Parcel Size (Ha)	Average # of persons per Holding
1ha. & below	361,985	530,480	184,843	1,498,020	1.46	0.34	4.15
1 to 2ha	141,930	275,510	211,940	666,180	1.94	0.76	4.69
2 to 3 ha	53,600	130,400	137,359	279,990	2.43	1.05	5.22
Cumulative %	91%	84%	62%	88%			
3 to 4ha.	27,370	74,390	96,762	143,800	2.71	1.30	5.25
4 to 5ha.	6,440	39,340	36,790	48,000	3,47	1.32	5.68
Above 5ha.	23,385	78,110	193,822	143,030	3.34	2.48	6.11
Total	616,710	1,118,230	863,516	2,779,020,1.81	0.77	4.50	

Source: George Anglade, Espace Haitien, 1974.

Table IV-9
HAITI: TOTAL AREA, CULTIVATED AREA AND POPULATION DENSITY, 1982

	Surface Area 1000/Km²		Total (1000's)	Population Density Persons/Km²	
Region	Total	Cultivated	Population	Total	Cultivated
West	4.649	1.546	1,551.792	334	1004
Southeast	2.215	0.601	367.911	166	612
North	2.045	0.873	564.002	276	646
Northeast	1.752	0.420	189.573	108	451
Artibonite	4.532	1.214	732.932	162	604
Center	3.700	0.820	361.470	98	441
South	2.894	1.158	502.624	174	434
Grande Anse	3.284	0.848	489.957	149	578
Northwest	2.330	0.711	293.530	126	413
Unknown*	0.299				
Total	27.000	8.191	5,053.791	182	617

Note: One square kilometer equals 100 hectares
Note: The population is quoted between 5 and 6 millions
*: To balance Haiti total surface area

Source: Institut Haitien de Statistiques et d'Informatique, Analyse de quelques indicateurs démographiques tire des Recensements de 1950, 1971 et 1982; April 1982, Port-au-Prince, Haiti.

If holdings up to 3 ha are considered, then the statistics are even more striking. These lands constitute 91 percent of all holdings, support 88 percent of the peasant population and occupy 62 percent of all cultivated lands.

A comparison of total area, cultivated area, population densities, expressed in terms of total area and area cultivated for 1982, is shown in Table IV-9 DATPE reports an overall population density for the country of 677 inviduals per square kilometer (100 ha) of cultivated land. Regionally, the north, transversale, west and south regions contain 584; 448; 876; and 544 individuals per square km of cultivated land respectively. The high population density for the west region reflects the concentration of population in Port-au-Prince. With this very high density of population and remarkably high degree of parcelization, the need for the application of improved technology, use of water resources for irrigation, resources conservation and

improvement, as well as improvement of living standards for the rural population, become immediate.

E.- AGRICULTURAL PERSPECTIVE ON LAND TENURE

The tenure status of Haitian lands is complicated by the existence of several types of land tenure, the uncertainty of tenure and status of much of the land, the uncertainty as to the amount and geographical location of state-owned lands, and the tenancy status of farmers occupying this land. Moreover, while the majority of farmers own land, a large percentage rent, lease or sharecrop land while leasing out some owned land to others.

The 1950 census showed that as many as eighty percent of all farmers were land owners, with essentially no differences among regions. Table IV-10 shows the distribution of land ownership by tenure categories and by region as of 1950. The tenure pattern derived from a socio-economic survey in 1970 in which two percent of households were covered, (Table IV-11) shows distribution of land by mode of tenure and parcel size (CEPAL/FAO, 1983).

Data from a number of studies, restricted to specific areas and reported by Zuvekas (1977), showed that farmers owning at least part of their land ranged from 56 to 100 percent of the farmers in the sites studied. In many cases, farmers did not own all the land culti-

Table IV-10
LAND TENURE IN 1950

Tenure Category	Northwest	North	Artibonite	West	South	Total
1. Farming land adjacent to homesite plus other land: Total	14,326	48,182	51,878	86,224	76,936	277,546
Owners	12,060	41,140	44,718	71,617	66,143	235,678
Renting from State	709	1,022	850	2,086	594	5,261
Renting from private owners	276	1,476	1,391	3,487	1,563	8,282
Managers	484	1,730	1,375	2,172	2,281	8,042
Sharecroppers	556	1,983	1,128	3,754	2,207	9,628
Tenure status unknown	241	832	2,416	3,108	4,058	10,655
2. Farm only land adjacent to homesite: Total	10,063	27,795	32,848	73,602	44,992	189,300
Owners	7,363	22,005	25,931	56,106	36,626	148,031
Renting from State	965	868	902	3,562	882	7,179
Renting from private owners	196	893	1,601	2,908	1,137	6,735
Managers	651	1,730	1,761	2,927	2,230	9,299
Sharecroppers	675	1,687	1,309	5,051	1,782	10,504
Tenure Status unknown	213	612	1,344	3,048	2,335	7,552
3. Farming only land away from homesite	5,818	22,662	32,593	24,929	23,032	109,034
4. Farm Households - Total	30,207	98,639	117,319	184,755	144,960	575,880

Source: Haiti, IHS (1955) reported by Zuvekas 1977.

Table IV-11

LAND TENURE IN 1970

Tenure Category	Number of Parcels	% of Parcels
Owners	893,659	60.2
Renting from State	56,473	3.8
Renting from private owners	155,557	10.5
Sharecroppers	213,528	14.4
Other for of tenure	165,168	11.1
Total	1,484,385	100.0

Source: Haiti, IHS, (1975) reported by Zuvekas (1977).

vated, nor did they always cultivate all the land they owned.

The status of land titles is very unclear. Where attempts have been made to precisely determine ownership, it has been found that between 30 and 68 percent of farmers in the areas studied claimed to have titles. However, even when titles existed, the validity of many was frequently questionable. Sixty-seven percent of titles examined in the ODPG project area were found to be not recorded with the local Direction Générale des Impôts (assessment and tax offices), suggesting that these could be challenged.

Farmers are reluctant to divulge information on land holdings and tenure status. The confidence of farmers in the equity of the system has been seriously eroded by frequent cases of exploitation by the economically and politically powerful elements of the Haitian society, the exorbitant cost of litigation to obtain and/or defend titles, and the unscrupulous exercise of authority by local judges in administering land titling processes.

The absence of cadastral survey is a further complication. A recent (Dec. 1984) Decree establishes a Cadastral Institute in charge of carrying out a cadastral survey under the supervision of the Ministry of Interior. The unclear legal status of land ownership results in title insecurity, which adversely impacts on investment in land improvement, use of inputs, and the application of conservation practices.

F.- PRODUCTION

The production of agricultural commodities provides a livelihood for seventy-two percent of the Haitian population (IHS, 1984). The export of agricultural commodities accounted for 48.7 percent of total exports in 1983, and in 1981 the contribution of agriculture to GDP was thirty-one percent. During the period 1970-1980, the annual growth of the sector averaged 1.1 percent. Since 1980, growth has been negative, falling by 1%, 4.7% and 0.6% for 1980, 1981 and 1982, respectively.

Figure IV-3 traces certain trends in the agricultural sector with respect to contribution to GDP and export earning, while Figures IV-4, IV-5, IV,-6, and IV-7 provide trends in total production of food, production of major commodities and yield of principal crops. Figure IV-8 provides similar data for livestock.

Table IV-12 provides data on distribution of production of principal agricultural commodities by region for the year 1979, while Table IV-13 provides data on the values of production of the principal commodites. Several general observations can be made from these figures and the tabular data presented.

The total area under crops in 1979 exceeded, by over 25 percent, the area generally considered to be arable, and about five times the area classed as "good lands" by the CEP team. This is partially due to the production of two crops per year in many cases. This

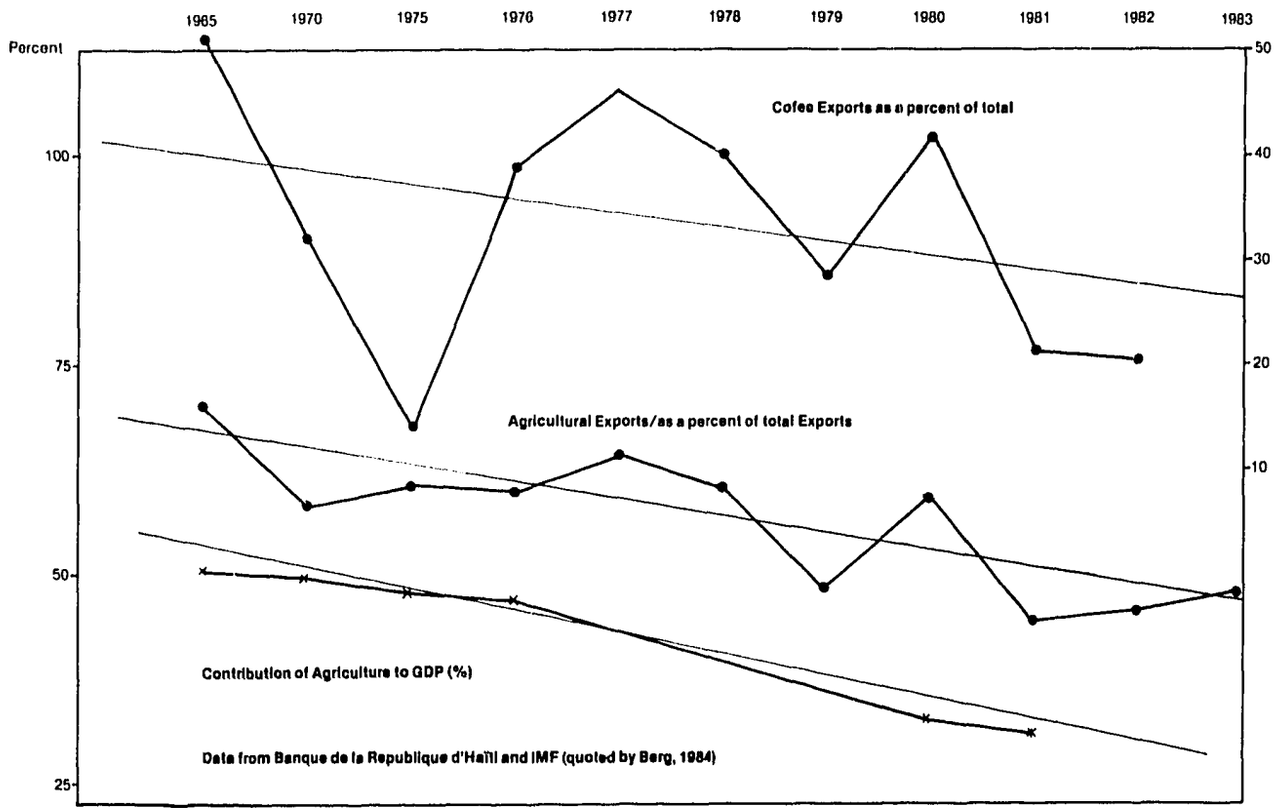


Figure IV-3: Trend in Contribution to GDP and Export Value by Agriculture (%).

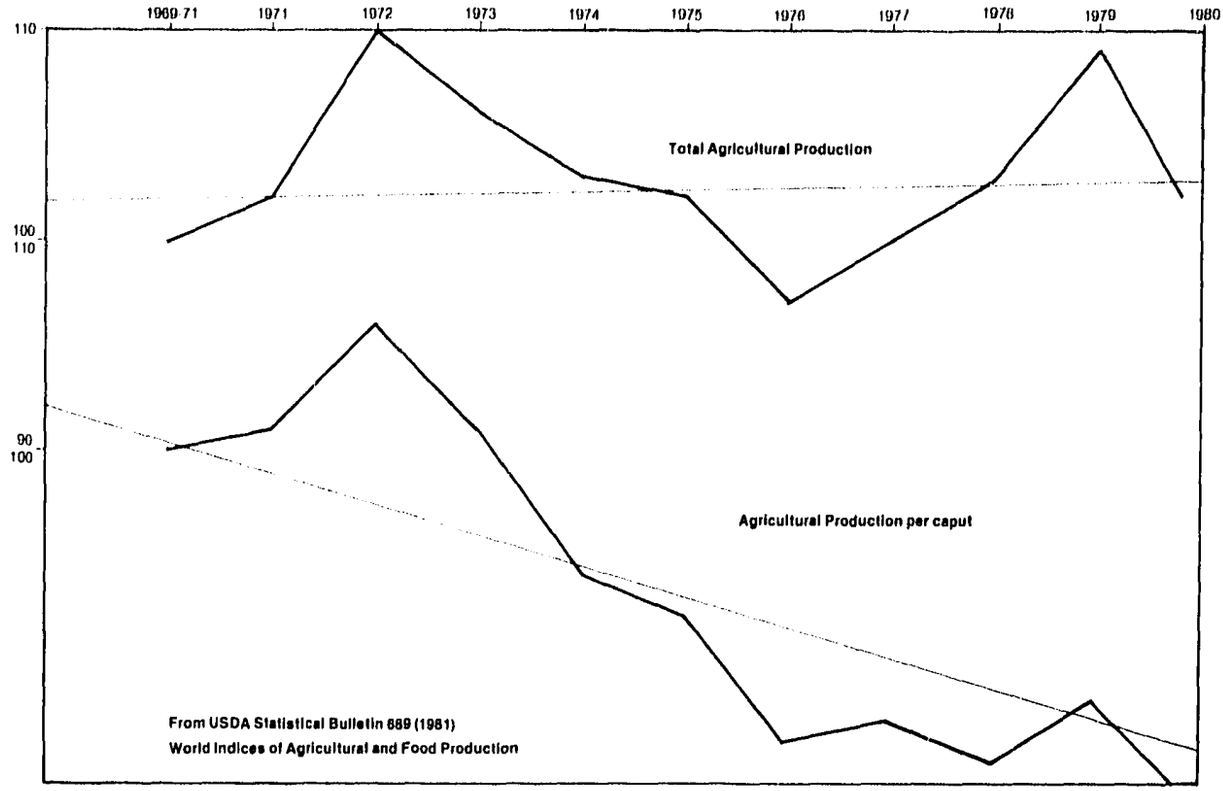


Fig. IV-4: Agricultural production: total versus per capita

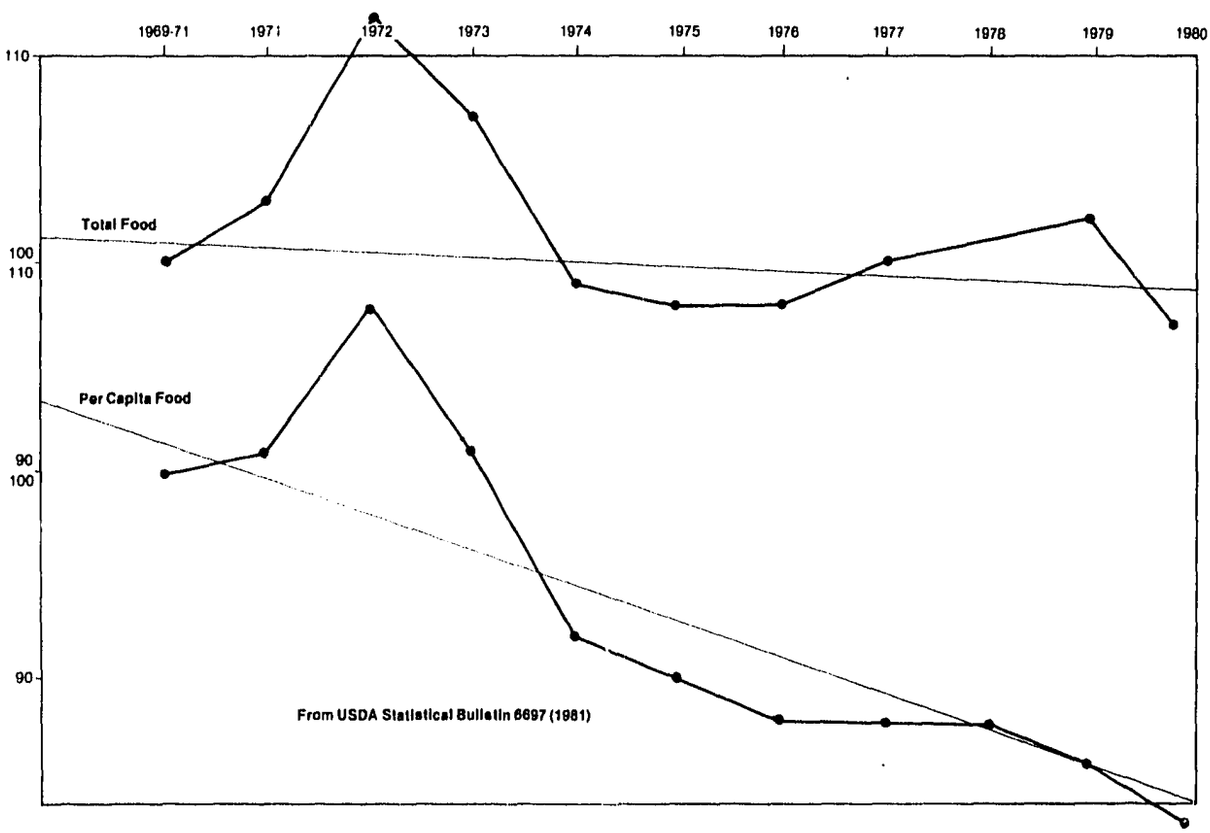


Fig. IV-5: Trends in total production of food

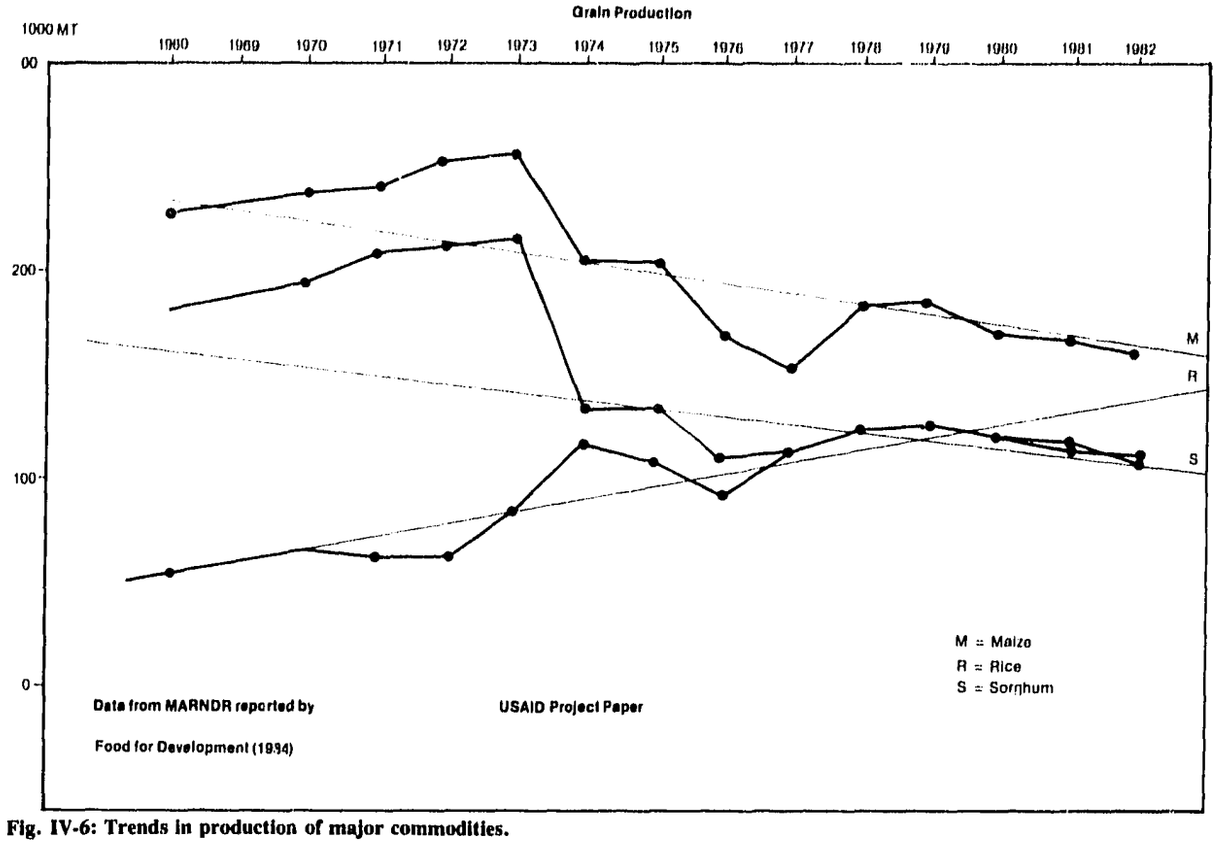


Fig. IV-6: Trends in production of major commodities.

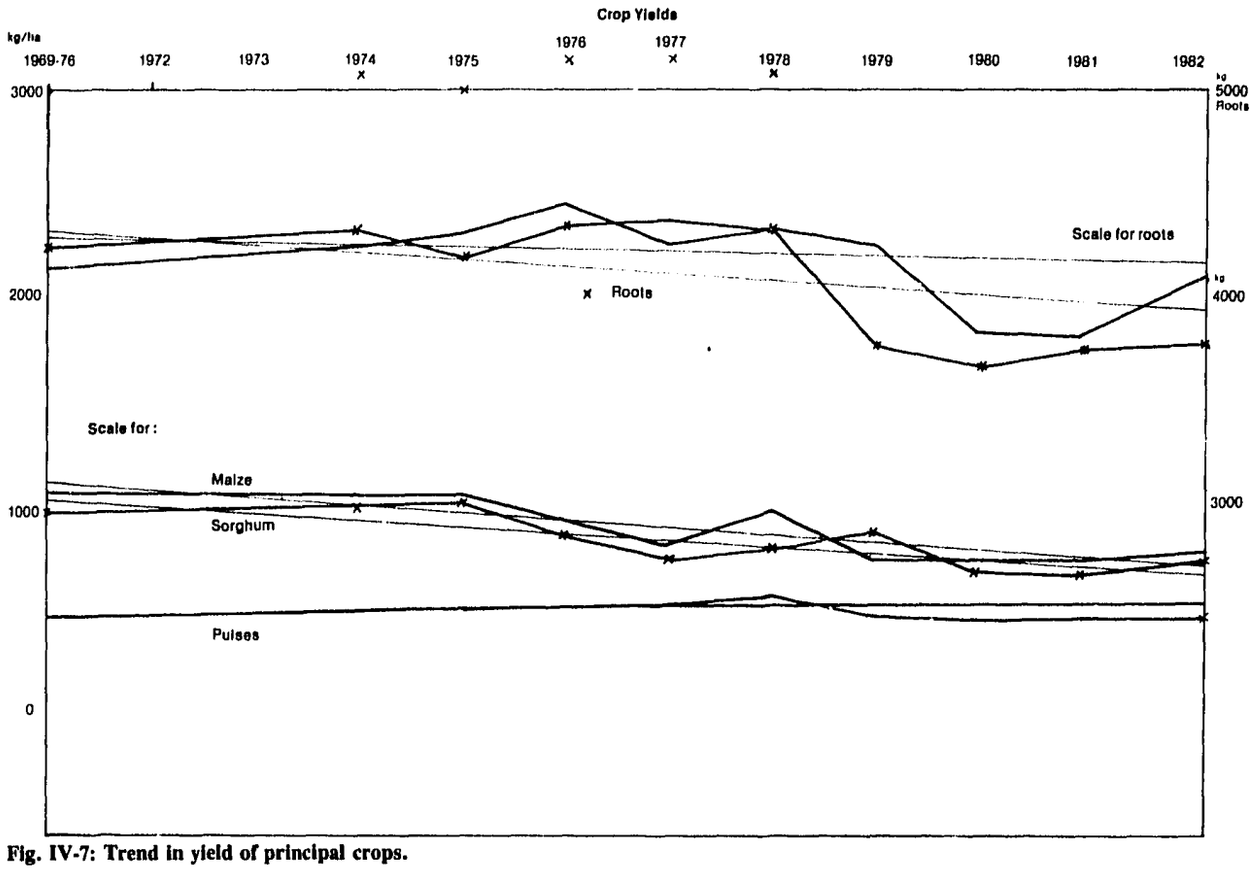


Fig. IV-7: Trend in yield of principal crops.

Table IV-12
PRODUCTION, AREA AND YIELDS OF PRINCIPAL CROPS BY REGIONS IN 1979 (1)

	Production MT					Area Hectares					Avg yield, Kg/ha.				
Crop	N	T	W	S	Haiti	N	T	W	S	Haiti	N	T	W	S	Haiti
Maize	23903	61377	35930	62121	183331	36334	74438	53018	69959	233749	658	825	768	888	784
Millet/ Sorghum	3330	55975	40453	23524	123282	10325	66687	41902	38051	156696	331	839	965	618	787
Rice	13055	94015	4721	10325	122116	7059	36340	3158	7419	53996	1850	2587	1494	1392	2262
Beans (dry)	11576	13047	16885	11190	52695	16128	21554	28460	23536	89678	718	605	593	475	588
Pigeon Peas	3473	10070	6417	5651	25541	7240	24829	18744	18567	69380	480	406	342	304	368
Beans	4002	4992	2856	2243	14093	6886	14029	9839	6420	39174	450	355	290	349	360
Peanut	9762	6872	12277	6629	36629	12860	8872	17560	7770	47062	753	776	699	853	754
Sesame	1362	1528	491	744	4125	4609	5549	1342	2387	13887	296	275	366	312	297
Manioc	63927	76037	51041	62351	253356	14909	19374	12732	15846	62861	4288	3925	4008	5197	62861
Yams	17486	27466	21277	43928	110157	6777	6174	11909	33639	2583	3129	3446	3689	3275	
Sweet Potato	49868	78993	65436	70491	264788	12209	18179	15715	16427	62530	4085	4345	4164	4291	4714
Plaintain	79020	100939	52649	68666	301274	10364	14.802	8825	13493	47484	7624	6819	5966	5089	6345
Coco Yam	3959	15472	6015	13683	39129	1869	8728	7431	7176	21204	2342	1773	1753	1907	1845
Banana	52335	44307	48613	64975	210230	9642	7362	6738	12876	33618	6056	6018	7215	5008	6253
Total Food	337057	571090	350061	446521	1740746										
Coffee (4)	7117	5876	10032	12844	35900	33678	18196	40047	45617	137618	1262	1929	1496	1682	1558
Cocoa (3)	2052	2088	1814	5502	11456	632	645	188	3105	4570	3252	.95	1771	2507	
Cotton	491	2472	1039	5589	1342	5046	4419	2819	13646	366	490	133	369	410	
Rural Pop. 1971 (1000)	582	1007	1027	913	3529										
Food Prod. (2) per capita	579	579	341	389	493										

(1) From DATPE Ministry of Plan: Regions et Stratégie de Développement Régional (1984)
(2) Based on rural population
(3) Cocoa production has remained on average around 3000 Mt per year, but 1979 was an exceptionaly good production year.
(4) Coffee figures are from OPRODEX

N = North region
T = Transversal region
W = West region
S = South region

intensity of land use, nevertheless, with such primitive agricultural practices and less than optimal soil conditions is exceedingly high.

Grain crops occupy 37 percent of all the cultivated area; pulses and oil crops 22 percent; root and other starchy foods 22 percent; sugar cane 5 percent and export crops (mostly tree crops) 15 percent.

Although food crops cover about 80 percent of the cultivated area, the value of production is only about one half that of export crops, excluding sugar.

Comparable figures on livestock production are not available. However, one estimate (Ithaca International, 1983) places the total value of livestock production at 24 percent of the value of the agriculture total, and 8 percent of GDP.

Livestock number (Figure IV-8) show an increasing trend between 1965 and 1971. During the period 1979 to 1982 the trend is flat except for swine, whose population was eradicated temporarily, and for poultry, which show an increasing trend.

Crop and food production has been static since 1970, while both have followed a decreasing trend on a per capital basis.

Production of the widely grown grain crops, maize and sorghum, accounting for 37 percent of all cropped area, has followed a decreasing trend since 1970. The trend in rice production is upward and follows closely the population growth line.

The production trend for pulses and beans has been flat, while root and other starch foods have followed slightly rising trends; at a slower rate, however, than population growth. Per capital daily calorie supply has diminished 4.5 percent in past twenty years (FAO, 1983).

Coffee production has remained essentially the same since 1974, with slightly decreasing yields per hectare. Cocoa production (3000 MT) hasn't significantly changed in the last ten years.

Although important differences among regions exist with respect to production of different crops, on bal-

Table IV-13

THE VALUE OF PRODUCTION OF CERTAIN AGRICULTURAL COMMODITIES FOR 1979 (1)

		Value of Production (1000 Gourdes)					Percentage of Total			
		N	T	W	S	Haiti	N	T	W	S
Food	Maize	17,688	45,419	26,588	45,969	135,664	13.04	33.48	19.60	33.88
	Millet	2,464	41,421	29,935	17,408	91,228	2.7	45.40	32.82	19.08
	Rice	28,721	206,833	10,386	22,715	268,655	10.69	76.99	3.87	8.45
	Beans	23,152	26,094	33,770	22,380	105,396	21.97	24.76	32.04	21.23
	Peanut	17,798	15,118	27,009	14,584	74,509	23.89	20.29	36.25	19.57
	Manioc	12,785	15,207	10,208	12,070	50,270				
	Plaintain	59,265	75,704	39,487	51,499	225,955	26,23	33.50	17.48	22.79
	Subtotals	**161,873**	**425,796**	**177,383**	**186,625**	**951,677**				
Export	Coffee	38955	32162	54910	70302	196329	19.83	16.37	27.95	35.85
	Cocoa	24,624	25,056	21,768	66,024	137,472	17.91	18.23	15.83	48.03
	Cotton	982	4,944	3,174	2,078	11,178	8.79	44.21	28.40	16.60
	Export Crops Total(2)	**64561**	**62162**	**79852**	**138404**	**344979**				
	Per Capita(3)	**111**	**62**	**78**	**152**					
Fruit	Coconut	222.6	162.5	311.1	771.6	146.78	15.17	11.07	21.19	52.57
	Mangoes	1,239.0	1,375,3	433.1	1,411.3	4458.7	27.79	30.84	9.72	31.65
	Oranges	1,012.1	304.1	366.3	439.6	2122.1	47.78	14.36	17.10	20.76
	Chadèques	488.2	153.3	377.6	343.0	1362.1	35.84	11.26	27.72	25.18
	Total Fruit	**2,961.9**	**19,952**	**14,881**	**29,655**	**9410.7**				
	Fruit Per Capita	51	17	14	32					
Total (Food + Export + Fruit) =						**1,306,067**				

(1) From DATPE (1984)
(2) Comparable data not available for other exports (sisal, sugar cane); coffee values from OPRODEX.
(3) Based on rural population from table IV-12
(4) Comparable data not available for other fruits.

ance, and on a per capita basis, there is relatively little disparity among the regions except for a considerably low per capita production of foods in the western region. In terms of non-food crops, it is the transversale region which is at a disadvantage.

Technology and Productivity

The Haitian farmer employs the most rudimentary technology. The method of cultivation employed has undergone few changes since the nineteenth century. Tools are generally limited to the hoe and the "machete". Table IV-14 provides data on number and type of tools (CEPAL/FAO, 1983). Varieties of crop plants used are largely traditional, which the population has maintained with virtually no improvement through the years. Neither manure, compost or commercial fertilizers are used to any extent. Minimal fallow of sufficient duration for natural restoration of soil fertility and effective crop rotation are practiced. Pest control is limited to a few pests and crops.

Crop production under irrigation suffers from: poor land leveling; poor maintenance of the water distribution system; inadequate maintenance and control of primary water distribution systems; lack of basic water requirements information; poor drainage; and the virtual lack of yield increasing inputs (improved seeds, fertilizers, pest control); all required to obtain the most effective returns from irrigation.

The production of perennial crops suffers from overage and low density of perennial crops; overshading and excessive density in coffee plantings; inadequate attention to weedings; and lack of fertilizer inputs, improved varieties and pest control. Lack of water and soil conservation characterizes much of the tree crop agriculture. The result is very low crop yield, among the lowest in the world. In a comparison of yields of five important crops in 10 developing and 6 developed countries, yields reported in Haiti were the lowest in all but 3 of 65 comparisons (DATPE, 1984).

Heavy losses from a wide variety of pests on mature crops in the field, as well as in storage, further reduced the effective productivity and availability of crops for consumption.

Production practices with livestock are even less de-

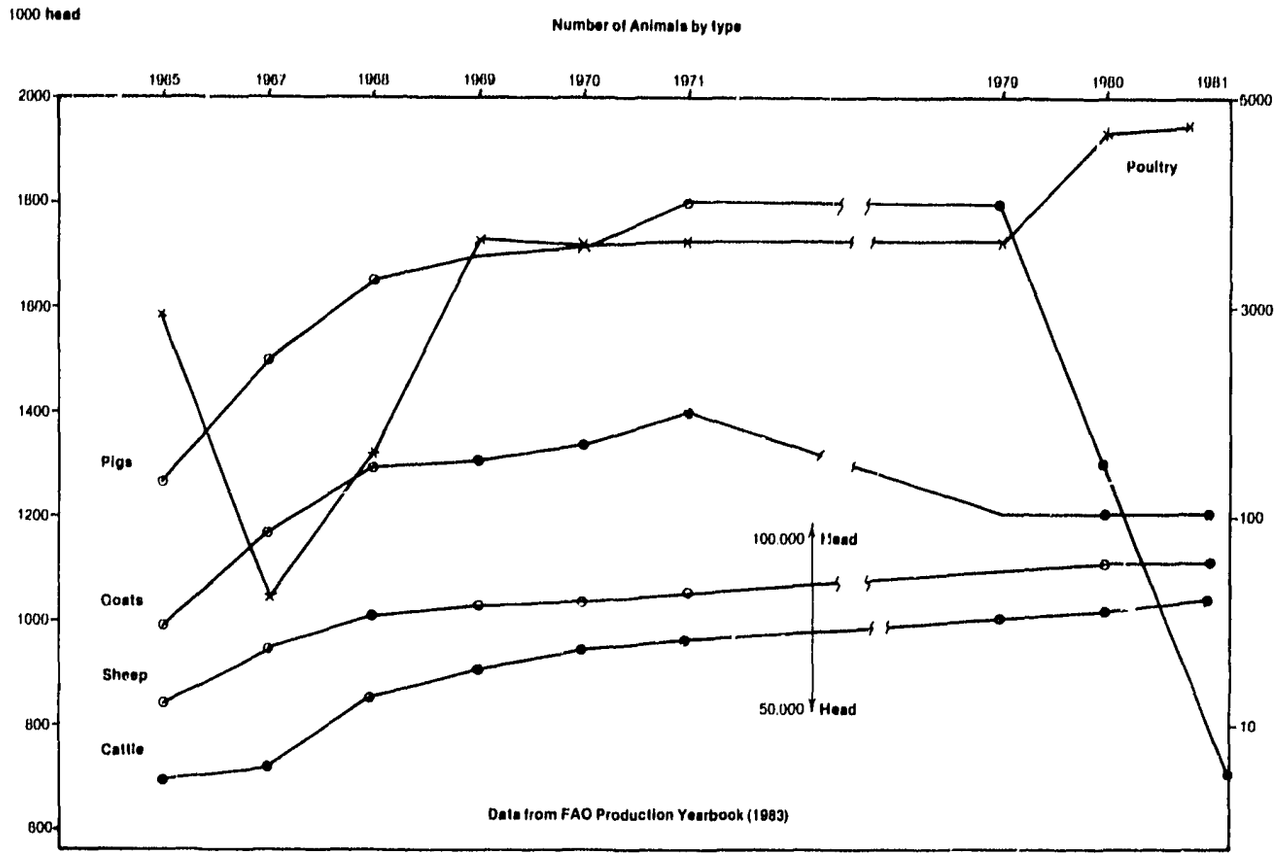


Fig. IV-8: Trends in livestock production.

Table IV-14
DISTRIBUTION OF AGRICULTURE TOOLS BY FARM SIZE
Number of Tools by Type

Farm size	# of farms	tractors	Plow	Hoes	Machetes	Sickles	Picks	Dig/Bars	Spades	Rakes	Shovels	Sprayer	Other	Total
Global	1500	—	7	1493	1314	960	277	286	30	22	37	–	52	4478
0,01 – 0,49	600	—	–	525	443	285	60	45	15	7	7	–	7	1394
0,50 – 0,99	420	—	7	465	375	293	60	53	15	–	15	–	30	1313
1,00 – 1,99	345	—	–	375	353	270	135	143	–	7	15	–	15	1313
2,00 – 4,99	120	–	–	113	128	97	15	37	–	–	–	–	–	390
3,00 – 9,90	–	—	–	–	–	–	–	–	–	–	–	–	–	–
10,00 – 19,90	15	—	–	15	15	15	7	8	–	8	–	–	–	68

veloped. Most animals are left to forage for available feed as free roaming individuals, herded on open ranges or staked out. A few ranches have fenced pastures and some attention is given to management of pastures and grazing. The livestock population exceeds the carrying capacity of the existing grazing areas. Overgrazing is evident everywhere.

Harvesting, storage and feeding or forage/hay is not practiced by the small farmer. Feeding of animals with bi- products (rice and wheat bran, oil seed cakes, molasses) is practiced to a very limited degree. Most of the feed bi-products are exported. Productivity is low, with livestock only reaching a live weight of up to 300 kg after 5 to 6 years, and cows producing about one-half quart of milk per day (Ithaca International, 1983).

After cattle, which to the small farmer is the principal repository of capital after land, swine was the most important animal production enterprise until pigs were eliminated to control the spread of African swine fever (Ithaca International, 1983). Pigs are now being reintroduced.

The low level of productivity in the agricultural sector and the limited application of improved practices can be traced to a wide range of interrelated constraining factors: difficult topography; variability of rainfall; inadequate security in land tenure; virtual absence of capital formation and access to capital through credit, hence very low levels of investment by the farmer; limited public investment in the rural areas; limited availability of improved crop varieties and production practices; poor research and extension services; and extraordinary cultural factors, such as a long history of exploitation of the rural population by the urban elite and political power structure, and by elements of the rural population itself leading to apathy and distrust of any element external to the family and as a consequence resulting in a lack of cooperation among the rural population. An exhaustive listing of constraints is given in Table IV-15.

Research

As the agricultural resource base continues to deteriorate and as the population continues to increase, the maintenance of production at current levels will not be feasible without the application of new production practices which increase yields.

The existing research base on which to recommend practices for increasing production is still very limited. A research unit headquarted at MARNDR with access to seven state farms representing the more important ecological zones of the country, has existed for over forty years. Considerable assistance was provided to this unit by USOM during the period 1958-1962. Between 1962 and 1972, however, the unit was essentially dormant. Virtually no effective research was being done recently. Beginning in the early 1970's, limited assistance for agricultural research was provided by Virginia Polytechnic Institute (VPI). This activity concentrated on maize variety testing and selection and, to a lesser extent, testing of bean varieties. The work was concentrated on the Levy Farm in Les Cayes.

A less extensive study of a range of cultural practices was also undertaken. The principal results from this work were the identification of five better yielding maize varieties, of which one was recommended because of wider adaptatility to the population. The report concluded, however, that the conditions of production practices, including quality of seed, fertilization, plant density, pest control, and adequate moistue, were more important determinants of yields than the crop variety (VPI, 1979).

In 1981, the Agricultural Research Service (Service d'Etude et Recherche Agronomique (SERA) was reorganized. A center for research and agricultural documentation (CRDA) was created within the Faculty of Agronomy and Veterinary Medicine (FAMV). The creation of the center, lacking the responsibility for research in the FAMV, was predicated on the avail-

TABLE IV 15
CONSTRAINTS TO AGRICULTURAL DEVELOPMENT IN HAITI: A TENTATIVE RANKING

Type of Constraints	Degree of Importance (a)
Farm-Level Constraints	1
Acess to Productive Resources	
Land and land tenure	2
Capital	2
Labor Supply	3
Technology	1
Natural Constraints	
Natural Disasters	2
Climate, soils, topography, water ressources	2
Insects, diseases, rodents	2
Soil Erosion and Related Man-Made Constraints	1
Support System Constraints	
Supply-Demand Constraints	
Supply Constraints	1
Demand Constraints	2
Concessional food grain imports	3
Marketing Constraints	
Dispersed production	3
Lack of uniform weights and measures/grades and standards	3
Lack of storage facilities	2
Handling and transport costs	1
Lack of inventory financing	3
Lack of market information	3
Institutional Constraints	
Administrative/managerial/ technical capacities	1
Cooperatives and other farmer organizations	1
Production Credit	2
Input suppliers	2
Research	1
Extension	2
Other services	2
National-Level (Policy) Constraints	
Tax Policy	2
Monetary Policy	3
Price Policy	2
Credit Policy	2
Land Tenure and Land Redistribution Policies	1
Policies Affecting Rural Levels of Living and Income Distribution	2
Employment Policy	3
General Government Support for Agricultural Development	1
Implementation Constraints	
Bilateral and International Agency Procedures	*
GOH Procedures	*

(a) 1 = Major 2 = Moderate 3 = Minor
* Regarded by the DARNDR as significant constraints.

Table IV-16

ACTUAL CROP YIELDS WITH TRADITIONAL PRACTICES AND EXPECTED CROP YIELDS WITH IRRIGATION AND APPROPRIATE LEVELS OF TECHNOLOGY AT THE DUBREUIL PROJECT AREA

Crop	Crop Cycle Days	Actual, traditional practices and no irrigation	Actual, appropriate technology and irrigation	Potential, appropriate technology and irrigation
Corn	120-150	800	4000	6000
Beans	80	670	1500	2000
Sorghum	100	750	3000	5000
Rice	90-140	1200	4000	6000
Pigeonpeas	235	600	2000	2500
Cowpeas	60-90	–	2000	3000
Soybeans	80-100	–	1500	3000
Sweet potatoes	135-150	2250	5300	6000
Cassava	300	4000	6000	10000
Tobacco	90-120	–	1200	1700
Sugarcane	365	30000	70000	120000
Irish potatoes	75	–	–	12000

1. Actual yields of corn, beans, sorghum, rice, sweetpotatoes and sugar cane taken from UN-FAO, 1975, Enquete et Démonstration Agricole dans la Péninsule Sud, Haiti (28). For other crops, taken from Texas A&M/Haiti 1981 and 1982 Annual Reports (25, 26) and from Hargreaves and Samani (12).
2. Yields of corn, beans, sorghum, rice, sweetpotatoes and sugarcane taken from references 12, 25, 26 and 28.
3. Potential or near maximum yields, are adapted or taken from references 12, 25, 26 and 28. They are bases on the use of irrigation and the adoption of improved technologies.

ability of a staff of some twenty-eight qualified personnel in FAMV and financial support from CIDA.

Other assistance for research was also provided by USAID in 1981 through a Texas A & M team, and by CIMMYT with Canada's financial support. The nature of and results from these programs, detailed in annual reports and papers prepared by the two groups are provided in Table IV-16.

The CIMMYT work illustrated the approach of that institution to Farming Systems Research (FRS), i.e. several steps through which key factors involved in the production equation are isolated and their impact evaluated as a basis for defining research priorities. The information developed, in illustrating the approach, identified nitrogen fertilization as the most important determinant of yields. The next in importance was crop variety. Two varieties, La Maquina 7827 and 7928, outperformed the traditional varieties when nitrogen was applied. Without nitrogen, the differences were much smaller and varied with location and other practices.

The Texas A & M studies focused on selection and testing of varieties of maize, sorghum, beans and pigeon pea for yield and adaptability, introduction of cultural practices on productivity, and comparison of a number of cropping systems involving intercropping, multiple and rotational cropping systems.

The work of the Texas A & M team, working concurrently, confirmed the superiority of the two CIMMYT maize varieties and identified superior varieties of sorghum, pigeon pea, common bean, tomato and okra. Packages of technology were defined for each of these.

Economic analyses were made of some 29 cropping systems under traditional and improved technology. The improved technology resulted in up to 15-fold increases in net returns, with most systems returning over 4-fold increases. However, systems involving sorghum and maize alone or intercropped with cow peas or pigeon peas, rarely resulted in significant (less than 2-fold) increases in returns. Generally, intercropping systems yielded greater net returns than monocropping systems. Intercropping is commonly practiced by the Haitian farmer.

While the economic analysis of the several systems suggests that substantial improvement in productivity and economic returns could be obtained by appropriate cropping systems and production practices, they should be used with caution. In all systems studied, the improved practices package included irrigation, while the traditional package did not. In over 50 percent of the cases, fertilizer was included in the improved package. Consequently, the impact of other practices were confounded with response to irrigation and fertilizer, the two factors with the greatest possible

impact. The immediate applicability of the results are, thus, limited almost entirely to areas with irrigation. Moreover, as irrigated fields are used mostly for rice and sugar cane, the possible impact of these research activities on a large number of farmers producing food crops under rainfed conditions will be minimal.

TABLE IV-17
ADOPTION OF IMPROVED TECHNOLOGY BY FARMERS

Technology	Percent of Farmers Employing Traditional Practices	Improved Practices
Maize varieties	55.2	44.8
Millet/Sorghum varieties	57.1	42.7
Bean varieties	83.3	16.7
Fertilizers	26.8 (non-used)	73.2
Pesticides	35.7 (non-used)	64.3

The improved varieties selected could possibly have some impact, however, if adequate seed production programs and effective distribution systems are implemented. Some interest in seed production is found among agricultural input suppliers in the private sector.

Many estimates have been reported on the potential increase in productivity which could be obtained from the application of better technology. In most cases, appropriate irrigation and fertilization are required. Only very limited information is available on farmer acceptance of improved technology. One study (IICA/BCA, 1979) surveyed the use of improved technology by farmers in several of the «Ilots de Développement» («developpment islands» approach which was launched in the early 70's, but was abandoned after some five years of operation). Although the samples in each «Ilot» was small, the aggregate provides some idea of the rate of adoption of several practices (Table IV-17). Unfortunately, the survey did not provide information on the impact of the improved technology on productivity.

It is clear from the above that there is little information on the impact of technology on productivity under rainfed production practices, and without the use of fertilizer in Haiti. It is also clear that there is virtually no research addressing the problems of improving practices, whether for increasing productivity or for reducing erosion and water loss. There are serious doubts that terracing, or similar physical measures to reduce water loss and erosion, are applicable to most of the land subject to erosion in Haiti. Perhaps a more appropriate approach would be to employ vegetative cover (legume species, mixtures of grasses and legumes, shrubs and trees in a strip pattern altenating with cultivated crops). A proper choice of vegetative cover would not only provide protection, but could be used as animal feed.

The difficulties of obtaining wide application of such a system cannot be underestimated. It would mean close cooperation of many farmers, probably entire and/or, frequently, several communities. It would also reduce the land in crop production resulting in a serious constraint on populations which are already on the very edge of survival. Yet, there is no alternative but to reduce the area under cultivation, if soil loss is to be halted and ultimately reversed.

Use of Agricultural Inputs

Good quality seeds of improved varieties, fertilizers and pesticides are the principal agricultural inputs, other than irrigation, which contribute to increasing crop production. The use of these inputs in Haiti remains at minimal levels.

Seeds. Seeds of vegetable crops are imported through the private sector. There is essentially no seed production operations per se for the traditional, widely grown crops. Seeds are produced by individual farmers and/or traded among farmers. There have been few introductions of new varieties of food crops either from outside of from local research. A notable exception is rice, in which case an introduced variety has become widely accepted. Limited amounts of this seed variety are produced and distributed by ODVA, which also attempts to maintain purity and quality by reimportation. Other seed requirements are met by farmers. An effort was made to establish a seed production, processing and quality control unit in MARNDR in 1977. The operations ceased to exist in 1981.

Few, if any, superior varieties of widely produced crops have been available, and for those which are available demand is met by the traditional diffusion by peasants and "Madam Saras". The testing and demonstrating of the superiority of new varieties by recent research efforts will probably create such a demand.

Traditional diffusion processes will probably be able to continue to assure production and distribution. The principal task in the future will be to provide sufficient seed for initial wide-spread diffusion and for subsequent distribution of sufficient amounts from well maintained stock to assure seed purity and quality. Probably more important than production itself, is the need to improve storage, in order to maintain the quality and germinative powers from one season to the next.

Fertilizers. Haiti uses far less fertilizer than any other country in the Caribbean region, using about one fifth as much as the Dominican Republic. One reason for this has been the generally exploitative practices employed by ferlilizer importers and suppliers. These practices include not only excessive price, but also lack of attention to quality, including frequent

resort to adulteration. Since the establishment in 1981 of a bulk mixing plant near Port-au-Prince by a joint venture of local and foreign capital, prices have decreased and quality control improved (ASSA, personal communication, 1985). This firm distributed, through vendors in the principle consumption areas, 570 MT in 1982, of an estimated total consumption of about 8000 MT. Nitrogenous fertilizers, principally urea, account for about 50 percent of consumption, with a wide variety of complex fertilizers making up the remaining 50 percent.

About sixty percent of all fertilizer is used for rice; vegetable production accounts for a large share of the remainder. Little is used on maize, sorghum or sugar cane.

Pesticides. A wide variety of pesticides are utilized. Five or six importers distribute most of the volume consumed. In 1983-84, it was estimated that between 300,000 and 400,000 kg, valued at slightly over $1,000,000, were used for agricultural purposes. Approximately 300,000 kg of Fenitrothion were imported in 1983, to control mosquitoes and prevent malaria.

Most of the pesticides are used on tobacco, vegetables and cotton. Zinc Phosphide and, to a lesser extent, Wafarin, are widely used for rat control in rice fields in a campaign organized by the Plant Protection Service (SPV) of MARNDR.

Private importers estimate that pesticide use has been increasing at a rate of about ten percent during the last three to four years. Utilization is limited by economic constraints and general lack of knowledge about pest control application by farmers.

The GOH ratified the International Convention of Rome, in December of 1981, for plant protection. A legislative proposal has been drafted which sets forth regulations for the application of the Rome Code with some modifications. This proposal is being studied by several ministries.

Although a number of the chemicals being used are highly toxic and some have long residual effects, the small amounts being used do not present an environmental problem. However, they present potential dangers to users unless certain precautions are taken. The SNEM prescribes a set of precautions for applicators of the insecticide Fenitrothion, and for the residents of the homes being treated; and an organized system of supervision and monitoring has been established. There is, however, no similar system for informing the public and protecting the users of pesticides used in agriculture.

Irrigated Agriculture. Since the colonial period, irrigation has played an important role in Haitian agriculture. It is reported (Harza, 1979) that irrigation covered 140,000 ha. during the colonial period. Although as much as twenty percent of the arable area of the country is potentially irrigable, less than ten percent has actually been developed for irrigation (70,000 ha) (FAO, 1983). The irrigated and potentially irrigated land areas contain the best land (soils and physical features) in the country. Greater and more effective exploitation of the irrigation potentials is limited by the slow rate of development of water and land resources, the poor state of maintenance of the irrigations systems, continuing deterioration of irrigated lands and structures because of erosion, flooding and silting, and insufficient use of water for production. For example, in the Artibonite Valley, which has the largest irrigation sytem, about 58 percent of the potential has been developed, yet only about 30 percent of the potential, or fifty percent of the developed area, is actually currently in production using irrigation (Le Baron et al., 1984).

The ineffective development and use of the water and land potential for irrigated crop production stems largely from the limited effectiveness of public services responsible for public administration and management of water resources.

The following institutional problems summarize the many obstacles to developing irrigation systems of value for Haiti:

- The shifting of responsibilities for water development and management, over time, between the Department of Public Works and that of Agriculture, including a period of shared responsibility by the two departments;
- The inadequacy of staffing and financial support of the Irrigation Service of the MARNDR (the entity now, and since 1958, charged with the total responsibility of water development and management), the division of authority between the Irrigation Service and autonomous entities such as the ODVA and ODPG;
- The independence of financing of projects through special allocations of national budgets to autonomous entities;
- The major role played by donor agencies in financing water and irrigation development activities by the autonomous agencies, as well as projects which are under direct control of the Irrigation Service;
- The limited participation of the farmers in decisions about water and irrigation development, or in planning and design of the systems;
- The lack of cooperation and frequent conflicts among the Irrigation Service, district agriculture personnel, local authorities and the local population;

- The arbitrary exercise of authority and functions at the local level resulting in serious inequities;
- The wide discrepancies in the levying and collection of the irrigation fees, often resulting in collection of less than 50 percent of taxes due, this due, in part, to ineffectiveness of maintenance operations leading to farmer reluctance to pay the taxes.

Although the legal basis for the rights and responsibilities of the state, the land owner and the farmer have been defined in numerous legal cases, the law seems to be poorly understood and applied. Water users associations have been generally more effective in assuring proper maintenance of systems and distribution of water, but these organizations suffer from many of the same problems of the systems which are totally managed by the Irrigation Service. The limited financial resources which the associations command are insufficient to assure adequate control of operations and maintenance within the system.

The effectiveness of irrigation in agricultural production is much reduced by poor production practices, such as: use of excess water; inadequate drainage; poor land preparation, especially land leveling; lack of or limited use of other improved practices; limited use of good seed of improved crop varieties, proper fertilizers inadequate weed and pest control, which are essential to fully exploit the advantage of irrigation. Yields of crops which are grown under irrigation are very low compared to those obtained in other countries. Rice yielded 2-2. 5 MT/ha compared to 4-6 MT/ha or more, sugar cane yields of 40-50 MT/ha compared to upwards of 100 MT/ha.

The developement of irrigated agriculture has been largely based on surface water. There are, nevertheless, two important areas in which irrigation is based on pumped water. In Cul de Sac, HASCO pumps water from fifty wells for irrigation of some 3500 ha of sugar cane; 19 other wells in the Cul de Sac are exploited by cooperatives for production of a wide variety of crops. In the plains of Gonaive, limited surface water is supplemented by well-pumped water from thirty-nine deep wells for irrigating approximately 3000 ha.

Although there appears to be some potential for tapping additional groundwater for irrigation, this has received little attention. It appears that irrigation from pumped wells is generally thought to be too expensive. This may simply be a reflection of the fact that pumping charges are payable by the users as these accrue or even in some cases in advance, while the real cost of surface water is frequently masked by only partial payment of user's fees and public support of operations and maintenance. Thus the perceived cost of irrigation from surface water may be substantially understated, while that for pumped wells may be much less so. For example, in the Cul-de-Sac, the cooperative farmers pay in advance for the pump operator and the fuel cost (maintenance of wells and pumps are paid as needed from the cooperatives' equity capital). These operating costs vary from 18 to 24 gourdes per hour. At the higher range, the cost of irrigation for producing one crop of beans was estimated to be $285.00 per hectare (Hauge, 1984).

The pumping costs in the ODPG project are difficult to estimate because of the complex system of charging and collecting payments. That the costs are high, however, is suggested by the substantial arrears in payments for electricity (Hauge, 1984), in spite of a fifty percent subsidy by Electricité d'Haiti. Some of the apparent high costs are due to mismanagement, easy credit, and arbitrary collection of charges.

G.- CONCLUSIONS AND RECOMMENDATIONS

From the time of independence, utilizing primitive production technology, the Haitian peasant was hard put to produce surpluses over consumption to improve his productivity or to bring about greater efficiency and diversity in his use of the natural resources.

Historically, economic development beginning with agrarian societies was based on a generation of surpluses from agriculture. In the Haitian experience, the small surpluses which were produced and invested failed to generate development because of: a) the lack of organization, cooperation and community action by the rural population and b) by the policies of the government and exploitive practices of the urban elite resulting in the systematic transfer of resource benefits from the rural sector. Without surpluses for land improvement and a sense of permanency and ownership, pervasive undermining of the natural agricultural base has been the consequence leading to the serious degradation which exists today.

The reversal of this relentless degradation of renewable resources will be particularly difficult in Haiti because: a) the rural population still has little disposition for organization and cooperation and appears to have little confidence in assistance from the government; b) the already overexploited resource base is barely providing for the survival of the majority of the peasant population; c) means for increasing productivity or to make up for losses from retired or diverted land use are virtually non-existant, except irrigation.

There are no reserves which can be mobilized in most of the rainfed agricultural areas. As a result, any loss in production due to retirement of land for conservation purposes or any altered use which even on the shortest time frame, would result in reduction in production, will jeopardize the very survival of the affected population.

The outlook for developing and applying, on the short to medium term, productivity increasing practi-

ces, which would be economically sound for most of the rainfed areas, is rather remote. Replacing annual crops in areas unsuited for such crops with tree crops is one possible option. This approach is, however, limited by the relatively few tree crops which are adapted to the environment and for which markets would pose no problem. It is also doubtful that returns from the tree crops would in most cases be superior or equal to the meager output of the traditional annual food crops.

The ability of the government to intervene is limited by the weakness of the existing institutions and the limited financial resources now being allocated to the agricultural sector. Functional operations budgets of the Ministry of Agriculture have averaged only about 5 percent of the national budget during the past several years. At the same time the rural population is paying a disproportionate share of the taxes. In 1975-76 it was estimated that the rural sector contributed 41.1 percent of domestic revenues, but only received 17.2 percent for services in the rural sector. The government has been reluctant in the past to relax rural sector taxation as an incentive to greater investment. Also with the policy of the GOH to operate with a balanced budget revenues, increasing the operational budget for agriculture will likely be difficult. While external organizations could contribute the development capital necessary, the capacity to use resources efficiently is limited by weak institutional structures, a lack of training and education and inadequate operational budgets.

The best strategy for maintaining agricultural production on the short to medium term and to eventually increase production, lies in the more effective use of irrigated lands and in the development of additional irrigation potential. This could be achieved with minimal adverse environmental impact. However, a prerequisite to more effective production from irrigation, is the protection of upper watershed areas to avoid the destructive effects on irrigation systems from flooding and siltation caused by poor land practices in the uplands. Protection of watersheds by depopulating the hillsides could displace some farmers on critical lands, but not their entire population. Intensification of irrigated crop production will probably absorb few if any of these displaced individuals, consequently means for providing subsistance to these small farmers will have to be found.

Intensification of production in irrigated areas, itself, will require a concentrated and determined effort. The impediments to more effective use of irrigation are legion. Some have become institutionalized in the Haitian society and will be difficult to change. Nevertheless, since improvements in this area are likely to be more visible and more productive than other changes which could be considered, this alternative should be pursued agressively.

Production options on the irrigated land are also a factor. Concentration on high valued crops, to the extent that these can be consumed, processed and/or marketed, should be considered. In this connection, the traditional use of a significant portion of the irrigated area for sugar cane, currently being produced at a loss in terms of world sugar prices, should be reconsidered.

Initiate an Irrigation Study. A thorough study of all costs involved in irrigation: capital, system maintenance and operations on-farm distribution and drainage, structures maintenance and operations, land preparation (leveling) etc., is warranted. The study should consider sprinkler irrigation from wells. The cost of sprinkler equipment could be largely offset by the savings from reduced need for water distribution systems and lands leveling. More efficent water use would also reduce pumping costs.

V

Coastal and Marine Resources

A.- INTRODUCTION

Haiti's coastal waters include both the Atlantic Ocean (to the North), and the Caribbean Sea (to the east and south). The insular shelf, an estimated 5000 km^2, occurs as a narrow platform 0-200 m deep, extending for the most part less than 300 m offshore, before dropping abruptly to the ocean floor some 300 to 4000 m below.

The coastal zone supports 180 km^2 of mangrove wetlands (IUCN, 1983), and barrier and fringing coral reefs and meadows. Four large offshore islands: Ile de la Tortue, La Gonave, Grande Cayemite and Ile à Vache and numerous smaller islands contribute to the richness of the coastal system. Protected bays and estuaries, white coral sand beaches, limestone cliffs, and rocky shore line the coast. Long stretches of this coastline are inacessible by road and, consequently, have remained in a pristine state. Mangrove, coral reef, and seagrass habitats appear to be well developed in Haiti and represent a major renewable resource for fishing and tourism.

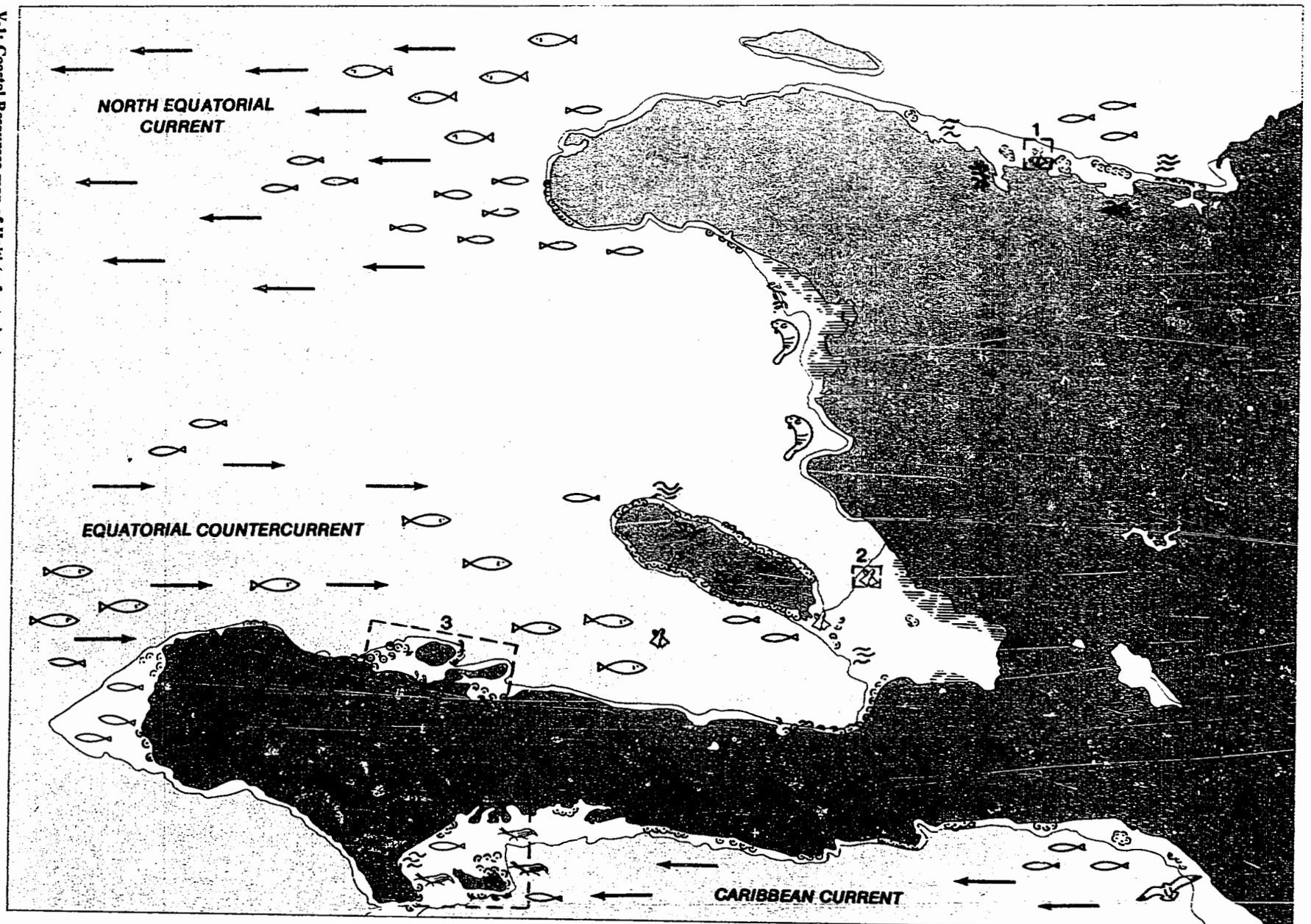
B. COASTAL RESOURCES

Seagrass Beds

Rich seagrass beds are known to occur along the north coast, and at Les Cayes. Potentially rich areas appear to be La Gonave and Les Cayemites area. Seagrass meadows, in particular, represent the greatest concentrated source of primary productivity, providing oxygen and nutrients to marine species and a means of stabilizing substrates. Their distribution in Haiti is poorly known. However, it is likely that offshore areas, including shallow offshore islands such as Ile à Vache, where turbidity and sedimentation from land runoff do not occur, harbor productive seagrass beds.

Coral Reefs

An inventory of the many extensive barrier and fringing and associated patch reefs has not been made, and the productivity and species diversity have never been assessed. It is assumed, however, that with the absence of large scale coastal development and commercial fishing except in the more polluted areas of



PREPARED BY WILCOX ASSOCIATES

Fig. V-1: Coastal Resources map of Haiti (refer to key)

Table V-1
LIST OF MAJOR MANGROVE SWAMPS IN HAITI

Location	Area (Ha)	Percent of Country Total	Forest Type
I. North Coast			
A. Ft. Liberté area			
1. Rivière Massacre	60	0.27	R,B
2. Coastal	70	0.31	B,F
3. Baie de F. Liberté	340	1.52	F,B
B. Baie de Caracol	3,990	17.84	F
C. Cap Haitien	760	3.40	B,F,
D. Limbé			
1. Baie de l'Acul	480	2.14	F,B
2. Rivière Limbé	100	0.45	B
E. Port-de-Paix	70	0.31	B
II. West Coast			
A. Anse Rouge	350	1.57	F
B. L'Estère	8,490	37.97	F
C. Artibonite	490	2.19	F,B
D. Port-au-Prince	670	3.00	F
III. South Peninsula			
A. Petit-Gôave	50	0.22	F
B. Trouin	70	0.31	B
C. Miragôane	350	1.57	F
D. Baradère	1,200	5.37	F,B
E. St-Jean du Sud	180	0.81	F
F. Cayes area			
1. Marsay	140	0.63	F,B
2. Cavaillon	350	1.56	B
3. Mombin	60	0.27	B
4. Rivière Millionaire	80	0.36	B
5. Scattered coastal	400	1.79	F,B.
G. Aquin			
IV. Satellite Islands			
A. Ile de la Tortue	110	0.49	F
B. Ile de la Gonave	1,150	5.14	F
C. Grande Cayemite	250	1.12	F
D. Ile-à-Vache	1,610	7.20	B
Total Area 22,360 or 0.8% of country total			

Mangrove Forest Types: F-Fringing / B-Basin / R-Riverine
* Note: Between 1956-1957 about 7% of mangrove vegetation disappeared.
Source: J. Thorbjarnason: Status and Ecology of the American Crocodile in Haiti. U. of Florida (1984).

the baie de Port-au-Prince and certain heavily fished areas nearshore, the reef habitat is healthy and productive.

Coral reefs rank among the most biologically productive and diverse of all natural systems even though the waters that surround them are devoid of nutrients which normally support plankton found in richer, more temperate waters.

Reefs provide food and shelter for resident and migratory species, protect coastal property from tropical storm damage by acting as self-repairing breakwaters and offer a storehouse for potentially valuable species (e.g. pharmaceuticals, commercially harvestable species).

Mangroves

Haiti's mangrove wetlands, also largely unaffected by coastal development, are important reservoirs of plant and animal species, and contribute to the diversity and ecological significance of the coastal marine environment. They protect adjacent estuarine and nearshore marine ecosystems, provide essential habitat to a wide diversity of wildlife, especially birds, and offer vast breeding and nursery grounds to reef fish. Significant mangrove forests occur on the north coast between baie de l'Acul and Fort-Liberté, the region of the Artibonite estuary, the Grandes Cayemites area on the north coast of the southwest peninsula, and Les Cayes region including Ile à Vache (Table V-1). Important mangrove systems are also found on the large offshore island of La Gonave, primarily on the north coast, but also fringing much of the south coast in small discrete areas. Mangroves are used for charcoal and construction (polewood), but impacts are not yet significant. Mangroves are protected by Article 97 of the Fisheries Laws of November 27, 1978 (Table V-2), which forbids their cutting for any reason because of their nursery value for finfish and shellfish. This law, however, is not enforced.

Coastal Waters

In general, the waters of Haiti are not naturally productive, due to a number of factors:
– The Caribbean is deep, 80 percent deeper than 1800 m;

– The coastal shelf area of 5000 km^2, commonly the most accessible and productive fishing ground, is narrow and used mostly by bottom-dwelling fish;

TABLE V-2
EXTRACTS OF THE NOV. 27, 1978, FISHING LAW OF HAITI

Art. 97 It is forbidden:
a. To capture, to sell, to export the «triton» (*Claromis variegata*)
b. To capture the green and the Caray turtle during the nesting season between May and October.
c. To collect turtle eggs of any kind within the boundaries of the territorial waters.
d. To capture sea turtles and Caray on the beach.
e. To collect sea crabs between Dec. 11th and Mar. 31st.
f. To capture marine mammals such as seals and sea lions, whales, dolphins, porpoises within the territorial waters without a special permit from the Ministry of Agriculture (DARNDR)
g. To cut mangrove vegetation which serves as the natural habitat for numerous marine species (oyster in particular).

Art. 115. The exploitation and sale of spoiled sea food is prohibited. Any Fish Service Inspector can seize the stock and if necessary, proceed to destroy it.

Art 112. It is forbidden:
a. To capture, sell, buy small conch shells and to engage in the commerce of their shells.
b. To export the shells of sea turtles without authorization of Fishery Service.
c. To export the following shells without authorization of the Fishery Service
– *Nerita poloronta* (Dent saignante)
– *Linova pica* (Brig noir)
– *Cassis tuberosis, Cassis madascariencis* (Casques)
d. To export lobster and conch without adequate cleaning
e. To use the chemical products such as "Salpetre" "Chlorox" and others to clean shellfish.
f. To use the refrigerator as a storage facility when the freezer is required.

Restrictions by species
a. Lobsters – Weighing less than 151 gr or 5 oz. cannot be captured
– Season is closed between Apr. 1 and Sept. 30
– Females with eggs cannot be captured
b. Conch – No shell less than 10 cm in length can be collected
– Use of "hooka" (air compressors) to dive for conch between Feb. 1 and July 31 is forbidden.

– Surface waters are warm year-round at 26-28° C, and the water column is relatively stable, that is, there is little mixing or exchange of deep and shallow waters;

Nutrients which sink to deeper depths in tropical waters are not recycled to the surface as in many temperate fishing grounds;

– River-source nutrients are low since there are few perennial streams, and those which do enter the water column are rapidly used or sink to deeper waters;

– Nutrient production from mangroves, coral reefs and seagrass beds, while locally important, cover a small area compared to that of the open seas.

Specific areas, however, do exhibit a comparatively higher productivity. In such areas as the western tip of the southern peninsula, prevailing currents are warm, easterly and influenced by the strong North Equatorial Current, bringing seasonal migration of pelagic fish such as skipjack, mackerel, dolphinfish and billfish into Haitian waters. The exact nature and extent of these fish stocks, however, are not known. At Cap Dame Marie, where the continental shelf (less than 200m deep) extends over 20 km offshore, the Cuban (Equatorial) Countercurrent forces waters eastward, causing some enrichment of coastal waters. The absence of upwelling or seasonal mixing of warm surface waters with colder, nutrient-laden deeper waters off the shelf, does limit primary (plankton) production along the coast, but nutrients essential for the proliferation of plankton occur in areas draining mangrove forests or other river runoff areas such as baie des Cayes and Canal de l'Est on the southwest coast, baie de la Tortue, Baie du Grand Pierre and Baie des Gonaives of the Artibonite River, and selected locations along the north coast from Liberté to Baie de l'Acul.

C.- SUMMARY DESCRIPTION OF COASTAL AREAS

Ft. Liberté to Môle St. Nicolas

The area between Chou Chou Bay and Ft. Liberté has productive bays and coves, sandy beaches, mangroves, extensive seagrass beds, and coral formations including fringing reefs and a barrier reef more than 17 km in length stretching between Cap Haitien and Ft. Liberté. The shoreline at Morne du Haut Cap is separated from Cap Haitien by mountains, and has limited accessibility by unimproved road. Within this region, unimpacted by shoreline development, are two small bays which appear to have potential as marine reserves to enhance fish breeding and nursery grounds: Baie de Labadie and Baie de Cadrasse (J.C. Dicquemare, 1985 pesonal communication). Important fishing grounds include Ft. Liberté and the Baie de l'Acul du Nord (DAPTE, 1984).

Unique features include good conch (Strombus gigas) habitat from Ile de la Tortue to Ft. Liberté, significant mangrove area between Baie de l'Acul and Ft. Liberté, excellent shrimp habitat (Penaeus brasiliensis, P. duorarum P. schmittii, Trachypenaeus similis, Alpheus sp.) in Baie de l'Acul, and good habitat for Manatee (Trichechus manatus) and green turtles (sightings of both endangered species are infrequent). There have been crocodile (Crocodylus acutus, or American crocodile) sightings at Lagones aux Boeufs near the border. There is a conch mariculture project in Ft. Liberté bay, an area with suitable benthic vegetation, well protected with fringing reefs and good circulation and high oxygen levels (PROTOS 1985, personal communication). Conch Ministries, a PVO based in West Virginia, is buing juvenile conch from the Pride-operated hatchery based on Turk and Caicos islands, to reseed Ft. Liberté bay and to conduct experiments on the best way for local fishermen to manage the resource. Ft. Liberté is also the location of a Tilapia project funded by the Project Technische Ontribtilelings Somerverling Development (PROTOS), a PVO from Belgium and managed by volunteers working closely with community members.

This stretch of coastline is the site of offshore 18th and 19th century shipwrecks (some estimates go as high as 250), including the Santa Maria, Columbus' flagship. Bord-de-Mer de Limonade, a fishing village, just east of Cap Haitien is believed to be the site of the ill-fated colony of La Navidad.

The major population center is Cap Haitien, the second largest city in Haiti. The extended shelf area north of Cap Haitien offers increased potential for fishing. Offshore, along the coast, is a major migratory pathway for whales.

The north coast of Ile de la Tortue is devoid of reefs, and drops sharply down to 3600m, directly offshore. The south coast from Point Saline in the west to Pointe Portugal in the east is protected by a long continuous barrier reef. This large offshore island has 47 species of birds, and is believed to have had a large and distinct animal fauna in pre-colombian times (C. Woods, 1985 personal communication).

Môle St. Nicolas to Gonaïves

From Môle St. Nicolas to Gonaives there are eleven fishing centers: Gonaives, La Pie, Grande Savane, L'Etang, Coridone, Pt. Demong, Anse Rouge, Petit Anse, Baie de Henne, La Plateforme and Môle St. Nicolas. The fishing village of Môle St. Nicolas (population 2000) is located on the Baie du Môle, a well protected deep water harbor on the westernmost point of the northwest peninsula, 297 km from Port-au-Prince. At the bay's entrance, the edge of the shelf is only one-half mile distant. In case of severe weather, i.e. cyclones, fishermen take refuge in the Baie Carenage.

One of Haiti's poorest regions, the northwest coastal area is arid and almost completely deforested. The

villagers support themselves by fishing, charcoal making, salt production and limited cultivation. Although post-harvest losses are reported to be common in Haiti's fishing villages, here the use of ice-packed buckets delivered each morning to the buyers, the salting of some species and an efficient marketing system, prevent spoilage.

Gonaives to Baie de St-Marc

The Artibonite estuary and adjacent regions have hundreds of hectares of rice paddies which extend on either side of the Artibonite River within several kilometers of the estuary. Three large bays, Gonaives, Tortue and Grande Pierre, occur, north of the river and are said to harbor a small group of manatee. The small village of Grande Saline and a smaller bay (name unknown) lies just south of the river. These mangroves border the bays while a vast zone of flat, often tidal influenced lands without vegetation, lies nearby, providing feeding habitat for hundreds of flamingos and other shorebirds.

Gonaives is a major fishing port (DAPTE, 1984). The insular shelf widens in the Gonaives, Grande Saline region, providing extended fishing grounds.

The brine shrimp (Artemia sp.) has recently been discovered in the salt ponds just north of Grande Saline, where salt is being harvested in numerous small ponds on both sides of the river.

Brine shrimp are found throughout the year in all salt ponds, especially when salt concentrations are low (C. Mock, 1984).

The area, however, was declared unsuitable for shrimp and Artemia farming by an American investment group because of the soil characteristics.

Baie de St. Marc to Ile à Cabri

Located well within the Gulf of La Gonave and sheltered by La Gonave Island to the south, this area contains many extensive fringing reefs and offshore reef formations, including those that surround Les Arcadins.

With the exception of the densely populated area of St. Marc, the region can be characterized as a low density beach resort areas, easily accessible to tourists from Port-au-Prince. There are seven beach resort hotels with coastal recreational facilities, as well as private beach houses, dotting the coastline.

The area below Baie de St-Marc and above Ile à Cabri is relatively pristine. The Ile à Cabri area, once a significantly productive reef, lagoon and mangrove system, has been heavily impacted by coastal industry.

The baie de St-Marc contains a coral encrusted wall of great beauty, directly offshore, (A. Baskin, 1985 personnal communication) and an extensive fringing reef along its northern coast, where manatee have been sighted. However, it is also the location of the densely populated town of St-Marc, which may be adversely impacting the bay's ecological system.

Les Arcadins, small points of land located seven miles offshore from the nearest shore at Pt. Paturan, are known for unusually large and abundant specimens of both fish and invertebrates and extensive seagrass beds in surrounding waters. This area is prized by snorkelers and Scuba divers.

It is also the fishing grounds of Lully a well-established village and fishing cooperative.

Ile à Cabri to Leogane

Demarcated by Port-au-Prince Bay and the capital city of Port-au-Prince, there are no large rivers, strong tides or winds in the inner harbor to create fast currents in nearshore areas resulting in a low flushing rate of sediments and toxic wates entering the bay from land runoff. The mean tidal variation is only 1.18 ft. The maximum wave height recorded in the harbor does not exceed 3 feet.

The coastline is largely developed, with altered topography and drainage, and bordered by landfills, docks and other impermeable surfaces. There is abnormally high turbidity in nearshore waters. Stormwater containing heavy sediment loads and low sewage drains into the bay from open channels and closed lines.

At one time there were well-developed mangroves, lagoons and coral reefs lining the shore. Now the combination of dredging, harbor activity, silt deposits and sewage pollution has apparently irreversibly reduced benthic diversity and productivity in nearshore waters.

Approximately 7.1 km off the coast of Port-au-Prince lies a reef system, the Grand Banc, which includes Pelican Caye. Sand Caye, a second reef area, lies approximately 4.9 Km offshore. Both areas appear to be utilized by artisanal fishermen and tourists from Port-au-Prince (e.g. «Yellowbird» cruises, which leave from Port-au-Prince.)

Leogane to Jérémie

The south coast of the Baie de Port-au-Prince is well populated nearest Port-au-Prince, with population centers clustered in the river valleys. Farther along the coast near Jérémie, the sparsely settled Grand Cayemite area offers spectacular scenery, including extensive mangrove forested islands and mangrove lagoon systems, coastal mangrove wetlands, rocky cliffs, offshore reefs, and seagrass beds.

There is reportedly a large fishing population who

fish the nearshore coral reefs and several secluded resort areas featuring a pristine environmental setting. The southern highway from Port-au-Prince does not hug the coastline as in the north and, consequently, the shore is less accessible and less impacted by development.

A unique feature, the small islet, Rochelois, is an atoll-like reef with a lighthouse, approximately 13 km from shore and often frequented by divers and fishermen alike. The reef extends in a circle from 0 to 600 ft., less than half a kilometer from the atoll. The clear waters surrounding Rochelois, unimpacted by land runoff, have encouraged the growth of extensive coral formations, including a coral encrusted wall of great beauty at the shelf's edge (G. Kenn, 1985, personal communication).

Baradères to Les Cayemites

Baradères-Cayemites, an area located just east of Jérémie on the southern peninsula, features an extensive and pristine coral reef system, as well as large untouched mangrove formations. Spectacular bays ringed with mangroves and offshore sandy cays lined with surfacing reefs, contain many samples of the coastal and marine environments of Haiti.

As such, it deserves protection as one of the first marine reserves of the country. (See Marine Reserve discussed on p. 75.

Jérémie to Cap Tiburon

The area west of Jérémie between Dame Marie and Cap Tiburon features the largest shallow submerged shelf (339 Km^2) of potentially good fishing grounds in Haiti (FAO, 1983). At Cap Dame-Marie, the equatorial countercurrent forces waters eastward, mixing and enriching coastal waters.

The fishing village of Anse d'Hainault lies in the center of the western coast of the southern peninsula of Haiti. It is located 210 km west of Port-au-Prince, and 40 km from Jérémie. The town lies on a small area of flatland about half a kilometer square at the mouth of a valley which discharges into the Baie de Nault. It is entirely surrounded by mountainous country. Anse d'Hainault is on the most exposed coastline of Haiti. It is particularly vulnerable to west winds during the hurricane season, but winds from the north or south can also cause high wave conditions at this point. Sheltered anchorage along this coast is very infrequent, with Anse d'Hainault offering the best protection.

The Baie de Nault is protected by two barrier reefs north and south of the bay, and also by two sand bars formed by these reefs and stretching almost across the mouth of the bay. Depth of water in the natural passage at the center of this bar is over 5m.

Following a six month field study at Anse d'Hainault the FAO mission in Haiti is proposing to continue in this potentially viable fishing area by funding training to preserve fish and make and repair nets.

Cap Tiburon to Port-Salut

This area is not well known. Port-à-Piment is the major coastal shipping port located about four hours by truck from Les Cayes. Small coastal villages dot the shore, built close to the mouths of rivers which empty into the sea. The inhabitants mostly sustain themselves through farming.

Port-Salut to Baie d'Aquin

Les Cayes region features mangrove forests which stretch along the coast to Baie d'Aquin, and part of the Ile à Vache, a large island approximately 2 km from the coast. The mangrove forests, considered to be some of the most productive in Haiti, the vast seagrass beds and well developed coral reef systems in shallow coastal waters, form a vast spawning, nursery and fishing ground. The submerged coastal shelf widens at Cayes, enhancing the fisheries potential. Fishermen report seasonal migrations of tuna and bonito as well as large catches of conch, lobster and shrimp.

A unique feature of Les Cayes regions is the approximately 50 flamingos frequenting the Baie de Flamands. Crocodiles are found in the mangroves between Les Cayes and Baie d'Aquin (J. Thorbjarnason, 1985, personal communication).

The wreck of the Haiti warship, St. Simon , which sank in 1901, is half-submerged at a distance of 80 m directly in front of Les Cayes.

Baie d'Aquin to Anse-à-Pitre

The south coast is characterized as a high wave energy area, with cliffs and rocky shores, waves on crashing surf, white coral sand beaches and sandy bottoms along the submerged shelf. Although many rivers empty into the sea along the coast, there is good visibility and little turbidity. There appears to be a barrier reef running parallel to the coast at the edge of the shelf, approximatly 0.5 to 1 km from shore, but little is known of this area. There are also well defined reef systems along the coast at Côtes de Fer and Cayes Jacmel.

Jacmel, located on the Baie de Jacmel, is a unique town port favored by tourists.

The limestone cliffs between Point de Lagon and Anse à Pitres, near the border between Haiti and the Dominican Republic, feature significant sea bird populations.

La Gonave

La Gonave Island is situated in the middle of the Bay of Port-au-Prince, 60 km from the city of Port-au-

Prince and 18 km from Point Montrouis, the closest point on the main island. The island is 45 km long and 20 to 25 km wide (less than 700 km²).

Large barrier and fringing reefs ring the island with the exception of the westernmost shoreline. The best known reefs are located at the eastern end of the island where a large shallow shelf of 60 ft or less stretches between Gonaives and the inner reaches of Port-au-Prince Bay. Two areas, in particular, are close to Port-au-Prince Bay and popular recreational areas: the small island and surrounding reefs of Petit-Gonave, and Pointe Fantasque. Iguanas still remain on Petit Gonave.

The southeast coast of La Gonave is lined by mountains dropping abruptly to the sea, while the southwest features coastal plains where mangroves, salt flats and beaches provide excellent habitat for shore birds and sea birds. Nesting areas include Brown pelican, flamingos and frigate birds. Anse à Galets, the largest village on Gonave and nearest point to Montrouis on the main island, is situated at the northeastern end of the island on a spit of of land almost entirely enclosed by a barrier reef. Behind the town, the land rises steeply into the mountain ranges which cover almost the entire island. Small cargo boats sail regularly between Anse à Galets and Montrouis bringing conch, lobster, turtle, fish and other products to the market at Montrouis.

D.- USES OF COASTAL AREAS

Marine and Coastal Fisheries

Despite 1500 km of coastline, Haiti produces 5000 tons of fish annually and must import on an average 12,000 tons of dried and salted fish (valued at $3.4 million) to meet domestic demand (FAO, 1983) (Tables V-3, V-4, V-5).

TABLE V-3
ESTIMATE OF TOTAL FISH CONSUMPTION IN HAITI

Source	Range of Consumption (T/year) Minimum	Maximum
Total fish catch – Haiti	3,000	5,000
Imports	10,000	14,000
Exports	500	1,000
Local consumption (restaurants hotels, home use	12,500	18,000
Average consumption per year*	2.5 Kg	3.6 Kg

* Fishing villages; 30 to 50 kg fish/per person/per year

Source: La Pêche Artisanale Côtière en Haiti Elements Pour une Stratégie de Développement, G. Chapond, FAO, Port-au-Prince, Jan. 10, 1984.

Domestic consumption of fish products is relatively low and can be broken down by user group as follows:

fishing families	1,500,000 kg
urban areas	900,000 kg
rural areas	2,500,000 kg

A narrow insular shelf, characteristically low productivity of tropical coastal waters, and the absence of a developed fishing industry, have thus far resulted in a low annual fish catch. Although no accurate assessments of fish stocks exist in Haiti, a 1983 FAO study on the biological, social and economic aspects of the fisheries of Haiti has provided estimates of actual and potential yields of major fish resources based on sampling and fishing effort data collected in 1982-1983 (Table V-4).

TABLE V-4
ESTIMATES OF FISHERIES PRODUCTIVITY

Fishery Resource	Actual Yields (Tons)	Potential Yields (Tons)
Demersal (insular, shelf & slope)	2,500–3,000	3,000–4,000
Pelagic		
Nearshore	1,000–1,500	3,500–5,000
Offshore	Negligible	5,000
Lobsters	500	600
Mollusks	200	7
Other shellfish	400	7
Totals	4,600–5,600	12,000–15,000

Source: FAO – Report No. 72/83 – IF-HAI II

Table V-5
HAITI'S TRADE IN MARINE FISHERIES (1980-81)

Exports	Weight (tons)	value (U.S. $000's)
Lobster tails	23.4	309
Frozen shrimp	.2	1.3
Frozen conch	125.6	552.6
Other shellfish	462.2	1,321.8
Aquarium fish	2.2	15.4
Total	614.6	2,200.1
Imports Salted & dried fish	12,000	3,400

Source (Tables 1, 2, 3): FAO Report no. 72/83 IF-HAI 11

Haiti's fisheries resources fall roughly into three categories: demersal, shellfish and pelagic species.

Demersal Species

Reef and bottom-dwelling (demersal) species, including members of the snapper (lutjanid) and grouper (serranid) families (Table V-4), are traditionnaly the most sought after for flavor and value throughout the Caribbean. Of the more than 300 species of demersal fish recorded in Haiti waters, only 150 are regularly found and harvested. Snappers and groupers of various kinds account for 70 percent (or nearly 1300 tons) of the total fish catch for this group in Haiti.

Shellfish Species.

Shellfish (lobster, shrimp, conch and other mollusks) associated with coral reefs and seagrass beds (lobster and conch) and mangrove wetlands (shrimp) are distributed throughout the coastal zone. Nearly 1000 metric tons of lobster and conch, Haiti's principal fishery exports (Table V-6), are harvested each year. While little information exists on standing stocks of shellfish species, recent National Marine Fisheries Service (NMFS) statistics (Table V-7) reported declines in catch of both conch and lobster, suggesting that these may be overfished, at least in certain areas. Their easy access by divers (in the less than 15 m of water) makes them especially vulnerable. The high prices obtained for shellfish (e.g. lobster, conch, as well as snapper and grouper) have led to increased fishing effort and localized overexploitation along the entire nearshore reef areas. This is particularly true in areas with easy access to both fishing grounds and markets, as are the banks between Port-au-Prince and Gonave. This area is fished many times a day, with yields of only 1-3 kg/boat/day.

Shrimp, in contrast, appears to be underutilized, particularly in the Bay of Port-au-Prince near the mangroves of Grande Saline and in the southern Cayes between Aquin and Ile à Vache, where lack of appropriate harvesting techniques has resulted in low yields (Hatziolos, 1984).

TABLE V-6
EXPORT IN KGS, IN % OF SHELL FISH
October 1983 – September 1984

Shellfish	Kgs	%
Shells (Conch & Others)	272,970	74.2
Conch meat	54,399	14.8
Lobsters	32,285	8.8
Aquarium Fish	2,303	0.6
Shrimps	3,723	1.0
Turtle shells	2,198	0.6
Crabs	197	–
Total	368,045	100

Source: R. Kavanaght, 1984. Le Commerce de Produits de pêche en Haiti.
Direction de Pêche des Ressources Naturelles, Service de Pêche et pisciculture. Report, Dec. 1984.

Pelagic Species

Nearshore pelagics, or small open water schooling fish, such as herring, sardines, anchovies and jacks appear to be significantly more productive than demersal species in Haiti (estimated at 3000-7000 tons/year). Catch data indicate that current harvests of these coastal pelagics are well below potential yields (Table V-4).

Offshore pelagic species, or oceanic schooling fishes, including tuna, bonito, mackerel, skipjack and marlin, occur off the shelf in waters deeper than 180m. Seasonal migration of tuna and bonito (April-May and August-October) bring large schools of these species to shelf waters off Les Cayemites and Miragoâne These migrations, however, are often associated with strong easterly winds, especially in the fall when fishing is difficult. Landings are made generally by small resident populations along the northern and southern coasts of Haiti. Essentially unharvested, Haiti's offshore pelagic fishery, with estimated yields of about 5000 MT/year, is an untapped resource with considerable potential for development.

Ornamental Reef Fish

Although the hundreds of small ornamental fish species found on the reefs throughout the Caribbean are not considered harvestable by commercial fishermen, the artisanal fisherman takes them for food and profit. Overfishing, including the daily taking of sexually immature fish in these easily accessible areas can eventually lead to the permanent disappearance of many species from the reef and a deterioration of the complex ecological system.

Widespread fish collecting for export to the tropical aquarium industry in the United States and Japan adds to the problem. In 1982, Haitian exports of live fish and shellfish to the U.S. earned almost $753,000, while in comparison shrimp earned only $100,000 (NMFS, 1982). Many more fish are taken than sold. Fish mortality is high as a result of careless trapping, collecting (dynamiting and poisoning), and subsequent handling of fish.

Characteristics of the Fishing Industry

Coastal fishing in Haiti is primarily artisanal, supported by unskilled labor and equipped with rudimentary and generally inadequate gear. The GOH Fisheries Services' efforts have been directed towards inland fisheries and aquaculture, although most of the fish consumed and sold comes from the sea. Most fishermen are only concerned with providing fish for immediate consumption. Brokers may take a portion of the catch and preserve it for resale in large population centers such as Port-au-Prince. Major species found in the markets are snapper, lobster, conch, shrimp and parrot fish. Occasionally, seafood stores which cater to the Haitian upper classes and tourists will have swordfish and other pelagic species.

Table V-7
HAITI FISHERIES EXPORT TO THE UNITED STATES (1979-1982)

Product	lbs	Kg(000)	US$
	Year 1979		
Saltwater fish fillets frozen	294	0.13	456
Lobster tail fresh & frozen	260,235	118.04	1,401,709
Shrimp shell-on	5,045	2.29	21,187
Crabs fresh & frozen	5,022	2.28	5,375
Other shellfish	203,935	92.50	223,715
Total edible product	474,531	215.24	1,652,442
Marine shells crude	862,369	391.16	237,234
Articles of shell	–	–	2,500
Sponges & other non-edible products	100	.05	400
Fish & shellfish live for aquarium	–	–	125,581
Total	1,337,000	606.45	2,018,207
	Year 1980		
Saltwater fish fillet frozen	37,500	17.01	37,500
Lobster live fresh	4,320	1.96	21,600
Lobster tails	197,440	89.56	1,037,216
Other lobsters	33,941	15.40	167,315
Shrimp shell-on	17,753	8.05	87,114
Shrimp peeled	251,192	113.94	571,988
Other shellfish	279,023	126.56	408,581
Total edible products	821,169	372.48	2,331,314
Coral crude	7,329	3.32	2,279
Articles of shells	–	–	14,981
Seaweed & other non-edible fishery products	2,295	1.04	3,450
Fish & shellfish live for aquarium	–	–	179,820
Total	1,219,190	553.01	2,705,211
	Year 1981		
Product	**lbs**	**Kg (000)**	**US$**
Lobster live fresh	990	.45	5,346
Lobster tails	316,077	143.37	1,988,830
Other lobster	74,481	33.78	419,825
Shrimp shell-on	44,044	19.96	155,313
Shrimp peeled	2,400	1.09	14,400
Other shellfish	391,962	177.79	754,630
Edible fisheries	829,914	376.44	3,338,344
Coral Crude	15,760	7.15	14,620
Marine Shells Crude	450,330	204.27	406,473
Articles of shell	–	–	5,016
Fish & shellfish live for aquarium	–	–	146,303
Total	1,296,004	587,86	3,910,756
	Year 1982		
Lobster tails	279,325	126.70	1,926,157
Other lobsters	44,620	20.24	298,890
Shrimp shell-on	18,275	8.29	81,178
Shrimp canned	9,650	4.38	17,937
Other shellfish fresh & frozen	111,1980	50.43	214,082
Edible Fisheries Products	463,060	210.04	2,538,239
Coral crude	2,586	1.17	4,248
Marine shells crude	332,754	150.93	182,326
Articles of shell for aquarium	–	–	752,819
Total	798,400	362.14	3,524,226

Source: National Marine Fisheries Service
Resource Statistics Division; US Imports.

Rural Haitians are usually not oriented toward the sea. Low fish catch may represent lack of tradition, technology and expertise (rather than short supplies of fish), and lack of an interested government in fisheries and coastal zone management. Comprehensive legislation exists to protect coastal and marine resources, but enforcement is non-existent. Table V-2 summarizes the most pertinent fish regulations (Moniteur, November 20, 1978).

Haiti's artisanal fishing fleet consists of approximately 3000, almost entirely non-motorized sailboats and rowboats (3-6m) whose maximum fishing radius, under optimum conditions, is about 5 km. At least 150 days out of the year, however, heavy winds and seas keep fishermen in port. Both catch per unit effort (average 5-10 kg/trip) and total annual catch (about one ton) are greater for the larger better equipped and more seaworthy boats (FAO, 1983).

Estimates of the number of fishermen in Haiti vary widely, between 3000 full-time to 8000 part-time (Kavanaght, 1985). Fishing gear ranges from one to three to multiple hook and line, to palm-woven fish traps. Free diving for conch and lobster, and spearfishing occur in clear waters of less than 15 m. Hooka units (compressed air) are used, but are prohibited between February 1 and July 31 each year. Hook and line, and fish traps are among the most commonly used gear because of their low cost ($2-$20) and rate of return. Use of nets, ranging in size from several meters (tremails) to 400 m in length (beach seines), bring in substantial yields: $100/catch (tremails) and up to five tons of schooling fish (beach seines) at certain times of year. The tremail, the most effective method for the capture of demersal fish, must be raised within two to three hours to prevent asphyxiation and rapid deterioration of the catch. Current usage appears to leave the net in place for an entire morning or afternoon, spoiling a large portion of the catch. Fish traps are sometimes left in place for three or four days (M. Fitzgerald, 1985, personnal communication).

The commercial distribution and marketing of the fish catch in Haiti is transmitted through a network of rural merchants and geared to markets in Port-au-Prince. A substantial portion of the catch, however, never reaches the marketplace due to spoilage from lack of preservation. During long hours at sea (an estimated 11 to 15 hours at Anse d'Hainault, for example) fish exposed to the sun often spoil before the boats can return to port.

Access to refrigeration facilities is repeatedly cited as the most pressing need of fishermen. Ice is a scarce commodity in most rural fishing villages and refrigeration facilities exist in only a few central locations throughout the country. Smaller, temporary refrigeration units are occasionally supplied by middlemen at key distribution points. This system is generally inadequate in areas where roads are poor and access difficult. Units typically break down because of improper maintenance or chronic power failures. In remote areas of the northwest (e.g. Môle St-Nicolas) and in the southwest (Baie d'Hainault; Table V-8), where fishing yields are comparatively high, these facilities are unavailable.

Post-harvest losses, due to lack of preservation and successful distribution, lead to wasted fisheries resources and an eventual return to subsistance fishing. Independent entepreneurs have tried on two occasions to organize mobile distribution units, loading the catch at sea directly onto mother ships bound for Port-au-Prince (L. Sharon, 1985 personal communication). Although initially successful, these efforts were later abandoned. Not only is the issue of preservation problematic from boat to dock, a significant quantity of fisheries exports from Haiti to the U.S. are detained at U.S. borders each year because of inadequate packaging or preservation. For example, U.S. Customs data for FY 1980 indicated that eight detentions of frozen conch meat were made because of either decomposition, insects, filth, or leaky containers. Total dollar value of the loss was not given.

Lack of extension facilities to market the catch outside the area of production places a heavy burden on local market structure. Despite a large rural population eager to fish, the lack of efficient distribution networks, inaccessibility of the villages and the (relatively) high price of fish (Table V-9) make it difficult for these harvests to be utilized beyond coastal population centers. Fishermen are left with excess catch and meager profits.

The major constraints to improved fishery production in Haiti are: (1) Lack of fish in areas where artisanal fishermen have access; (2) Inadequate boats and

Table V-8
ANSE D'HAINAULT: RESULTS OF FISHING BY 7 BOATS (Between Sept. 1 and Nov. 18, 1984)

Month	No. of Trips	Fish Catch (lbs)	Average Fish Catch (lbs)
September	44	3,050	69.3
October	56	4,077.5	72.8
Nov. 1 to Nov. 18	30	2,247	30
Total	130	9,374.5	130

Source: M.L. Le Menach Fisheries Expert (FAO field study, 1984).

Table V-9
FISH PRICES IN JUNE 1983

Product	Price of Production	Price Port-au-Prince	Price Rural
White fish fresh	1,80-2,00	2,20-2,50	-
Red fish fresh	2,00-2,20	2,50-2,70	-
Small fish	0,80-1,50	1,50-2,00	-
Local dry fish	1,80-2,00	2,00-2,50	2,00-2,50
Lobster	5,00-7,00	-	
Conch fresh (unit)	0,15-0,20	0,20-0,50	-
Fresh water fish	1,00-1,25	1,50-2,00	1,25-1,50

Source: Rapport FAO/FIDA June 1983

gear denying fishermen access to many productive or potentially productive areas; (3) Lack of skills and proper training in the most efficient, cost-effective techniques for harvesting species and ensuring sustained utilization of renewable marine resources; and (4) Lack of sufficient fish preservation, distribution and marketing infrastructure and organization in many locations.

The following solutions to the above mentioned constraints have been proposed:

- Install artificial reefs and habitat enhancement devices in accessible and suitable areas. If placed in ecologically appropriate locations, these artificial reefs and fish-aggregating devices might prove an excellent means of taking the pressure off overfished, depleted natural reef systems.
- Improve boat design, fishing gear and harvesting techniques. Focusing fishing activities in deeper waters off the shelf with such improvements, could expose fishermen to marketable species such as skipjack, mackerel, bonito, marlin and tuna. However, without working with Haitian fishermen and without adequate infrastructure to preserve, distribute and market fish catch, heavy post-harvest losses and wasted fish resources could result. An extension service for fishermen, access to refrigeration, better roads to service and fishing centers, and infrastructure responsive to fishermen, are needed before an offshore fishery is developed.
- Increase shrimp production through the development of appropriate harvesting techniques. Good shrimping grounds are reported in the Golfe de La Gonave, off the mangroves of Grande Saline and in the southern Cayes district, between Aquin and Ile à Vache. From preliminary investigations, this is an area where appropriate technology might be most effectively applied. Small mid-water trawls, such as those used off the North Carolina coast, could be successfully introduced in Haiti to increase production without adverse environmental impacts.

Mariculture

Although mariculture in Haiti is still in the early development stage, several activities have been proposed. These include: brine shrimp (Artemia sp.) farming in salt ponds of the Artibonite estuary; shrimp farming (Penaeus sp.) in the mangrove wetlands of Baie de l'Acul du Nord; conch farming (Strombus gigas) in the Baie de Ft. Liberté (now in progress) and elsewhere along the North Coast; and the cultivation of mangrove oysters (Ostrea sp.) in the protected estuaries and bays of Haiti's northern and western coasts.

A brief survey of seaweed and algae was conducted in selected areas along the coast to identify species of algae and seaweed rich in agar in 1980-81 (Renoux Meunier, 1978). Culture of the spiny lobster (Panulirus argus) has been attempted in a small lagoon on the southern coast of the northwestern peninsula (UNDP, 1980). Culture of reef fish in floating cages in many protected bays along the coast has been suggested.

Conch Cultivation

Conch (Strombus gigas) generally inhabit nearshore waters, easily accessible to subsistance fishermen, sport divers and commercial fishermen alike. In Haiti, increased fishing pressure has quickly led to a decline in local conch population and a drop in yields (Hatziolos, 1984). Research into the hatchery techniques for rearing queen conch larvae (which began in 1980) has led to serious consideration of conch mariculture as a viable program in the Caribbean. Commercial hatchery production of juvenile conch in captivity has begun. Seeding reefs with conch to maintain overfished stocks or to culture conch to marketable size for profit, seems feasible in Haiti. The cultivation of conch would not only reduce pressure on wild populations, but increase production of a valuable export commodity (both meat and shell) and a popular source of protein among Haitians.

Shrimp Farming

Habitat for farming shrimp in Haiti is found in the extensive mangrove wetlands of the Grand Saline region and Baie de l'Acul in the north. Questions remain,

however, regarding pesticide loads in the rivers draining the Artibonite valley, lack of essential infrastructure (e.g. electricity) to support shrimp farming opertions and the high costs of shrimp farming for feed and technical assistance. Reports from Ecuador, moreover, indicate serious problems emerging from the widespread mangrove habitat destruction from building shrimp ponds. Post-larval and juvenile shrimp are disappearing as mangroves are cleared, making it more and more difficult to seed the ponds with local shrimp species upon which this technology depends

Brine Shrimp Harvesting

A recent study of the development potential for eastern Caribbean Artemia sp. (Island Resources Foundation, 1984) has indicated that brine shrimp culture in salt ponds, where it is endemic, is a viable proposition, particulary as a cottage industry. Brine shrimp is used as an aquarium feed when processed into pellets. Following investigation of the brine shrimp farming potential in Haiti, this species was found in the salt ponds of the Artibonite estuary.

Although the site was rejected due to soil characteristics, it is apparent that the opportunity for brine shrimp culture does exist. Salt ponds trap sediments, protect fragile reef environments from siltation and act as habitat for numerous migrating and resident populations of shorebirds, including a number of rare and threatened birds species. Farming brine shrimp in the salt ponds of Haiti, if properly managed, could maintain the ecological role of salt ponds in coastal areas, provide an alternative source of income to local fishermen, and preserve the original Artemia gene pool.

Oyster Culture

A small scale culture project at Ft. Liberté bay attempted a hanging oyster culture, starting with the imported Crassotrea gigas. When most of these died, a second oyster (this time a local species, Crassotrea luca was introduced. The project failed apparently because of wide fluctuations in salinity caused by runoff from heavy rains, attacks by boring sponges and lack of funding to continue the experiments. Unlike some countries in the Caribbean, most people in Haiti consume oysters. The viability of culturing oysters cannot be assessed, however, seaweed culture, without additional research.

Seaweed Culture

Certain areas along the coast have been identified as having seaweed and algae species rich in agar, a commercially desirable product. No further research has been conducted and the costs of seaweed culture in Haiti have not been assessed. Areas identified with this potential are:

- From Grand Savane to Anse Rouge (northwest): Spyridia filamentosa, Hypnaea musciformis, Acanthrophora spicifera, Gracilaria cylindrica;
- La Gonave island: Gracilaria crassissima;
- Area of Petite Rivière de Nippes (from Charlier to Anse-à-Veu): Hypnaea musciformis;
- Baie Anglaise, Zanglais, St-Louis du Sud: Gracilaris sp.)
- From Jacmel to Marigot: Gracilaria sp. (Figure VI)

King Crab Culture

Recent field laboratory experiments conducted in the Caribbean (SML) indicate that growing Mithrax spinosissimus (Caribbean King crab – in reality a spider crab), on screened floating cages and rafts, is possible. Although such a project is not yet operational, a prefeasibility study for Haiti would be desirable to assess the technical and economic viability of beginning a pilot project in Haiti waters, where crabs are known to occur and fishermen are familiar with their harvest and marketing.

Fresh Water Fisheries

Haiti has many short rivers with steep gradients, flowing swiftly from mountains to sea. Most tend to have a torrential flow pattern with stormy flows during the rainy season and dry beds during the dry season. There is one large river, the Artibonite, whose watershed includes most of the Plateau Central and which empties into the Golfe de la Gonave. The total area of fresh water lakes and lagoons is approximately 23,000 ha, of which most is represented by Etang Saumatre (16,000 ha) and Lake Peligre, a reservoir of 3200 ha, created in 1956-57 by the construction of a hydroelectric facility across the Artibonite River. Very little information is available about the productivity of these fresh water sources. A partial list of indigenous lake species is shown in Table V-10.

Table V-10
NATIVE FISH FAUNA OF ETANG SAUMATRE

Species	Family
Cichlasoma batiensis	Cichlidae
Cyprinodon bondi	Cyprinodontidae
Gobionellus sp.	Gobeiidae
Dormitator maculutus	Elotridae
Stronylura notata	Belonidae
Limia tridens	Poeciliidae
Limia melanonotata	Poeciliidae
Gambusia hispaniolae	Poeciliidae

Source: Thorbjarnason (1984): Status and Ecology of the American Crocodile in Haiti.

In addition to the lakes and rivers, there are numerous fish ponds stocked mostly with Tilapia sp. and carp. These ponds are maintained by individual farmers, NGO's and the GOH Fisheries Service. Total fresh water fish production from these ponds is estimated at about 1200 tons/year (Kavanaght, 1984).

Aquaculture

Fish culture was introduced in the 1950's by the FAO Technical Assistance Project as a means of improving nutrition in rural areas. Chinese carp (Trichogaster pectoralis), common carp (Cyprinus carpio) and Tilapia mossambica were stocked in rivers, lakes and irrigation canals, where they reproduced rapidly. Nursery and experimental ponds were constructed at the Damien Fish Culture Staiton outside Port-au-Prince, and extension work began in 1952. An estimated 5000 ponds were constructed between 1958 and 1977 (Table V-11). Lack of trained personnel and extension agents, as well as a limited budget, apparently brought the program to a standstill by 1965 or 1966 (D. Puelle, 1983). By 1985, only 400 ponds remained in the Cul de Sac region, the area most accessible from the Damien Station (G. LaFontant, 1985, personnal communication).

Recently, there has been a revived interested in fish culture in rural areas of Haiti. The present impetus comes from the private sector (PVO's and from international organizations such as FAO and the Peace Corps). Technical assistance for these aquaculture projects is provided by expatriate volunteers, foreign university faculty and students, and a few Haitian technicians.

Fish presently cultured in Haiti include: Tilapia nilotica, most widely used; Tilapia mossambica, a less efficient producer and now rarely used; Tilapia aurea, used only on La Gonave Island; and the common carp, which requires more technical skill than Tilapia to culture. Table V-12 lists approximate dates and origins of exotic fish species introduced in Haiti since 1952. Recent private sector proposals suggest that future PVO projects might include the building of fish ponds on salt flats and growing Tilapia in coastal waters. The potentially serious impacts upon marine ecosystems of introducing exotic species has, however, not been assessed.

All fresh water fisheries' research is handled by the Damien Fish Culture Station and staffed by the Fisheries Service. The aquaculture program is, however, severely limited by inadequate funding and staffing. Extension work with the individual farmer is an essential prerequisite of successful fish culture, yet the program can count on only a handful of trained extension agents with limited transport equipment to distribute fry to outlying areas.

Exotic Species Introduction

Since there is virtually no information available on the natural productivity of inland and coastal waters

Table V-11
DISTRIBUTION OF FISH; CONSTRUCTION OF PONDS; STOCKING OF PONDS, LAKES AND RIVERS 1958 – 1973

Fiscal Year	Distributed Carp	Distributed Tilapia	Ponds Constructed	Ponds Stocked	Stocked Rivers	Stocked Lakes
58-59	113,428	106,428	00	400	3	2
59-60	94,428	212,858	754	754	2	1
60-61	115,428	164,000	754	754	3	1
61-62	98,428	74,428	600	600	1	2
62-63	99,728	106,428	800	800	2	1
63-64	115,428	63,625	900	900	4	1
64-65	117,428	70,500	414	414	–	1
65-66	25,000	15,000	100	100	–	–
66-67	–	–	–	–	–	–
67-68	13,000	8,000	62	62	–	–
68-69	15,673	8,000	62	62	–	–
69-70	35,620	2,025	98	175	–	–
70-71	34,822	1,125	70	225	–	–
72-73	–	–	–	–	–	–
Totals	920,528	828,917	5,032	5,549	15	9

Source: Technical assistance in Freshwater Fisheries Development in Haiti, 1973.
Note: This data has been included because it is the official record from the Dept. of Agriculture. However, the original information used to compile this table is highly questionable. It is the opinion of the author that the values given are grossly inflated. (Puelle, 1983).

other than very localized data on fish catch, it is very difficult to assess the impacts of having introduced exotic species such as Tilapia sp. and carp into the aquatic environment of Haiti. Findings in the Dominican Republic indicate, however, that few if any natural and brackish water environments remain unaffected by exotic species introduction (Hartshorn et al, 1981).

Aquaculture in Haiti is being promoted primarily as an alternative source of protein for the rural population and a source of cash income. Some attempts have been made to grow Tilapia commercially, but these efforts have been largely unsuccessful. Introduction of an exotic species, such as Tilapia, into coastal water, as a result of pond construction along the coast, should be assessed and monitored for their impact on coastal lagoons and reef ecosystems; especially since Tilapia exhibits some tolerance to saltwater and could conceivably compete for resources with native species. Recent proposals to raise Tilapia in estuarine environments should be reviewed carefully.

Seaports and Coastal Trade

Since the early sixteenth century, a system of coastal trading ports existed throughout Haiti (Figure V-2). By the early 1960's, the system had lost much of its dynamic nature due to lack of adequate facilities and investment to improve harbors and docks, as well as to the closing of many regional ports to foreign commerce in favor of Port-au-Prince. At present, only 12 ports are open for trade:

Port-au-Prince	Jérémie
Cap-Haitien	Les Cayes
Port-de-Paix	St-Marc
Gonaives	Jacmel
Petit-Goâve	Ft. Liberté
Miragonae	Aquin

Cities such as Les Cayes, Jacmel and Jérémie, however, do little if any international maritime commerce. Port-au-Prince has the highest trade volume and tonnage of any port in Haiti. Ports which are closed to international shipping include, among others, Môle St-Nicolas, Port-à-Piment, Anse d'Hainault, Anse-à-Veau, Grande Saline, Corail and Pestel.

A 1977 classification of coastal trading vessels roughly divides the commercial fleet into 580 sailboats and 26 motorized launches. Some boats are not included because of tonnage less than one.

Range (Tons)	No. of Vessels	Average Tonnage
1–15	155	12
16–30	155	22
31–45	137	39
46–60	41	51
61–higher	10	57

Source: Le Menach, FAO (1985)

Since 1977, the number of Haitian vessels has diminished due to further decline in local seaport activity and retirement/loss of old vessels. Recently, the GOH has stressed regionalization as a strategy to improve the quality of life in rural and remote areas. Perhaps a resurgence of coastal seaports and increased vessel usage will be seen in the future.

Table V-12
EXOTIC FISH SPECIES INTRODUCED IN HAITI

Species	Year	From	Where	Purpose	Reference
Tilapia mossambica	1951	Jamaica	DFCS	FC	Lin (1952)
Cyprinus carpio	1951	Alabama	DFCS	FC	Lin (1952)
Trichogaster pectoralis *	1952	Singapore	DFCS	FC	FAO (1956)
Cyprinus carpio	1952	Israel	DFCS	FC	FAO (1956).
Pocilia reticulata	1977	Domin. Rép.	DFCS	MC	
Tilapia nilotica	1979	Limonade FC	Starley, p. com		
Ctenopharyngodon idellus **	1979		Limonade	FC	Starley, p. com.
Tilapia aurea	1982	Illinois	LaGonave	FC	Puelle (1983)
Gambusia affinis	1983	Florida	Ft. Librté	MC	Linden, p. com.
Ictalurus sp.	1983		DFCS	FC	Wilson, p. com.

* disappeared from DFCS since 1955; DFCS = Damien fish cult. station
** disappeared from Limonade since 1981; FC = Fish Culture
MC = Mosquitoe Larvae Control

Source: Vlaminck (PROTOS), Aquaculture Stat. Fort-Liberté.

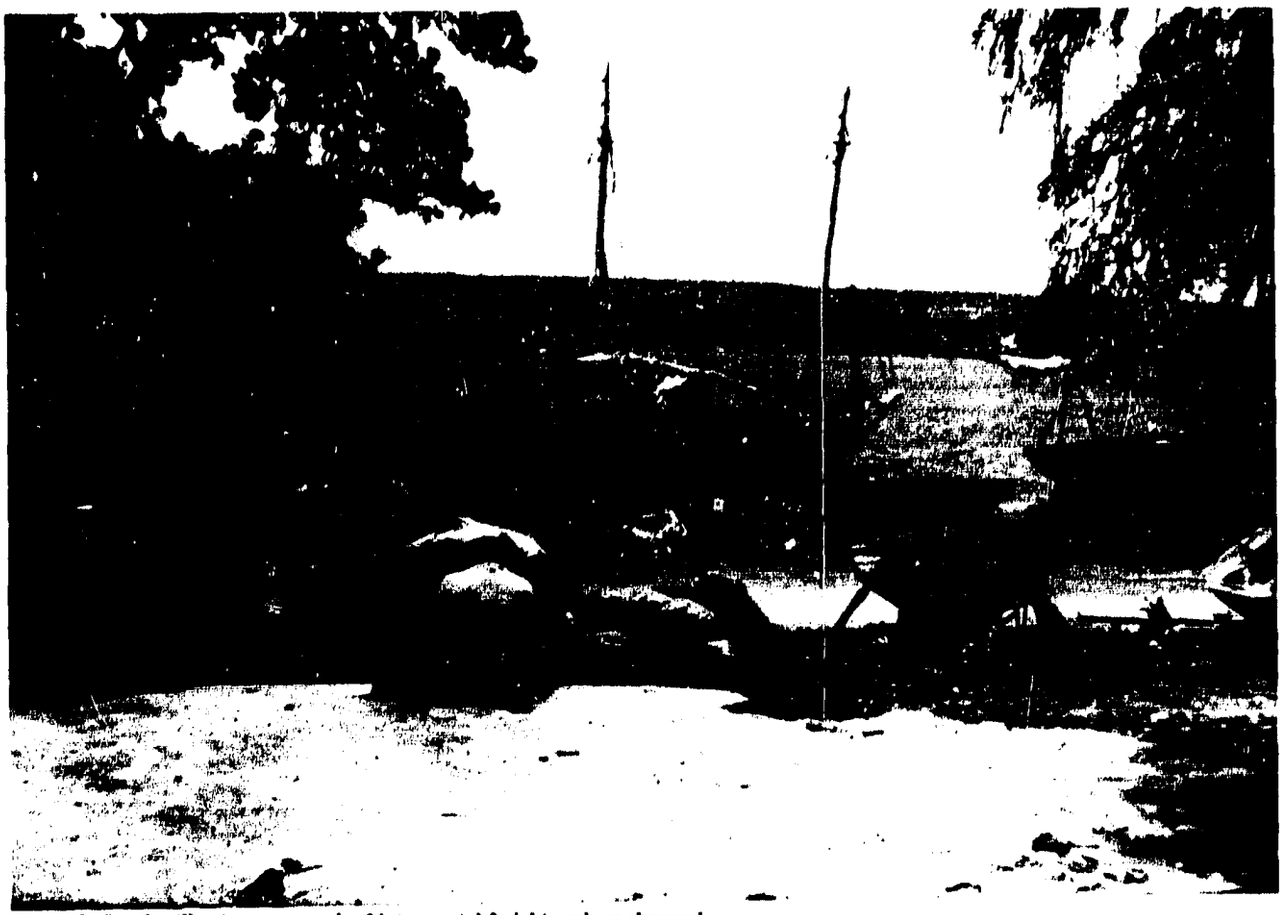


Fig. V-2: Small sailboats carry much of intercoastal freight such as charcoal.

E.- ENDANGERED SPECIES AND CRITICAL HABITAT

Many threatened or endangered animal species inhabit coastal and marine areas of Haiti. Those which utilize mangrove habitats include among others:

- American Crocodile (Crocodylus acutus)
- Green Sea Turtle (Chelonia mydas)
- Hawksbill Turtle (Eretmochelys imbricata)
- Loggerhead Turtle (Carreta caretta)
- American Flamingo (Phoenicopterus ruber)
- Roseate Spoonbill (Ajaia ajaia)
- Reddish Egret (Dichromanassa rubescens)
- West Indian Tree Duck (Dendrocygna arborea)
- Masked Duck (Oxyura dominica)
- White-crowned Pigeon (Columbia leucocephala)
- Hispaniolan Trogon (Temnotrogon roseigaster)
- Peregrine Falcon (Falco peregrinus)
- West Indian Manatee (Trichecus manatus)

Of the marine mammals, the West Indian Manatee is faced with extinction. Recent aerial surveys have located a well established population of manatees (between 5 and 8) living in the mangrove areas of the Artibonite estuary (C. Woods, 1985 personal communication). Sightings have also occured at Montrouis and the bay of St-Marc, where fresh water enters the sea and at Ft. Liberté, west of Cap Haitien. Hunting pressure on the manatee is unknown.

Haiti's remote, deep sand beaches offer excellent nesting habitat for sea turtles. Of four endangered species of turtles, three have been reported in Haitian waters: Chelonia mydas (green turtle), Caretta caretta, (the loggerhead) and to a lesser extent Eretmochelys imbricata (hawskbill turtle). Divers along the northern coast have also reported the leatherback (Dermochelys coriacea), as an occasional visitor (J.C. Diquemare, 1985 personal communication).

Location of nesting beaches and primary nesting season are unknown. Fishermen take turtle for food and in the case of the hawskbill and the green turtle, sell the shell to tourists and to manufacturers of turtle jewelry. Table V-7 summarizes trade with the U.S. in seafood products, including turtle shells and aquarium fish. Export of turtle shells are higher than those in Table V-7, as Japan buys all the shells exported by two firms in Port-au-Prince (quantity unknown). See Wildlife Trade section, Chapter VI).

American flamingos are found throughout Haiti, especially in the mud flats near Port-au-Prince and the Etang Saumatre and the salt ponds at the estuary of the Artibonite river, on La Gonave and at the Baie

de Flamands. They are sometimes hunted and eaten in certain areas. Roseate spoonbills, as well as other rare and threatened shorebirds feed in the mangrove wetlands at Ft. Liberté, where they are also hunted and trapped in violation of hunting regulations.

Although the Etang Saumatre appears to have the largest concentrations of the American crocodile (Crocodylus acutus) this endangered species also exists in mangrove areas throughout the coast (J. Thorbjarnason, 1985, personal communication). This species is referred to locally as «caiman», although, it is not a true caiman.

F.- CONCLUSIONS AND RECOMMENDATIONS

1.- Improvements in Fisheries Production

For many developing countries such as Haiti, fisheries are a vital source of protein and foreign exchange. Yet fisheries resources are being rapidly depleted in many instances, by overfishing, use of inappropriate fishing techniques and the destruction of critical feeding and breeding habitats such as mangrove wetlands, coral reefs and seagrass beds.

In Haiti, mountainous terrain, poor, non-existent coastal roads and lack of coastal development have, thus far, protected the country's vast wealth of coastal and marine environments from significant destructive developments. The only major impact on the sea's resources comes from the relentless fishing by thousands of artisanal fishermen who must fish all year long, without benefit of adequate training, appropriate equipment, technical assistance and marketing infrastructure. Although accurate data of fish stocks are unavailable, all evidence points to the fact that while easily accessible nearshore areas are being fished to the limit (and often overfished), species farther offshore are underutilized. The recent expedition by Jacques Cousteau of Haitian coastal waters supports this empirical observation.

The extensive ecological systems along the vast coastline of Haiti, can be regarded as natural capital , potentially providing a continuous flow of goods and services to support and enhance economic development. Continued overfishing of nearshore areas will eventually seriously affect both species populations and diversity, as has already occurred in other parts of the Caribbean.

To stop this trend a new committment from the GOH is needed. The GOH Fisheries Service is presently underbudgeted (e.g., $60,000 for FY 83), understaffed and undertrained. For example, of the 35 employees of the Service, only eight are technical staff and two are extension agents.

No reliable statistics are kept on fish catch, either locally or nationally, nor are fish stock assessments carried out to determine the country's exploitable marine resources. Although legislation does exist (Fisheries Law 1978) which limits the harvest of lobster and conch below a certain size and during certain times of the year, this is rarely enforced.

The lack of effective management of Haiti's resources is the fundamental problem in conserving the resource base as well as in the development of a significant fishing industry. GOH institutional capabilities are insufficient to address the needs of the rural fishermen, rural consumers and the private sector. Developing a fishing industry to fish the underutilized areas will also take pressure off the nearshore reef systems and could potentially contribute to the national economy. Increases in fish production could be achieved on a modest scale by:

Conducting a fish stock assessment in potentially productive areas;

Locating and organizing communities and groups as fishery production and marketing cooperatives in order to provide assistance and coordinate catch and fish distribution;

- extending credit to such groups for the purchase of equipment and to give them access beyond nearshore areas;

- stimulating small-scale industries related to fishing (e.g. gear manufacturing and maintenance, boat construction, fish salting and drying operations), to meet demand;

- strengthening and expanding marketing capabilities to ensure that fishermen receive reasonable profits for their efforts;

- extending fish distribution networks to rural populations to provide them access to this source of protein;

- providing training and appropriate equipment and for the fishing of demersal/benthic (nearshore) fish stocks in order to avoid depletion of these resources;

- encouraging the private sector to stimulate expansion of artisanal fishing operations through investments and more effective distribution systems.

These activities should be concentrated in areas of greatest potential (e.g. along the southern coast between Jérémie and Les Irois and between Aquin and Belle-Anse, and in the northwest, between Môle St. Nicolas and Baie de Henne). Activities should also be coordinated to avoid duplication of efforts and to identify activities with greatest cost-effectiveness.

Mariculture or the cultivation of marine species to increase optimum sustained yields is another possible strategy to relieve fishing pressure from natural fish stocks, especially nearshore.

The limits of natural production, especially in areas

of low productivity such as the Caribbean region, are poorly understood. Developing mariculture opportunities in Haiti could add to the food supply, improve nutrition in rural areas and contribute to foreign exchange earnings. The most promising opportunities will be those that increase the carrying capacity of natural systems such as reefs and seagrass beds, for locally acceptable fish and shellfish (i.e., conch) which can be harvested. Impacts of introduction of exotic species on ecosystems should be, however, carefully assessed. Especially designated marine and coastal reserves should be set aside to protect indigenous fish resources and the gene pool of commercial species such as shrimp, conch, lobster.

2.- Protection and Management of Coastal Marine Habitats

A recent (1983) amendement to the U.S. Foreign Assistance Act authorizes the President to provide assistance to countries in need of protecting and maintaining the habitat of threatened and endangered wildlife species. Particular emphasis was given to the establishment wildlife sanctuaries and reserves, the enactment and enforcement of antipoaching measures, and support of research programs to identify, study and catalog rare animal and plant species, especially in tropical environments. Haiti is one of the largest Caribbean countries, with a suprisingly untouched coastal and marine environment. Much of its wildlife, particularly in the coastal areas, has never been specifically identified and studied.

With its limited resources and yet significant coastal wildlife habitat, Haiti is good candidate for application of the amendment mentioned above, as part of a coastal resources planning effort. U.S. donors, such as USAID, could sponsor small research efforts with students and faculties from qualified academic institutions, in Haiti and elsewhere, to inventory rare and threatened species such as sea turtles, shorebirds and seabirds. A few efforts of this nature have already begun with the participation of faculty and students from the University of Florida with ISPAN. Participation of Haitian residents, however, is crucial if long-term protection of coastal resources is to be accomplished.

The plan need not be a highly sophisticated one, as in the case of coastal zone programs in the United States. It should, however, provide information and maps (at useful scales) of critical areas in need of protection, such as mangrove wetland/coral reef/seagrass bed areas along Haiti's coast and areas suitable for marine reserves and parks, and propose sound integrated sustainable economic development of Haiti's coastal resources, primarily for fisheries and tourism. Criteria for selection of critical coastal areas have already been developed worldwide and could be applied to Haiti. These areas would include habitat for commercially important fish and shellfish species, rare and endangered species, areas of unusual scenic value as sites for present or future tourism, and proposed sites for mariculture.

The coastal resources plan would provide the conceptual, scientific, administrative and legal framework for decisions affecting coastal marine resources by the GOH and external proposals could be researched and evaluated as part of an integrated plan, and not piecemeal, as so often and so deleteriously has been done in the case of land development.

Projects to be evaluated within the planning management context would include existing proposals for conch cultivation, shrimp farming, brine shrimp harvesting, oyster culture, seaweed culture and King crab mariculture.

3.- Establishment of Marine Reserves and Parks as Part of the Coastal Resources Plan

Protection and Management of Coastal Marine Habitats and marine parks, can be effectively used for both public education and research, and to replenish depleted breeding stocks of valuable but vulnerable fish and shellfish species that quickly disappear from heavily fished areas. Once identified and managed as critical areas, they serve as important habitats for commercially valuable fish, as well as for rare and endangered fish and invertebrates.

The success of these protected areas depends heavily on their role in a larger or even national system of coastal resource protection, the existence of an appropriate management framework, and their general acceptance by local residents.

There are legal precedents for protecting coastal resources. In 1942, the GOH ratified the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere. The convention calls for international cooperation in the protection of flora and fauna throughout the hemisphere, including the establishment of protected areas, such as national parks and reserves. Subsequently, the GOH Hunting Law (1971) was enacted which forbids the hunting of various threatened and endangered coastal birds, as well as other species. Interpretive education, research and management programs, developed as part of a marine park/reserve system in Haiti, could, if prepared appropriately, help to create a better awareness of the law and an appreciation for the resource.

The following areas are proposed for either marine parks (multiple use areas) or marine reserves (restricted usage):

Arcadins

The Arcadins are a group of small islands with adjacent reefs approximately seven miles from the nearest point of land (Pt. Paturan) and 36 miles north of Port-au-Prince. The largest of tne three, Lighthouse Island (300 m by 100 m) features a white sand beach

and an unmanned lighthouse. Surrounding the three islands, Lighthouse, Ti Teal and Ile de Sud are reported to be unusually large and diverse specimens of marine life, (e.g. sponges, anemones, bristle worms, seafans, and extensive coral formations). The reefs are accessible to inexperienced divers. Recreational divers frequently sight deep water fish species such as Big kingfish, African pompano, wahoo, sailfish and marlin that move in from the edge of the insular shelf, which, at the Arcadins, is quite close. Some divers report finding rare invertebrate species that apparently have never been identified (A. Baskin, 1985, personal communication).

The Arcadins are also a traditional fishing ground for the fishing community at Lully. The coral reefs and seagrass beds, evidently provide excellent fish habitat for a variety of desirable species.

This area, if managed wisely, with the cooperation of both the fishing village and the recreational users from nearby tourist beach hotels, could provide a renewable fisheries habitat, a means of educating the public to better conservation practices, and an attraction to tourists which will help boost the lagging tourist economy. A marine park at the Arcadins should, however, be planned carefully as part of an overall coastal management plan which would also set aside other marine coastal areas for special protective management.

Barradères – Cayemites Marine Réserve

One of Haiti's most outstanding coastal areas, includes a shallow bay (Barradères) and an archipelago of islands (Cayemites). It is located along the stretch of coast between Petit Trou de Nippes and Corail. The bay is lined with more than 1200 ha of mangrove vegetation, most of it in pristine state. The archipelago contains small and spectacular cays which dot an extensive reef system between the larger island and the peninsula of Barradères. The reef resources of this area (Cayemite Bay) are reported as being among the richest and more spectacular of the Caribbean region. No scientific survey or resource inventory exists. It ranks at the top of the list among coastal areas deserving some form of protective management (reserve). An extensive inventory of marine and coastal resources is also urgently warranted.

The lack of development of this area does not appear to be due, however, to limited potential, but rather to lack of road access. The hinterland of this area is characterized by karst topography of small rounded hills, still covered by forest vegetation. Unspoiled beaches, mangrove swamps, and the extensive reef system represent undoubtedly the best sample of coastal resources in Haiti. Some charcoal making activity is evident on the Barradères peninsula and on Grande Cayemite.

Ile a Vache

The Ile à Vache, just to the south of Les Cayes, contains a beautiful mangrove system on its eastern half which provides habitat for a small colony of crocodiles and numerous shorebirds and waterfowl. Just off the eastern end of the island is one of the largest coral reef systems found in Haitian waters.

Baie de Labadie and Baie de Cadrasse

These small bays, unimpacted by shore line development, have excellent potential as marine reserves where breeding stocks of commercially desirable species could be protected.

VI

Wildlands Conservation

A.- INTRODUCTION

The arrival of the Amerindians (aboriginal peoples), primarily the Arawaks some 7000 years ago, did not greatly alter the ecosystems of the island. Although perhaps as many as one million Amerindians lived on Hispaniola at the time Columbus landed, a vast majority lived in the coastal zones and depended on seafoods, mostly shellfish for their subsistance. Agricultural activities were confined to the plains. The Amerindians also hunted certain hutias as a source of food (Woods, 1984). Primates became extinct before the arrival of the Amerindians. The Amerindians introduced domestic dogs (Canis familiaris) to the island which presumably hunted many of the native mammals, thus contributing to their extinction.

When Christopher Columbus first set foot on Haiti in 1492, and claimed it for Spain, he described it as an «earthly paradise.» Immediately, the Spanish began a pattern of destructive exploitation of human and natural resources, a pattern that has marked the history of Haiti. Gold was mined, and the Amerindian population enslaved and virtually wiped out. The plains were cleared and cattle and goats introduced. Hardwoods were cut for lumber. Rats (Rattus rattus and Rattus norvegicus) invaded the island, taking over the biological niches of some native rodents. Cats, dogs and swine became feral. The Spanish imported Slaves from Africa to replace the fast disappearing aboriginal people.

The Spanish were succeeded by the French who reaped enormous profit from the large plantations of sugar, coffee, indigo and cocoa. The French did not limit their agricultural activities to the plains, but also cleared numerous virgin forests on mountain sides for hardwood lumber and to plant coffee. The large mahogany forests of La Gonave were cut down. Most of the colonists regarded Haiti as a territory to exploit for quick profit without any regard for the conservation of the natural resources or their renewal. The entire colonial system was based on a brutal and oppressive exploitation of African slaves.

The slaves, after years of bitter and bloody struggle, gained their freedom and founded Haiti, an independent nation, in 1804. Unfortunately, although slavery was abolished, the inappropriate exploitation of natural resources continued unabated. The freed slaves were given small tracts of land in the mountains, which they cleared to create small farms. Any unclaimed land was cut for lumber. In 1845, 18,600 mc of mahogany alone were exported (World Bank, 1982a). Other hardwoods were cut for fuelwood, charcoal and construction, and slash-and-burn agricultural techniques were adopted. Fragmentation of land holdings was required by Haitian inheritance laws, causing further intensification of land use. Poor agricultural techniques caused erosion which, in turn, lessened water retention capacity; the subsequent decreased yields forced the growing population of peasants to clear more and more land in the mountains, and to make more charcoal as a source of complimentary revenue (Cohen, 1984).

As mentioned in chapter III, only 6.7% of Haiti's land area remains under forest cover. These areas are found in only the most inaccessible mountains and isolated unproductive zones.

The following is an assessment of the past, present and future status of wildlands and wildlife in Haiti, and its relationship to sustainable economic and human development. Wildlands, defined as those areas that have not been significantly affected by human activities, are very rare in Haiti. Some direct causes for the disappearance of Haiti's wildlands are: (1) an exponentially increasing population density (about 700/ha of arable land as of 1985) combined with extensive poverty (average $300 per capita 1985), (2) a mountainous topography with relatively few fertile plains, (3) damaging agriculture practices and (4) widespread deforestation.

The prior introduction of domestic animals such as dogs, cats, rats, mice, cattle and goats by the Indians, Spanish and French, the hunting of wild animals, and the long standing deforestation of Haiti's wildlands

have contributed to a significant decrease in Haiti's wildlife. Of the 25 endemic land mammals once found in Haiti, only two remain (Plagiodontia aedium and Solenodon paradoxus) (see Figures 1 and 2), and of the 75 species of resident and/or endemic birds, 45 are rare or threatened (C. Woods, personal communication, 1985). Over 129 species of endemic orchids are endangered and most other Hispaniolan plants can be considered in risk of extinction, with the exception of the most undesirable and unexploitable trees and shrubs which propagate rapidly under the most difficult conditions (Dod, 1985). Surprisingly, however, there are small areas in the most remote and inaccessible mountains and in certain coastal zones that can be still considered modified wildlands, which contain very important samples of endemic flora and fauna.

Haiti's geologic history, its varied topography and variability of temperature and precipitation have created a greater diversity of biomes than can be found in the eastern part of North American. Due to the isolation and adaptation to specific environments a great number of Haitian plants and animals eventually became separated endemic species.

B.- FLORA OF HAITI

As a result of the diversity of Haiti's ecosystems and their biological isolation, Haiti has a particulary rich and varied flora. At the present time, over 5000 species of plants are known to exist in Haiti, of which about two thirds are woody plants, trees or shrubs. In addition, there are about 600 species of ferns (T. Zanoni, personal communication, 1985); 36 percent of all plants are endemic to the island (Hernandez, 1980). Over 300 kinds of orchids can be found throughout the island of Hispaniola, of which 40 percent are endemic (Dod, 1985). There are undoubtedly many undiscovered species of plants in Haiti, since the flora has not been thoroughly investigated.

The vegetation varies considerably from a very dry desert zone dominated by spiny shrubs, cacti, bayahonds (Prosopis juliflora) and acacia (Acacia farnesiana) to heterogenous subtropical moist and wet forests dominated by such broadleaf trees as mahogany, campeche (Haematoxylum campechianum) and manglier (Rhizophora mangle) to montane subtropical forests of native pine (Pinus occidentalis), "Bois Mabel" Brunellia comocladifolia) and "Bois Tremble" (Didymopanax tremulum). A list of endangered plant species is found in the Table VI-1. Of all the ecosystems in Haiti, the coastal zones and mangrove forests are the least threatened. Only seven percent of the mangrove forests disappeared between 1956 and 1977 (Thorbjarnarson, 1984).

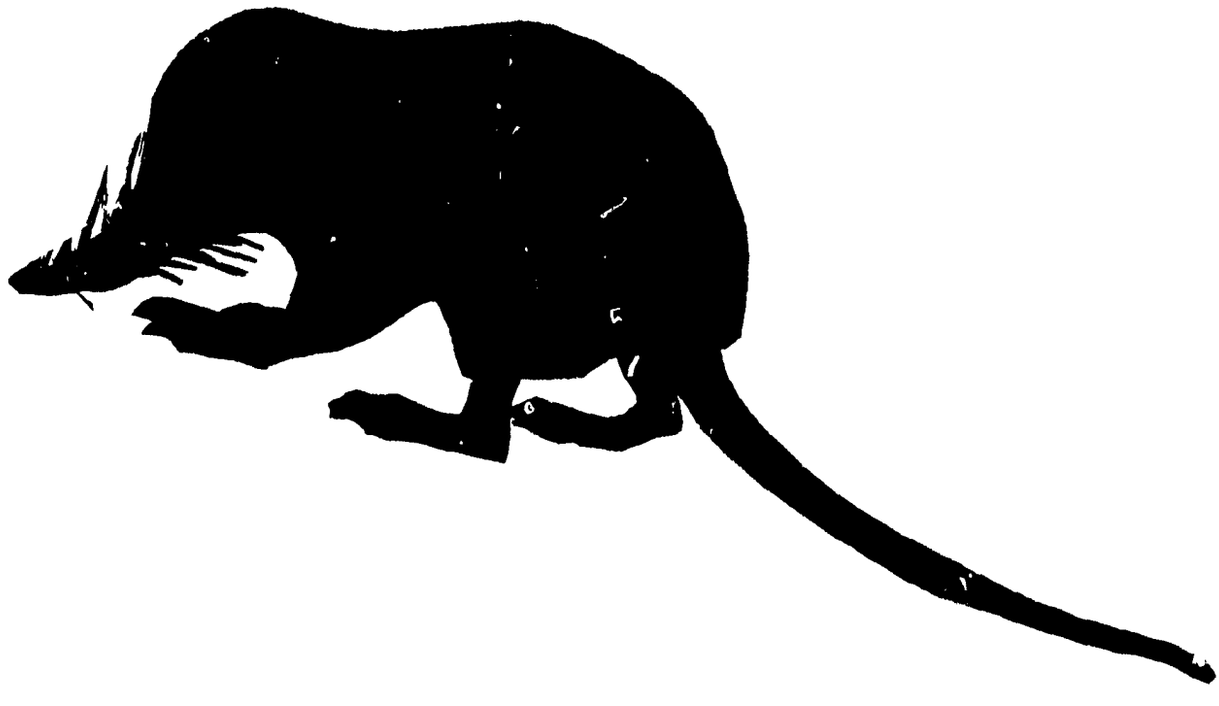


Fig.: VI-1: Line drawing of Solendon paradoxus (nez long), an endangered mammal.

Table VI-1

LIST OF VEGETATION THREATENED AND IN NEED OF PROTECTION

Common French Name	Family	Scientific Name
Arbricotier	Guttiferae	Mammea americana
Acajou, noix d'acajou	Anacardiaceae	Anacardium occidentale
Acajou	Meliacea	Swietenia mahogani
Bois campêche	Leguminosae	Hematoxylum campechianum
Bois Chandelle	Rutaceae	Amyris balsamifera
Bois capab	Rhamnaceae	Colubrina arborescens et C. Reclinata
Bois Pin	Pinaceae	Pinus occidentalis
Blimblin	Oxalidaceae	Averrhoa bilimbi
Cachiman La Chine	Annonaceae	Annona cherimolia
Caimite	Sapotaceae	Chrysophyllum cainito
Cèdre	Meliaceae	Cedrela odorata
Cirouelle	Anacardiaceae	Spondias purpurea
Chêne	Bignoniacea	Catalpa longissima
Dalemarie	Guttiferae	Calophyllum calaba
Divi-divi	Leguminosa	Caesalpinio coriaria
Ebène	Boraginaceae	Rochefortia acanthophora
Fromagier	Bombacaceae	Bombax tussacii
Gaiac	Zygophyllaceae	Guaiacum officinale
Grain ouary	Leguminosea	Canavalia obtusifolia
Ilán-Ilán	Annonaceae	Cananga odorata
Jaune d'oeuf	Sapotaceae	Lucuma domingensis
Latanier chapeau	Palmae	Sabal causiarum
Mancenillier	Anacardiaceae	Metopium toxiferum
Macoutouca	Palmae	Euterpe globosa
Pomme zombi	Euphorbiaceae	Hippomane mancinella
Mangle; Paletuvier	Combretaceae	Conocarpus erectus
Mangle blanc	Combretaceae	Laguncularia racemosa
Manglier rouge	Rhizophoracea	Rhizophora mangle
Manglier petites feuilles, pativier	Sapindaceae	Dodonaea viscosa
Mapou	Bombacaceae	Ceiba pentandra
Mapou zombi; baobab	Bombacaceae	Adansonia digitata
Palme coyeau	Palmae	Coccothrinax argentea
Catié	Palmae	Pseudophoenix vinifera
Palmiste	Palmae	Roystonia regia
Pomme cythère	Anacardiaceae	Spondias cytherea
Raisin de Mer, raisinier	Polygonaceae	Coccoloba uvifera
Romarin	Euphorbiaceae	Croton linearis
Roucou, Roucouyier	Bixaceae	Bixa orellana
Sapotille marron	Sapotaceae	Manilkara albescens
Tavernon	Leguminosae	Lysiloma latisiliqua
Zicaque, Icaquier	Rosaceae	Chrysobalanus icaco

Source: MARNDR / Direction des Ressources Naturelles – Service de Protection l'Environnement et de la Faune.

C.- FAUNA OF HAITI

Birds

As a result of its isolation and the variety of its eco-zones, Haiti also has a rich and unique fauna. There are more than 220 species of birds in Haiti, of which 75 are considered resident. A number of them are endemic to the island, such as the La Selle Thrush (Turdus swalesi), the Hispaniolan Trogon (Temnotrogon roseigaster), the Hispaniolan Parrot (Amazona ventralis) and Parakeet (Aratinga chloroptera), the Chat Tanager (Calyptophilus frugivorous), the Palmchat (Dulus dominicus), and the Black-crowned Palm Tanager (P. poliocephalus) (Table VI-2). The Grey-crowned Palm Tanager [illegible] d remaining completely unique to Haiti

Large colonies of American Flamingos (Phoenicopterus ruber) are still found wading near the shores of Etang Saumatre and smaller numbers are found in the Bay of Port-au-Prince, la Baie des Flamandes and in the Artibonite. Magnificient Frigate birds (Fregata magnificens), perhaps the most aerial of all seabirds, and the unusual White-tailed Tropicbirds, can be seen soaring off the coast of Haiti's southern peninsula.

Hispaniola and Haiti, in particular, have at least two breeding colonies of the almost extinct Black-capped Petrel (Pterodroma hasitata), a large seabird that feeds over the sea for weeks at a time (Figure VI -3). During the breeding season it returns to its burrows in steep inaccessible cliffs high in the mountains of La Selle as well as the Massif de La Hotte (Windgate, 1964).

Table VI-2

ENDEMIC LAND BIRDS FOUND IN HAITI

Scientific Name	Common Name
* Turdus swalesi	La Selle Thrush
Todus subulatus	Broad-billed Tody
* Todus angustirostris	Narrow-billed Tody
* Amazona ventralis	Hispaniolan Parrot
Aratinga chloroptera	Hispaniolan Parakeet
* Microligea palustris	Ground Warbler
** Xenoligea montana	White-winged Warbler
Dulus dominicus	Palmchat
* Carduellis dominicensis	Hispaniolan Siskin
* Nesoctites micromegas	Antillean Piculet
Melanerpes striatus	Hispaniolan Woodpecker
Saurothera longirostris	Hispaniolan lizard cuckoo
Hyetornis refigularis	Bay-Breasted cuckoo
Temnotrogon roseigaster	Hispaniolan Trogon
Chlorostilbon swainsonii	Hispaniolan Emerald
Phaenicophilus palmarun	Black-crowned Palm Tanager
* Phaenicophilus poliocephalus	Grey-crowned Palm Tanager
** Calyptophilus frugivorus	Chat Tanager
* Vireo nanus	Flat-billed Vireo
* Buteo ridgewayii	Ridgeway's Hawk
** Siphonorhis brewsteri	Least Parakeet

Found on Hispaniola but not on other West Indies islands. These species are however, found in North and South America.

Dendroica pinus	Pine Warbler
Loxia leucoptera	White-winged Crossbill
Speotyto cunicularia	Burrowing Owl
Asio flanneus	Short-eared Owl
Zonotrichia capensis	Rufous-collored Sparrow
Euphonia musica	Blue-hooded Euphonia
Pterodrome hasitata	Black-capped Petrel
Corvus leucognaphelus (1)	White-necked Crow
* Falco Peregrinus	Peregrine Falcon

Source: Woods, Dodd and Paryski, Pers. Comm., 1985

(1) Found on Hispaniola and once found on Puerto Rico (but now missing)

* = Threatened – ** = Endangered – # Resident Land Birds 73 – # Endemic Land Birds 21 – % Endemics = 29%

Fig. VI-2: Line drawing of Plagiodontia aedium (zagouti), an endangered mammal.

The Narrow-billed (Todus sangustirostris) and the Broad-billed (Todus subulatus) Todies reside only in Hispaniola. The Todies are small, fluffy, insect-eating birds of vibrant green with blazing red throats, and are among the most beautiful small birds in the world. High in the mountains of La Hotte and La Selle one can hear the mystical flute-like call of the Rufous-throated Solitaire (Myadestes genibaris), aptly called «oiseau musicien» in Haiti. In huge communal nests perched high in palm trees lives the endemic and highly social Palmchat (Dulus dominicus). The Village Weaver (Ploceus cucullatus), a brightly colored yellow and black, highly vocal bird, was brought to Haiti, presumably by slaves, from Africa.

Haiti is also the winter home for hundreds of species of migratory North American warblers, ducks, shorebirds, terns, herons, ibises, bitterns, egrets, hawks and falcons, including the highly endangered Peregrine Falcon (Falco peregrinus). Many of these North American birds, such as the Great Blue Heron and the American Redstart, now reside permanently in Haiti.

Mammals

Unfortunately, only two species of Haiti's endemic mammals, which once included primates and a large 400 pound giant sloth, now survive: the Zagouti (Plagiodontia aedium), a secretive nocturnal rodent the size of a very large guinea pig (Figure VI-2), nez longue (Solenodon paradoxus) a nocturnal insectivore with a long pink snout and human-like hairless feet (Figure VI-1). Both these animals are threatened with extinction. Another mammal, the manatee (Trichecus manatus), large sea cow , still survives off the coasts of Haiti, but is now reduced in numbers and only occasionaly observed (Rathburn, et al., in press).

Reptiles

Haiti still has significant numbers of American crocodiles (Crocodylus acutus). They were once widely distributed in Haiti, but now their range has been quite reduced and existing populations severely depleted. The largest population resides in l'Etang Saumâtre, with 450 adults (Thorbjarnason, 1984). Fortunately, the crocodile has a wide distribution, and, even though endangered world-wide, can be saved in Haiti if adequately protected.

Haiti has a large population of endemic herptofauna (reptiles and amphibians), including many unusual boas and other snakes. Snakes in Haiti are rapidly disappearing due to illegal exportation to North America and Europe, where there is a particularly large market for highly exotic pets, and because they are usually killed when encountered by peasants. Even tarantulas are exported illegally to North America as pets.

D.- THREATS TO WILDLIFE

The major threat to Haiti's wildlife is the destruction of habitat. As mentioned, the vegetative land cover

Fig. VI-3: A rare photograph of the Black-capped petrel, a near extinct sea bird that nests in the Pic Macaya and Morne La Visite National Parks (Courtesy of P. Paryski, ISPAN).

in Haiti is rapidly and progressively disappearing. The belief, held in common by Haitians rich and poor, that in the remote parts of Haiti mythical lush jungles still grow, is no longer tenable. According to a recent survey by Cohen (1984), in the Pic Macaya area in the western part of the southern peninsula, land covered by virgin forest decreased from one-hundred percent in 1956 to four percent in 1984, indicating the rapidity with which even the most inaccessible areas (Pic Macaya has no road access) are being deforested. This process deprives wildlife of food, shelter and water, and completely upsets the ecological equilibrium of the various biomes. Human economic development has also been negatively affected by this process. Lowenstein (1984) has estimated that the deforestation of the Pic Macaya area alone is now costing over $9 million a year in declining agricultural and hydroelectric production. Some birds, such as the Hispaniolan Woodpecker (Melanerpes striatus), the Black-crowned Palm Tanager, the Grassquits (Tiaris olivacea & T. bicolor), the Palmchat, the Banaquit (Coereba flaveola) and the Kestrel (Falco sparverius), fortunately seem to have a remarkable ability to adapt to environments and have may increased in population (Woods, personal communication, 1985). However, if the destruction is not halted soon, and if it continues at the same rate, entire habitats will be irrevocably damaged within the next ten years (Cohen, 1984), resulting in the extinction of many valuable species of plants and animals, particulary birds, such as the Black-capped Petrel, the La Selle Thrush, the Hispaniolan Parrot and Parakeet, the Hispaniolan Trongon, the Rufous-throated Solitaire, the Chat Tanager, and the Ground and White-winged Warblers (Table VI-3).

Also affecting the status of wildlife in Haiti has been the introduction of non-native species such as rats and mice (Rattus rattus and (Mus musculus). Arriving with the Spanish they have successfuly competed with native rodents and insectivores, and have taken over their ecological niche and driven them into extinction (e.g. Brotomys vocatus, Nesophantes sp. and perhaps even certain species of Plagiodontia and Isolobodon – Woods, 1985). Dogs and particularly feral cats, also destroy large numbers of endemic mammals and birds. The mongoose (Herpestes auropunctatus) was introduced in 1908 to eliminate rats, mice and certain boas from sugar cane fields. The mongoose reduced the

Table VI-3
LIST OF ANIMALS THREATENED AND IN NEED OF PROTECTION
(Non-exhaustive list)

Local Name	English Name	Scientific Name
A.- Mammals		
Lamantin	West Indian Manatee	Trichechus manatus
Zagouti	Agouti	Plagiodontia aedium
Nez long	------	Solenodon paradoxus
	West Indian Shrew	Nesophantes *
B.- Reptiles		
Caiman, Crocodile	American Crocodile	Crocodylus acutus
Tortue de mer	Sea Turtle	Dermocheys coriacea
------	------	Chrysemys decorata
Iguane	Iguana	Cyclura cornuta cornuta
Couleuvres (Boa)	Boa	Epicrates subflavus
C.- Birds		
Malfini, Petit malfini, Emouchet	Sharp-shinned Hawk	Accipiter striatus
------	Peregrine Falcon	Falco peregrinus
Malfini, Gros malfini	W.I. Red tail Hawk	Buteo jamaicensis
Malfini savane	Ridway's Hawk	Rupornis ridgwayi
Gris-Gris	Sparrow hawk	Falco sparverius
Ramier, Millet, Ceniza, Ramier ceniza	Plain Pigeon	Columba inornata
Ramier	Red necked pigeon	Columba squamosa
Jacquot	Hispaniolan parrot	Amazona ventralis
Perruche, Perniche	Hispaniolan parakeet	Aratinga chloroptera
Maître bois, chuet-boua	Hispaniolan Stygian Owl	Asio stygius
Ouanga Négresse	Hispaniolan Emerald hummingbird	Chlorostilbon swainsonii
Hirondelle noire, Gros martinet noir	Black Swift	Cypseloides niger
Dame ou Demoiselle anglaise, Pie de montagne, caleçon rouge	Hispaniolan Trogan	Temnotrogon roseigaster
Colibri morne, Chicorette	Narrow-billed Tody	Todus angustirostris
Charpentier camelle, charpentier bois	Antillean Piculet	Nesoctites micromegas
Chitte Sara	Greater Antillean Elaenia	Elaenia fallax
Oiseau de la pluie, jolle-jolle	Golden Swallow	Kalochelidon euchrysea
Ouète-ouète noir, Merle	La Selle Trush	Turdus swalesi
Musicien, oiseau musicien	Rufous-Throated solitaire	Myadestes genibarbis
Petit chitte, quatre yeux	White winged Warbler	Xenoligea montana
Petit chitte	Ground Warbler	Microligea palustris
Louis d'or, Perruche	Blue hooded Euphonia	Euphonia musica
Mounedélé	Stripe-headed Tanager	Spindalis zena
Cornichon	Chat-Tanager	Calyptophilus frugivorus
Petit serin	Antillean siskin	Carduelis dominicencis
Bec-croisé	White-winged Crossbill	Loxia leucoptera
Petrel à coiffe noire	Black-capped petrel	Pterodroma hasitata
Aigrette, Crabier blanc, Quock blanc	Great Egret	Egretta alba
Crabier blanc, quock blanc	Snowy egret	Egretta thula
Cailles	Common Bob-white	Colinus virginianus
Faisan	Wood Ibis, Wood Stork	Mycteria americana
Flamand rose	Flamingo	Phoenicopterus ruber
Crabier Tricoloured	Heron	Hydranassa tricolor ruficollis
Crabier; Valet de Caiman	Little green hero	Butorides virescens vires
Crabier, Cracra, Valet de caiman	West Indian green heron	Butorides virescens maculutus
Crabier, Crabier bleu, Crabier noir, quock, quock blanc	Little blue heron	Florida caerulea caerulescens
Crabier, quock, coq d'eau, Coq de nuit	Black crowned night heron	Nycticorax nycticorax hoactili
Crabier de bois	Yellow crowned night heron	Nyctanassa violacea violacea
Perdrix rouge (male), perdrix noire (female)	Ruddy Quail Dove	Geotrygon montana
Perdrix grise	Keywest Quail	Geotrygon chrysia
	Antillean Wood Duck	Aix sponsa

Source: Direction Ressources Naturelles, Service de l'Environnement et de la Faune, MARNDR, Décembre 1984
* Possiblement disparu

number of native boas, but ignored the rats and mice, preferring to eat chickens and many kinds of native birds. Today the mongoose, rats and mice are found virtually everywhere in Haiti including the peaks of the highest and most inaccessible mountains, such as Pic Macaya (2347m) (Woods, 1984).

Domestic livestock, primarily cows and goats, were introduced by the Spanish and proved to be highly successful in Haiti. The export of hides provided a major sourse of revenue for the early Spanish colonists. Livestock, however, has directly contributed to the destruction of vegetative land cover. Ironically, the elimination of the Haitian pig, due to the program to eradicate swine fever, has also contributed to the process of deforestation. Haitian peasants traditionally raised pigs as a capital security that could be sold for cash in times of urgent need, such as death in the family, school bills, or a marriage. Now, deprived of revenue from the slaughter of pigs, the Haitian peasants cut down and sell trees, even fruit trees, in times of dire need.

Wildlife is also being eliminated by hunting, and by incidental killing, primarily of crocodiles and manatees. The Haitian peasant generally does not hunt wildlife, since he has no firearms, and only sporadically uses the flora for medicinal herbs. However, tree cutting for construction timber, sculpture wood, basket-making and charcoal, remains the most significant cause of deforestation.

E.- WILDLIFE TRADE

According to U.S. statistics, Haiti is the largest Caribbean supplier of raw coral and ornamental fish to the United States. Haiti also exports significant numbers of live reptiles, amphibians and arachnids (primarily tarantulas and scorpions) to the U.S. (World Wildlife Fund, 1982); and is a major source and transshipment port for raw and processed tortoise shell headed for Japan (WATS, vol. 1, p. 150).

In 1977, Haiti exported 1172 kg of raw tortoise shell (1.31 percent of the total world market). In 1982, Haiti exported shell (carapace) of Caretta caretta (328 kg), Chelonia mydas (250 kg), and Eretmochelys imbricata (241 kg) (WATS, 3-218). A major supplier of coral to the U.S. in 1978 and 1980, Haitian species appearing on the market included brain corals such as Acropora sp. and Millepora sp. A government communique, issued in 1977, banned coral exportation for two years (Wells, International Trade in Corals, IUCN, 1981). However in 1982, '83 and '84 between 3,000 and 6,000 pound per year of raw corals were imported illegally from Haiti and in 1981, exports amounted to over 15,000 pounds. The long-term implications of both legal and illegal wildlife trade on Haiti's vast, productive reef systems and indigenous species of birds, fish and reptiles are not known.

F.- NATIONAL PARKS

La Visite National Park

Area:	2200 ha
Established	April, 1983, by Presidential Decree
Administraded by:	MARNDR in cooperation with ISPAN
Vegetation:	pine forest, Savannah, and montane wet cloud forest
Objectives of the park:	• protection of a major water catchment zone for the agricultural Plaine du Cul de Sac and Plaine du Marigot • protection of endemic and rare species of flora and fauna • tourism / recreation • scientific research

Located high in the western part of the Massif de la Selle, the park includes three peaks: Morne La Visite (2150m), Pic Cabaio (2282 m), and Tete Opaque (2268 m), and a high saucer-shaped plateau of thick topsoil underlain by limestone and conglomerate rock.

The northern boundaries of the park contain striking and grandiose 1000 m limestone cliffs, some of which contain virgin montane cloud forest. On the exceedingly steep northern cliff faces, exist one of the three remaining breeding colonies of the strange, once believed to be extinct, Black-capped Petrel (Pterodroma hasitata) and one of the two remaining endemic land mammals on the island, the hutia (Plagiodontia aedium). These two species are highly endangered, as are some twenty-two other birds which are residents in the park, including the melodius Rufous-throated Solitaire (Myadestes genibaris), the La Selle Thrust (Turdus swalesi), the endemic White-winged Warbler, the Ground Warbler (Microligea palustris), the beautiful Hispaniolan Parrot (Amazona ventralis), the Hispaniolan Parakeet (Aratinga chloroptera).

The park, within its 2200 ha, contains savannah, pine forest (Pinus occidentalis), montane cloud forests, the remnant of an endemic juniper forest (Juniperus ekmanii), many endemic plants and orchids, numerous springs, sinkholes and cave systems, the headwaters of two major rivers (Rivière Blanche and Rivière Grise), as well as a number of waterfalls and small canyons, thus making it an area of unique and varied natural beauty.

The park was established under the auspices of the Institut de Sauvegarde du Patrimoine National (ISPAN), and the Ministère d'Agriculture des Ressources Naturelles et du Développement Rural (MARNDR). Funding was obtained from USAID with technical assistance by the University of Florida (Gainesville) and the International Union for the Conservation of Nature (IUCN). The development of this park has just

begun and a park management program and adequate infrastructure have yet to be established. A number of squatters live within the park, unfortunately practicing damaging agricultural methods and cutting lumber.

Macaya National Park

Area:	5500 ha
Established:	April, 1983, by Presidential Decree
Administered by:	MARNDR in cooperation with ISPAN
Vegetation:	pine and montane wet cloud forest
Objectives of the park:	• protection of a major watershed zone for the agricultural Plaine des Cayes, the Grande Anse and the Rivière du Cavaillon (hydroelectric production) • protection of endemic and rare species of flora and fauna • scientific research

Pic Macaya National Park, located near the tip of the southern peninsula of Haiti, provides the water supply for Haiti's most productive agricultural area, the Plaine des Cayes. Two major east-west and extremely steep mountain ridges, Morne Macaya (2347 m) and Morne Formond (2250 m), form the center of the park. Due to its remoteness and inaccessibility, the park has remained undisturbed until very recently, and within its boundaries are still found large tracts of impenetrable rain and cloud forest. This park contains a rich and unique fauna and flora with a high degree of endemism. Recently new species of orchids, including the beautiful (Lepanthopsis michelii, have been discovered in the park. Pines 45m high and 2m in diameter loom over the peaks and trap moisture from the almost ever present cloud cover, giving the area over 6m of total precipitation a year.

The park includes a significant breeding colony of Black-capped Petrels, and provides habitat for numerous other birds including the Hispaniolan Trogon, the Chat Tanager, the Stripe-head Tanager (Spindalis lena), the Hispaniolan Parrot and Parakeet, the Rufous-throated Solitaire, and the Gray-crowned Palm Tanager, which probably resides only in Haiti. Endemic mammals such as the Plagiodontia aedium and Solenodon paradoxus, as well as numerous species of endemic herpetofauna and mollusks, are found in the park.

This park was established under the auspices of ISPAN and the MARNDR. Funding was provided by USAID with technical assistance from the University of Florida and IUCN. The first steps are being taken to protect the resources of the park, define its boundaries and establish basic protective infrastructure. Recent Ministerial Decrees have stopped illegal cutting of trees for lumber, yet slash-and-burn activities on the fringes of the proteced area continue. Deforestation in the Park Macaya area is particularly intense and dramatic, although few peasants live within the park. Pine is being cut by unscrupulous lumbermen, and peasants are fire-clearing many of the steep slopes to plant corn, malanga (Xanthosoma saggitifolium) and mason-bell (Colocasia esculenta).

An emergency committee composed of representatives of MARNDR, ISPAN and USAID has been formed to formulate and undertake an immediate action program to meet this crisis. Among the proposals being made are: (1) a complete survey and physical delimitation of park boundaries, (2) the establishment of a 15,000 ha buffer zone, (3) the training and deployment of a park ranger corps, (4) the construction of a park headquaters, and (5) the strict enforcement of all existing legislation concerning protection of natural resources and the environment of the park.

National Historic Park La Citadelle, Sans-Souci et Ramiers

Area:	2200 ha
Established:	1961 by Presidential Decree
Administered by:	Office National du Tourism in cooperation with ISPAN
Vegetation:	subtropical wet forest
Objectives of of the park:	• protection of the historic monuments: the Citadelle Henry Christophe, the Palais de Sans-Souci and the site of Ramiers. • tourism / recreation • protection of endemic species of flora and fauna

Although this park was established primarily to assure the protection of Haiti's most important historic monuments (the Citadelle, the Palace of Sans-Souci, and the Site of Ramiers; built in 1806 by King Henri Christophe, a national hero in the fight for Haitian independence), it does have a secondary role as a natural park. The park contains samples of subtropical wet forest and a rugged karst topography serving as a refuge for many upland and lowland birds, such as the Narrow Billed Tody (upland), hummingbirds, the Peregrine Falcon, and for large flocks of parrots sometimes mixed with parakeets (Woods, 1984).

However, the natural environment of the park has not yet been adequately protected. The park is being developed with the technical and financial aid of UNESCO and the U.S. Peace Corps.

G.- GOH PROTECTION OF WILDLIFE

Presently there are two Haitian government organi-

zations whose responsibilities include the protection of Haiti's wildlands and wildlife: MARNDR and ISPAN. The Department of Natural Resources (DRN) of MARNDR is primarily responsible for the conservation and protection of Haiti's natural resources. The structure of this department has been altered repeatedly in the last few years. Haiti has a good number of laws protecting natural resources and flora and fauna, but the laws are rarely enforced.

The Hunting Decree of 1971 outlaws hunting of bird species listed in Article 18 and all domestic species. (Article 2) No hunting is permitted during closed season or without a license from the Chief of State, Major of Armed Forces or his Officers (Arts. 3, 5, 15, 27). It is illegal to take nests, eggs or the young of birds or animals ecept nuisance species designated by the MARNDR. No mammals or other classes of animals are covered by the DRN, Article 19 Decree. The Secretary of MARNDR established hunting seasons and conditions (Art. 16). Bird and game animals may be temporarily captured for scientific purposes. (Art. 20).

Law No. 9 of the Rural Code of 1962, which may be obsolete, prohibits hunting of birds during nesting season and of certain specified non-game birds (Library of Congress, 1979). The DRN has, in the last year, been taking serious measures ot protect Haiti's wildlife. New laws governing the exportation of animals and plants have been enacted to end a growing and illegal international trade in Haitian animals, most of them endemic and in danger of extinction. A World Bank financed project for the appropriate exploitation and protection of certain forests is underway. A division to manage parks and protected areas, for which the Department is presently responsible, has been established. In this task, the DRN is cooperative with ISPAN, the other GOH organization whose objectives include the protection of Haiti's natural heritage. It was ISPAN, that initiated the movement to create a system of natural parks and reserves in Haiti, and it was ISPAN that obtained a grant from USAID for the establishment of the first two parks at Morne La Visite and Pic Macaya. The parks' project, after some initial difficulties, is proceeding well, especially since the media and many government leaders have recognized the necessity of protecting Haiti's threatened natural heritage and resources.

Government agencies, however, are hampered by lack of funds and a lack of communication and coordination between concerned organizations, and by a number of very difficult political and socio-economic problems, such as the displacement of extremely poor peasants from areas that must be protected. To be successful, the protected areas project requires the enforcement of existing laws and no small amount of political will.

H.- CONCLUSIONS AND RECOMMENDATIONS

In general, the threat to Haiti's wildlands has come from human destruction of the environment as a direct result of extensive poverty, a rapidly increasing population, a highly individualistic survival mentality, a counterproductive land tenure and inheritance system, a lack of planning, inappropriate agricultural techniques, and the lack of an adequate governmental and private agricultural infrastructures.

A secondary threat to wildlife in Haiti has come from the introduction of such mammals as dogs, cats, rats, mongoose, and domestic livestock such as goats, cattle and pigs.

Wild plants have been destroyed by the advance of rural populations clearing remote locations, and by slash-and-burn agricultural followed in a number of cases by the degradation of the natural ecosystems to a state of near-sterile conditions (desertification).

The vestiges of Haiti's wildlife and wildlands are at a very critical point. Ecologically, it is ten minutes before midnight in Haiti, due mainly to the destruction of the land cover and consequent desertification. In a few years this process will be irreversible and there will be no possibility of natural regeneration of endemic plants and animals (C. Woods, personal communication, 1985). The conservation of Haiti's natural resources is necessary to preserve the country's viability as a natural and social system and for sustained economic development. If the remaining natural ecosystems, which constitute the major watershed areas as well, are not protected and allowed to degenerate, there will be no water to irrigate the agricultural plains, to be used for human consumption and for hydroelectric power generation. There will be little arable soil on which to plant, and carrying capacity of the land will be irreversibly reduced.

To protect Haiti's remaining wildlands and wildlife, it is suggested that the following measures be undertaken:

1. Designate areas deserving protective management

These areas would compliment a coastal resources plan since most of them provide seabird and shore bird habitat, especially during the winter months.

L'Etang Saumâtre is a large brackish lake 30 kms to the east of Port-au-Prince in the Plaine du Cul de Sac; it is connected by an irrigation canal to a much smaller lake, Trou Caiman. Both of these lakes were believed to have been formed during the early Quaternary era, when the seabed was uplifted as a result of the drifting together of the northern and southern land masses of Hispaniola (Woodring, 1926; Maurasse 1982). Due to the inflow of fresh water from the adjacent mountains the salinity of both these lakes is slowly diminishing (Thorbjarnason, 1984), thus creating a biologically flexible environment. Although the land around both lakes is inhabited, large areas of man-

grove and swamp surround the lake and a strip of land on the eastern shore of L'Etang Saumâtre belonging to Haiti, but surrounded by the Dominican Republic, is entirely uninhabited. The area attracts large numbers of migratory North American waterfowl and shorebirds.

Large flocks of flamingos, terns, ducks, stilts, herons, plovers, gulls, ibises and egrets mingle on and off the shores of both lakes, especially during the winter months. L'Etang Saumatre also contains a significant number of crocodiles (Crocodylus acutus) estimated at 450 adults (Thorbjarnarson, 1984), and a colony of iguanas on a small isolated rocky islet. The crocodiles are occasionally trapped and killed by local fishermen in their nets, but they are threatened primarily by the destruction of their breeding grounds. The waterfowl, particularly ducks, are hunted often quite wantonly killed during the winter months and many times even Flamingos are shot by unscrupulous hunters.

Etang de Miragoâne in the southern peninsula near Les Cayes harbors a small flock of American Flamingos and other waterfowl and shorebirds. It is a deep freshwater lake that once had crocodiles.

The **Ile de la Gonave** once contained beautiful hardwood forests that were cut for lumber during the 20th century, but still has an active population of some 84 species of birds (Wetmore and Swales, 1931) and a breeding colony of iguanas on its western tip.

Tortue Island, off the north coast of Haiti, has 47 different species of birds and is believed (Woods, personal communication, 1985) to have had a large and distinct animal fauna in precolombian times and may yet contain some species of rodent (Isolobodon sp.) and insectivores (Nesophantes sp.) that are extinct elsewhere in Haiti.

The **Artibonite/Estere** river estuary zone contains large tracts of mangrove, swamps and wetlands providing sanctuary for many migratory and resident birds, particularly shore birds such as herons, ibises and egrets. The Estere area has the largest mangrove forest in Haiti containing some 8490 ha. The area contains the best remaining habitat for the manatee and most remaining manatees live there.

The **Ile de la Navasse,** claimed by both Haiti and the United States, is reported to provide nesting grounds for many seabirds. It is uninhabited and its flora and fauna have not been investigated.

Three areas that should be considered immediately are:

Etang Saumâtre and its surrounding coast and the mountainside to its north since it harbor numerous waterfowl, crocodiles and iguanas and since many springs flow on it shores.

Pointe Moustique: a small, forest covered peninsula (360 m) to the northeast of Aquin on the southern coast of the southern peninsula, as untouched area that harbors numerous seabirds and coast ecosystems.

Eastern half of **Ile à Vache**, which has an extremely healthy mangrove swamp and an extended coral reef system.

2. Create a National Park Service under INHACA with the direct technical support of MARNDR. This organization should have direct access to the Presidency, to give it enough political weight to act effectively. By coordinating with MARNDR, it would avoid any potential policy conflicts between utiliztion and conservation of natural resources. It should have an adequate budget and staff and be adequately equipped and trained.

3. Adopt the IUCN World Conservation Strategy objectives. These objectives are:

– to maintain lessential ecological processes and life-support systems (such as soil regeneration and protection, the cleansing of waters), on which human survival and development depends;

– to preserve genetic diversity (the range of genetic material found in the world's organisms), on which depend the functioning of many of the above processes and life-support systems, the breeding programs necessary for the protection and improvement of cultivated plants, domesticated animals and microorganisms, as well as many scientific and medical advances, technical innovations, and the security of the many industries that use living resources;

– to ensure sustainable utilization of species and ecosystems (notably fish and other wildlife, forests and grazing lands), which support millions of rural communities as well as major industries. Any attempt to preserve Haitian wildlands and wildlife must be based on the principle of conserving nature for human development.

4. Implement the following as support to or which complement recommendations 1, 2 and 3:

– Prepare detailed studies in order to expand the system of protected areas to include other significant natural areas and the representative samples of Haiti's unique terrestrial, coastal and marine ecosystems.

– Initiate a program of public education about the environment and resource conservation for both urban and rural schools.

– Strictly enforce all existing laws on the protection of flora and fauna, watersheds, and the utillization of governmental lands.

– Establish a Natural History Museum and Botanical Gardens to become centers for research and education about Haiti's endemic flora and fauna.

– Eliminate taxes on imported wood products to encourage tree conservation and establish price controls.

– Implement a fruit tree and fuelwood reforestation program in the mountains, as well as in the flatlands.

– Establish a program of scientific research on Haiti's floral and fauna. Such a program should be undertaken with the participation of qualified scientific institutions abroad, which as in the case of the Florida State Museum and the University of Florida, have already collected samples of native plants and animals and compiled the most extensive data base on the island's flora and fauna.

– Donor agencies perform environmental impact studies as a part of project design and include natural resource or environmental management components (e.g., conservation and restoration) as an integral part of any rural development project.

Unfortunately the problems of conservation in Haiti and one might add, in most countries, are to a great extent political. Until decisions are made at the highest levels to implement an effective conservation program, very little can be done. The lack of understanding of the importance of environmental conservation and the extensive poverty of the great majority of the Haitian people are factors that must be considered.

It is clear, that unless urgent and immediate action is taken by the GOH, an unprecedented ecological and environmental crisis will occur, irreversibly destroying Haiti's natural resource base, the country's endemic fauna and flora and diminishing the carrying capacity of the nation to support its population.

VII

The Peasantry and the Physical Environment

A.- INTRODUCTION

Haiti is the New World's most agrarian society. Following its birth as a modern nation in the western hemisphere's only successful slave revolution (1804), Haiti quickly became a country of peasants. Since that time, the vast majority of Haiti's citizens have continued to be independent farmers dedicated to living on their own land. In spite of significant urban migration and the recent growth of a dynamic assembly industry sector in the capital, over 80% of the country's population remains rural, freeholding, and directly dependent upon agriculture for its livelihood. The Haitian countryside is occupied throughout its entire length and breadth by peasant households. Each household is a distinct unit of production and consumption which is grounded quite literally in its land resources. Thus, to understand the Haitian physical environment and its prospects, it is essential to explore the complex historical, material and spiritual relationships that link the landscape to its inhabitants.

B.- FROM SLAVE TO PEASANT

Haitian peasant culture has its beginnings in the 18th century. It was born in the struggle of nearly one million slaves of West and Central African origin to survive and to assert their humanity in the face of a brutal plantation regime under French rule. By the middle of the 18th century, creole slaves – the children and grandchilden of enslaved Africans who were originally purchased from many language groups by plantation owners eager to impede potentially dangerous communication and cooperation – were already speaking a fully developed Haitian Creole as their common native tongue. Slaves assigned provision grounds and forced to work in their off-time in order to defray the costs of their own upkeep had developed effective techniques of intensive food cultivation. Turning necessity to opportunity, the slaves not only provisioned themselves, but operated an island-wide internal market system, generated modest personal incomes, and even passed de facto rights in particular parcels of land on to their children. Under pain of severe penalty, many slaves also persisted in serving personalized spirits and family ancestors in innovative, African-based rituals of celebration that were the precursors of modern Haitian religion. In short, the foundations of today's peasant culture were laid long before the Revolution brought freedom and independence.

These emergent creole traditions were further enriched by continuously high levels of slave importation from Africa throughout the 18th century. The high demand for slave labor was fueled by an extremely high mortality rate due to the harsh regimen of the sugar plantations. In 1789, on the eve of the Haitian Revolution, the slaves born in Africa as free men and women, may well have outnumbered the creole slaves born to the condition of bondage in St. Domingue. Together, they were close to 500,000 strong, as compared to approximately 30,000 free persons of color (gens de couleurs, or affranchis) and 40,000 whites. Fifteen years later, those who survived the Revolution were thus able to draw freely on their memories of Africa, as well as to build upon their accomplishments as slaves, in constructing a new way of life.

The Haitians of the 19th century set out to define their newly-won freedom in terms of personal autonomy and economic self-sufficiency. The former slaves staunchly resisted the efforts of Haiti's new leaders and large landowners to engage them as nominally free laborers on the same plantations that they had so

recently worked under the lash. Unwilling to work for any overseer, they sought to establish themselves as independent, landholding, agricultural producers.

Popular struggles for access to land continued throughout the 19th century, and even now continue in some fertile areas still controlled by absentee landlords. Nevertheless, the people of Haiti succeeded in their quest for land. In their scattered homesteads, far from the centers of national and international power, the peasants of the 19th century constructed a new way of life, and they wisely built upon the firm bedrock of land ownership and food production. Rights to land and control over one's labor became the hallmarks of freedom and remain so to this day.

In the 20th century, the peasantry is facing serious challenges that threaten its continued viability. While the productivity of peasant agriculture has long underwritten the national economy, no corresponding reinvestment of resources, either public or private, has yet been made in the rural sector. Under such circumstances, a decline in peasant productivity was inevitable. The pressures of population growth, erosion, shrinking farm size and soil exhaustion have trapped the peasantry in a vicious cycle of ever-diminishing returns to labor. Currently, the majority have little hope of even one profitable agricultural season, let alone prospects for long-term savings and investment. While they remain, for the most part, committed to their way of life as independent, small-scale agricultural producers, they are hardly satisfied with the steadily worsening conditions of their existence. Looking ahead to the next generation, today's peasant commonly strives to ensure the future of his children outside of the agricultural sector through education, emigration, and alternative forms of employment.

In retrospect, it is all too easy to allow Haiti's current predicament to obscure the fundamental accomplishments of the Haitian people. Freed by their own hands of both colonial control and slavery, they were to articulate a vision of freedom that was, above all, their own. For the better part of a century the peasantry pursued that vision successfully, with results that compared quite favorably to the circumstances of their Afro-American compatriots throughout the hemisphere. If their descendants today have been unable to sustain that powerful vision of freedom in its entirety, nor even to maintain a satisfactory standard of living, this in no way diminishes the historical and cultural significance of their original achievement.

C.- CHARACTERISTICS OF THE PEASANT FARMING SYSTEM

Land scarcity, in the face of an expanding rural population, has resulted in the cutting of Haiti's forests to meet the need for cropland, even in mountains and fragile land areas unsuitable for sustained agriculture. While the large-scale cutting of trees for charcoal production is an important cause of deforestation in certain areas, overall it is very much secondary to the simple expansion of peasant agriculture under conditions of demographic pressure and declining productivity.

Yet, if peasant agriculture has been the primary cause of the destruction of Haiti's forest cover and widespread environmental degradation, it has been so only in response to a whole host of constraints external to peasant farming itself. Peasant farming may ultimately prove to have significant potential for positive impacts on the environment, as well. In fact, traditional features of peasant farming have been instrumental in the success of current programs to ameliorate the environment and reverse negative trends. These elements include the peasant orientation to the market, mixed cropping strategies, and indigneous agroforestry associations.

Peasant agriculture is virtually ubiquitous in Haiti, and is certain to remain so in the foreseeable future. Therefore, any proposed future interventions in rural areas must necessarily take account of the basic features of peasant farm systems and strive to offer the small farmer a real chance to participate in the solution of Haiti's environmental problems.

Heterogeneity of the peasantry

The Haitian peasantry is not a single homogeneous class. Variations in peasant economic status are reflected in highly differentiated relations to the market, patterns of landholding, and varied cropping strategies. Wealthier peasant families generally have greater access to savings. These families are likely to invest in land and livestock, but surpluses may also be invested in commerce, speculation, money-lending or emigration. Wealthier peasants are more oriented to perennial and export crops, and can afford both the higher capital inputs and the lag between investment and return that these crops require.

In contrast, poor peasant households tend to conceal the presence of a hidden rural proletariat. Most of the rural poor are not landless sharecroppers. They are more likely to be small landowners who are forced to supplement their farm income by occasional or seasonal day labor and petty commerce. The vast majority of peasant families are landowners; yet the majority of them are also land poor in absolute as well as in relative terms.

Thus, even on privately held lands, most hillside farmers are too poor to forego even a portion of their annual crop production and income for soil conservation structures or for the establishment of perennial, multi-year cropping patterns. Even where the appropriate technologies are already known to peasants, the required inputs, including tools and intermediate-term investment capital, are not readily available.

Complex land tenure patterns

The predominant feature of peasant tenure is its "mixed" character. Farmers generally work several plots under several different modes of tenure, simultaneously renting, sharecropping, owning and renting out land. A given farmer's operational farm unit may vary from season to season depending on his needs and on his ability to gain access to land, usually through personal and kin ties. Furthermore, peasant land tenure is characterized by a dual system of formal, legal tenure and of holding land by "custom", in ways neither provided for, nor excluded by, the law. This often ambiguous system of law and custom serves several functions: to protect the moral rights of kin, to avoid or delay the cost of paying taxes on transfers of title, and to avoid potential abuses by officials and competing claimants.

The varied character of land holding affects agricultural decision-making. Some plots are more readily alienated than others. Some are used as collateral on loans. Some are privately farmed while collectively owned, through group inheritance. The relative security of a plot clearly affects the farmer's willingness to invest in it, or to plant it with perennials, or to build costly earthworks for soil conservation. Indeed, where land is not owned outright by those who work it, as is the case with a significant percentage of fragile hillside lands, there may even be positive incentive for the operator to overexploit the plot under his temporary control. There is good evidence that both State lands and absentee holdings are virtually "mined" by poor leaseholders and sharecroppers with no permanent stake in the resource base precisely because they are under intense pressure to survive from one cropping season to the next. Certain land reforms, such as the "privatization" of selected State land and absentee holdings in favor of those who work to improve them, or at least the assurance of relatively secure access through long-term leaseholds granted to the actual farmers in place, might go a long way towards improving the current situation in some of the most fragile and critical areas of the country.

On the other hand, the much discussed general climate of insecurity of tenure on small, owner-operated holdings may neither be as widespread nor as amenable to legislated, externally-imposed solutions as is commonly suggested. Certainly, the situation on such private peasant holdings does not provide prima facie justification for a national cadastral survey, as is sometimes recommended. On the contrary, there is good evidence on record that local cadasters have already led to abuses, and even to the loss of land by small, powerless farmers. While customary arrangements and ambiguous ownership may complicate the implementation of projects' land management strategies, they often serve to protect access to land on the part of small peasant farmers.

In principle, an effective national cadastral survey is desirable; in practice, it is unlikely to lead to a more equitable distribution of holdings or to more secure land tenure under present social and political arrangements. In any case, it requires more than a pre-project cadaster to insure that land tenure arrangements and security remain relatively unaffacted by land improvement projects. The most significant constraints to land tenure security reside in the socio-political context of peasant powerlessness rather than in the lack of adequately surveyed and titled garden plots.

Diversity of farming strategies

Just as there is no homogeneous peasant class, there is no homogeneous farming economy in Haiti. Rather, there is a range of peasant economies, each one with its own mix of strategies and varied impacts, both positive and negative, upon the environment. This diversity is attributable, in large measure, to immense variation in micro-climatic conditions, as well as to the highly dispersed pattern of multi-plot farm units in any particular area.

Where there is sufficient rain, mountain peasant agriculture is based on intensive intercropping, and tubers are an important food crop. Well-watered highlands tend to have more land devoted to perennials, and a greater diversity of cultigens, except in areas of specialized vegetable production such as Kenscoff (near Port-au-Prince), where the traditional coffee/corn/bean association has been supplanted. Arid lowlands tend more toward "extensive" cropping strategies, fewer crops, longer periods of fallow, fewer planting seasons, and a greater reliance on grazing. Where irrigation is available in lowland plains, peasant agriculture more easily controls the factor of risk and therefore focuses on cash cropping, with high capital inputs and high labor demand, attracting large numbers of landless and land-poor agricultural wage laborers.

In short, differing crop strategies represent distinct variations in crop rotation, length of fallow, land tenure, slack season activity, patterns of storage, and the relative monetization of peasant houshold economies. These complex variations in farming strategies and potential are directly correlated with the significant environmental diversity characteristic of Haiti. They are bound to complicate any national programs aimed at the improvement of peasant farming systems from the point of view of their ecological soundness and sustainability.

Peasant access to land, labor and capital

Capital is by far the scarcest of the peasant household's production factors. Capital shortages are a significant constraint to peasant production and tend to foster destructive land use practices. Labor is the least scarce factor of production, while land is the pivotal factor. Land serves as the powerful fulcrum for gaining

access to labor and capital resources. Land is the primary source of livelihood and the most significant form of investment. Peasant farmers have relatively more control over land and labor resources than over capital.

As the most significant form of peasant wealth, land is readily bought and sold. Since land changes hands easily, there may be some disincentive to invest in perennials crops, except as a long-range investment strategy among the better off peasants. On the other hand, land improvement investments, especially is the form of trees plantings, significantly enhance the local market value of any particular plot of land, and the net incentive for such investments, particularly those requiring low capital inputs, is likely to be positive.

Market/cash orientation

While there is a mix of monetary and non-monetary features in the peasant economy, the Haitian peasant adaptation evolved in a modern, post-colonial setting, and has always been firmly embedded in a cash nexus.

Today's peasant is neither a classic subsistence producer, nor the marketer of a true surplus. Rather he is a deficit producer and a marketer for subsistence goals. That is, the average peasant producer produces less than the minimum necessary to support himself and his family; he operates at a loss, and likely loses ground in one way or another every year. Yet he must go to market (or, more precisely, send his wife to market) every single week, in order to secure those basic necessities without which his daily consumption requirements cannot be met. Such essential items include cooking oil, salt, matches, laundry soaps, cooking vessels, cloth, and a host of other manufactured, processed or non-locally produced goods. These necessities are available only through purchase, and some portion of perennially scarce on-farm produce must be sold to generate the needed cash. Paradoxically, the poorer the peasant, the higher the proportion of his on-farm produce sold at market. This inverse relationship holds at least within the lower and middle strata of the peasantry, until the true surplus producer emerges in the upper reaches of rural society. The terms of exchange, needless to say, are controlled from without, and are almost invariably weighted against the small local producer.

Fig. VII-1: Going into a town market (photo WFP/Rome)

Increasing importance of annual crops

In the face of this constant need for small sums of cash in order to provision the household with daily necessities, peasant farming strategies currently depend primarily on the sale of food crops. Not only has food-crop production always been spread more evenly throughout the annual cycle than traditional export crop production but, during the past fifteen years, prices for domestic food crops have tended to rise faster than prices for export crops. Although food-crop prices are characterized by significant fluctuations in the short run, they have steadily risen in price in the long run. On the other hand, both prices and the production of export crops have tended to be highly unstable.

This situation has clearly tended to favor food crops produced for the local market as the primary cash crop of the peasant production system. Moreover, the necessity for cash crops with a quick turnaround time and favorable prices provides an additional strong incentive to plant annual, "erosion-intensive" crops such as corn and beans, as opposed to the slower growing, soil-holding perennials such as tree crops, coffee and cocoa.

Avoidance of risk

With a large percentage of small farmers living on the very margins of survival, peasant farming is more strongly oriented to minimizing risk than to maximizing production. The risk factor tends to promote a diversity of holdings and tenure arrangements on small plots in order to spread the risk within a single peasant farm unit. Different plots located in different micro-climatic zones, are managed in different ways.

One extremely significant, yet virtually uncontrollable risk factor, with profound effects on peasant farming systems, is the island's location in the path of numerous tropical storms and hurricanes. The following list of natural disasters is not complete, but it is indicative of the unusual significance of natural disasters in a domain of production where success is tenuous, at best, and where peasant's ability to absorb loss is very limited.

1947	drought	1967	Hurricane Beulah
1954	Hurricane Hazel	1967	drought
1956	Hurricane Greta	1968	drought
1956	drought	1968	floods
1958	Hurricane Ella	1969	drought
1958	drought	1971	floods
1959	Hurricane Gracie	1972	drought
1959	drought	1975	drought
1963	Hurricane Flora	1976	drought
1963	floods	1977	drought
1964	Hurricane Cleo	1979	Hurricanes David & Frederick
1966	Hurricane Inez		
1966	drought	1980	floods

Major storms are not only destructive in the short run, but they may have a long-term impact on the environment, as well, by forcing peasants to adapt to drastic conditions by altering their farming strategies in ways that ultimately lead to even greater negative effects on the local ecology. Thus, for example, peasants in the Jacmel region cite hurricanes as the precipitating cause for a significant transformation of their farming practices – a major shift away from perennial-crop production to annual-crop production. Once a hurricane destroyed established coffee plantations on south-facing slopes, and simultaneously destroyed the bulk of the local food supply still in the ground, there was little choice but to plant food crops extensively on the once-protected hillside lands, and to do so as quickly as possible. Unable financially to wait for new coffee plantings to become productive, most peasants in the area apparently failed to re-established their perennial plantations, and continue to produce annuals on lands where they are essentialy inappropriate.

Charcoal production and fuelwood consumption

The production of charcoal comes primarily, but not exclusively, from large-scale production zones in semi-arid regions of the country (i.e., Northwest, Côte-de-Fer). Large-scale production of charcoal is a relatively recent phenomenon. Its advent coincides with the tremendous growth of Port-au-Prince since the 1940's, and also with the destruction of crops and the felling of trees by hurricanes. In many charcoal producing areas, the first period of charcoal production can be dated within living memory, and this date often coincides with the passing of a destructive hurricane. The landmark date in this regard is 1954, with the tremendous destruction left in the wake of Hurricane Hazel

Unlike charcoal, whose demand curve has risen dramatically with the recent explosion of the urban population, the peasant demand for fuelwood for household cooking needs, though absolutely high, has risen relatively gradually with rural population growth and has always been evenly distributed geographically. These local needs have traditionnaly been met through the gathering of dead wood and the pruning of branches from living trees. The commercial exploitation of both fuelwood (for rural and urban industries such as bakeries, dry cleaners, essential oil distilleries, etc.) and charcoal, on the other hand, has always been focused and intense, moving from one locale to another only after near-total deforestation has occured. Peasants in many parts of the country have only turned from gathering dead wood to cutting trees down for their own fuelwood needs after their local resources have suffered the effects of such commercial exploitation. In some specific areas, in fact, this dynamic may be as significant a factor in severe deforestation as the sheer effects of population pressure on agriculture expansion and household fuelwood demand.

Peasants, trees and agroforestry

Given the wholesale destruction of forest cover built into peasant agriculture, the impression is sometimes given that peasants do not plant trees. This is emphatically not the case. Peasants have commonly planted fruit trees, although not in large numbers. Trees of many kinds are traditionally planted in patterned agroforestry associations, as evidenced in the botany of the peasant houseyard and residential compound, in living fences or boundary markers (for gardens, yards or animal pens), and in shade cover for such crops as coffee and cacao. Peasant farmers also have a distinct preference for self-regenerating and self-propagating trees. In arid zones, there is a traditional practice of managing woodlots of Prosopis (bayahonde or mesquite), a coppicing, drought-resistant wood species highly valued by peasants as construction timber and for charcoal production.

Indeed, trees of virtually any kind are of such considerable importance to the peasant that distinct rules of ownership and inheritance apply to them. Patrimonial land may be divided, for example, while trees on the same land, and their produce, might remain a collective resource for generations. Trees may be owned entirely separetely from the land upon which they grow. Land may be rented or sharecropped separately from the trees present on the land, which themselves may be rented for one or more seasons.

Traditionally, peasant farmers have tended not to plant hardwood trees, but hardwood seedlings are often protected, or transplanted from sites where they sprout by natural regeneration. USAID's Agroforestry Outreach Project, however, has clearly demonstrated that peasants are more than willing to plant non-fruit-bearing trees on a large scale, if certain conditions are met. Small peasant farmers, in collaboration with this project, are presently planting trees, at their own expense in land and labor, at the rate of seven million trees per year. Overall project objectives are to promote cash cropping of trees by small farmers, to plant multi-purpose trees as a renewable natural resource, to foster soil conservation, to develop new sources of

Fig. VII-2: Gathering firewood in the arid Northwest (photo WFP/Rome)

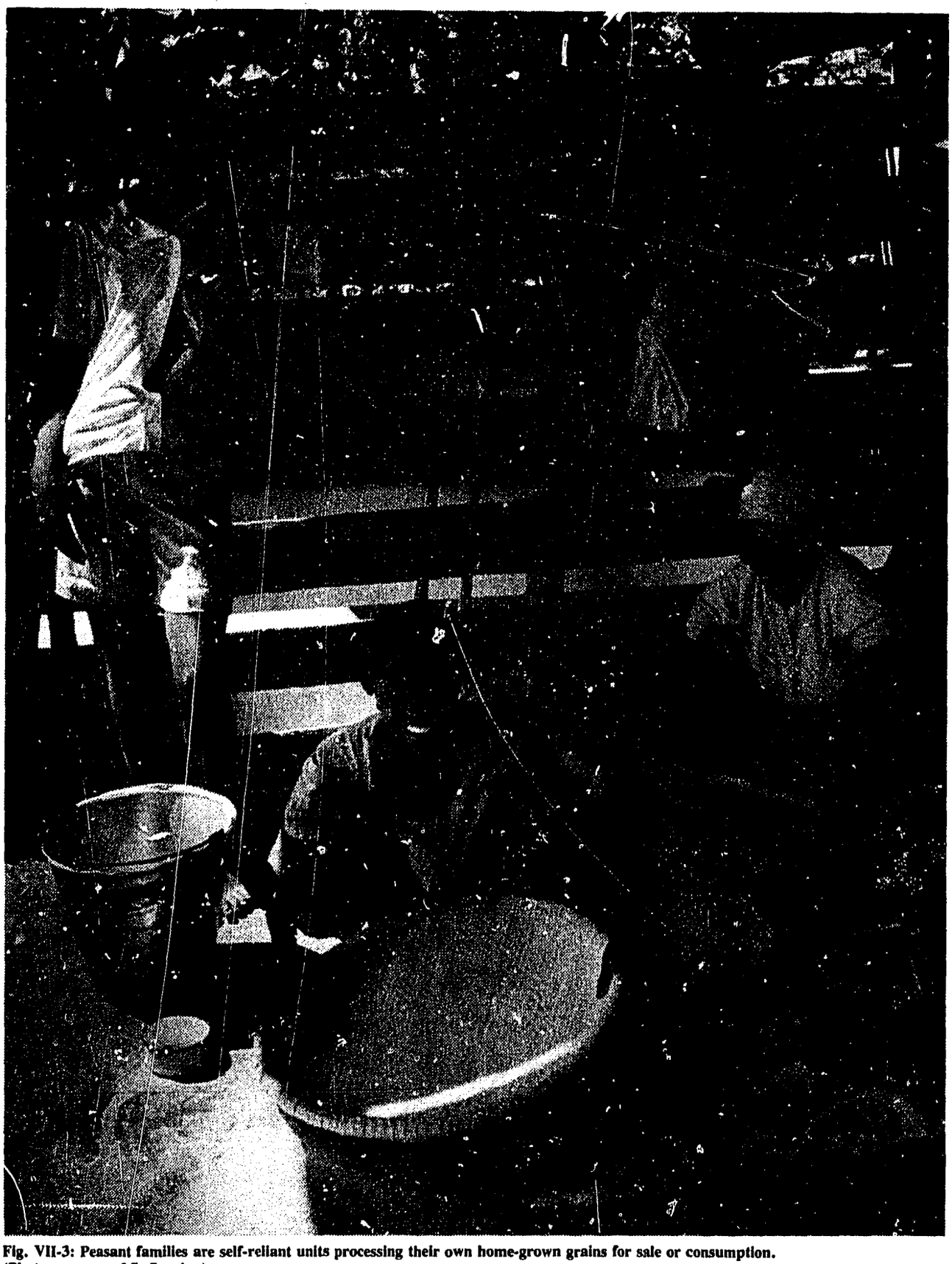


Fig. VII-3: Peasant families are self-reliant units processing their own home-grown grains for sale or consumption. (Photo courtesy of S. Seguino)

income in rural areas, and to generate new supplies of timber, fuelwood, fruit and forage.

Much like the land, which at one time, at least, ensured the continued viability of peasants as independent producers and free men, trees too are imbued with more than just material significance. They play a symbolic role in the spiritual lives of rural Haitians, as well. Some trees on peasant lands, for example, are protected from cutting by strong taboos linked to family spirits or special pilgrimage sites. Many trees, especially certain species and most old trees, are considered to be repositories of various types of spirits. It is customary in many areas to plant a tree over the spot where the afterbirth is buried at childbirth, and to consecrate its future production and value to the newborn. The child is expected, someday, to profit from it, and to be anchored by it as he or she grows up to face the increasingly stringent demands of making a living on the land.

D.- RELEVANT LITERATURE

The best regional study of human geography in Haiti is the work by H. Wood, Northern Haiti: Land, Land Use and Settlement. A Geographical Study of the Département du Nord, University of Toronto Press, 1963.

The best general study of Haitian peasants is a work by another geographer, P. Moral, Le Paysan Haitien, Maisonneuve et Larose, Paris, 1961.

The effect of peasant settlement on the land in two countries is vividly contrasted in E. Palmer's dissertation, Land Use and Landscape Changes Along the Dominican-Haitian Borderlands, University of Florida, 1976.

The most important recent work in Haitian geography is the political geography of G. Anglade: L'Espace Haitien (1974), Espace et Liberté en Haiti (1982) and especially, the Atlas Critique d'Haiti (1982), Montréal (Centre de Recherches Caraïbes de l'Université de Montréal).

VIII

Water Resources / Sanitation / and Environmental Health

A.- INTRODUCTION

Signs of environmental pollution are evident in Haiti, particularly in the densely populated sections of urban areas. Surface and groundwaters are being polluted by human waste; and solid wastes are dumped into the drainage ways. The air in Port-au-Prince contains dust and emissions from poorly inspected vehicles. Control of environmental pollution is non-existent. The two most pressing environmental health issues are access to a relatively safe water supply system and access to a safe method of human waste disposal.

Haiti's population is projected to increase from 5,200,000 in 1985 to 6,500,000 in 2006, the long range planning horizon selected by the Ministry of Plan. During that period the proportion of rural population will decrease from 74 to 43 percent, while the metropolitan area will grow from 720,000 to 2,200,000 persons. Employment and government services are better in the Port-au-Prince area, which thus attracts many people. Other national development constraints include a high population density (670 people per square kilometer of arable land), low agricultural productivity and a lack of basic infrastructure.

Socio-economic trends are alarming and development prospects constrained. However, a planning process has begun and it holds the promise of future improvement. The Ministry of Plan has prepared a development strategy dividing the country into four new planning regions. The scenario envisioned for the year 2006 is for essential services to be available to all urban areas and the largest rural centers; for 60 percent of total jobs to be outside the metropolitan area and for four provincial cities to exceed a population of 100,000 serving as regional development poles. Another notable planning effort is under way for water supply and land use in the metropolitan area of Port-au-Prince.

The water supply sector has a long way to go to meet its needs both in the metropolitan areas and in the remainder of the country. The Centrale Autonome Métropolitaine d'Eau Potable (CAMEP) now supplies only 60 percent of its potential customers. This percentage is expected to decrease to 50 percent in the next six years. The Service National d'Eau Potable (SNEP) serves 700,000 people or 16 percent of the population outside the metropolitan area. This proportion is expected to increase to 39 percent in 1991.

It is unlikely that PLAN's goals for the international water and sanitation decade will be realized, but the gap between targeted demand and level of population served will keep narrowing. Progress towards some reasonable goal is slow, but some planning activities underway are promising and should be encouraged. An effective CONADE (National Water Council) would be a powerful planning and regulatory agency to protect water resources and ensure their reasonable availability for competing uses.

Water resources, though not precisely known, are believed adequate to meet basic domestic needs. The main constraint is deficient cashflows and for CAMEP, to a certain extent, losses through leaks and piracy. Water quality at most systems can be improved by more frequent testing. Establishing a national code of drinking water quality standards would help in the selection of water sources and the preparation of treatment guidelines. Finally, employees at the intermediate and lower levels could be motivated and upgraded through training.

The metropolitan drainage program, underway, will help alleviate considerably the problems of stormwater and solid waste disposal in the Port-au-Prince area. Other programs are under consideration for some large provincial cities. Disposal of stormwater and solid waste is critical in rural areas.

Only 35 percent of the population have adequate means of human waste disposal. That is an increase

from 20 percent in 1971. PLAN envisions a program to construct family latrines for all the unserved population by 1990. A most serious problem is disposal of sullage (from latrines) and septage (from septic tanks). With its limited means, the Division of Public Hygiene meets only 10-20 percent of the needs, the remainder of the work being done unsafely by honey dippers.

B.- URBAN AND RURAL POPULATION TRENDS

Table VIII-1 presents the population estimates and projections proposed for the four new planning regions based on the results of the three censuses of 1950, 1971 and 1982 as reported by the Haitian Institute of Statistics (September 1982).

The total population of the country for the period 1950-2006 is shown on Figure VIII-1 along with projection made by the Ministry of Plan and Institute of Statistics (IHS) for comparison. In the results of the censuses, urban areas include cities, commune seats and certain communities with similar housing patterns, some which may have only a few hundred persons (Institut Haitien de Statistiques, 1978). The majority of the population (74 percent) live in rural areas and most of the urban population (55 percent) is in the metropolitan area. Outside Port-au-Prince, only 10 cities have more than 10,000 people.

The populations (IHS, 1980) of the largest cities are estimated as follows:

Port-au-Prince	830,000	Port-de-Paix	16,000
Cap-Haitien	66,300	Jacmel	14,100
Gonaïves	35,100	Desdunes	14,000
Les Cayes	35,100	Hinche	10,400
St. Marc	24,900	Jérémie	19,000
Petite-Rivière de l'Artibonite	10,000		

From an environmental planning standpoint, Plan divides the population into three groups (National Program for Water Supply and Sanitation, 1984):
– Urban and semi-urban communities, including Port-au-Prince and census centers that will have a popula-

Table VIII-1
POPULATION ESTIMATES AND PROJECTIONS

	1982	1985	1991	2006
North Dept.	564,002			
Northeast Dept.	189,573			
North Region Total	753,575	770,00	810,000	900,000
Artibonite Dept.	732,932			
Center Dept.	361,470			
Northwest Dept.	293,531			
Transversale Region Total	1,387,933	1,390,000	1,420,000	1,500,000
West Dept.	1,551,792			
Southeast Dept.	367,911			
West Region Total	1,919,703	2,040,000	2,330,000	3,000,000
South Dept.	502,624			
Grand'Anse Dept.	489,957			
South Region Total	992,581	1,000,000	1,040,000	1,100,000
Haiti Total	5,053,792	5,200,000	5,600,000	6,500,000
Urban Population	1,301,208	1,500,000	2,100,000	3,700,000
(%)	26%	29%	37%	57%
Metropolitan Area Port-au-Prince	719,617	830,000	1,200,000	2,200,000
Other Urban Areas (%)	45%	44.8%	43.2%	41%
Rural Population	3,752,584	3,700,000	3,500,000	2,800,000
(%)	74%	71%	63%	43%

Source: Based on census result and trends predicted by the Ministry of Plan (1984).

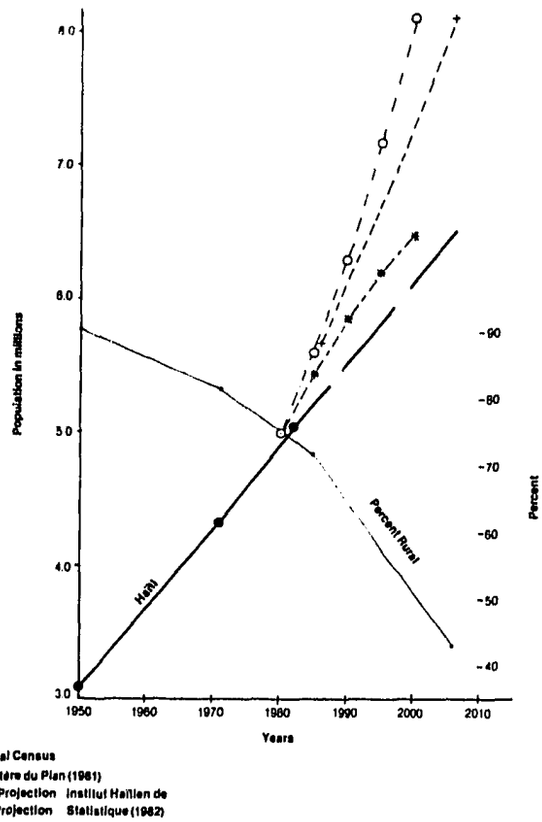


Fig. VIII-1: Population Trends

tion of 5,000 or more in 1990. Thirty such communities (including the capital) have a present total population of about 1,200,000.

– Concentrated rural communities that can be supplied from regional systems, springs and drilled or excavated

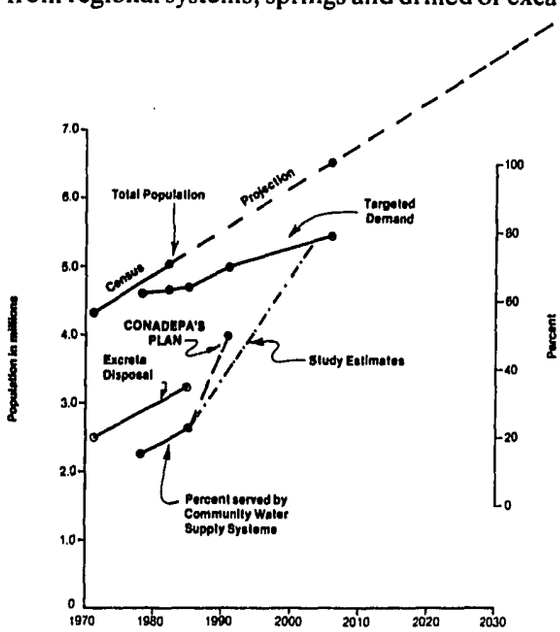


Fig. VIII-2: Water supply plan

wells. These relatively dense communities include the remaining 150 urban towns with a total population of 300,000 plus approximately 1,000,000 people in the «sections rurales».

– Scattered rural communities that can be served only by individual systems and include the remainder of the rural population, that is 2,700,000 people.

If present population trends continue, one can expect Haiti's population to greatly increase thereby increasing the need for water supply sanitation services, and pollution control. Overall densities will increase to 235/Km².

The rural population will actually decrease and its relative share will go from 74 percent in 1985 to 43 percent in 2006. Under these conditions, it becomes more imperative than ever to manage environmental resources carefully and to plan for long term objectives even if project implementation cannot go beyond short-term needs. In rural areas and the smallest towns and villages, projects to increase basic services such as water supply and sanitation should continue.

At the other end of the spectrum, the situation will become explosive in the metropolitan area unless necessary actions are taken to meet the needs of a population exceeding 2,000,000 people. The current infrastructure elements, barely adequate for the population of 150,000 in 1950, will require considerable improvements. It is imperative to adopt measures as part of a land use plan that will provide adequate water supply and sanitation services as well as pollution controls.

An important first step in these planning endeavors was taken during the preparation of the CAMEP's master plan to supply the metropolitan area with water to the year 1995 (SAFEGE, 1984). In cooperation with other divisions of the Ministry of Public Works, CAMEP's consultant prepared a preliminary land use master plan that essentially proposes a preliminary land use master plan that essentially proposes a development scenario for Port-au-Prince including:

– protecting agricultural lands as well as lands with a slope greater than 25 percent (at the same time this will protect part of the CAMEP's watershed from the risks of pollution by residential or industrial development);

– directing future expansion towards the northeastern and northwestern areas.

The prospect of 2,200,000 people (34 percent of Haiti's projected population) in the metropolitan area is frightening, but may be worse if the provincial towns cannot slow down the exodus towards Port-au-Prince and absorb a reasonable share of the population growth. Programs to develop these towns into primary and secondary centers of development should continue at an intensified rate.

C.- WATER RESOURCES

Water Supply

Two government ministries share the responsibility for managing and developing water resources in Haiti. The Ministry of Agriculture, through the Service des Ressources en Eau is in charge of water resources studies, research, control and protection and also develops water resources for irrigation. The Ministry of Public Works provides drinking water through two organizations: CAMEP for the metropolitan area and SNEP for the remainder of the country. In practice, however, there is little control over the use of water resources and several other government and non-government organizations execute water supply programs.

Despite past studies, there is no definitive assessment of Haiti's water resources. A current project sponsored by an agency of the United Nations is collecting and analyzing data that may allow a quantification of the resource. However, it is generally agreed that there is enough water for drinking purposes and that the water supply problem is: to find means of developing the resource (DATPE, 1984).

Groundwater is abundant and easily accessible in some areas, particularly in the coastal plains (Plaine du Nord, Rivière Colombier, Plaine des Gonaives, Basse Artibonite, Plaines du Cul-de-Sac, de Léogâne, de Jacmel et des Cayes). Aquifers in these areas yield between 10 and 120 liters per second. Their waters are of good quality except for salt water intrusion in some cases. Groundwater resources in the Plains of Gonaives and Cul-de-Sac have been exploited to a certain extent. Other areas are rich in groundwater that cannot be easily developed (40 percent of the country receives between 1600 and 2000 mm of rainfall per year, but has a karstic substratum). Groundwater sources could yield between 0 and 1000 liters per second of water of good quality, except for an excessive hardness. Finally, some areas are poor in groundwater because of low precipitation or the presence of impermeable layers, as in the Central Plateau and parts of the northwest peninsula and the Island of La Gonave (DATPE, 1984).

A complete inventory of water uses is not available for all the watersheds. For the Cul-de-Sac plain (which is not representative of the entire country because of extensive uses and relatively abundant resources), groundwater use may be summarized as follows (SAFEGE, 1974):

irrigation	100,000,000 mc/year
industry	15,000,000 mc/year
Port-au-Prince's potable	8,000,000 mc/year
individuals wells	125,000 mc/year

Water Quality

Water supplied by CAMEP and SNEP is disinfected before distribution and is considered relatively safe. However, in some installations, treatment is irregular because of breakdowns and the absence of backup equipment. Water from surface sources and uncapped springs presents a high risk of contamination. Water supplied by private vendors in the Port-au-Prince area is considered unsafe because it is not disinfected and its sources are not protected. Strictly speaking, there is no controlled potable water in the country; even the treated and bottled water sold by two plants cannot be absolutely guaranteed; although the treatment method is satisfactory, contamination may occur during the bottling operation (DATPE, 1984).

Water-related diseases are prevalent in Haiti, particularly in the rural areas where potable water systems are rare. In 1980, several thousand cases of water-related diseases were reported as shown on table VIII-2. The actual number of infections is much higher, particularly for diarrhea, which is not often reported. In any case, the numbers are too high. Children are particularly affected. In 1979, diarrheas alone caused the

Table VIII-2
SOME REPORTED CASES OF WATER-RELATED DISEASES IN 1980

Area and	Population	Diarrhea		Intestinal Infections		Typhoid	
		Cases	/1000	Cases	/1000	Cases	/1000
Port-au-Prince	650,000	6608	10.2	4694	7.2	460	0.7
Gonaïves	33,000	255	7.7	167	5.1	11	0.3
Port-de-Paix	15,000	455	30.3	2171	145	114	7.6
Hinche	10,000	694	69.4	738	74	100	10.0
St-Marc	23,000	851	37.0	314	13.7	266	11.6
Petit-Goâve	7,000	294	42.0	1357	194	2	0.3
Belladère	2,500	875	350	272	109	68	27.2
Jacmel	13,000	320	24.6	152	11.7	87	6.7
North Dept.	560,000	3145	5.6	6819	12.2	141	0.3
South Dept.	500,000	1909	3.8	2380	4.8	462	0.9

Source: CONADEPA (April 1984), from Bulletin de Statistiques et d'Epidémiologie, Département de la Santé Publique et de la Population.

death of 9 percent of the babies under one year (UNICEF, 1984).

Existing Water Supply Systems

In 1978 there were 40 domestic water supply systems in the country serving 700,000 people or 15 percent of the population, mostly in Port-au-Prince and other urban areas (Harza Engineering Company, 1979).

Since then several other systems have been added to the network and some have been expanded. It is estimated that, by the end of 1985, a total population of 1,200,000 or 23 percent will have access to a community water supply. A good portion of these people live in the metropolitan area (42 percent) and in the 13 provincial cities of 10,000 or more (25 percent). Thus, 67 percent of the urban population will have access to a community water supply while there will be practically no water supply systems in the rural areas with a scattered population.

The existing water supply systems are the results of investment programs by government agencies, and bilateral and multilateral cooperation organizations. (Table VIII-3). The government devotes 4 percent of the budget to potable water projects and this contribution is financed by external assistance at 85 percent (UNICEF, 1984). Their actions are summarized as follows:

- CAMEP is an agency of the Ministry of Public Works, Transports and Communications (TPTC) created to provide drinking water to an area that includes the cities of Port-au-Prince and Pétionville, the communities of Carrefour and Delmas, the towns of Gressier and Croix-des-Bouquets, and the Quartier Croix des Missions. This vast franchise area is designated as the «Communauté Urbaine» or Metropolitan District. Presently, CAMEP serves only Port-au-Prince, Pétionville, Carrefour and Delmas. The last major expansions of the system were financed in 1969 and 1977 by the Inter-American Development Bank.

CAMEP supplies its customers from 17 springs producing 44,000 mc per day and three wells in the plain of Cul-de-Sac producing 22,500 mc per day. It is estimated that the safe yield of these combined sources is 70,000 mc per day. CAMEP uses distribution reservoirs with a total capacity of 36,650 mc. Maintenance of these structures and the distribution pipes leave much to be desired. The quality of the raw water is generally good except for a high salinity in the Cul-de-Sac and traces of bacteriological contamination at two springs, Plaisance and Cerisier, caused probably by malfunctioning latrines and septic tanks. All the sources (springs and wells) have a disinfection unit except one spring (Source Doco), but the equipment at some installations often does not work.

Fig. VIII-3: Refuse disposal and sanitation are problematic in most poor neighborhoods of Port-au-Prince (Photo, courtesy of S. Seguino).

Table VIII-3
SUMMARY OF EXISTING AND PROPOSED WATER SUPPLY SYSTEMS

Service Area	Population Served in 1978	1985	1991
Metropolitan Area	460,000	500,000	600,000
Balance of West Dept.	60,000	150,000	290,000
Southeast Department	14,600	30,000	80,000
North Department	30,900	150,000	290,000
Northeast Department	5,400	15,000	90,000
Artibonite Department	51,000	160,000	360,000
Center Department	17,500	30,000	80,000
Northwest Department	36,300	40,000	130,000
South Department	24,000	75,000	230,000
Grand'Anse Department	14,900	50,000	150,000
Total Served	715,000	1,200,000	2,300,000
Total Population	4,750,000	5,200,000	5,600,000
Percent Served	15%	23%	41%

SYSTEMS TO BE COMPLETED IN 1985 (UNDER POCHEP AND UNICEF)

Service Area	Pop. Served	Service Area	Pop. served
North (18)	15,200	West (50)	27,400
Northeast (0)	0	Southwest (3)	4,900
Artibonite (38)	34,100	South (18)	23,100
Center (4)	6,500	Grande Anse (8)	9,500
Northwest (0)	0		
		Subtotal (139)	120,700

Total SNEP in Operation in 1985: 725,800

Source: Harza Engineering Company (1979);) SNEP (January 1985) and Project POCHEP's files

CAMEP presently serves about 500,000 people through:

– 40,000 connections, 25 percent of which are illegal and do not contribute any revenue (total 300,000 people).

– 80 functioning standpipes at the disposal of the sixty-five percent of the urban population that is below the absolute level of poverty. Actually, less than 80,000 people derive their water from this source; the overwhelming majority of the group purchase water from private vendors (300,000 people), share a connection with a subscriber (100,000), break illegally into CAMEP's pipes (40,000) or use approximately 120 spring and private wells.

Water loss through leaks and waste is estimated at 50 percent (70 percent by one account). There are no water meters. CAMEP's annual revenue is less than $700,000 while the vendors collect close to $4,000,000 (DATPE, 1984, and Fass, 1982).

• SNEP is another agency of the Ministry of Public Works. It is responsible for the construction, operation and maintenance of all water supply systems outside the metropolitan area. SNEP has an executive office (Direction Générale) and four regional offices at Port-au-Prince, Cap-Haitien, Gonaives and Cayes. SNEP's financial means are extremely limited, but the agency has received assistance from several donors including United Nations agencies (UNICEF, WHO), the World Bank (IBRD) the Inter American Development Bank (IDB), the German Foundation for Technical Assistance (GTZ), and the U.S. Agency for International Development (USAID).

This year SNEP will have 185 water supply systems in operation, serving a total population of 700,000 in the departments, including those to be completed in 1985.

Most of these systems are capped springs, three notable exceptions being those serving lthe cities of Cap-Haitien, Gonaives and Cayes. The community systems range from a dug or bored well with a hand pump serving 200 people, to the system at Cap-Haitien serving close to 60,000 people through house connections and public fountains. Several organizations assisted in the financing of these systems or participated in their construction, particularly: the IDB (10 largest cities), the Organization pour le Développement du Nord (ODN) the DSPP (Département de la Santé Publique

et de la Population) at the Ministry of Health and several non-governmental organizations such as CARE, World Church Service, Missionary Church Association, German Foundation for Technical Assistance, Canadian Agency for International Development (CIDA).

There is no evidence of national drinking water supply standards. Conversations with managers of CAMEP, SNEP, the Public Hygiene Division, and the Sanitation Office indicate that the main concern is bacteriological contamination, although physical-chemical analyses are sometimes also conducted. Some portable kits for testing water quality are available to SNEP.

Included in the existing systems are those constructed by the sanitation office (Bureau d'Assainissement) of the Ministry of Health. The 35 systems serve 92,000 people in 73 communities whose populations vary from 700 to more than 5,000. Under an agreement between the Ministries of Health and Public Works, and the financing agencies (IDB and the European Economic Community), the systems are constructed under Poste Communautaire de l'Hygiène et de l'Eau Potable (POCHEP), but SNEP will operate and maintain them. The Bureau d'Assainissement expects to complete the first phase of the POCHEP project by September 1985.

- UNICEF has cooperated with SNEP in the installation of 100 hand pumps (INDIA Mark II), to serve 40,000 people throughout the country and 15 gravity systems for 17,000 people in the Northwest.

Water Supply Trends and Prospects

In recent years the country has made some progress towards meeting the water supply needs of the population. On the average, the number of people having access to a community system increases by 70,000 every year. However, the rate of progress is reduced by population growth. Thus, in the past 7 years the number of people served has increased from 700,000 to 1,200,000, but the percentage served has only increased from 15 to 23. (Figure VIII-2). If this trend were to continue, it would take more than 60 years for supply to catch up with needs. What are the prospects for improvement?

PLAN's CONADEPA (GOH, 1984) has prepared a water supply plan with the following objectives for 1990 the end of the International Water and Sanitation Decade:

- Supply the entire population of the metropolitan area; 30 percent through private connections and 70 percent through public standpipes (total population 1,200,000 in 1991).

- Supply the remainder of the urban population through private connections and public standpipes in proportions varying from 25/75 to 5/95, depending on the size of the communities (total population: 900,000 in 1991).

- Supply all the concentrated rural communities through standpipes (total population: 1,000,000 in 1991).

- For scattered rural communities, provide sanitary surveillance services to improve the quality of existing individual drinking water sources. A few simple facilities would be built, e.g. cisterns for collecting rainwater (total population: 2,500,000 in 1991).

Thus, PLAN envisions that by the end of the water and sanitation decade, community systems will serve 55 percent of the population and the Ministry of Health will improve the quality of the drinking water for the remainder. This is a very ambitious plan that requires investments of $90,000,000 on the part of the government (including external assistance) and $50,000,000 from the communities.

Some projects under design or construction are likely to be completed by 1991. They include:

- Installation of 400 additional hand pumps (INDIA Mark II) to serve 100,000 people in the plains of Cul-de-Sac, Léogane, Artibonite, Nord and Cayes, and financed by the CIDA, Rotary International and the GOH. Included in the project is the purchase of a drilling machine that SNEP can use to supply additional communities.

- Water supply systems for 12 towns in the Plateau Central: Pignon, La Victoire, Ranquitte, Maissade, Savanne Haleine, Mombin Crochu, Cerca-La-Source, Colladère, Saltadèe, Thomonde, La Belonne, and Malte Peralte (Los Palis is already in operation). Financed by UN, the population served in 1991 will be 16,000.

- ODN, with a loan from the IBRD, will construct wells and gravity systems to serve 125,000 people in the North and Northeast.

- CARE, with USAID financing and SNEP's participation, will build or rehabilitate 40 gravity systems and solar energy installations to serve 160,000 people in the southern peninsula.

- UNICEF, with the financial participation of the Government and the beneficiaries, will construct or rehabilitate gravity systems to supply 72,000 people in several communities of the northwest, west, and Grand-Anse.

- The Government and Protos (Belgian NGO) will finance and construct a potable water system for 11,000 people at Hinche.

- With a grant from the GTZ the GKW enginering firm has prepared feasibility studies and preliminary design of water supply systems to serve 7 secondary cities: Pase-Reine (near Gonaives), Desdunes, Desca-

heaux, Dessalines, Petite-Rivière de l'Artibonite, Ville Bonheur, Arcahaie, and Cabaret. Total population in 1991 is estimated at 78,000.

Several non-governmental organizations are active in the water supply sector. In addition, the Ministry of Plan will soon seek financing for a second phase of the POCHEP project; its preliminary design has already been completed under a grant of IDB, which, reportedly, is willing to finance part of it (estimated cost: $21,000,000). These two sources will supply approximately 300,000 persons.

It may be assumed that the existing systems outside the metropolitan area have enough capacity to accomodate at least half their natural growth or will expand accordingly. With the existing capacity and control to reduce losses and curb illegal connections, Port-au-Prince can easily increase the number of its customers by 20 percent, which is by far insufficient to meet additional demand. In all, the existing systems can serve 230,000 more people in 1991.

Thus, by 1991, it is reasonable to expect a total of 2,300,000 people (41 percent of the population) to have access to a community water supply. That is an increase of 1,100,000 or 92 percent in the next six years. Although less optimistic than PLAN's plan, this estimate shows an improvement over the progress made between 1978 and 1985. If this trend continues, before the year 2006, about 80 percent of the population will have access to a community system. Then supply will catch up with a targeted demand, defined as the entire urban population plus 50 percent of the rural population (it is not reasonable to serve the scattered rural areas through community systems). Beyond 1990-91, the water supply situation is less clear. It may be noted, however, that SNEP has on file, feasibility studies and preliminary plans for more than 100 water supply systems and only financing is needed for their implementation. For CAMEP there is a water supply master plan, just prepared with assistance from Fonds d'Aide et de Coopération, France (FAC).

The fundamental objective of the CAMEP master plan is to provide, by 1995, the entire metropolitan area with chemically as well as bacteriologically safe potable water, in sufficient quantity and at a reasonable access distance. The water will be treated as necessary (removal of carbon dioxide and disinfection). In the long run (beyond year 2000), CAMEP must consider the use of surface waters (Rivers: Froide, Momance, Grise) to meet its demand (CAMEP 1984).

SNEP is preparing a survey of water supply needs within its jurisdiction. The study starts with an accurate inventory of existing systems. It will enable the agency to determine a priority list.

Another notable activity at SNEP is the program of institutional reinforcement conducted with the assistance of the German government. It aims at increasing SNEP's planning and management capabilities.

In its national program, PLAN mentions some other worthwhile projects:

- A pilot project to supply water through public standpipes to 150,000 people in the low income, northwest sections of Port-au-Prince. The Office National du Logement (ONL), a national housing agency, is already involved in rehabilitating housing for 3000 families in part of this area (at Drouillard, Linthau I and Linthau II). Stormwater removal will also be provided under the second phase of the metropolitan drainage plan. Financing has not yet been secured.
- A national rural water supply master plan to be prepared by SNEP with support and participation from the Ministry of Health and active NGO's.
- A pilot project to provide water supply and sanitation installations to 50,000 people in a rural area to be selected. The project would be implemented by SNEP in close coordination with the current primary health care program.
- A promotion program to encourage potential CAMEP customers to obtain private connections to the network. The program will be implemented by CAMEP in collaboration with ONL and the Ministry of Health.
- Improvement of the Kenscoff system to serve additional SNEP and CAMEP customers.
- An inventory of existing water supply systems and a determination of needs of rural and urban populations, to be carried out by the Ministry of Agriculture.
- A campaign to encourage the population to participate in the water supply and sanitation programs.
- An information and training program for low cost water supply and sanitation options to be financed by Canadian International Development Agency, UNDP and others.
- An organization of Conseil National de l'Eau (CONADE), a national water authority to coordinate the plan and manage water resources for the entire country, including water supply and sanitation activities. This is an importation project that was scheduled to begin in October 1982, but has made little progress.

The water supply sector faces some serious difficulties. The most serious problem is deficient cashflows. Both SNEP and CAMEP are heavily subsidized because revenues are not sufficient to meet operating and maintenance expenses as well as expansion needs. For example, for the years 1981 through 1983, SNEP has shown an average deficit of $520,000 per year (more than 50 percent of its budget). This does not include capital amortization for the systems that were donated. Means to increase SNEP's revenues, for example, by financial participation of the beneficiaries, should be pursued in addition to external assistance. Governmental subsidies have gradually decreased by 18 percent between 1981 and 1983. CAMEP has a similar problem, but it could be solved more easily as CAMEP's customers can generally afford to pay for water service. For example, water vendors in the Port-au-

Prince area, some of whom use CAMEP's water, could control water losses, curb illegal connections and collect fees from all users. Another area that can be improved for both agencies is the control of the quality of the water delivered. In the rural and semi-urban areas, however, it is recognized that water supply availability is more urgent than water quality as sanitary education has not advanced far enough to guarantee that contamination does not occur between source and point of consumption. The mere supply of drinking water is a health improvement.

- The establishment of a national code of drinking water standards and the preparation of treatment guidelines. The CEP team suggests that the recent WHO drinking water standards be adopted with modifications, as necessary, to take into account rural and urban socio-economic conditions and financial means. For example, these standards can very well apply to CAMEP, but is is not practical to require the same level of quality in rural systems that supply fewer people, do not bring revenues and whose water is likely to suffer some secondary contamination before consumption.

- The upgrading and motivation of personnel resources at the intermediate and lower levels through training and incentives. However, at the management and supervisory levels of both CAMEP and SNEP, although much dedication and pride was detected there may be at times a sense of frustration caused by the limited means to be applied to overwhelming task.

D. SANITATION

Whereas water supply has received a great deal of attention from governmental agencies, as well as bilateral and multilateral organizations, environmental sanitation is almost completely neglected. The lack of funds mainly hampers rapid progress in the field of drinking water supply, but its complementary field is treated as a poor cousin. There are frequent complaints about the inadequacy of the water systems, but a real perception of the need for environmental sanitation measures is lacking. Haitian leadership appears to be not willing to pay for such measures, until environmental pollution becomes a nuisance that affects them directly.

Adequate legislation to deal with urban sanitation problems is lacking. For example, the only article in the hygiene code regulating the disposal of human waste merely states (paragraph 20): "all houses and commercial or business establishment must have latrines or septic tanks that must satisfy the requirements of the sanitary officer as to their location and all other aspects... It is prohibited to spill fecal matter or urine on the ground."

The extent of pollution problems in rural and urban areas is not well known, but there is a consensus among workers in the public health field that environmental conditions are poor, except in a very few rich communities. Many streets of Port-au-Prince, which receive more attention than the remainder of the country, are filthy. In some areas, they are covered with litter and mud. In the crowded low-income areas of the city, water is scarce and sanitation poor, wastes are disposed close to living quarters thus creating a dangerous situation.

Responsibility for ensuring healthy environmental conditions revolves mainly around the Ministry of Public Health and Population with three notable exceptions. Its Division of Public Hygiene is in charge of human waste disposal and many other activities. Its Sanitation Office is involved in water supply and latrine construction (POCHEP). Municipal administrations handle solid waste disposal at Port-au-Prince and most provincial cities, while stormwater drainage and street cleaning are the responsibility of the TPTC. There is a Division of Land Development and Environmental Protection at the Ministry of Plan, but it is not active in pollution control. The same is true for an environmental protection service within MARNDR. Human waste and solid waste disposal, drainage, environmental pollution, some cases of industrial waste management and sanitary education are briefly discussed in the following paragraphs.

Human waste and the Division of Public Hygiene

This branch of the Ministry of Health has a sanitation subdivision that includes four sections:

- House inspections, refuse disposal and control of drinking water quality through laboratory tests for chlorine residual.
- Food and beverage quality control, from production to consumption (markets, bars, restaurants, hotels, etc.)
- Vector Control
- Human waste disposal (construction of latrines and disposal of wastes from latrines and septic tanks).

The Division has about 150 employees, including a sanitary engineer, 2 sanitary inspectors and 13 sanitary officers. Some members are old or handicapped. The Division's budget amounts to $784,000 provided mostly by the Ministry of Health (80 percent). Revenues from human waste disposal charges represent less than 3 percent of the budget. USAID contributes 13 percent through the rural health project. The division operates through four regional offices, divided into districts. The metropolitan district includes eight subdistricts.

The vast majority of the Haitian population do not have an adequate means of human waste disposal. According to the results of a 1971 census, (Parisien, 1979, from a publication of the Institute of Statistics), less than one percent of the population had a flush toilet and, presumably, a septic tank, and 19 percent used latrines; the remaining 80 percent used open fields, sometimes adjacent to the housing units. According to UNICEF (1984) the proportion of the population using latrines or septic tanks would now be around 40 percent, most of them in the urban areas. In 1984, WHO estimated that at the end of 1983, 41 percent

of the urban population and 12 percent of the rural population would thus have access to an acceptable means of waste disposal. PLAN (GOH 1984e) estimated the overall proportion at 33 percent.

Generally speaking, the design and construction of the latrines and septic tanks are inadequate because there are no relevant regulations. Their operation and maintenance are also deficient and most of them are overloaded, requiring frequent emptying. One common deficiency is the lack of ventilation, causing odors in houses with septic tanks and both odors and flies in latrines. No authority reviews the design of septic tanks nor inspects their construction.

In 1984, the Division of Public Hygiene emptied 100 septic tanks and 230 latrines in Port-au-Prince. According to the Division's director, this represents only 10 to 20 percent of the needed disposal. The Division has only two trucks for this service. For lack of an adequate final disposal site, the waste thus removed from the latrines and septic tanks is dumped untreated onto a private field. Some time ago, the Division managed to obtain a disposal site at the foot of Morne à Cabris (9 ha. of government land). With the asisstance of the Ministries of Health and Public Works, the site was transformed to operate as a landfill that could serve indefinitely since the wastes would be removed after decomposition and reused as fertilizer. However, for unexplained reasons, the palace guard condemned the site before it could start functioning (as an emergency measure, they allowed the discharge of one truck load). Another site, found at Truitier near the refuse disposal landfill (10 km from the city), is awaiting preparation. It is not easily accessible when it rains.

The remaining 80-90 percent of the septage and sullage is collected by honey dippers at night, transported in precarious and unsanitary conditions through city streets, and dumped at sea, in the storm sewers or sometimes anywhere.

There is no municipal sewage collection and disposal system in Haiti, but in Port-au-Prince, Engineering Science Inc. (1972) studied the wastewater disposal problem for the city. It recommended a separate wastewater collection system for a portion of the city and improvement of the septic tanks elsewhere. An advanced primary treatment would be provided at two plants (including the removal of grease, oil and flottable matter) before discharge of the effluents into the ocean at Lamentin to the west and Cité Soleil to the north. The project has not been implemented because of its high cost.

There are illegal connections of effluent pipes to the drainage system although the extent of this problem is not known. It is suspected that such connections are practiced by industrial and commercial entities, individuals and even government institutions. For example, it is reported that the effluent of the septic tank of the INLR is pumped directly into the Bois de Chêne, an important canal draining a good portion of Port-au-Prince. In general, disposal of septic tank effluents is a problem as few tanks are followed by an adequate absorption field. Two other known instances of sewage disposal into the drainage system are at a market, Marché Vallières, and a school, Ecole République du Vénézuéla (personal communication, Division of Public Hygiene, 1985). Illegal connections are common in the lower zone of Port-au-Prince because of its intense development and a high water table that makes wastewater disposal difficult. Sometimes, kitchen and laundry wastewaters find their way into storm sewers, as well as through street collectors.

The provincial cities face similar, but less severe problems because of their lower population densities. A recent survey (GKW, 1984) found the following conditions in the 10 cities that had water supply systems installed in 1983 (St. Marc, Gonaïves, Jacmel, Cap-Haitien, Les Cayes, Port-de-Paix, Jérémie, Aquin, Léogâne, Miragoâne): There are very few flush toilets; the tanks into which they discharge are not adequate. More than 40 percent of the the population does not have a means of human waste disposal other than uncontrolled defecation. Most of the others use latrines, more than half of which need improvement. When the pit is filled, it is covered with earth and another is dug. Wastewater is disposed in the yard by infiltration or discharge into the drainage system.

In the rural areas, there are very few latrines. The rural population disposes of excreta on the beaches, in fields, drainage ditches, dumps, and vacant lots.

D.- SOLID WASTE DISPOSAL

Solid waste disposal is the responsibility of the "Mairie" in metropolitan Port-au-Prince. The mayor is Director General of the SMCRS, or Service Métropolitain de Collecte des Résidus Solides (Métropolitan Solid Waste Disposal Authority) and a sanitary engineer serves as its technical director and deputy director general. In the provincial towns, the sanitary district (Division of Public Hygiene) or the Mairie, or both, provide the refuse collection service.

Until recently, refuse disposal was chaotic in Port-au-Prince. Unsanitary conditions existed because the population in residential and business areas discarded its refuse literally everywhere: steets, storm sewers, drainage ditches, sea and water courses. In some areas, the population openly burned part of its refuse to dispose of it or reduce its volume. In addition to the obvious public health hazards, these practices led to the obstruction of the drainage facilities to the point that the solid waste disposal problem had to be solved before the drainage network could be improved and extended.

In 1980, SCET International/Beture conducted a solid waste disposal study. As a result, a program is being implemented, although with some delay. According to the technical director of the SMCRS, 70 percent of the recommendations have already been realized: the managing structure is already in place; 30 new

trucks are working and the remaining 35 trucks have been ordered; the administration building is completed, but not yet occupied; and the public promotion campaign is under way. The proportion should reach 100 percent by July 1985. The SMCRS now collects 300 tons of refuse per day out of an estimated production of 519 tons per day including:

- 380 tons from 950,000 persons in Port-au-Prince, Pétionville, Delmas and Carrefour at 0.4 kg per person per day (SCET's population estimate);
- 50 tons from commercial and industrial subscribers;
- 75 tons from the public markets; and
- 14 tons from parks, hotels, schools, etc.

SMCRS collects the refuse three times a week in front of the houses in certain areas, and daily from 600 liter garbage cans or spot dumps in the less affluent areas. These dumps will be eliminated when the program is in full operation. The refuse thus collected is disposed in a sanitary landfill at Truitier a few kilometers from the city. With its 200 ha this site can last at least 20 years. A sensible improvement in the solid waste situation has been noted as a result of this incomplete program, except the lower areas of the city where the storm sewers still bring debris following rainstorms.

Concerning solid waste disposal, a municipal refuse composting plant operated for a few years near Port-au-Prince, beginning in March 1980 (Farr, 1981). A pilot project demonstrated the feasibility of co-composting municipal refuse and latrine wastes (D.J. Dalmat, J.F. Farr et al., 1983). At a construction cost of $7,000,000, the facility uses the PRATT process, a European design. It has a design capacity of 1000 tons/24 hours. In 1983, it was processing only 30-100 tons per day. The status of this facility is not known nor are the real reasons for its closure. Besides the apparent difficulty in receiving the raw refuse, the facility produced compost that was too expensive for the farmers ($11 per ton) and not easily accessible to potential customers. There has been a proposal to relocate the plant at Truiter near the sanitary landfill and the proposed site for disposal of latrine wastes by the Division of Public Hygiene. It would then be convenient to the tracks of HASCO, (sugar plantations) a potential large customer. This would also allow a more efficient operation by reducing the number of employees and transportation costs.

F.- STORMWATER DRAINAGE

For years, stormwater drainage of Port-au-Prince was totally indadequate resulting in a considerable loss of lives and damage to buildings and personal property. The problem was aggravated by natural features (e.g. steep slopes), uncontrolled development, removal of tree cover and an inadequate refuse collection service that encouraged disposal in the storm sewers and drainage ways. With assistance from the IDB and the Organization of Petroleum Exporting Countries (OPEC), Haiti is implementing the first phase of a drainage project for metropolitan Port-au-Prince at a cost of $45,000,000. There are three subprojects:

- Reforestration of Morne l'Hôpital to slow down runoff, reduce erosion and sediment loads to the sewers. This subproject is completed: 400,000 trees were planted, but they represent only 20 percent of the area's reforestation needs. Platforms and retaining dry stone walls were also built.
- Collection of solid wastes, as discussed above.
- Repair and realignment of existing channels; construction of additional collectors. The Bois de Chêne canal has already been enlarged and secondary collectors have been cleaned. The construction of new collectors is 90-95 percent complete. Results observed to date are encouraging.

All the principal provincial towns have stormwater systems consisting of underground pipes, concrete canals and street draining ditches, all of which receive also refuse and wastewaters, to a certain extent. Their maintenance is inadequate. Two of the cities, Gonaives and Les Cayes are flat, low-lying and subject to frequent flooding; their drainage would justify a special study.

G.- POLLUTION

There are many cases of environmental pollution in Haiti, but there exists little documentation of them. Some were mentioned in the preceding discussions of water supply, drainage and waste disposal.

There are point and non-point sources of air and water pollution, still undocumented. Most of the known cases are in Port-au-Prince and its vicinity.

Air pollution has not reached any great proportion, but on a clear day, from the hills surrounding Port-au-Prince, one can observe the smoke or dust from at least 12 chimneys shifting with the wind. The most serious discharges are those of the sugar factory, HASCO, and the cement plant (Ciment d'Haiti). The black smoke emanating from HASCO is the result of burning cane residue to produce steam. The combustion is incomplete and escaping particles eventually fall on residential areas such as Delmas. Homeowners have complained about this nuisance and the government has asked the plant to do something about it, but to no avail. HASCO's position is that the particles are not toxic and that the solution to the problem would require prohibitive investments. It has been suggested (Parisien, 1979) that one way to reduce this impact is to concentrate combustion in the morning, when the prevailing winds are more seaward. The cement plant emits dust that affects mostly the nearby residences of some 20 employees and to a lesser extent the community of Source Matelas. The metropolitan area is too far (30 km) to be affected.

Another source of air pollution in Port-au-Prince is vehicular traffic. The situation is worse during morning

and evening rush hours, when commuters converge towards the main business district from three directions or hurry to return home. Pétionville traffic is then chaotic and very slow along Delmas road and Avenue John Brown. The intersection of Delmas, Martin Luther King and Hailé Sélassié is a permanent bottleneck. Some sections of the road to Carrefour are always heavily congested, a situation that is aggravated by a large number of slow moving trucks with diesel engines.

Vehicle inspection is not thorough. Air pollution is heavy along the congested arteries, due to emissions of carbon monoxide and hydrocarbons. Until traffic congestion can be relieved, mitigating measures could be adopted. Emissions tests in vehicle inspection, the restriction of traffic, particularly of slow moving trucks, at certain times on some roads could be considered. Regulating «tap-tap camionettes» which create a great deal of the chaos along the road to Carrefour, might be considered (e.g. institution specific «tap-tap» stops for picking up or discharging passengers).

Dust and odor constitute other common forms of air pollution. In sections of Port-au-Prince and other cities, the streets are not paved and where traffic is relatively heavy, dust is a nuisance. Bad odors emanate from some open markets and garbage dumps.

Problems similar to those of HASCO may occur at other sugar plants (Darbone near Léogane, Cayes and Cap-Haitien) and at numerous guildives throughout the country producing "clairin" out of sugar cane.

Water pollution occurs in three forms. Surface waters are polluted by sediments resulting from erosion and by all debris or refuse. Runoff from both urban and rural areas brings to the receiving water courses oils, grease and fecal matter. Surface Water is not used now to any extent for drinking water, but it may become the long term source of potable water to supply metropolitan Port-au-Prince. One potential source for the area, Rivière Grise, may be subject to incidents of pollution at Damien by HAMPCO, Rhum Barbancourt, and small guildives. The main cause of pollution of groundwater is faulty and overloaded latrines. Inadequate septic tank-soil absorption systems also pollute the groundwater. Although it is not documented, pollution of ground water must be severe in densely populated areas of Port-au-Prince where latrine pits are very deep. Some areas also have a high water table. Groundwater pollution is more dangerous where the population uses drinking water from wells, sometimes located too close to latrines.

The third form of water pollution affects the sea, which receives a huge volume of waste produced by land activities. In some cases, the wastes are discharged directly by industries, and individuals. In other cases they are brought to the sea by rivers, drainage ditches, or the wind. In the Port-au-Prince area, several small and relatively large commercial or industrial enterprises along the coast discharge their liquid and solid wastes linto the sea: slaughterhouses, meat and fish vendors, HASCO, Ciment d'Haiti. Pollution of Port-au-Prince bay should be studied carefully: Contaminants tend to get trapped in the inner parts of the bay due to the direction of the currents circulating around the island of La Gonave.

Industrial pollution does not seem to cause concern in government circles. Perhaps it is a lack of awareness or it may be to save worker's jobs that prevent action from being taken. Industrial managers do not seem to be concerned either. The following summarizes information from major industries in Haiti:

HASCO produced sugar from cane cultivated in is own fields or bought from others. The company uses septic tanks to treat the wastewater from its toilets and discharges the processed wastewater into the sea. The company uses its sludge as fertilizer to supplement compost it buys from the Dominican Republic. The solid residue of the sugar cane, called bagasse, is burned to supplement fuel oil. Ashes are used in road beds or disposed of on fields.

ACIERIE D'HAITI produces all the steel used in construction and other activities in Haiti. Annual production is 18,000 tons, only 25 percent of planned capacity. The company uses water from CAMEP and rain water. It has a septic tank for toilet wastewater. It recycles its cooling water after sedimentation and disposes of the sludge at the Truitier sanitary landfill.

HAMPCO (Haitian American Meat and Produce Co.) processes meat and uses water from wells. Effluents from the slaughter house are chlorinated before discharge. A septic tank receives toilet wastewater. Manure is transported by wagon to sugar cane fields.

RHUM BARBANCOURT uses well water, and recycles the boiler water. Oil is recovered from the processed waste and reused. The effluent is mixed with cooling water and used for irrigation. Part of the bagasse is used as fuel. The remainder is disposed in the fields or donated to local farmers to use as poultry litter. The company is considering the feasibility of using the bagasse to make briquettes that can be burned as domestic fuel instead of wood.

ENAOL extracts vegetable oils from soybeans imported from the United States and Argentina. The oil produced is used locally. The residue serves as animal feed. There is little waste oil or solid waste. Processed wastewater is disposed through canals and most of it is absorbed in the soils before it reaches the beach. The operation is practically dust free. Water supply comes from Bon Repos (12 km). Cooling water is recirculated.

MINOTERIE D'HAITI produces wheat flour for consumption in Haiti. There is no process wastewater. Cooling water is recycled. It is a dust free operation because of the use of filters.

CIMENT D'HAITI uses sea water and fresh water from wells and a spring. It generates no process was-

tewater and little solid waste, but produces a great deal of dust.

Note: ENAOL and Minoterie d'Haiti are located at 26km; Ciment d'Haiti 31 km along the road to the North. Impact upon a beach (Ibo Beach) and the village of Source Matelas is unknown.

H.- CONCLUSIONS AND RECOMMENDATIONS: PLAN AND IMPLEMENT A SYSTEM OF SANITATION SERVICES

From 1971 to 1985 the proportion of the population disposing of its human waste into latrines and septic tanks has increased from 20 to 35 percent. At this rate of progress it would take more than 60 years to assure sanitary disposal of the human waste for the entire population. PLAN has proposed that all the inhabitants dispose of their wastes in family latrines by 1990, except 25,000 people in downtown Port-au-Prince who will have access to a sewerage system and a few others who can afford septic tanks. To achieve this goal, PLAN envisioned a sanitation project that was to start in 1983 under the supervision of the Bureau d'Assainissement. The project was to construct 450,000 latrines in urban and rural areas. It is doubtful that the goal of 100 percent service will be reached in 1990.

The trend in the collection and disposal of septage and sullage is more alarming. Service has decreased over the past 40 years. In 1947, at the peak of its performance in that regard, the Division of Public Hygiene had a total of five trucks for collection of septage and sullage. Now it has only two. Thus capacity has decreased by 60 percent while the population of the metropolitan area has increased fivefold.

Drainage and solid waste disposal are expected to improve considerably in Port-au-Prince and the other cities as a result of current or proposed sanitation projects. Other population problems will worsen if nothing is done.

IX.

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X.

Appendices

APPENDIX A

CROP SUITABILITY ZONING

A computer analysis was made of the MAI values for Haiti.

The number of consecutive months with MAI values exceeding 0.33 and the average MAI for those consecutive months were calculated. These calculations were used to zone Haiti into six climatic divisions.

The following zones are shown on a map presented as Figure: A-1

ZONE 1

This zone is generally not suitable for the production of cultivated crops without irrigation. Locations having all months with MAI less than 0.33, those with only one month with MAI greater than 0.33 and bi-modal climates with one month with MAI exceeding 0.33 then several dry months and then another month with MAI greater than 0.33 are including. The MAI values for the rainy month are usually low.

ZONE 2

The areas of lower rainfall are generally characterized by bi-modal precipitation. The two rainy periods are usually separated by two or more dry months (usually June and July). Zone 2 generally has two rainy months followed some months later by two or more rainy months with MAI values exceeding 0.33. Climates with two rainy months and then later one month of usable rainfall or one month followed later by two months are also included. For the periods of two rainy months the average MAI value found is 0.51 with a standard deviation of 0.10 (68 percent of the MAI values are between 0.41 and 0.61).

Average potential evapotranspiration for the two months is about 320 mm. Rainfall is dependably available to supply somewhat more than half this amount. Crops requiring 60 days or less for production can be produced. Application of fertilizers should not exceed about 50 percent of normal amounts. Some millets and mungbeans mature in 60 days or less.

Rainfall is useful for plant growth only when it enters the crop root zone and becomes available to the plant. Some measures may be necessary in order to conserve rainfall.

ZONE 3

The precipitation in this zone is also bi-modal. The minimum growing season consists of three rainy months and in some areas there may be both a three month and a four month rainy season. The average MAI for these three and four month periods is 0.63 with a standard deviation of 0.17.

Some varieties of beans, groundnut, millet, sorghum, soybeans and vegetables can be produced. Yields under rainfed agriculture will be low. Application of somewhat more than half or normal rates of fertilization may be considered.

Experience with the black soils at ICRISAT (International Crop Research Institue for the Semi-Arid Tropics) in India under similar conditions of rainfall amounts and climate has indicated the advantages of broad (1.5 m width) beds and furrows on flat (about 0.5 percent) slopes. On the heavier soils this system improves surface drainage and also slows runoff increasing the opportunity time for water to penetrate into the soil. Increases in gross crop value have usually been threefold.

ZONE 4

The rainy season (number of consecutive months of precipitation such that MAI values exceed 0.33) in this zone varies from five to six months. The average MAI is 0.70 with a standard deviation of 0.12. Rainfall is usually dependable enough that with the application of somewhat over 100 kg of nitrogen good yields of maize (corn) can be produced on the better soils under good management. If conditions are favorable, yields of six to eight tons per hectare should be possible. Good drainage is a requisite. Some double cropping is possible.

ZONE 5

This zone has a rainy season of seven to nine months. The average MAI IS 0.86 with a standard deviation of 0.15. With good water conservation, adequate drainage management the climate is suitable for production of high yields of a large number of crops.

Large areas are mapped as zone 5E. These locations have two or more months of excessive rainfall. Good natural or artificial drainage is required for most general crops. Rainfed rice production is recommended on the areas of favorable soils and topography. Grapefruit and sugarcane can be considered for rainfed production on suitable soils and topography. Coffee produces well at suitable elevations.

ZONE 6

The rainy season extends to from ten to twelve months. Most of this zone is mountainous. On suitable soils and topography rice, bananas, plaintain, grapefruit, pineapple and sugarcane can be considered. The average MAI is 0.92 with a standard deviation of 0.10. Significant areas have two or more months of excessive precipitation. These locations are shown as zone 6E.

Rainfall is generally sufficient so that normal applications of fertilizers should be considered provided other management practices are satisfactory.

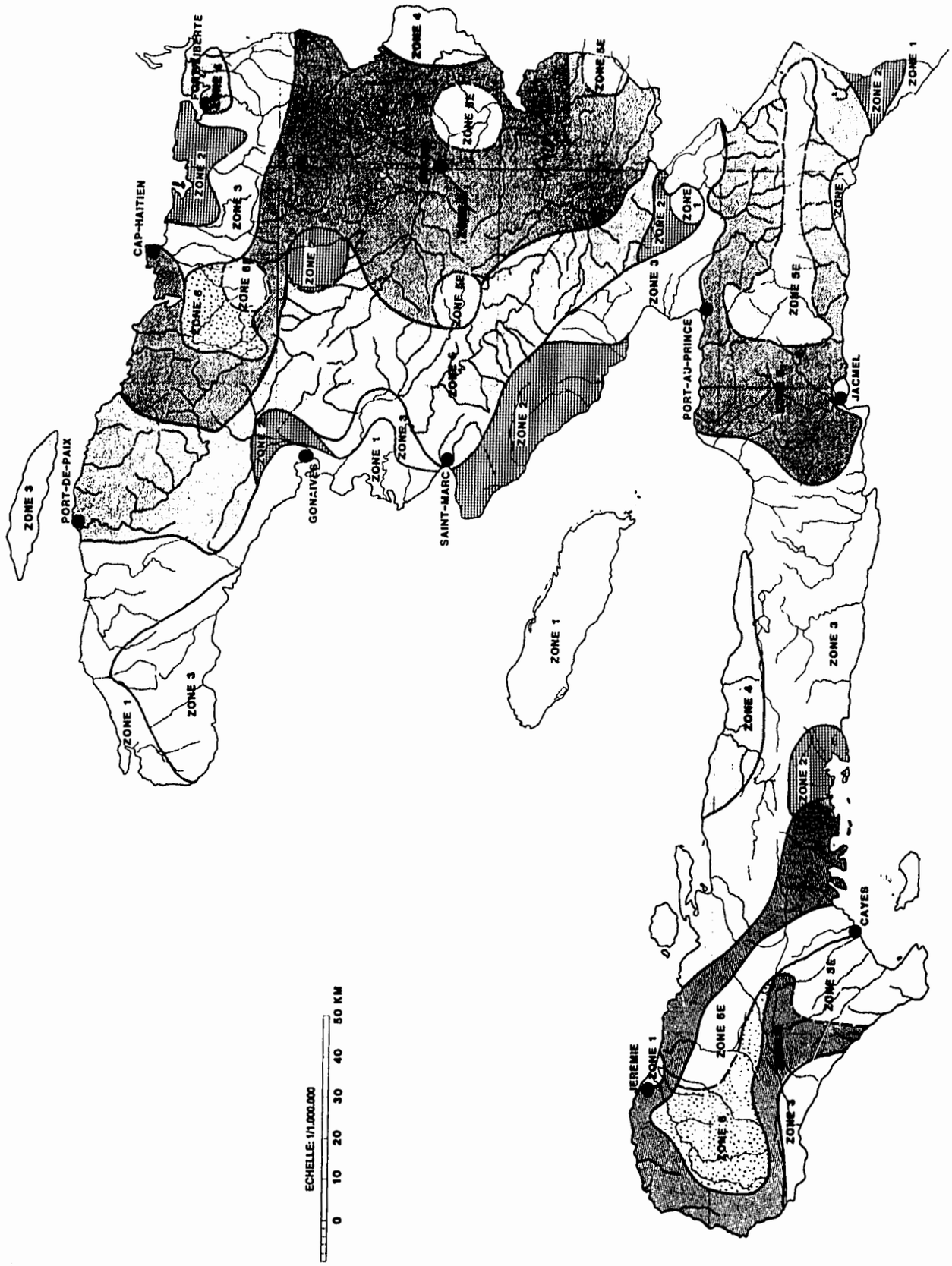

Figure A-1: Crop Suitability Zones

In averaging the MAI values for this zone (and also the other zones) MAI Indices exceeding 1.00 were averaged in as being equal to 1.00. This was to prevent assigning a bias due to unusual rainfall amounts.

LIMITATIONS

The map, provides a good representation of how conditions vary. The boundaries between areas of the various zones are not accurate. Several areas are separated based upon an analysis of data from a single rainfall station. The measured data may or may not be typical of the area. No allowance could be made for possible inaccuracies of the measuring, recording or reporting of rainfall.

In drawing the boundaries between zones some use was made of topographic conditions and of five years of experience working with irrigation and agriculture in general in Haiti. As more data become available and more experience with agriculture can be utilized it will be desirable that this zonation be improved and updated.

The monthly MAI values shown in chapter IV indicate approximate planting dates. These will vary somewhat from year to year and for the crop selected. In general, if the rainy reason is well defined, a month at the beginning of the rainy season with MAI at 0.30 to 0.50 will indicate a desirable planting date of about the middle of the month.

TAKEN FROM

G.H. Hargreaves and Z.A. Samani (1983) Rainfed Agriculture in Haiti (A Practical Manual). International Irrigation Center, Department of Agricultural and Irrigation Engineering, Utah State University, Logan, Utah, pp. 21-25.

APPENDIX B

ENVIRONMENTAL LEGISLATION FOR HAITI

The laws, decrees, presidential executive orders, regulations and circulars collected for this CEP are listed in Index I of this Appendix. The list consists of over 100 entries, gathered from the following sources:

- FAO/UNDP, 1974	40 Items
- Supplements from Raymond Laurin	5
- Supplements from Jaro Mayda	45
- Miscellaneous items from ministries	12
- Library of Congress, 1979	1
- A list of unknown origin	1

The list is indexed (refer to Index 1) by principal sectors and systems. Any items passed the Haitian legislature or other GOH groups after January 1, 1985 are not included.

INDEX I
INDEX OF ENVIRONMENTAL LEGISLATION BY SECTOR AND YEAR OF ENACTMENT

(Some items are entered under more than one heading. A number in parentheses following the year indicates how many items have been indexed for that year).

Agriculture	1826, 1864, 1935, 1936, 1941, 1945, 1950, 1951, 1952, 1950(2), 1959, 1960, 1962, 1975.
Education/Training	1973(2), 1975, 1978(2), 1979(2).
Fisheries	1959, 1962, 1971, 1978, 1979, (see "resources protection").
Forestry	a) Protection against exploitation Limits of timber cutting for export: 1933, 1936, 1937, 1944(2), 1945(2), 1955, 1958, 1962, 1981, 1983. b) Reforestration: promotion, financing 1938, 1944, 1966, 1972(2), 1974, 1979(2) 1981 ("Water/Supply"). c) Reserved areas, national parks: 1926(2), 1936, 1937, 1944, 1947, 1968, 1980(2), 1981, 1983.
Hunting	See "Wildlife".
Industries	a) Rural: 1962(3) (includes commercial charcoal regulations). b) Manufacture: 1974, 1976, 1979 ("wastes").
Irrigation	See "Agriculture".
Land Use	1927, 1962, 1964, 1972, 1975(2).
Mineral/Energy Resources	1950, 1963, 1964, 1971, 1973, 1974, 1977 1984.
Noise	1984. (Quarries).
Parks	See "Forestry (c)".
Planning/Regional development	1960, 1963, 1965, 1971(2), 1974, 1975, 1976, 1978.
Public Health/Populations:	1919, 1937, 1945, 1954, 1978. See also "Water quality, wastes".
Marine/Coastal resources/ Protection	1972, 1975, 1977, 1979.
Soil Management	1958, 1962, 1963, 1977. See also: "Water Supply, Watershed management".
Urban planning/ Housing Regulations	(environmental aspects): 1937.
Water Quality	1919, 1945, 1978.
Water Supply	(including "Watershed management"): 1937(2), 1943, 1951, 1959, 1962, 1963, 1964, 1974, 1977, 1978, 1979 (2), 1980.
Wildlife	1941, 1962, 1971.

INDEX II
LIST OF ENVIRONMENTAL LEGISLATION

CR	= Rural Code
L	= Law
D	= Decree
DL	= Decree-Law
CO	= Communiqué
PD	= Presidential Decree

1826	-CR-	Rural Code-Haiti, May 6, 1826 (Extracts)
1864	-CR-	Rural Code-Haiti, 1864 (extracts)
1919	-L-	Law of Feb 24, 1919: creates service Nat'l d'Hygiene (implemented by Reglement Sanitaire, April 12, 1919).
1926	-L-	Law of Feb. 3, 1926 on National Forest Reserves.
	A-	Min. Decree of Apr. 30, 1926 on the St-Raphael National Forest.
1927	-L-	Law of July 26, 1927: public lands divided into public and private domain.
1935	-L-	Law of Sept. 30, 1935 reorganizing the National Service for Agricultural Production and Rural Education.
1936	-L-	Law of 8, 1936 establishing the Cerisier Plaisance - Reserved Zone

	L-	Law of May 28 prescribing measures to stop deforestation
	L-	Law of June 4 giving special guarantees to whoever cultivates soil methodically.
1937	-DL-	Decree-Law of Jun. 23, 1937 on forest regulation
	DL-	Decree-Law of Jul. 27. 27, 1937 on Urbanisme Arts. 37-45: Disposal of liquid wates drainage Arts. 69-72: Industrial or commercial establishments: regulation of those which endanger or inconvenience residential areas or create problems of public health, or have an impact on on agricultural activities. Art. 73: Penalties G100-600 (1937 value).
	D-	Min. Decree of Aug. 13, 1937 declaring Reserved Zone the region between Fonds Verrettes and Bodarie.
1938	-D-	Min. Decree of May 3, 1978 establishing the Day of the Tree.
1941	-DL-	Decree-Law of Aug. 28, 1941 approving the contract between Haiti and the Société Haitiano-Américaine de Développement Agricole (SHADA).
	DL-	Decree-Law of Nov. 27, 1941 approving Convention on the Protection of the Flora, Fauna and Natural Sceneries of the American Continent, provisional list of plant and animal species requiring protection; related appendices.
1943	-D-	Decree of Mar. 20, 1943 protecting the springs of Thor.
1944	-L-	Law of Mar. 1, 1944 prohibiting the export of logs and boards of mahogany and of all other precious woods non-processed
	D-	Decree of Apr. 4, 1944 declaring "Reserved Zone" all the national territory comprised within the boundaries of the Ile La Gonave and Ile La Tortue.
	DL-	Decree Law of Sept. 29, 1944 coordinating activities relates to reforestation, soil conservation, irrigation, and drainage of the plains and mountains and creating the water and Forests Services
	DL-	Decree Law of Jun. 27, 1947 submitting to previous authorization the elling, debarking and incision of pines, mahogany, oaks, (gaiacs, bayahonde, campeche, cedres, tavernons, etc.)
	CO-	Communiqué of Jul. 4, 1945 providing for a tariff for the felling of trees on state lands and for the inspection fees to conform with the D/L of Jun. 27, 1945.
	L-	Law of Sept. 24, 1945: Art. 2 creates, among other departments, Département de la Santé Publique (implemented by D/Nov. 26, 1945, defining attributes of DSP, and D/Sept. 25, 1947, organizing the Services of DSP.
	DL-	Decree-Law of Dec. 24, 1945 modifying the designation and present organization of the National Service for Agricultural Production and Rural Education without changing its general structure and principles.
1947	-D-	Min. Decree of Mar. 15, 1947 declaring national forest reserves the rural sections comprising the mountains called «Mornes du Cap».
1950	-FD-	Pres. Decree of Mar. 17, 1950: Irrigation works in Plaine Artibonite declared of public utility.
1951	-D-	Min. Decree of Aug. 17, 1951 modifying the boundaries of the Cerisier – Plaisance Reserved Zone.
	L-	Law of Aug. 28, 1951, coordinating the activities of the various «Services» of the Department of Agriculture in order to improve administration and delivery of their services (Art. II defines the attributes and duties of the water and Forest Division).
1952	-L-	Law of Sept. 20, 1952: yearly tax on "rural irrigation lands".
1954	-CH-	Code d'Hyigiène d'Haiti, 1954: excepts from various general codes (civil, penal commercial, etc.), relevant to public health concerns.
1955	-L-	Law of Aug 17, 1955 regulating planting, felling transport and commerce of wood used of limestone furnaces.
1958	-L-	Law of Sept. 1958 protecting soils from erosion, defining the boundaries of "reserved zones" and regulating forest exploitation in Haiti.
	L-	Organic Law of March 14, 1958 (art. 1, 2, 9 and 10).
	D-	Decree of December 23, 1958: creates Experimental stations demonstration farms (Regul. issued in Jan. 1959).
1959	-D-	Min. Decree of March 13, 1959 modifying the boundaries of the reserved Zone of the watershed of the Cerisier – Plaisance springs.
	L-	Law of Nov. 25, 1959: Establ. «Fonds spec. d'irrigation».
	D-	Decree of Sept. 2, 1960: creates ODVA (reorganized by law of May 24, 1971).
1962	-CR-	Rural Code (May 24, 1962): Law VII, Art. 140: Prohibition of dumping of industrial and domestic liquid wastes into streams and irrigation canals.
	CR-	Rural Code: Law XII; Commerce, Transportation and storage of grains and livestock feed.
	CR-	Rural Code: Law VI; Cattle raising
	CR-	Rural Code: Law IX; on hunting and fishing
	CR-	Rural Code: Law VIII; Forests Resources.
1963	-L-	Law of Jul. 1, 1963. CONADEP given autonomous status reporting directly to the President.
	L-	Law of Aug. 27, 1963 declaring "zone under protection" the Morne L'Hôpital watershed.
	L-	Law of Aug. 30, 1963 declaring of "public use" the infrastructure works already in place and those to built in order to restore the Morne l'Hopital watershed.
1964	-D-	Decree of May 13, 1964: establishes CAMEP
	C-	Constitution of 1964, amened 1971: Art. 22: Obligation of owne s to cultivate their land and protect it against erosion.

1965	-D-	Decree of Jan. 18, 1965: (CONADEP abolished; replaced by Commissariat National du Développement et Planification, attached to Department of Finances and Economic Affaires.
1966	-L-	Law of Jul. 5, 1966 declaring the year 1966 the first of a five-year reforestration campaign over the entire national territory.
1968	-D-	Decree of Mar. 18, 1968 defining "National Parks", "Natural Sites" all those forested or non-forested lands within which historic or natural monuments are established.
1971	-D-	Decree of March 31, 1971 organizing the enforcement of hunting regulation, establishing the "Police de la Chasse" (game wardens), conforming to the International Convention ratified by Haiti on the protection of nature and the preservation of wildlife in the western hemisphere
	L.-	Law of Sept. 9, 1971: adopts planning priorities based on Five-year projections: 1971 - 72 (the beginning of 5-year planning).
1972	··D-	Decree of Feb. 23, 1972: creates ODPG (Organization de Développement de la Plaine des Gonaïves) to substitue a previous presidential commission.
	D-	Decree of Mar. 29, 1972 approving the contract between Haiti and the New Haiti North Social and Economic Authority, S.A.
	D-	Decree of Apr. 6, 1972: defining the limits of territorial waters, continuous zone (fishing rights).
	D-	Decree of Nov. 20, 1972 declaring reforestation works acivities of general interest and public utility.
	D-	Decree of Nov. 20, 1972 creating a national land use commission called "Commission Nationale d'Aménagement du Territoire" (CONAT) and the "Comité d'Aménagement Forestiers".
	D-	Decree of Nov. 20, 1972, creating a special reforestation fund called "Fond Spécial de Reboisement" (FSR).
	D-	Decree of Nov. 20, 1972, creating "Forets Communaux".
1973	-D-	Decree of Oct. 19, 1973: creates INAG (Inst. Nat. d'Administration et Gestion).
	FD-	Pres. Decree of Oct. 9, 1973: regulation for INAG.
	D-	Decree of Nov. 20, 1973: Kerosène tax reduced from G. 50 to G. 41/gal.
1974	-D-	Decree of Oct. 10, 1974: declaring property of the state all mineral deposits, deposits of lignite, natural gas, mineral water sources, geothermal sources and other concentrations of natural energies and mineral resources.
	L-	Law of Jul. 18, 1974: defines the status of industrial parks.
	L-	Law of June 12, 1974: declares all groundwater to be in public domain and gives to the Dept. Of Agriculture the control over its exploitation.
	D-	Decree of Feb. 4, 1974: reorganization of CONADEP (Développement et Planification).
	D-	Decree of Sept. 14, and Nov. 4 1974, imposing an additional tax of 10% on land taxes. (50% pour le compte "Fonds de Reboisement et de Protection du Sol - FRPS).
1975	-D-	Decree of Mar. 13, 1975: ratifies Int'l Convention on the prevention of pollution of the seas (of Dec. 29, 1972).
	L-	Law of Aug. 11, 1975: Art. 22 (preceding item) reiterated, extended to all unusued land, in framework of government program of agricultural development. Penalties for non compliance.
	D-	Decree of Mar. 11, 1975: Taxe G.8.50 for each diploma issued by any establishment for professional/vocational training.
	L-	Law of July 28, 1975: Artibonite Valley given a "special status".
1976	-L-	Dec. 11, 1976: creates ODNO (Organization de Développement du Nord'Ouest).
	D-	Decree of Mar. 3, 1976: on exploitation (by the state) of mineral and energy resources.
1977	-D-	Decree of Mar. 17, 1977: exempting kerosene from custom duties.
	D-	Decree of Apr. 8, 1977, extending territorial sea to 12 miles and declaring Exclusive Economic Zone (200) (emancipation of the law of the sea, signed in 1983).
	D-	Decree of Aug. 31, 1977: establishes SNEP.
	D-	Decree of June 16, 1977: establishes CONAELE
1978	-D-	Decree of Mar. 7, 1978: Transfer rural education from DARNDR (Agriculture) to the Dept. of Education
	D-	Decree of Oct. 27, 1978: Fishing regulations (Service de Peche established in 1959; Law IX of Rural Code is 1962).
	DL-	Decree Law of Oct. 30, 1978: CONADEP replaced by Département du Plan.
	PD-	Pres. Decree of Nov. 17, 1978: creates in TPTC a special section of stormwater drainage.
	-C-	Communiqué DARNDR of Dec. 18, 1978: Public advise on need for permits to exploit groundwater and on coordination between MMER, TPTC and DARNDR.
1979	-C-	Communiqué DARNDR of March 18, 1979: prohibition of any neo-drilling of wells in the Plaine du Cul de Sac, until the termination of hydro-geological studies to determine the risk of intrusion of sea water into the aquifer.
	D-	Decree of Apr. 4, 1979: creates INAGHEI (Institut National d'Administration, de Gestion et de Hautes Etudes Internationales) as part of Univ. d'Etat.
	D-	Decree of Apr. 5, 1979: abrogates the decrees of Sept. and Nov. 1974.
	D-	Decree of Apr. 20, 1979: new regulation for INAG
	D-	Decree of Jul. 12, 1979: declaring of public use the Centre de Formation Professionnelle.

	M-	Memorandum DARNDR of Aug. 27, 1979: declaring Opération Koumbite (volunteer non-profit reforestation organ., since 1972) to be of public utility.
	PD-	Pres. Decree of Nov. 9, 1979: First ind. park established in Gonaives, 27 ha (déclaration of this area as reserved zone of public utility).
	L-	Law of Nov. 27, 1979 on Fisheries and Marine Resources.
1980	-L-	Law of Sept. 4, 1980: Forest reserved zone (4), administered by SHADA.
	C-	Communiqué DARNDR of Déc. 16, 1980: obligation of all projects public or private that catch surface water or that exploit groundwater, to be declared Procedures in case of infractions.
	L-	Law of Sept. 7, 1980: on forest protection.
1981	-C-	Communiqué of Feb. 4, 1981: prohibiting the cutting of pines
	D-	Decree of Marc. 6, 1981: proclaiming the «saison d'arbre»
1983	-D-	Decree of Apr. 4, 1983: Creating national parks "Morne LaVisite" and "Morne Macaya".
1984	-D-	Decree of Mar. 2, 1984: Exploitation of quarries on the whole national territory.
1985	-D-	Decree of Jan. 15 1985: Pic Macaya region declared "Protection Zone". Enforcement of protective measures initiated.

APPENDIX C

PARTIAL LIST OF MAPS, AERIAL PHOTOGRAPHS AND LANDSAT IMAGES FOR HAITI

Prepared by Jim Talbot

Listing of all maps, aerial photographs and Landsat images available to technical consultants, including their possible location.

1. Record Group 127: Records of the U.S. Marine Corps from the General Services Administration, National Archives and Records Service, Washington, D.C. 20408; contact Mr. Robert E. Richardson, Cartographic and Architectural Branch.

2. Geography and Map Division, Library of Congress, Washington, D.C. 20540; another repository of Haiti maps.

3. Department of State, Washington, D.C. 20520; contact the library's map department for a copy of a 1:1,000,000 scale map of Haiti.

4. General Information and Operation Map of the Republic of Haiti at a scale of 1:150,000; Map No. 484 available from the National Archives; three copies and a negative are in Haiti: one at MARNDR-DRN, one at ISPAN and one is held by Paul Paryski; at the moment Jim Talbot has the negative.

5. République d'Haiti, échelle 1:250,000, Projection Transversale de Mercator, Organisation des Etats Américains; map of aerial photos, coordinates and their map numbers based on 1968 study conducted by OAS; the aerial photos are those of the 1956 series; available from OAS.

6. Defense Mapping Agency Hydrographic Center, Washington, D.C. 20390 has prepared navigational maps at a scale of 1:10040 on Mercador Projection from a survey conducted in 1956; provided are soundings in fathoms, heights in meters.

7. Institut Géographique National, Service de la Documentation Géographique, 2, avenue Pasteur, 94160 Saint-Mande, or Direction Générale, 136 bis, rue de Grenelle, 75700 Paris, prepared Black and White and Color Infrared Photographs at a scale of 1:40,000 available only at the Haitian Service Geodesie et Cartographie.

8. Aerial photographs available at the Service de Géodésie et de Cartographie, Port-au-Prince.

9. Landsat images availables from EROS DATA CENTER, Sioux Falls, South Dakota 57198.

10. Tactical Pilotage Charts, scale of 1:500,000 are available from the Aeronautical Chart and Information Center, Second and Arsenal, St. Louis, Missouri 63118, Attn: PDP.

11. République d'Haiti, Echelle 1:500,000, is available at most bookstores; this is general geopolitical map in color.

12. Topographic maps at scales of 1:50,000 (entire country) and 1:100,000 (only some of the country) are available from Service Geodesie; these are Transverse Mercator Projections which show contour intervals of 20 meters; where 2 cm = 1000 m.

13. OAS has prepared a series of natural resources and population maps based on 1956 on 1956 aerial photos; AID Library has these as do most of the International Organizations and the various ministries.

14. Direction de l'Aménagement du Territoire et Protection de l'Environnement (DATPE) with the assistance of Fonds d'Aide et de Coopération and a French consulting firm, BDPA, prepared a series of natural resource and population and transportation maps at a scale of 1:250,000 based on 1978 aerial photos; this was essentially an update of the OAS series of maps.

15. Other maps and aerial photos are probably available from the various ministries such as TPTC, MARNDR, Plan, MMER which were targeted toward specific themes.

Jim Talbot, REMS/CAR,
June 14, 1985