MADAGASCAR

ENVIRONMENTAL ACTION PLAN

Volume 1

GENERAL SYNTHESIS AND PROPOSED ACTIONS

July 1988 Preliminary version

World Bank

United States Agency for International Development

Coopération Suisse

United Nations Educational, Scientific & Cultural Organisation

United Nations Development Program

World Wide Fund for Nature

PROPOSED ENVIRONMENTAL ACTION PLAN, MADAGASCAR JULY 1988

DEMOCRATIC REPUBLIC OF MADAGASCAR

MONETARY EQUIVALENTS

Monetary unit = Malagasy franc (FMG)

US$1 = 1,280 Malagasy francs (FMG)
(end May 1988)

FINANCIAL YEAR

Government of Madagascar : January 1 - December 31

Fanalamanga : July 1 - June 30

WEIGHTS AND MEASURES

Weights and measures are based on the metric system

GOVERNMENTAL ADMINISTRATION

Fokontany = group of villages
(about 11,400 in all)

Firaisam-pokontany = group of Fokontany (corresponds
(or Firaisana) to a canton) (about 1,250 in all)

Fivondromam-pokontany = group of Firaisana (the equivalent
(or Fivondronana) of a sub-prefecture) (about 115 in all)

Faritany = group of Fivondronana (corresponds
to a province) (six in all)

PROPOSED ENVIRONMENTAL ACTION PLAN, MADAGASCAR JULY 1988

FOREWORD

Since becoming President of the World Bank, Mr. Barber Conable has emphasized the importance of the environment and the long-term management of natural resources in the promotion of sustainable development. With this in mind, he committed his support to some thirty Member States who showed particular determination in analyzing the problems of conserving and managing their environment and, moreover, were ready to implement appropriate measures within the framework of an Environmental Action Plan (EAP).

Madagascar was one of the first countries to respond to the President's appeal. The Malagasy Government, particularly concerned by the rapid degradation of the environment, wished to remedy the situation without delay. This is not the first step Madagascar has taken in this direction. Having already defined its Development Conservation Strategy, the Government is ready to implement concrete programs for action to end the spiral of degradation in which the country finds itself.

Protection of Madagascar's environment is equally an international priority. Because of inadequate means to ensure its conservation and management, a unique patrimony of biological diversity is in danger of disappearing. The case of Madagascar presents the international community an opportunity to create and implement an original solution for development assistance that will preserve this biological diversity -- a diversity which is part of the common heritage of all humanity. If successful, such a solution will serve as a future model for other countries.

But Madagascar is also undergoing a serious economic crisis. To overcome it, the Government, with the support of the World Bank and the principal donors, has initiated a broad program of structural adjustment of its economy. Concurrently, a program designed to combat poverty is under preparation. This program hopes to lessen the effects of this adjustment on the most disadvantaged sections of the population. The EAP, another type of adjustment, concerns itself with the conservation and management of natural resources, thus reinforcing the other two programs in a balanced policy of global development.

In preparing the EAP, the Government has mobilized its reserve of experience and expertise (about 150 Malagasy specialists from all fields have participated), while the World Bank has joined forces with other donors and international organizations (USAID, Swiss Cooperation, UNDP, UNESCO and WWF). The interaction between these participants has taken place in a climate of efficiency and harmony, and they deserve our thanks and congratulations.

This synthesis, which includes proposals for action for the EAP, is based on preparatory work carried out by Malagasy specialists. It is the result of a mission to Madagascar by donors and international bodies (see Annex 1 for list of experts) in March 1983. The report was prepared by F. FALLOUX (AFTEN/World Bank), with the assistance of J.R. MERCIER and N. SAVINE (consultants).

PROPOSED ENVIRONMENTAL ACTION PLAN, MADAGASCAR JULY 1988

TABLE OF CONTENTS

	Page No.
ABBREVIATIONS	6
GLOSSARY	8
SUMMARY AND CONCLUSIONS	9
INTRODUCTION	16
CHAPTER I: MADAGASCAR'S RESOURCES	18
A. A LARGE AND DIVERSE ISLAND	18
B. A SPARSELY INHABITED COUNTRY	19
C. A HIGH LEVEL OF EDUCATION COMPARED TO OTHER AFRICAN COUNTRIES	20
D. A DOMINANT AGRICULTURAL SECTOR WITH GOOD DEVELOPMENT POTENTIAL	20
E. AN IMPORTANT POTENTIAL IN ENERGY AND MINING	22
F. AN EXCEPTIONAL LEVEL OF BIOLOGICAL DIVERSITY AND ENDEMISM, WITH A STRONG POTENTIAL FOR TOURISM	22
CHAPTER II: AN ENVIRONMENT CAUGHT IN A SPIRAL OF DEGRADATION	24
A. RECORD EROSION LEADING TO DECREASED AGRICULTURAL PRODUCTIVITY	24
B. DISAPPEARING FORESTRY POTENTIAL	26
C. AN EXTRAORDINARY PATRIMONY OF BIOLOGICAL DIVERSITY THREATENED	27
D. A SERIOUS DETERIORATION IN URBAN LIVING STANDARDS	28
E. THE HIGH ANNUAL PRICE MADAGASCAR MUST PAY	28
CHAPTER III: THE HEART OF THE PROBLEM, CAUSES AND PRINCIPAL CONSTRAINT	29
A. AN UNFORTUNATE COMBINATION OF FACTORS	29
B. PARTICULARLY SEVERE GENERAL CONSTRAINTS	40

C. THE WILLINGNESS OF THE NATION TO REVERSE PRESENT TRENDS AND HELP LIFT THE COUNTRY OUT OF THE SPIRAL OF DEGRADATION 41

CHAPTER IV:
PROPOSED OBJECTIVES AND STRATEGY FOR THE EAP 43

A. LIST OF GENERAL DEVELOPMENT OBJECTIVES 43

B. GENERAL OBJECTIVES OF THE EAP 43

C. GENERAL STRATEGY OF THE EAP 43

D. OBJECTIVES AND STRATEGIES, BY THEME 45
1. Soil conservation 46
2. Protection and management of Madagascar's biological diversity 46
3. Development of ecological tourism 47
4. Establishment of an institutional framework for the environment 48
5. Improvement of living conditions in urban and rural areas 50
6. Establishment of tools for the management, protection and continuous monitoring of the environment 51
7. Development of environmental research 52
8. Development of education, training, information, and sensitization to matters of environmental protection and management 52

E. REGIONAL OBJECTIVES AND STRATEGIES 53

CHAPTER V:
EAP PRIORITY PROGRAMS AND IMPACT ON DEVELOPMENT POLICY 58

A. A PROGRAM FOR THE PROTECTION AND MANAGEMENT OF BIOLOGICAL DIVERSITY COMBINED WITH THE DEVELOPMENT OF ECOLOGICAL TOURISM 57

B. A PROGRAM FOR ENVIRONMENTAL IMPROVEMENT IN RURAL AND URBAN COMMUNITIES 61

C. A MAPPING AND LAND MANAGEMENT PROGRAM 63

D. A PROGRAM FOR ENVIRONMENTAL EDUCATION, TRAINING AND SENSITIZATION 64

E. A SUPPORT PROGRAM FOR THE EAP 66

F. IMPACT OF THE EAP ON CURRENT POLICY DEVELOPMENT

CHAPTER VI:
THE FINANCIAL AND ECONOMIC ASPECTS OF THE EAP AND ITS IMPLEMENTATION 72

A. ESTIMATE OF THE TOTAL COST OF THE EAP AND AN OUTLINE OF ITS FINANCE PLAN 70

B. ECONOMIC BENEFITS OF THE EAP 72

C. IMPLEMENTATION OF THE EAP 73

ANNEX 1: LIST OF THOSE INVOLVED IN THE ELABORATION OF THE EAP AND OF THEIR RESPECTIVE FUNCTIONS

ANNEX 2: ESTIMATE OF ANNUAL COSTS: EFFECTS OF BURNING OF AGRICULTURAL LAND AND FOREST; EFFECTS OF EROSION ON THE MAINTENANCE OF INFRASTRUCTURES

ANNEX 3: LIST OF ADDITIONAL STUDIES

ANNEX 4: HYPOTHESES USED TO CALCULATE ESTIMATED NEED FOR RICE-GROWING LAND IN THE YEAR 2015

ABBREVIATIONS

ABEDA	Arab Bank for Economic Development in Africa
AVF	Amenagement des Valiees Forestieres (Forest Valley Development)
BPPA	Bureau des Projets de la Plaine d'Antananarivo (Antananarivo Plain Project Office)
BPU	Bureau de Planification Urbaine (Urban Planning Office)
BRGM	Bureau de Recherches Geologiques et Minieres (Office of Geological and Mining Research)
CIRAD	Centre International de Recherches Agronomiques pour le Developpement (International Center of Agronomic Research for Development)
CITES	Convention on International Trade in Endangered Species
CNCD	Commission Nationale pour la Conservation et le Developpement (National Commission for Conservation and Development)
CNRE	Centre National de Recherches sur l'Environnement (National Center for Environmental Research)
CTFT	Centre Technique Forestier Tropical (Technical Center for Tropical Forestry)
CTP	Comit Technique Permanent (Permanent Technical Committee)
DEF	Direction des Eaux et Forets (Directorate of Water Resources and Forests)
DEP	Direction de l'Evaluation des Projets (Directorate of Project Evaluation)
DGP	Direction Generale du Plan (General Directorate for Planning)
EAP	Environmental Action Plan
EDF	European Development Fund
EIE	Etudes d'Impact sur l'Environnement (Environmental Impact Studies)
FDR	Fonds de Developpement Rural (Rural Development Fund)
FNE	Fonds National pour l'Environnement (National Environmental Fund)
FOFIFA	Foibem Pirenena Momba ny Fykarohana Amphirina amin'ny Fampandrosoana ny Ambanivohitra (National Center of Applied Research for Rural Development)
FTM	Foiben-Taosahintanin i Madagasikara (Cartography Institute of Madagascar)
GDP	Gross Domestic Product
GNP	Gross National Product
IDA	International Development Association
MINESEB	Ministry of Basic Education
MINESUP	Ministry of Higher Education
MININFO	Ministry of Information
MPAEF	Ministry of Livestock Production, Water Resources and Forests
MPARA	Ministry of Agricultural Production and Agrarian Reform
MRSTD	Ministry of Scientific Research and Technology for Development)
MTP	Ministry of Public Works

NGO	Non-Governmental Organization
PDRA	Master Plan for Agricultural Research
SAFER	Agricultural Land and Rural Economy Association
SINE	National Institutional Structure for the Environment
SPN	Nature Protection Service
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USAID	United States Agency for International Development
VIP	Decentralized Local Authorities
WHO	World Health Organisation
WWF	World Wide Fund for Nature

GLOSSARY

LAVAKA:	One of the most spectacular kinds of accelerated erosion, developed in the iron-ore zone, particularly on the levelled-off surfaces of the western slope of the highlands. The present upsurge in Lavaka is caused by deforestation, but it can develop naturally on the slopes.
MANGROVE SWAMP:	Vegetational formation characteristic of the coastal areas of the tropical zone where species (particularly the mangroves) have developed numerous adaptations to habitats which are stagnant, saline and unstable. In Madagascar, mangroves have developed mainly on the West coast. They constitute an extremely favorable biotope for the feeding of young shrimp.
PANGALANE:	Coastal stretch of water (lagoon) characterized by an alternation of salt water and fresh water which promotes high vegetable and animal productivity. The Pangalanes, situated on the East Coast of Madagascar, are linked by a channel between Foul Pointe and Farafangana.
SAVOKA:	Secondary forest arising from natural recolonization of land which was once stripped bare.
TANETY:	Farming on non-irrigated slopes, developed for rainfed crops.
TAVY:	Slash-and-burn cultivation following land reclamation.

SUMMARY AND CONCLUSIONS

(i) **Madagascar has good development potential.** The country is vast (587,000 km2) and diversified with climates ranging from temperate to tropical that permit all types of agriculture. For the most part, Madagascar is still a sparsely populated country with just over 10 million inhabitants and an average population density of 17.5 inhabitants/km2. Agriculture is the dominant sector (85% of the labor force, 35% of GDP and 80% of foreign currency income), with about 1.5 million small family farming units (2 ha). Within the African context, Madagascar has developed its irrigated infrastructure most fully (about 1 million ha irrigated), with a potential of 200,000-300,000 ha still to be developed. The country's land reserves are still considerable but, because of the mountainous landscape, difficult to exploit. In addition to agriculture, Madagascar has good energy and mining potential. Its level of education, particularly high for an African country, is an asset for continued agricultural development and diversification of the economy.

(ii) **Madagascar is unique in its biological diversity and level of endemism in its flora and fauna.** Moreover, its natural ecosystems play an important role in protecting the agricultural land and in regulating its water systems. This biological richness, part of the international patrimony, may also provide excellent support for "adventure" tourism. In spite of this sector's considerable potential, it presently represents less than 1% of GNP. Extensive development is possible.

Unfortunately, development potential may be irretrievably lost if the country continues the spiral of degradation. Madagascar holds the world's record for erosion, causing considerable damage to agricultural land, infrastructures, and coastal ecosystems. The natural forest, once covering most of the country, may disappear in the upcoming decades. Nor are towns immune to this degradation. Urban infrastructures, insufficiently maintained and developed, cannot absorb the influx of the rural unemployed. Madagascar must pay a considerable price each year for this accelerating environmental damage. Roughly, this amounts to US$100-290 million, or 5-15% of the country's GDP.

(iv) **The spiral of degradation stems from an unfortunate combination of diverse factors.** Historical and economic factors -- e.g. changes within the government, excessive state control, and a price mechanism which provides little incentive to producers -- contribute to the process. Demographics are critical: the population is growing more quickly than its agricultural production and, because of the absence of regulation, is unevenly distributed. Most densely populated areas do not correspond to the greatest concentrations of resources. This puts heavy pressure on some very densely populated regions, leading to increased poverty and rapid deterioration of public health. The failure of social regulatory mechanisms has engendered insecurity and generally uncontrolled land use. Land use traditions and practices have developed with little thought to conservation of the fragile ecosystem. The combined result is different social groups adopting strategies for individual survival, taking a "wait-and-see" attitude or opting for short-term withdrawal, to the detriment of a healthy, sustainable management of the country's resources.

(v) **To this must be added severe general constraints on the Malagasy environment and economy:** inadequate financial resources thaT prevant maintainance of the existing infrastructures; the difficult physical communications, due mostly to

the mountainous countryside and deterioration of roads; institutions ill-equipped in personnel (quality and quantity) and means; a general lack of tools and data to better conserve, maintain, and monitor the environmment.

(vi) **Aware of the degradation of the country's natural resources, the Government in 1984 adopted a National Conservation Strategy for Development,** calling attention to man's part in his environment. In 1985 the Government took a new initiative and organized an international conference on Malagasy environmental problems. At the Conference's end, the Government promised to develop an institutional framework to provide better tools for the management of its environment and to set up operations that would stop resource degradation.

(vii) **Today, awareness of environmental problems is stronger; positive schemes have been launched in:** (a) soil conservation, reforestation and agroforestry; (b) protection of the biological diversity; (c) addressing problems of domestic energy; and (d) improving urban living standards. Although these schemes have brought experience and more refined methods of intervention, their results are far from expectations raised in 1984/85 and too limited to have any impact on the country's continuing degradation.

(viii) **The EAP, whose preparation was launched by the Government with the support of certain donors, is a movement to stimulate action in favor of the environment.** It has been conceived within the general framework of the country's global development policy and its three goals (combating poverty, re-establishing internal and external financial balances, and developing a better regional balance). This "tripod" is reflected in the three major joint operations: structural adjustment, the EAP, and the program for social improvement (PASAGE). In addition, it will be necessary to promote a dynamic population policy in order to return to a population growth rate compatible with sustainable resource development.

(ix) **The EAP's goal is to end the spiral of degradation by reconciling the population with its environment.** In particular, it aims to:

(a) develop human resources (sensitization, education, training and participation);
(b) promote sustained development through improved natural resource managment;
(c) conserve and manage the patrimony of biological diversity; and
(d) raise rural and urban living standards.

To achieve these goals, the proposed strategy is based on the following principles:

- A long-term view (15-20 years) and continuity of national programs with international support;
- An emphasis on communication and dialogue instead of a top-down approach;
- Presentation of the EAP programs to the local communities as benefits rather than constraints;
- Setting up appropriate mechanisms to finance the large number of small projects concerning the environment and village lands.

(x) **Five priority programs are proposed:**

(a) a program for the protection and management of the biological diversity, combined with development of "adventure" tourism;

(b) a program of environmental protection in rural and urban communities through creation of a National Environmental Fund (NEF);
(c) a mapping and land management program;
(d) a program of environmental education, training and sensitization; and
(e) a support program with three components: reinforcement of the institutional framework, development of environmental studies and research, and strengthening of resource management tools). The EAP objectives and strategies and associated programs are described in the principal document by theme and region. Since there is no such breakdown in this summary, please see Chapters IV.D. and IV.E.

(xi) **A program for the protection and management of the biological patrimony combined with the development of natural history tourism would include:**
(a) where the risk of deforestation is high, a major intervention of extensive investment, combining development of protection systems with an integrated development program for peripheral zones;
(b) where there is less risk, a less intensive intervention with the same kind of protection but more reduced investment in the periphery; and
(c) where the risk is low, a minor intervention with no peripheral investment in the first stages (as in the case of marine ecosystems).

It would also be based on complementary operations foreseen in other programs:
(a) a land surveying and management operation;
(b) implementation in peripheral zones of mini-projects for environmental improvement;
(c) launching of a vast campaign of sensitization, training, and education on biological diversity;
(d) launching of a support program of study and research; and
(e) establishment of an ecological data bank.

From an institutional viewpoint, the Nature Protection Service (SPN) of the Directorate of Water Resources and Forests (DEF) could eventually be transformed into an autonomous body -- under the auspices of the Ministry of Livestock Production, Water Resources and Forests (MPAEF) -- to manage the parks and natural reserves. At first, a private national and international effort should back it within the framework of an international foundation.

From a financial point of view, the global cost of conservation and management, including rural development in peripheral zones, would first estimate a total 160 billion FMG (US$130 million) for the coming 20 years, or an average of 8 billion FMG p.a. (US$6.5 million). This estimate would evolve over time. The share linked to development (about 50%) could be financed by concessional loans or grants, while the majority of conservation financing should come from international grants. In the medium term, a well-developed tourist sector could contribute about 20% of the financing.

Because of several newly begun programs and the recent WWF study, preparation for this program and implementation of some of its actions are well underway. The ten reserves at greatest risk of degradation will be equipped and well managed within the next five years.

(xii) **The program for improving the environment of rural and urban communities will essentially be financed by a National Environment Fund (FNE)** and modelled on the Rural Development Fund (FDR) on the following basis:

(a) definition of mini-projects for environmental improvement; and
(b) preparation of mini-projects, and decisions about their financing, at the closest possible level to the communities concerned.

From the institutional viewpoint, implementation of this program will be based on:

(a) the participation of local associations in the framework of standard contracts, with support from Non-Governmental Organizations (NGO);
(b) technical support from field agents;
(c) financing from banking systems; and
(d) establishment of a simplified and flexible institutional framework.

The idea of an FNE is not new to Madagascar. It would constitute a restricted source of financing for all environmental action at the local communities level. This underlines the interaction of this program with the other components of the EAP. The FNE could be financed by successive installments of funds from concessional lending sources such as the International Development Association (IDA), possibly supplemented by grants provided by bilateral assistance.

Preparation of this program could begin immediately. It may, however, be divided into two parts - rural and urban communities - with the latter being integrated in the framework of current and future urban programs.

A pilot phase of the program could be financed within the framework of the PASAGE program. This would accelerate implementation of the EAP by providing closer linkage between social aspects and the environment.

(xiii) **The mapping and land management program** seeks to refine, consolidate, and implement programs already established by the Madagascar Mapping Institute (FTM) and the Directorate of Land Assets It should respond to user demand, which assumes:

(a) land legislation to be known and understood by all;
(b) decentralized land management at the level of local institutions;
(c) the use of land surveying techniques that are inexpensive and easily accessible to users.

From an institutional viewpoint, the program requires a better definition of the tasks of the FTM and Directorate of Land Assets as well as the full participation of decentralized collectives.

The cost of this program over 15 years is estimated at about 215 billion FMG (about US$168 million). If possible, however, this amount should be decreased (for example, by concentrating first on priority zones). This program could be ready before the end of 1989.

(xiv) **A program of environmental education, training, and sensitization** is essential to the success of the actions proposed within the framework of the EAP. It should involve the general population, officials at all positions, and the trainers. It would comprise the following actions:

(a) ensuring the training and recycling of agents involved in EAP implementation;
(b) preparing and providing appropriate teaching tools, and training teachers and professors to introduce and reinforce environmental concerns in school curricula;
(c) developing environmental studies at the university level;
(d) developing a national communications network and strengthening production and diffusion of information; and
(e) setting up a system of monitoring and evaluating these programs and their impact in order to make adjustments in form, content, and methods.

From an institutional point of view, conception of the environmental education programs and the environmental information and sensitization campaigns should be developed and coordinated jointly by government representatives, decentralized structures, NGOs, and national and international associations. Three Ministries (Ministry of Information - MININFO, Ministry of Basic Education - MINESB, and Ministry of Higher Education - MINISUP) will play an important role. This role will probably be coordinated by the National Institutional Structure for the Environment (SINE) -- which should define the respective roles of the different structures.

The global cost and timetable for this program will be based on results of preliminary studies and supplementary actions yet to be launched.

(xv) **The EAP support program will have three components.** The first would strengthen the institutional framework at three levels. First, the personnel of existing and proposed ground level institutions need to be sensitized and trained; for environmental policy, and particularly the EAP, cannot be implemented without the full participation of those in the field. Next, sectoral bodies (different ministries) must be trained and better equipped to increase their essential role of support to the local communities and to better integrate environmental concerns in their programs. Improved coordination between these bodies should be encouraged, and problems should be dealt with in a systematic and multi-sectorial way. Implementation of the EAP calls for the clear identification of the SINE, which will be responsible for coordination and the global management of the environment. The options of where to locate this SINE within the governmental organization chart (Direction Generale du Plan, Primature, Presidence of the Republique) are currently under study by a small, high-level group.

Meanwhile, seven principal functions of this SINE have been identified:

- "leadership" in the field of environment;
- taking initiative for environmental sensitization, information and training;
- budgetary allocation of the FNE according to priorities;
- control, monitoring, and evaluation of actions taken within the framework of the national environmental policy;

- methodological studies, legal counsel and controlling application of environmental legislation;
- maintaining organic links with the implementing agencies;
- maintaining contacts with donors and other external bodies.

The following will be financed:

(a) installation, infrastructures and equipment for the SINE; and
(b) training and technical assistance.

For the development of environmental research, several programs under consideration include:

(a) the preservation and improvement of resources;
(b) the supplementary acquisition and management of basic data as preliminary to hydrological research;
(c) the study of the restoration of ichthyological resources for pisciculture;
(d) establishment of inventories in the natural ecosystems and protected areas;
(e) research on the coastal marine zones;
(f) hydrogeological research in the South;
(g) ecological observation and epidemiological investigation of malaria and schistosomiasis.

The National Center for Environmental Research (CNRE) will ensure coordination, establish priorities in cooperation with the other research institutes, and be responsible for the allocation of funds. Finally, a data bank system is proposed to set up procedures for environmental impact studies (EIE) in order to screen investments. The central data bank could be situated at the level of the SINE or of the DGP. Either way, the system will be conceived according to user needs. Several studies are foreseen which will help define actions financed under this program.

(xvi) **Malagasy environmental legislation is fairly complete, but still hardly applied at ground level.** It is proposed to recast some of the texts into an environmental code and to make changes in the areas of conservation, land legislation and screening of investments.

In the area of conservation, it seems necessary to modify the list of species which cannot be exported, to revise taxation on exports, and to modify the statute covering protected areas in order to allow the controlled development of "adventure" tourism.

In the area of land management, the modifications proposed cover 4 aspects:

(a) modification of the law on sharecropping in favor of those cultivating the land, through use of land taxes;
(b) introduction of clauses aimed at easing the land situation at the level of extended families;
(c) land consolidation in zones where there has been excessive division of farming units; and
(d) restoration of the spirit of the law on land taxation to make it into the major tool of land and environmental policy.

(xvii) **The EAP provides a new perspective on several projects currently being reoriented** to take better account of the environment (master plans from the Lake Alaotra and Middle West regions). Furthermore, the Master

Plan for Agricultural Research (PDRA) and the national program of agricultural extension, both being prepared with World Bank assistance, will need to be coordinated with the EAP. In the first case, it will be necessary to introduce environmental aspects linked to agriculture and define the respective roles of the CNRE and the FOFIFA. In the second case, agricultural extension networks will have to be reoriented towards sustainable production systems, intensification of rainfed crops on Tanety, and soil conservation; this will involve the training of field agents as well as considerable support from the technical ministries concerned.

(xviii) **At first estimate, the cost of implementation of the EAP** over a period of 15-20 years will be x billion FMG ($US300-500 million) -- not taking into account direct investment in the tourism and hotel fields. Nearly half this sum (30-40%) will represent physical investments. A first phase of the EAP, amounting to x Fmg (US$100-150 million), could be implemented in the next 5-10 years. The contribution of the Government and of users to this financing, relatively low at first, will increase progressively until it reaches a target of 20-30% during the third phase. External participation will thus predominate, notably in relation to conservation of biological diversity. This EAP cost estimate appears high, but it corresponds to the price of environmental degradation that Madagascar pays each year.

(xix) **The EAP will bring economic benefits at several levels** (development of tourism, 5-15%, improvement in agricultural production, preservation of natural resources, creation of jobs). In addition there will be significant benefits that cannot be estimated in economic terms, such as the preservation of an exceptional patrimony of biological diversity.

(xx) **Preparation of the EAP will be completed and implemented in successive stages.** While supplementary studies are being prepared in Madagascar, the present document and specific synthesis reports have been prepared by the donors (on the basis of the work of Malagasy groups). They will be sent to the Malagasy Government, probably before the end of July 1988. A donor mission to Madagascar is planned for October-November 1988 to discuss these documents with the Government. Also discussed will be the supplementary studies, the pilot operations in preparation for the EAP programs, and the logistics of the international conference slated for end 1988/beginning 1989. During this conference the Government will set forth its final version of the EAP and discuss its financing. The conference should be accompanied by an energetic media operation to officially launch the EAP. Feasibility studies will then be done for the approved priority programs. They will be based on results of the supplementary studies, with a view to establishing their financing needs. The EAP should form an integral part of the Five Year Plan projected for 1991. Several pilot actions have been foreseen in priority zones. Their goal is to test and refine intervention methods before implementation of the programs as well as making the population aware of the EAP's benefits.

(xxi) In the synthesis document, EAP objectives and strategy have been divided for the five major regions of the country as well as the eight priority themes initially chosen. This breakdown is found in the principal text, not in the present summary.

INTRODUCTION

Conscious of the degradation of Madagascar's natural resources, the Government in 1984 adopted a National Strategy of Conservation for Development. This strategy, rightly stressing man's role, was based on six principal themes: sensitization of the population, improvement of knowledge, behavioral changes in regard to the environment, technical competency, the capacity to evaluate, and participation.

In 1985, Madagascar, once again demonstrating its will to eliminate the spiral of environmental degradation, invited numerous foreign experts to discuss Malagasy environmental problems in the context of an international conference. The dialogue was frank and open. Stressing the urgency of massive intervention on a national scale, one of the eminent participants even referred to the country's "ecological suicide." Following the conference, the Government created a National Commission for Conservation and Development (CNCD), with a Permanent Technical Committee (CTP) presided over by the Director General of Planning. The Government also directed itself toward improving its legislative system in the field of environment, setting up an environmental data bank, and identifying priority areas for intervention. It made provisions for the creation of an autonomous executive structure with a multi-sectoral mandate for the application of the National Strategy. Finally, with a view to better protecting and managing the unique Malagasy ecosystems, the Government signed an agreement with the World Wide Fund for Nature (WWF).

Today, people are certainly more aware of the degradation of the country's natural resources, and some positive steps have been taken. But their results fall short of the hopes which arose in 1984/85 and, moreover, are too limited to have any impact on the spiral of degradation into which the country seems drawn. The awareness which began in Antananarivo has failed to reach the local communities. Absence of an executive institutional framework has probably made difficult the translating of National Strategy into real ground level operations. And the deterioration of security in certain areas of the country, combined with serious economical and financial problems for individual families as well as government, has preoccupied everyone, relegating environmental problems to a lower priority.

Preparation of the Environmental Action Plan (EAP), launched by the government with support from certain donors, responds to the desire to move from strategies to operational interventions -- without losing sight of the global approach to problems. It involves a new awareness of the environment in the broadest sense, going far beyond simple conservation. Present-day economic and social difficulties cannot be disassociated from the spiral of environmental degradation In fact, these are visible facets of the same, more serious problem.

In particular, the EAP has drawn attention to the great economic importance of natural resources. This approach emphasizes the technical themes of environmental management (soil conservation, conservation and management of biological diversity, ecological tourism, urban environment) and the means of implementing programs in this field (research, sensitization-training, tools, institutional framework).

Instead of simply detailing the peripheral and sectoral symptoms of environmental degradation in this presentation, we are attempting to analyze the problem and its principal causes in depth so that we may find effective solutions. We have also tried to outline the main directions the EAP should take. Without wishing to anticipate conclusions of this study, it does seem that Malagasy society lives in disharmony with its own environment and consumes its capital of natural resources too quickly, without thought for the medium and long term. To resolve this problem, global, country-wide action must be taken immediately.

While making the necessary macro economic adjustments and combatting poverty and its social consequences, Malagasy society must reconcile itself with its environment. The principal components of the National Strategy are still viable today -- particularly those concerning the need to mobilize, inform, train, and encourage those who have major roles to play at all levels, beginning with the Fokontany. This strategy should be translated into concrete action, implemented with due regard for regional characteristics, and managed in a flexible manner.

This document (Volume I) contains the general presentation and proposed guidelines for the EAP. It is based on a second document (Volume II) which includes the working groups' summaries and specific proposals regarding the eight priority issues initially identified (soil conservation; protection and management of biological diversity; ecological tourism; urban environment; institutional framework; tools to better protect, manage and monitor the environment; environmental research and sensitizing, training and education on environmental issues).

PROPOSED ENVIRONMENTAL ACTION PLAN, MADAGASCAR JULY 1988

CHAPTER I

MADAGASCAR'S RESOURCES

A. A LARGE AND DIVERSE ISLAND

With an area of 587,000 km2 (about 227,000 sq.miles), Madagascar is the fourth largest island in the world. Situated about 400 km from the coast of Africa, the country stretches over 1,600 km from North to South between latitudes 12 and 25 South. Because of its position and mountainous countryside, the Malagasy environment harbors a great diversity of landscapes and climates and thus all varieties of agriculture, from tropical to temperate.

The diversity of the Malagasy ecosystems makes it imperative that development policy in this country take account of the regional factor. In general, the country can be divided into five major regions:

(i) **The Western Coastal Region** faces the Mozambique Channel and slopes gradually from the Highlands to the sea. It is composed of vast sedimentary plains separated by steeper reliefs and crossed by numerous rivers which sweep along large quantities of sediment during the rainy reason, often causing flooding. Some of these rivers are relatively large and permanent (the Betsiboka and the Mangoky), but other, smaller rivers, dry out between May and November. Annual rainfall amounts to about 1,500 mm in the North, but drops to 800-900 mm in the Southwest, with the rainy reason lasting from November to March. Temperatures are tropical, with an annual average of 30-32 C and a minimum temperature of 23 in summer and 13 in winter. The area is devoted to livestock. It has great irrigation potential, part of which is developed (for example, Samangoky, Monrondava perimeter) and used for growing cotton and rice. But the cost of developing this potential remains high because of the irregularity of the river regimes and the substantial amount of sediment they carry.

(ii) **The High Plateau** covers the central part of the island almost end to end. The cultivated areas are principally situated at an altitude of 1,200-1,400 meters and in certain depressions -- such as Lake Alaotra, which is situated at 900 meters. Average annual rainfall amounts to 1,500 mm, with a more concentrated rainy season during the summer -- October to April. Winters are relatively cold with scattered frosts. Minimum and maximum average temperatures are, respectively, 14 and 27 C in summer, 6 and 21 C in winter. The largest area of irrigated rice is in this region, as are all temperate crops, notably fruit trees. There is an intermediary sub-region, the Middle West. West of Antananarivo, its population is scattered compared to east of the High Plateau. This area has good possibilities for agricultural development.

(iii) **The Eastern Coastal Region** is a strip of land only 25-100 km broad, dropping steeply from the Highlands to the Indian Ocean. All agriculture is concentrated in the valleys of the numerous small rivers which descend from the West to the East and in the few small coastal plains. Rainfall, which remains at much the same level all year long, reaches an average of 2,000 mm in the North and 1,500 in the South. The humid tropical climate of this region, which also boasts good insulation, allows the cultivation of all tropical crops.

(iv) **The small Northern Region** combines the characteristics of the three preceding regions. Average annual rainfall varies between 1,000 and 3,000 mm. On the East Coast, this amount is spread evenly over the whole year, while on the West Coast it is concentrated in summer. This is a fertile tropical zone that produces basics (subsistance crops?) such as sugar cane, cocoa, spices, and oils but, because of communication difficulties, remains separated from the rest of the island.

(v) **The Southwest Region** is the driest, most disadvantaged, and least developed area of the country. It has a relatively flat topography and suffers from a low rainfall (an annual average of 400-600 mm) that is unevenly distributed (8-9 months dry season). Extensive animal husbandry is the dominant economic activity.

B. A SPARSELY INHABITED COUNTRY

For the most part, Madagascar is still a sparsely populated country. It has just over 10 million inhabitants and an average density of 17.5 inhabitants per km2 (compared to Rwanda, for example, with 211/km2). The gross ratio of the total area per rural inhabitant (7.3 ha), compared to the area actually cultivated (about 0.4 ha), shows there is an enormous future land reserve. However, because of the lack of reliable data on land use, it would be extremely difficult to estimate this land reserve. This general lack of data on natural resources will be apparent throughout this document; therefore, the re-establishment of a reliable system will be one of the principal recommendations of the EAP.

According to agricultural statistics for 1970, the country was divided as follows:

cultivated agricultural surface area (CAS)	5%
pastures (PAT)	58%
rivers and lakes (R&L)	2%
forests (FOR)	21%
non-utilized cultivatable land (NUCL)	9%
non-cultivatable land (NCL)	5%

Roughly estimated, Madagascar could at least double if not triple its present cultivated land area, estimated at about 3 million ha. Noteworthy are the vast areas of grazing land and the importance of animal husbandry; Madagascar has a bovine population of about 10 million, and cattle are still raised on large expanses of land (5-6 ha per head).

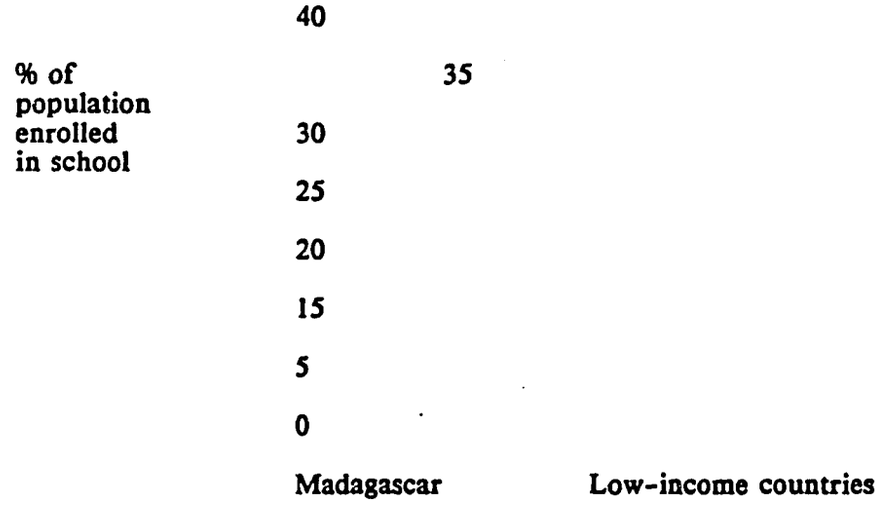
LAND USE

NCL (5%)
CAS (5%)
NUCL (9%)
FOR (21%)
PAT (58%)
R&L (2%)

C. A HIGH LEVEL OF EDUCATION COMPARED TO OTHER AFRICAN COUNTRIES

The education sector is a special priority for the Malagasy Government and has been the subject of intensive efforts during the last two decades. As seen in the following diagrams, the quantitative results are impressive:

Comparison of enrollment ratios in secondary education



Between 1965 and 1984, there was extraordinary growth in the number of children enrolled in school. According to World Bank statistics, enrollment ratios have now reached 121% for primary education (the percentage exceeds 100% because some children below 6 and over 11 are enrolled in primary school), 36% for secondary, and 5% for higher education. These levels are rarely reached in poor countries. Average enrollment ratios for low-income countries (the World Bank lists 35 such countries) excluding China and India are, respectively, 70%, 23% and 3%. Only in countries much richer than Madagascar can such an enrollment effort generally be found: for example, Iran has similar ratios but a per capita Gross National Product (GNP) twenty times higher than that of Madagascar.

D. A DOMINANT AGRICULTURAL SECTOR WITH GOOD DEVELOPMENT POTENTIAL

In Madagascar there are about 1.5 million, generally small (2 ha), farming units directly employing 85% of the labor force. Eighty percent of foreign currency income is derived from agriculture, which is the No.1 sector of economic activity accounting for 35% of the Gross Domestic Product (GDP).

The annual growth rate of this sector has been only about 2% over the past ten years; however, possibilities for medium-term improvement are still excellent -- provided the contraints mentioned in Chapters II and III are lifted. The Malagasy farmer is a good rice-grower with a feeling for

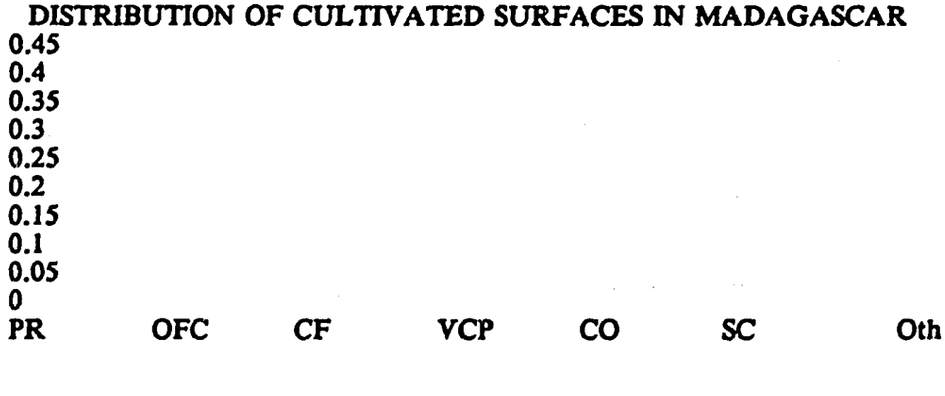
microhydraulics; this is evident in the terraced ricefields of the Highlands. Under favorable socio-economic conditions, as in the late 1960's during Operation Rice Production, production can be very intensive.
The 3 million ha of cultivated land are divided among the different crops as follows:

paddy rice (unhulled)	45%	
other food crops		40%
coffee	7%	
vanilla, cloves, pepper		3%
cotton	>1%	
sugar cane		>1%
others	3%	

Source: Agriculture Sector Report, World Bank 1983
(approximate figures).

These data are illustrated by the following figure:

DISTRIBUTION OF CULTIVATED SURFACES IN MADAGASCAR



Of the 3 million ha, 1 million are irrigated using one of five different systems:

	average	total
large irrigation schemes	>3,000 ha	80,000 ha
medium irrigation schemes	1,500 ha	80,000 ha
small irrigation schemes	100-150 ha	300,000 ha
microhydraulics	5-10 ha	
family-owned rice fields	<5 ha	500,000 ha

Although upgrading some of the existing areas is the most urgent priority now, the development potential of irrigation in the medium and long term is great (200-300,000 ha), particularly in the large areas. However, the investment required may be relatively high (US$5,000-10,000/ha).

E. AN IMPORTANT POTENTIAL IN ENERGY AND MINING

Madagascar's energy potential is extremely high and far superior to actual consumption. According to the national energy balance, the country consumes about 2 million tons of oil equivalent per year (Mtep), three quarters of which is in the form of ligneous fuel (wood and charcoal). Compared to an industrialized country, the use of "modern" energy forms is thus very modest (the equivalent of the total consumption of a town of less than 200,000 inhabitants).

Available energy resources are enormous. Hydro-electricity alone has an estimated potential of more than 4,000 MW, while actually exploited power is 100 MW. The SAKOA deposit contains about 1,000 billion tons of coal. Unfortunately, these resources -- either for technical or financial reasons (lack of profitability of the SAKOA operation) or because of their distance from consumers -- are not immediately available.

Madagascar is known for the diversity of its mineral resources, including metals (iron titanate, chromite, iron, gold, aluminum, nickel, copper, lead, molybdite, tin), crystals for industrial usage or for jewelery (graphite, mica, quartz, beryl, semi-precious stones), and minerals for fertilizer.

Until now, the mining sector has been little developed (3% of foreign exchange income), with only a few small chromite, graphite and quartz operations. However, this situation is changing -- as evidenced by a large ilmenite (titanium) mining project under preparation near Taolanaro (Fort Dauphin). This project will have an important positive impact on the country's exports (over 10% of foreign exchange income) and will stimulate further mineral investments. From an environmental point of view, this project will provide the opportunity to carry out a textbook-style impact study, which could form the basis for appropriate legislation and methodology, as recommended by the EAP.

As for potential deposits of fertilizer or inputs, phosphate prospectings were carried out in 1985 under a study of Madagascar's mineral resources by the French Office of Geological and Mining Research (BRGM) with EEC funding. First results indicate the country contains no deposits suitable for a large export program, but it may contain sufficient reserves to satisfy the nation's needs. The same applies to deposits of limestone used for limestone fertilizer. With the present price situation, it is practically impossible for the large majority of Malagasy farmers to buy imported fertilizer. When the minerals in the soil are not replenished, the result is a considerable increase in erosion as well as a drop in the productivity of the cultivated land. (This will be seen in Chapter II.) With a combination of natural phosphates and organic by-products, inexpensive fertilizer could be produced locally. This would contribute to an increase in agricultural productivity and a reduction in erosion. It will be recalled that the ferruginous soil of Madagascar is particularly deficient in phosphorus which stimulates root development in plants and thus increases the stability of the land.

F. AN EXCEPTIONAL LEVEL OF BIOLOGICAL DIVERSITY AND ENDEMISM, WITH A STRONG POTENTIAL FOR TOURISM

About 200 million years ago, Madagascar became separated from the African continent, causing the evolution of its flora and fauna to take an

original route, independent of the continental influence. Consequently, the endemism rate of the Malagasy flora and fauna is exceptionally high: 100% of the lemurs, about 95% of the reptiles and birds, 85% of the vegetation are found only in Madagascar. Because of the great diversity of ecosystems, Madagascar has a unique heritage of biological diversity (about 1,200 kinds of vegetation and some tens of thousands of animal species), offering a paradise for naturalists.

In addition to its scientific and genetic interest, the Malagasy patrimony of biological diversity has an extremely important ecological value: the natural forest ecosystems are the best protection against erosion; they also regulate downstream hydrological systems. And biological diversity generates direct benefits in relation to sustain forest management, phytopharmacy, and export and sale of different plant species.

The synergism between biological diversity and tourism is an important asset for Madagascar. The tourist sector in Madagascar is still hardly developed (less than 1% of GDP), but the country's biological diversity, the beauty of its coasts and inland scenery, and the richness of its culture and its arts and crafts, give it a great potential. And, international tourists are increasingly looking for adventure and discovery. But as we shall see later, development of this sector would require a dynamic policy for conservation and management of parks and natural reserves.

PROPOSED ENVIRONMENTAL ACTION PLAN, MADAGASCAR JULY 1988

CHAPTER II

AN ENVIRONMENT CAUGHT IN A SPIRAL OF DEGRADATION

Madagascar could loose or gravely compromise its assets if the country does not manage to pull itself out of its spiral of degradation. This is reflected in direct impacts on the environment and in the considerably higher economic costs, provisionally estimated at US$100-300 million/p.a., or 5-15% of the GDP.

A. RECORD EROSION LEADING TO DECREASED AGRICULTURAL PRODUCTIVITY

In spite of its favorable rainfall conditions, Madagascar, once the green island, is now called "the red island", and is known for its "lavaka" (a term currently used by the international community to characterize the most acute types of accelerated erosion). In defense of Malagasy farmers, we must recognize they generally face a landscape which is extremely erosive because of steep slopes, the low structural stability of the ferruginous soils which cover most of Madagascar, and the "rain aggressivity" index (*).

This extreme erodibility of the land demands that any agriculture systematically include soil conservational practices. Unfortunately, this is not found in Madagascar. Each year during the dry season, the island is set ablaze. The grazing land in the West, the Tanetys on the Highlands, and the forest on the eastern cliff are all burned. There is no clear record of the global surface area burned each year: the lowest estimates are about one million hectares, while the highest go up to 3-5 million. The grazing areas of the West are affected (certainly over one million hectares), followed by the Tanetys of the High Plateau (perhaps around half a million ha), and the slashing and burning in the Eastern Coastal Region (possibly around 200,000 ha). The following map, established by the "Soil conservation" working group, shows the island's different zones according to erosion risk.

MAP

Key

W High risk, West Coast
E High risk, East Coast
Medium risk
Low risk
Zones where Lavaka is likely to form

(*) - Wischmeier's formula, by which earth lost to erosion can be calculated, contains a factor (R) which measures rain aggressivity. For the sake of comparison, this factor varies between 60 and 260 in the Central-North and the North-West of the United States respectively, and between 350 and 500 on the Malagasy High Plateau (Manankazo and Ampamaherana/CTFT).

Most rainfed agriculture (approximately 1-1.5 million ha) is carried out without concern for conservation. The resulting damage, ugh generally less extensive than ranch burning, is considerable.

1. Damage to agricultural land

The effects of careless land burning and rainfed agriculture can be roughly estimated through results of research undertaken in Madagascar by the National Center of Applied Research for Rural Development (FOFIFA), in cooperation with the Technical Center for Tropical Forestry (CTFT). The CTFT is one of the French institutes forming the International Center of Agronomical Research for Development (CIRAD).

(i) **Land loss.** Under the conditions found in the natural tropical forest of the Eastern Region or the thick grassland in the Western Region and on the High Plateau, land losses are negligible. However, when forest or thick grazing land is burned, land loss (fine and coarse components) can reach and even exceed 50t/ha per plot. Under certain conditions (slopes and fragile soils), burning of the natural cover without taking any steps to ensure conservation can result in permanent land loss for agricultural and forestry purposes.

(ii) **Decreased fertility.** Studies carried out by FOFIA and CTFT show that erosion of soil cultivated without care for conservation is accompanied by a significant loss of fertilizer components. With ranch burning, the loss is as great, if not greater, especially of organic matter. This effect is most evident when the land is cultivated for several years in a row without organic and mineral fertilizer. With the present ratio of input costs to produce prices, this is generally the case. Non-fertilized soils lose proportionally more earth and water than fertilized soils, resulting in a rapid decrease in yield.

(iii) **Increased water run-off.** Under natural forest, in densely reforested areas, or in thick grassland, annual average water run-off is generally low (usually under 5% of rainfall), while on burnt ground or unprotected cultivated ground it increases to 20% and even 30%. Maximum run-off during fierce storms, notably cyclonic rains, can reach 70%. Thus, the absence of soil conservation strongly increases the effects of the rains and cyclones, raising river levels and causing flooding.

2. More costly infrastructural maintenance

One can also estimate the increase in maintenance costs for the main infrastructures due to erosion:

(i) **In irrigation systems** the increase in annual maintenance costs has been evaluated at 15-20,000 FMG/ha for large systems, about 10,000 FMG/ha for small and medium systems, and 5,000 FMG/ha for very small systems. This represents a total additional annual cost of about 10 billion FMG (about US$8 million) for the entire country.

(ii) **The road infrastructure** is also very sensitive to erosion. In Madagascar, it is estimated that the average annual incremental maintenance cost is around 125,000 FMG/km/p.a., representing a total annual added cost of about 1.9 billion FMG (or about US$1.5 million).

(iii) **Sedimentation in hydroelectric dam reservoirs** has risen considerably -- for example, the Mandraka dam was recently shut down for six months so that 200,000 m2 of sediment could be removed. The cost of this operation, combined with the value of the electricity lost and the downstream damage (destruction of fish, silting up of ricefields), has been estimated at about 1.3 billion FMG (US$1 million). The operation will have to be repeated every 10 years -- an annual cost of about 250 million FMG (US$0.2 million) for all Malagasy dams.

(iv) **Harbor sedimentation** is also considerable, notably in Mahajunga harbor. Twelve years ago, it was the island's main port with a merchandise volume of 270,000 t/p.a. Today, this figure has dropped to about 70,000 t/p.a. with transshipment by barge. Because of the considerable annual increase in sediment from the Betsiboka (several million tons), even this level of activity may not be sustainable. Unless extensive dredging is undertaken, Mahajunga harbor has no future. In other Malagasy harbors it would appear the sedimentation is linked more to coastal movements of marine deposits than to accumulations from rivers. It is likely, however, that some of those deposits probably originated from inland erosion.

3. Excessive investment costs for infrastructures.

The effects of erosion are not limited to increased maintenance costs for infrastructures. They also cause an increase in investment costs and a reduction of their amortization period. For major command areas, investment in joint facilities (30% of total investment) is estimated to have increased about 10%. This is due to the obligatory overdesigning of the protective dikes, the dam spillways and the floodgates, and the need to include large sedimentation troughs at the top of the command areas. Over-investment amounts to about 200-250,000 FMG/ha (US$160-200). Meanwhile, the useful lifetime of these joint facilities will probably not exceed 20 years without major reconstruction, compared with the normal 30 years. The same phenomenon will likely occur with the other infrastructures, with a possible increase in costs of 5-10%.

4. Damage to the coastal ecosystems.

Finally, erosion has a negative effect on coastal ecosystems (pH changes, silting up of communication channels with the sea, etc.). This is the case with the mangroves in the West and the pangalanes in the East, which constitute important areas for the reproduction of shellfish and fish. However, this degradation is difficult to quantify.

B. DISAPPEARING FOREST POTENTIAL

1. A severely damaged natural forest

Most of Madagascar was initially covered in natural forests. But now these forests have been totally destroyed over 80% of the country. Deforestation has been particularly severe on the High Plateau. Here the natural vegetation, rich in many species, was replaced by other communities composed of a very limited number of exotic species (graminae grasslands, e.g. prairie grasslands, at Aristida and Loudetia).

How many hectares of natural forest are left today? No one knows for certain. The last global evaluation from aerial photos was in 1958 (estimate made by Guichon in 1958, based on aerial photos, the majority of which were taken in 1949). Since then, the authors have tried to measure the surface area of remaining forest land, using this evaluation as a base and estimating an annual rate of deforestation. In 1972, it was estimated at about 12.5 million ha, assuming the annual rate of destruction was about 150,000 ha.

Assuming the rate of destruction is now between 150,000 and 300,000 ha/p.a. (probable increase due to stronger demographic pressure, combined with less effective supervision), the surface area of Malagasy forest land would comprise between 8 and 10 million ha, including 6.4 million ha of classified natural forest and 1.1 million ha of reserves and natural parks.

What value can be attributed to a hectare of natural forest in, for example, the Eastern Coastal Region? Some foresters consider this forest's sustainable timber productivity is 2m3/ha/p.a., for a net uncut value of about 100,000 FMG/m3 (US$80). Assuming this represents a natural capital yield of 10%, this means the value of a hectare of natural forest would be 2 million FMG (US$1,600) (this estimate seems acceptable since it is known that the investment cost for planting one hectare of forest is US$1,000). This value does not take into account the capital of biological diversity, nor the protective role of the forest, particularly as a hydrological buffer. This value would be totally lost in cases where the steep slope or the fragility of the stripped soils caused permanent destruction of the cleared area -- from an agricultural as well as forestry point of view (perhaps 5-10%). When a crop of Tavy is planted, with long-term rice/fallow rotation, 75-80% of this value can be lost.

2. A high demand for fuelwood resulting in destruction of trees surrounding urban areas

There is a chronic lack of data to take even approximate stock of the current resources and demand for wood fuel in the areas surrounding Madagascar's cities. However, a simulation exercise, based on reasonable hypotheses, has made it possible to study the impact of demand for wood fuel on bush communities around Antananarivo, the capital city. Current observations indicate that, in all probability, current demand -- combined with the mediocre productivity of vulnerable bush formation -- will lead to a chronic deficit. It has been estimated (Madagascar: problems and energy options) that, to ensure durable supplies in the Antananarivo area, it will be necessary to plant 10-20,000 hectares per annum. This is clearly out of range for the Government at this time.

C. AN EXTRAORDINARY PATRIMONY OF BIOLOGICAL DIVERSITY AT RISK

The majority of the country's 36 parks and natural reserves are situated near areas of deforestation and high population density. But the Nature Protection Service (SPN) at the Directorate of Water Resources and Forests (DEF) has neither the financial means nor the operational capacity to manage these areas and prevent penetration of the reserves by itinerant farmers, charcoal makers, and poachers. Consequently, some species of lemurs are disappearing permanently, along with other species of flora and fauna. This is, literally, an incalculable loss.

D. A SERIOUS DETERIORATION IN URBAN LIVING STANDARDS

Madagascar has been experiencing considerable rural-urban migration, leading to uncontrollable growth, particularly in the capital, Antananarivo. Living conditions for the "newly-urbanized" are generally bad or extremely bad. Cramped housing, lack of water treatment equipment, and an inadequate system of garbage collection and treatment combine to produce an unacceptable standard of living for a large proportion of the urban population.

E. THE HIGH ANNUAL PRICE MADAGASCAR MUST PAY

It is easy to identify and describe the damaging effects of degradation on the environment, but this may not be sufficient to convince us to act. This is why, in spite of the lack of base data, we have attempted to estimate what this degradation costs Madagascar each year. We have considered two scenarios: the first, low-end scenario, corresponds to an annual ranch burning of about 1 million ha and destruction of about 100,000 ha of natural forests; the second, high-end scenario, corresponds to ranch burning of 3 million ha with deforestation of 300,000 ha. We have assumed the effect on the infrastructures is the same in each case, although certainly it is greater in the second. A description of these hypotheses and the resulting estimates and approximations made can be found in Annex 2.

ANNUAL COSTS

US$100-300 MILLION

OR

15% OF THE GDP!!

The cost to Madagascar would be between 125 and 350 billion FMG/p.a. (i.e. between US$100 and 290 million), or 5-15% of the country's GDP. Under the first scenario, 75% would result from forest destruction, 15% would represent the drop in productivity of land assets in rainfed agriculture, and 10% would be caused by increased costs for maintenance of the infrastructures.

PROPOSED ENVIRONMENTAL ACTION PLAN, MADAGASCAR JULY 1988

CHAPTER III

THE HEART OF THE PROBLEM, CAUSES AND PRINCIPAL CONSTRAINTS

A. AN UNFORTUNATE COMBINATION OF FACTORS

The different aspects of environmental degradation appear to be symptoms of a more serious problem affecting Malagasy society. A variety of economic and historical factors are involved -- extensive changes within the government, pricing mechanisms that provide little incentive for producers, and excessive state control. These have been thoroughly analyzed by the Government and donors. The high population growth rate places considerable pressure on land in densely populated areas, resulting in uncontrolled land use in fragile ecosystems. For historical reasons, and through lack of regulation, the population is very unevenly distributed, with the highest densities often found in areas which are now poor in resources. The imbalance between land and population leads to increasing poverty and a rapid breakdown of the public health system, while the failure of social regulating mechanisms results in a lack of personal and property security. Land use traditions and practices make little provision for environmental conservation. Meanwhile, the inadequacy of institutions and tools for conservation and management and monitoring of the environment leaves the Government little ability to address problems. The result is different social groups adopting strategies for individual survival, taking a "wait-and-see" attitude or opting for short-term withdrawal -- to the detriment of a healthy, sustainable management of the country's resources. Notably, it is not a question of inadequacy of environmental and land legislation -- Malagasy laws in this area are rather good. Rather it is a problem of application.

Many vicious cycles contribute to increased environmental damage and accelerated degradation. The following are two examples:

Example I: The peasants of the East Coast, badly paid for their export products (previously lower than 20-30% of the FOB price), have increased their cultivation of Tavy, thereby clearing more forest land. In addition to destroying the ecological patrimony of the rain forests (at an rate estimated at between 150,000 and 300,000 ha) and nearly sterilizing some mountain slopes, the stimulated erosion has caused silting of the ricefields in the valley. This in turn increases the need to resort to Tavy. This same erosion has damaged infrastructures, particularly roads, which has made it more difficult to collect products thus causing a drop in prices for the producers. This too encourages the cultivation of Tavy.

Example II: Cattle-stealing, once viewed as a sport when only a tiny part of the herd was affected, has now become a national scourge. This large-scale theft encourages the anarchic usage of grazing land. The land is burnt partly to stimulate regrowth of the vegetation. But the more the grazing land is burnt, the poorer it becomes in palatable species, and the more area one is forced to burn. Mounting insecurity is driving agriculturalists away from the Middle West, undermining attempts to

decompress the High Plateau and to reconcentrate the population. The lack of land and the population pressure lead to increased degradation and encourage rural exodus to cities whose infrastructures and economies are little prepared to absorb these waves of landless peasants. The urban environment breaks down: in some areas, state, private, and public property have been illegally taken over. Urban resources have decreased, causing an acceleration of the degradation of infrastructures. The health situation has become alarming (further outbreaks of malaria; an increase of over 125% in hospital deaths between 1984 and 1986; an increase of over 225% in malnutrition for the same period).

1. A turbulent recent history during which changes and short-term priorities have often masked the need for better conservation and management of the environment.

The Malagasy Republic, although legally independent since 1960, remains very dependent on France. The French Government, in turn, has not allowed the Malagasy elite sufficient control of the destiny of their country. One example is the nearly total absence, in 1972, of Malagasy researchers in the national research institutions. Consequently, when the Second Republic came to power, it was shaken by changes caused by the total transfer of responsibilities. For several years this shock wave hindered the establishment of a national development policy.

In 1973, removal of the poll tax and the tax on cattle, and the replacement of civil administrators by elected representatives at the level of decentralized structures, represented a liberation of the regions and rural areas from the central government. Some rural inhabitants found they could get away with, distilling alcohol, selling rice at high prices, and cattle-stealing, as the newly elected officials were unable to manage and control the situation. In this context, many Fokontany became small autonomous republics.

Following this period of liberation, with the situation once again under control, the realities of state control and economic centralization came as a shock. The failure of the state marketing system led rural producers to turn inward, abandoning all medium-term investment in the battle against erosion. Land pressure endangered relations between landowners and sharecroppers and, as a result, the latter opted for short-term, destructive "mining" of the land. The high rate of population growth gave rise to a class of landless peasants. At the same time new, wealthy landowners appeared who were able to protect themselves against insecurity in the sparsely inhabited regions of the Middle East and thus profit from the new incentives provided by price deregulation. The rural exodus increased while, because of security problems, once-cultivated ricefields and land were abandoned. Regional imbalances of population to resources were further exaggerated, with particularly strong pressure on the most endangered ecosystems, notably on the Eastern and Western coastal strips.

2. A population growth rate that exceeds food production.

According to the most recent estimates (Sector Studies - Population and Health, World Bank [July 1987]), the population of Madagascar is increasing at an annual rate of 3%. If this continues, the country could approach 17 million inhabitants by the year 2000 and over 28 million in 2015. Assuming that an active demographic policy lowers fertility, the population would still reach 15 million in 2000 and 20 million in 2015. This point is illustrated in the following figure:

POPULATION PROJECTIONS

Total population (millions)	29		
	28		
	27		
	26		
	25		
	24		
	23		
	22		
	21		
	20		
	19		
	18		
	17		
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	1985	2000	2015
	0DF	GDF	RDF(*)

In comparison, the average annual growth rate of agricultural production has been only 2% since 1970. Food production for domestic consumption has probably increased even less since rice production has grown only 0.5% during the last ten years. It should be remembered that rice is a staple food in Madagascar, with an average annual consumption of 150 kg per inhabitant. Madagascar, which was a net rice exporter until the end of the 1970s, must now import rice every year. Although the recent policy of price deregulation has stimulated production and permitted a major reduction in rice imports, these imports were still more than 100,000 tons during recent years (compared to a record 350,000 tons in 1982). Meanwhile, according to recent clinical studies, there is growing malnutrition among the most disadvantaged sections of the population.

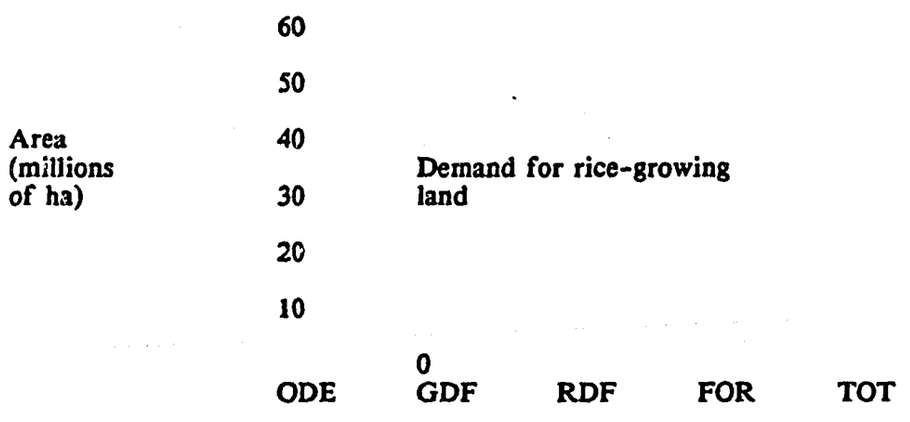
(*) 0DF = no decrease in fertility, GDF = gradual decrease in fertility, RDF = rapid decrease in fertility (World Bank 1987)

In the absence of a drop in fertility, food production must increase by 4.6% annually until the year 2000 and after that by 3.5% in order to satisfy domestic consumption needs. Few countries, industrial or developing, have been able to sustain a rate of 3.5% growth in food production over periods as long as 20-30 years.

This increased demand for foodstuffs will create serious problems. Based on crude hypotheses regarding future demand for rice and available irrigated land (see Annex 4), we find that most additional demand for rice must be satisfied by increasing the area used for cultivation of rainfed rice. Since these crops cannot be produced two consecutive years on the same plot, farmers must resort to Tavy. This will result in an increase of cultivated land of between 11 and 23 million hectares (depending on the rate of future population growth) for the country as a whole, or 1-2 times the present forest area!

Comparison of the rate of population growth versus food production shows the formidable challenge Madagascar faces. It would be unrealistic to believe that increased food production alone could fill the gap: for Madagascar, there is no choice but to increase food production AND reduce the population growth rate. Even if this policy results in a rapid fertility drop with a slight increase in food production, the challenge still remains considerable, and pressure on the environment will be great. Thus it will be necessary to attack, immediately and simultaneously, all constraints, as proposed in the EAP Strategy described in Chapter IV.

DEMAND FOR RICE-GROWING LAND
PROJECTIONS FOR THE YEAR 2015



3. Endangered forest resources

Madagascar also faces a formidable challenge in the field of energy: satisfying demand for fuelwood and charcoal, which represent about 80% of the energy the country consumes. Although, from a global viewpoint domestic consumption up to now has been theoretically equal to the annual sustainable yield of the Malagasy forest (*), serious deficits in urban areas have resulted in the destruction of surrounding forests. This challenge in the area of energy is partly linked to the food challenge: the more wood is cut, the more erosion is stimulated, and the more agricultural productivity diminishes.

Assuming the present population growth rate continues and the same amount of wood is consumed per capita, 9.1 million tons of wood equivalents will be needed in the year 2000 and 15.4 in 2015 to satisfy demand, as seen in the following graph:

DEMAND FOR WOOD FUELS

	16			
	14			
	12			
	10			
Total demand,	8			
millions of	6			
tons B	4			
	2			
	0			
	-2			
	-4			
	-6			
	-8			
	-10			
1985	2000	2015		
	Demand		Surplus/deficit	

Thus, the conclusion about energy is similar to that about food production: it would be unrealistic to expect that growth in forestry production could keep pace with the present rate of population growth. Madagascar has no choice but to increase forestry production (preservation of existing forests, planting of new forests and agroforestry), while trying to decrease demand (rapid drop in fertility, more efficient stoves, and alternative energy).

(*) This assertion is based on an annual consumption of 5.6 million tons wood equivalent in Madagascar for an estimated total forest cover of 13.1 million ha, the annual sustainable yield of which would be about 6.5 million tons wood equivalent (1 ton wood equivalent corresponds to 0.3 tons oil equivalent). These figures must not, however, be taken too literally, given the uncertainties regarding the data base.

4. An uneven distribution of population

As discussed in Chapter I, Madagascar is still a sparsely populated country; however, its population is unevenly distributed. About 2/3 of the population is concentrated in 20-25% of the land area, corresponding to the Eastern part of the Faritany from Antananarivo and Fianarantsoa on the High Plateau and to the Central and Southern parts of the Faritany from Toamasina in the Eastern Coastal Region.

In this heavily populated area, population density often exceeds 80 inhabitants/km2. With the steep relief of the country, much higher densities (often 200-300 inhabitants/km2) occur in the valleys where the population is concentrated. This results in extremely small and sub-divided farming units which are often insufficient to feed a family. Contrasting with these high density areas on the High Plateau are areas in the West which are practically empty (less than 5 inhabitants/km2). Animal husbandry is so extensive there that some of the zebu herd has returned to the wild. In Madagascar's western regions, it is estimated that 20-25% of the herd has become "Malia", i.e. practically returned to the wild. (For some seasoned cattle breeders, having a Malia herd is a way to deal with cattle-stealing and increasing insecurity.)

The juxtaposition of overpopulated and empty areas should result in a strong migratory flow, yet it has always been relatively modest (30-50,000 inhabitants per annum at the end of the 1960s). This is probably due to a combination of factor -- Malagasy traditions (attachment to ancestral land), ethnic relations (frontier between the coastal populations and those of the High Plateau), and health aspects (certain areas with potential for expansion are riddled with malaria, which presently seems to be on the rise). Another factor is the recent security problems that have strongly diminished, and even reversed, the migratory flow. Today farmers are abandoning their new land in the West to return to the High Plateau from where they came. This results in a reconcentration of the population with additional pressure (both human and animal) on the environment in already heavily populated areas. On the High Plateau (particularly in the Ankarata and the Itremo), one can even see migrations aimed at conquering and cultivating mountainous land, whose steep slopes make it particularly fragile and vulnerable to severe erosion.

Throughout Madagascar's history, governments have tried to encourage the settlement of the Western and Middle Western areas (notably around Tsiroanomandidy, which has good development potential) through projects designed to colonize new land. These costly projects have never affected more than a relatively limited number of migrants and have not lived up to expectations.

In order to restore migratory flows and relieve the congestion of the High Plateau, it is urgent re-establish security for people and for their property. An incentive policy must then be defined which would encourage migration to the West. This is proposed in Chapter IV in the framework of the EAP.

5. Agricultural traditions are sometimes harmful to the environment

Madagascar does not appear to have had an indigenous population. From the 5th century BC, the country was populated by successive migrations from the East (probably from Indonesia) and from Africa. The "migrant" character of the Malagasy population is significant; world history and in

particular African history, suggests that indigenous populations tend to be more closely linked with their natural habitat than are migrants, as their symbiotic ties have been strengthened progressively over a long period of time.

The Malagasy populations, notably on the High Plateau, have a long tradition of growing irrigated rice and, as evidenced by the terraced and valley-bed paddies, experience with microhydraulics, The rice-growers' principal concern is flooding and turning their paddies to mud as early as possible in order to bed out the rice at the most favorable moment (October, November) -- depending on the hot period and the cycle length of the varieties used. The following table shows the rice cultivation calendar in relation to climatic factors (rainfall, temperature).

Month	J A S O N D J F M A M J
Plowing	XXXXXXXXXXXXXXX
Nursery	XXXXXXXXXXXXXXX
Bedding out	XXXXXXXXXXXXXXXXXXXXXXXXX
Harvest	XXXXXXXXXXXXXXXXX
Hydrology	XXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX
	(uncertain irrigation) (risk of flooding)
Heat	XXXXXXXXXXXXXXXXXXXXXXXXXX

Source: FOFIFA, JL Rakotomanana (Climate, erosion and cultivation techniques on the High Plateau of Madagascar, December 1987)

By burning Tanety lands on watersheds, rice-growers can stimulate run-off at the beginning of the rainy season and thus be able to flood their rice paddies early for bedding out. This ensures maximum profit from the hot period. This is confirmed by FOFIFA measurements which show that burned off land can shed an average of 26 mm of water in December (Manankazo station), while land on which soil conservations measures are practiced sheds practically no water at all. At the same time, the Tanety burning sets in motion the regrowth of grass; this is critical if there is no fodder available to feed the oxen when they are most needed -- at the time of plowing and harrowing the paddies.

In the grassland areas of the West, the tradition of ranch burning is tied to the systems of extensive animal husbandry practiced. At the end of the dry season/beginning of the rainy season, the ground has to be thoroughly cleaned of mulch to encourage rapid regrowth. As there are no firebreaks, fires are spread by the wind over large areas. This system of burning grassland has probably been exacerbated by two factors:

(i) **the recent period of insecurity which interrupted the North-South** transhumance systems; and

(ii) **the progressive cultivation of humid areas** which formerly supplied a reserve of green fodder towards the end of the dry season.

In the Eastern Coastal Region, rice-growing on Tavy is an ancestral tradition which produces rice highly prized for its taste. This type of agriculture has probably been stimulated by low prices of export products (coffee, vanilla, cloves).

To help rural communities better conserve and control their environment, it will be necessary to offer them viable alternatives, taking into account the constraints they face. For example, on the High Plateau, one might expect to see many new varieties of short-cycle rice, not sensitive to photoperiodism and thus not requiring early flooding. Direct sowing without bedding out is also possible. This underlines the necessity of carrying out applied research (research/development) on production systems while maintaining a continued dialogue with farmers. In this connection, the research services, notably in the field of soil conservation, already have results from over 30 years' research. This should speed up implementation. Finally, development of the necessary alternative production systems -- superior in income, organization, and work distribution -- are not sufficient. Farmers must also be convinced to change the methods which are an integral part of their culture. This can only be achieved in the framework of intensive sensitization and extension campaigns, using the most efficient media channels, as proposed in the EAP.

6. Adequate land legislation, but practices which fail to result in good environmental management

Madagascar has an adequate land legislation system, based on the registration of land titles. (The system of land title registration was introduced by Torrens in Australia in the 19th century. Within this system, private land ownership is guaranteed by the state and land transactions are in theory simpler and less costly than under systems of deed registration [practiced the USA]. Experts consider that systems based on Torrens are generally better adapted to developing countries wishing to launch a cadastral process of land registration). At present, about 20,000 km2 have been surveyed, primarily on the High Plateau and in urban areas. The Directorate of Land Assets considers, however, that the cadastral survey should be carried out once again over about 9,000 km2, or 45% of the areas already surveyed). Although the proportion of titled land remains relatively modest compared to the entire territory (just over 3%), the tradition of land titles providing guarantees of individual property is now well established in Malagasy society, particularly on the High Plateau. Another positive, or potentially positive, aspect is land taxation, which has existed in Madagascar for several decades and which seems totally accepted by the population.

Since the 1960s, and particularly since 1972, successive governments have attempted to launch a dynamic land policy with eight principal aims:

(i) **To increase security for private landowners,** by speeding up land registration and the issuance of property titles in order to cover the whole country rapidly and to clarify once and for all the national real estate situation. To this end, the process of collective registration has been initiated (Law of December 18, 1967), procedures have been simplified and costs reduced.

(ii) **To encourage the cultivation of abandoned agricultural land.** The State has the right to expropriate any uncultivated property and redistribute it in order to ensure that it will be turned to good account (Regulation No.74-021 of June 1974).

(iii) **To use the fiscal system as a land policy instrument,** for example by encouraging better usage of the land. Thus, owners of ricefields and land used for rainfed agriculture [manioc, maize, other annual crops] are exempt from land taxation if their land is properly developed. However, they are taxed 1,000 FMG/ha for rainfed cultivation areas and 2,000 FMG/ha for flooded ricefields if their land is neglected.

(iv) **To further direct land development,** by banning the practice of sharecropping (Regulation No.73-013 of December 1, 1973) and threatening landowners who ignore the ban with expropriation.

(v) **To relieve the pressure densely populated on areas,** by encouraging land development in relatively empty sectors with good agricultural potential.

(vi) **To protect natural forests,** by controlling ranch burning (Tavy), by converting forest valleys into permanent ricefields and by stabilizing agriculture in already cleared areas.

(vii) **To recover and redistribute colonial claims** (about 40,000 ha).

(viii) **To promote different levels of cooperatives** (first level - work; second level - work and some production methods; and third level -- land collectivization).

Application of this land policy is, unfortunately, still limited. Because of a lack of means, there has been practically no progress in land registration. A very small fraction of abandoned land has been recovered by the State but has yet to be distributed. Sharecropping, although officially forbidden, continues to be widely practiced. Although the laws exist, protection of natural forests is not sufficiently ensured. Decongestion of the densely populated areas and settlement of new land in the West has not taken place - the migratory flow has even been reversed in some cases. Colonial claims have been recovered and transformed into cooperatives, but their productivity has dropped sharply. Finally, attempts to form cooperatives with collectivization of production methods have come nowhere near expectations.

The government's land policy has been little implemented -- but what about land practices in the field and their consequences for the environment?

(i) **Lack of land security.** This is obvious by the multitude of land conflicts -- within families, between landowners and sharecroppers, or between neighbors. Although ricefields are generally individually owned, this is not always true for areas of rainfed crops on Tanety or forest fallow (SAVOKA); nor is it true for grassland areas which are still, in many cases, considered common land. Under such conditions, it is unreasonable to expect farmers to invest in land improvement; they have no guarantee of possession. The Government needs to pursue its goals of registration and issuance of land titles but, as suggested in the EAP, at an accelerated rate and with more resources.

(ii) **Sharecropping.** This system of land development has existed in Madagascar since time immemorial and, although officially banned, involves between 10% and 40% of the land in the High Plateau. As a compromise, the Government attempted in the 1960s to protect sharecroppers by limiting the landowner's share to 1/4 of the harvest. Despite its good intentions, the official ban has had a negative effect on agricultural productivity and environmental protection. Sharecroppers' land security seems to have decreased, as landowners are reluctant to employ the same sharecroppers several years running for fear of expropriation. Some sharecroppers have become agricultural wage-earners, with landowners, particularly urban landowners, preferring to return their land to more or less fictional direct development. In many cases former sharecroppers have simply lost any possibility of cultivating the land. Some have gone to towns and most often joined the ranks of the unemployed; others have "squatted" in forestry areas which they have slashed and burned for cultivation, while at the same time some ricefields have been more or less abandoned. In every case, the result has been, at best, a stagnation of agricultural production and a virtual absence of land investment or, at worst, considerable environmental degradation. It would doubtless be preferable for the Government to officially recognize sharecropping and to help it evolve towards tenant farming, by introducing long-lasting land leases which would provide the land security needed by both sharecroppers and farmers. This is proposed in the EAP.

(iii) **Undivided properties.** Many families have kept their properties undivided over several generations, and today the number of claimants is extremely high. This results in numerous intra-familial conflicts and, once again, unsatisfactory management with very low land investment as no claimant is prepared to invest. It would be appropriate to revise the legislation concerning property inheritances in favor of the claimant(s) who remain on the land, and to study new formulae (for example, the possibility of non-stock property corporations) guaranteeing both claimants' ownership and land security for the person who will run the property.

(iv) **Land taxation.** The Government's goal has been to use the land tax as a land policy instrument by penalizing, as of 1987, unused agricultural land (1,000-2,000 FMG/ha), and placing higher taxes on medium and large properties by means of an additional "registration" tax. This "registration" tax is a kind of income tax which was added to the property tax [IRNS]) introduced in 1978. Before 1986, it constituted a type of property surcharge, corresponding to twice the property tax for all farm units of 10 ha or less. This represented nearly all farm units in the country, as properties over 10 ha are highly exceptional. This property surcharge was changed by Law 86-005 of June 12 1986, so that small units would be less penalized (50% of the property tax for units of less than 5 ha, 100% for those situated between 5 and 10 ha and 200% for those over 10 ha). The Government has also tried to improve the return on land taxation, estimated at 50% in 1987, to a total amount of 15 billion FMG (US$12 million) for the country as a whole. Note that 3% of this tax remains with the Fokontany while 97% goes to the budget of the Fivondronampokontany; neither of these amounts is earmarked for any particular expenditure.

While the Government is to be congratulated on its intention to use the land tax as a land policy instrument, some difficulties are being encountered in implementation. The first arises from the absence of land registers -- recourse is made to self-declarations by landowners, where

some could be tempted to reduce the surface area of their land or affirm that it is totally under cultivation. The second difficulty concerns the relatively low level of the tax, i.e. less than 0.3% of the land value (on the property market, the value of one hectare of ricefield is approximately 1 million FMG). The incentive is thus extremely limited and many complain that the trip they must make to pay their land tax costs them several times more than the tax itself. Finally, bearing in mind the loss represented by the destruction of natural forests, it would perhaps be advisable to introduce a special dissuasive tax on the Tavy. The EAP suggests tackling the first difficulty by progressively setting up good-quality land archives. It also suggests carrying out additional studies on property taxation in order to improve its efficiency as a policy instrument for better protection and management of the environment.

(v) **Collectivization of land in the framework of certain cooperatives.** International experience in developing countries shows that collectivization of land has always resulted in a drop in productivity and an unsatisfactory management of natural resources. Madagascar's own experience, although more limited than that of other countries, leads to the same conclusions. The country should perhaps study once again the possibility of cooperatives with joint property ownership, and even consider redistributing the land to individuals, either on lease (as in China) or on direct ownership (as in Algeria where self-managed properties have been redistributed).

(vi) **Subdivision of properties.** Because of the complicated web of inheritances spanning several generations, properties are often split up into very small units separated by relatively large distances (several kilometers). Management of such properties is particularly difficult and their division makes any form of property development, which must be planned at the level of groups of plots and watershed, more problematic. Land restructuration would seem to be necessary, as suggested in the EAP.

To conclude the discussion of the land situation, some current practices should be modified in order to improve agricultural productivity in a permanent fashion and better preserve the environment. The elements of the Government's land development policy need to be adapted somewhat so that, when implemented, the policy responds globally to the problems at hand.

(vii) **An institutional framework ill-equipped to meet environmental needs.** Until now, the Government has experienced great difficulty in monitoring and reacting to recent developments in the deterioration of the Malagasy environment. This is due to the lack of base data at all levels of administration and lack (in quantity and quality) of qualified personnel. In addition, the different State institutions are too compartmentalized to deal with environmental problems which are, by definition, inter-sectoral.

Essentially consultative bodies, the CNCD and the CTP have had little impact on the evolution of the situation. In fact, at the end of the 1985 Conference, an autonomous operative structure was to be created that would serve as an executive branch of the CNCD and the CTP. Unfortunately this structure never materialized, but the principal on which it was based remains valid.

It is absolutely necessary to have an adequate national institutional framework for the environment, to serve as a focal point, to set the tone for environmental policy, and to manage and help the EAP evolve. But this national institutional framework is far from being

sufficient, particularly in the environment area, where it is necessary to influence participants at the grassroots level. This implies that key institutions should be in the field, whether they be decentralized structures (Fokontany), associations of farmers, cattle breeders or citizens, or Non-Governmental Organizations (NGO) of all types. All these institutions should form the mainspring of the EAP.

(viii) **A lack of awareness among the population about environmental concerns.** It is clear that until now analysis of environmental problems and outlining of solutions have essentially been the exclusive concern of the upper echelons of public administration in the capital. It is now important to bring the matter to local communities and consumer associations. This should constitute one of the major thrusts of the EAP, as we will see in Chapter IV.

(ix) **Insufficient coordination among donors, who have yet to tackle the global aspects of the environment.** The Malagasy administration has remained compartmentalized, but the donors too are insufficiently coordinated. They have all too often funded sectors and regions without paying attention to the overall picture. It must also be recognized that donors and the Government became aware of environmental problems at the same time.

B. PARTICULARLY SEVERE GENERAL CONSTRAINTS

During the preparatory stages of the EAP, certain constraints proved to be common to all social and economic sectors, with considerable influence on the degradation of living conditions and the environment. Among those constraints, five appeared systematically in the analysis of the priority themes chosen:

1. Insufficient financial resources at all levels.

The declining purchasing power of the population can be felt at all levels of the Government and decentralized bodies. The low return from tax collection, duties and other sources of financing for public expenditure makes it impossible to keep up with the required amount of investment, in particular for upkeep, and even calls into question the coverage of operating expenses. This renders the Government and the decentralized bodies helpless when faced with the enormity of the tasks to be accomplished in the public interest (health, education, extension, improvement of living conditions, etc.).

2. Difficult physical communications in the island's "archipelago."

The island's geography, in particular its mountainous landscape, and the deteriorated state of the basic infrastructures make it difficult and costly for people to travel. Implementation of the EAP assumes a considerable effort of coordination between users and the different administrative levels. To bypass this constraint in mobility, better employment of the media (radio, television, newspapers, leaflets) is proposed.

3. A lack of quantity and quality in government personnel.

Since the beginning of the Second Republic, a great effort has been made in the field of education, but the qualifications of students

graduating from schools and the University do not correspond to the needs of the country. In addition, low salaries offered by government offices and a limited number of budgetary posts have made it difficult to recruit the best specialists for the right positions. Finally, there are no reception facilities for young graduates beginning their first jobs. These factors have generated serious staffing problems at many levels of responsibility. It should also be noted that several sectors lack trained personnel (management of forests and ecosystems, for example).

To bypass this constraint, it is suggested not only to strengthen the public institutions involved in environmental matters but also to supplement public capacity by calling on local associations, NGOs and, generally, any form of private initiative.

4. A general lack of basic information.

As we have already stressed, Madagascar's data base is not current and reliable enough to allow for planning and action. Environment in particular, has no indicator of the status of natural resources and their evolution over time. This is particularly regrettable since, in the 1960s, Madagascar was considered a model country for collection and management of basic data in the African context. There has since been a progressive deterioration in the data system. It must now be rebuilt using new techniques to establish the best level of cost effectiveness.

5. Generally adequate, but insufficiently implemented legislation

This constraint is evidenced by the lack of personal and property security which exists both in the rural West and South-West, and in the cities. It no doubt arises from a general lack of respect for the law, combined with insufficient administrative and financial means to enforce it.

C. WILLINGNESS OF THE NATION TO REVERSE PRESENT TRENDS AND LIFT THE COUNTRY OUT OF THE SPIRAL OF DEGRADATION

With the support of the donors, principally the World Bank, the Government has embarked upon significant modifications in its macroeconomic framework and its investment policy. This adjustment comprises a first step in deregulating agricultural prices which should result in a much stronger incentive for production and a restructuration of the public and parapublic sector, with the State stepping aside in favor of the private sector in productive and commercial activities. It should be accompanied by renewed investment in the key sectors presenting the highest profitability and the greatest potential for generation of foreign currency.

Social problems, to a greater or lesser extent exacerbated by the deterioration in the economy, should also be tackled beginning with poverty, children and families in distress, malnutrition, the considerable deterioration in health (notably the strong upsurge in malaria) and the serious unemployment problems (PASAGE program).

As mentioned in the introduction to this document, the Government has taken several steps in the area of the environment, notably the

development of a National Strategy of Conservation for Development in 1984. Some programs have also been implemented (and others are about to begin) to translate this strategy into concrete action on the ground. The following are among the principal programs:

(i) **In the area of soil conservation,** development of the forest valleys (AVF), the SAVOKA operation in formerly cleared areas and projects financed by Switzerland and Norway for protection of watershed and development of the Tanety by reforestation and agroforestry;

(ii) **In the area of biological diversity,** various small projects for protection and management of natural reserves, launched by the Nature Protection Service (SPN/DEP) with the participation of the WWF and American universities and financed by USAID and UNESCO, and the project for forest protection and management to be financed by the International Development Association (IDA), Switzerland and Norway. This project, which is just getting off the ground, aims inter alia to expand the SAVOKA and AVF operations by integrating them, to reinforce management of three natural reserves, and to support the Directorate of Water Resources and Forests of the MPAEF;

(iii) **In the area of energy,** the evaluation of energy resources and the "Energy I" project financed by IDA, the BEI and the Arab Bank for Economic Development in Africa (ABEDA) which, along with the rehabilitation of the JIRAMA, hopes to ensure better energy planning and an improvement in charcoaling and in furnace output;

(iv) **In the area of the urban environment,** IDA-financed projects directed at the renovation of neighborhoods, sanitation and improved trash disposal (the Antananarivo composting plant); and

(v) **In the field of education, training and sensitization to the environment,** a series of initiatives and mini-projects such as the production of textbooks (WWF), radio and television programs, etc.

Finally, through private initiative, some significant environmental associations have been created in Madagascar (for example, the Association for the Conservation and Knowledge of Nature, the Association of Friends of the Andasibe Reserve).

Unfortunately, these programs and actions have so far had very little direct impact on the spiral of degradation in the country. Nevertheless, they have helped by providing experience and defining the methods which must now be put to good account within the framework of the EAP.

PROPOSED ENVIRONMENTAL ACTION PLAN, MADAGASCAR JULY 1988

CHAPTER IV

PROPOSED OBJECTIVES AND STRATEGY FOR THE EAP

A. LIST OF GENERAL DEVELOPMENT OBJECTIVES

The EAP was conceived within the more general context of the global policy of national development which is based on the pursuit of three complementary goals: the war against poverty, the re-establishment of financial balances, both internal and external, and the establishment of a better regional balance. This "tripod" -- essential to building an acceptable future -- finds its symmetry in the three complementary government operations, with the support of the donors:

- structural adjustment,
- the Environmental Action Plan,
- the PASAGE program.

In effect, re-establishing the balance of payments without an environmental policy could have harmful consequences for nature and for lasting development. (For example, the new price incentive for maize exports have encouraged some large landowners to clear land and embark on relatively large-scale mechanized cultivation on fragile ground, without care for conservation. Losses incurred in terms of medium-term productivity would appear to far exceed any short-term benefits.) Similarly, it would be difficult to make adjustments to natural resources without effecting a structural adjustment of the economy and, in particular, of agricultural price policy. Finally, the lack of a social program would equally endanger adjustments in the economic and environmental fields, "poverty being the cause and principal effect of the global problems of the environment" (report of the "Bruntland" Commission on the environment and development: "Our Common Future").

Mention should be made of the need to promote a dynamic program in the area of population. A lower population growth rate aimed at improving income and living conditions for the people of Madagascar will also ease pressure on the environment and lay foundations for lasting development. It should also be emphasized that improved security is one of the sina qua non conditions of implementation of the EAP.

B. GENERAL OBJECTIVES OF THE EAP

The EAP hopes to reconcile the population with its environment. With this in mind, it proposes four objectives:

(i) **To develop human resources:**

- to reinforce sensitization and training of the population,
- to encourage the population's participation, particularly by strengthening associative movements, in order to supplement public management capacity,
- to reinforce the teaching of environmental matters in general education programs,
- to develop training and recycling channels.

(ii) **To promote lasting development by better managing natural resources:**
- to economize natural resources in all sectors (economy of ligneous fuels, electricity, water),
- to better develop natural resources locally (reforestation, agroforestry, soil conservation, reduction in water pollution),
- to maintain the natural fertility of the milieu and stimulate its capacity to resist disease and parasites by encouraging, on the one hand soil-improving plants and trees, the use of locally-produced fertilizers and, as well, subtle methods of integrated pest management,
- to screen investments (industrial, agricultural, touristic, etc.) which do not ensure sustained development and which would have a negative effect on natural resources.

(iii) **To conserve and manage the patrimony of biological diversity:**
- to protect the natural milieu "everywhere" (outside of protected areas),
- to create and manage protected areas (including economic development in the peripheral areas),
- to coordinate conservation and "discovery" tourism.

(iv) **To improve rural and urban living conditions:**
- to help strengthen local finances,
- to help strengthen local technical services,
- to develop and improve utilities.

To achieve these aims, three initial priority themes will be necessary: (i) **strengthen the institutional framework**; (ii) **develop research**; and (iii) **improve tools.** The following page shows the structure of the chosen goals.

C. GENERAL STRATEGY OF THE EAP

This strategy is that adopted by the Government in 1984, with certain adjustments and additions. Its emphasis is on man in his biosphere, the increase of his knowledge, his sensitization, and the expected impact of his change in attitude toward his environment. It stresses mobilization and the participation of the main participants in social, economic and political life, with particular emphasis on local communities taking charge of the protection and management of their own land.

The strategy emphasizes the following principles:

(i) **Approaching problems and implementing their solutions in an integrated way.** As we saw in Chapter III, the degradation of the environment is caused by many factors. Thus it is vital to treat these factors globally and simultaneously if positive results are to be achieved.

(ii) **Long-term vision and continuity of the international support received by Madagascar.** All the tasks to be undertaken (conserving and managing the heritage of biological diversity, tackling the property and cadastral issue, promoting soil conservation and agroforestry) will need 15-20 year programs. Their success will in part be tied to the continuity of their implementation and, particularly, their financing.

(iii) **Stressing communication and dialogue rather than the hierarchical transmission of commands.** To achieve this, it is suggested that a combination of media be used to reach the whole population and to setup a network with the grassroots organizations and the NGOs to supplement the traditional government channels of communication.

(iv) **Presenting EAP programs to local communities as sources of benefit, rather than constraint.** To this end, it is suggested that stress be laid on attractive alternative ways to manage natural resources so that consumers will adopt them and abandon their current practices.

(v) **Setting up the appropriate mechanisms to finance the many small projects relating to the environment** (protection of watershed, agroforestry, development of village-owned land, management of forests and nature reserves, etc.). Traditional government channels of communication are suitable for large-scale investment but much less for small projects. However, experience acquired in the field of the Rural Development Fund (FDR) in other developing countries shows it is possible to set up channels which are much simpler from the financing point of view (usage of banking systems), technical preparation (standard projects partially prepared in advance) and implementation (usage of consumer associations and NGOs). This experience could be valuable for Madagascar's environment.

Further on, the aims and general strategy are more fully taken up at two levels: by priority subjects, and by region (given the wide diversity of Malagasy ecosystems and the need to adapt solutions to regional particularities).

D. OBJECTIVES AND STRATEGIES -- BY THEME

The objectives and strategies by theme are based on worked carried out by the groups, within the framework of the preparation of the EAP and with assistance from the experts from the donors' major mission.

Exploit natural resources locally	Establish good management of natural resources		Combat poverty
Economize natural resources "everywhere"			
Screen investments which would endanger natural resources		Re-establish the external balance	
Create and manage protected areas	Conserve and manage the biological diversity		
Coordinate conservation and "discovery" tourism			
Protect the diversity	Improve urban and rural living conditions	Establish a biological	
			regional balance "everywhere"

Assist with the reinforcement of local finances

Assist with the reinforcement of local technical services

Sub-objectives	Objectives	GOALS
Tools and information	Research	Training
Investments	Policy	Institutional framework

1. Soil conservation

(i) **Redirecting relations (Peasants <-> Research <-> Extension, <-> Education, Training, Sensitization),** towards more lasting agricultural development by introducing soil conservation, the preservation of natural fertility and agroforestry as priority subjects.

(ii) **Increasing land security** to help farmers settle, then encourage them to invest in the medium-term in the area of soil conservation, agroforestry, and reforestation. This would strengthen the Government's land surveying and management policy, as will be seen further on.

(iii) **Setting up financial mechanisms,** as mentioned above, such as a National Envi.onmental Fund (FNE), to finance mini-programs designed to develop village lands.

(iv) **Mobilizing local associations, the decentralized structures of theTokontany and the NGOs,** by developing programs of sensitization and training and by helping them clarify their land development projects by use of adapted mechanisms/tools.

(v) **Attacking priority areas** where the high element of risk is combined with good production potential (such as the zones of Antahala, Mananjary, Alaotra, etc.). See the risk chart produced by the "soil conservation" group.

(vi) **Aiming at a better management of fertilization and pest control** to improve the fertility of cultivable soils -- by seeking alternatives to synthetic fertilizers too expensive for the farmers, and to foresee secondary effects connected with the widespread usage of agrochemical products in certain local projects.

Key
Degradation
coefficient

2. Protection and management of the heritage of biological diversity

In this area, time is of the essence. Action must be taken quickly, or there is a risk that Madagascar's biological diversity will be irreparably damaged. To this end, the following is proposed:

(i) **Becoming better acquainted with the extent and content (flora and fauna) of the natural forests.**

(ii) **Better preserving Madagascar's ecological riches** by increasing the number of protected areas from 36 to 50, or from 10,350 km2 to about 14,000 km2, and by updating data on the different species. This proposal is based on a study recently carried out by the WWF in association with the Directorate of Water Resources and Forests (DEF).

(iii) **Discouraging Tavy cultivation and other means of deforestation,** within the framework of an integrated development on the perimeter of the protected areas and natural forests still in existence.

(iv) **Stabilizing the land situation** by ensuring better legal protectionof the protected areas. In the present situation, the legislative process has only partially covered many existing natural reserves (for example, decree of classification without land title registering these reserves as being owned by the State), which could lead to complicated litigations in the future. The legislative process should be implemented in its entirety for the 14 new reserves proposed.) and classified natural forests, and by regularizing the land situation of peripheral farmers.

(v) **Encouraging participation by local communities in the management of parks and natural reserves** by means of job creation (supervisory personnel, guides, tourist welcomers, etc.).

(vi) **Allocating resources to the different protected areas according to priorities.** These priorities will be determined by the level of ecological richness and the degree of risk of destruction brought about by human pressure.

(vii) **Strongly increasing governmental capacity to manage and monitor the protected areas** and, to a lesser extent, the classified natural forests, and supplementing this capacity by calling strongly on private capacity (grassroots organizations, national and international NGOs, foreign universities, hotel chains, etc.).

(viii) **Clarifying methods of sustainable development of natural forests.**

(ix) **Setting up a financing mechanism to ensure the conservation of thebiological diversity.** This financing could come from three sources:

- contributions from hotel chains, foreign universities, some NGOs;
- fiscal income on the controlled marketing of endemic species of vegetation; and
- subsidies from the international community (the EAP should provide the opportunity to set up this mechanism).

3. Development of ecological tourism

Madagascar has an advantage over other countries in being able to incorporate the management and protection of its exceptional ecological heritage with "discovery" tourism. This unique tourism, combined with more traditional, relaxing activities could eventually become one of the most important sectors of the national economy in obtaining foreign currency. The following are thus proposed:

(i) **Identifying and evaluating potential sites for tourism, in close collaboration** with the natural reserves and the necessary investments (reception system, communication and transport networks).

(ii) **Allowing the development of ecological tourism** in protected areas by revising the relevant legislation.

(iii) **Combining investment by hotel chains and international transporters with that of local businesses.** In this context, an international operator could establish franchise contracts with local businesses to have, in addition to the large hotel infrastructures, more modest and "folkloric" satellite hotels connected with the Malagasy parks and reserves.

(iv) **Encouraging, and even imposing, by means of impact studies the participation of international and national groups in the management of the reserves and parks, under governmental control.**

(v) **Profiting, in association with the ecological heritage, from the country's cultural riches, collector minerals and the craft resources.** This would imply public awareness and participation in the development of tourism.

(vi) **Encouraging, progressively, national tourism.**

(vii) **Increasing Madagascar's capacity to negotiate with international groups, through training.**

(viii) **Developing peripheral services in hotel and tourism training.**

4. Establishment of an institutional framework for the environment.

The efficiency of this framework will depend on the quality and dynamism of the institutions at three levels: local, sectorial and intersectorial. The local level assumes great importance; this is where the consumers of natural resources are -- the main participants. Their decisions have a direct effect on the environment. Environmental policy and particularly the EAP could not be implemented without the massive participation of these participants at the grassroot level. In other words, the first institutions to take into account, to sensitize and train, are those which already exist at the base and those whose creation should be encouraged. The decentralized village associations (VIP) and the NGOs will probably have an important role to play in achieving these local goals. The VIPs are more particularly concerned with land surveying and management plans, but it is the local partners who will be affected by the preparation and realization of the mini-projects concerning conservation and the mini-programs of reforestation and agroforestry. Among the NGOs in question are the already existing associations, or those yet to be created, for the preservation of the natural reserves, and the associations of users of irrigation schemes or reforestation areas. But others will also have an important role to play as long as their goal is local development.

At the sectorial level, already existing bodies should broaden their basic role of support to the local communities. At the same time, they must work to better include concern for the environment in their respective programs. In order to function, local institutions will ask support from the field workers of these sectorial bodies, who will be responsible for increasing their awareness, training them, and discussing new technical alternatives to adapt and implement. There is no need to create a new network of special environmental agents when existing networks could be used (Ministry of Agricultural Production and Agrarian Reform [MPARA], Ministry of Livestock Production, Water Resources and Forests [MPAEF], Ministry of Public Works [MTP], etc.), by training and better equipping them to deal with environmental problems. It should be stressed that the EAP should not call into question the specific responsibilities of the different technical ministries and of other sectorial bodies; rather it should demand better coordination and a new willingness to deal with problems systematically and at a multi-sectorial level in order to achieve long-lasting global development.

Note should be made of the recent creation of the National Center for Environmental Research (CNRE) within the Ministry of Scientific Research and Technology for Development (MRSTD). This center's task is to better orient environmental research programs towards priorities following from the EAP, and to coordinate their implementation by specialized research institutes (for example FOFIFA, CNRE etc.). The CNRE could also directly carry out research which could not be undertaken by existing institutes.

Responsibility for the coordination and global management of the environment lies at the national intersectorial level; however, at the present time no Malagasy institution is officially assigned this responsibility. It is therefore difficult to establish a coherent and efficient environmental policy. Implementation of the Environmental Action Plan requires clarification of this problem and the unambiguous identification of a national institutional structure for the environment (SINE).

First steps have been taken to create this SINE and decide the place it will hold in the governmental organization chart. Creation of a Ministry of the Environment was vetoed a priori for two reasons: (a) the additional cost involved would go against the government's spirit of structural adjustment; and (b) the difficulty for this new ministry, on an equal footing with the other technical ministries and without a grassroots level network, to ensure the coordination and management of the environment.

It was clear from the start that a technical ministry could not be the focal point of an environmental plan, given its statutary impossibility to coordinate the actions of the other ministries. The three realistic options are thus the General Directorate of the Plan (DGP), the Office of the Prime Minister, and the Office of the President of the Republic. These options are being studied by a small, high-level working group whose conclusions soon should be published. Without judging these conclusions in advance, we have however identified the principal functions the SINE will have to fulfill:

(i) "leadership" in the field of environment, generally and in the setting up and implementation of the EAP, and in particular, integration with the Economic Plan and other tasks such as the screening of investments,

(ii) initiative for environmental sensitization, information and training,

(iii) budgetary allocation of the FNE according to priorities, in the area of the environment in general and in the implementation of the EAP in particular,

(iv) control, monitoring, and evaluation of action taken in the context of the national environmental policy and, in particular, the updating of the Environmental Action Plan,

(v) divising of methods, legal counselling, and control of the implementation of environmental legislation,

(vi) maintenance of organic ties with the implementing agencies (Ministries, NGOs, etc.) of actions financed within the framework of the national environmental policy,

(vii) **contacts with the donors and other external bodies,** involved in environmental matters.

5. Improvement of urban and rural living conditions

It is proposed to:

(i) **Extend urban programs** (Urban Planning Office [BPU], Antananarivo Plain Project Office [BPPA]), **to Madagascar's other major cities,** by regularizing the illegal occupation of dwellings and by furthering public investment in the following areas:

- restoration and reinforcement of trash collection and treatment equipment, and of the sanitation system;
- development of trash treatment products (particularly usage of compost as an agricultural fertilizer).

(ii) **Improve the community facilities of the Fivondronana** in the provinces where urban migration is greatest, with a view to slowing it down.

(iii) **Emphasize the improvement of village living conditions,** by increasing and improving the water supply systems, by eliminating sources of infection (stagnant water, feces, ..) and by developing public health systems.

(iv) **Ensure good maintenance and periodical renewal of equipment** by means of a reliable system of cost recovery. A close study of local finance mechanisms should be carried out.

(v) **Sensitize and educate all those concerned** in order to achieve better management of living conditions (hygiene, respect for waterways, in particular).

In reference to the war on disease (malaria and, to a lesser degree, schistosomiasis), special mention should be made of the following: In 1972, experts from the World Health Organization (WHO) considered malaria to be virtually eradicated from the High Plateau. Likewise, certain programs aimed at controlling schistosomiasis were gaining tangible success. Today malaria has reinfected the High Plateau and has caused thousands of deaths, with the number increasing rapidly. Schistosomiasis has had an even stronger impact, particularly in the coastal regions. A vast program designed to combat these diseases is being prepared under the auspices of the PASAGE Program.

6. Setting up mechanisms for the management, protection and continuous monitoring of the environment

It is proposed to:

(i) **Improve the existing land policy** (the status of sharecropping, inheritance, undivided properties, taxation) **and provide the appropriate means for its implementation;**

(ii) **Intensify land registration efforts while renewing basic cartography.** Operations conducted according to the collective registration process will be launched in the priority areas (high population density, extensive land conflicts, high level of degradation, ..);

(iii) **Assess the data bank system already in existence and its implied inter-institutional relations** according to needs, particularly those of local users, and progressively develop such a system, keeping only those data corresponding to user demand.

(iv) **Establish investment-screening procedures in the environmental area.**

This would involve:

- the study of legislative texts instituting these procedures and their conditions of implementation;
- clarification, in cooperation with the National Center for Environmental Research (CNRE), which has just been created within the Ministry of Scientific Research and Technology for Development (MRSTD), using concrete examples, of methods used in environmental impact studies (E.I.E.) on different investment types (industries, agricultural development, development of tourism, etc.), in keeping with international regulations;
- training of high-level specialists, some of whom will be attached to the CNRE;
- continuous improvement of methods, based on acquired experience and ecological monitoring of developments.

The screening of environmental investments could be made the responsibility of the new Directorate of Project Evaluation (DEP), recently created within the DGP, which is responsible for verifying the quality of economic evaluations and controlling the impact of these projects on the national debt and the increase in recurrent charges.

7. Development of environmental research

It is proposed to:

(i) **Redirect research programs currently being carried out or under preparation,** to better address environmental concerns.

(ii) **Seek assistance from existing research institutions,** whose cooperation will be assured by the CNRE. This body will define priorities, prepare programs, see to their implementation and monitor their progress. It will cooperate closely with the SINE.

(iii) **Instill the "environmental spirit"** by encouraging new methods such as:

- giving priority to use of the "system" process and to pluridisciplinary studies, bringing together specialists in human sciences, ecology, economy, and agro-forestry;

- close association between practitioners (farmers, foresters, pastoralists etc), extension agents and those involved in fundamental and applied research; and

- the establishment of networks of inter-institutional environmental research, in liaison with the corresponding exterior networks.

8. Development of education, training, information and sensitization of the protection and management of the environment

This theme constitutes the backbone of the implementation of the EAP, as already mentioned in the General Strategy for the environment (cf. beginning of this Chapter). It revolves around methods rather than content, which has already been defined for each of the other themes.

In the area of information and sensitization, the proposals made are the following:

(i) **Gain better knowledge of the motivations of those concerned;**

(ii) **Analyze existing communication networks and their efficacy;**

(iii) **Strengthen, better coordinate, and develop communication networks to reach the greatest number of people.** In particular, this involves studying the most cost-effective media combinations and using other means (fairs, sports occasions, shows, etc.);

(iv) **Form a central team responsible for the conception and synchronized transmission of messages to each target group** (school children and students, farmers, city-dwellers, etc.). This team would be connected with several secondary transmission centers;

(v) **Seek assistance from local associations, and the NGOs in general, and help them strengthen their programs of information and environmental sensitization;**

(vi) **Ensure the systematic monitoring of broadcasts by conducting surveys in** order to improve the form and content of the messages, as well as broadcasting methods; and

(vii) **Launch pilot operations for environmental information and diffusion in** the framework of current projects or those which should be implemented.

In the field of training and education, the needs identified by the different level groups seem to be great, and they concern all aspects of the environment. It is proposed to:

(i) **Make a detailed inventory of these needs, identify the institutions which could meet them and prepare a corresponding pluriannual plan:**

(ii) **Give priority to training users on the ground and to ways of implementing this training;**

(iii) **Continue to introduce the environment into school curricula and adapt higher education** to fill the demand for environmental managers. The Ministry of Basic Education (MINESEB) and the Ministry of Higher Education (MINESUP) have made a start in this direction, but will need more means to increase the effectiveness of their actions;

(iv) **Develop manuals and other support documents for training and education programs.** Mention should be made of the pioneering work undertaken by the MINESEB, with the support of the WWF, in the development of textbooks based on the subject of the environment.

E. REGIONAL OBJECTIVES AND STRATEGIES

In this chapter, brief reference is made to some of the principal traits (problems and assets) of each of Madagascar's large regions, and the objectives and strategies concerning them are defined.

1. The High Plateau

The High Plateau is characterized by a high population density, strong land pressure and farmers who, in order to survive, must turn more and more to planting rainfed crops on the slopes of the Tanety -- leading to erosion and silting up of downstream ricefields. Deforestation for coal production is much practiced here because of urban and rural demand. The influence of towns, and particularly their surrounding areas, often results in confusing land situations which contribute to the degradation of cultural systems. However, the assets of the High Plateau are far from negligible and it should be possible to establish production systems which are both more intensive and less dangerous to the environment: the farmers generally have good technical training, particularly in rice-growing (although this is included among the borderline ecological conditions); the large urban markets are close by; the great diversity of micro-climates, ranging from tropical to temperate, allows for all types of agriculture and high-income production. To this end, the objectives and strategy could take the following directions:

(i) **Village land management programs,** with particular accent on the Tanety to better conserve the soil, slow down erosion, and develop a more intensive rainfed agriculture according to a cultivation system aimed at restoring fertility with the minimum agro-chemical input(*).

(ii) **Stimulation of crop diversification,** by trying to redirect part of the rice-growing, notably on marginal lands for rice production, towards other supplementary agricultural crops, in particular high-income crops oriented towards urban markets.

(iii) **Increased land security** with a view to stimulating land investment.

(iv) **Redirection of pre- and post-production services** (research, agricultural credit, extension) **towards protection of the environment, land development, and reforestation.** Note that

there should be much more efficient extension on rainfed agriculture (soil conservation, agro-forestry, development of the Tanety and crop diversification) and high-income production for the urban markets (fruit and vegetables, small hoofed livestock and poultry) than on rice-growing where farmers are already relatively well trained.

(v) **Improvement of the urban living conditions,** by restoring a dynamic land policy, by improving housing, health networks, the collection and treatment of waste matter, by increasing urban financial resources and by creating employment.

2. The Eastern Coastal Region

This coastal region contains a large part of Madagascar's remaining natural patrimony. This is also the region where this very fragile patrimony runs the highest risk of degradation, given the strong land pressure, the increase in the Tavy, notably in the Central South, and the steep slopes and cyclones which increase tenfold the erosion process. This, too, is the most favorable area for the development of export crops such as coffee, vanilla and cloves. The peasants are less trained than those on the High Plateau, but the potential for increasing productivity is much higher here. The regional strategy recommended would revolve around the following actions:

(i) **Emphasis on the protection and management of the biological diversity combined with ecological tourism.**

(*) organic fertilizer, "alley cropping" - agriculture in alleys bordered by rows of bush and vegetable plantations, e.g. the Leucaena, trimmed or grazed annually, providing the soil with azote - and integrated pest control.

(ii) **Increased food security,** by developing and restoring rice-growing in the coastal plains and forest-clad valleys, and by strengthening the road network to facilitate marketing. This is, the case in the Maroantsetra plain (about 30,000 ha) where production potential (2 harvests, years of high yield) is much higher than on the High Plateau, while actual productivity is particularly low (1-1.5 t/ha). Development of this rice-growing should ease pressure on the natural forests by reducing the Tavy.

(iii) **Extra emphasis on the development of tree crops for export,** bearing in mind the opportunities and constraints of the international market. This involves increasing the country's foreign currency resources, protecting the slopes which have been excessively stripped by the Tavy and, at the same time, progressively developing a category of producers who are concerned with environmental conservation.

(iv) **A land management policy oriented towards better usage of land** according to the degree of its slope and fertility, and towards discouraging Tavy crops, by means of effective supervision and dissuasive taxation.

(v) **Reinforcement of pre- and post-production services,** with special emphasis on extension and research, which have been rather neglected until now, but which could prove to be one of the best agricultural investments.

(vi) **Particular emphasis on a development plan for the Pangalanes,** in order to develop their piscicultural production and check the degradation caused by sedimentation.

3. The zones of the Middle West

According to the regional classification adopted in Chapter I, these zones are part of the High Plateau, yet they are quite distinctive by their low population density and the preponderance of extensive animal husbandry. These zones have always been considered the most likely to ease the population pressure in the eastern part of the High Plateau. Unfortunately, insecurity and theft, particularly of cattle, have reached such alarming proportions that natural government-stimulated migratory flows have been seriously slowed, and even reversed in certain cases (cf. Chapter III). In spite of this, a number of large new properties have been established which ensure their own security and which have developed mechanized crops without always taking care to avoid erosion. First and foremost, the greatest priority is to restore security - without this no form of development will be possible. Should these zones become more secure, they should be used for agriculture/livestock with rice-growing in the valleys, rainfed crops and agroforestry ("alley cropping") on the most fertile Tanety and grazing on the others. Fresh attempts at developing new land could be organized using methods of soil conservation and agroforestry -- on condition that installation costs remain reasonable. In fact, this is what the Government, in preparing a new development project for the Middle West, intends. This project could provide the opportunity to implement a new, fair policy of land distribution, as proposed in the EAP.

4. The Western Coastal Region

Although less rich in biological diversity than those of the Eastern coast, the natural ecosystems of the West coast are still extremely interesting, and highly endemic. From the agricultural point of view, they are essentially livestock zones. Irrigation potential is high, but difficult and costly to implement, given the instability of the milieu and the phenomena of erosion and sedimentation that increase the development and maintenance costs of the facilities and limit their lifetime (as in Monrondava). The strategy for this region resembles that suggested for the Eastern coastal strip -- however with a much higher fishing and aquaculture potential. A special effort of research and development should be made, particularly in the area of fodder, with trials, notably of forage trees and "bourgou" (Echinochloa) in the flood plains.

5. The North

This area combines the ecological characteristics of the other regions. Its population density is relatively low, its biological diversity particularly high, and the soil is mostly rich. But, because of its steep landscapes, the risks of degradation are great. It will also be recalled that, apart from aerial transport, communication with the rest of the country is difficult. The existence of a high-potential export market with R union should also be noted. The strategy for this region would be similar to that suggested for the East Coast, with particular emphasis on a combination of biological diversity and tourism.

6. The South

This is by far the most disadvantaged region of the island with an extremely poor hydrolic system consisting of low, unevenly distributed rainfall. Extensive animal husbandry is practiced in this area. Special emphasis should be given to hydrogeological research to determine the profitability of tapping the aquifers. The coastal zones should be given special attention because of the interest of their flora and fauna. In addition, this region has undeniable cultural, scenic, and ecological assets which could make it one of the major attractions for ecological tourism. The following should be undertaken:

(i) **Preservation of the vegetation and extension of useful species;**

(ii) **Establishment of brushy species,** linked with small anti-erosive developments, to further water infiltration and the recharging of the aquifers;

(iii) **Multiplication of windbreak hedges,** with forage species (cactus, acacia, etc.) with a view to creating a bocage landscape like thatof Vala Mahafaly;

(iv) **Introduction or selection of varieties which tolerate dry conditions** (sorghum, cowpea, possibly millet).

CHAPTER V

EAP PRIORITY PROGRAMS AND IMPACT ON CURRENT DEVELOPMENT POLICY

To achieve the EAP's goals, five priority programs are proposed:

(i) **A program for the protection and management of the biological diversity, combined with the development of ecological tourism;**

(ii) **A program to improve the environmental situation in rural and urban communities by the creation of a National Environment Fund;**

(iii) **A mapping and land management program;**

(iv) **A program of education, training and sensitization to the environment;**

(v) **A program of support for the EAP with three components:**

- strengthening of the institutional framework;
- development of environmental studies and research; and
- reinforcement of instruments (data bases, methodologies, monitoring and evaluation systems, etc.).

These programs are extremely interdependent and consequently should be implemented simultaneously with an expected effect of synergy. Although on a national scale, they will be carried out in successive phases defined according to the priority of the different zones. Finally, their implementation is urgent if the current spiral of degradation, which appears to be worsening, is to be stopped. For each program, we have outlined specific objectives, strategy and contents, identified interdependent relations, reviewed institutional aspects and listed the different phases -- particularly studies and pilot actions that will facilitate their preparation and launching. Following EAP approval, extensive work will need to be done to prepare feasibility studies for the different programs, particularly in their different phases of development.

A. A PROGRAM FOR THE PROTECTION AND MANAGEMENT OF BIOLOGICAL DIVERSITY COMBINED WITH THE DEVELOPMENT OF ECOLOGICAL TOURISM (CF OBJECTIVES AND STRATEGY PARA. IV.D.2)

This program would consist of the creation and management of 14 new protected areas, as well as reinforcement of infrastructures (tracks, huts, observatories, reception) and management of the 36 areas already in existence. It would revolve principally around the eastern and northern regions and the coastal areas of the West and South. It is proposed to classify these 50 protected areas into three categories according to the degree of risk (from land pressure, population density, state of degradation, vulnerability). Depending on the category, the following actions are envisaged:

(i) **Where the risk is highest, major intervention,** with extensive investment, combining development and protection systems with an integrated development program for the peripheral zones;

(ii) **Where the risk is less, moderate intervention,** with the same protection but less investment for the periphery;

(iii) **Where the risk is low, minimal intervention** involving no initial peripheral investment (as with marine ecosystems, for example).

Implementation of this program also assumes interventions by other programs envisaged, such as:

(i) **Land management and surveying.** This involves, first, ensuring the legal protection of the 50 chosen protected areas and the classified natural forests (classification decree + registration of the corresponding land titles to the State's private property). The land situation of the farmers in the already deforested zones must then be settled. Finally, good, cost-effective, monitoring methods should be established, with systems of penalization, for example, in the form of special land taxes. This must be accompanied by a vast program of sensitization and training. Such cadastral intervention, which assumes aerial coverage, will also allow basic cartography to be established.

(ii) **The implementation in peripheral zones of mini-projects for environmental improvement** (soil and water conservation, agroforestry, reforestation, small valley developments, etc.) financed through the FNE. It is likely this financing will be more significant than for zones not concerned by protected areas in order to facilitate the stabilization of the agricultural systems and avoid peripheral ranch burning.

(iii) **The launching of a vast campaign of sensitization, training, and education on the Malagasy biological diversity,** with particular emphasis on the promotion of local associations connected with each reserve and on the training of rural inhabitants for jobs generated in this sector (park wardens, supervisors, and ecological guides for example);

(iv) **Setting up a program of additional studies and research,** aimed at supplementing the inventories of flora and fauna in progress, clarifying methods of developing natural forests without endangering their existence, and identifying the best means of encouraging popular participation. Priority must be given to continued remote sensing (LANDSAT and SPOT) which, combined with aerial cover, should allow a better estimate of surface areas of natural forest, their level of degradation, and of the protected areas.

(v) **Setting up of a data base specific to ecology,** which could be managed by the CNRE.

From the institutional point of view, launching of the Forest Management and Protection Project should allow reinforcement of the SPN within the DEF to begin. This would eventually be transformed into an autonomous body charged with the management of parks and natural reserves, under the aegis of the MPAEF. To begin with, this task must be supported by private efforts, both national and international (local associations, NGOs, zoos, foreign universities, hotel chains, industrial groups). This effort could be solidified within the framework of an international foundation helping the SPN to channel funds and to select and recruit temporary expatriate personnel, and helping the MRSTD to ensure scientific monitoring of the protected areas and become integrated into international scientific networks.

Roughly estimated, the global cost of conservation and management, including rural development of peripheral zones, would be about 160 billion FMG (US$130 million) for the next 20 years, or an average of about 8 billion FMG per annum ($US6.5 million), but evolving over time.

About 50% of this global cost would correspond to development operations in the peripheral zones, the rest being directly tied to conservation. The part concerned with development of these zones could be financed by concessional IDA-type loans or grants, via the FNE. Regarding conservation: at the beginning of the financing phase a large part, if not all, should come from grants made by the international community. However, it is foreseen that the contribution from the tourist sector could reach 20% in the medium term, assuming a relatively rapid expansion in this sector.

INVESTMENT PATTERNS FOR PROTECTED AREAS

Because of a recent study carried out by the WWF, preparation of this program is relatively far advanced. However, there are still a number of steps to cover before it can be launched, as indicated in the timetable figured below. At the same time, thanks to the Forest Protection and Management Project and similar projects(USAID), reinforcement of the management of certain reserves, development of peripheral zones, and institutional reinforcement will be undertaken without delay. In the next two years, it is anticipated the ten reserves running the greatest risk of degradation will be equipped and well managed, with mini development programs begun in the peripheral zones. The other reserves will be progressively integrated according to inventories and base studies and the development of human resources.

Timetable for preparation and implementation of the Program for the Protection and Management of the Biological Diversity

	1988 1989
	M J J A S O N D/J F M A M J J U S O N D/
F O R E S T R Y P R O G R A M I I I	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
PROGRAM PREPARATION	
- inventories of flora and fauna	XXXXXXXXXXXXXXXXXXXXXXXXX
- inventory of natural forests (SPOT)	XXXXXXXXXXX
- international foundation study	XXXXXXXXXXXXX
- classification of reserves and investment studies	XXXXXXXXX
- preparation of feasibility study	XXXXXXXXXXXXXXXXXXXXX
PILOT ACTIONS	
- surveying and land operation for a test reserve	XXXXXXXXXX
- sociological study on community participation	XXXXXXXXXX
- test contract with hotel group	XXXXXXXXXXX
- training in negotiations (Dir. Tourism)	XXX

For tourism, Madagascar has just prepared an ambitious national plan whose objective is to reach 100,000 tourists/p.a. within 5 years (1992). Although this appears rather optimistic, it does show the dynamism of the Tourism Directorate, which seeks to develop a new image. It would combine classical beach tourism with a tourism of adventure and discovery, relying on the extremely diversified network of natural reserves and combining all the assets of the southern region. Contracts are already being negotiated with international hotel groups who could take charge of all or part of the financing and management of some reserves. To facilitate these negotiations, some employees from the Directorate will be trained in international negotiations within the framework of the pilot actions financed by the small Environmental Fund set up for preparation of the EAP. A possible alternative contribution to financing conservation via tourism is a systematic hotel tax especially allocated to this objective. This solution would also ensure the continuity of the hotel sector's financial contribution.

B. A PROGRAM FOR ENVIRONMENTAL IMPROVEMENT IN RURAL AND URBAN COMMUNITIES

As proposed in the EAP strategy, this program would be financed essentially by means of the FNE. This would function on the same model as the Rural Development Fund (FDR) which now has several decades of experience in the African context, as well as that of other continents. Let us recall the basic principles:

(i) **Definition of standard mini-projects of environmental improvement,** the number of cases being limited beforehand to several technical reference models corresponding to the major part of expected consumer demand. These models would be drawn up during preparation of the program's feasibility file. At first estimate, the mini-projects for rural communities would revolve around soil and water conservation, land development, forest nurseries, agroforestry and reforestation, small-scale irrigation equipment and the small village infrastructure; for urban communities, the mini-projects could involve trash management, small water supply systems, and small infrastructures.

(ii) **Preparation of mini-projects and decisions on their financing at a level as close as possible to the communities concerned.** This would be made possible by the existence of the standard models mentioned above, which would limit the difficulties and time necessary for preparing these mini-projects. The preparation would thus be an adaptation of the models to the specific conditions of a village, which could be carried out directly by management staff on the ground.

From the institutional point of view, implementation of the program is based on:

(i) **The participation of local structures within the context of standard contracts,** as mentioned in para. V.B; and NGO assistance to supplement the government networks of field agents. It is foreseen that these structures will make their contribution in the form of work and contract to maintain and renew the investments realized within simple systems of cost recovery;

(ii) **Technical support of the field agents** (MPARA, MPAEF, etc.);

(iii) **Usage of banking systems for financing,** as opposed to government channels; and

(iv) **Establishment of a simplified and flexible institutional framework.** In the case of Madagascar, global responsibility for the FNE could be given to the SINE (cf. IV.D.4) and the financial and economic process delegated to the banking networks. The experience of the Rural Development Fund (FDR) has demonstrated the strong synergy that exists with the Agricultural Savings Bank (ASB), one often complementing the other. In addition, the existence of an FDR often permits the bank to develop its network on the ground more rapidly, with the creation of an agency being justified by the combination FDR + ASB, when the latter alone would not permit it.

The FNE concept is not an entirely new one. Madagascar has implemented numerous small irrigation operations and other infrastructural mini-projects (financed by the European Development Fund [EDF], and NGOs). With support from Switzerland, Madagascar has also carried out successful reforestation and soil conservation operations. During preparation of the Program, it will thus be necessary to study these operations and draw practical lessons from them. Some thought should also be given to contracts, as mentioned in Chapter V, and in particular the role of local institutions and the NGOs. The next area of study should be the institutional framework, the structure of the FNE, its relation to the banking networks, the SINE and the technical ministries, and its level of decentralization. Finally, it will be necessary to study relations between the FNE and the Social Action Fund whose creation is foreseen within the framework of the PASAGE program. This program's liaison with the other components of EAP is practically systematic, given that the FNE constitutes the privileged financing tool of all environmental action at the level of the local communities, whether they be concerned with protection of the biological diversity, management of community land or implementation of the land program. The FNE could be financed by successive installments of funds from IDA-type concessional sources, with the possible participation of bilateral aid in the form of grants.

Preparation of this program could begin now, with a first FNE phase being implemented towards the end of 1989. It may, however, be divided in two -- one part relating to rural communities, the other to urban communities. This latter could be addressed within the framework of current and future urban programs. During this preparation, it will be a question of identifying different kinds of mini-projects dealing with environmental improvement by major region, verifying demand at the rural and urban community level, and defining priority zones in which the FNE could be launched.

The preparation and launching of this environmental improvement program might even be accelerated -- if an integrated pilot phase of the PASAGE program could be foreseen -- financed by the Social Intervention Fund (FIS) whose creation is envisaged within the framework of this program. In this way, financial arrangements and the feasibility of some environmental operations in priority zones could be tested at the community level.

Since the PASAGE should be negotiated in September 1988, it might be possible to implement the pilot phase of environmental improvement by the beginning of 1989.

In addition to the mini-projects financed by the FNE at the rural communities level, more far-reaching environmental improvement programs are proposed, e.g. at the vast watershed level at Lake Alaotra and in the Middle West regions.

C. A MAPPING AND LAND MANAGEMENT PROGRAM

This program involves refining, consolidating, and implementing programs already established by the Cartography Institute of Madagascar (FTM) and the Direction du Patrimoine. For this reason, and thanks to group work, its preparation is already well advanced. Let us briefly recall the objectives of this program:

(i) **Increase land security for rural as well as urban dwellers** by proceeding with land registration, the issuance of land titles, and the establishment of a simple management system at the local community levels;

(ii) **Reconstitute and update the country's cartographical base;**

(iii) **Regularize the land situation for all the protected areas and peripheral developments;** and

(iv) **Strengthen and simultaneously simplify the institutional land framework,** in order to supply users with the necessary assistance to realize the first objective.

The program as a whole should be designed to respond first and foremost to user demand. This assumes three conditions be fulfilled:

1st condition : everyone should be aware of and understand the land legislation.

We have seen that the population of Madagascar was already sensitized to land registration, but we must go further, taking specific action to provide more information. This calls for the drawing up of a clear document describing this legislation and the government bodies responsible for its implementation. The next step is a land information campaign, to be carried out using the most cost-effective combination of media. Existing networks of agricultural popularization could be used. Training, particularly of the people involved in land management at the local institution level, will also be a priority.

2nd condition : a decentralized land management at the level of the local institutions.

Arrangements must be made for the Fokontany to effectively ensure a major part of the land management of their community land.

3rd condition : reasonably priced surveying techniques of easy access to users.

Until now cadastral surveys have been carried out at the cost of fastidious and expensive topographical work. Experience demonstrates that these investments are most often viewed with suspicion by the users who have trouble understanding the surveying process. Direct usage of enlargements of aerial photos (orthophotos on hilly land) is much quicker

and has the advantage of being understood by the consumers. By using aerophotogrammetry for land surveys two birds are killed with one stone, since the same process will be used for basic cartography. This new surveying method is the one the Direction du Patrimoine and the FTM want to promote in Madagascar. The Government's plan is to implement land registration throughout the country within 15 years. It will begin with the priority zones which will be chosen according to the following criteria:

(a) urban and peri-urban zones;
(b) population density and state of degradation in rural zones;
(c) number and gravity of land conflicts;
(d) production potential; and
(e) presence of a protected area.

From the institutional point of view, the program is based on a better definition of the tasks of the FTM (geodesy, aerophotogrammetry, cartography) and of the Direction du Patrimoine (land surveying, archive management and cadastral plans). It also assumes the full participation of the decentralized village associations, as mentioned above. The global cost of this program over a period of 15 years has been estimated at 215 billion FMG (about US$168 million). Nonetheless, this would be a complete program and it should, if possible, be revised downward during preparation. For example, in non-priority areas, surveying operations could be differed beyond this period.

Additional studies (land taxation, periodical studies of land distribution, definition of priority zones) and pilot actions (mini surveying operations in the Middle West) are planned to test the new methods of cadastral surveying in different situations. This program could perhaps be ready before the end of 1989. It would also be possible to integrate all or part of these studies and pilot actions in the PASAGE program in order to ensure financing and accelerate implementation.

D. A PROGRAM FOR ENVIRONMENTAL EDUCATION, TRAINING AND SENSITIZATION

This program is essential to the success of the other actions proposed by the EAP. It should involve the populace, the people in charge, and the trainers. The objectives and strategy were defined in para. IV.D.8. The program will comprise the following actions:

(i) **Ensure the training and recycling of agents who will be involved in implementing the EAP;**

(ii) **Reinforce the teaching of environmental matters in school curricula by creating, realizing and furnishing the appropriate pedagogical tools and by training teachers and professors;**

(iii) **Develop university studies in the field of the environment;**

(iv) **Develop a national communication network and strengthen production and diffusion of appropriate programs;**

(v) **Set up a system of monitoring and evaluation of these programs and their impact, in order to modify their form, content and methods.**

Among those actions described above, it would probably be easier to implement those specifically concerned with training in the context of the other programs, while those concerning education, communication, and sensitization will be included in this program.

From an institutional point of view, the creation of programs on environmental education and programs concerned with information and sensitization to the environment should be effected in a joint and coordinated manner between Government representatives, decentralized structures, NGOs, and national and international associations. Three Ministries (MININFO, MINESEB and MINESUP) will have decisive roles to play, probably under the coordination of the SINE. The other technical ministries will also have a part to play, notably in the definition of messages and specific training. The SINE will need to clearly define the respective roles, in order to avoid any overlapping of responsibilities.

It is still difficult to estimate the cost of this program and its implementation timetable. At this stage, only a certain number of preliminary studies and additional actions have been identified:

(i) **Choosing target groups, identifying their needs, and studying the means needed to achieve them;**

(ii) **Evaluating projects and earlier programs** with a view to drawing lessons from them;

(iii) **Implementing test programs of information and sensitization and measuring their impact,** in order to refine contents and diffusion methods.

Once again, financing of these additional studies could be included in the PASAGE program.

E. A SUPPORT PROGRAM FOR THE EAP

The principal components of this program are:

(i) **Reinforcement of the institutional framework;**

(ii) **Development of environmental studies and research;** and

(iii) **Reinforcement of instruments** (data banks, methodologies, monitoring and evaluation systems, etc.).

In the area of institutional reinforcement, it is foreseen that the following actions will be financed:

(i) **Installation, infrastructures and equipment for the SINE;**

(ii) **Technical training and assistance.**

As for environmental research, the following sub-programs will be developed:

(i) **Preservation and improvement of resources,** using two different strategies for the various regions. On the Highlands and in the East, it

is proposed that soil conservation and agroforestry be emphasized in order to reconquer and improve the Tanety and stabilize agriculture around the natural forests. To the West and the South, it is proposed to protect the existing ecosystems, notably the grasslands, by adapting to the natural dynamics and to enrich their vegetable potential (fodder trees, etc.);

(ii) **Supplementary acquisition and management of data bases before any research in the hydrological area.** This is to be facilitated by the study undertaken with the support of the World Bank and the financial assistance of the UNDP. It is proposed to resume the studies on erosion and the runoff from watershed, in continuation of those launched by the FOFIFA with the assistance of the CTFT;

(iii) **Study of the reconstitution of fish resources in the field of pisciculture on the central Highlands and in the Eastern Pangalanes;**

(iv) **Continuation of inventories in the natural ecosystems and the protected areas;** study of the dynamics of their evolution and of the possible enrichment of the natural communities; and selection of species useful in the formation for the ulterior enrichment of the biologically impoverished areas (recently reclaimed land, High Plateau);

(v) **Research on the marine coastal zones,** notably reevaluation of stocks (particularly of shrimps) and study of the biology of the mangrove zones (shrimp spawning areas, conchyliculture);

(vi) **Emphasis on hydrogeological research in the South,** to determine the profitability of tapping subsoil water;

(vii) **Emphasis on ecological observation and epidemiological monitoring of malaria and schistosomiasis in the public health field.** Role of local associations in the management of living conditions. For the implementation of this program, the CNRE will ensure the coordination of the research sub-programs, determine priorities in collaboration with the other research institutes, and will be responsible for allocation of funds (cf. Chap. IV.D.7). There will need to be a very clear definition of responsibilities, to avoid any overlapping. As we have seen, this is particularly important between the PDRA and the sub-programs mentioned above.

In the field of instrument reinforcement, the cartographical and cadastral section has already been discussed. Regarding data banks, it is foreseen that each specific institution will receive support in the management of its own data and their updating. In addition, a central data bank is foreseen which would permit the consolidation and crossing of specific data with a view to setting up a simple system of geographical data. This could be situated at the SINE or DGP level. It will be recalled that these data banks should be created according to consumer needs, which implies the elimination of all unnecessary data burdening the system.

In preparing the data bank system, it would be advisable to define standard formats and the frequency of collection, updating, treatment and transmission to the central data bank. During the preparation, it will also be necessary to foresee a very detailed feasibility study of this data bank system. Such a study could also be financed within the framework of the PASAGE program. At a rough estimate, the program could finance the equipment of these data banks, and the technical training and assistance necessary to reinforce them.

Finally, a number of studies are foreseen whose aim would be to prepare possible legislative modifications, to refine methods (impact studies, etc.) and to clarify the system of monitoring and evaluating the EAP. Once these studies have been carried out, it will be possible to better define actions to finance in the framework of the program.

F. IMPACT OF THE EAP ON CURRENT DEVELOPMENT POLICY

I. IMPACT ON LEGISLATION

Madagascar currently has a relatively complete set of legislative texts covering the environment, but these are still little implemented in the field. These texts could be recast within an environmental code. In addition, propositions for modifications and amendments have been suggested in the areas of conservation, land legislation, and investment screening.

In the area of conservation, Madagascar is a member of the Convention on International Trade of Endangered Species (CITES) and has adopted its regulations. However, it seems necessary to modify the list of species strictly forbidden for export (with the exception of those animal species raised in captivity by approved livestock owners and for vegetable species artificially reproduced by approved horticulturists) following latest surveys and studies of the Malagasy flora and fauna. It is also necessary to revise taxes on exports that do not always reflect reality (rarity and commercial potential of the different species). Finally, the status of protected areas should be modified to allow controlled development of "discovery" tourism. It is certainly in the area of land that the propositions to modify legislation are the most important. They involve 4 aspects:

(i) **Sharecropping and land leasing in general.** As we have seen, in spite of being illegal, sharecropping is in fact practiced on a large scale. This being the case, it would seem reasonable to repeal this law and once again recognize the legality of sharecropping. At the same time, regulations should be introduced which, on the one hand, offer the sharecropper sufficient land security (long-term contract for a minimum of ten years with compensation procedure for land investment) and an acceptable share amount (if possible lower than one quarter of the harvest), and, on the other hand, unambiguously guarantee land ownership. Another possibility would be to substitute sharecropping with tenant farming. This arrangement is often more adapted to providing farmers with good land security. The Government could keep the spirit of the law, by favoring those who cultivate the land, while changing its form. The best tool in this case would be land taxation which could progressively lead landowners to either invest and directly develop their properties, or sell.

(ii) **Undivided properties.** It appears necessary to study and introduce permanent texts to settle the land situation in the case of extended families, without wronging the beneficiaries but providing the administrator with the opportunity to effectively manage the entire property, "for the common good". We have mentioned the possibility of a statute of civil land companies, or joint family farming units as possible solutions to this problem. This should be studied quickly in the context of preparation of the land management and mapping program.

(iii) **Land consolidation.** In areas where the splitting up of farming units is excessive and hampers village land development, it is going to be necessary to begin consolidating at the same time as, or just after, collective registration. In this area, it could be of interest to consider the experience of the Agricultural Land and Rural Economy Association (SAFER) in France (*) and perhaps adapt it to Malagasy conditions.

(iv) **Land taxation.** In the spirit of the law, this taxation was conceivedas an instrument of land policy, as a substitute for income tax in rural zones and ,at the same time, as a source of income for the decentralized structures. Its application reveals a certain number of defects which the EAP proposes to correct. Amongst these are the low level of taxation, the limited dissuasive value of this taxation on abandoned land, the absence of deterrants for Tavy. It should also be mentioned that the proportion of income from this taxation which remains with the Fokontany is derisory (3%) and provides no incitement for them to collect it. The spirit of the law must be restored in such a way that this taxation becomes the major instrument of the country's land and environmental policy. In order to make these fiscal reform decisions easier, it is proposed to carry out an indepth study on the land question within the framework of the country's general tax system.

II. THE IMPORTANT ROLE OF LOCAL STRUCTURES

The local structures (Fokontany, miscellaneous associations), which already play an important role in the country's administration, will constitute the mainspring of the application of Malagasy environmental policy, particularly in implementation of the EAP. To support these local structures and clearly define their prerogatives within the framework of the EAP, it is proposed to install a flexible contract system between them and the bodies, public or private, providing technical and/or financial support. These contracts could first of all contain a reminder of the rights and responsibilities of the different parties in the management of environmental resources, and then a definition of their respective agreements within the context of EAP activities.

(*) These mixed-economy societies are intended to encourage consolidation by acquiring land stock with a view to facilitating exchanges and the creation of viable farming units. Principal SAFER shareholders and the Agricultural Credit Bank, farmers' associations and the Ministry of Agriculture. There is a SAFER for every agricultural region.

The following is a first list of responsibilities which will fall to the local structures:

(i) **To be arbitrators on land issues for the community village land or districts in urban areas.**

(ii) **To act as implementing agency for collective environmental land improvements.** This means mobilizing local labor and organizing collective works for development of the rural and urban environment.

(iii) **To collect fees,** particularly land taxes, assuming that a large portion of these remain at their level.

(iv) **To keep and update simplified land registers.** In this area, and particularly in rural zones, data which should remain in the village and those which should be kept at the regional level should be clearly defined.

(v) **To set up and maintain boundary marking networks,** whether they be physical boundaries (geodesic boundaries, boundaries of village land, in collaboration with the neighboring village[s]) or living boundaries (trees or hedges). A priori, living boundaries would constitute a better solution as they respond not only to the need to define limits but also to that of developing agroforestry (production of ligneous fuels and effects of windbreaks). It will be recalled, however, that there is no question of systemizing the usage of boundaries in the land surveys, which would make them extremely costly. Rather, it will be left up to the users to make their own physical boundaries, wherever they deem it necessary.

(vi) **To manage community land and participation in the management of the natural forests and reserves adjoining their land.**

(vii) **To make sure the environmental land code is respected,** assuming there will be a recasting as suggested above, and to ensure land data at their level.

For their part, the support bodies will be responsible for:

(i) **training members of local structures,** particularly those responsible for implementation of the EAP;

(ii) **carrying out land surveys, elaborating and helping the structures set up simplified land data systems** which would be managed by them;

(iii) **carrying out diagnostic studies of the village land and helping the structures elaborate their programs of land and environmental improvement;**

(iv) **financing these programs,** mainly through the FNE; and finally

(v) **ensuring the monitoring of these operations.**

It is proposed to carry out a study to refine the above-mentioned procedure and to make it operational.

III. EFFECTS ON CURRENT PROGRAMS

When the EAP was prepared, account was taken of experience acquired and lessons drawn from a certain number of studies or projects, already carried out or just beginning. Let us remember the particular influence of projects financed by the Swiss Cooperation, for soil conservation and the pioneering actions taken by the WWF, with USAID support, to conserve the biological diversity and the participation of the people, as well as the evaluation of energy resources (cf. III.C).

The EAP sheds new light on other projects which are being redirected to take better account of the environment. The most interesting case is that of the new master plan being drawn up for the Lake Alaotra region. This master plan would incorporate global and harmonious management of the environment (protection of watershed, soil conservation, reforestation and protection of marshlands - the Lake Alaotra marshlands are part of 14 new reserves whose creation is proposed within the framework of the EAP) with hydraulic investments, which until now have been the nearly exclusive object of financing. Given the quality of the institutional framework (SOMALAC), mobilization of the population and the interest in these guidelines for the environment, it is proposed that the Lake Alaotra region should be treated as a pilot project when implementing the EAP so that it will serve as a model for other projects.

Another case concerns the Middle West region for which another master plan is being prepared. It is suggested this be based on a balanced land distribution, taking into account the environmental aspects and thus constituting another pilot operation for the EAP, but in the field of the colonization of new land.

Finally, the Master Plan for Agricultural Research (PDRA) and the national program of agricultural extension, both being prepared with the support of the World Bank, assume great importance in the implementation of the EAP.

As for research, now is the time to:

(i) **Adjust priorities**, and, in particular, to incorporate in the PDRA environmental aspects of agriculture (soil conservation, agroforestry, reforestation, etc.);

(ii) **Clearly define the respective roles of the FOFIFA and the CNRE.** The agricultural extension networks must be redirected beyond narrow technical themes, towards sustainable production systems and towards intensification of rainfed crops on Tanety with soil conservation. These networks will have a key role to play in the sensitization and training of farmers' associations on the ground. This would involve an intensive program of training for field agents on sustainable production systems and environmental aspects, and strong support from the Ministries concerned (MPARA, MPAEF and MRSDT). With the introduction of the "Training and Visits" system, it should be possible to:

(i) tighten links between research and extension;

(ii) reinforce training at all levels; and

(iii) create one single body to whom farmers can turn, with this varied extension supported by theme specialists.

PROPOSED ENVIRONMENTAL ACTION PLAN, MADAGASCAR JULY 1988

CHAPTER VI

THE FINANCIAL AND ECONOMIC ASPECTS OF THE EAP AND ITS IMPLEMENTATION

A. ESTIMATE OF THE TOTAL COST OF THE EAP AND OUTLINE OF ITS FINANCING

At this stage, when the EAP is being outlined, it is still difficult to estimate precisely the global cost of its implementation. At most, we may have a first estimate and an idea of its distribution between the different programs proposed. Over a period of 15-20 years, this cost could amount to 400-500 billion FMG (US$300-400 million), distributed as follows:

- about 30-40% in physical investment (productive and protection infrastructures, notably soil conservation, reforestation, agroforestry)
- about 20% for the conservation and management of the biological diversity
- about 10-20% for the development of human resources
- about 25% in the land area (registration, surveying)
- about 5% for management of the EAP as a whole, including monitoring and evaluation.

It will be noted that direct investment in the tourist and hotel sector is not taken into account since they are financed in the classical way -- by commercial banks. Only certain indirect peripheral costs in the field of training, control and management of this sector are included. Over the next 5-10 years, a first phase of the EAP could be implemented for the sum of 130-190 billion FMG (US$100-150 million), with a distribution differing from the global distribution (relatively more importance given to the establishment of environmental management instruments and to the development of human resources). A major part of this program's financing (about 90-95%) should come from the exterior, Government and consumer participation being relatively restricted in the beginning, but increasing gradually over successive phases, with an objective of 20-30% at the time of the third phase. As for conservation of the biological diversity, the major share of financing should come from grants from the international community which benefits directly from the program, national participation initially being minimal. This participation should, however, increase, up to about 20% in the medium term, notably due to tax payments by the hotel industry (cf. para. V.A).

In absolute terms, this rough estimate of the EAP's (US$300-400 million over 15-20 years) may seem high. However, it is equivalent to the annual price Madagascar pays because of environmental degradation. This is the price to eradicate the spiral of degradation.

B. ECONOMIC BENEFITS OF THE EAP

Given the approximate level of EAP costs, no economic analysis, partial or global, could be carried out. The most we can do is list and qualify the expected benefits and refer to the rates of return of similar operations in other countries.

(i) **In the area of conservation of the biological diversity** strictosensu, the essential expected benefit is the preservation of a richness of national and international dimensions, which is still difficult to estimate from the economical point of view. Other indirect benefits can be cited in a qualitative fashion, such as the contribution to development by tourism, the ecological function of the protected areas and the natural forests (protection against erosion, regulation of the water cycle, etc.), potential resources in the field of genetics and phytopharmacy.

(ii) **In the areas of soil and water conservation, agroforestry and reforestation,** these interventions should result in a halt to degradation, even improved agricultural productivity, within the framework of sustained production systems. Economic profitability should be between 5 and 15%, based on similar operations elsewhere (12-15% for operations involving implantation of small filtering dikes in Yatenga [Burkina Faso]).

(iii) **As concerns land registration and land surveying,** the first studies undertaken by the World Bank have demonstrated that land registration operations have a very high profitability (for example, a study carried out in Thailand reveals an internal rate of profitability of 70-80% for land registration), and have proven to be one of the best investments in the agricultural field. Without sufficient land security, it is difficult for farmers to invest in land and to protect and manage the environment in a sustainable fashion.

(iv) **EAP can also be expected to have a positive effect on employment, at two levels:** the first, and by far most important, is that environmental improvement projects will demand a high rate of human investment at the local community level. The second is the new jobs thath will be created in the environmental sector (wardens, guides, tourism personnel, etc.). This impact on employment should be particularly felt in Madagascar where well qualified personnel can easily be trained. Globally speaking, the emphasis on the development of human resources and on the sensitization of the population should result in multiplier effects EAP beyond directly financed operations.

C. IMPLEMENTATION OF THE EAP

I. THE PROVISIONAL TIMETABLE FOR COMPLETION AND IMPLEMENTATION

This provisional timetable was based on discussions held in Madagascar in March 1988 and in Toulouse and Washington in June 1988.

(i) **In Madagascar, working groups drew up a list of supplementary studies and prepared the terms of reference.** Implementation of these studies began during May and should take about one year.

(ii) **Outside Madagascar, specific synthesis papers, as well as the present report, have been prepared by the donors on the basis of the group work in Madagascar and will probably be sent to the Malagasy Government before the end of July 1988.**

(iii) **These reports will be reviewed by the Malagasy Government, with the possible organization of an internal seminar.**

(iv) A further mission of donors is planned for September 1988 to discuss the EAP documents, review the implementation of supplementary studies and pilot operations, initiate preparation of the EAP programs, and prepare the logistics of the international conference described below [cf. (vi)].

(v) Following this mission, the Government will prepare the final version of the EAP.

(vi) An international conference will be organized in Madagascar at the end of 1988 or beginning of 1989, during which the Government will present its EAP to the donors and discuss financing. This conference should also be a media operation for the official launching of the EAP.

(vii) Finally, at the end of the conference feasibility studies will be prepared for the definitively approved EAP programs for eventual presentation to the donors. It should be noted that the EAP should eventually be integrated with the Five-Year Plan beginning in 1991, preparation of which should begin in 1989.

II. SUPPLEMENTARY STUDIES, PILOT OPERATIONS AND PROGRAM PREPARATION

At the end of the March 1988 mission, initiation of supplementary studies was decided, as mentioned above, to be financed by the environmental fund of the EAP preparation (list of studies in Annex No.3). These studies should help with the elaboration of feasibility studies for the different EAP programs. In addition, pilot operations are planned in some priority areas with a view to testing and refining intervention methods before implementation of the programs and to sensitizing the population to the benefits of the EAP.

Finally, it should be noted that the PASAGE program should allow for the financing of different activities, as a supplement to the Environmental Fund.

PROPOSED ENVIRONMENTAL ACTION PLAN, MADAGASCAR JULY 1988

ANNEX 1

LIST OF PARTICIPANTS IN THE DEVELOPMENT OF THE EAP AND OF THEIR RESPECTIVE FUNCTIONS

A. NATIONAL WORKING GROUPS

NAME	FIRST NAME	ORGANIZATION	TEL	SUB-GROUP

(see French version for names etc.)

B. COMPOSITION OF MARCH 1988 DONOR MISSION

PROPOSED ENVIRONMENTAL ACTION PLAN, MADAGASCAR JULY 1988

ANNEX 2

ESTIMATE OF ANNUAL COSTS:

EFFECTS OF BURNING OF AGRICULTURAL LAND AND FOREST;

EFFECTS OF EROSION ON THE MAINTENANCE OF INFRASTRUCTURES

A - COST OF THE EFFECTS OF BURNING LAND

A.1. Low hypothesis

- 1 million ha burned land per annum distributed as follows:

  . 600,000 ha of grassland of which 5% unreclaimable and lost (30,000 ha) and 95% with a productivity decreased by 5% (570,000 ha)

  . 300,000 ha of Tanety of which 5% unreclaimable (15,000 ha) and 95% with a 10% decrease in productivity (285,000 ha)

  . 100,000 ha of natural forest of which 50% of good quality and 50% degraded.

- Concerning grassland, one bovine is reckoned per 5 ha, and a yield of 40 kg of meat per bovine annually. It is assumed that the annual yield per ha represents a yield of 10% on capital. The fictitious value of one ha of grassland is thus equivalent to the value of 80 kg dressed weight at US$1.3 per kg. The value of one ha of grassland is thus US$100 and the loss of 30,000 ha represents about US$3 million. The 5% decrease in productivity over 570,000 ha, according to the above hypothesis, represents US$0.25 per annum.

- As regards the Tanety, we have a very pessimistic average productivity of 0.5 t/ha of paddy equivalent at a price of 100 FMG/ha and an exchange rate of 1,250 FMG per US dollar. The 10% decrease in productivity thus represents US$4/ha, or about US$1 million for 285,000 ha. Total loss, based on the same calculation as for the grasslands, corresponds to an approximate value of US$400/ha, i.e. a total loss of US$6 million for the 15,000 ha.

- Productivity for natural forests is estimated at 2m3/ha/p.a. for good quality forests and only half of that for damaged forests. The net price per m3 uncut is estimated at US$80. The value of good quality forest is thus US$1,600 per ha, 50% less for damaged forest. The loss represented by the unreclaimable 10% (assuming half good quality and half damaged) would be US$12 million p.a. As for the 90% replaced by the Tavy, assuming the value of a Tavy is equivalent to US$400/ha (like the Tanety), the loss would be US$1m200/ha for good quality forest and US$400/ha for damaged forest. The loss would then be US$72 million for the 90% forest replaced by the Tavy and US$84 million p.a. for all forest destroyed.

- To summarize: the global cost using this hypothesis amounts to about US$94 million.

A.2. High hypothesis

- 3 million ha burned land per annum distributed as follows:

. 1,800,000 ha of grassland of which 5% unreclaimable and lost (90,000 ha) and 95% with a 5% decrease in productivity (1,710,000 ha)

. 900,000 ha of Tanety of which 5% unreclaimable (45,000 ha) and 95% with a 10% decrease in productivity (855,000 ha)

. 300,000 ha of natural forest of which 50% good quality forest and 50% damaged.

- To summarize: the global cost in this case amounts to about US$230 million.

B - COST OF THE EFFECTS OF EROSION ON THE MAINTENANCE OF INFRASTRUCTURES

B.1. Irrigation:

15,000 FMG/ha for large irrigation systems (80,000 ha)
10,000 FMG/ha for medium irrigation systems (400,000 ha)
5,000 FMG/ha for small irrigation systems (500,000 ha)

Total additional cost of US$7-8 million

B.2. Road infrastructure: US$1.5 million per annum for the whole network

B.3. Port infrastructure: standard estimate of US$1 million

B.4. Summary: about US$10 million

C - GENERAL SUMMARY

C.1. Low hypothesis: US$104 million per annum

C.2. High hypothesis: US$294 million per annum.

PROPOSED ENVIRONMENTAL ACTION PLAN, MADAGASCAR JULY 1988

ANNEX 3

LIST OF SUPPLEMENTARY STUDIES

- Support for the FOFIFA for agroforestry and soil conservation - Tavy
- Possibilities for using natural phosphates
- FJH/IRNT evaluation of the surface area of forests
- Studies on ligneous fuels in rural zones
- Lake Alaotra - environmental scheme
- Sociological study on the participation of communities in the management and protection of protected areas
- Study on the contract system between local structures and support bodies
- Valorization of household waste
- Capacity of the decentralized village associations in the management of household waste and sanitation - 6 towns
- Health - statistical study on causes of mortality
- Training of 25 documentalists
- Synthesis of data and land studies (taxation, distribution, priority zones)
- Preparation of pilot survey project - land development over 15,000 km2 - West
- Survey of existing data banks
- Feasibility study on the system of data banks
- Preparation of possible modifications to the legislation in order to institute environmental impact studies and define conditions under which they will be applied
- How rural inhabitants perceive their environment - Study
- Motivation of teaching personnel vis- -vis the environment
- List of needs in environmental training
- NGO study
- Preliminary study on communication networks
- Evaluation of tourist sites
- Training in negotiation (4 Malagasies)
- Preparation of a system to monitor and evaluate the EAP

PROPOSED ENVIRONMENTAL ACTION PLAN, MADAGASCAR JULY 1988

ANNEX 4

HYPOTHESES USED TO CALCULATE ESTIMATED NEED FOR RICE-GROWING LAND IN THE YEAR 2015

This calculation was carried out solely to provide rough orders of magnitude of a development that would be catastrophic for Madagagascar's future. The assumptions used are thus extremely simple, if not simplistic.

(i) rice imports remain at their current level, so the aim is to satisfy increased demand for rice based on national production;

(ii) yields remain at their current level, i.e. 2 t/ha for irrigated rice and 0.7 t/ha for rainfed rice;

(iii) rainfed rice is a tavy crop - the same plot can be used only once every five years;

(iv) population growth rates are those used by the World Bank in its population projections: three assumptions regarding the change in fertility levels have been employed: no decrease (continuation of current development), gradual decrease, and rapid decrease (extremely ambitious birth control objectives, highly unlikely to be achieved).

The following table shows that, under these hypotheses, the need for additional rice-growing land is 11-23 million ha in the year 2015, which is obviously out of proportion with the investment means actually available to Madagascar.

Production of additional rice required (thousands of tons/p.a.)	1985	2000	2015
0DF	2051	3325	5594
GDF	2051	3106	4420
RDF	2051	3006	3942

Paddy surface required (irrigated, without global constraint)

0DF	0	956	2658
GDF	0	791	1777
RDF	0	717	1418
Average yield	2 t paddy/ha		
Transformation	0.67 t rice/t paddy		

Required paddy surface (rainfed) (thousands of ha)	annual surface required			Total
	1985	2000	2015	2015
0DF	0	1344	4586	23180
GDF	0	1031	2908	14541
RDF	0	889	2226	11128
Average yield	0.7 t paddy/ha			
Available irrigated surface	250,000 ha			
Rotation	5 years			

Note:
0DF = zero decrease in fertility
GDF = gradual decrease in fertility
RDF = rapid decrease in fertility