CHEMONICS
CONSULTING DIVISION

PRELIMINARY ASSESSMENT OF ENVIRONMENTAL CONCERNS IN ECUADOR

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DECEMBER 17, 1979

CHEMONICS
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December 17, 1979

Mr. Allen Hankins
LAC/DR
Agency for International Development
Department of State
Washington, D.C. 20523

Dear Mr. Hankins:

Chemonics International Consulting Division is pleased to transmit to you this final draft report in completion of the requirements of Work Order No. 1, Environmental Program Support Services - Equador. This work order has been performed under our Indefinite Quantity Contract, No. AID/SOD/PDC-C-0220.

The draft report is a product of an approximate one month of field investigation undertaken by three Chemonics technicians skilled in the areas of environmental economics, natural resources and forestry ecology.

Chemonics' home office has, of its own volition, made certain changes to the report as received from the field. These changes were primarily of a format or editing nature, and did not attempt to revise the substantive content. We have also incorporated certain minor changes suggested by USAID/Equador which we felt were appropriate. We wish to note, however, that the attached is a draft report, as required by Article IV of the Work Order. Should AID/W or USAID/Equador desire a final report, including substantive revision, further field work would be required. Chemonics would be pleased to undertake that task under a future work order.

We wish to thank AID/W, USAID/Equador and the various GOE institutions for their cooperation and support in completion of this assignment.

Sincerely,

Candace C. Conrad

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Deputy Director

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CHAPTER I

INTRODUCTION

On request of the USAID Mission to Ecuador, an environmental sector analysis was carried out by a team of three foreign experts under contract to Chemonics with special expertise in natural resource economy, management and ecology. The one-month assignment, which commenced on October 15, 1979, was based on the following terms of reference:

- consult with private and public Ecuadorean institutions which are interested in and responsible for environmental concerns;
- review public and private policy documents with respect to environmental protection;
- assess the extent and magnitude of Ecuador's environmental degradation through deforestation, soil erosion, mismanagement of water resources, overgrazing, and other factors;
- determine the most appropriate institutional focus for a USAID/E program in this area;
- formulate an environmental program strategy for USAID/E.

Because of the complexity of the subject area and the relatively short time allocated to the reconnaissance, the report cannot be considered comprehensive. However, an attempt was made to analyze Ecuador's institutional framework with respect to natural resource management and development policies and to highlight the most serious conflicts and environmental constraints.

The study team used a mixture of techniques to develop recommendations for a dynamic environmental program strategy for USAID/Ecuador.

Previous studies and key personnel from institutions and agencies concerned with environmental problems provided the

background for the report. It was decided, however, to delete most of the traditional biophysical description of the country and all lengthy statistical information. These are referred to in the list of selected references in Appendix II. The assessment of organizational structures, legal responsibilities, policies, problems, programs and resources in environmental management of each contact institution was performed by means of a questionnaire, found in Appendix I. Finally, field trips were taken to important areas to provide the team with a better understanding of environmental problems in Ecuador.

The report is divided into four sections:

- Chapter I is this brief introduction;
- Chapter II, "Areas of Environmental Concern," discusses the extent of Ecuador's environmental degradation in each major area of concern, including desertification, deforestation, soil erosion, chemical water contamination, and air and noise pollution;
- Chapter III, "Descriptive Analysis of Agencies and Institutions with Environmental Responsibilities," describes each agency or institution and analyzes its capacity to deal with the environmental problems listed in Chapter II;
- Chapter IV, "Recommendations," presents an environmental program strategy for AID/E, through strengthening of existing institutions and increased public awareness.

The team would like to acknowledge the assistance of the Ministry of Health (IEOS) and the USAID Mission to Ecuador. Special thanks are extended to Dr. Vincent Cussumano for his helpful support. The team is most grateful to all institutions, agencies and individuals who provided information and material for this report.

CHAPTER II

AREAS OF ENVIRONMENTAL CONCERN

In this part of the report, the most serious environmental problems are summarized. Although an attempt is made to describe and analyze the characteristics of environmental degradation, the scope of a general environmental-sector overview does not allow for great depth and detail. It should be pointed out that much material has been covered quite adequately by previous sector-specific missions to Ecuador, which have produced very comprehensive reports and made valuable recommendations. References to these reports will be made in the following chapters.

A. General Remarks

Ecuador can be divided into three major biogeoclimatic zones: the Sierra, or mountain zone; the Oriente, or humid lowlands in the upper Amazon basin; and the Costa, the arid to humid coastal lowlands.

Problems of environmental degradation differ with the zones. The massive deforestation in the Sierra has caused large-scale erosion and serious destruction of major watersheds, negatively affecting downstream areas in the form of uncontrolled floods and inundations. The indiscriminate destruction of coastal lowland forests and poor agricultural practices are causes for desertification. The degradation of the coastal mangrove forests and the continuous chemical pollution of coastal waters, estuaries and river deltas have seriously affected some of the most diversified, yet delicate ecosystems. As a consequence, the socio-economy of the low-income population of coastal communities continues to decline. Spontaneous and directed colonization along the foothills of the Andes and parts of the Oriente, following the construction of linear development projects, gives reason for great concern. Still favored by

official colonization policy, settlers continue to destroy tropical rain forest to generate pastures and fields, although tropical rain forest ecosystems are known to be delicate and little suitable for ranching and farming.

The most serious environmental destruction is found in the coastal lowlands and the Sierra, in areas with the highest population density in Ecuador. Population pressures are responsible for increasing colonization attempts in areas yet ecologically intact. With an annual birthrate of 4.4 percent, Ecuador's population of 7.5 million is expected to double within the next 20 years.1/

On danger of repetition, it is emphasized that Ecuador's population size in general, and the density distribution in particular, is mostly responsible for the alarming environmental degradation. In many areas, the population density has exceeded the ecological carrying capacity of the land, and only with great financial and technical efforts can the basic needs of these populations be met and the land be rehabilitated. If such efforts are not made in combination with a well-designed "family planning" program, the future outlook for Ecuador should give reason for international political concern.

B. Desertification

In the past 25 years, the amount of arid land in Ecuador increased by 31.5 percent (INERHI information). Out of the 134,000 square kilometers of land in the coastal and Precordillera region, 10,000 square kilometers are now classified as arid. In the Costa, only Esmeraldas Province has significant forest cover left. However, estimates by the Forestry Division indicate that most of the forest will have been destroyed within another decade, accelerating the desertification process.2/

1/ Environmental degradation also contributes to increased colonization, thus creating a vicious circle.

2/ Estimates from certain sources indicate a progressive rate of desertification of approximately 5,000 ha. per year and 10,000 ha. per year for deforestation.

As a result of clear-cut logging in this province, six rivers and several lakes have already dried up. Santa Elena Peninsula, which at the turn of the century was covered with a productive forest, has been converted into desert. A combination of agriculture and petro-industry development are the causes for the Santa Elena disaster. Large areas of Manabí Province have experienced the same process.

Most nutrients of tropical and subtropical forests are in plants rather than soils, so when these lands are cleared, nutrients disappear. The topsoil may support agriculture and/or ranching activities for some time, but if no nutrients are brought back to the soil in the form of green mulch or chemical fertilizer, the vegetative cover will disappear and increasingly expose the soil to wind and water erosion. Wind accelerates the "dehydration" process, and soon only parental material or degraded, unfertile soils are left. Livestock ranching in marginal lands of the Costa and Precordillera definitely accelerates desertification through overgrazing and compacting of the soil, increasing run-off.

The desertification phenomenon is caused by a series of factors and generally is the result of a chain reaction. It may be initiated by the removal of the vegetation cover, followed by unfavorable agriculture practices, which may result in erosion and increasing aridity. Or it may begin through the removal of forest, which may be followed by livestock grazing, destroying the bottom layer of vegetation, hence accelerating dehydration through a combination of wind and surface run-off. This can be evidenced in large parts of Manabí Province, especially in the surroundings of Portoviejo. Much has been speculated with respect to climatic changes resulting from forest destruction and over-utilization of habitat by livestock; however, more research is needed to substantiate such theories. An interesting parallel to Ecuador's desertification process may

be the African Sahel zone, where the desert advances approximately one mile per annum. Possibly initiated by macroclimatic changes, this process is accelerated by overgrazing and the complete destruction of the naturally sparse forest.

C. Deforestation

Fifty-two percent of Ecuador is still in forest, primarily in the Oriente. Deforestation, however, is extensive. It is most obvious in the Sierra where moderate climate and fertile soils supported most of Ecuador's population until the last few decades. The original vegetation of the Inter-Andean zone below the Paramo ("paramo-mist zone," found above 3,000 meters) was probably forest, composed mainly of broadleaf, evergreen species of neotropic origin (Lamar and Stroehlein, 1975).

Some remnants of this forest persist in steeper and less accessible areas, but even these have probably been modified through repeated woodcutting, burning and grazing. Forests in the Sierra were cut long ago for fuel, timber, and conversion of land to agriculture. Deforestation is becoming a major problem, especially in the watershed areas of the Sierra. The native forests at altitudes between 1,000 to 2,000 meters have been completely cleared, and the demand for timber and firewood is increasing. The lack of cover in critical watersheds results in a loss of fertility on agricultural lands, sedimentation in irrigation systems and sources of potable water, and a reduction in the life of hydroelectric reservoirs, all of which have economic and environmental costs. The alarming increase in large-scale inundations and uncontrolled floods may be the direct result of of forest clearing.

In the Costa, the ever-increasing destruction of forests is the result of poorly designed and controlled exploitation processes (inadequate concession system) and the continuous conversion of forest land to agriculture.

> Deforestation today is most evident in the Oriente, the virgin tropical rainforest that occupies over half of Ecuador's territory. In the Oriente vast areas of tropical rainforests have been converted to grazing land; but a lack of soil fertility results in abandonment after a few seasons. This is partly due to the government's policy of granting 50-hectare plots of land in the Oriente to farmers, with the stipulation that the land must be cleared and farmed within five years. The nutrients of the rain forest are in the plants and not the soil. As a result, farmers move on and clear another space. Another impetus to clear land in the Oriente is the result of development of the petro-industry. Exploration continues throughout the tropical rain forest, and as roads are cut and pipelines built, spontaneous migrations bring people who clear land along road cuts, and deforestation begins. 1/

The destruction of forests has another adverse effect: it reduces the habitats for many wildlife species, and puts pressure on the tribal communities of the Oriente.

Another great area of international concern are the Galapagos Islands, where a combination of forest removal and overgrazing have caused large-scale erosion and desertification.

D. Soil Erosion

Erosion is the most evident problem of the highlands of Ecuador, but is encountered throughout the western slopes of the Andes, the coastal flats and the Galapagos. The topsoil has been removed from large areas, particularly on the lower slopes, resulting in migration of population into higher areas and the Oriente, into areas of potentially lower productivity.

The increasing population has resulted in repeated subdivision of property and the creation of "minifundias," which are cultivated on a subsistence basis. Essentially all suitable and most unsuitable land between 2,000 to 3,000 meters is cultivated for crop production.

1/ "Draft Environmental Report on Ecuador."

Areas which cannot be cultivated are used for grazing. Livestock is raised on pasture and crop residues. The zone above 3,000 meters has been primarily used for extensive livestock grazing. Most of the stock move into this zone from adjacent lower elevations and do not remain there on a permanent basis. Increasing demand for cultivable land has resulted in more land at higher altitudes being used for crop production, so that increasing amounts of land between 3,000 to 3,500 meters are being cultivated.1/

The severe soil erosion in the Sierra is caused by a combination of overgrazing on steep slopes, cultivation of marginal and sloping lands, poor agronomic practices and deforestation. The Andes, a comparatively young formation, are tectonically active. As a result of this tectonic activity, soils in the Sierra are often composed of ash, pumice and other loose materials which are easily eroded. All rivers in Ecuador rise in the Sierra, and as they flow over steep slopes and loose soil, they cut deep gorges into the hills, carrying more soil and causing damage in downstream valleys and coastal plains.

Poor farming practices throughout Ecuador are major contributors to erosion. Few farmers are aware of conservation methods such as terracing, and most till by hand. Soils which have not been subjected to excess tillage or overgrazing seem to be stable. Where run-off is concentrated adjacent to roads or construction, or in poorly arranged fields or irrigation systems, erosion is severe. Cultivation tends to move soils down the slopes, and the process is aggravated by hand-tillage in the Sierra and on the western slopes.

The continuous removal of topsoil causes excessive run-off and results in downstream flooding and damage from siltation. Although rows generally run on the contours, terracing is not practiced.

1/ Smith and Stroehlein, 1975.

A common problem in irrigated areas is associated with removing excess water from the fields. This is especially true in high altitudes where slopes are steep and erosion difficult to control. Gulleys are frequently caused by excess irrigation water. Presently, most fields are heavily grazed after harvest, and little organic matter is maintained to stabilize soil structure; this aggravates erosion, especially on steep hillsides. The subsistence farmers who generally raise livestock as a sideline graze their animals on marginal land or eroded areas; overgrazing is common and severe.

Most of the Paramo has not been overgrazed to the point of serious deterioration, mainly because the Paramo is marginal to livestock production and unsuitable for agriculture. However, in some areas, overgrazing has resulted in an almost denuded condition (i.e., the plains and hills around Cotopaxi).

Widespread, indiscriminate burning of grassland and woodland in the Sierra and coastal zones should be discouraged. It destroys plant residues, decreases absorption of water by the soil and accelerates soil and water run-off.

Wind erosion is a problem in areas with fine and sandy soils (around Palmira) and all semi-arid areas where vegetation cover has been removed. Shelterbelts are still not used on a broad scale.

In the cotton-growing areas of the Costa, contour strip-cropping, terracing and grassed waterways should be used as soil conserving practices. Severe gully erosion is occurring in these areas (Hicks, 1977). Priority attention should be given to a soil conservation program in coastal areas where large sections of land are being converted from bananas to corn and soybean. The rainfall in this area is high and the soils are very susceptible to alluvial erosion.

Erosion is rapidly increasing along the eastern foothills of the Andes and adjacent areas in the Oriente, as a result of indiscriminate destruction of forest through colonization and badly controlled forest exploitation by concessionnaires.

Most of the soil erosion problems could be greatly reduced by the use of practical, soil conservation measures. The protection of watersheds in the highlands is essential to prevent floods, silting of reservoirs, drying of streams, and other environmental problems. Erosion in upper watersheds not only causes destruction of productive areas, but also results in downstream damages. Watershed protection begins on the individual farm with soil conservation. It also begins with prevention of forest destruction within watersheds which are still under forests.

Salination of soils has not yet been identified as a serious environmental problem in Ecuador, although it occurs along the lower slopes of the Andes and in the Costa area. However, at an early stage, people who are too optimistic about irrigation potential for arid and semi-arid zones should be cautioned and made aware of the high susceptibility of soils to salination.

E. Chemical Water Contamination

In this section, comments will be made on chemical contaminants, on causes of chemical contamination, and on its potential effects.

In general, although the degree of chemical water contamination is severe, and even intolerable in certain specific areas (in and around Guayaquil); the level of contamination by chemicals is still relatively low throughout most of the country. Industrial wastes, fertilizers and pesticides are the major contributors.

There are in Ecuador rudimentary laws which try to prevent discharge of chemicals. However, there is very little concern over the issue, and relatively little enforcement or control.

Discharges from the petro-industry in combination with other toxic industrial wastes have caused severe damage to the estuary of Guayas river and the mangrove ecosystems found along the coast of the Province of Esmeraldas. This has caused a heavy depression in the shrimp industry and has adversely affected coastal fish production.

Most cities and communities in Ecuador have insufficient or nonexistent sewer systems, with or without connection to treatment plants. Raw sewage is commonly discharged into waterways, resulting in entrophication of water systems and in destruction of potential drinking water (the city of Guayaquil charges US$1 per gallon of drinking water in remote areas, distributed by special tank wagons).

F. Air and Noise Pollution

Although air and noise pollution may be most irritating to city dwellers, these problems will undoubtedly be dealt with when they become intolerable. Noise pollution could be reduced considerably with an increase in civil obedience. Since air and noise pollution presently do not have significant, long-lasting, negative effects on Ecuador's natural ecosystems except for homo sapiens himself, they will not be considered in this report.

CHAPTER III

DESCRIPTIVE ANALYSIS OF AGENCIES AND INSTITUTIONS WITH ENVIRONMENTAL RESPONSIBILITIES

In this chapter, all agencies and institutions with legal responsibility for and interest in the protection of the environment and the management of natural renewable and unrenewable resources are described and evaluated.

Besides government institutions, special programmes, and associated agencies, all major international organizations with permanent representation in Ecuador were contacted to explore specific programmes in the area of concern.

The information received through these contacts formed the basis for the recommendations presented in Chapter IV of this report.

A. Government and Parastatal Entities

1. CONADE (Consejo Nacional de Desarrollo)

CONADE, or the National Planning Board, is an executive agency with ministerial rank chaired by the vice-president. All Ministries with economic responsibilities are represented on the board. CONADE's responsibilities are planning and coordination of national programs.

It is only recently that the general orientation of CONADE changed from a purely economic orientation to a broader concept including social and environmental concerns. Considerable progress is necessary before it can undertake its new responsibilities fully.

The need for the development of technical guidelines to be used for environmental impact assessments has been recognized. However, CONADE expressed great concern about the lack of sufficient trained staff. Presently, only two professionals work in environmental planning: an economist and a city planner.

CONADE hopes to increase its environmental planning capability through the enrollment of technical staff and administrators in workshops on environmental assessments offered by the Spanish UN-sponsored CIFCA (Centro Interamericano de Formación para Ciencias Ambientales).

Another new area of responsibility for CONADE will be the coordination of all national rural development programs, to prevent work duplication, and to assure that the various program objectives comply with national development policy.

2. IEOS (Instituto Ecuatoriano de Obras Sanitarias)

The Ecuadorian Institute for Sanitation Works is located in the Office of the Under-secretary for Environmental Health and Sanitation Works, which is part of the Ministry of Public Health. IEOS is responsible for building health facilities and water supply systems and for latrinization. The programs are implemented through twenty provincial offices. The Division of "Saneam Ambiental" (environmental guarantee) operates primarily in the public sanitation sector. For control of contamination, the division has a total of two staff members.

The "contamination control" sector has initiated several data collection programs in the larger cities for background information on environmental contamination. Although some laboratory equipment is available for sample evaluation, the sector lacks the manpower to use this equipment effectively.

Under law (Decreto 374), IEOS has responsibility for coordinating the activities of all institutions covered by the Law of Prevention and Control of Environmental Contamination. The Inter-institutional Committee for Environmental Protection is responsible for determining criteria for the use of air, water and soil resources and for the control of contamination in the country; it decides if development projects involve the

national use of air, water and soil resources without harming the environment. It promotes the development of educational and informational programs on the problems of environmental pollution, and supervises urban development and work projects such as national parks, industrial areas, and mining which may adversely affect the environment. The committee is composed of representatives of the Ministries of Public Health, National Resources and Energy, Agriculture and Livestock, and the National Planning Board (CONADE). It is presided over by the Ecuadorian Institute for Sanitation Works (IEOS).

The Committee has not been able to meet even though the law has been in effect for about 18 months. This may be indicative of the general lack of interest in environmental issues, but also of inter-ministerial conflicts. Even if this committee were able to meet, IEOS does not have the professional and technical staff to coordinate all environmental protection activities. Only with staff loans from other ministries or large budget increases could IEOS begin to coordinate such activities.

3. MAG (Ministry of Agriculture)

The Ministry of Agriculture is responsible for formulating and coordinating national policy in agriculture and is also the principal institution to receive technical assistance funds for agricultural producers and rural communities. Apart from the centralized activities of agriculture, livestock, forestry and rural development, four decentralized institutes are responsible for a specific segment of public activity: INIAP agricultural research; INERHI, hydraulic resources; IERAC, agricultural reform and colonization; and INCRAE, colonization in the Amazon region.

There are also four semi-autonomous regional bodies (CREA, PREDESUR, CRM and CEDEGE) which operate in specific zones

of the country and are involved in a wide range of activities, including not only irrigation and agricultural projects, but also rural development, road construction and industrial projects.

Field programs in the ten administrative zones are, or will be, implemented by special service units: ASAs (Agency for Agricultural Services); and PIDAs (Projects for Integrated Agricultural Development).

a. Division of Central Planning

Under the Ministry of Agriculture and in coordination with CONADE, this division is responsible for agriculture and forestry program planning. Further, it formulates policies, has authority for project and budget approval and periodically evaluates projects and programs for the Ministry. It identifies and plans development projects for agrarian reform and colonization. However, the division lacks the expertise and baseline data for such planning activities. Consequently, little consideration is given to environmental hazards which may be caused by such projects.

All colonization and agrarian reform projects and associated development activities should be assessed in terms of economic, social and environmental impacts. Such assessments should become an integral part of planning.

b. Division of Rural Development

The Division of Rural Development is part of the Ministry of Agriculture. Its objectives are to promote the technical and cultural development of the rural population and to strengthen rural organizations and basic community services. All activities and programs are to be coordinated with the Rural Development Program (UNDER) of the National Planning Board (CONADE) and are to be in compliance with regional economic development policies.

There are three main areas of activity. These are:

- campesino organization;
- basic education for campesinos; and
- community services.

The rural development program realizes that in some cases, new agricultural production technology is neither useful to, nor accepted by, the subsistence farmer. In order to be more effective, the Ministry of Agriculture presently attempts to address its activities to large-scale production as well as subsistence farmers. In addition, the current philosophy of MAG's Division of Rural Development has focussed on the improvement of basic campesino education to assure more successful technology transfer.

c. Division of Crop Development

The Division of Crop Development has broad responsibilities for the development of agriculture through departments for seed certification, agricultural engineering and plant pathology.

Official policies and procedures specify national use of agricultural practices to protect soils and the environment. For example, fertilization is recommended only after analysis of soils. Engineering policies provide for proper use of mechanization, irrigation systems and drainage.

The division is increasingly concerned about the indiscriminate and increasing use of pesticides. In the period from 1972 to 1976, the imports of pesticides increased from an estimated 2,200 tons in 1972 to about 9,000 tons in 1976. The division strongly supports a law (expected to pass this session) proposing the controlled use of pesticides. New pesticide legislation would cover the control of pesticide production, importation and labeling and the application of all chemicals with potentially adverse impact on the environment.

The division is presently working on guidelines and policies for implementation of the proposed law. It is realized, however, that a problem remains with respect to disseminating the information to the farm level.

The new law in combination with the environmentally concerned staff of the division provides an excellent opportunity to design an assistance program for extension activities in rural areas.

d. Division of Livestock Development

As part of the Ministry of Agriculture, the Division of Livestock Development's main objective is to promote the development of livestock for meat and milk production through cross-breeding and genetic studies.

The high Sierras support mostly milk production or a mixture of beef and milk, while 90 percent of Ecuador's beef ranching is undertaken in the tropical zones. There is some evidence of expansion of cattle enterprises in the Sierra, which may be caused by decreasing soil fertility for crop production, and utilization of ranges in higher altitudes.

Much of the colonization efforts in the tropics are also aimed at increasing cattle production. However, parasites and poor nutrition remain negative factors in potential beef production. Poor nutrition is a result of poor management practices. Overgrazing for an extended period destroys the most palatable grass species first and the livestock turns progressively to less desirable plants. This in turn decreases the soil's ability to retain moisture, hence poor production gains momentum. The INIAP station in Pichilinde estimates that with proper management on a typical, tropical, small farm the annual beef production could be increased by a factor of about 2.3 with proper fencing and better range and agro-forest management practices. With such obvious economic returns, there should

be sufficient incentive for any farmer to better his management practices, if the information on more suitable practices were made available to him.

If research results of INIAP are a true indication of potential returns from proper range and pasture management, then an obvious program for the Division of Livestock Development would be the initiation of a rotating credit fund that would allow the farmer to invest in short-term improvements for long-term benefits.

e. Division of Forestry

As part of the Ministry of Agriculture, the Forestry Division is responsible for the rational management of Ecuador's forest resources, the management of land to be rehabilitated, and all marginal lands. Further, the Forestry Division has legal authority over all national parks, wildlife and forest reserves. Since responsibility extends to the management and conservation of wildlife and its habitants, the Forestry Division has land-use management responsibility for all of the surface and water areas where wildlife occurs. The division also has the vital responsibility for protection and management of watersheds, the preservation of soils and the rational explcitation of natural forests.

Almost 60 percent (13,455,000 ha.), of the nation's total area is under natural forest. Approximately 2,300,000 ha. are earmarked for reforestation. Most of the natural forest is in the Amazon basin. Here, only limited, although uncontrolled exploitation has taken place, and the overall potential is unknown.

In contrast, the other major forest resource, the tropical hardwoods of the western lowlands, mainly in Esmeraldas, is likely to be exhausted within the next decade. The Sierra has already been over-cut, and its contribution to the future

supply of forest products depends on the rate of afforestation and species composition. The optimum use of the Andean slopes would be for environmental protection, although uncontrolled colonization efforts continue to affect these areas adversely. The domestic demand for wood is strong (in the Sierra, predominantly as fuel for heating and cooking, but also for construction). Prices are correspondingly high. This situation forces the lower-income population to seek alternative fuels in ways which hasten the denuding of the countryside.

The programs now being developed seek to promote a conservation-oriented exploitation of the natural tropical resources in the Oriente, through post-inventory concessions to the private sector. However, inventories are lacking, and the present concession system is likely to continue to be detrimental to the forests. The present concession system allows for little control of exploitation procedures, and waste of wood has reached intolerable proportions.

In the Sierra, emphasis is on afforestation for fiber production, soil stabilization and water conservation. The plantings of eucalyptus continue, although the unfavourable C/N ration of the species contributes to soil degradation.

The dramatic increase of forest destruction in the Esmeraldas, the lower slopes of the Andes and the Oriente is caused primarily through spontaneous colonization, following the construction of linear development projects, and shifting agriculture. Wildlife and fish resources, which are still the only source of animal protein supply to many low or no-income communities, especially in the Oriente, continue to be destroyed with progressing colonization and resource exploration/exploitation pressures.

Taking the magnitude of deforestation and erosion problems into consideration, and the magnitude of the potential benefits which could be derived through intelligent management of natural forests and plantations, it is difficult to understand why the Forestry Division has actually decreased in personnel and budget over the past years.

There are other problems. Although the current policy concept of the division has a rather wide scope and covers many aspects of environmental protection, it cannot be implemented because it exceeds the scope of national-level policies. Further, current forestry legislation as well as legislation pertaining to the management of wildlife resources and national parks does not have much relevance to the present administrative structure of the division. The legislation is outdated, completely inadequate and impractical.

An enforcement system does not exist. Forest and park rangers are low in numbers, technically poorly prepared and insufficiently equipped to fulfill their duties. Because of a shortage of funds and qualified personnel, in-service training for rangers is totally insufficient. Many technicians, mostly graduates from agricultural technical institutes, but also from the Technical Forestry School, leave the service because of the lack of job opportunities and incentives.

The professional staff of the division is composed mostly of graduates from the Universities of Esmeraldas, Loja, and more recently, Universidad Central in Quito; but agronomists and engineers may also be found in the division entrusted with the functions of a forester. Ecuador's university training in forestry has a very low standard. Highly trained professionals who received their education abroad suffer frustrations and leave the Forestry Division because of the lack of opportunities and means to apply their knowledge.

The most significant constraints suffered by the Forestry Division are summarized as follows:

- the policy concept is good, but not serviceable;
- forestry legislation is outdated and does not back up the present administrative structure of the division;

- goals and objectives of the division have a good scope, but are not accepted by the Ministry because of different priorities;

- the authority of the division is defined, but only nominally;

- planning is limited to a short-term vision, because long-term planning is either not acceptable to the planning board of the Ministry, or suffers continuous alterations;

- education and performance of staff and technical personnel is of low quality;

- career planning and promotion incentives are lacking;

- interdepartmental competition for funds and authority is detrimental to the cause;

- funds for day-to-day work implementation are insufficient, and funds for basic applied research are almost non-existent.

However, the major problem of the Forestry Division seems to be its total dependence on the Ministry of Agriculture, which favors priorities other than forestry.

f. Associated Programs

(1) INERHI (Instituto Nacional de Recursos Hidráulicos)

INERHI is a MAG-associated agency whose main function is to implement the National Irrigation and Drainage Plan. Some of the other important functions are:

- to study, plan, construct, and operate irrigation and drainage systems;

- to carry out evaluation of national water resources, and to establish a complete inventory of those resources;

- to collaborate with other agencies in the use and protection of river basins;

- to promote the establishment of private and public irrigation enterprises;

- to maintain a registry of water rights granted by the government.

In order to carry out these functions, the institute has four divisions: the Division of Hydraulic Resources, which operates nine river-basin water agencies that have legal power to regulate water use in their areas; the Division of Irrigation, Drainage and Flood Control, which operates through twelve different districts; and two other divisions for technical support and management of the institute.

INERHI has been very active in planning major and secondary canals, but has paid little attention to the development of distributing the water to the farm level. This has caused problems in the completion of projects because small farmers are frequently unable to join the system for financial or legal reasons.

At the present time, INERHI's planning of major projects fails to include environmental, economic and social impact assessments. With such assessments, problems might be identified that might recur within future projects. INERHI believes that it has the capability but lacks the resources for such assessments. Since over a third of the capital for INERHI's development projects comes from foreign loans, it should be the responsibility of the donor to make environmental impact studies mandatory.

(2) INIAP (Instituto Nacional de Investigaciones Agropecuarias)

The National Institute of Agricultural Research is an autonomous organization associated with the Ministry of Agriculture. It is responsible for agricultural research in several areas of the country.

The general objective of the institute is to develop the technology to increase agricultural productivity. Specific research to reach this objective can be divided into the

following areas: genetic improvement; improvement of cultural practices; methods of pest control, and livestock research.

In its technology transfer program, INIAP conducts field days, offers courses, prepares publications and provides new seed varieties to farmers.

Although formal ties to MAG's extension service exist, research results do not seem to be adequately disseminated, especially not to the small farmer. Even though the research stations show substantial potential for agricultural production increase, the overall production (total and per ha.) in Ecuador is decreasing. This decline may be due to socio-economic factors rather than agricultural techniques. If this is true, INIAP should redirect its research to more urgent socio-economic and environmental issues.

INIAP has legal responsibility to conduct basic agricultural production research. Research on the use of shrubs and trees to control erosion is part of INIAP's research program. The budget allocation of only 3 percent for socio-economic and 11 percent for natural resources research, compared to 86 percent for technological production research, is an indication of the institution's philosophy toward basic agricultural production versus the broad spectrum of natural resource management.

Previous missions to USAID/Ecuador have recommended strongly that INIAP redirect its resources to such areas as:

- soil and water conservation practices to be used in farm management and planning for development;
- cost-effective ways of conserving soil and water resources;
- pasture improvement with better drainage and irrigation;
- range management;
- in conjunction with forestry and planting, managing of shrubs and trees as part of a total farm-management scheme;

- alternative ways to encourage the subsistence farmer to plant trees to insure short-term income in a long-term management scheme;

- more effective means of technology transfer to subsistence farmers.

In addition to the above suggestions, socio-economic research is needed to identify the cost (environmental, social and economic) and benefits of land-development policies. Such policies have a direct influence on agricultural production and are an integral part of total food production.

(3) PRONAREG (Programa Nacional de Regionalización Agraria)

PRONAREG became fully operational in 1975 as a special program of the Ministry of Agriculture. As long-term objectives for the special program, the production of thematic maps in the agricultural sector were earmarked. The program got started with financial aid from Israel in 1973 and was expanded in 1974 when the agreement was signed with ORSTOM (France) to provide large-scale technical assistance in the form of equipment, technical expertise and training of PRONAREG's staff. The contract was renewed in 1977 and expires in 1982. The special program is composed of the following departments which carry the responsibility for the compilation and evaluation of baseline information: edaphology, geomorphology, hydrology, ecology, soils, geography, socio-economy, meteorology, cartography and support services.

The training level of the professional staff is quite high. Most department directors have received postgraduate or other special training in corresponding fields abroad. PRONAREG is well organized and is administered by very dedicated persons.

PRONAREG has carried out a highly detailed, nation-wide inventory of the agricultural resource base (actual land use and potential), socio-economic conditions, and infrastructure. The material has been partly published; the rest is ready to be

published as soon as funds are located. The data, recorded and interpreted on a sub-canton basis, will enable a refined delineation of agricultural/rural development regions and zones in terms of potential and needs.[1/]

PRONAREG is a centralized effort and there are no representations or permanent working teams in the provinces. The program closely cooperates with specialized agencies on resource inventories. The methodologies employed for soil classification and biogeoclimatic stratification of the country are sound. Black and white aerial photos are the basis for resource interpretation and mapping.

Despite these advantages, there are certain problems. The rapid expansion of PRONAREG within a relatively short period of time and the wide scope of PRONAREG's objectives have resulted in serious constraints. Although the work quality of the specific departments is beyond doubt, PRONAREG's key personnel feel that the Ministry of Agriculture does not provide the support the program "deserves." As a result, PRONAREG presently seeks autonomy. A proposal was submitted to the vice-president to create a new institute (Instituto Nacional de Recursos Agrarios, in short INRA), composed of PRONAREG, but with amplified authority.

One of the most significant constraints seems to be competition with CLIRSEN. Objectives and authorities of CLIRSEN and PRONAREG are relatively well defined, but there is some work overlap and consequently, wasted funds and human resources. There is a definite need to unite forces and pool expertise.

It is recommended that PRONAREG's primary function, i.e., provision of services to MAG, be maintained without, however, precluding provision of services to other ministries as re-

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1/ Report No. 2373 EC of the World Bank.

quired (see "Recommendations," Chapter IV).

(4) IERAC (Instituto Ecuatoriano de Reforma Agraria y Colonización)

IERAC has responsibility for agrarian reform, colonization projects and issuance of land titles. In addition, IERAC assists farm cooperatives and trains campesinos. It is also engaged in the construction of roads, schools, buildings and bridges as part of providing services and infrastructure to the reform and colonization areas.

Of these various activities, agrarian reform has been given emphasis in the belief that the concentration of large land holdings are at the root of rural poverty in Ecuador. Without land titles, farmers are not allowed to participate in the benefits of development projects or credit schemes. Since 1964, IERAC has awarded some 27,000 titles for more than 1.1 million ha. and has promoted several settlement schemes. Its policy to provide land of 50 ha. to be cleared within a certain time has supported a program which causes grave environmental concerns.

The 1978 law specifies that IERAC's ongoing colonization programs in the Oriente be transferred to INCRAE, but that IERAC keep the responsibility for land titling and share continuing responsibility with specific settlement schemes in the coastal region.

(5) INCRAE (Instituto Nacional de Colonización de la Región Amazónica)

INCRAE is responsible for planning, coordinating and executing colonization in the eastern provinces of Napo, Morona Santiago and Zamora Chinchipe. A director has recently been named, but working relationships with IERAC, CRAE and PREDESUR need to be finalized.

The Oriente area of the Andes has about 2.7 percent of Ecuador's population and about 48 percent of the national territory. About 95 percent of the region is covered by tropical forest. The objectives of the Ecuadorian Government for new colonization in the Amazon region seem to be:

- exploitation of natural resources;
- resettlement of people from over-populated areas;
- colonization of national territory to protect national sovereignty.

The major renewable natural resource of the Oriente is its tropical forest. Spontaneous colonization has resulted in exploitation of valuable hardwoods while other species are being needlessly wasted. Practically no attention is paid to the danger of erosion resulting from careless cutting along steep slopes and river banks. To get maximum long-term value from these forests, a careful plan of total resource management needs to be developed.

INCRAE is aware of the Oriente's natural resource potentials and physical limitations for exploitation. It has recently sponsored a seminar on the ecology of the Ecuadorian Amazon. Results of this seminar are being used to stratify areas for forestry, national parks, agriculture and ethnic reserves.

For the establishment of a valid, comprehensive, natural resource management plan for the Oriente, INCRAE needs technical and budgetary assistance. Inventories have to be made, feasibility and resource capability studies carried out, and regional development plans designed. With the assistance of the U.S. Department of the Interior and Pennsylvania State University, a proposal for the establishment of an "Amazonian Biological Station" has been submitted to MAG. The station's

main objectives aim at the compilation of ecological baseline data.

g. Associated Regional Institutions

(1) CREA (Centro de Reconversión Económica de Azuay, Cañar y Morona

The Center for the Economic Reconversion of Azuay, Cañar and Morona Santiago was created in 1958 as a result of an economic slump in the hat industry. CREA has worked mainly in integrated rural development projects, specifically, working with farmers to promote the use of yield-increasing technologies in Azuay and Cañar and cooperating in road construction in established settlements. Its second task has been to develop rural infrastructure (roads, water, etc.) and assist new settlers in Santiago Province. The homesteading policy of CREA is to assist settlers in meeting subsistence costs during the early periods of ground preparation which usually means clearing the land of trees. With help from outside institutions, a rural road system is being planned to open much of the area for new agricultural development.

(2) CRM (Centro de Rehabilitación de Manabí)

The Center of Rehabilitation of Manabí was created in 1962 to deal with problems of persistent drought in the area. Although water supply shortage has always been a problem in the province of Manabí, population pressures resulting in deforestation and desertification are now causing some social problems in the area.

In order to address these social problems, CRM has initiated 37 rural development projects including projects to provide drinking water and sewer and irrigation systems. Major projects presently include completion of the Poza Honda drinking water

and irrigation system and the development of the Chone-Carrizal irrigation scheme. The Poza Honda reservoir and urban water distribution system have been completed. The distribution canals and drainage facilities for the proposed 10,000-ha. irrigation system are scheduled for completion in 1981. The dam for the Chone-Carrizal irrigation project (5,500 ha.) is also scheduled for completion in 1981. The second phase, to be completed in 1984, will expand the irrigated acreage to a total of 18,000 ha.

Desertification and deforestation are the most obvious environmental problems in the Manabí province. Sedimentation and soil erosion are causing problems to the supply and quality of drinking water. FAO is conducting an investigation of water sedimentation and erosion on the Poza Honda watershed. A small-scale reforestation project has already been undertaken to reduce the soil erosion and sedimentation, but a large-scale watershed management program may have to be launched to address the problem fully.

(3) CEDEGE (Comisión de Estudios para el Desarrollo de la Cuenca del Río Guayas)

The Study Commission for the Development of the Guayas River Basin was formed by the Ecuadorian Government in order to develop the economic potential of the Guayas region (portions of the Province of Bolívar, Cañar, Cotopaxi, Chimborazo, Guayas, Los Ríos, Pichincha and Manabí).

CEDEGE has focused on irrigation projects for agricultural development. As a major example, studies are nearing completion for the Daule-Peripa Project. At a cost of about US $600 million, the project would construct a dam to irrigate 100,000 ha. to provide water for Guayaquil and to produce 50 million kw. of electricity. For a project of this size, detailed environmental impact studies are needed to avoid problems

of proportional magnitude. A long-term side effect of large-scale irrigation projects such as this one could be salinization of irrigated soils if sufficient drainage facilities are lacking.

Soil erosion, deforestation and water contamination have also been identified as serious problems in the Guayas region. In addition to providing farmers with basic information on soil management, CEDEGE has initiated a reforestation project for watershed protection, erosion control and wood fuel production. In order to identify the source of contamination of the Guayas River and its estuary, CEDEGE has entered into an agreement with the city of Guayaquil to study the problem. Programs for control of contamination and restoration of the fish and shrimp industry are hoped for.

(4) PREDESUR (Programa Regional para el Desarrollo del Sur de Ecuador

The Program for the Development of the Southern Region of Ecuador was established in 1971 to participate in joint development of irrigation projects with Peru. It also has responsibility for promoting the development of the provinces of El Oro, Loja and Zamora-Chinchipe through colonization and integrated rural development projects.

Its main project is the development of the Puyango-Tumbez dam, which will irrigate 50,000 ha. in Peru. A forest inventory (with French assistance) has also been completed. Further, about 56 development possibilities have been identified. The proposals include several irrigation projects, reforestation in Loja, and assistance to spontaneous colonization in Zamora-Chinchipe. For the latter, a foreign loan from the IDB of about US $17 million is being proposed to develop rural roads and provide agricultural credit.

(5) Regional Institution Synopsis

To execute their projects, regional entities sign contracts with public institutions, including MAG, and with private agencies. A project might involve contracts with INERHI for construction of irrigation infrastructure, with MAG for extension, with IERAC for land titles, with the Ministry of Public Works for roads, etc.

With the exception of CRM, which has direct access to tax funds, the entities depend upon central government transfers, foreign borrowing and grants for their income. Although attached to MAG, the regional institutions operate with considerable independence. The Ministry has had little influence over their programs, and regional problems are the main factors which determine activities. However, sound, national-regional development policy, to identify regional development priorities and to provide direction to programs, is still lacking.

Large dams and irrigation projects are often seen as the answer to regional economic problems. In most cases, cost/benefit analyses and environmental impact studies have not been sufficiently completed. For the large Daule-Peripa Project, for example, a very shallow environmental assessment was done by a foreign consultant. His general overview did not address soil erosion problems and possible downstream impacts. As a second example, magnesium sedimentation in the Poza Honda Project may have been avoided with proper soil surveys and a complete environmental impact study.

The staff of the regional development programs are usually trained civil engineers or production agronomists who lack the training for complete physical, environmental and economic assessment of large irrigation and rural development projects. For example, these projects have not identified soil erosion

control methods that may be undertaken to stabilize watersheds, nor have they investigated the impact on marketing capabilities from an expected increase in crop production.

4. Ministry of National Resources and Energy

The Ministry has the legal responsibility for the management of all unrenewable resources, but also for fisheries, a renewable resource. This combination is difficult to understand and quite contradictory. The institutions liased with the Ministry, such as CEPE and INECEL, were identified as major contributors to environmental destruction and water pollution. To provide this Ministry with the authority to manage fish resources as well means that the fox has been made guardian of the chicken coop. The conflict of interest is so obvious that it is easy to understand why legal authority with respect to water contamination is not being given to the Subsecretariat of Fisheries and why the Subsecretariat continues to be neglected in fund allocations and budget approvals. It would be wise to attach the fishery institutions to a different umbrella organization administratively, although the establishment of a separate Ministry for Fisheries or Renewable Resources might be a more appropriate long-term solution.

a. DGH (Dirección de Hidrocarburos)

A part of the Ministry of Natural Resources and Energy, the Department of Hydrocarbons is the technical, administrative agency for the industrialization of hydrocarbon exploitation in Ecuador, and works with the Ministry of National Defense and CEPE to develop hydrocarbon policy.

Hydrocarbon policy concerns the optimum use of resources, conservation of reserves, and all economic matters related to the development of hydrocarbons, which in Ecuador is oil.

DGH is presently very concerned with environmental degradation caused through oil exploration and exploitation. The Ministry has the right to enforce fines for oil spills. It feels that oil development also creates other environmental problems such as unplanned colonization. According to key personnel of DGH, a national environmental policy and enforcement agency has to be developed for control of environmental degradation.

b. DGM (Dirección General de Geología y Minas)

As part of the Ministry of Natural Resources, the DGM oversees all mining activities in Ecuador. According to the director, there are no environmental problems in this sector because there are no active mines in Ecuador. For future developments, it would be the responsibility of the Ministry of Public Health to enforce any environmental laws.

c. CEPE (Corporación Estatal Petrolera Ecuatoriana)

As part of the Ministry of Natural Resources and Energy, CEPE carries the responsibility for execution of all programs in oil exploration, "perforation" and exploitation. In close collaboration with the Division of Hydrocarbons, CEPE's responsibility also extends to assistance in the development of hydrocarbon policy (see "a" above).

Environmental degradation is caused directly by certain of CEPE's linear development projects (access roads, permanent service roads, pipelines, etc.) as well as by indirect, adverse impacts on natural ecosystems (spontaneous colonization of virgin areas following road construction). It is emphasized once again that the major reason for this environmental degradation is the lack of technical guidelines. With adequate directives, the most problematic, adverse, direct and indirect impacts on the environment could possibly be avoided.

In formulating its planning cycles, the goals and objectives of the CEPE for oil exploration or exploitation presently place greatest emphasis on exploration activities to search offshore and throughout the country for untapped oil deposits. This policy is easily understood in light of the current rate of oil exploitation compared to the known reserves. Ecuador will soon be out of domestic oil if new sources cannot be found. However, it is not too late to prevent the environmental damage which could be expected with the forecasted increase in exploration activities, if available technical know-how is applied.

d. INECEL (Instituto Ecuatoriano de Electrificación)

The Ministry of Natural Resources and Energy is the umbrella organization for INECEL. The special agency's principal functions are to formulate and update the national electrification plan and to implement the program in Ecuador.

INECEL has adopted a five-year planning cycle. Energy demand forecasts are based on the following two methods:

- sector-specific consumption statistics (domestic and industrial demand increase over past five years correlated to the economic development policy concept of the government);
- domestic and industrial consumption statistics correlated to the annual population increment.

INECEL's statistical records and energy consumption forecasts place Ecuador's highest hydroelectric potential at 250,000,000 kilowatts per annum, an optimistic guestimate. Current demand for electric energy is an estimated 50,000,000 kilowatts per year. Assuming a continuous population increase at the present rate of 3.4 percent per year, the population, and consequently, energy consumption, will have doubled by the year 2,000.

The environmental damage caused by the construction of hydroelectric power plants in Ecuador has already reached alarming proportions. Continuing population pressure can only aggravate this situation. Moreover, up to the present time, no environmental impact studies have been carried out in connection with dam construction, and technical guidelines for such studies are nonexistent. As a result, many hydroplants may be out of production in the near future due to heavy sedimentation in dams and other causes.

One of INECEL's major goals for the upcoming planning period will be the completion of all major transmission circuits and cross connections in Ecuador. The lack of basic, technical environmental guidelines for the construction of transmission lines has resulted in much damage to ecosystems. Of primary concern are the destruction of forests and vegetative cover under and along the lines due to careless construction of service roads and support towers. This phenomenon has resulted in disturbances of vital watersheds and in soil erosion.

Within the 1973-1978 planning period, some emphasis was placed on the construction of thermal plants fed with natural oil. Although several plants were completed and are still operating, the program will be phased out by 1981 in view of the short supply of natural oil. There are no coal deposits in Ecuador to replace oil in thermal plants.

Presently, INECEL makes some efforts to explore the potential of alternative energy sources. Under consideration are the utilization of geothermal, aeolic and solar energy, which may all be considered as environmentally healthy sources.

An Atomic Energy Commission has been formed to study the possibility of nuclear reactors in the country. It would

be prudent to make the Commission aware of environmental and health hazards caused through nuclear power at an early stage.

To summarize, the key management personnel of INECEL is aware of some of the environmental damage described in the previous subsection. However, because of a lack of expertise, only damage done to private property is being assessed and compensated. Key personnel of INECEL expressed a surprising degree of understanding and willingness for cooperation if appropriate guidelines would be supplied by the Government.

e. Fisheries Programs

(1) Subsecretariat for Fisheries Resources

The Subsecretariat for Fisheries is incorporated into the Ministry of Natural Resources and Mines, although its location is in Guayaquil. The Subsecretariat's responsibilities cover fresh-water fisheries and pond cultures, the formulation of resource exploitation policies and the control of industrial exploitation. There are also several semi-autonomous institutions (below) charged with responsibility for specific aspects within the area of fisheries, all, to some degree, under the administrative umbrella of the Ministry of Natural Resources.

(2) La Escuela de Pesca (EP)

The main function of the school located in Manta, is the training of technicians and professionals for Ecuador's different fishery institutions. The director of the school is responsible to the Subsecretariat, although the responsibilities are only vaguely expressed in the corresponding laws.

(3) Instituto Nacional de Pesca (INP)

INP is a research institution with the following major functions:

- to determine species distribution and population sizes of fish resources in the coastal waters and fresh water systems;
- to prepare rational exploitation guidelines;
- to conduct economic research on resources;
- to assess water contamination and prepare guidelines for prevention;
- to prepare public relations programs.

On technical matters, the institute has reporting responsibilities to the Subsecretariat.

(4) Consejo Nacional de Desarrollo Pesquero

The Consejo Nacional de Desarrollo Pesquero is directly responsible to the Minister of Natural Resources. The board is composed of representatives of the following Ministries and other government bodies: Ministries of Foreign Affairs, Finance, Industry and Commerce, the Marine Armed Forces, and the National Planning Board. The Consejo is responsible for review and approval of all programs prepared by the different fishery-related institutions.

f. Concluding Observations

The very diffuse legislation in the area of fisheries is the cause of many interinstitutional conflicts. The lack of clearly defined authorities is responsible for work overlap in some areas and lack of work in others. Although the Subsecretariat has legal responsibility for the management of all fish sources and their habitants, water contamination is not covered by fishery legislation. The degree of

water contamination along Ecuador's coast and the contamination of major rivers and estuaries through pesticides, industrial waste products and silt is dramatic and should be of primary concern to the Subsecretariat. The damage done to aquatic systems in the country by the oil industry can hardly be justified. Refineries in Santa Elena and oil spills along the coast and into the river systems have destroyed much of the mangrove ecosystem and many live organisms.

The majority of the technical and professional personnel employed by the different fishery agencies has received in-country training. However, the educational level is rather low and the academic and technical curricula of universities and technical institutions do not equip the student sufficiently for the work he is expected to perform.

The major constraints as characterized by the Subsecretariat are priorized as follows:

- insufficient legislation;
- lack of clear authority;
- lack of a progressive policy concept and well-defined goals and objectives;
- lack of conscience and ethics among commercial and subsistence fishermen;
- lack of public awareness of contamination problems.

The Subsecretariat is represented in all provinces of the country in the form of enforcement officers. However, the major focus of law enforcement is on control of fisheries and the enforcement of laws referring to the resource base. Water contamination and general pollution problems go beyond the Subsecretariat's authority.

The Subsecretariat does not have permanent representation with the Ministry in Quito, although it is administratively fully integrated. The lack of representation may have caused the break-down in communications which has occurred and may also be responsible for the generally poor coordination of programs, and poor cooperation with other agencies. Two alternatives to this problem are offered: either the Subsecretariat should be relocated and operated from Quito to strengthen its position, or it should receive a higher degree of autonomy.

Fish resources and fish habitats are an easy subject for degradation and destruction. Water in general may be considered the most important resource, demanding the highest management priority.

5. Ministry of National Defense

a. CLIRSEN (Centro de Levantamientos Integrados de Recursos Naturales por Sensores Remotos)

As part of the Ministry of National Defense, CLIRSEN was created in 1977 with the following functions:

- to make a national inventory of all renewable and unrenewable resources;
- to plan, organize, direct, coordinate, execute and control remote-sensing activities;
- to contribute to the cartographic mapping of Ecuador, and the establishment of thematic maps;
- to give technical assistance in project implementation to all public and private institutions, upon request.

CLIRSEN is a well-organized, rapidly growing institution. It is composed of the following technical sections: geography, geology, hydrology, agriculture, forestry, oceanography, all charged with the compilation of baseline data. The technical

sections are supported by several service sections. In general, CLIRSEN hosts a group of highly motivated and well-trained professionals who have established good working relationships with other government institutions assisting in data collection. The institute is well funded and does not suffer budget constraints. It has successful extension programs and enjoys good prestige in the country. CLIRSEN is in the process of establishing an automized data bank for all resource information, to serve the public and private sector alike. The institute concentrates on the use of satellite imagery and radar sensoring, but intends to get involved in multispectral photography as well. Environmental monitoring has not yet been included by CLIRSEN.

Satellite imagery is ideally suited for periodic, large-area surveys. Emphasis should be placed on monitoring processes of desertification, deforestation in the Oriente and Costa, soil erosion and destruction of watersheds, over-grazing, etc. Multispectral photography may well be suited to monitor marine pollution, and destruction of coastal mangrove forests and estuaries. It would also be desirable to develop expertise for photo-interpretation with regard to water pollution.

b. Oceanographic Institute

The Oceanographic Institute, located in Guayaquil, is an establishment of the Navy and falls under the jurisdiction of the Ministry of National Defense. The institute's major functions are:

- to provide navigational education;
- to produce marine charts;
- to carry out research in the areas of marine geology (sediments and geophysics), marine biology (primary and secondary production), marine meteorology, and marine pollution.

Although the functions of the Institute are clearly defined and backed up by good legislation, programs are poorly implemented due to a chronic shortage of well-trained professionals and funds. The institute does not yet employ marine biologists, but does employ some technicians for basic data compilation.

The key persons in the institute are fully aware of the extent of marine pollution, especially in the form of heavy metal and oil contamination in the areas of Esmeraldas, La Libertad, Santa Elena and the coastal waters around Guayaquil. But Ecuador still lacks specialists in marine pollution. Only scanty scientific information on pollution problems in Ecuador is available. It is generally disseminated through workshops and seminars. The institute makes a great effort to develop good working relations with related technical institutions in Ecuador and abroad to share research responsibilities and pool existing technical know-how.

In the current year, the Oceanographic Institute initiated the establishment of a commission for marine pollution. The commission is composed of representatives of the Polytechnical Institute of Guayaquil, the Ministry of Foreign Affairs, the National Institute of Fisheries and the Oceanographic Institute. The Commission still lacks funds for program implementation, however.

B. Related Institutions

1. CENDES (Centro de Desarrollo Industrial)

The Center for Industrial Development promotes industrial growth in Ecuador. Key personnel expressed little concern about environmental degradation, which has been and

is continuously caused by industrial development. The general tenor of the center is that environmental problems and law enforcement are the responsibility of the Ministry of Public Health.

However, some concern was expressed about wasteful wood exploitation, and feasibility studies have been initiated to explore development potential for wood-processing industries to make better use of waste products and less desirable tropical hardwood species.

2. Educational Institutions

For the purposes of this report, educational institutions with environmental protection components in their curriculum have been evaluated. The information presented results from discussions with key university personnel competent in the area of concern.

Ecuador has a total of about 20 universities and technical institutes found in the major cities of the country. Only two of all academic institutions offer a full program in biology which may be considered relevant education vis-a-vis environmental protection. The Catholic University of Quito and the State University of Guayaquil have a biological/ecological science program leading to a degree comparable to the B.S. The faculties produce a total of 20 to 50 graduates per year. Approximately 70 percent of the graduates find employment as teachers and 30 percent are absorbed by government institutions and private industry. Only a few of the latter work in fields related to the profession. At present, no postgraduate training in ecology/biology is offered in Ecuador, although profession-related employment opportunities seem to increase with postgraduate degrees.

Most universities have agricultural and veterinary faculties which provide postgraduate training. These faculties do not offer basic ecological courses, except for specific knowledge conveyed in areas of soils science and watershed management as it may be applied to production increase in agriculture.

Forestry training may be received from the universities of Esmeraldas, Loja and Universidad Central in Quito. The teaching staff in forestry is composed primarily of agronomists with little understanding and/or technical knowledge of forestry subjects.

Some technical institutions with university status offer special degrees in "natural resources" (i.e., fisheries, soil science, hydrology, geology, etc.). One is the Polytechnic Institute of Guayaquil, which educates engineers.

In general, the level of academic training in Ecuador is low. The majority of university teachers hold degrees comparable to the North American masters or lower; only a few have received postgraduate training abroad and even fewer hold a doctoral degree.

A major constraint for university education may be that educational requirements to enter universities and to obtain a degree are not standardized. Another shortcoming is the definite shortage of research facilities for field work. Consequently, education concentrates on text-book studies which don't familiarize students with actual problems in the field. Unfortunately, the language requirements are low, limiting students and teachers to Spanish literature.

For medium-level training, not more than ten institutions are available, producing more than 90 percent of Ecuador's agricultural technicians. Within technical institutions, there seems to be little understanding for the complexity of resource management.

3. City of Guayaquil

Guayaquil is the largest city in Ecuador, with about 35 percent of the country's population within its jurisdiction. The city itself is growing at a rate of about 7 percent per year. Its population and industrial growth is putting great environmental stress on the ecological systems around the city. Heavy pollution (mainly from industry) is taking place in one of the main arms of the bay.

The city is located at the confluence of two main rivers; the Daule river and the Babahoyo meet to become the River Guayas at Guayaquil, forming a very productive estuary. There is great concern about upriver pollution and development that threatens to destroy a major fishing industry in the estuary. The shrimp catch in Guayaquil's estuary has recently decreased this year by about 50 percent from previous years.

Other specific concerns are deforestation and desertification found in Santa Elena Island, and the destruction of coastal mangrove forests which are prime breeding grounds for fish as well as shrimp. A project of interest to the city is to utilize the effluent from the city's treatment plant to irrigate and reforest Santa Elena Island. This could be a pioneer project in reforestation programs.

The city presently attempts to develop a simulation model of the estuary to measure degree and extent of pollution. However, trained personnel in several disciplines are needed to identify contamination sources and to investigate the complex ecological interrelationships within the systems. City management personnel believe that a national environmental policy and program are needed to eliminate work duplication that presently characterizes most contamination control programs.

4. Fundación NATURA

Fundacion NATURA is a private organization dedicated to nature protection. It is composed of approximately 100 active, highly motivated members working mostly in responsible management positions in government service and in the private production and service sector. Several members are highly qualified professionals working in universities and other educational institutions. NATURA is basically a fund-raising organization which finances but also implements specific conservation projects. A powerful group, it successfully lobbies its interests both within the nation and internationally. The major thrust of its activity aims at raising the level of public awareness of environmental problems and attempting to develop a public conscience. NATURA's public relation campaigns involve mass media such as television, local radio stations and newspapers. Although it is located in Quito, the Foundation recruits members throughout the country.

C. International Institutions

To complement the institutional review, all major international agencies with permanent representation in Ecuador were contacted. Ongoing activities and future programs were discussed to evaluate active and proposed involvement in the area of concern. This program analysis should serve a dual purpose: to avoid technical assistant overlap and to coordinate international assistance programs whenever feasible.

1. FAO (Food and Agriculture Organization of the UN)

Following the recent change of government, an ad hoc committee was formed under the auspices of the vice-president to develop new guidelines and strategies for the agriculture and forestry sectors. Advisory expertise to the planning committee (CONADE)

was provided by FAO in the form of an economic/agricultural planner. The policy guidelines as prepared by the committee place some emphasis on the importance of soil protection and watershed management.

Secondly, a UNDP-financed integrated agriculture development project in the provinces of Imbabura and Carchí gives direct assistance to subsistence farmers and rural committees aimed at strengthening the administrative structure and management efforts of provincial governmental bodies.

In preparation is a large-scale rural development project with emphasis on organization of centralized management for the rural development sector. In addition, FAO country programming for the next five-year period will focus on:

- rural development (integrated development projects in the agricultural sector with emphasis on subsistence farmer training and cooperative/community development);
- forestry (resource inventory and utilization planning in Rio Napo area);
- watershed management (close cooperation with INERHI with emphasis on regional development; and
- small-scale fisheries (strengthening of coastal fishing and development of freshwater pond fish cultures).

FAO's country representative emphasized that all projects should be based upon an intelligent concept of land and water-use management set into the framework of a sound environmental protection policy.

2. UNEP (United Nations Environmental Protection Program)

The only UNEP project presently implemented covers Ecuador's environmental legislation. In the first phase, all pertinent information on historic institutional development

and environmental problems will be compiled, analyzing the organization and administrative structure of all governmental and private institutions with legal responsibilities for environmental protection.

The second phase will concentrate on the compilation of all existing relevant legislation and a critical analysis of interinstitutional relations within the government and relations between government institutions and sectors of industry and commerce.

In preparation is a project on desertification problems in Ecuador. The major objectives are:

- to prepare a summary of the nature and magnitude of the country's desertification problems;
- to analyze and evaluate the capacity of each cooperating institution to respond to the problems;
- to propose the establishment of a coordinating agency within the existing governmental organizational structure, to assist in the formulation of the proposed agency's policies and objectives, and to locate funds for its action programs; and,
- to identify needs for international assistance to solve desertification problems, and propose avenues for coordination of assistance programs.

Also in preparation is a project proposal for land-use planning and management of the Oriente, which has been submitted to UNEP headquarters. Upon approval, the project will be carried out in collaboration with INCRAE. The major objectives can be summarized as follows:

- to determine the ecological status of Ecuador's Amazon region with emphasis on the identification of the environmental impact caused by spontaneous and directed colonization projects;

- to identify needs and opportunities for international assistance to be provided to INCRAE in the form of technical expertise for an intelligent land-use management program; and

- to formulate a project proposal for land-use planning and management of the region's ecosystems.

Finally, UNEP signed a contract with MTV (Centralized Hungarian Television Company) for the production of a movie film on all Ecuadorian national parks. This film will be one of a series entitled "El Planeta Herido," depicting specific countries of the world. The project will be completed by 1980.

All UNEP projects are of short-term character, not exceeding 3 work months each. The projects provide the expertise of one international consultant only, and aim at the preparation of large-scale follow-up projects through other international assistance agencies.

3. UNESCO

By definition, all of UNESCO's programs center around scientific research and education. UNESCO's current involvement in Ecuador entails the following specific projects:

- the investigation of the "economy" of the Catholic University in Quito;

- inventory of equipment within several scientific institutions; and

- strengthening of scientific institutions.

All those projects are of short duration and are classified as "reconnaissance" surveys.

A more substantial project on education in rural communities becomes operational in 1979 (US $650,000 for three years). The UNESCO programs give specific emphasis to environmental protection.

4. OAS-IICA (Organization of American States - Inter-American Institute of Agricultural Sciences

IICA is an autonomous organization of the OAS (Organization of American States) whose function is to provide technical and educational aid. Its major aim is to strengthen learning programs within institutions in developing countries.

In Ecuador, IICA is working with the Ministry of Agriculture to provide technical agricultural education to students at mid-level schools and to provide small-farm management and basic education to low-income farmers.

IICA has no specific programs which focus on environmental protection, unless programs such as farm-management education can be classified as such.

5. IDB (Inter-American Development Bank)

The Inter-American Development Bank has financed several projects in agricultural and rural development in Ecuador. Most of its programs finance regional development work (through CREA, PREDESUR, CRM, and CEDEGE). These programs aim at the development of the infrastructure of regional areas through the provision of production credit, and education for management of agricultural production. The financing of dams for irrigation, power and drinking water have always been an integral part of BID's development programs. Environmental concerns and a synecological approach to natural resource management are only secondary to economic development and short-term agricultural production.

6. IADS (International Agriculture Development Service)

General efforts of IADS focus on small-scale integrated rural development projects; one has been fielded in the Sierra with emphasis on wheat production, and a second in the

area of Samborondon (coastal lowlands) in collaboration with a cooperative to increase rice production through a better system of irrigation and drainage. One of the project's objectives will be to establish schools and provide medical services to the affected communities and to teach the subsistence farmers to solve basic problems of sanitation.

Although environmental protection concerns may not be explicitly expressed in IADS's projects, they form an integral part of the subsistence-farmer education program. Soil conservation and watershed management are focal points of interest.

7. U.S. Peace Corps

The U.S. Peace Corps has strong representation with over 200 volunteers in Ecuador. Approximately one third of the group works on different aspects of rural development with MAG, and one third with other rural development agencies. The final third deals with special education.

The heavy involvement of the Peace Corps in the rural development sector is indicative of the organization's priorities in the country. Some 30 volunteers are active in an agriculture extension project which covers forestry and many aspects of agriculture. Four volunteers with special expertise in the establishment of tree nurseries are presently under recruitment.

Over the past few years, Peace Corps implemented a project in cooperation with CREA on reforestation and species introduction trials. Unfortunately, the project is phasing out.

One of the major targets for future Peace Corps programs will be assistance to small farmers in crop production,

tree breeding, planting and fish production in pond cultures.

8. International Institutions: Concluding Observations

The review of the different international assistance programs reveals that major emphasis is placed on integrated rural development. Although the technical term "integrated rural development" is used synonymously by all organizations, the underlying policy concepts may differ considerably from organization to organization and may cause undesirable confusion. In most instances, the so-called "integrated" projects cover only very specific aspects of the complex area of rural development. However, such projects do deal directly or indirectly with natural ecosystems and rural environments. Consequently, all such projects should include components of environmental protection efforts, which result in immediate and long-term benefits to the rural communities. It is felt that environmental issues are still not quite understood by most organizations. As a result, living standards and production levels within rural communities may be raised through assistance programs for a period of time, but environmental degradation continues.

In general, all international donor institutions and organizations active in Ecuador seem to have little or no concern for environmental protection within their programs. On the other hand, organizations with a technical assistance orientation seem to be at least aware of some environmental problems and try, to varying degrees, to incorporate environmental protection in their policy concepts.

It should be pointed out that there are a multitude of private foundations and assistance agencies from all over the world with vested interests and activities in Ecuador. This

situation has lead to considerable overlap in technical programs, wasteful duplication of work, and also to an undesirable interdepartmental competition for funds.

Based on this assessment of private and public Ecuadorian institutions, the Chemonics study team, in the fourth and final chapter of this report, has made a number of recommendations toward an appropriate institutional focus and an environmental stragegy for a USAID/E program.

CHAPTER IV

RECOMMENDATIONS

A. General Remarks

Even though some environmental problems have been identified by Ecuadorian institutions, their causes are generally ignored. Developmental policies are being implemented without proper planning. Laws aimed at prevention of pollution and environmental degradation are generally ahead of Ecuadorian institutional ability to enforce them and are generally ignored by the public. Several organizations and institutions make a serious effort to solve environmental problems, but often work in isolation and do not coordinate their effors with other groups, either because of budget limitations or institutional competition.

Our recommendations to USAID for a dynamic environmental program strategy fall into two general areas. One aims to increase public and administrative awareness through education, research and extension activities. The other is to strengthen Ecuadorian institutions that have some technical prerequisites to make good use of assistance programs.

B. Strengthening Institutions

1. Interinstitutional Committee for Environmental Protection

The Interinstitutional Committee for Environmental Protection was created by the Prevention and Control of Environmental Contamination Law, 1976, to establish guidelines for the regulation, control, and prohibition of environmental degradation. The members include a variety of ministries that have responsibility for all aspects of natural resource use, pollution and environmental education.

The law is vague in setting guidlines for the enforcement of environmental legislation, except that each agency shall have its specific responsibilities and that IEOS shall be the coordinating agency. Because of inter-ministerial competition, or other reasons, IEOS has not yet been able to convene the first meeting of the committee.

The 1976 legislation, by placing the committee under the coordination of IEOS (Ministry of Public Health), emphasized control of pollution instead of environmental management. Yet in Ecuador, the major problems of environmental degradation are caused by developments in agriculture, energy and industry.

An environmental protection program would be more effective if the Interinstitutional Committee for Environmental Protection were under the chairmanship of the Vice-president, on an equal basis with CONADE (Central Planning Board). As a coordinating body, the committee would establish guidelines and policies for the ministries to implement and execute environmental laws.

Assistance for the formulation of a conceptual framework would also be required. The committee would urgently need support for the development of technical guidelines with respect to environmental impact analysis. It would be necessary to extend assistance to the training of specialists, so that development projects which are passed to the committee for "screening," could be evaluated more thoroughly, and better advice given to the respective agencies on prevention of environmental degradation. All development programs submitted to CONADE for approval should be passed to the committee for "screening."

2. Ministry of Agriculture

The Ministry of Agriculture has the legal mandate for the management of all surface area in Ecuador, including forest resources, soil and water for agriculture and crop production, rangelands, and all marginal lands. Such a wide mandate requires extremely disciplined and well-organized planning to encompass the short and long-term view of resource utilization through optimum resource management. Indirectly, the Ministry is also responsible for colonization policies via the regional development institutions connected with the Ministry of Agriculture. The overriding function of the Ministry to provide the country with food and other basic resources is well recognized. However, a critical analysis of the Ministry's specific divisions and regional development agencies revealed that the Ministry in the past has fallen too often into the trap of short-term economics, neglecting long-term, adverse impacts on the resource base. Spontaneous, poorly researched investment and development decisions have contributed to Ecuador's environmental degradation.

It would be desirable to assist MAG in revising its overall policy concepts to take environmental protection and the wise use of resources into account, to assist MAG in the formulation of legislation to back up these policies sufficiently, to provide clear authorities and guidelines to all dependent agencies, and to assist MAG's Planning Division in prioritizing projects and resource sections with short and long-term perspectives. However, at this stage, it seems to be more appropriate to strengthen some of the more motivated, action-oriented divisions and liased institutions of MAG, to defend the cause through successful implementation of specific projects. In this light, the following recommendations are made.

a. Forestry Division

Major emphasis is placed on strengthening the forestry sector for self-evident reasons. From the descriptive analysis of the Forestry Division (see Chapter III. A.3.e.), the discrepancy between the scope of responsibility and actual program implementation is obvious. As one of the major limitations to the division, its lack of autonomy was identified. The absolute dependence upon the Ministry of Agriculture, which has yet to recognize the role of the Forestry Service with respect to land-use management, has been a severe obstacle to expansion in staff and budget. Although socio-economic and cultural impacts resulting from increased deforestation, desertification and erosion are well documented, program proposals submitted to the Ministry's Planning Division have not been acted upon. This situation applies to program proposals for the protection of watersheds, land rehabilitation (reforestation), and control of forest destruction.

The Forestry Division is responsible for the management of the country's most important renewable resource, which may be one of the major contributors to the future economic growth of Ecuador. We suggest that the main strategy to be adopted by the Forestry Division in order to obtain better governmental support should be through action-oriented projects with a simultaneous effort to become institutionalized. It is recommended:

- to develop a comprehensive policy concept which highlights the economic potential of the forest resources;
- to update and reorganize the division, which should clearly identify lines of authority;

- to ensure that legislation have a positive orientation to invite the public for active involvement in management, and to provide incentives and stimuli to the public for the protection of forests and watersheds;

- to review critically all categories of protected areas to recommend expansion if necessary, before conversion into different use forms takes place;

- to conduct a country-wide inventory of all forest resources with emphasis on forests in the Amazon basin;

- to prepare technical guidelines for the exploitation of native forests to avoid further waste of wood products and forest destruction;

- to revise the present concession system;

- to establish a country-wide control enforcement system;

- to train a corps of enforcement personnel which should possibly be given management authority on a geographic sector level;

- to update the inventory of lands suitable for reforestation;

- to develop reforestation strategies for the private and public sectors, placing emphasis on incentive systems;

- to develop protection strategies for the country's major watersheds;

- to develop attractive pilot projects which promise short-term economic returns and good employment opportunities for low-income population, and which stir the interest of politicians and public alike;

- to produce practical documentation and teaching material on tree-breeding, establishment and maintenance of tree nurseries and basic principles of plantation management;

- to promote rational wildlife utilization, and principles of soil and water protection (see below);

- to prepare and conduct short-term workshops in rural communities where documentation and teaching material should be utilized (see below);

- to develop action programs in cooperation with INCRAE and other regional development agenices for the protection and intelligent utilization of native forests.

Recommendations for research and education are made in sub-sections c.1. and c.2. below.

The Forestry Division has prepared a comprehensive document which outlines new policy concepts and objectives, and which would provide it with a higher degree of autonomy. The proposal is well composed and covers all aspects of responsibilities. If approved by the government, the Forestry Division would be institutionalized, have more authority and could become fully operational. It is recommended to postpone any large-scale assistance project until a decision about the future of the division is made. However, there are ample opportunities for technical and financial assistance in the specific areas outlined in the recommendations. Assistance for well-defined pilot projects which could serve as "models" may be very rewarding.

b. Ecuadorian Institute for Amazonian Studies

The Amazon Region makes up about one half of Ecuador's total land area and is inhabited by only a small fraction of the nation's population. INCRAE was established by the government to plan and implement the development of the Amazon region (see Chapter III.A.3.f.(5)). Preliminary plans, prepared by a young and dedicated staff, identify general development possibilities but also point out critical natural resource limitations of the Oriente. To prepare long-range plans for the region, INCRAE has recommended the creation of an Ecuadorian Institute for Amazonian Studies.

Support for this institute should be based on the following concepts:

(1) The Resource Base

Ninety-five percent of the Oriente is still largely under virgin tropical rain forest, stocking on soils which are generally poor in nutrients and highly erodible. The most appropriate land-use strategy is the rational management of the forest resources.

(2) Long-term Benefits

Ecuador's policy for land reform and colonization has not significantly increased the food production of the country. In fact, poor tilling methods and over-grazing have effectively decreased agricultural production in some areas. Alternative uses of the forest for sustained-yield logging, tourism, or for national park and reserves (wildlife, ethnic, etc.) may actually be of greater economic and social benefit to Ecuador than short-term agricultural production.

(3) Regional Planning

Land-use development planning has to be based on a good understanding of the resources. At present, little ecologic/biologic/economic baseline data for the Oriente is available.

INCRAE's preliminary development plan for the Oriente has stratified land for agriculture, exploitation and protection forest, national parks, wildlife reserves, ethnic reserves and others. However, this plan is designed arbitrarily and needs a more scientific foundation. It is therefore recommended to form a multidisciplinary team composed of international and national experts in the areas

of tropical ecology, tropical forestry, soil science, meteorology, hydrology, geology, resource economy, plant ecology, anthropology, etc. This team should review INCRAE's development plan and formulate a proposal for further studies before a final decision about a specific land-use plan in the Oriente is made. The proposed Amazonian Biological Research Station (Chapter III.A.3.f.(f)) which should become an integral part of the Ecuadorian Institute for Amazonian Studies, could provide some of the necessary baseline information. Once established, the institute could make very valuable contributions to the general area of tropical ecology.

c. CLIRSEN-PRONAREG (Information Center for Renewable and Unrenewable Natural Resources)

The unfortunate technical competition between PRONAREG and CLIRSEN causes a problem which is not easily solved. The dilemma is that both are highly competent in terms of staff and work performance, that one is institutionalized (CLIRSEN) whereas the other is attempting to become institutionalized (PRONAREG), that interests and programs are overlapping, that CLIRSEN works predominantly with satellite imagery and radar but wants to expand into multispectral photography, and that PRONAREG works primarily with black and white imagery. To make matters worse, both use different map scales and both have identical subject sections (PRONAREG more than CLIRSEN) charged with the compilation of baseline data.

It goes beyond the scope of this report to suggest a solution to the problem, which eventually will have to be a political decision. However, it would be in the interests of the environmental sector to establish a centralized information bank.

(3) To substantiate and complement the environmental monitoring program, meteorological stations should be established and maintained at strategic locations throughout the country.

(4) Assistance should be provided through CLIRSEN to the Forestry Division for the proposed inventory of the tropical rain forest in the Oriente and coastal areas. This may require outside expert advice on the most appropriate photo scales and spectral zones to be used, but also on photo interpretation and ground-truth work.

3. City of Guayaquil - Guayas Estuary Model

Industrialization, high population and the resulting pollution and contamination are destroying what was once the most productive estuary in Ecuador. The 50 percent reduction in shrimp harvest is the result of an environmental problem and is creating an economic hardship to the already poor native fishermen (see Chapter III.B.3.). The management of the city of Guayaquil is aware of the interrelationship between industrial pollution and ecological disasters but it lacks the technical capability and finances to support the establishment of a model to identify the contamination sources thoroughly and specify programs to alleviate the problems.

It is recommended that assistance be given to the city of Guayaquil to develop the proposed Guayas Estuary Model. A technical committee composed of the following institutions would be coordinated by the management of the city of Guayaquil:

- Polytechnic Institute of Guayaquil;

- Institute of Oceanography;
- Subsecretariat of Fisheries;
- National School of Fisheries;
- CEDEGE.

While the above institutions represent considerable talent in certain areas, specific technical expertise may have to be developed or imported. It is also recommended that support be directed toward building research capabilities in specific estuarian-related disciplines and in coastal resource management.

4. Fundación NATURA

A very successful television program based on National Geographic films and sponsored by NATURA is nearly completed. This program, as well as other campaigns involving mass media, aims at raising the level of public awareness of environmental problems, particularly of wildlife and ecological systems. The public response to the National Geographic film has been very positive. However, similar material in Spanish is lacking to continue the series.

NATURA is also proposing to initiate a series of mass media programs that would discuss specific environmental problems in Ecuador. A short film would be used to introduce a round of national discussions on problems such as desertification and the dying shrimp industry. Experts in the specific areas would be invited to discuss problems on national television and other mass media. Films and discussions would form the basis for a NATURA-sponsored Ecuadorian environmental information center.

As part of their environmental information program, NATURA also proposes to prepare a basic textbook on ecology

that would be used in introductory university classes in Ecuador. As an introductory textbook, it would cover basic ecological concepts, but would also include specific Ecuadorian problems and concerns. Also, as part of their educational campaign, a textbook to train elementary teachers is being planned. Elementary teachers trained in basic ecology would introduce these concepts in their classrooms and communities.

It is recommended that NATURA be supported in their education and extension efforts to raise public awareness of environmental problems in Ecuador. Support is especially needed in efforts to prepare films and textbooks on ecology and environmental problems. These films and educational materials could also be used for information purposes in other Spanish-speaking countries with (or without) a permanent USAID Mission.

On request, NATURA should be assisted to establish better contacts to related international movements, such as the Sierra Club, National and International Wildlife Federation, Conservation Society and others.

C. Increasing Public Awareness

Creating a public awareness for environmental problems and resource management requires the development and dissemination of practical, understandable information. While previous sub-sections of this report outlined some special recommendations for specific agencies and institutions, this sub-section summarizes several possible programs on information development and transfer that could be used to support an environmental program in Ecuador.

1. Education and Training

Ecuador's technology transfer process is limited by a lack of clearly defined policies with respect to education and personnel. This limitation applies in particular to the environmental sector. Although basic ecology and related subjects may be part of some education programs (see "Educational Institutions," Chapter III.B.2.) such programs fail to transfer sufficient knowledge to management personnel and technical staff in the broad area of natural resource management and related fields. As a result, environmental problems and the complex interrelationships of natural systems, defined as "ecology," are little understood and/or appreciated. It would be beyond the scope of this report to design detailed curricula for the different educational levels. However, the following recommendations may provide some guidelines for what is needed and what can be done to improve the quality of programs and personnel and to raise the level of public awareness.

a. Elementary Education

Except for a limited number of "school gardens" used for demonstration purposes, children in Ecuador are presently little prepared through elementary education for life in a rural environment. It is nonetheless at the elementary level where education can be most influential. If this opportunity for the dissemination of information is lost, education efforts will become increasingly more tedious and costly.

This fact has been recognized by the Fundación NATURA which presently prepares an ambitious educational program addressed predominantly to elementary education (see subsection B.4. above).

b. Medium-level Training

It is recommended to assist in the design and review of training programs for technicians to prepare them for resource-management-related work. Assistance should be directed to existing technical institutes (agriculture/forestry/fisheries) and to the design of in-service training programs. The training should have a "synecological" tenor, to provide the basis for environmental problem understanding and appreciation.

c. University Education

The long-range program for graduate education may require an agreement with a recognized foreign university, or a consortium of foreign universities with well-established graduate programs, before ultimate transfer of graduate programs to a local university takes place. The activity could commence with an exchange of teaching personnel and the provision of fellowships. However, experience has shown that long-term fellowships may not be the best solution. On return to their countries, well-trained professionals frequently work in fields unrelated to their specific training because adequate job opportunities are lacking. Other graduates lack the desire to return to the country of origin.

d. In-service Training and Short-term Fellowships

To avoid complications with long-term fellowships abroad, programs for in-service training should be designed and implemented with the aid of foreign expertise. Further, short-term fellowships, not exceeding 4 months, should be given as an incentive to qualified, dedicated professionals, to participate in workshops and work with related agencies abroad. Such experience has proved in the past to be stimulating for the professional and rewarding to the country with respect to work performance.

e. Enforcement Personnel

Each executive agency (and its corresponding ministry) presently has its own enforcement personnel, more-or-less well-equipped in terms of training and enforcement means.

As indicated in the passage on IEOS (sub-section B.1. above), it is recommended that the enforcement of environmental, subject-specific legislation (i.e., forestry, agriculture, fisheries, etc.) continue to be the responsibility of the corresponding agency. However, the enforcement personnel of all agencies should be familiarized with all relevant legislation, basic principles of resource management and environmental protection. Further, good training in "policing" should be provided.

f. Personnel Policy.

Although there is little opportunity for outside assistance, it should be pointed out that a definite constraint to Ecuador's technology transfer process is caused by the lack of well-defined work plans, the lack of supervision of personnel, the lack of definition of control levels, inadequate incentives, and poor promotion opportunities.

The technology transfer process may be improved by a personnel policy which respects job descriptions and classifications, job evaluations, advancement procedures, and which provides for attractive incentives.

2. Research, the Complement of Action Programs

As indicated in the recommendations for the strengthening of institutions, research in Ecuador should be practice-oriented; it should provide guidance to general resource management, provide the basis for optimum land- and resource-use

decisions, and should have a synecological orientation. Research should give the background for land-use planning and should be the basis for programmed colonization. With regards to environmental degradation, applied research should provide not only the "diagnosis" of a problem, but also the necessary "remedies." Although truly academic research has its merits and its place, it may be difficult to justify in a developing country. In this light, the following recommendations are made.

a. Sector of Agriculture and Rural Development

(1) Production Farming

Research being conducted in the area of agriculture, primarily through INIAP's rather well-equipped research stations, is still much too theoretical and impractical. Although INIAP places great emphasis on production increase in its research efforts, the long-term objectives need to be more clearly defined.

It is recommended that agricultural research address two distinct problem areas. The first is assistance to the low-income rural community (campesino level). Programs should be developed in the form of well-illustrated and documented "packages" for specific production areas. The packages should provide practical guidelines for a complete production cycle (i.e., crop production would include field preparation, tools to be used, seeds, cultivation care, harvest, storage, and marketing). The "package" should be kept simple, to be easily understood by the campesino and interpreter assistant. This effort in combination with a well-composed financing system, would help to alleviate some of the most urgent problems currently confronting the campesino and the government. It may provide sufficient incentive for the campesino to stay on

the land and to keep down the dangerous increase in migration to cities and the Oriente. The package programs have to be set in the framework of environmentally sound guidelines to prevent any further degradation of soil, water and ecosystems in general. "Integrated" assistance packages may include information on planting procedures (selection of suitable tree and shrub species for multiple use), tailored to the specific environment, i.e., hedges as windbreaks, mixed tree stands for soil and steep slope stabilization and watershed protection in endangered and degraded watersheds.

The second problem area to be addressed is large-scale production farming. Although this area may exceed the scope of the team's responsibilities, it should be made clear that the country's food problems will not be solved through exclusive assistance to Ecuador's low-income rural population. There is a definite need to direct research and assistance to large-area crop production. The so-called "integrated rural development projects" definitely have their place, but will never be able to produce sufficient food for the ever-increasing population of the country. In agricultural research, emphasis should therefore be placed on the development of technology for large-area farming in the form of mono- and mixed-crop cultures, guided by responsible awareness of environmental problems (i.e., rational use of pesticides and fertilizers and protection of water and soil resources).

(2) Industry in Rural Areas

It is suggested that the feasibility of small industry within rural areas of high population density be researched. Provision of attractive incentives to small industry should be considered to absorb the surplus labour force, hence taking some pressure off the already stressed ecosystems.

(3) Livestock

Research has to be intensified for range management, to increase animal protein production and reduce range deterioration. Research efforts should concentrate on area-specific grazing capacities, rest rotations, genetic improvement of stocks, and artificial insemination (see Chapter III.A.3.d.). With improved stock quality and a good system of rest rotation, milk and meat production could be increased considerably. It may then be considered to convert low-production (marginal) rangeland into a different land-use form such as offered through plantation forest.

A concluding remark for agricultural and related research: it may be a wise policy to invite clientele advice for applied research programming. The clientele (campesinos and large-scale farmers) knows best what it wants and what is needed; it also may have a good perspective on environmental problems. If this becomes common practice, an "academic only" approach to agricultural research could be avoided.

b. Research in Forestry Sector

Forestry research on suitable native species should be intensified. In addition to the programs of species introduction and testing in terms of numbers of seed sources and species, a multidisciplinary effort should be made to define suitable climatic, edaphic and altitudinal conditions for adaptability of species in both the Paramo and lower zones. Some basic research on the most suitable species for highly eroded and degraded coastal areas has to be conducted.

It is recommended to make good use of well-documented research on the family "leguminosae." "Legumes" have been very successfully utilized in other parts of the world with

similar climatic conditions for sand stabilization and desert rehabilitation.

Research should be conducted on economical methods for establishing and managing forest plantations on eroded sites. Attention should be given to needs or possibilities for land preparation (terracing, etc.), fertilizer, use of grass species, legumes and shrubs as understory, or in alternate strips with trees, to achieve stabilization and reclamation of these areas.

Studies on the management of established forests should be performed. The studies should address areas such as the need for the economics of thinning, pruning, and control of undergrowth; methods of harvesting and successful regeneration; acceptable levels of grazing by livestock; fire and disease control; potential habitat improvements for wildlife; introduction of nutritious and palatable browsing plants and native perennials in understory for wildlife population enhancement, especially for the depressed populations of white-tailed deer and perdizes. These problems have received little attention to date.

Opportunities to enhance wildlife habitat and increase crop production through shelterbelts on wind-exposed and sloping hills should be researched.

Information is needed on alternative tree species (to replace eucalyptus) which would provide good leaf mulch and ground cover for soil conservation purposes, and at the same time, provide a fast-growing, commercial produce. (Eucalyptus appear to provide little value as protection against soil erosion, especially in grazed woodlands).

c. Economic Research in Agro/forestry

Because of population pressures and the need to increase food production, Ecuador has had a history of encouraging colonization and other population-dispersion policies.

There is no evidence that these policies have increased food production, but overwhelming evidence that such practices have caused severe environmental degradation.

In this light, it is recommended to support a socio-economic research effort that analyzes the effects of such policies. The following specific problems should be addressed:

- the effects of migration on social cohesiveness;
- long-term costs (economic and environmental) of development projects;
- net production gains or losses as a result of development and migration;
- costs of alternative employment development.

Colonization and land-titling policies encourage the destruction of forests (clear cutting/slash burning) to generate new agricultural land. It is suggested that a good system of agro/forestry may provide higher economic returns and greater long-term benefits to the farmers. Returns from "proper" forest management have to be researched, to provide regional and national planners with alternative development models. Such research should center on:

- utilization and marketing potential of tropical wood products;
- economic returns (over specific time) from forest management versus, and in combination with, cattle grazing;
- optimum plot size for agro-forestry-oriented farms;

d. Other Research

Although research on specific environmental problems is needed, the subject is covered to some degree within research recommendations for the agriculture and forestry sector, and the corresponding chapters on institutional strengthening. However, the following specific recommendations are made:

- conduct research to determine the rate of desertification, through support to CLIRSEN, and identify its causes, through the mutual efforts of several agencies, such as the regional development institutions, city planning boards, universities and other educational institutes, and special service agencies;

- develop a methodology and the technical expertise for the prevention of desertification and land rehabilitation through international assistance programs;

- identify erosion problems throughout the country with emphasis on the Sierra region and increase land rehabilitation efforts including research on reforestation, better range management and agriculture practices;

- research the problems caused by deforestation and provide technical guidlines to minimize problems (i.e., protection of watersheds, and avoidance of infrastructure development and industrial projects in ecologically sensitive areas, etc.);

- research the opportunities for rehabilitation of coastal mangrove forests and estuaries through provision of international support to regional development agencies and coastal cities, in coordination with corresponding technical institutes;

- identify the extent and causes of air and water pollution and develop an appropriate methodology to minimize problems, through provision of international technical expertise in procedure for IEOS and CONADE.

3. Extension

Information available through education and research forms the basis for most extension programs. Therefore, many

of the recommendations outlined in the sections on research and education are to some extent related to the recommendations for extension.

Many of Ecuador's environmental problems such as deforestation, soil erosion, desertification and water contamination are indirectly or directly caused by subsistence farming. Unfortunately, such environmental degradation is a byproduct of the farmer's efforts to meet his basic needs. It is mostly because of ignorance that to prepare his fields, the farmer uses techniques and methods which favour erosion and accelerate run-off. It also may be because of lack of information that the subsistence farmer does not terrace on slopes, or follow contour lines for tilling, that he cuts and burns forest and water-retaining vegetation in watersheds, that he grazes his stock on crop residues and eroded sites, that he does not rest his range, or that he uses pesticides and fertilizers which may contaminate water needed for drinking by a downstream community. In this light, emphasis is placed on technology and environmental information transfer to subsistence farmers. With better knowledge, production could be increased and much environmental damage prevented. Some recommendations to be included in extension programs are highlighted below. Most of these recommendations have occurred in a different context throughout the report and corresponding references will be made.

- Provide in-service training for extension specialists to teach farmers the safe handling and use of pesticides (see c.1. above);
- develop "integrated" assistance packages, the information to be prepared by INIAP, the Forestry Division and extension personnel, in precise, compact, easy-to-understand form (see c.2. above);

- identify, through extension, possibilities for small industry establishment in rural areas, based on wood or agricultural products, or other small, labour-intensive industries (see c.2. above);

- direct extension activities to the establishment of cooperatives for tree nurseries, but also for tree planting;

- utilize results from research into the economics of agro/forestry for development planning and small-farmer consultation (see c.2. above).

There are many other areas where extension could effectively be used to prevent and reduce environmental degradation; however, these have been adequately discussed in a different context.

In conclusion, it is hoped that the recommendations presented in this report, as well as the environmental and institutional assessment in Chapters II and III, will be of assistance to USAID/E in formulating appropriate, effective and timely environmental strategies and programs.

APPENDIX I

"QUESTIONNAIRE" USED FOR MEETINGS WITH AGENCIES AND INSTITUTIONS

- Identify general area of responsibility.
- Determine aspects of conservation (environmental protection) within the agency's overall responsibility. If the agency has definite responsibility for the area of concern, information should be gathered on: administrative/organizational structure; work volume and task specification in relation to available staff personnel; supporting services; education and career opportunities; program planning and budget.
- Evaluate the relative importance of specific environmental problems.
- Assess the degree of the agency's awareness of problems.
- Identify the legislative authority of the agency, efficiency of the program execution and enforcement of the agency's regulations on the national and regional level.
- Assess the agency's policy concept in light of national policy.
- Discuss the agency's environmental program concept.
- Discuss the availability of human resources for planning and project implemention.
- Discuss pros and cons of (de)centralization of activities.
- Identify constraints and shortcomings (i.e., lack of policies, goals and objectives, lack of defined authority, lack of legislative support, insufficient planning, shortage of personnel and/or funds, inadequacy of technical staff, lack of problem awareness/understanding, research needs, etc.).
- Discuss strategies (to be) adopted by agency to overcome problems.
- Attempt to priorize problems and programs.

APPENDIX II

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APPENDIX III

GLOSSARY

National Contacts:

CEDEGE:	Comisión de Estudios para el Desarrollo de la Cuenca del Rio Guayas. (Study Commission for the Development of the Guayas Basin)
CEPE:	Corporación Estatal Petrolera Ecuatoriana (Ecuadorian Petroleum Corporation)
CONADE:	Consejo Nacional de Desarrollo (National Planning Board)
CLIRSEN:	Centro de Levantamientos Integrados de Recursos Naturales por Sensores Remotos (Remote Sensing Institute)
CREA:	Centro de Reconversión Económica de Azuay, Cañar y Morona (Center for the Economic Rehabilitation of Azuay, Cañar and Morona)
CRM:	Centro de Rehabilitación de Manabí (Center for the Rehabilitation of Manabí)
EP:	Excuela de Pesca (School of Fisheries)
EPNA:	Empresa Pesquera Nacional (National Institute for Commercialization of Fish)
DGH:	Dirección General de Hidrocarburos (Department of Hydrocarbons)
IEOS:	Instituto Ecuatoriano de Obras Sanitarias (Ecuadorian Institute of Sanitary Constructions)
IERAC:	Instituto Ecuatoriano de Reforma Agraria y Colonización (Ecuadorian Institute for Agrarian Reform and Colonization)
INECEL:	Instituto Ecuatoriano de Reforma Agraria y Colonización (Ecuadorian Institute for Agrarian Reform and Colonization)
INERHI:	Instituto Ecuatoriano de Recursos Hidráulicos (Ecuadorian Institute of Hydraulic Resources)

INCRAE: Instituto Nacional de Colonización de la Región Amazónica Ecuatoriana (National Institute for the Colonization of the Ecuadorian Amazon Region)

INIAP: Instituto Nacional de Investigaciones Agropecuarias (National Agricultural Research Institute)

MSP: Ministerio de Salud Pública (Ministry of Public Health)

MAG: Ministerio de Agricultura (Ministry of Agriculture)

PREDESUR: Programa Regional para el Desarrollo del Sur de Ecuador (Program for the Development of Ecuador's Southern Region)

PRONAREG: Programa Nacional de Regionalización Agraria (National Program to Regionalize Agriculture)

Divisions of Ministry of Agriculture:

- Planning
- Rural development
- Forestry
- Livestock

Ministry of Natural Resources and Energy

- Geology and Mines
- Subsecretariat of Fisheries

Ministry of National Defense

- Oceanographic Institute

Catholic University of Quito

City Management of Guayaquil

Natural Science Museum of Quito

Fundación NATURA

International Contacts:

FAO:	Food and Agricultural Organization
UNDP:	United Nations Development Program
UNESCO:	United Nations Economic and Social Council
OAS-IICA:	Organization of American States
IDB:	Inter-American Development Bank
IADS:	International Agricultural Development Service
ORSTOM:	Office de la Recherche Scientifique et Technique d'Outre-mer

Other abbreviations used:

ASA:	Agencia de Servicios Agropecuarios (Agency for Agriculture and Cattle Services)
CENDES:	Centro de Desarrollo Industrial (Center for Industrial Development)
EMPROVIT:	Empresa Nacional de Productos Vitales (National Vital Products Agency)
ENAC:	Empresa Nacional de Almacenamiento y Comercialización de Productos Agropecuarios (National Agency of storage and sale of Agricultural Products)
PIDA:	Proyectos Integrados de Desarrollo Agropecuario (Integral Agricultural Development Projects)