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General Design of an Environmental Management System

United Nation Industry Development Organisation

Executive Summary

FICHTNER

May 1995

1. INTRODUCTION

The environmental management system as described in Report 1 in details is a system of measurements, assessments and forecasts as well as data gathering and data providing of condition of the environment carried out by the units of central and local administration as well as NGO's, universities, institutes and industries.

The basic elements of the EMS and the basic structure and organization of its main components EMoS and EIS, are adoptable to every country and is suitable for the most different compositions of ecological systems. In an agreement of in future cooperating countries the designed system allows to honour all the obligations arising from the environmental conventions signed by each country and enable to comply the regulations and suggestions existing in this field in TCA countries. This is one of the factors which allows comparison of the obtained results on international scales.

2. THE ENVIRONMENTAL MANAGEMENT SYSTEM

2.1 Legal Situation

The legal situation should be regulated on the basis of laws, ordinances and administrative regulations. Counted among these are environmental legislation, whose objective is the protection of the environment, as well penal legislation, which is designed to effectively prevent violations of the environmental protection legislation.

2.2 Organisation

Likewise a basic prerequisite is an appropriate organisation. Counted among this are the following elements:

- Governmental organisations (e.g. ministries, agencies in the provinces)
- enforcement agencies (e.g. inspectorate of environmental protection)
- institutions supporting the state agencies; these could be wholly or partly state-owned or completely private
- agencies which organise the Environmental Monitoring System as well as the Environmental Information System
- steering group coordinating and formulating all environmental protection activities, exercising an advisory function.

These should effectively cooperate with each other. **Figure 1** shows a possible organisational system.

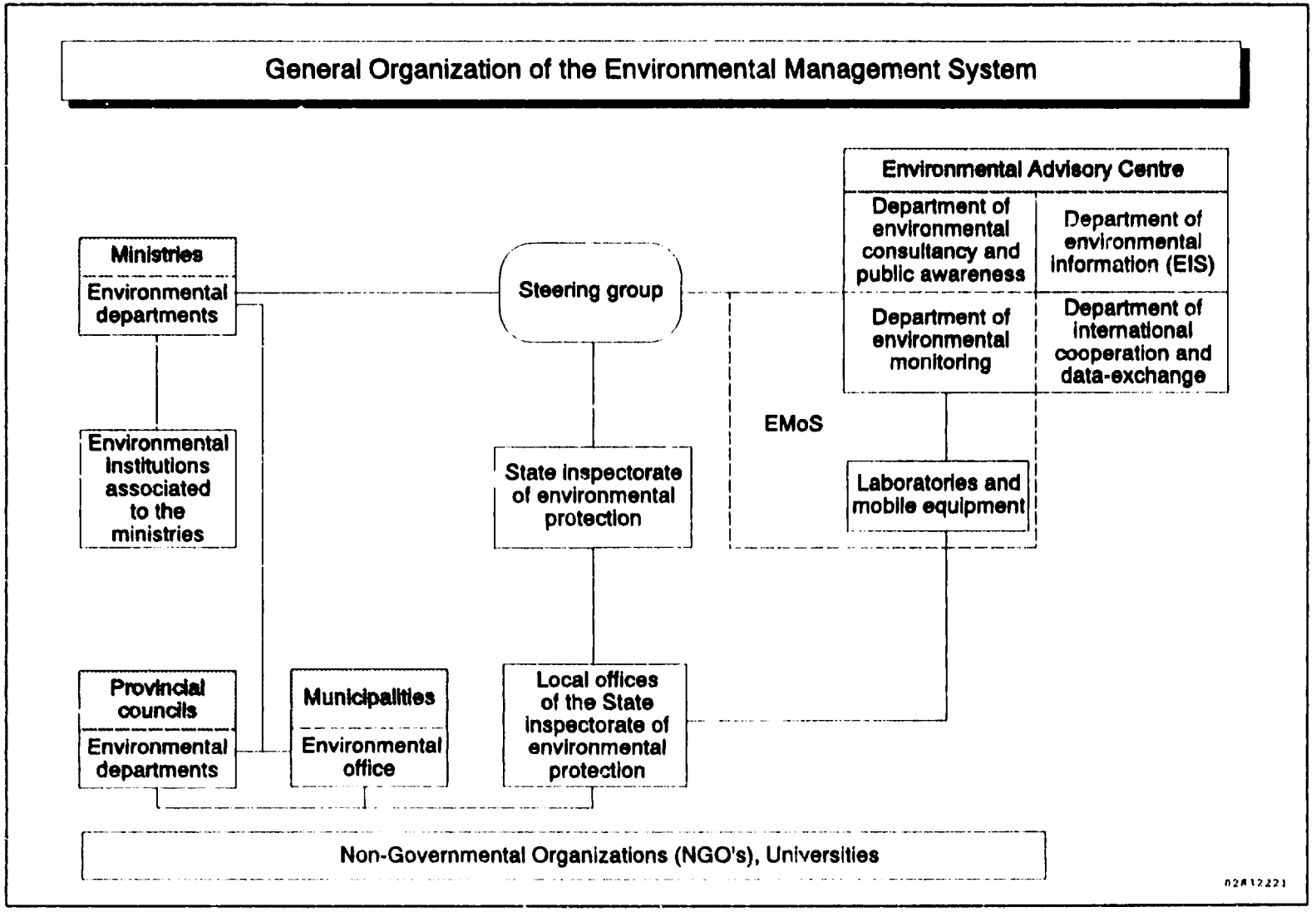

Figure 1: General Organization of the Environmental Management System

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The modus operandi of the institutions is described in the following.

- The ministries, with help of their associated institutions, determine the needs of environmental information about their country, in order to formulate laws, change plans etc. As a rule they also have the financial power, i.e. they finance the activities of the Environmental Advisory Centre or administer an environmental fund, as e.g. in Equador.

- In the Environmental Monitoring System the data are screened and checked. Specific analysis are carried out in the EMoS Laboratory. Emos is commissioning the local laboratories, which need to be certified to national standard.

- The Environmental Information System processes all incoming data by comparing data, preparing data reacting on specific questions, informing the environmental instectorate and preparing proposals for further projects

- The steering group coordinates the interests of the different ministries and their associated institutions involved in environmental protection and the Environmental Advisory Centre

- The state inspectorate also obtains its information among other from EIS. The EIS and the linked EMoS will form an important source of information for identifying companies which violate the environmental regulations as well as polluted areas. The will have the power to impose fines and penalties for enforcing the environmental law.

- Local laboratories collect and analyse local data and transmit to the national monitoring system. They work on behalf of and are commissioned by the Environmental Advirsory Centre

- At provincial level the Environmental departments will also be interested in access to data of provicial importance. Depending on the structure of decision-making and power, they will have different access to the data. Nevertheless the data will be needed for local and provicial planning.

2.3 Environmental Monitoring System

The following will make up a functional Environmental Monitoring System:

- Measurement schedule
- sampling
- laboratory analysis
- personnel
- quality assurance

Measuring schedule

For sampling to serve the intended purpose, it is necessary to draw up a measuring schedule. This should take into consideration:

- the causes of environmental impacts and
- influences are exerted in which environmental media.

The principal causes of adverse environmental impacts are petroleum, mining- and agroindustry. The most practical approach is firstly to analyse the cumulative parameters in the environmental media air, water and soil. Should there be any noticeably high values of a particular cumulative parameter, further analysis should be carried out.

In the **petroleum industry** it is necessary to measure the combustion parameters SO_2, NO_x, CO_2, CO and particulates, as well as the cumulative parameters total organic carbon ($C_{org.}$) in the atmosphere. At the same time, the conditions at the instant of sampling are given, like air temperature, atmospheric pressure, wind speed and direction, and air humidity. If high values are determined for $C_{org.}$, aromatic hydrocarbons, chlorinated hydrocarbons and other hydrocarbon species should be measured. In water, firstly the summation parameters total organic halogens (TOX), total organic carbon (TOC), dissolved organic carbon (DOC), biological oxygen demand (BOD) and chemical oxygen demand (COD) should be measured. Associated parameters are temperature, conductivity, suspended particulate matter (SBM), pH and oxygen content. Furthermore, the content of anions and cations should be measured as well as, in drinking water, the levels of bacteria and parasites' eggs should be determined. This serves the purpose of utilising the water as drinking water for the personnel there assigned as well as the surrounding population. If the summation parameters are at a high level, aromatic hydrocarbons, chlorofluoro hydrocarbons and long-chain hydrocarbons as well the variation of oxygen concentration over 24 hours should be measured. Falling under soil analysis are water content, water capacity, pH, sulphur content as well the sum of the hydrocarbons. Required flanking measurements are determination of grain size and of temperature. For high measured levels, like for air and soil, hydrocarbons should be determined individually.

In the **mining industry** due to the fact that it need power-generation with gasoline-motors, the combustion parameters quoted above as well as heavy metals in the atmosphere should be measured. Also to be included are the flanking parameters as given above. In water, the above quoted summation parameters, flanking parameters as well as those heavy metals which could be flushed from the soil as well as by using heavy metals in mining (e.g. mercury in gold-mining) could be measured. In drinking water, for hygienic reasons the contents of bacteria and parasites' eggs should be determined. In the soil, the heavy metals as well as the flanking parameters quoted above should be determined.

In the **agroindustry** the contents of pesticides in use in the atmosphere should be determined. The above quoted flanking parameters will also be measured. In water, the above quoted summation parameters, anions, cations, heavy metals as well as the flanking parameters should be determined. For hygienic reasons, where used as drinking water, the content of bacteria and parasites' eggs should be determined. In the soil, anions, cations, heavy metals as well the flanking parameters given above should be measured. To the extent required, measurements should be made of the pesticides in use. The plants growing in the soils in question which are intended for human consumption, should be investigated for the presence of parasites' eggs.

Sampling

Sampling is undertaken using buses equipped as mobile measuring stations. These shall meet the requirements resulting from the nature of the topography. As a rule, four-wheel drive vehicles will be needed.

For the measurement of ground-level concentrations of air pollutants, in a first step two, for water sampling and analysis likewise two, and for soil sampling one measuring bus(es) should be used.

The air quality monitoring buses should contain:

- a weather station for measurement of
  - . temperature
  - . atmospheric pressure
  - . wind direction
  - . wind speed
  - . 10 m high mast.

- sampling equipment for measuring
  - . suspended dust
  - . gases
  - . heavy metals
  - . organic pollutants.

The buses should equipped with accumulators for energy supply in order to ensure that the measuring equipment can be operated and that no exhaust gases from power sources in the measuring bus will be included.

The water monitoring bus should contain the following equipment:

- Equipment for sampling water and sediments at various depths
- Equipment for measuring physical and chemical parameters like
  - . temperature
  - . pH
  - . conductivity

- oxygen
- phosphate
- ammonium
- nitrite
- nitrate
- chloride

A cooling facility should be provided in the bus, so that the samples can be transported cooled or frozen to the laboratory.

The bus for soil sampling should be equipped with an appropriate drilling unit, capable of reaching if needed depths down to 10 m (depending on the nature of the soil). These drilling units should be driven hydraulically, and for this reason the vehicle must be equipped with an appropriate power supply.

Mostly analysis will be performed in the laboratory. Because, however, various parameters become modified following sampling, these will have to be measured directly in the measuring bus. **Table 2.3-1** shows which parameters will be analysed in the field in the measuring vehicle and which in the laboratory, as well as those flanking measurements taken routinely and if required.

Parameter	Preparation					
	Air		Water		Soil	
Physical investigation						
Temperature	m	R	m	R	m	R
Conductivity	-	R	m	R	L	R
Grain size	-	-	-	-	L	i.r.
Dust	L	R	-	-	-	-
Atmosphere pressure	m	R	-	-	-	-
Wind direction	m	R				
Wind speed	m	R	-	-	-	-
Water content	-	-	-	-	L	R
SPM	-	-	L	-	-	-
Humidity	m/L	R	-	R	-	-
Water capacity	-	-	-	-	L	i.r.
Chemical investigation						
pH	-	-	m	R	L	R
O_2/O_2 24 h	m	i.r.	m	R/i.r.	-	i.r.
NO_x, SO_2, CO, CO_2, O_3	m	R	-	-	-	-
Anions/Cations	L	i.r.	m	R	L	i.r.
TOX	-	-	L	R	L	i.r.
TOC/Corg	L	R	L	R	L	R
DOC	-	-	L	R	L	R
BOD	-	-	m	R	-	-
COD	-	-	L	R	-	-
Heavy metals	L	i.r.	L	i.r.	L	i.r.
Aromatic hydrocarbons	L	i.r.	L	i.r.	L	i.r.
CFCs	L	i.r.	L	i.r.	L	i.r.
Other hydrocarbons	L	i.r.	L	i.r.	L	i.r.
Biological investigation						
Bacteria	L	i.r.	L	R	-	-
Parasite eggs	-	-	L	R	L	i.r.

m: mobile measuring vehicles
L: laboratory
R: routine
i.r.: if required

Table 2.3-1: Parameters to be analysed in the laboratory or in the mobile measuring vehicles and flanking measurements performed routinely or if required.

Laboratory analysis

For laboratory analysis, certain sample preparation equipment as well corresponding analysis equipment is required. Table 2.3-2 shows the various parameters with appropriate sample preparation and analysis equipment.

Parameter	Required equipment	Preparation		
		Air	Water	Soil
Physical investigation				
Temperature	Thermometer	-	-	-
Conductivity	Conductivity meter		-	Screens
Grain size	Screening sieves			
Dust	Dust measuring equipment (filters, cascade)	Aerated temperature-controlled cupboard		
Atmosphere pressure	Barometer		-	
Wind direction	Wind direction indicator		-	
Wind speed	Anemometer		-	
Water content	Drying cupboard			
SPM				
Humidity	Hygrometer, Drying cupboard	-	-	-
Water capacity	Laboratory vessels			-
Chemical investigation				
pH	pH meter		-	-
O_2/O_2 24 h	Oxygen electrode			
NO_x, SO_2, CO, CO_2, O_3	1-line monitoring instruments (gas analyser)	-		
Anions/Cations	Photometer	Glass equipment		
TOX	Glase equipment, IR detector	-	-	-
TOC/Corg	Glass equipment, Saprometer/FID	-	-	-
DOC	Glass equipment			
BOD	Glass equipment/drying cupboard	-	-	-
COD	Glass equipment/drying cupboard	-	-	-
Heavy metals	ICP, AAS	Pressurized scruple inspection chamber, glass equipment	Filter	Grinding mill, pressurized sample inspection chamber, glass equipment

Parameter	Required equipment	Preparation		
		Air	Water	Soil
Aromatic hydrocarbons	HPLC with fluorescence and MS GC with ECD and FID	Rotary evaporator	Rotary evaporator	Rotary evaporator, Soxlett
CFCs	GC with ECD and FID	Rotary evaporator, glass equipment, filtration equipment	Rotary evaporator, glass equipment, filtration equipment	Rotary evaporator, Soxlett, glass equipment, filtration equipment
Other hydrocarbons	GC with ECD and FID	Rotary evaporator, glass equipment, filtration equipment	Rotary evaporator, glass equipment, filtration equipment	Rotary evaporator, Soxlett, glass equipment, filtration equipment
Biological investigation				
Bacteria	Diverse items of equipment, incubator cupboard		-	-
Parasite eggs	Diverse items of equipment, microskope		-	-

Table 2.3-2: Required analysis equipment and associated equipment for sample preparation

Personnel

Two persons should be assigned to manning each measuring vehicle for sampling. These should be trained as chemical technicians.

Laboratory analysis should be conducted by chemists and suitably qualified assistants. Staff as follows are required:

- 1 inorganic chemist for inorganic analysis
- 2 assistants for inorganic analysis
- 1 organic chemist for HPLC
- 2 assistants for HPLC
- 1 organic chemist or analytical chemist for the GC
- 2 assistants for the GC
- 1 chemist and 2 assistants additional

Quality assurance

In order to ensure that the results of laboratory analysis are reproducable, it is necessary that a quality assurance system be put in place. This requires a central laboratory which dispatches defined samples to various investigation laboratories, where they are investigated quantitatively for the previously defined parameters. If the results of the parameters to be investigated agree with those of the cetnral laboratory, the laboratory can be certified for the analysis concerned.

These ring trials have to be repeated on a routine basis, approximately every year. As errors could also arise during sampling, ring trials will also have to be conducted of this. These should likewise be organised and controlled from a central laboratory. It is recommended that initially two or three laboratories be equipped in line with the above requirements. These should be in a position to conduct all sampling and analysis reproducibly. In a subsequent step, however, these laboratories should be withdrawn from sampling and analysis for the monitoring system. They should then certify other laboratories for the monitoring system. Certification should be open to all laboratories. The two or three laboratories will then be responsible for organising the ring trials and certification.

2.4 Environmental Information System

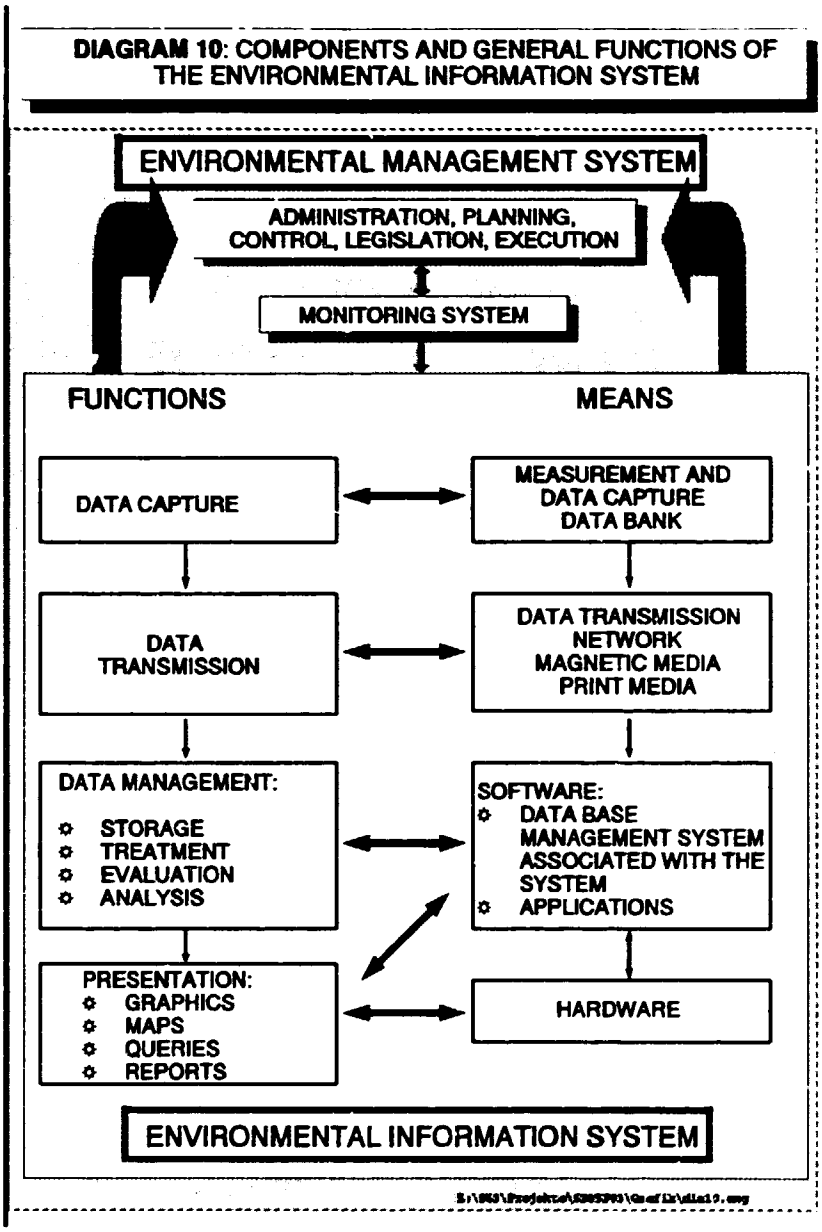
The Environmental Information System (EIS) described detailed in report no. 3 is the functional, technical and organizational foundation for:

- data gathering
- data transmission
- data management, and
- presentation of data and information to the end user regarding the environment, primarily on the Amazon Region of Ecuador.

Diagram 10 shows the system's main functions and their relationships with the means required to perform them, as well as their position within the Environmental Management System.

The system's structure and operations are open-ended, so it can become part of a regional network involving all Amazonian countries.

This approach to the EIS also makes it possible to add users according to future needs, possibilities and political and technical decisions. Its users will be mainly public and private institutions, universities and Non-governmental Organizations (NGOs), although other types of users may be added in the future.



In order to satisfy these requirements, an Integrated Information System is the structural goal, comprising:

Communications Network

The data transmission network is conceived of in a modular form, with main nodes in the biggest cities of each country by the final phase. Each node will serve a local network to integrate the users of that zone. The network architecture will be structured by phases according to progress with the Monitoring System (report 1, chap. 6.2), consolidating each phase prior to proceeding with the next.

Hardware

The hardware is modular, specifying minimum features required to join the network and EIS. However, when a user purchases or upgrades hardware (e.g. computer, modem, hard disk, CD-ROM, etc.) they should obtain the most recent technology available.

Software

The software should be, insofar as possible, modular and, above all, compatible, to make possible the timely, reliable transmission and management of data originating with and available on the network. Obviously, specific software programs and/or packages must be considered (e.g. REED by UNIDO, GISs (e.g. Arclufo, Spans), statistics (e.g. SAS, SPSS)) that some institutions are running or which are available on the market.

Central application software, to be used at the main node with a Environmental Information Center may be held up in the EAC, must be designed and implemented by phases to handle functions of control, administration, presentation of reports generated, and queries for EIS's different users, as well as follow-up on the technical and/or legal measures taken in the event of infractions and/or environmental impacts in general.

Data Bank

The system's main and secondary nodes will handle specific data banks for their functions and activities in regard to environmental impacts air, water, soil, flora, fauna, etc.

At the main node the data bank will compile suitably screened information and data from throughout the network. It will comprise:

- Specific data structures for access, queries and information from institutions and users of EIS.
- Data structure for control and supervision at the executive and legislative levels.
- Availability of data for applications in studies and projects.

Costs

The costs estimated for the initial system implementation phase are:

Cost of Implementation and Development

- Communications	6,500 US$
- Hardware	
. Central station	75,000 US$
. Secondary stations (10)	50,000 US$

- Software	
. Basic and data base management system software	25.000 US$
. Packages	60.000 US$
. Basic application software	220.000 US$
TOTAL	436,500 US$

Fixed monthly costs

- Maintenance	2,500 US$
- Operational expenses. During the first year, these are covered under applications software development	
- Operating costs as of the second year	8,000 US$
MONTHLY TOTAL (first year)	2,500 US$
MONTHLY TOTAL (as of the 2nd year)	8,000 US$

Design of an Environmental Management System for Amazon Region

United Nation Industry Development Organisation

Report 1

FICHTNER

May 1995

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LIST OF ABBREVIATIONS

AAS	Atomic Absorption Spectroscope
AME	Asociación de Municipalidades Ecuatorianas
ACT	Amazonian Cooperation Treaty
BOD	Biological Oxygen Demand
CAAM	Comisión Asesora Ambiental
CEDEGE	Comisión de Estudios para la Cuenca del Guayas
CEDIME	Centro de Investigaciones de los Movimientos Sociales del Ecuador
CEEA	Comisión Ecuatoriana de Energía Atómica
CENAIM	Centro Nacional de Acuicultura e Investigación Marines
CENDES	Centro de Desarrollo Industrial
CETUR	Corporación Ecuatoriana de Turismo
CFCs	Chlorofluorocarbons
CFN	Corporación Financiera Nacional
CI	Cámaras de Industrias
CIPA	Comité Interinstitucional de la Protección del Medio Ambiente
CLIRSEN	Centro de Levantamiento Integrado de Recursos Naturales con Sensores Remotos
CNT	Consejo Nacional de Tránsito
COD	Chemical Oxygen Demand
CODIGEM	Corporación de Desarrollo e Investigación Geológico Minero Metalúrgica
CONACYT	Consejo Nacional de Ciencia y Tecnología
CONADE	Consejo Nacional de Desarrollo
CONFENIAE	Confederación de Nacionalidades Indígenas de la Amazonía Ecuatoriana
CONSEP	Consejo Nacional de Control de Sustancias Estupefacientes y Sicotrópicas
CONUEP	Consejo Nacional de las Universidades y Escuelas Politecnicas
CORMADERA	Cooperación Madera
CP	Consejos Provinciales
CPE	Consejo de Puertos Ecuatorianos
C.P.Islas Galápagos	Comisión Permanente para las Islas Galápagos
CREA	Centro de Reconversión Económica de Azuay, Cañar y Morona Santiago
CRM	Centro de Rehabilitación de Manabi
DAC	Dirección de Aviación Civil
DDC	Dirección de Defensa Civil
DINAGA	Dirección Nacional de Gestión Ambiental
DOC	Desolved Organic Carbon
ECD	Electron Capture Detector
E Ch D	Estación Charles Darwin
EIS	Environmental Information System
EMaseo	Empresa Metropolitana de Aseo
EMS	Environmental Management System
EMoS	Environmental Monitoring System
EPN	Escuela Polytecnica Nacional de Ecuador
ETAPA	Empresa Pública Municipal de Teléfonos, Aqua Potable y Alcantariallado
ESPOL	Escuela Politecnica de Litoral
FEPP	Fondo Ecuatoriano Populorum Progreso

FID	Flame Ionisation Detector
FN	Fundación Natura
GC	Gas Chromatographe
GTZ	Sociedad Alemana de Cooperación Técnica
HPLC	High Pressure Liquid Chromatographe
IC	Ion Chromatographe
ICP	Inductly Coupled Plasma
IDEA	Instituto de Estrategias Agropecuarias
IEA	Instituto para el Ecodesarrollo Regional Amazónico
IERAC	Instituto Ecuatoriano de Reforma Agraria y Colonización
IESS	Instituto Ecuatoriano de Seguridad Social
ILDIS	Instituto Latinoamericano de Investigaciones Sociales Fundación Friedrich Ebert
INAMHI	Instituto Nacional de Meteorología e Hidrología
INCRAE	Instituto de Colonización de la Región Amazónica Ecuatoriana
INDA	Instituto Nacional de Desarrollo Agrario
INDAINE	Instituto Nacional de Energía
INEC	Instituto Nacional de Estadísticas y Censos
INECEL	Instituto Ecuatoriano de Electrificación
INEFAN	Instituto Ecuatoriano Forestal y de Areas Silvestres y Areas Naturales
INERHI	Instituto Ecuatoriano de Recursos Hidráulicos
INGALA	Instituto Nacional Galápagos
INIAP	Instituto Nacional de Investigaciones Agropecuarias
INOCAR	Instituto Oceanográfico de la Armada del Ecuador
INP	Instituto Nacional de Pesca
INPC	Instituto Nacional de Patrimonio Cultural
JBN	Junta de Beneficencia Nacional
MAG	Ministerio de Agricultura y Ganadería
MBS	Ministerio de Bienestar Social
MDN	Ministerio de Defensa Nacional
MECD	Ministerio de Educación, Cultura y Deportes
MEM	Ministerio de Energía y Minas
MFCP	Ministerio de Finanzas y Crédito Público
MGP	Ministerio de Gobierno y Policía
MICIP	Ministerio de Industrias, Comercio, Integración y Pesca
MIT	Ministerio de Información y Turismo
MOP	Ministerio de Obras Públicas
MRE	Ministerio de Relaciones Exteriores
MSP	Ministerio de Salud Pública
MVDU	Ministerio de Vivienda y Desarrollo Urbano
NGO	Non-government organization
OEA	Organización de Estados Americanos
PETROECUADOR	Empresa Petrolera Ecuatoriana
PMRC	Programa de Manejo de Recursos Costeros
PREDESUR	Subcomisión Ecuatoriana de las Cuencas Puyango-Tumbes y Catamayo-Chira, Programa de Desarrollo Regional del Sur del Ecuador
PRONADER	Programa Nacional de Desarrollo Rural
PRONAREG	Programa Nacional de Regionalización

SENDA	Secretaría Nacional de Desarrollo Administrativo
SESA	Servicio Ecuatoriano de Sanidad Agropecuaria
SSA	Subsecretaría de Saneamiento Ambiental
TOC	Total Organic Carbon
UC	Universidad Central
UNAMA	Unidad Asesora del Medio Ambiente
UNIDO	United Nations Industrial Development Organization
UPA	Unidad de Protección Ambiental de PETROECUADOR
UTP Loja	Universidad Técnica Particular de Loja

EXECUTIVE SUMMARY

Considering, first of all, the environmental situation in the Amazon Region and in general throughout Ecuador, this country's government has requested and applied for international assistance to address environmental control, in order to mitigate, eliminate and prevent existing environmental impacts and those that may arise in the future due to the process of the country's industrial and agricultural development. The United Nations Industrial Development Organization (UNIDO) has presented its technical assistance in the form of a project that will develop the required environmental control system.

This assistance involves the development of an Environmental Management System, starting with the pilot plan in the Amazon Region of Ecuador. In a subsequent phase of the system, it will expand in a modular fashion to the other countries of the Amazon Region (member countries of the Amazon Cooperation Treaty, ACT). The system must be able to

- recognize environmental impacts,
- evaluate them and
- provide the necessary assistance to establish national and regional programs that will make it possible to
  - mitigate and eliminate environmental damage and
  - to establish laws, regulations, standards and norms as a basis for protecting the environment while the member countries develop industrially.

UNIDO has decided to engage consulting services to implement the first phase of the project, and has commissioned the FICHTNER company, in February 1994, to develop on environmental management system, divided in 4 reports as follows.

1) The design of the pilot installation of an **Environmental Management System** for the Ecuadorian Amazon Region.

2) The design of a short-term action plan as a basis to formulate and implement Ecuador's national environmental policy.

3) The design of a pilot communications network on the national level to generate and exchange information on environmental management (**Environmental Information System**).

4) The design for laying the foundations of a long-term action plan to monitor and manage environmental impacts throughout the Amazon Region.

The project aims to contribute, alongside Ecuador's own institutions, to establishing the plans and procedures for action to control and take corrective measures in view of the country's deteriorating environment and that of the region, on the basis of coordination and programming of consensus-based actions with the public, private institutions and other national and international entities, in order to optimize the rational use of natural, human, economic, technical and scientific resources. These aspects must also contribute to promoting environmental conservation.

Pilot Area

One of the ecological systems of the greatest global importance for climate and the maintenance of fresh water on Earth is in the Amazon Region. Despite current losses of tropical mountainous and flatlands forests, basically due to petroleum extraction, agroindustry and the resulting migration --with its problems of human settlements without proper infrastructure-- the Amazon Region remains a natural ecological system that, where it is intact, is unmatched the world over for its significance and size.

The Amazon Region covers an area of nearly 7.2 million km^2, which amounts to 7% of the Earth's total land area. The flora and fauna of this region comprises over half the planet's biological wealth, including a broad variety of wild species and many trees that have not yet been discovered, much less classified.

The pilot project in Ecuador involves the Amazon Region in the eastern part of the country. Ecuador has 1.7% of the total Amazon region; however, in comparison with its total land area (after the Rio de Janeiro Agreement of 1942) this region is almost half (45%) of its territory. The five eastern provinces (Sucumbíos, Napo, Pastaza, Morona Santiago and Zamora Chinchipe) are almost entirely in the Amazonian lowlands. Westward, this area reaches the slopes of the Andes mountains. These provinces are basically the area of interest for this project. However, for certain considerations, the geographical area of Ecuador as a whole is involved.

The most important industries in the region covered by the study are:

- oil industry
- mining industry (in particular gold mining)
- agroindustry.

Oil industry

Oil industry is the key sector for Ecuador. 50% of the national budget come from oil revenues.

Some 630,000 hectares of the Ecuadorian Amazon region are actually involved in petroleum production and 3 million hectares are under exploration, including six blocks that were awarded on June 7, 1994 for the exploration phase.

The oil industry has considerable environmental impacts:

- Refinery emissions, in particular sulphur dioxide, carbon monoxide and nitroxen oxides in an estimated amount of 2,000 tons per year each
- Drilling waste water contaminated by oil and chemicals are discharged without adequate treatment
- Along the pipe-lines, there are oil contaminations due to leakages
- Watercourses are neglectfully blocked and diverted
- Ground water is contaminated due to the drilling activities and flow directions are impaired
- Each mile of access road causes the loss of approx. 500 hectares of forest. The streets are often randomly cut through the forest
- Erosion of deforested areas
- The activities disturb fauna and flora.

Mining industry

Mining, in particular gold mining which is mainly located in Ecuador's south-east provinces in the foothills of the Andes, has shown in recent years a surprising growth. New licences have been awarded. More than 90% of the gold extraction is done manually with inadequate methods of extraction.

The most important environmental impacts of mining are:

- Emission of mercury caused the thermal amalgam-gold extraction methods
- Impairment of the ground water due to mining activities
- Effluent polluted by mercury, heavy metals, cyanides, sulphates, etc.
- Change of the course of brooks and rivers
- Uncontrolled logging to win fuel and to create grassland
- Risk of mine sinking and destabilisation of the surrounding area
- Erosion due to logging
- Impairment of fauna and flora due to soil and water contamination and interference in the habitat.

Agroindustry

About 58% of the economically active population in the Ecuadorian Amazon region work in agriculture. Due to poor cultivation techniques, the natural resources are insufficiently used.

Agroindustry in the Ecuadorian Amazon region is based fundamentally on the production of tea, African palm for oil and grease production, and lumbering. Tea plantations cover a small land area in Pastaza Province, whereas palm-growing covers vast land areas in Napo and Sucumbios provinces.

The essential environmental impacts of agroindustry are:

- Logging of large areas for wood exploitation and particularly to cultivate the African Palm
- Non regenerable destruction of 70% of the vegetation layer due to careless logging techniques
- Contamination of soil and water courses due to the excessive use of agrochemicals (pesticides, insecticides, herbicides) for the sake of monocultures
- Sweeping away of humus by rain and heavy erosion
- Farmers take possession of new land ignoring that the soil quality is not adequate for agriculture. After a few years these fields are worthless so that new areas are cleared
- Impairment of fauna and flora, particularly by progressive narrowing of the habitat.

Ecuador's environmental laws and administration structure

In context with the study, Ecuador's legislation concerning the protection of the environment and the national institutions and organisational structure for the implementation of such regulations were examined.

There exists a great number of regulations and policies on the basis of

- the law to avoid and control pollution (1976)
- the Basic Environmental Policies (1994)

and international agreements, such as

- the Bale Convention
- the Montreal Protocol
- the Convention on climate changes.

The adoption of these provisions falls into the competence of various ministries. The responsibility for their implementation lies with

- various ministries
- regional and local authorities
- public and private organisations some of which have been specifically designated and/or founded for these tasks.

Inadequate coordination in the formulation of the policies and also in the monitoring and implementation has caused on overlapping of competences in some cases and supervision deficits in some other cases. The effects is that no authority has a complete knowledge of the present environmental impairments which adversely affects the implementation of laws and directives.

There is no complete system and no coordinating institution which would comprise, coordinate and be actively involved in the design of all concerns of environmental protection. The description of such an environment management system is outlined in the following and described in greater detail in chapter 5.

Environmental Management System

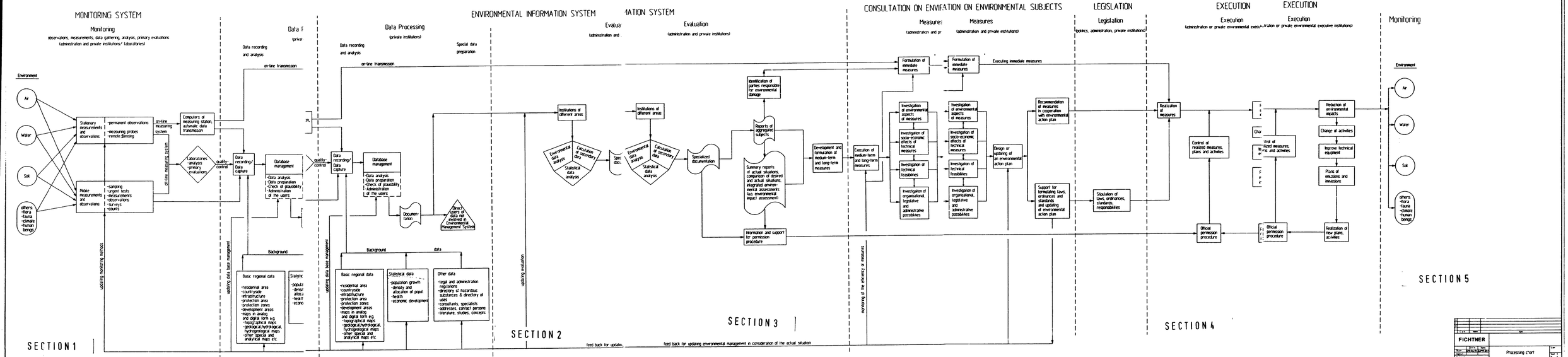
The main purpose of an Environmental Management System (EMS) is to prevent negative environmental impacts from being caused by human economic activities and mitigate or eliminate existing negative impacts. Only with the assistance of ongoing, broad-based analysis and observations of the environmental situation, along with the adoption of measures for improvement and for the prevention of negative environmental impacts, can we move in the direction of the ultimate objective, which is to maintain sustainable development that is compatible with a healthy environment, and moderate utilization of resources.

The system's core tasks are grounded in:

- Continually preparing and updating national environmental policy, and formulating and establishing environmental objectives.
- Continually formulating and completing a suitable legal framework to support and reinforce institutions and authorities at the various levels of administration, so that they can perform their functions effectively,
- Structuring a legal instrument for effective control of the environmental situation, updating and adapting criminal laws for effective enforcement in the event of environmental crimes,
- Continually preparing, developing and coordinating ordinances, norms and standards as a basis for effective environmental control and in order to provide a clear, accurate document on environmental matters.
- Developing, implementing and overseeing measures to orient sustainable development that will not harm the environment,
- Reinforcing and/or structuring environmental management units in every province,
- Organizing and implementing environmental control with the support of an Environmental Monitoring System and an Environmental Information System,
- Organizing, recording and coordinating, nation-wide, major national environmental activities (studies, concepts and projects).

The following **diagram 1** shows the components of the EMS and the overall linkages among them.

Diagram 1: Functional S·1: Functional Structure of an Environmental Management Systnent System



Environmental Monitoring System

The tasks, objectives and steps for the introduction of a monitoring system are described in **diagram 2** and **3**.

DIAGRAM 2
THE MONITORING SYSTEM

Task:

Registration and acquisition of data by

- ☼ recording measured data
- ☼ observations
- ☼ monitoring
- ☼ surveys

Steps to a monitoring system

1. **Definition and delimitation of the investigation**

   Analysis of environmental situation ⇒ definition of measured data ⇒ definition of investigation area

   e.g.: environmental pollution due to mineral oil exploration ⇒ list of all media and hazardous substances to be measured ⇒ delimitation of the investigation area and neighbouring areas

2. **Finalizing measured data and specification of measurement systems**

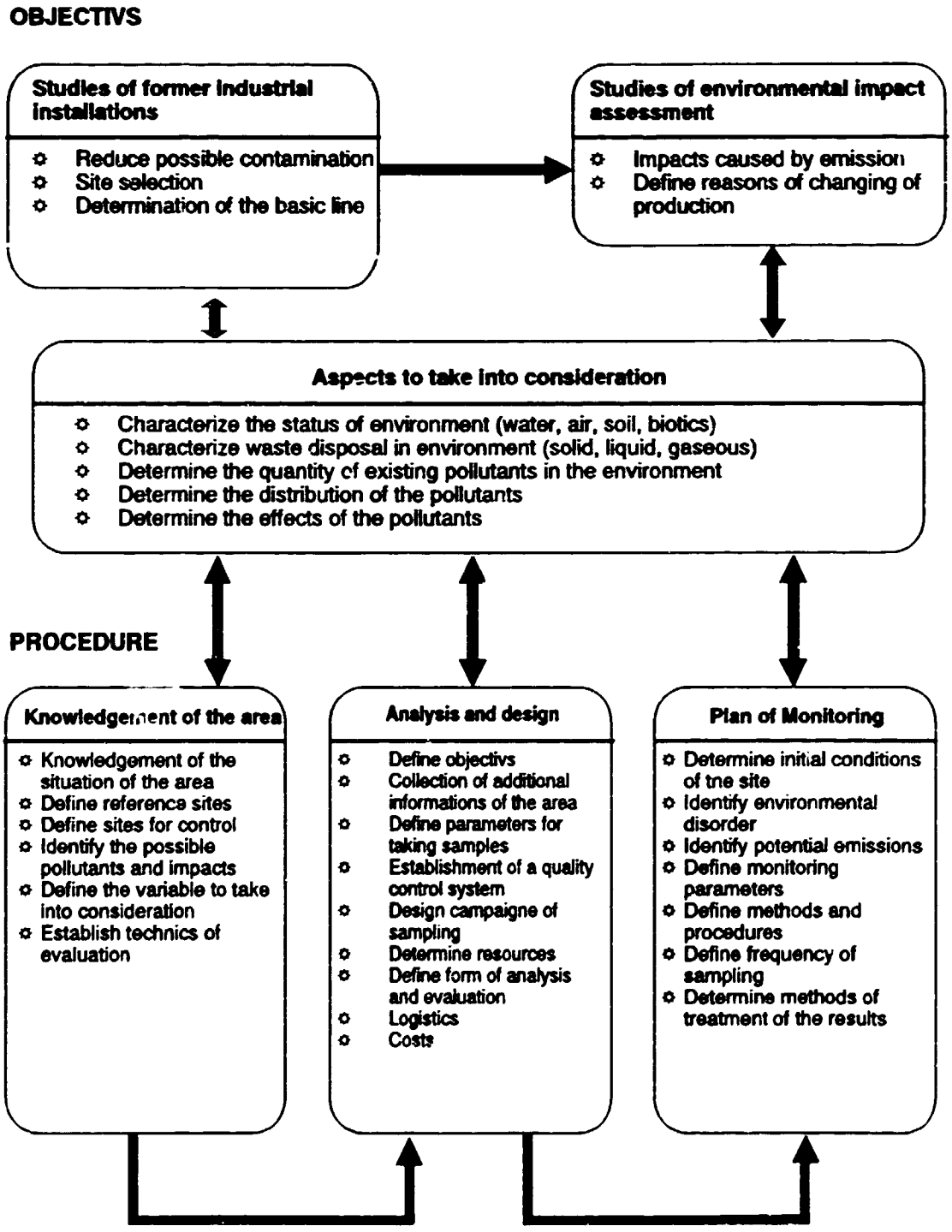
   e.g.: sampling, on-line measurement system, census, medical investigations

3. **Specification of tasks and accountabilities of the departments and institutions involved in the monitoring system**

   e.g.: MAG, MEM, EPN, CEEA, UPA, CONAIE

4. **Implementation of monitoring system**
   - ☼ priority list of implementation steps
   - ☼ specification and implementation of centres of development to provide impetus to system development

DIAGRAM 3
OBJECTIVES AND TASKS OF THE ENVIRONMENTAL MONITORING SYSTEM



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The sectors of petroleum, mining and agro-industry have different repercussions on environment. **Table 4** shows the parameters which must be examined in the three industrial sectors in the different environmental media of air, water and soil.

Parameter	Air		Water			Soil
	Flue gas	Atmo-sphere	Waste water	Suffice waters	Drinking water	
Physical investigation						
pH	-	-	1 2 3	1 2 3	1 2 3	1 2 3
Temperature	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
Conductivity	-	-	1 2 3	1 2 3	1 2 3	1 2 3
Grain size	-	-	-	-	-	3
Dust	1 2	1 2	-	-	-	-
Pressure	1 2	1 2	-	-	-	-
Wind direction	-	1 2	-	-	-	-
Wind speed	-	1 2	-	-	-	-
Water content	1 2	1 2	1 2	1 2 3	-	1 2 3
Water capacity	-	-	-	-	-	3
Chemical investigation						
Heavy metals	1 2	1 2	1 2 3	1 2 3	1 2 3	1 2 3
Anions	1 2	1 2	1 2 3	1 2 3	1 2 3	1 2 3
TOC	1 2	1 2	1 2 3	1 2 3	1 2 3	1 2 3
DOC	-	-	1 2 3	1 2 3	1 2 3	-
BOD	-	-	1 2 3	1 2 3	1 2 3	-
COD	-	-	1 2 3	1 2 3	1 2 3	-
Aromatic hydrocarbons	1 2	1 2	1 2 3	1 2 3	1 2 3	1 2 3
CFCs	1 2	1 2	1 2 3	1 2 3	1 2 3	1 2 3
Other hydrocarbons	1 2	1 2	1 2 3	1 2 3	1 2 3	1 2 3
Gasses (SO_2, NO_x, CO_2, CO, O_2)	1 2	1 2	-	-	-	-
Biological investigation						
Bacteria	-	-	3	3	3	3
Parasite eggs	-	-	3	3	3	3
Flora	-	-	1 2 3	1 2 3	1 2 3	1 2 3
Fauna	-	-	1 2 3	1 2 3	1 2 3	1 2 3

1 Petroleum Industry
2 Mining Industry
3 Agroindustry

Table 4: Parameters to be investigated

Surveyw were carried out in laboratories to find out which parameters can be examined in the various laboratories. The analyzers and their application were registered and the equipment required for the monitoring system was determined. **Table 5** shows the parameters to be examined, the relevant analyzers and the cost of the devices to be procured.

Parameter	Required equipment	Existing equipment	Location	Additions	Costs
Physical investigation					
pH	pH meter	pH	UC, EPN, ESA		•
Temperature	Thermometer				•
Conductivity	Conductivity meter				•
Grain size	Screening sieves				•
Dust	Dust measuring equipment (filters, cascade)	Filters, cascade	SSA, CEEA	6 measuring devices	•
Atmosphere pressure	Barometer				•
Wind direction	Wind direction indicator				•
Wind speed	Anemometer				•
Water content	Drying cupboard Scales				•
Water capacity	Laboratory vessels				
Chemical investigation					
Heavy metals	ICP, AAS	AAS	CEEA, EPN, PUCE, CO-DIGEM, UC	ICP IAAS (flame-type, graphite tubular cell and hybrid system)	113.000 75.000
Anions	Ion chromatograph				75.000
TOC	Glass equipment FID				•
BOD	Glass equipment drying cupboard				•
COD	Glass equipment drying cupboard				•
Aromatic hydrocarbons	HPLC with X-ray				80.000
CFCs	GC with ECD and FID	GC	MAG-Tumbaco CEEA (EPN, UC)	GC with ECD and FID	25.000
Other hydrocarbons	GC with ECD and FIS			GC with ECD and FID	s.o.
Gases	1-line monitoring instruments (gas analyser)	Discontinuous chemical analyses	SSA, EPN	3xNO_x, 3xSO_2, 3xO_2, 3xCO_2, 3xCO	45.000
Biological investigation					
Bacteria	Diverse items of equipment	Diverse items of equipment	UC, SSA	-	not
Parasite eggs	Diverse items of equipment	Diverse items of equipment	ETAPA, EPN	-	avai
Flora	Diverse items of equipment	Diverse items of equipment	IGM, CLIRSEN	-	lable
Fauna	Diverse items of equipment	Diverse items of equipment	MAG	-	
Total					413.000

Table 5: Existing and required analysis equipment, as well as the costs of procurement of the equipment required

It is further recommended to provide several measuring units for mobile use. These costs and other costs are shown in **table 6**.

Material/equipment	Unit costs	Total costs $-US
Laboratory including air-conditioned room, poisons cabinet, solvents cabinet, scales, etc.	50,000.-	50,000.-
Analysis apparatus Titrimeter, flasks, beakers, coolers, burners, rotary evaporators, etc.	25,000.-	25,000.-
3 Sampling equipments for air, probes, pumps, pressure ganges, dryers, heating, cooling, etc.	12,500.-	37,500.-
2 Pollutant deposition measuring scales, vehicles, equipments	93,500.-	187,000.-
2 Water quality measuring scales, vehicles, equipments	62,500.-	125,000.-
1 Vehicle for sampling soils and contaminated land	75,000.-	75,000.-
Consumables	40,000.-	40,000.-
Contingencies	40,000.-	40,000.-
Total		**579,500.-**

Table 6: Cost of Meassuring units, furnishing and conversion of laboratories and estimated annual costs for consumables, repairs or replacements

In addition, personnel costs for the implementation of the system and set-up support and training of basis personnel must be taken into account as follows:

Execution of initial implementation plan

Execution of plan	350,000 US $
Foreign advisory support and local training, incl. quality control plan and required literature	200,000 US $
Training for personnel abroad	200,000 US $
Total, initial plan execution	750,000 US $

Diagrams 7 and **8** show the environmental monitoring system - initial implementation plan - and the flow chart of the sampling campaign process.

DIAGRAM 7
FLOWCHART OF THE SAMPLING CAMPAIGN PROCESS

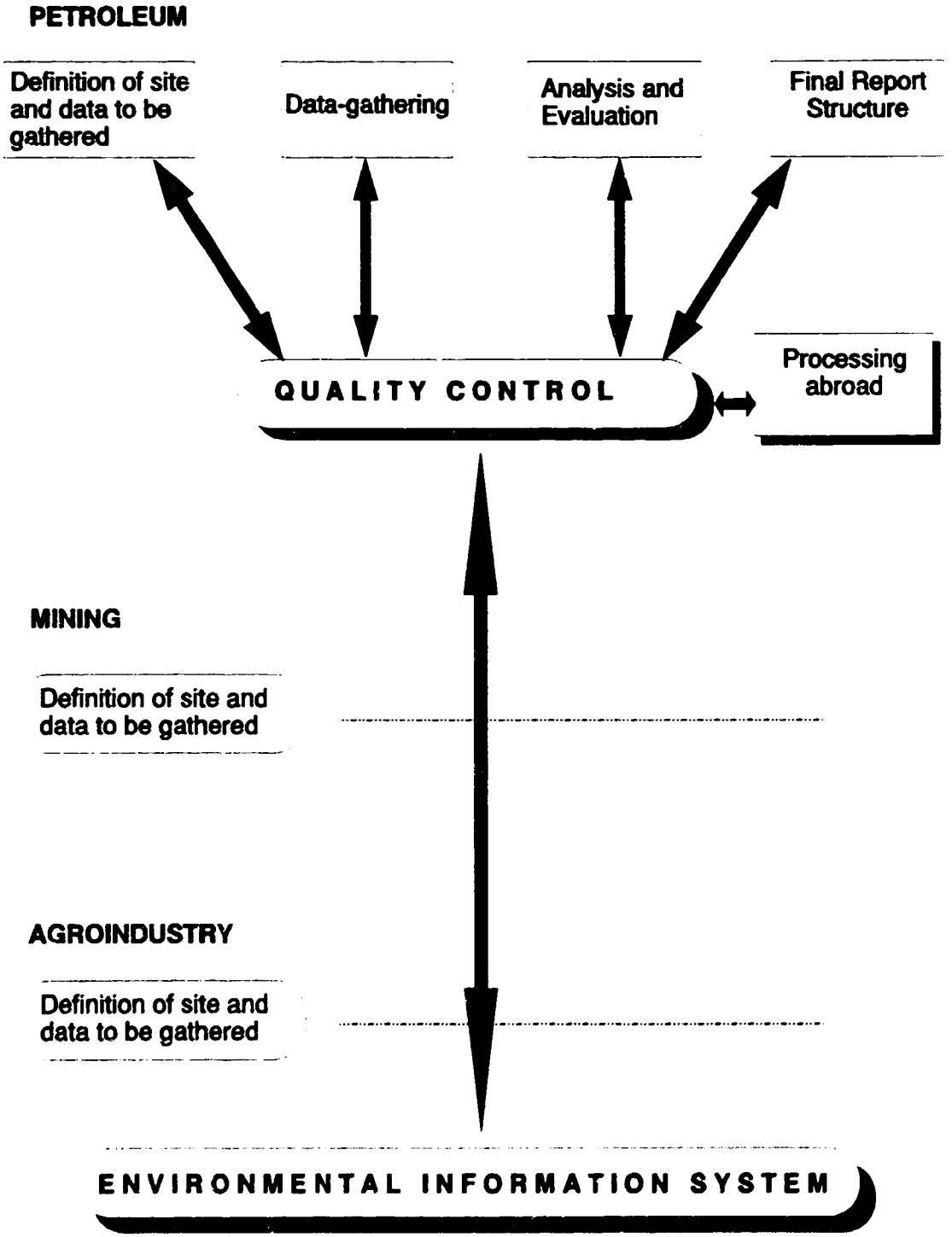

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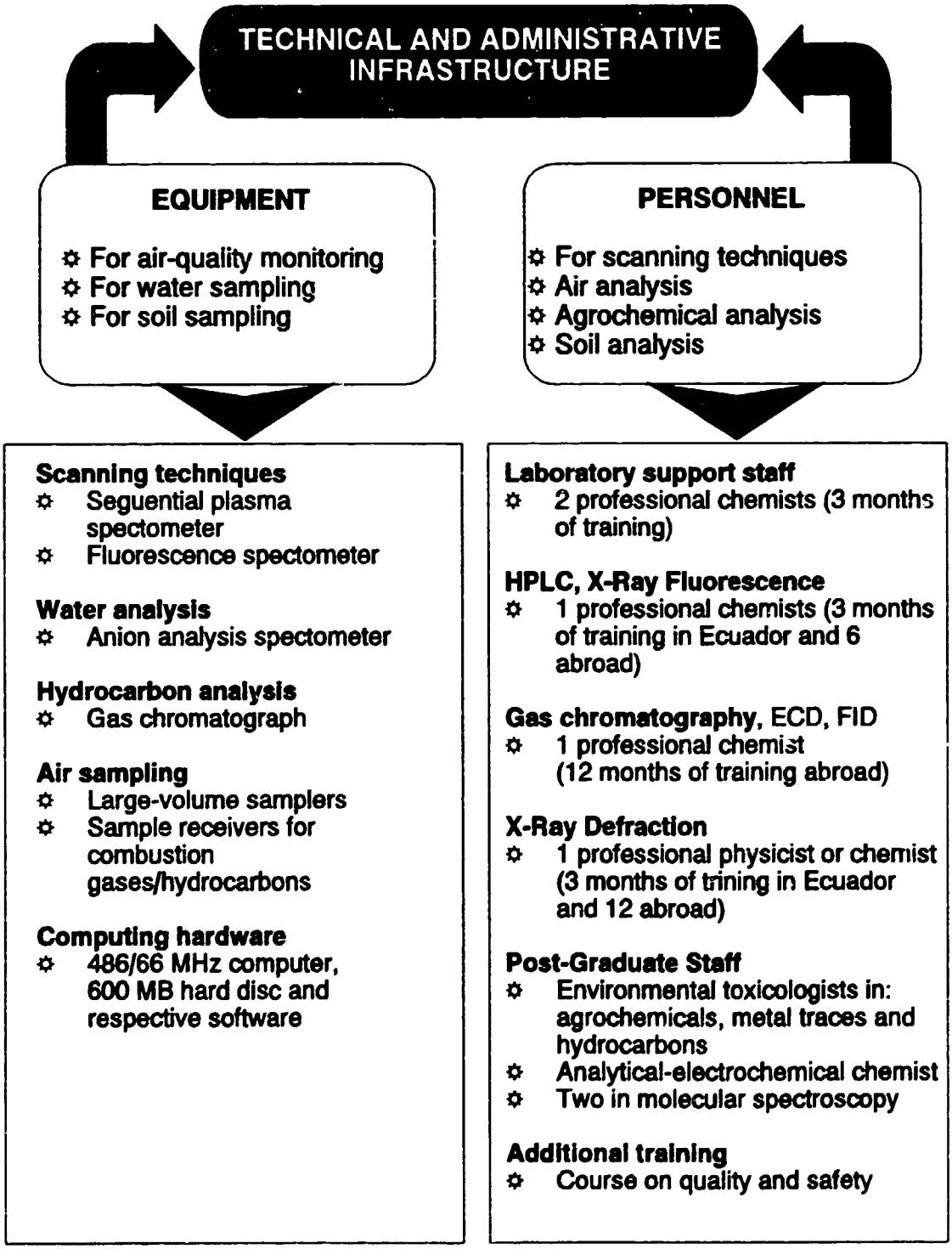
DIAGRAM 8
COMPONENTS OF A MONITORING SYSTEM



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A gapless set-up and a qualified and professional operation of the monitoring system will be ensured provided that the following personnel is hired in the first set-up year:

- Hiring a foreign consulting firm to operate the system during its first year of life
- Hiring an individual consultant
- Hiring scientific and technical staff, technical support staff and administrative/logistical support staff as follows:

Project leadership
- Project Director
- Project Assistant Manager
- Assistant to the Director

Professionals in charge of work in different sub-projects
- Agroindustry sub-project
  Director
  Field Assistant

- Petroleum sub-project
  Director
  Field Assistant
  Field personnel

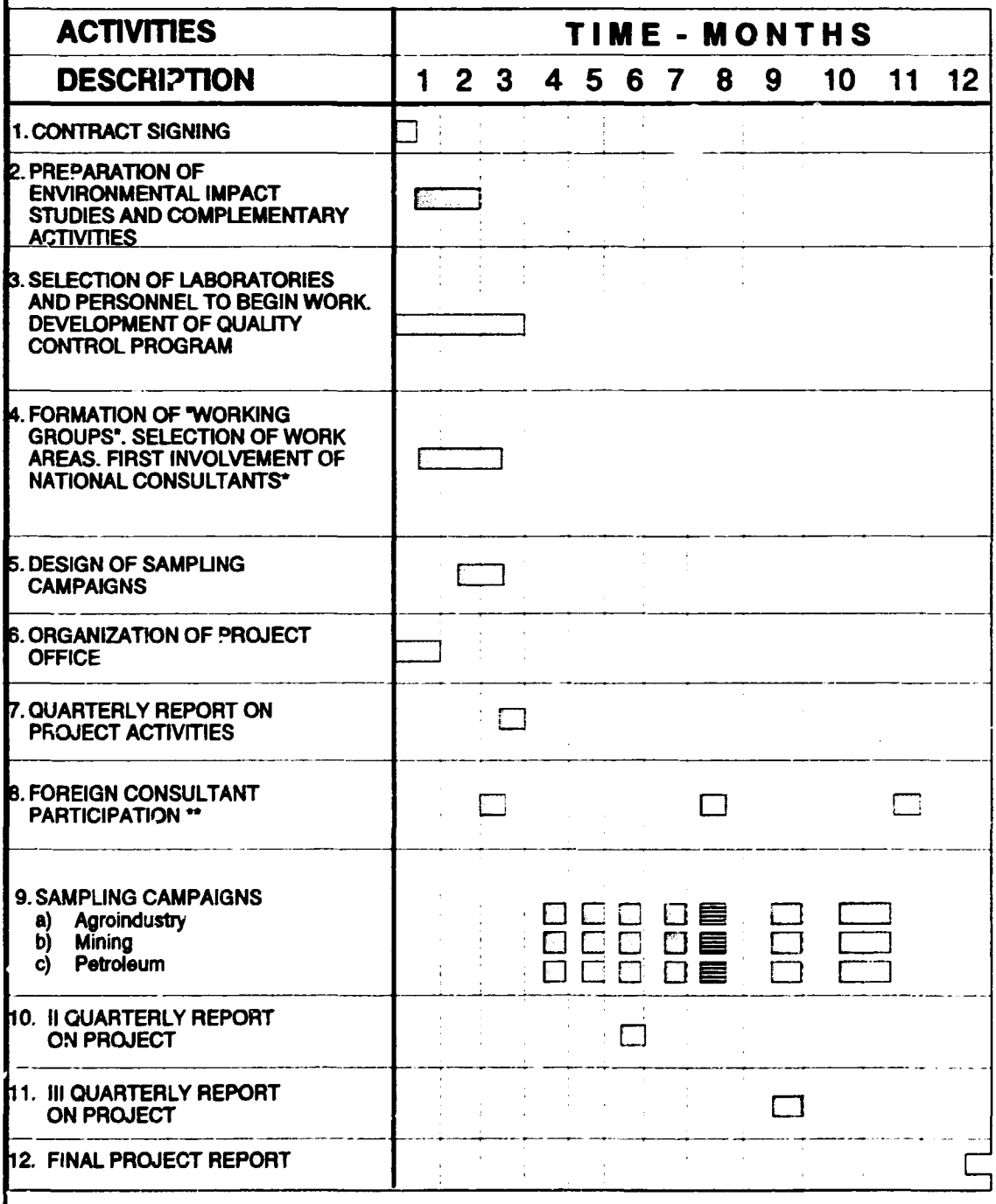
- Mining sub-project
  Director
  Field Assistant
  Field personnel

Administrative Personnel
- Administrative Assistant
- Secretary
- Draftsman
- Messenger
- Driver

Consultants
- Expatriate 1
- National 5

Time frame and contents of the set-up plan for the first year (implementation) is shown in **diagram 9** as well as the estimated costs in the than following tabulation.

DIAGRAM 9
TIMETABLE OF ACTIVITIES TO BE PERFORMED



* National consultants will participate in selecting areas and designing sampling campaigns. They will occasionally oversee campaign implementation. Attendance at the quality control program will be mandatory for laboratories beginning this work and those that join in later.

** Foreign Consultant: He or she will help review sampling campaign designs; regarding the transformation and ultimate destination of pollutants; and will propose possible projects deriving from the work that has been defined.

Evaluation of Sampling Campaigns; search for the origin of pollution; definition of areas for research.

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ESTIMATED COSTS

ICP	113,000 US$
AAS	75,000 US$
IC	75,000 US$
HPLC	80,000 US$
GC/ECD, FID	25,000 US$
Gas analyser	45,000 US$
Laboratory	50,000 US$
Analysis apparatus	25,000 US$
Sampling equipments for air	37,500 US$
Vehicles for pollutant deposition measuring scales	187,000 US$
Vehicles for water quality measuring scales	125,000 US$
Vehicle for sampling soils	75,000 US$
Consumables	40,000 US$
Contingencies	40,000 US$
Total Equipment	992,500 US$
EXECUTION OF INITIAL IMPLEMENTATION PLAN	
Execution of Plan	350,000 US$
Foreign Advisory Support and Local Training, including quality control plan and required literature	200,000 US$
Training for Personnel Abroad*	200,000 US$
Total, Initial Plan Execution	750,000 US$
TOTAL, INITIAL PLAN FOR EMoS	**1,742,500 US$**

* It is expected that additional scholarship support will be obtained, especially for longer-term professional studies.

Environmental Information System

The Environmental Information System (EIS) described detailed in report no. 3 is the functional, technical and organizational foundation for:

- data gathering
- data transmission
- data management, and
- presentation of data and information to the end user regarding the environment, primarily on the Amazon Region of Ecuador.

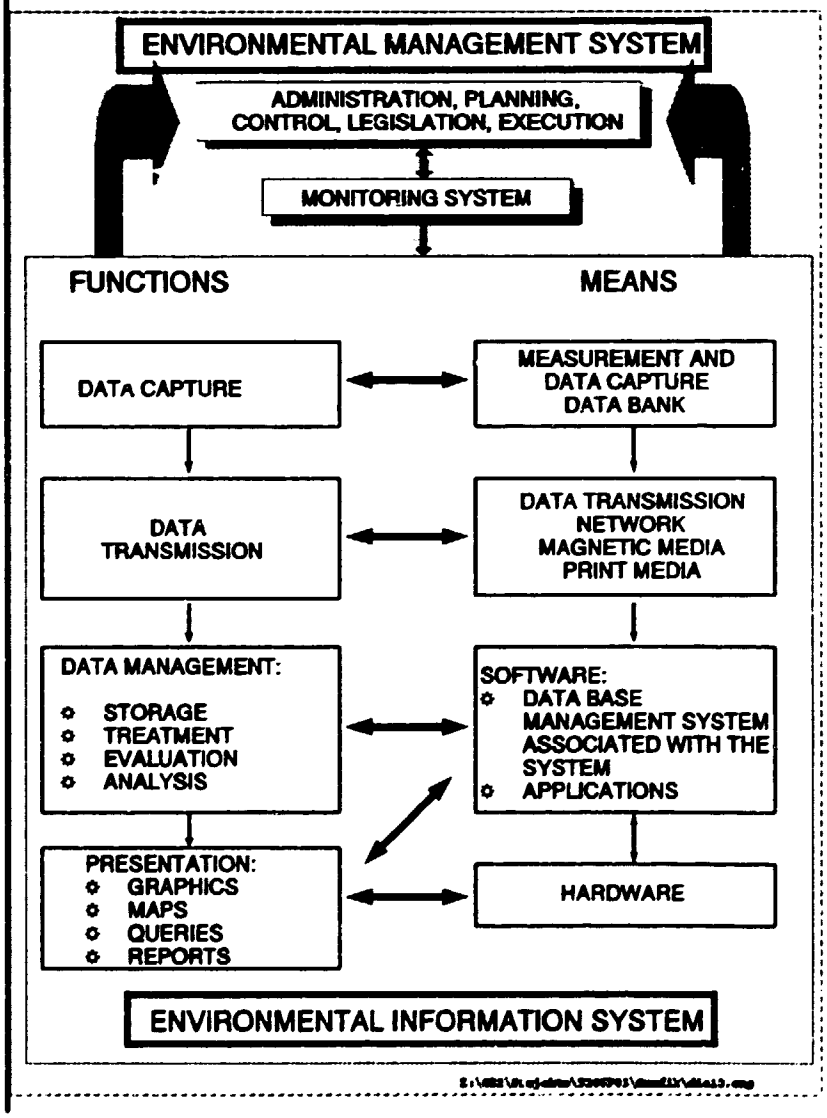
Diagram 10 shows the system's main functions and their relationships with the means required to perform them, as well as their position within the Environmental Management System.

The system's structure and operations are open-ended, so it can become part of a regional network involving all Amazonian countries.

This approach to the EIS also makes it possible to add users according to future needs, possibilities and political and technical decisions. Its users will be mainly public and private institutions, universities and Non-governmental Organizations (NGOs), although other types of users may be added in the future.

In order to satisfy these requirements, an Integrated Information System is the structural goal, comprising:

DIAGRAM 10: COMPONENTS AND GENERAL FUNCTIONS OF THE ENVIRONMENTAL INFORMATION SYSTEM



Communications Network

The data transmission network is conceived of in a modular form, with main nodes in Quito, Guayaquil, Cuenca and Loja, by the final phase. Each node will serve a local network to integrate the users of that zone. The network architecture will be structured by phases according to progress with the Monitoring System (report 1, chap. 6.2), consolidating each phase prior to proceeding with the next.

Hardware

The hardware is modular, specifying minimum features required to join the network and EIS. However, when a user purchases or upgrades hardware (e.g. computer, modem, hard disk, CD-ROM, etc.) they should obtain the most recent technology available.

Software

The software should be, insofar as possible, modular and, above all, compatible, to make possible the timely, reliable transmission and management of data originating with and available on the network. Obviously, specific software programs and/or packages must be considered (e.g. GISs, statistics) that some institutions are running or which are available on the market.

Central application software, to be used at the main node in Quito with a Environmental Information Center (EIC) may be held up in Central Coordination Unit (CCU), must be designed and implemented by phases to handle functions of control, administration, presentation of reports generated, and queries for EIS's different users, as well as follow-up on the technical and/or legal measures taken in the event of infractions and/or environmental impacts in general.

Data Bank

The system's main and secondary nodes will handle specific data banks for their functions and activities in regard to environmental impacts air, water, soil, flora, fauna, etc.

At the main node the data bank will compile suitably screened information and data from throughout the network. It will comprise:

- Specific data structures for access, queries and information from institutions and users of EIS.
- Data structure for control and supervision at the executive and legislative levels.
- Availability of data for applications in studies and projects.

Costs

The costs estimated for the initial system implementation phase are:

Cost of Implementation and Development

- Communications	6.500 US$
- Hardware	
. Central station	75.000 US$
. Secondary stations (10)	50.000 US$
- Software	
. Basic and data base management system software	25.000 US$
. Packages	60.000 US$
. Basic application software	220.000 US$
TOTAL	436.500 US$

Fixed monthly costs

- Maintenance	2.500 US$
- Operational expenses. During the first year, these are covered under applications software development	
- Operating costs as of the second year	8.000 US$
MONTHLY TOTAL (first year)	2.500 US$
MONTHLY TOTAL (as of the 2nd year)	8.000 US$

Organization of the Environmental Management System

The implementation of an EMS will require to establish --along with the components defined in the Environmental Monitoring System (EMoS) and in the Information System (EIS), which in principle will cover the technical tasks required to monitor and analyze the environment-- other components or subcomponents to handle the work of:

advisory support, administration, coordination, planning and implementation.

The subcomponents of the administration component should be:

- A central coordination unit to monitor, supervise, direct, make general plans and coordinate the system's proper operation.
- Environmental institutions and units in the central government.
- Environmental institutions and units in sub-national governments.
- Environmental units in municipalities and provincial councils.
- Non-governmental organizations to provide support for specific environmental tasks.

Each level must have well-defined functions and tasks, so that their responsibilities and fields of action will not overlap or interfere with each other.

The afar mentioned coordination unit will assist in formulation of such a system.

The main purpose of the Coordination Unit is to ensure that all processes carried out in the EMS are duly coordinated and interlinked, comprising an integrated system, thereby preventing redundancies in functions and tasks, avoiding loose ends and providing the executive levels with the information and mechanisms they need for management purposes.

Another objective is to maintain the system's technical integrity by coordinating the delivery of information, technical and personnel matters, results of analyses, evaluations and studies generated by the EMoS and placed at the users' disposal through the EIS.

The main tasks of the coordination unit should be:

- Political Advisory Assistance
- Advisory support for legislation purposes
- Advisory support for executive purposes
- Advisory support for the Monitoring System
- Organisation and coordination of the Environmental Information System
- Advisory support to enhance research and training activities
- Dissemination work
- Arbitration

Structure of the Coordination Unit

Without any pretense to providing the final solution to the organizational and functional structure of the Coordination Unit of the Environmental Management System, we would just like to present some suggestions to be covered in its organization.

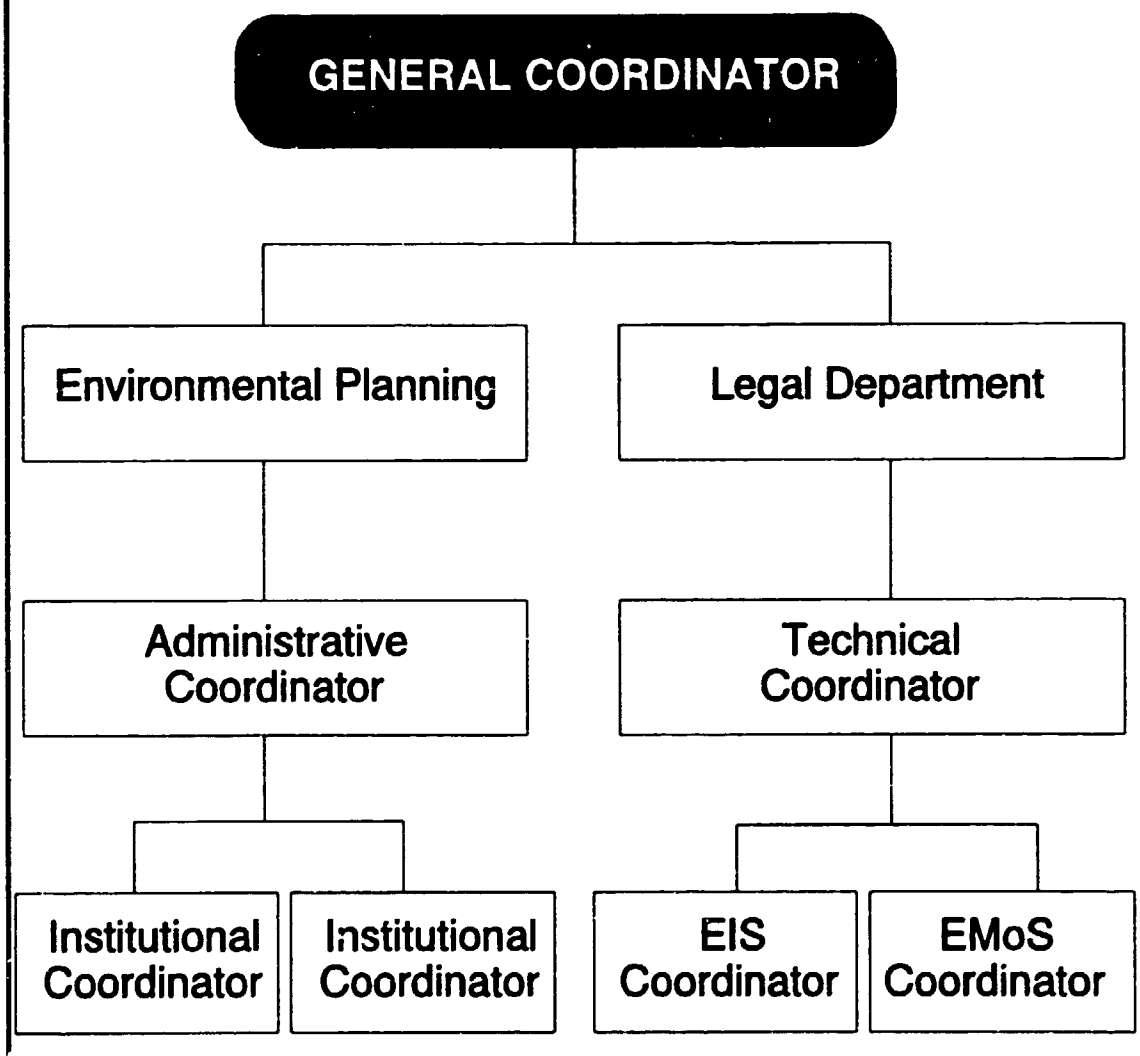
The Coordinating Unit's structure must obviously be equal to the task of performing the functions and tasks outlined above. This means that the unit must have competent administrative units for:

- Decision-making and the power to enforce them, and elicit commitments from institutions to undertake the implementation of decisions that have been made. In other words, this body must comprise top-level officials, both public and private.

- Advisory support for all technical matters involving the development of the Environmental Management System, which will obviously involve the monitoring system, information system and environmental planning. Some of the functions and tasks related to this point could be delegated to one or more institutions, but with adequate coordination.

As a general outline, **diagram 11** shows the organizational structure of the Unit's basic components.

DIAGRAM 11
GENERAL ORGANIZATIONAL HIERARCHY OF THE EMS COORDINATION UNIT



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1. INTRODUCTION, PRESENTATION OF TASKS AND PROCEDURE

1.1 Introduction

Mankind's complex, large-scale actions within Nature have seriously damaged the environment, and continue to do so. This calls for a quick turnaround in our procedures and actions to protect Nature.

Agriculture, industry and energy-related economics produce significant impacts on the environment.[1]

Industrialized countries bear the greatest burden and responsibility for global environmental pollution (in the USA, primary energy consumption is 5 to 6 times the per capita average for the rest of the world) /22/.

However, energy consumption has also increased in developing countries. This increase is a logical outgrowth of continuing industrial development in these countries and, above all, those that are growing the fastest. Most energy (petroleum) is used in these countries for industry and transportation. Fossil fuels are the main energy source, and are largely used in technically inefficient facilities to produce other forms of energy.

Basically, economic pressures force Third World countries to maintain economic development at the expense of the environment. This is especially the case in the extraction of raw materials, and in the expansion and industrialization of agriculture, since these countries' the economic capital[2] is based on geological and mining reserves and environmental resources.

The way that natural resources are exploited prevents their balanced recovery. Above all, fragile ecological systems, such as the woodlands in tropical and subtropical regions, are destroyed, leaving no possibility whatsoever of restoring them.

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1 During the last 300 years, agriculture and industry have doubled the amount of methane in the atmosphere, and the concentration of CO_2 has increased by about 25%. Since 1900, the world population has tripled, the worldwide economy has multiplied 20-fold, and fossil fuel consumption has multiplied by a factor of 50. Four fifths of these increases have taken place since 1950. /22/.

2 This includes:
- Petroleum for energy production and export;
- Minerals, fundamentally for export;
- Soil for agricultural production, largely for export;
- Forests to produce wood for export;
- Water to obtain power, and for industry;
- Fishing resources, mostly for export.

1.1.1 The Ecological System of the Amazon Region

One of the ecological systems of the greatest global importance for climate and the maintenance of fresh water on Earth is in the Amazon Region. Despite current losses of tropical mountainous and flatlands forests, basically due to petroleum extraction, agroindustry and the resulting migration --with its problems of human settlements without proper infrastructure-- the Amazon Region remains a natural ecological system that, where it is intact, is unmatched the world over for its significance and size.

The Amazon Region covers an area of nearly 7.2 million km^2, which amounts to 7% of the Earth's total land area. The flora and fauna of this region comprises over half the planet's biological wealth, including a broad variety of wild species and many trees that have not yet been discovered, much less classified.

The global significance of the fresh water contents of the Amazon Basin can be appreciated in the following data: the region holds 15 to 20% of all the fresh water in the world. Just the Amazon River accounts for 15.4% of all the fresh water reaching the world's oceans. This volume of water, which the river picks up along its 6500-kilometer length, is delivered by thousands of tributaries, canals and streams of all sizes /1/.

Although the Amazon Region can be divided climatically into large geographical spaces (plains and mountainous foothills), its type and variety of soils are differentiated according to the structure of the region's terrain and comprise much smaller areas. In the tropical flatlands and mountainous regions, where the climate is always moist, featuring only very short periods without rain, the soils range from extremely clayey and poor in nutrients to alluvial soils that are rich in nutrients. Above all in the flat areas of the Amazon Basin, poor-quality lateritic (clayey) soils are predominant.

Constant temperatures averaging 24°C and unchanging dampness, with rainfall over 3000 mm per year, lead to erosion and loss of soil nutrients /40/.

Nevertheless, there is exuberant vegetation, based on a biological cycle that goes no deeper than the top of the ground. This layer is made up of a mass of plant matter -- leaf litter and dead plants. A quick chemical and biological exchange within this mass of organic matter produces the necessary nutrients, which are directly absorbed by the plants' and trees' flat roots (net primary exchange).

This constant, quick exchange of nutrients under specific climatic conditions and the inability to store them makes the humid tropic ecological

system fragile and unstable when people affect the system in an uncontrolled manner that is unrelated to the system's operation.

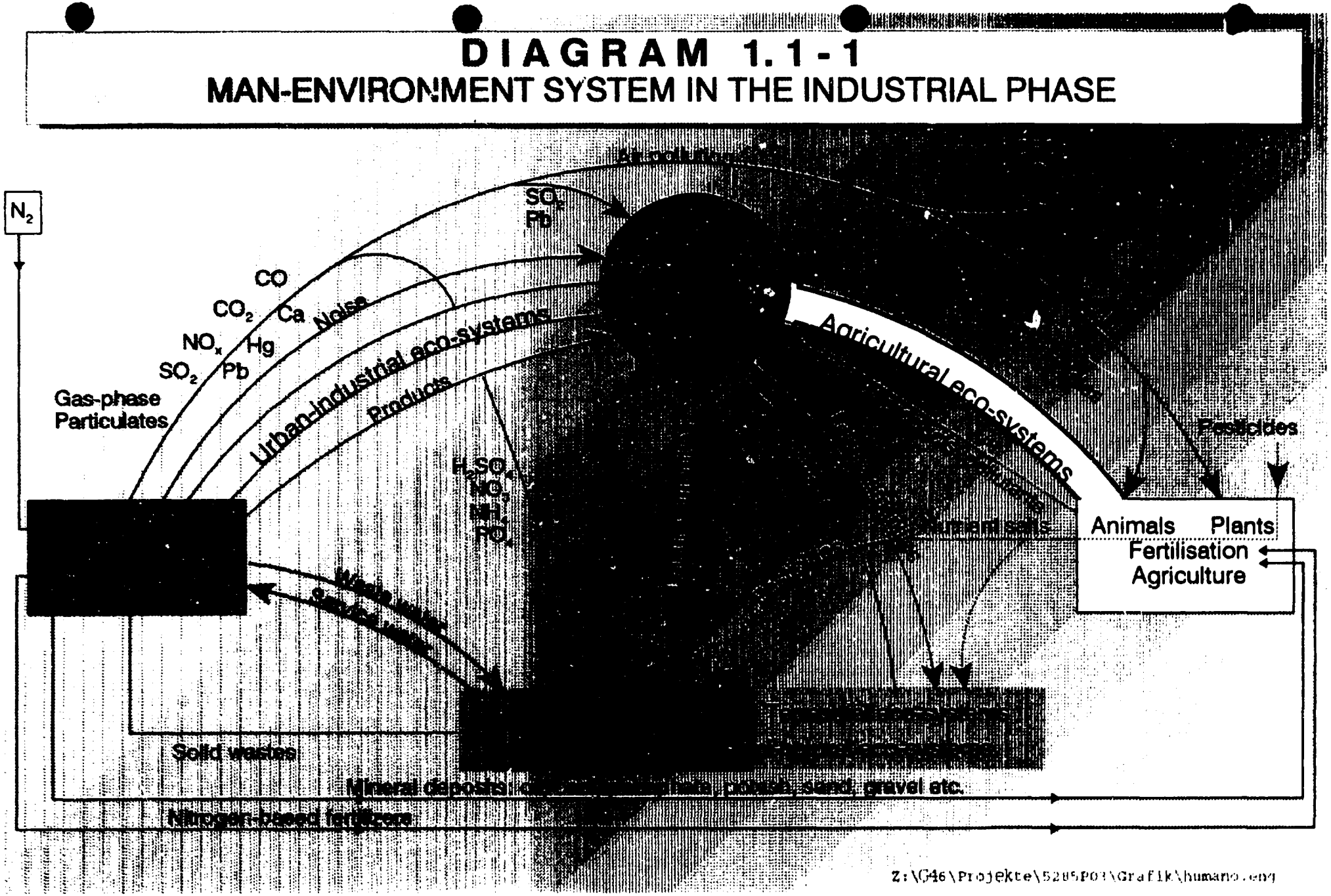
Perturbations of the system, such as un-technical, unbridled logging, interrupt the nutrient exchange cycle. Without plant covering, the microbiotic status changes as well.

Significant environmental impacts on the air, water and soil of the Amazon Region include: exploitation of **geological/mineral resources** (petroleum, iron, bauxite, manganese, gold) which pollute with heavy metals, and **agricultural production** which, even with the use of chemical fertilizers, insecticides, fungicides and herbicides, has been unable to increase harvests significantly, along with deforestation and the growing need to use new land areas for agriculture. The immediate consequences of this situation are negative impacts on the flora, fauna and health of the population.

The ecological system of the Amazon Region has partly become an environmental system under human use; large areas of the Andean foothills are already under the influence of industrial development. The consequent environmental impacts and relationship with this system are shown in **diagram 1.1-1.**

Increased industrialization of the Amazon Region entails intense socioeconomic conflicts among the people living in the zone. The native peoples are driven out of their lands and/or restricted to certain natural areas to live in, and forced to confront an unknown technical world. This leads to changes in their customs and behavior. The consequences often include: destruction of families and community unity, unemployment, alcoholism, prostitution, criminal activity and major health problems.

DIAGRAM 1.1-1
MAN-ENVIRONMENT SYSTEM IN THE INDUSTRIAL PHASE



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1.2 Presentation of Tasks

Considering, first of all, the environmental situation in the Amazon Region and in general throughout Ecuador, this country's government has requested and applied for international assistance to address these issues, in order to mitigate, eliminate and prevent existing environmental impacts and those that may arise in the future due to the process of the country's industrial and agricultural development. The United Nations Industrial Development Organization (UNIDO) has presented its technical assistance in the form of a project that will develop the required environmental control system.

This assistance involves the development of an Environmental Management System, starting with the pilot plan in the Amazon Region of Ecuador. In a subsequent phase of the system, it will expand in a modular fashion to the other countries of the Amazon Region (member countries of the Amazon Cooperation Treaty, ACT). The system must be able to: recognize environmental impacts, evaluate them and provide the necessary assistance to establish national and regional programs[3] that will make it possible to mitigate and eliminate environmental damage and to establish laws, regulations, standards and norms as a basis for protecting the environment while the member countries develop industrially.

UNIDO has decided to engage consulting services to implement the first phase of the project, and has commissioned the FICHTNER company, in February 1994, to develop:

- the design of the pilot installation of an **Environmental Management System** for the Ecuadorian Amazon Region,

- the design of a short-term action plan as a basis to formulate and implement Ecuador's national environmental policy,

- the design of a pilot communications network on the national level to generate and exchange information on environmental management (**Environmental Information System**) and

- the design for laying the foundations of a long-term action plan to monitor and manage environmental impacts throughout the Amazon Region.

---

[3] These countries, Venezuela, Colombia, Ecuador, Peru, Bolivia, Brazil, Suriname and Guyana, are the South American countries with territory in the Amazon Region. They have signed an agreement geared to address the region's environmental problems, the Amazon Cooperation Treaty (ACT), "**to undertake joint efforts and action to promote harmonious development of their respective Amazonian territories so that this joint action may produce equitable, mutually beneficial results, as well to promote the preservation of the environment and the conservation and rational use of the natural resources of those territories**".

The project aims to contribute, alongside Ecuador's own institutions, to establishing the plans and procedures for action to control and take corrective measures in view of the country's deteriorating environment and that of the region, on the basis of coordination and programming of consensus-based actions with the public, private institutions and other national and international entities, in order to optimize the rational use of natural, human, economic, technical and scientific resources. These aspects must also contribute to promoting environmental conservation.

For the Amazon Region, the pilot plan must create a module of the future system that will backstop the shared action by all eight countries of this region, making it possible for them to undertake joint efforts to improve and maintain the environment throughout the region and in their own countries, under sustainable, well-balanced future industrial development.

1.3 Procedure

The complete program, for development of an environmental management system, is divided into four reports according to the development points described in chapter 1.2. The overall procedure is shown in **diagram 1.3-1**.

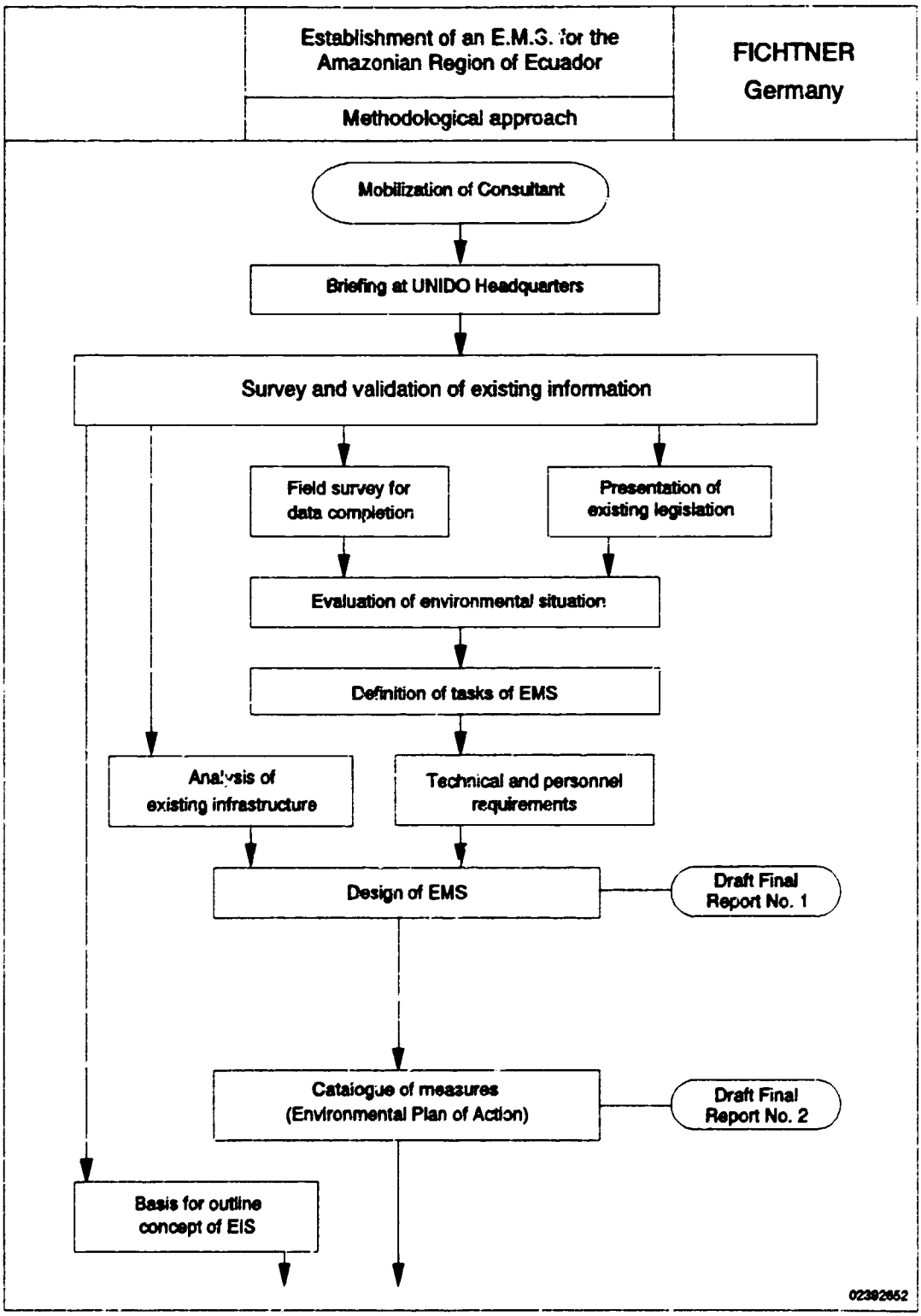


Diagram 1.3-1a:

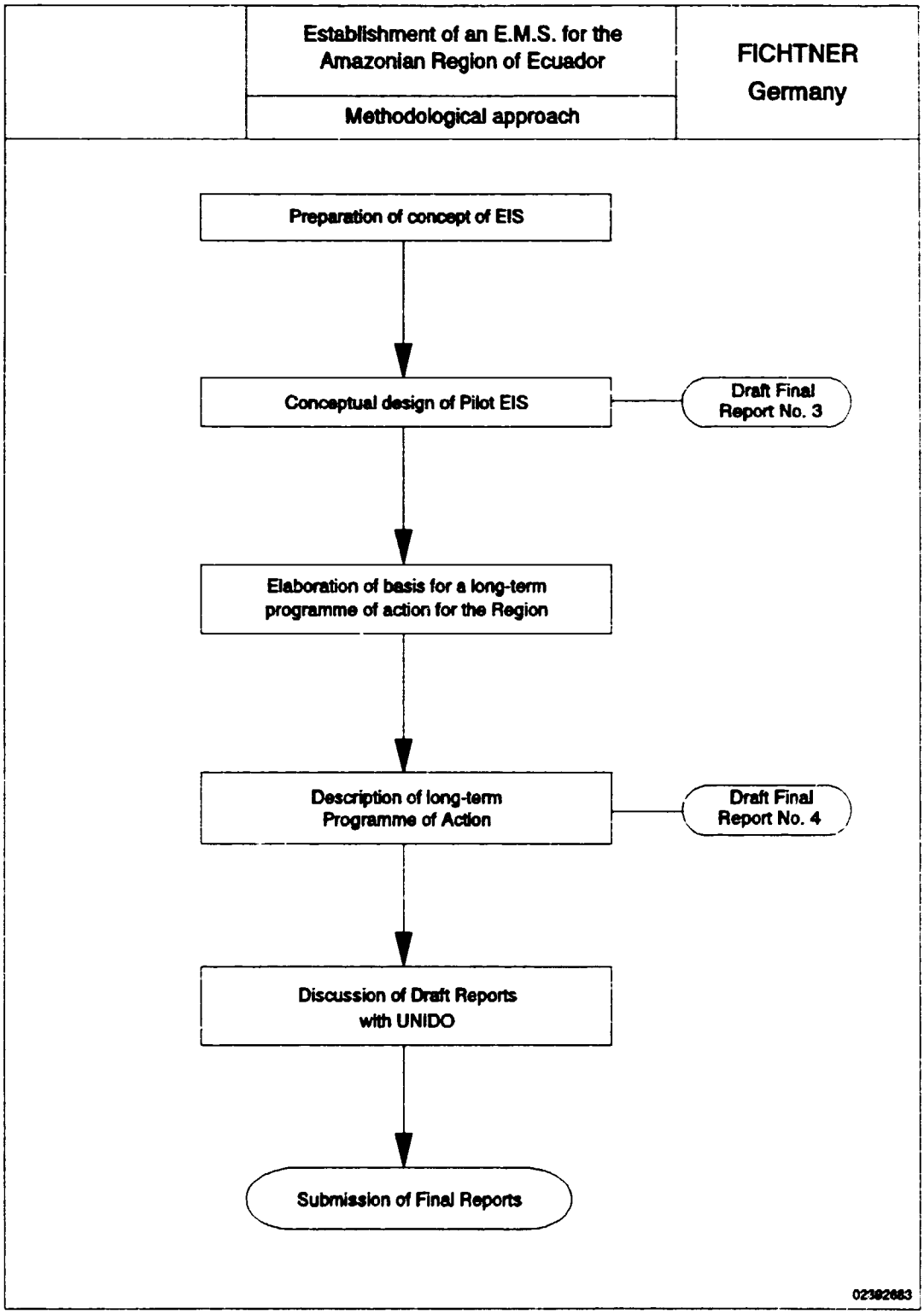


Diagram 1.3-1b:

2. NATURAL AND ECONOMIC STRUCTURES OF THE AREA UNDER STUDY IN ECUADOR

2.1 Natural Structures

2.1.1 Location and Size of the Ecuadorian Amazon Region

The area to be considered in the present project is the Amazon Region in South America. Seven countries have large territorial areas in the Amazon Basin, which covers approximately from 4 to 12 degrees south latitude.

Countries of the Amazon Basin	Area (%) of total Amazon Basin	Area (%) of Amazonian territory compared to country's total land area
Brazil	67.80	58.50
Bolivia	11.20	75.00
Peru	13.02	74.44
Ecuador	1.67	45.00
Colombia	5.52	36.00
Venezuela	0.72	5.78
Guyana	0.08	2.73

Table 2.1-1: Land areas of Amazonian Countries in the Amazon Basin

The pilot project in Ecuador involves the Amazon Region in the eastern part of the country. Ecuador has 1.7% of the total Amazon region; however, in comparison with its total land area (after the Rio de Janeiro Agreement of 1942) this region is almost half (45%) of its territory. The five eastern provinces (Sucumbíos, Napo, Pastaza, Morona Santiago and Zamora Chinchipe) are almost entirely in the Amazonian lowlands. Westward, this area reaches the slopes of the Andes mountains. These provinces are basically the area of interest for this project. However, for certain considerations, the geographical area of Ecuador as a whole is involved.

2.1.2 Division of natural space

The region is divided into two zones that differ in terms of climate, morphology and soils:

- the sub-Andean zone, and
- the Amazon Basin

The **sub-Andean zone** is the western boundary of the Amazon Basin. Its terrain is quite rugged and changes from small hills near the Amazon Basin to the highly-eroded sub-mountainous regions.

Rainfall on the slopes and foothills of the Andes, ranging from 500 to 2000 meters above sea level, is heaviest at altitudes from 1000 to 1500 meters, averaging as much as 5000 mm per year. This rainfall is collected in the main rivers: Quijos, Napo, Pastaza, Morona and Santiago.

The soil is rich and deep. The layer of humus, in the form of colloidal black loam ("black Andean soil") is often as much as one meter deep. This soil is based on volcanic ash.

The **Amazon Basin**, located below 500 meters altitude, is a flat plain crossed by the Amazon River. Annual rainfall averages 2800 mm, the year round (with no real dry season). Temperatures average 24°C, and relative humidity averages 90%. Sunshine averages three hours per day, although the equatorial region is where the sun's rays are most intense.

The soil structure ranges from "organic-latosole" to soil with laterite. "Organic latosole" is found on the flatlands: tropical, acidic, always moist (hydromorphic) and extremely deep (> 3m). Its composition, with mineral clay fractions such as kaolite, is very nutrient-poor. Nutrients can reach plants only through rapid cycling of mineral exchange. If Amazon Region soil quality is classified in terms of suitability for agriculture, 90% is virtually worthless /28/ /41/ /52/.

2.2 Economic Structure of Ecuador

2.2.1 Economic Structure at the National Level

The following is based on publications by the Governmental Institution of the Republic of Germany for Foreign Trade Information, dated 8/1993, 2/1994 and 7/1994 /7/, /54/. Wherever possible, data have been updated using figures from the National Statistics and Census Institute (INEC) and/or Central Bank of Ecuador publications /53/.

The Government of President Sixto Durán-Ballén, in power now for over two years, has made significant headway with macroeconomic improve-

ments, based on a package of economic measures. Devaluation of the nation's currency, including a floating rate, marked price hikes for fuels and electric rates, and public spending cutbacks have contributed to decreasing inflation and interest rates, and to increasing the monetary reserve.

Price increases have accelerated since March/April 1993. Attempts at new reforms, such as those partially in effect (discontinuation of subsidies for public administration, privatization, market reinforcement and opening) have been rejected by certain segments of the population.

As of mid-1994, legal changes and improvements attempting to strengthen the economy, and the privatization process as well, seem to be falling quite short of the mark, considering the current social situation of most workers and small farmers. Domestic unrest, demonstrations and conflicts among affected parties and the police have resulted.

Political action regarding economic structure has addressed, to date, the country's strongest economic activities, such as agroindustry and industrial fish-farming, industrial production and, in general, the hydrocarbons sector. It is foreseen that these economic areas will be further reinforced (see **Table 2.2-1**) /7/.

	1991	1992	1993[1]
Gross domestic product[2] (GDP, in US$ x 10^6)	11.6	12.5	14.5
Per capita GDP (in US$)	1,058	1,142	1,324
Variation (in %)	4.4	3.7	1.7
Variation by sectors			
Agriculture and fish-farming	6.0	4.7	1.3
Petroleum, mining, electricity	7.7	4.6	7.2
Industry	2.5	4.5	2.7
Construction	-0.5	0.7	2.3
Public services	4.8	2.6	-0.1
Share in GDP by sectors (in %)			
Agriculture and fish-farming	17.6	18.0	14.0
Petroleum, mining, electricity	13.6	13.9	11.8
Industry	15.2	15.3	23.0
Construction	2.8	2.7	4.1
Public services	50.8	50.1	42.1
Inflation (in annual average %)	48.7	54.6	45.0
Unemployment (in %)	8.5	8.9	9.1
Exports (in US$ X 10^6, FOB)	2,851.5	3,007.6	2,903.9
Imports (in US$ X 10^6, CIF)	2,398.6	2,430.4	2,562.2
Net reserves (in US$ x 10^6 at year-end)	760	782	1,254
Total foreign debt (in US$ x 10^6)	12.3	12.1	12.8

[1] Provisional 1993 data, partly estimated.

[2] The GDP in US$ is higher because of the high exchange rate, than it would be if calculated at the 1.7% growth rate.

Source: Central Bank of Ecuador, CEPLAES/ILDIS, *Analisis Semanal*

Table 2.2-1: General Economic Data

Agriculture and fish-farming

The relatively high increase in these areas during the last two years is based, firstly, on exports of agricultural products and secondly on domestic-market consumption. Self-supply has improved in terms of rice, field corn, potatoes, barley and African palm (see **Table 2.2-2**) /7/.

Product	1991 (in 1000 t)	1992 (in 1000 t)
Banana	3,525.0	3,994.6
Cacao	101.0	94.0
Coffee	138.6	137.7
Cotton	34.0	32.8
Rice	848.0	1,029.6
Sugar cane	3,661.0	3,591.0
Field corn	408.0	422.8
Potatoes	372.3	497.0
African palm fruit	872.7	902.1

Source: Central Bank of Ecuador, CEPLAES/ILDIS

Table 2.2-2: Agricultural Production

There was a strong demand for bananas[4] in 1991, which resulted in increased production. Banana production is currently twice the 1982 volume, amounting to 4.0 million tons in 1992 /7/. Due to plant diseases, monoculture, flooding and falling world-market prices, the banana "boom" has become weaker. Moreover, in 1993 the European Community erected protectionist barriers, resulting by early 1994 in a 20% loss in banana export revenues, although Ecuador was able to open up new markets and increase production. The European market can be kept, however, only on the basis of lost income for producers (see **Table 2.2-3**).

Shrimp production for export was already quite successful by the 1980s, and has largely been responsible for Ecuador's fish-farming and shrimp-raising expansion. Since 1993, this area has been at loggerheads with environmental protection (destroying large mangrove areas to expand shrimp-pond area, and interfering with other such natural salt-water areas), and with banana growers (whose use of pesticides and insecticides on banana plantations is affecting shrimp growing), as well as problems with production and prices. This field has also experienced reduced export revenues in 1993 compared to 1992 levels. However, during the first quarter of 1994, only shrimp-raising has increased its export volume /53/ /54/ (see **Table 2.2-3**).

[4] Bananas are the foremost export commodity: Ecuador is the world's largest exporter of bananas.

Productive and manufacturing industry

Finished-product industry has experienced a 4.6% increase from 1991 to 1992. Foodstuffs, beverages and tobacco have accounted for 58% of total industrial production. In 1992, coffee and cacao production were lower than in 1991, whereas the greatest growth occurred in chemicals and plastics (+17.1%) and mineral processing (+14.8%) /7/. A forecast of +1.1% industrial growth, published by the German Institute of Foreign Trade Information for 1994 /54/ seems more realistic than the original estimate made in 1993. A 3% decrease in the growth rate during the past year shows the influence and problems of the openness policy, above all in regard to Andean Pact countries, due to new markets and the resulting competition on the domestic market (as reflected in the daily news from April through September 1994).

Hydrocarbon and mining industry

Major investment and opening of the petroleum production market, with involvement by private firms through mid-1994 have increased production. Future privatization efforts regarding PETROECUADOR aim to further fortify this field. Petroleum exports in 1993 totalled 40% of all exports (see **Table 2.2-3**). During late 1993 and the first quarter of 1994, oil export revenues have waned, despite higher export volume, because of deteriorating petroleum prices /53/ /54/.

In the field of mining, 1992 saw a new legal framework geared to encourage investment in this sector. However, as of 1994, there is only minimal utilization of existing ores (e.g. iron, titanium, platinum, zinc, magnesium, copper, silver).

Despite the new framework law to facilitate investments, this field is of little economic significance. Raw materials are the highest category within mining exports /53/. Nevertheless, the impact of mining on Nature and the rural sector is highly significant.

According to the Minister of Energy and Mining, and considering progress made during the past two years, the mining sector will become more important. So far this year, the Corporation for Geological-Mining-Metallurgical Research and Development (CODIGEM), a Ministry agency, has received 20 mining investment projects, of which 11 are for exploration and extraction, and nine for mining development and support activities.

It is expected that examination and structuring of new geological, mining, metallurgical and hydrogeological maps will, according to CODIGEM reports, bring to light new gold, platinum, copper and molybdenum mines. The private sector is interested in investing an estimated US$ 50 million in exploration during 1994. Special customs tariffs for importation of machinery, equipment and trucks required in mining will favor installation and operation of mining facilities by Ecuadorian and foreign investors.

Product	1991	1992	1993
Total	2,851	3,008	2,904
Petroleum	1,152	1,337	-
crude oil	1,059	1,251	1,149
Bananas	716	647	503
Shrimp	491	526	451
Fish (including tuna)	50	54	47
Cacao	54	35	43
Coffee	85	60	74
Petroleum products	93	86	104
Others	303	349	533

Source: Central Bank of Ecuador

Table 2.2-3: Exports (in millions of US$, FOB)

2.2.2 Economic Development in the Area of Study

In view of the resources available in the area of study, it can be assumed that economic development in this region will be based on petroleum exploration and extraction, forestry, agroindustry (African palm production) and mining.

During the first half of 1994, Ecuador held the "seventh round" of petroleum exploration bidding. The so-called "exploration blocks" assigned during the seventh round cover an approximate land area of 30,000 km^2 in the Amazon jungle, stretching from the Colombian border to the Peruvian border. These blocks were awarded to foreign oil companies through a competitive bidding process. The purpose is to find and tap new petroleum reservoirs, with the assistance of foreign know-how and financing.

Economic utilization of woodlands in Ecuador is limited (with only a few exceptions) to the Coast and Highlands regions. The tropical rain forests to the east have not been greatly involved in logging, due to difficulties in access for removal of timber. However, petroleum industry infrastructure has helped log some tropical forest areas, with the removal of certain varieties of fine tropical hardwoods. The extraction of timber has increased all over Ecuador, from 7.5 to 9.3 million cubic meters between 1979 and 1988. Out of this total volume, 68% has been used for fuelwood and the preparation of charcoal /44/. Forestry is also expected to be of secondary importance in the eastern forests in the future.

African palm production has been established during the last few years in the Amazon region, and the land area and production volume are increasing.

Plant diseases and insect pests, due to monoculture, have forced growers to use chemicals. However, the development of processes and measures for effective use of chemicals has made it possible to partly decrease the amount and negative effects of these toxins.

Development of new techniques for the utilization of African palm as a lubricant and fuel would seem to indicate that, once brought on the market, these products will be in increasing demand, which will lead to increased areas under cultivation.

Mining in southern Ecuador is concentrated basically along the foothills of the Andes mountains. Efforts to increase mining activity are mostly localized in the region of study as well, along the foothills of the eastern Andes, especially in the provinces of Azuay, Loja, Morona Santiago and Zamora Chinchipe.

Forecasts /7/ /54/

Data on Ecuador's development during 1993 and so far during 1994 would seem to indicate that the country's economic growth has faltered, but no recession is foreseen. Major efforts to increase **petroleum production and processing**, through involvement of foreign firms, foreshadow a slight increase in export revenues and the GDP for coming years.

Future large-scale investment by Ecuadorian and foreign firms in exploration for and operation of new oilfields[5], would promise upcoming increases in the production volumes of oil and gas. The consequent environmental impacts are briefly discussed below, and addressed in detail in chapter 3.

Expansion of fishing, with increased exports, above all in regard to shrimp, would lead to forecasts along the same lines as those for oil and gas. Increased shrimp export volume will call for new ponds to raise them. This expansion is currently taking place in Esmeraldas province, aggressively destroying mangroves, with the consequent negative environmental impacts.

The Central Bank of Ecuador has forecast a GDP increase of 2 to 2.5%, mainly based on petroleum and fishing growth. Economic opening-up to other Andean Pact countries (predominantly Colombia) has given rise to competition with Ecuadorian industry. The Central Bank has forecast a 2.3

[5] An approximate land area of 30,000 km², divided into 12 blocks, has been awarded for petroleum exploration, out of which 20,000 km² are located in the Amazon region.

to 2.8% increase in industrial activity. The Governmental Institution for Foreign Trade of Germany /54/ feels that these forecasts are too optimistic, and foresees a GDP increase of only 1.1%.

2.2.3 Possible Environmental Impacts Caused by Economic Development

During the petroleum exploration phase, Ecuador's authorities expect that, under the leadership of the Ecuadorian Petroleum Company, PETROECUADOR, all oil companies will conduct studies on the possible environmental impacts of their activities and as required to prevent or, at least, limit environmental deterioration in exploitation zones, along with the consequent impacts on the health of nearby population groups.

However, in spite of precautionary measures that may be taken, expansion of oil production considers only the direct environmental impacts, ignoring those indirect effects of settlements, for example, in other areas of the Amazon Region due to the additional infrastructure and development related to petroleum activities. This is outlined in greater detail in chapter 3.

Tropical forests are lost as a consequence of the petroleum industry, due to the infrastructure that it requires (access and transportation roads, areas for facilities) and possible migration by people to contiguous areas in order to homestead areas for farming. No increase in environmental impacts is expected from forestry activities.

Environmental impacts are expected to increase as a result of agroindustry, above all in African palm plantations, which deforest large areas of tropical forest and use pesticides and chemical fertilizers.

Intensification of mining without regard for potential environmental impacts would suggest that increased ecological deterioration can be expected, including the wasting and erosion of soil that can transform whole areas into deserts.

3. THE STATUS OF THE ENVIRONMENT IN THE ECONOMICALLY EXPLOITED AREAS OF THE AMAZON REGION OF ECUADOR

3.1 Petroleum Industry

The government of Ecuador, by creating Petroecuador, took over control of petroleum activities, including direct operation of the Trans-Ecuadorian Pipeline, which had been managed by the former Petroecuador-Texaco Consortium, as well as the Anglo and Repetrol Refineries /33/ p. 140. Most activities involving petroleum production are under Petroecuador's responsibility, through its affiliated companies:

- Petroamazonas
- Petroproducción and
- Petropenínsula as well as
- Petroindustrial and
- Petrocomercial

The Ecuadorian northeast (Napo and Sucumbios provinces) produces more than 99% of the country's oil, according to the National Development Council (CONADE). This percentage is quite significant in economic terms, considering that petroleum revenues cover about 50% of the government's overall budget /11/ p. 9.

This reality, coupled with declining petroleum reserves, has led the government to support international private initiatives to provide capital and technology for gas and oil expansion.

Some 630 thousand hectares of the Ecuadorian Amazon region are actually involved in petroleum production and 3 million hectares are under exploration, including six blocks that were awarded on June 7, 1994 for the exploration phase (Tripetrol, Amoco-Mobil, Triton Energy corporation, Oryx, Santa Fe Minerals, Sipetrol and Clapson companies). (cf. EL COMERCIO, May 1994).

Petroleum activities have caused marked environmental impacts on directly affected areas and, rather than improving living conditions for the local people, have led to severely negative social impacts. To date, no suitable mechanisms have been established to incorporate the costs of social and environmental restitution into the oil business.

3.1.1 Environmental Impacts caused by the Petroleum Industry

3.1.1.1 Air

Noise emission: Noise is an inseparable component of the machinery used to build the infrastructure and perform drilling operations. The noise level often peaks at over 100 db.

Air pollution: Dust is raised in earth movements, infrastructure construction, and pollutants released by internal combustion engines, and as a result of the evaporation of hydrocarbons when fuels are spilled, which may cause toxic effects.

Burning of gas originating in oil production, with production of smoke and ash particles.

Refineries produce pollutant residues: Gases include sulphur dioxide, carbon monoxide and nitrous oxides. It is estimated that the emissions of each of these gases exceed 2000 tons/year /33/.

3.1.1.2 Water

Water resources are essential for life processes and therefore deserve careful attention for their preservation.

Changes in water quality: Water is affected by human activities that generate sewage waters, improper disposal of solid and liquid wastes, cement, fuels and the generation of particles in earth movement work. Drilling activities generate chemical residues and drilling muds that find their way into natural waterways.

Natural drainage and flowing waterways are blocked and/or altered by the construction of infrastructure and the improper disposal of materials. These alterations in watercourses affect vital hydrobiological resource processes.

Reduction of available flow is mainly due to the extraction of water for industrial and domestic uses.

Increased sediment load is caused by earth movement, removal of plant cover, higher runoff speed of waters draining over platform zones, picking up sediments as they go.

Conflict in usage: Degradation in the quality of a body of water (downstream of a project) may reduce its suitability for specific uses.

Pollution is produced by inadequate treatment of water before it is discharged. In some cases, use is restricted by spillage of drilling muds,

cement and/or fluids from testing or completion work. All along the pipeline, there are oil spills due to breakage and mudslides.

Contamination of underground water, due to poor cementing of casing pipe, which releases hydrocarbons or brackish water into surface aquifers. In other cases, there may be losses in circulation to aquifers due to excess downhole pressure.

3.1.1.3 Soil

Soil in the Amazon region is generally poor and fragile, which promotes its deterioration under environmental impacts. The exuberance of tropical rainforest vegetation is attributable to recycling of nutrients within the surface organic horizon.

Transport infrastructure: The indiscriminate building of roadways, whether necessary or not, for petroleum industry transport infrastructure, has been and remains one of the main causes of environmental degradation. This has favored tremendous deforestation through spontaneous, disorderly settlement, which has stripped the natural forest as far as 20 km alongside the roadway. It is estimated that, for each new kilometer of road, at least 500 hectares of woodlands are lost, plus the deforestation of areas related to petroleum activities per se /33/.

Erosion: Deforestation by colonists, activities of seismic prospecting and exploratory drilling leave the soil unprotected, and water drains swiftly over it, creating gullies in the weakest areas. This reinforces erosive processes such as landslides of huge amounts of soil.

Pollution: The soil is polluted by improper disposal of liquid and solid wastes, both industrial and domestic (sewage, drilling muds, solid residues and production fluids). Another pollutant is the use of petroleum slops to cover dirt roads.

Salinization: The salinization process is due to unsuitable disposal of brine required for the completion of producing wells, as well as accidental spills or poor disposal of salty muds and drilling cuttings.

Changes in fertility: This is caused by changes in the physical and chemical properties of the soil (pH, water retention, content of major and trace elements, etc.) due to impregnation with fluids from drilling work and/or production testing, along with improper disposal of cuttings.

The soil is compacted by movements of personnel and equipment, required to build infrastructure projects. This interrupts the soil's evolutionary cycle.

Topographical changes are made when infrastructure is built and land is flattened for heliports and platforms. These changes are reflected in different slopes, cutaways from mountainsides, and filling of gullies.

Changes in land use due to exploratory activity harm the natural or already damaged ecosystems in the area.

3.1.1.4 Others

Flora

Removal and deterioration of plant cover: For linear projects, flattening for heliports and platforms, excavations and additional zones required to develop infrastructure for petroleum exploration, production and transport, as well as dust emissions into the air, spillage of mud, cement, production fluids, lubricants, refuse and the consequent deterioration of water quality.

Reduction of primary productivity in natural ecosystems. Biomass productivity is lost due to earthworks leveling the soil to build penetration roadways and industrial facility platforms (drilling rigs) and domestic facilities (camps). This also influences the surrounding areas through activities required for extraction, with spillage of mud, cement, production fluids and lubricants.

Alteration of the successional state of vegetation: Petroleum activities interrupt the evolutionary sequence of vegetation that would regenerate it naturally, when land is levelled to build roadways and set up drilling rigs and camps.

Changes in plant cover are caused by seismic prospecting with detonation of explosives and the opening of trenches and roads (destroying small trees and bushes, other plants, roots and humus). This is also caused by installation of temporary camps and creation of heliports, since all this calls for clearing the vegetation. Until the plant canopy grows back, the soil is exposed, which entails high risks of losing the organic layer and its nutrients, due to excessive exposure to the sun and water.

Fauna

Displacement of species: Alteration and destruction of forest cover modifies the habitat, which induces wildlife to migrate and even disappear /33/. The noise of machinery and explosions from seismic and exploratory activity also have negative effects, creating stress and driving species away.

Alteration of animal behavior: Interruption in continuity of ecosystem structures due to the building of roadways and platforms prevents some species from moving around freely, as they could do so previously by

taking advantage of the pathways protected by plant cover providing natural camouflage.

Death of fauna: The greatest risk of mortality is for aquatic fauna, whether due to physical effects (increased turbidity, temperature, changing pH, etc.) or chemical effects (phenols, heavy metals, etc.) caused by dumping of industrial effluents and spilling of muds and fuels. Organisms with less ability to move around and longer life cycles may be useful as bioindicators.

Proliferation of infectious vectors, due to the poor disposal of food wastes and solid garbage, promotes the reproduction of rodents and undesirable insects that spread diseases.

Socioeconomic and cultural environment

Increased petroleum production, disregarding the environment and with little or no development planning for evolution of the Amazon region, has created social conflicts with great negative impact on the environment. Under this point, we mention: /11/, /15/, /33/.

Generation of development expectations: The presence of petroleum projects encourages great expectations for economic benefits and development at the local and regional level, distorting the normal course of business, industry and service activities.

Increased land prices: Dealings in properties, improvements and accessways for oil production activities encourage land prices to rise. Any roadway built by oil projects causes nearby land values to soar.

Generation of employment for exploration work basically involves unskilled labor, for which companies usually hire local people. Because there are expectations of finding work, people immigrate from nearby municipal areas.

Changes in occupation: A farm laborer's daily wages are much lower than in the oil-industry equivalent. An unskilled laborer prefers not to work his fields, to stay free in case there is an opportunity to work for an oil company, even if only temporarily, although benefits are better. While the company is around, it is difficult to find people who will work in agriculture, which is seriously affected.

Improvement of roadways and communication: When work teams come in, they improve existing roads or build new ones to provide access to the drilling site. In many cases, bridges and culverts must be improved so the roadbed substrates can have a higher bearing capacity.

Colonization: Immigration caused by expectations of employment along with the opening of roadways to worksites increases the pressure of settlers on unoccupied lands.

Pressure on infrastructure and services: Towns have grown quickly and in a disorderly manner, without proper infrastructure or even a minimum of adequate public services.

Increased cost of living: Increased demand for goods and services creates an inflationary pressure, which drives the cost of living up, making it very difficult for anyone not earning oil money to make ends meet.

Social degradation: The arrival of outsiders in the region increases the creation and development of night clubs for their entertainment, causing a high rate of prostitution, unwed mothers and slums that spring up, increasing the poverty of local folk and immigrants alike.

New administrative responsibilities: New expectations demand better planning and supervision by municipal authorities and local institutions. Environmental control is one responsibility of the municipality, and many are not ready for it.

Socio-political conflicts: Interests created among different population groups to obtain benefits from these new activities produce polarization and radicalization in some cases of political forces, causing internal struggles within community action committees and in the Municipal Council.

Transculturalization of local dwellers: In the case of both natives and peasants in remote zones, contact with petroleum workers leads to major cultural changes, affecting the scale of community values, to the detriment of existing social organization.

Increase of disease among the population: The arrival of newcomers in the zone, with possible ailments, and the scanty health infrastructure of some municipalities mean that infectious illnesses increase.

3.2 Mining Industry

Practically speaking, Ecuador has not yet developed a mining industry. This activity is based fundamentally on the so-called "informal miners".

The mining sector, especially gold-mining, has experienced a surprising growth in the last few years, with the inclusion of new production areas located mainly in the southeastern provinces of Ecuador (Morona-Santiago and Zamora-Chinchipe), where major ore beds are located, such as Guaysimi, Chinapinza and Nambija. Within the Podocarpus National park, located in southern Ecuador along the border of the provinces of Loja and

Zamora-Chinchipe, new concessions have been granted to governmental and private (Ecuadorian and foreign) firms /11/.

Some 90% of gold extraction is performed by hand, informally, with inappropriate technologies that are highly polluting due to their use of cyanide and mercury. This wastes much of the gold (some 60%) and causes serious environmental impacts in mining areas, with evident deterioration in the people's health.

Mining settlements in the southern Amazon region of Ecuador do not have even a minimal infrastructure, and exert ever-increasing pressure on natural resources, especially forests, since timber is used as fuelwood and forests are cleared for pasture. The most significant environmental impacts are outlined below.

3.2.1 Environmental impacts caused by the Mining Industry

3.2.1.1 Air

Noise: Ore is pulverized using, among other machinery, compressors, drills, generators and diesel engines, which generate high noise levels.

Air pollution is basically caused by:

- Dust raised by drilling, explosions, hauling and transport within digging areas, during the exploration phase and even more during production.
- Aerosol formation involving metallic mineral compounds (mercury, manganese and arsenic) that are toxic and harm miners' health and that of the neighboring population. Gold extraction uses mercury to form an amalgam with gold-bearing material, which is then burned, producing toxic fumes of mercury.
- Carbon monoxide is caused by incomplete combustion in blasting operations, diesel fuel burning and fires in mines /15/.

3.2.1.2 Water

Water pollution: In extraction processes, residual waters are discharged, either drained to the surface, or underground in mines, adding to those from ore processing. These latter waste waters have high heavy metal contents (especially mercury, arsenic and lead) which are discharged into waterways and produce a major risk for the environmental balance and human health.

In gold extraction processes, water pollution is predominantly due to chemicals, because potentially toxic reagents are used, including mercury, heavy metals, cyanides, sulphates and others. Residual waters from

pollution processes, which may in some cases contain organic mercury and cyanide at a very high toxicity level, modify the pH of the water vay with consequent impacts on flora, fauna and people /11/, /33/.

Changes in natural drainage or watercourses: Capital-intensive mining dredges riverbeds, for example to evaluate them and assess their profitability, with the consequent stirring-up of sediments, which alters curren: flow and returns water to the rivers under different conditions than before it was used.

Increased sedimentary load is produced by earth movement and stipping of plant coverage.

3.2.1.3 Soil /11/, /15/, /33/

Erosion: Deforestation caused by mining activities per se and by human settlements strip the plant cover, with a consequent increase in erosion due to surface water run-off.

Contamination: Soils are polluted by chemicals in mining effluents or from smelting operations. This contamination can kill those organisms that guarantee that the soil can sustain plant life. Chemicals are also absorbed through the soil into roots, fruits and seeds.

Destruction of the soil and subsoil by earth movements for mining extraction: Extraction using inadequate technology, the tunnel infrastructure and gallery shafts created by underground mining and the gorges created by open-pit mining destabilize the soil, causing frequent landslides, avalanches and dust release.

3.2.1.4 Others /11/, /33/

Flora

Removal and deterioration of the plant cover: Deforestation and erosion, as mentioned under the preceding item, cause deterioration of the plant cover, increasingly as extraction activities advance.

This directly impacts agricultural production capacity, the climate and the water supply.

Soil contamination with chemicals affects soil organisms, with the consequent alteration or disappearance of flora.

Plants readily pick up mercury from the soil, showing toxicity symptoms, such as decreased seed growth and root development, inhibited photosynthesis and, consequently, an overall drop in yield.

Water pollution (see 3.2.1.2) gives rise to changes in aquatic flora, with consequent impact on the fauna involved.

Fauna

Migration of species: the disappearance of forest cover and alteration of flora in extraction zones and surrounding areas is one of the main causes of migration and animal species extinction. When they lose their natural habitat, they seek other places to live.

Fauna mortality: Many species die due to the lack of food and shelter, or are indiscriminately hunted by colonists.

Acid drainage water from mining activities increases the concentration of metals in the water, which gives rise to disappearance of the organisms that break down organic matter. In addition, more solids are suspended in the water, which kills fish in rivers, because of the cyanide, mercury and other wastes /15/.

Socioeconomic and cultural setting

Human settlements: One of the main effects on the socioeconomic environment is the appearance and growth of towns without any services, located near informally-growing mining areas /33/.

Economic dependence: The isolation of mining settlements and the single product of these towns' economic activity (that is gold) means that socioeconomic relationships grow up around this metal, leading to outside dependence on consumer goods, inputs, machinery and appliances.

Rising cost of living: As already explained, in these towns, the proliferation of intermediaries and distortion of business transactions raises the price of everything that is sold.

Damage to health: Several aspects of miners' health and that of their families are affected, especially in the case of informal miners. These include:

- Dust and poor disposal of solid wastes. Prolonged exposure to the dust of mining activities makes workers prone to lung diseases such as fibrous pneumonoconiosis, silicosis and silico-tuberculosis /1/.

- The use of mercury and cyanide in the gold recovery process produces symptoms of poisoning, weakness and even death.

- High noise levels lead not only to hearing loss but also changes in heart rates, breathing and blood pressure.

- Mining activity can lead to destruction of cultural resources, historical sites or religious areas.

Cultural values of the area's communities are affected intensely by the introduction of new technologies and lifestyles. The growing presence of people in the area leads to vandalism in unprotected areas.

Changes in activities: Many farmers have become self-taught miners, since mining is more lucrative.

3.3 Agroindustry

Agroindustry in the Ecuadorian Amazon region is based fundamentally on the production of tea, African palm for oil and grease production, and lumbering. Tea plantations cover a small land area in Pastaza Province, whereas palm-growing covers vast land areas in Napo and Sucumbios provinces /11/.

These monoculture plantations belong to private companies and also to small-scale colonists and native growers, who live near the large producers. Introduction of a monoculture, including the formation of large plantations, creates a biological semi-desert, where there are only a few species of plants and animals in an environment which, to be productive and free of pests and diseases, requires a wide variety of hundreds of mutually interdependent species /33/.

Despite the highly-touted profitability of African palm, the environmental effects are considerable, since this has contributed to the loss of major areas of tropical forest. In addition, the land planted with palm is the most fertile in the whole region (Loreto, Shushufindi and areas adjacent to the city of Coca /11/.

Plantations are maintained using a large amount of agrochemicals that are applied without the necessary ecological precautions, as well as toxic chemicals for processing, which are dumped into riverways.

Over the years, zones under monoculture become increasingly unproductive, due to the decrease in organic activity, as well as packing and erosion of the soil by trampling of the heavy cattle and the rapid washing and leaching of soils /33/.

Commercial lumbering has proven highly deficient in environmental conservation and, economically speaking, it also faces great difficulties. 70% of each hectare subjected to heavy logging machinery is profoundly affected, its soil removed and its remaining vegetation destroyed, making it unlikely to recover /33/. It is estimated that the present annual degradation of some 35 thousand hectares of soil could even increase in the future.

It should also be mentioned that approximately 58% of the economically active population of the Ecuadorian Amazon region is engaged in agricultural activities (basically coffee and corn growing) and livestock-raising, using poor management techniques and utilization of natural resources, in addition to the lack of policies for support and financing /11/.

Areas used for pasture and cattle-raising are incredibly inefficient. For instance, in Napo and Sucumbios provinces, the grazing rate is 0.6 head of cattle per hectare /11/.

Both agriculture and cattle-raising are generally extensive, with very low productivity per unit of area and great waste of forest resources through deforestation by burning of forests to establish these activities /1/.

3.3.1 Environmental Impacts caused by Agroindustry

3.3.1.1 Air

Residues and wastes generate steam and odors, and when they are burned they produce ash residues.

The burning of tropical Amazon forests for conversion to agriculture and livestock holding generates an emission of 90.8 to 223 tons of CO_2 per hectare, which is a major greenhouse gas /1/.

3.3.1.2 Water

Water quality is affected by liquid effluents with wastes from raw material and spillage of sludge from processing wastes.

Contamination: The use of agrochemicals (pesticides, herbicides, etc.) and improper dumping of solid refuse, favored by the heavy rains, lead to pollution of watercourses.

3.3.1.3 Soil

Erosion: Deforestation, monoculture and the application of inadequate techniques, as well as clearing of land for farming that is not suited for agriculture, have all left the soil unprotected by the stratified structure of the vegetation canopy. This exposes the scanty organic layer to the effects of the sun and rain, resulting in erosion.

Expansion of farmland: Peasants participating in colonization processes (which are eminently extensive) mostly occupy areas without any consideration of the agricultural potential of the land or any technical or economic resources. Obviously, this form of agriculture on soils that are generally poor leads to a rapid drop-off in production and forces them to

clear even more forestland for agriculture. Prior agricultural areas are then made into pastures, which accelerates the soil deterioration processes /33/.

Monoculture: Introduction of monoculture, including the formation of enormous plantations (such as for African palm) creates a biological semi-desert, exposing the soil to the elements and increasing erosion, thus making palm growing areas more and more unproductive.

Contamination is caused by the use of pesticides, insecticides, herbicides and chemical fertilizers used in agriculture, as well as solid wastes, raw material refuse and processes product spillage (e.g. oil). The heavy rains quickly lead to soil, air and water pollution, with the consequent environmental impacts.

3.3.1.4 Others

Flora

Deterioration of plant cover and productivity: Logging and burning of forests to turn them into agricultural areas degrades the plant cover (cf. 3.3.1.3), and this cycle only accelerates with waning productivity of the soil and the consequent abandonment of farms, to clear new woodlands for farming.

Obviously, this directly affects the flora, altering and removing the zones where they live.

Soil pollution by agrochemicals can be picked up by plants, which then disperses the contamination.

Fauna

Displacement of species: Land and aerial species are driven away when people ruin their habitat.

The noise caused by machinery, such as in logging, also increases species migration.

Interruption of the ecosystem by agricultural activities and the decrease or disappearance of the fauna needed for survival of animal species also lead other animals to migrate.

Animal mortality: Some species can die out due to a lack of food supply and shelter, and are overhunted by settlers.

Socioeconomic and cultural setting

Colonization: Immigration by colonists, favored by roadbuilding, has been spontaneous and disorderly, leading to the failure of any attempt at planned settlement.

Occupation of land: Land has been colonized that is not suited for farming, and protected areas have even been invaded in some cases.

Social degradation: Most colonists come from regions surrounding the Amazon basin, and are unfamiliar with the way of life in such a different environment from their own. They are forced to adapt to the climatic conditions and face exposure to new illnesses.

Diseases previously not entcountered, such as malaria, and skin and intestinal infections have created epidemic foci in various colonization areas.

Impacts on native peoples: The indigenous peoples have been driven off their land, forcing them to migrate, generally to marginal zones which are not large enough for them to conserve their culture. Native peoples have had to cope with health problems, cultural aggression, violation of their rights, and their lands have largely been appropriated from them.

As agricultural production has become only a means of subsistence for colonists, and in view of the deterioration of soils and production, additional social problems have been generated, including abandonment of land, emigration toward new areas in search of land, or changes to other activities, such as mining.

4. ENVIRONMENTAL POLICY AND LEGISLATION AND ADMINISTRATIVE STRUCTURE IN ECUADOR

This chapter will attempt to present the interactive situation of policy, legislation and the relevant institutional structure in the area of environmental protection and use of natural resources in Ecuador.

The study of policy, legislation and relevant institutions for environmental management and natural resources that will be required is addressed on the basis of an analysis of (i) standards and (ii) institutions and their jurisdiction.

Special emphasis has been placed on productive activities involving mining, hydrocarbons and agroindustry.

4.1 Environmental Policy

The Dictionary of the Spanish Language introduces us to this topic by the following definitions (numbers 5 and 6) of the term *policy:* "... by extension, the art or gesture by which a matter is conducted or the means are used to achieve a given purpose; orientations or directives which govern the actions of a person or entity in a given matter or field" /70/.

That same Dictionary defines the *environment* as the whole of the physical circumstances surrounding living beings. This is too broad a framework so we will focus hereinafter on the issue of the environment in terms of policy, legislation and public institutions that are involved with natural resources and environmental pollution.

Thus, we will refer to environmental policy as the art, forms, orientations or directives that govern activities of public entities, in the field of environmental pollution and natural resource management.

Therefore, if policy is art, orientations or directives, it lacks the binding nature of legal norms. They are not mandatorily enforceable, and are not of a coercive nature. Enforceability is, in legal terminology, the possibility to oblige compliance /71/. However, there are exceptions, e.g. the policies made by the National Development Council (CONADE), and approved by the President of Ecuador, which pursuant to Article 92 of the Constitution are mandatory.

Article 79 of the Constitution describes the powers and duties of the President of Ecuador, and does not include the establishment of domestic policy for the national government. However, all functions established in that article have to do with leading the government, that is, with policy-

related actions. Moreover, subsection e) of that same Article 79 of the Constitution establishes the President's power to " ... determine foreign policy and direct international relations ... " /72/. So, it can also be stated that the President is able to establish policy or directives for domestic governance, and some such policy will be related to the environment.

In practice, and providing that the Constitution and laws are complied with, the President of the Republic is in charge of setting directives that will guide the implementation of activities for governmental administration.

This statement, as already pointed out, has no specific legal backing, i.e. no basis in the Constitution. Nevertheless, this presidential power is evident from the preceding analysis.

The General Budget of the State establishes an objective for the Presidency of the Republic of formulating and directing governmental policy, to ensure domestic order, promote social and economic welfare and exterior security for Ecuador.

There is also the classical doctrine of the division of functions within the State, which complete the trilogy with the Legislative Function, which is fundamentally charged with legislation and accountability, pursuant to Article 59 of the Constitution; and the Judicial Function, which is in charge of the court and justice administration system, pursuant to Article 93.

Policy established by the President is implemented, according to Article 86 of the Constitution, by national Ministers, who are in charge of dispatching the State's business. However, in strict legal terms, national policy implementation is the job of the Executive Function as a whole, according to the by-laws of the Administrative Legal Regime, Article 2 of which include:

a) The Presidency, Vice Presidency, and agencies reporting to them;

b) National Ministries and agencies reporting to them;

c) Corporate bodies of the public sector reporting to the Presidency, Vice Presidency or Ministries; and

d) Autonomous corporate public-sector bodies the boards of directors of which are mostly delegates or representatives of the central public administration.

The agencies covered by subsections a) and b) comprise the central public administration and those agencies and corporate bodies of the public sector covered by the other subsections comprise the institutional public administration of the Executive Function ... /73/.

This initial approach must necessarily be complemented by the institutions of the autonomous sub-national regime, comprising the country's provincial councils and municipalities. They are also empowered to establish policy, although not of a national nature, but only within the geographical area in which they perform their functions.

Then, and within the context of this chapter, the Executive Function is in charge of establishing the directives for management of natural resources and control of environmental pollution, nationwide. Although the work of other bodies cannot be ignored, especially municipalities and provincial councils in the so-called autonomous sub-national regime. They will be analyzed in the corresponding chapter of this report.

4.1.1 Objectives of environmental policy

Basic environmental policy in Ecuador, the Agenda for Development, the General Budget of the State.

Policy, then, if defined as an art, directive or orientation, must have a given purpose to fulfill.

Environmental policy, must have objectives to achieve by fulfilling the actions that it provides for.

Saint Thomas Aquinas, defined the ultimate purpose of the State as the common good. The objectives of environmental policy, i.e. the government's directives in the environmental field, are described in several documents, logically issued by the Executive Function, as already pointed out.

Among the most important policy documents are the Basic Environmental Policies of Ecuador, produced by the Environmental Advisory Commission of the Presidency of the Republic (CAAM); the Agenda for Development, by the National Development Council (CONADE); and the General Budget of the State.

Basic Environmental Policies of Ecuador.-
The Basic Environmental Policies of Ecuador appear in Executive Decree No. 1802 of June 1, 1994 and published in Official Registry No. 456 of the 7th of that same month and year.

They recognize 17 principles, on the basis of which a series of activities have been developed to put them into practice.

The principles, i.e. the orientations and directives for environmental management, established in the Basic Policies, are as described below.

- Environmental policy and other policies.-
The first is the keystone of environmental protection. In effect, it refers to promotion of sustainable development in regard to general policy as a whole.

Next, in policy No. 2, the term of "sustainable development" is discussed generically. Sustainable development, it states, includes harmonious, balanced treatment of social, economic and environmental matters.

All policy in other areas must be subject to these guidelines, according to policy No. 1, as well as the activities that feature potential environmental degradation or pollution (Policy 13).

- Individual and social stakeholders, co-responsibility, cooperation and coordination.-
According to the Basic Policies, environmental management is everybody's business, in the respective fields of action.

Raúl Brañes and Luis Carrera de la Torre, both cited by Efraín Pérez, in his Manual of Environmental Law and Natural Resources, currently being printed, refer to environmental management.

For R. Brañes, "environmental management is understood at present as the group of activities geared toward attempting to keep the environment in order and contribute to establishing sustainable development" /74/. Likewise, Carrera de la Torre calls environmental management "the group of normative, administrative, operational and control-related activities, closely inter-related, which must be implemented by the State and Society in general, to guarantee sustainable development and optimal quality of life" /33/.

Likewise, and in accordance with the above, another Basic Policy, No. 4, states that the environment is in all human activities and this irremediably produces an interaction among stakeholders and their interests. Therefore, according to Basic Policy No. 5, "Environmental Management will be grounded basically in solidarity, co-responsibility, cooperation and coordination among all inhabitants ... ".

Moreover, Policy 8 includes, in the participatory processes of environmental management, "those human groups that, for different historical reasons, have been very directly involved in decision-making and actions of national interest ... ". Among them, it includes the least privileged groups such as women, children and youth, organizations representing minorities, indigenous populations and their communities, workers, labor unions and other class-based organizations, businesspersons and their companies and organizations, farmers and rural workers, the scientific and technological community.

- Incentives.-
  It is individual responsibility to perform individual management in an ongoing manner. However, pursuant to policy No. 7, the State is responsible for supporting the establishment of incentives to facilitate compliance with regulations or the initiatives of private parties geared to achieve environmental management in Ecuador.

- Legislation and institutional structure.-
  Basic Policy No. 5 refers to the country's legal and institutional system.

  It states that the country has sufficient laws and institutions to achieve and maintain adequate environmental management. It also points out that the problem lies fundamentally in the crisis with the institutions that perform functions related to the enforcement of environmental protection actions. This institutional crisis, adds the policy, results in only partial compliance with norms. Therefore, measures to solve this problem involve institutional strengthening, systematization of existing standards, and complementation of existing legislation.

  Similarly, Policy No. 12 recognizes deficient maintenance of quality in public entities' facilities and services, and will therefore grant special priority to maintaining quality in equipment and services and in the efficiency of all productive and service-oriented activities.

- Education and Training.-
  This document establishes environmental education and training, as a State priority and means for environmental management, as parts of formal and informal education and training in general. Information and science and technology, research, application of endogenous technologies and adaptation of those from abroad, are also critical. This is the context of Policy 8.

- Territorial zoning.-
  Policy 8 also states that the government will promote the establishment of a permanent system of territorial zoning as one of the tools of sustainable development and therefore of adequate environmental management.

- International Cooperation.-
  Taking into account that environmental problems have global repercussions, Policy No. 10 states that Ecuador will "maintain an attitude of unceasing openness toward reaching agreements with other countries, at the bilateral, subregional, regional or worldwide levels ...; similarly, Ecuador shall place special emphasis upon and grant a very high priority to timely, efficient fulfillment of the provisions of conventions, treaties and any other form ...

- Prevention.-
  Principle No. 11 establishes the need to "... emphasize prevention and control with the purpose of preventing the occurrence of environmental damage ..." for which it provides for: obtaining of prior permits, limits of tolerance for every substance, exercise of supervision and control by the government over potentially degrading and polluting activities.

- Penalties.-
  The final subsection of Principle 11 states that, in the event that limits of tolerance are exceeded, degradation and pollution become violations and therefore subject to penalties for infringement. Penalties may include reparation for damage caused and restoration of the environment or resources.

- Environmental Impact Assessment - Impact Mitigation Programs.-
  The mandatory requirement to present environmental impact assessments and the environmental mitigation program, along with applications for authorization to conduct activities that may degrade or pollute the environment, is Policy No. 13. From the planning standpoint, this is crucial although, according to the way it has been used so far, it is insufficient, since there is express mention only of the obligation to present them together with the application, but no mention of the obligation to fulfill them.

- Technological parameters and foreign companies.-
  Foreign companies and national firms that are subsidiaries of transnational companies, and national firms in Ecuador must observe technological behavior in relation to the environment that will meet at least the highest standards and requirements of their countries of origin, without precluding compliance with relevant national regulations.

- Identification of environmental problems and critical geographical regions.-
  These two issues are found in Policies 15 and 16.

  Priority will be granted the treatment and solution by the State of the following critical problems:

  - poverty.
  - erosion and disorderly land use.
  - deforestation.
  - loss of biodiversity and genetic resources.
  - disorderly, irrational exploitation of natural resources.
  - water, air and soil pollution.
  - deficient generation and management of wastes, including toxic and hazardous wastes.
  - stagnation and deterioration of urban environmental conditions.
  - problems of national health due to pollution and malnutrition.
  - desertification and drought.
  - natural and environmental risks, disasters and emergencies.

The Ecuadorian government will also give special attention to the following geographical zones:

- forests of the northwest.
- mangrove ecosystems on the Coast.
- woodlands on the outer slopes of the Andes.
- Amazon jungle.
- Galapagos Archipelago region.
- Gulf of Guayaquil.
- Cities: Quito, Guayaquil, Cuenca, Ambato, Esmeraldas, Santo Domingo de los Colorados, Quevedo, Babahoyo, Machala, Portoviejo and Nueva Loja.
- Andean agricultural zones with heavy erosion processes.
- lake systems.

- Productive activities and the environment.-
Special attention will be placed on preventing and fighting pollution from the following productive activities:

- hydrocarbon-related activities, including exploration, production, transport and marketing.
- mining, particularly gold mining.
- fishing.
- large agro-industries in delicate ecological systems such as the Amazon Region.
- high-technology agricultural production, especially using fertilizers, pesticides and chemicals.
- industries that generate hazardous and toxic wastes in the country's main cities and other rural centers.
- industries that generate pollutant emissions and emissions that affect climatic changes and the ozone layer.
- the public- and private-service transport sector.

The Agenda for Development.-
The Agenda for Development is the current government's version of the National Development Plan.

According to Articles 90 and ff. of the national Constitution, the National Development Council sets general economic and social policy for the government and will draft development plans for approval by the President. CONADE (presided by the Vice President, pursuant to Article 83 of the Constitution) has " ... the jurisdiction (i.e. power or function) of setting the country's population policy, within the social and economic guidelines for addressing national problems, according to the principles of respect for State sovereignty and self-determination of parties involved" /72/.

This is the mechanism which establishes policies, guidelines, and general orientation for State administration.

Article 92 of the Constitution states that policy set by CONADE and economic and social plans that it prepares, once approved by the President of Ecuador, will be implemented and enforced mandatorily by the respective Ministries and other public-sector entities. Their leadership will be responsible for enforcement of these policies and plans.

The Agenda for Development's foreword states that this plan "... is grounded in identification of limiting factors and concrete proposals for action prepared by public entities and agencies, based on the demands of the principal groups of society" /75/.

This document presents the following system: the problem, which may be subdivided into its manifestations, causes and consequences; operations proposed to address it; and finally the expected outcomes.

In the part referring to public services, there is the following heading: "Environmental Deterioration and Mismanagement of Natural Resources".

- The problems.-
  Problems are manifested in a series of actions that range from intensive deforestation processes that continually destroy the country's woodlands, destruction of the mangroves, erosion processes affecting soils, the high degree of environmental pollution in the major cities and towns, shortening of the life expectancy of hydroelectric dams, and high risk of flooding, high degrees of pollution from hydrocarbon and mining production and intervention in every single area comprising the national system of protected natural areas.

- The causes.-
  Causes highlighted include lack of capacity on the part of both the State and civil society to act in order to cope with environmental problems, the absence of the environmental dimension in development planning, land use that does not consider that land's optimal potential, deficient systems for collection, disposal and recycling of solid and pollutant effluent wastes, poor quality of fuels and obsolescence of the vehicle fleet, inadequate planning of urban areas, lack of institutional coordination and capacity for management of hydrographic basins, absence of the environmental component in construction of infrastructure projects, failure to comply with legal standards in hydrocarbon and mining activities that would attenuate environmental impacts, lack of any national policy for conservation and utilization of biological diversity, centralized management of protected areas which is unparticipatory and remote from the dynamics of regional and national development, and inadequate information and knowledge on the part of the public.

- The consequences.-
  The consequences are an accelerating deterioration of natural resources, loss of biological diversity, negative impact on the capacity to produce

goods and services, deterioration in quality of life for the people, in particular regarding child health, and increasing environmental problems at the global level.

- The solutions.-
The actions proposed in the Agenda for Development, with an eye to solving these problems, are:

- define an environmental policy in the country with particular emphasis on the use of market mechanisms.
- formulate and concretely define the draft proposal for a National Environmental Law and define a mechanism for coordination of environmental policy at the national level.
- design and incorporate methods and techniques to quantify environmental variables and incorporate them into development planning, follow-up and evaluation systems.
- agro-ecological zoning of the nation's territory, as a basis for setting land-use policy on the basis of areas' potential and identification of critical areas affected by misuse of resources.
- evaluate the problem of solid wastes and industrial effluents at the national level. Identify critical cases and apply emergency plans.
- reduce and ultimately eliminate the use of toxic substances in the manufacture of fuels.
- achieve zoning of urban areas.
- strengthen --politically, administratively and technically-- a mechanism for coordinating hydrographic basin management and conservation policy.
- establish technical and administrative policy in order to oversee the preparation of environmental feasibility studies, their approval and follow-up on implementation of environmental management plans, in all development projects.
- formulate and apply a plan to put mining production in order, emphasizing technological and environmental control aspects.
- disseminate environmental regulations and norms that are currently in force for hydrocarbon activities and require compliance by establishing criminal-law penalties, requiring the deposit of environmental guarantee bonds for private firms and structuring a monitoring mechanism with input from the different sectors involved.
- regulate and oversee the different phases of fishing activity in order to encourage its sustainable development.
- strengthen --technically, administratively and financially-- the institutions responsible for carrying out the policies for management of protected natural areas.
- structure a national strategy for research into biological diversity and define options for sustainable utilization.

- Expected outcomes.-
  Expected outcomes from these actions are oriented toward reduction of the annual rate of deforestation, reduction of mangrove destruction, recovery of land degraded by erosion processes, significant reduction of pollution problems in the country's main towns and cities, establishment of a national strategy for conservation and management of hydrographic basins, application of technical standards and reduction of pollution by hydrocarbons and mining, and strengthening of the capacity to act in management and conservation of protected natural areas.

The General Budget of the State.-

Article 10 of the Law on Budgets of the Public Sector establishes that "entities and agencies must observe, during the budget-making process, the general action guidelines, directives and strategies of economic and social policy, as well as national medium- and short-term development plans and programs issued by the National Government" /76/. Agencies and dependencies covered by this article are those mentioned in Article 2 of that same law, as " ... administrative agencies and dependencies of the State and those corporate bodies created by Law in order to exercise State power or provide public services or for economic activities undertaken by the State, with the exception of agencies and enterprises covered under Title V, Section III of the Constitution ... " which are those belonging to the Autonomous Sub-National Regime.

Only those investment projects may be included in institutional proforma budgets that have been approved by the General Secretariat of Planning. The National Congress also has the power to present investment projects, duly supported, to the General Secretariat of Planning. Such projects must also contain the respective technical studies.

The proforma for the central government budget is submitted to the National Congress for approval and contain: "... governmental policy and strategy ...", as mandated by Article 18(a) of the Law of Budgets.

Thus, the General Budget of the State is largely a governmental policy instrument.

The two volumes of the General Budget of the State for 1994 are published in Official Registry Supplement No. 350 of January 3, 1994. It contains not only the budget allocations for the different public institutions, but also their objectives. Evidently, this is an instrument that will enable us to see not only which institutions have to do with handling natural resources and the environment but also what resources they have and what their objectives are.

Illustratively, we will mention that the central government's total expected revenues for 1994 come to $ 5,985,588,077,000. Out of this sum, the activity under Code B300, i.e. Environmental Preservation, comes in for $ 7,644,706,000 sucres, which is 0.12771% of the General Budget of the

State. In addition, there are other activities that have to do with management of natural resources, such as

- Agricultural Development ($ 75,129,421,000),
- Forestry Development ($ 13,809,726,000),
- Water Resource Development and Control ($ 364,300,034,000)
- and Environmental Sanitation ($ 114,145,892,000).

The General Budget of the State is also used as a tool to enforce policy in general, and as a mechanism to control public spending. The public institutions that have their budgets established in the General Budget of the State require, in order to access the funds needed for their operation, a special procedure in the Ministry of Finance and Public Credit. This Ministry has the power to rank expenditures by priorities. Therefore, it can slow down or speed up and promote public spending, depending on the country's current fiscal policy.

As for the institutional objectives of those entities that have to do with environmental management, established in the General Budget of the State, they will be referred to expressly in this study under item 4.1.2. which refers to administration, institutions and the environment.

4.1.2 International Conventions, Treaties and Commitments

One of the functions of the National Congress, established in Article 59 of the Constitution, is "g) to approve or reject public treaties and other international conventions."

Additionally, the Constitution, dealing with the President's powers and duties, in Article 79(e), includes that of "Determining foreign policy and directing international relations; entering into treaties and other international agreements in accordance with the Constitution and laws; ratifying them, upon prior approval by the National Congress; and exchanging or depositing, as the case may be, the requisite letters of ratification".

Thus, once the treaty, convention or any international commitment has gone through the process outlined in these provisions, it becomes the law of the land.

Article 5 of the Ecuadorian Civil Code provides that the law is not binding until promulgated by the President. Promulgation of laws and decrees must be done in the Official Registry, and the date of promulgation will be, for all legal purposes, the date of that Registry.

Now then, the legal acts of States belonging to the international legal community and which therefore are the source of international obligations, are extremely varied. Among them we find treaties, conventions, pacts, arrangements, agreements, regulations, unions, acts, protocols, modus

vivendi, declarations, cartels, capitulations, concordats, etc. A brief review of the most important types for this study is presented below.

Treaty is ordinarily used for agreements that deal with an important subject.

Convention is frequently applied when the rules of Law are to be expounded.

Pact is not used officially very often, and is usually limited to material connotations. Pacts are made from the formal standpoint through a treaty, convention or agreement.

By-laws have been used, above all, for collective treaties of an interpretive nature. From a technical standpoint, by-laws refer exclusively to the material contents of the act that is formalized in a convention, protocol, agreement or a simple attachment to any conventional instrument.

Act is used to enunciate the rules of Law. The term, "final act" designated the protocol made upon the conclusion of the work of Congress and of conferences to summarize the outcomes obtained in that session.

Declaration is used when legal principles are involved or a common political position is affirmed.

A **protocol** distinguishes two cases. Protocols for conferences are the simple verbal process geared to record facts, i.e. to register the entire proceedings of the meetings of a congress or conference. A protocol-agreement, also known as a final protocol, signature protocol or closing protocol, on the contrary, enunciates an agreement of the wills of States and has the purpose of affirming rules of Law.

According to this very quick overview, the most satisfactory definition, technically, of an international treaty is a definition of a formal nature, prepared on the basis of the procedure used for its conclusion. International treaties, in a limited sense, are defined by their form rather than their contents. The nomenclature could be unified under the term, "treaty", which is generally used.

It would be quite lengthy to list the conventions, treaties and other international instruments signed by Ecuador in regard to natural resources and environmental pollution.

However, we should mention the most recent ones, which are therefore the most important for this area, namely:

- The Protocol of Montreal,
- the Convention on Climatic Change, and
- the Convention of Basilea.

The Protocol of Montreal.-
Ecuador's adhesion to the "Protocol of Montreal, regarding substances that deplete the ozone layer" signed in Montreal, Canada, is in Executive Decree No. 1429 published in Official Registry No. 420 of April 1990.

Since then, and to this day, several instruments, such as decrees and resolutions of Congress have been issued with an eye to implementing the Protocol.

One of them designated the Ministry of Industry, Trade, Integration and Fisheries as the official entity to implement the Protocol. The government of Ecuador is also pursuing an institution-building project financed by the World Bank, through the local office of the United Nations Development Program.

Within this Ministry, there will be created the National Bureau of Environmental Management (DINAGA), reporting to the Under-Secretariat of Industry, and geared to overseeing and preventing environmental pollution by manufacturing and fishing activities. It also provides for the creation of two regional bureaus: the Regional Bureau of the Coast, headquartered in Guayaquil, and the Departmental Bureau for Coordination of the South, based in Cuenca.

The National Bureau has the duties of preparing cadastral records, evaluation of environmental impact assessments, monitoring of compliance with regulations, authorization for installation and operation of manufacturing and fishing production units, issuance of favorable opinions as a prerequisite for authorization to set up and operate manufacturing and fishing companies.

Ecuador has not produced or imported chloro fluoro carbons. Only PETROECUADOR could obtain a license to import them. However, the Ministry of Energy and Mining, through the Hydrocarbon Bureau, has the power to authorize the importation of propellant hydrocarbons not produced by PETROECUADOR.

The Convention on Climatic Change.-
This convention is rooted in the 1992 Rio de Janeiro meetings. The National Congress approved the "United Nations Convention on Climatic Change, signed in Rio de Janeiro, Brazil, on June 5, 1992". That approval appears in the unnumbered legislative resolution published in Official Registry No. 109 of January 18, 1993. Its ratification appears in Official Registry No. 148 of March 16, 1993.

The aim of the Convention is to achieve a stabilization in concentrations of greenhouse gases in the atmosphere at a level that will prevent hazardous anthropogenic interference with the climatic system.

That level will be achieved soon enough to enable ecosystems to adapt naturally to climatic change, guarantee that food production will not be threatened, and that economic development will evolve sustainably.

The signatory parties must adopt policies and measures for adaptation and attenuation of climatic change.

The developed countries that have signed this Convention must provide technical and financial support for developing countries.

The Convention of Basilea.-
In Official Registry No. 128 of February 12, 1993, the legislative resolution is published that states: "The Convention is hereby approved on Control over Trans-Border Movements of Hazardous Wastes". The ratification instrument for this convention is published in Official Registry No. 148 of March 16, 1993.

According to the Convention, wastes are defined as "substances or objects the disposal of which is done, proposed or obliged to do pursuant to national legislation".

Attachments to this convention include the categories of wastes that must be controlled, those that require special consideration, and the list of hazardous characteristics. It also classifies disposal operations into those that cannot lead to the recovery of resources, recycling, regeneration, direct reuse, or other uses, and operations that can lead to such outcomes.

This convention contains the commitment by the signatory States to prohibit or not to allow export of hazardous wastes and other wastes to those parties that have prohibited the export of such waste, when such a prohibition has been communicated to them, according to the convention itself.

To export hazardous wastes to those countries that have not prohibited their importation, it requires that the exporting State obtain the written authorization of the importing State. In such cases, it is a requirement for the wastes involved to be necessary for recycling or recovery industries in the importing State.

An important provision makes it a criminal act to engage in illicit trafficking in hazardous wastes or other wastes. It also makes it mandatory to immediately notify about any accidents in the movement of such materials, which might affect other States.

Governments must also make sure that facilities are suitable for disposal and environmentally rational handling of hazardous and other wastes, regardless of where they are disposed of, although insofar as possible they should be located within that country.

4.1.2.1 Agenda 21

The Agenda for Development was approved in the United Nations Conference for Environment and Development, held in Rio de Janeiro in 1992.

The legal nature of the Agenda for Development is framed within the genre of "Declarations", which make up so-called "soft law", because of the declarative-type contents. It is therefore "... the essential guidance for future interpretations of legislation and policy in all spheres of life" /77/. In this sense, it contains indicative prescriptions for countries and does not therefore have the force of law. The principles of Agenda 21, then, are an action plan for the signatory countries.

Agenda 21 contains four sections: the social and economic dimension, conservation and management of resources for development, strengthening of the role of major groups, and mechanisms for implementation (see **Attachment 4.1-1**).

The presupposition of Agenda 21 is to grant priority to actions that will improve the people's living conditions. The basis for this improvement is conservation of ecosystems, the deterioration of which would prevent fulfillment of proposed goals. In fact, integration of the environment and development will lead to "improvement of standards of living for all, to better-protected and handled ecosystems, and to a more secure, prosperous future".

No nation could fulfill this presupposition alone and unaided, but it will be possible through the creation of a "worldwide consortium for sustainable development". This will necessarily reflect an agreement among nations. In addition, internally within each country, it will require "consensus and political commitment at the highest possible level for development and environmental cooperation", and therefore the responsibility falls fundamentally to governments.

On the international level, the role of cooperation is to support and supplement national efforts. This task has been assigned to the United Nations and other international and regional organizations. One of the areas of this international support involves financing to cover additional expenses of managing global environmental problems and accelerating sustainable development.

The different countries must carry out the programs of Agenda 21 according to their own situations, capacities and priorities, in line with the guidance of the Declaration of Rio.

4.1.3 Enforceability

Policies are orientations or guidelines bec ıse they lack the mandatory nature of legal standards. Therefore, they are not enforceable, and are not mandatory. Enforceability, in legal terminology, means that compliance can be required by force.

Article 92 of the Constitution states that the policies determined by CONADE and the economic and social plans that it prepares, once approved by the President of Ecuador, will be implemented and complied with, mandatorily, by the respective Ministries and by the entities of the public sector. Their leadership will be responsible for the enforcement of these policies and plans.

Therefore, the policies that are established in this was (and only those policies) have the force of law.

Their enforcement faces general problems which affect other categories as well, which include international policies, plans and instruments as well as legislation that is in force in Ecuador; these problems include the State's lack of institutional capacity to enforce the law.

The application of the General Budget of the State begins on January 1st of each year, although the availability of funds depends on the financial management by the Ministry of Finance and Public Credit. The amounts of the budget that are not spent by December 31 of that year are not restored to the institution, but refunded to the funds of the Single Account of the National Treasury. Thus, Article 65 (last subsection) states that " ... After December 31, no obligations can be undertaken that will affect the budget of the preceding fiscal year".

As for international instruments, although ignorance of the law is not an excuse, as provided by Article 13 of the Ecuadorian Civil Code, lack of knowledge about their contents makes their enforcement more complicated.

As for Agenda 21, in each and every subject area that is touched on, mechanisms are recommended for implementation and, in general, are based on a general recognition of the importance for development of incorporating the environmental component with an eye to improving communities' living conditions.

For example, in regard to international legal instruments and mechanisms, Agenda 21 suggests, as mechanisms for enforcement, the establishment of an efficient, practical reporting system on effective, total, prompt implementation of international legal instruments. It also considers appropriate forms in which the relevant international bodies can contribute to subsequent establishment of such mechanisms.

Some prescriptions of International Conventions mentioned above require the establishment of complementary norms. However, another group may be applied immediately, such as administrative requirements, authorizations or requirements for special permits, e.g. for transportation or disposal of hazardous wastes established in the Convention of Basilea.

The enforceability of policies and international agreements requires a detailed analysis to define those prescriptions that require complementary norms, a certain institutionalization, or the simple incorporation into the current structure.

4.1.4 Programs and Projects

Attachment 2 of "Environmental Management in Ecuador" develops accurately, extensively and appropriately the topic of Environmental Programs and Projects in Ecuador. Additionally, a document prepared by the Amazon Cooperation Treaty, the specific data for which are not available, lists all programs and projects related with the environment and natural resources that are currently being implemented in Ecuador.

Therefore, under this section we will only make certain concrete references to this issue.

The terms, "programs and projects" are closely linked with planning and, therefore, with institutional budgets.

According to "Environmental Management in Ecuador", " ... [m]ethodologically, it is assumed that projects materialize development plans and policies set by a government. The objectives, development objectives in turn, orient investment decisions through projects. To be able to speak of suitable development management, a close correspondence must be established between policies, strategies and projects" /33/.

These are environmental management mechanisms, especially in regard to policy enforcement, since they are ways to incorporate the environmental dimension into development activities.

According to Nicolo Gligo, in "The Environmental Dimension in Development Planning", one of the problems faced by planning in Latin America in general is that " ... the subject of planning is not so clearly defined, since no clear knowledge is available on the structures and processes involved" /78/.

This statement has to do with the lack of knowledge about the problem and all its elements, but also other factors that the environmental problem involves, such as social and economic issues.

Finally, quite an elementary classification of programs and projects implemented in Ecuador is based on the nature of the funds financing them. Thus, some are programs and projects of a national nature, financed under

the General Budget of the State; and others are of an international or combined nature, in which financing comes from international funds although, on many occasions, this requires a significant matching counterpart in national contributions.

They must all be properly structured in the search for enforcement of national objectives.

4.2 Environmental Legislation

Ecuador's Basic Environmental Policies establish as a principle that the country's legislation has enough laws and institutions to achieve and maintain adequate environmental management, although those norms are only partially enforced and the institutions are in crisis. However, what is called for are complementary actions and systematization /79/.

4.2.1 Policy and Legislation

Legislation is, therefore, within this context, one of the many forms of expression for policy, together with all actions and activities, plans, programs and projects, and even financial management as already pointed out, all geared toward achieving the objectives established by the Executive Function of the State, in regard to natural resources and environmental pollution.

Within this framework, we may mention two types of problems. First, there are those related to elaboration of environmental laws; and second, there are problems with enforcement.

The initiative for issuing laws, according to Article 66 of the Constitution " ... is the responsibility of the congress ... , the President of the Republic and the Supreme Court of Justice."

Also acknowledged is the people's initiative to amend the Constitution and to amend and issue laws. The exercise of this right, states the Constitution, shall be regulated through a Law. This possibility has been practically nonexistent during Ecuadorian legislative history. The law to regulate its operation does not exist, either.

The Supreme Court of Justice has had quite a partial, limited influence in regard to processes of amendment or preparation of laws.

So, laws and norms in general, including regulations, instructions, standards, etc. with environmental contents are basically the responsibility of legislators and the President of Ecuador, along with their respective agencies.

Environmental legislation must cope with a twofold barrier in these two areas. For legislators, the environmental issues are not politically attractive. It does not win votes for the next election. And thus, the Special Commission for the Environment of the National Congress is only what they call a secondary Commission within their internal organization.

Moreover, for the Executive branch, the President and agencies reporting to the Presidency, environmental issues do not offer the immediate profitability and governmental management require. Rather, highly polluting productive activities that degrade resources, such as logging, hydrocarbons and mining, are more profitable for the government in the short term.

This reasoning is not absolute, but it does actually exist in the administrative structure of the Ecuadorian government, and that is why Ecuadorian environmental law has required for some time some standards that will renew and complement what is already in place.

Finally, and as a complement for this legislative requirement, it is necessary to reinforce those institutions whose duties are oriented toward controlling the use of natural resources and environmental pollution. Institution-building should act on three fronts: training, equipment and infrastructure, and processes of coordination and consensus-seeking.

4.2.2 Constitution, Laws and Regulations.-

The traditional description of environmental law common begins with the Political Constitution of the State.

Thus, Article 19(2), located under Title II, regarding Rights, Duties and Guarantees, Section I, on the Rights of Persons, states that the government guarantees " ... without precluding other rights that are necessary for full moral and material development deriving from the nature of the person .. 2. The right to live in a pollution-free environment. It is the State's duty to ensure that this right will not be affected and to oversee preservation of nature. The law will establish restrictions on the exercise of certain rights or freedoms in order to protect the environment; ..."

If we start with this constitutional consideration, we can refer to the broad, scattered environmental legislation that is in effect in Ecuador.

Attachment 4.2-1 lists the legal norms, laws or regulations of the greatest importance that are in effect in Ecuador, grouped by special topics. This listing is only illustrative. Several listings containing environmental legislation in its entirety have been made lately. Any of them can be used to get a feel for the magnitude of legislation that is in effect in this country.

One problem facing Ecuadorian legislation is the lack of systematization. In fact, a quick analysis of the list in attachment 4.2-1 shows the highly varied issues covered by environmental legislation. Hence, the institutions responsible for enforcing these norms are also widely varied.

This thematic and institutional range involves the joint work of institutions according to the thematic areas of their functions.

Most laws establish provisions regarding the mandatory obligation to carry out activities for coordination among the institutions involved. However, there are no effective mechanisms to carry this out.

Furthermore, these provisions are not always applied. Rather, there are a number of conflicts in fulfillment of the functions of several public institutions. One way to solve these conflicts will be by specializing the norms to be applied. Special norms have legal precedence over general ones, according to the principle established in the Civil Code, Article 4.

Special treatment is given two special laws, i.e. of the same hierarchical rank, which are called upon to regulate the same legal situation. This is the case of the Law of Mining and the Law on Forestry and Conservation of Natural Areas and Wildlife, especially in regard to the exploitation of underground resources in zones includes within the classification of Protected Natural Areas.

The legal norm to be applied in this case is the more recently promulgated one. This tacitly implies an amendment to the previous legal norm, according to the general principles established in the Civil Code, Articles 37 and 38.

Finally, a frequent way of solving these institutional conflicts is through application of general policies or directives that are germane to certain political junctures. At present, with the predominance of productive activities, these override those regarding conservation. However, the attempt is being made to incorporate a consensus-building process in which productive activities are carried out within protected natural areas in compliance with strict environmental control and evaluation systems. In any event, they are almost unenforceable.

Regulations are instruments containing norms that are useful to apply the provisions of the law. In no case can their contents modify, increase or decrease the contents of the law. In normative hierarchy, regulations are below the constitution, which is the supreme norm, and below laws.

Thus, for Kelsen, "... the highest level of positive law is the Constitution ..., the essential function of which is to designate the entities responsible for creating general norms and determining the procedure to be followed ..." /80/. He adds that, "... immediately after the Constitution we find the

general norms issuing from legislative procedures, which determine ... above all the contents of individual norms that will be dictated by judicial and administrative authorities" /80/.

Finally, to differentiate laws and regulations, he states that, "... this grants, in principles, a parliament elected by the people the power to create general norms, but admits that details can be added to them by other general norms issued by an administrative agency" /80/. So, the differentiation between a law and regulation has to do with the detailed contents of the latter, and the entity entitled to issue them; in the case of regulations, they are issued by an administrative entity.

The ranking of norms originating in decrees, agreements and resolutions is an issue that has been controversial, especially considering that such normative instruments apparently have the same legal stature, and they must be differentiated in regard to the field that they address and the authority that is empowered to issue them.

4.3 Environmental Management

4.3.1 Existing Instruments for Environmental Protection

As explained above, environmental management is currently understood as that group of activities geared toward putting the environment in order and contributing to the establishment of sustainable development, according to Brañes. Carrera de la Torre defines environmental management as the group of normative, administrative, operational and control activities, closely interrelated, that must be carried out by the State and Society at large in order to guarantee sustainable development and optimal quality of life.

Within this context, any action from the public or private domain becomes an instrument of environmental management.

However, Pérez points out that "environmental management comprises:

1. policies on the environment and development;
2. institutions that carry out normative, control and implementation activities for sustainable development;
3. legal norms;
4. administrative instruments consisting mainly of:
   - inductive measures of varying types (preventive, authorizations, standard-setting, technological standards, repressive, dissuasive, compensatory and incentivating);
   - environmental impact assessments;
   - land use zoning;
   - consensus-building; and
   - judicial penalties and control, including public actions."

Within this context, only actions involving public administration are environmental management.

To classify and appraise these instruments on a rating scale would be unnecessary and practically pointless, if we analyze that such instruments range from national, regional and local planning, to territorial zoning, the use of leading-edge technology that will avoid or reduce environmental pollution, formulation of laws, regulations and minimal standards to be fulfilled by users in order to achieve effective environmental protection, through rational use of natural resources and pollution prevention.

The following lines analyze the most relevant measures for this study.

4.3.2 Concessions, Permits, Licenses

These are administrative tools for environmental management and may be classed as control mechanisms.

Morcillo explains that the control function involves "the means established by environmental legislation for substantive legal norms that govern a given form of individual or social behavior regarding the environment or utilization of natural resources ..." /81/.

As for permits and licenses, J.M. de la Cuetara says that "for their service of keeping order, the Administration develops a limiting activity that we call the police; this includes a series of powers granted for this purpose by legal ordering: to prohibit, to order, to authorize or to penalize" /82/.

This same author feels that submission of a particular activity or initiative to the prerequisite of obtaining the pertinent administrative authorization is one of the police's most typical techniques. From a legal standpoint, this technique means that there is a prior obstacle to private parties' exercise of a right.

This, then, is a preventive technique. Authorizations are known as permits, licenses or releases, although there are also authorizations in approvals entitlements, registrations or dispatches.

Authorization is a general prohibition that disappears for a concrete case. The right appears, according to another current theory on this subject, as something tangible and defendable when the authorization is received and not before.

Concessions are granted in situations where some natural resources, whether renewable or non-renewable, is exploited, by any individual or corporate body, public or provide, for domestic or commercial purposes.

Licenses are granted to establishments to pursue some activity on a permanent basis, related to utilization of some natural resource or affecting the environment.

Permits are issued to legally authorize the exercise of activities regarding natural resource use.

The difference between a permit and a license is that the former grants the authorization to perform a given activity, whereas the latter grants the authorization to operate an establishment, which also requires permits if it will carry out activities that use natural resources.

The Constitution (Article 46) defines the sectors of the economy: first is the Public Sector, comprising wholly government-owned enterprises. The areas which only the State may exploit are established as follows:

- Non-renewable natural resources and, in general, those underground products and all ores and substances the nature of which is different from that of the soil;
- Services of drinking water supply, electric power and telecommunications; and
- Strategic enterprises as defined by the Law.

The State may, as an exception, delegate any of the above activities to private enterprise, in those cases established by the Law.

Our legislation uses both permits and licenses within tax matters.

In this connection we find several legal provisions regarding annual permits or licenses for operation in the tourism area, required in the Regulations of the Tourism Law, Article 47 and ff.; or in the autonomous sub-national system for operating permits required in the Law of Municipal Governance, article 382 and ff., referring to the annual patent for operation required for any commercial or industrial economic activity.

Another permit used as a control mechanism are licenses. This mechanism is used in forestry, pursuant to Articles 33 and 34 of the Forestry Law. Mobilization of forestry resources requires the so-called mobilization bill, according to Articles 42 and 43 of that Law, and Articles 104 and ff. of its Regulations.

As for concessions for natural resource use, they are mostly granted for hydrocarbon and mining activities.

4.3.3 Environmental Impact Assessments
Environmental Mitigation Programs
Action Plans

Environmental impact assessments are "... methodological tools geared toward seeking systematic quantification of the effects of human activities on environmental quality" /78/. The effects will be produced, according to this same author, "on resources (e.g. material or energy resources), impacts on waste assimilation capacity (pollution), impacts on means of recreation, the landscape and cultural heritage, and multiple aspects (combinations of the above)" /78/.

This systematic quantification of the effects of human activities is oriented toward identifying and predicting those effects and interpreting and communicating those impacts. "*Effects* are the consequence of a change induced by humans; whereas *Impacts* are variations in environmental quality. This term implies a value judgement regarding the importance of an environmental effect" /78/.

The purpose of this identification and prediction is to prevent, insofar as possible, or reduce the impacts that human activities have on the environment.

The basic contents of environmental impact assessments is as follows, according to the Environmental Evaluation Manual /15/, published by the National Financial Corporation:

- Description of the project and documentation regarding its rationale.
- Review and analysis of relevant institutional information.
- Identification of possible impacts of construction, operation, and dismantling of the project or alternatives.
- Preparation of a description of the environment affected.
- Prediction of impacts.
- Evaluation (interpretation) of anticipated impacts.
- Identification and evaluation mitigation measures.
- Selection of proposed actions from among the alternatives evaluated.
- Preparation of written documentation on the EIA process.
- Preparation of the environmental management plan.
- Monitoring of environmental impacts during project construction and operation.

The obligation to present environmental impact assessments and the environmental mitigation program, along with applications for authorization to pursue activities that will degrade or pollute the environment, is provided for in the Basic Policies.

An antecedent for this provision in the above policies is found in Agreement 4, which declares the Nineties as the Decade of Ecodevelop-

ment /83/. In fact, and according to E. Pérez, this Resolution orders that "All development projects must pay special attention to the impact that they may cause on the environment."

Ecuador's laws already mention EIAs, in the Law for Prevention and Control of Environmental Pollution. Some of the most important articles of this law are described in **Attachment 4.3-1**.

The Under-Secretariat of Environmental Sanitation (SSA, ex-IEOS) of the Ministry of Urban Development and Housing; the MAG; the MICIP, and the MEM will require individuals and corporate entities that are responsible for activities indicated in the respective regulations to conduct environmental impact assessments, in order to avoid causing harmful effects for health or deterioration in soil resources. The granting of permits requires prior approval of the EIAs. Their contents will depend on the provisions of the respective regulations.

The Municipality of Quito also requires an EIA, to grant the Environmental Quality Control Certificate. This certificate has the effects of the operation permit referred to in the Law of Municipal Governance.

The Environmental Regulations for Hydrocarbon Activities in Ecuador /84/ are designed to "... regulate hydrocarbon-related activities of exploration, drilling, production, storage, transport, industrialization and marketing of crude oil, petroleum derivatives and natural gas, which could produce environmental and social impacts ..." (see **Attachment 4.3-2**).

The Regulations refer to a series of requirements for environmental contents that must be met, during each stage of hydrocarbon operations.

In fact, Chapter III refers to Exploration, for which an environmental description and environmental management plan are required. Subsequent provisions refer to fulfillment of a series of activities by oil companies.

Chapter IV refers to the Drilling stage. Article 10 of the regulations establishes the obligation to present the environmental impact assessment and environmental management plan for the drilling phase. These documents, according to the regulations, are required only for stepout exploration wells.

For the Extraction stage,the regulations require the environmental impact assessment and environmental management plan for the area of influence of hydrocarbon production activities. The requirements also apply for the Transport and Storage and Industrialization phases.

The contents of these studies are described in Chapter X of the regulations.

As for mining activity, we shall consult the Law of Mining and its regulations for application, as well as various specific provisions that have been issued to regulate this field.

The Law of Mining mentions environmental impact assessments in Article 79, which states:

> Holders of mining concessions and of foundry, smelting and refining plants must perform environmental impact assessments to prevent, mitigate, control, rehabilitate and compensate for the environmental and social impacts deriving from their activities. These studies must be approved by the Under-Secretariat of the Environment of the Ministry of Energy and Mining.

Article 80 of the Law of Mining establishes the contents of the environmental management plan.

This Law also contains norms on water treatment (Article 81), reforestation (Art. 82), accumulation of residues (Art. 83), conservation of flora and fauna (Art. 84), management of wastes (Art. 84) and protection of ecosystems (Art. 86).

The norms for utilization of mercury in mining activities (Art. 9) establish that all mining activities –exploitation, exploration or refining-- in which mercury is used must first have the respective environmental impact assessment and environmental management plan to prevent, mitigate, control and rehabilitate the natural and social environment affected. The basic methodology for preparing and presenting them will be defined by the National Bureau of the Environment of the Ministry of Energy and Mining.

4.4 Institutional Structure for Environmental Administration

This part will first develop a description of the country's political division and then the administrative composition of the State, as a preface for understanding the institutional structure for environmental administration.

A general scheme of this structure is attached hereto.

4.4.1 Political and Administrative Division of the Ecuadorian State

The Constitution is divided into two parts: dogmatic and organic. The former contains the philosophical principles that underpin the existence of the State, in Articles 1 through 55. The latter, organic part establishes the way the State is organized, in the remaining articles to the end.

The dogma part establishes an initial division regarding State economics. Article 46 of the Constitution states that the Ecuadorian economy operates through four basic sectors:

- **The public sector**, comprising wholly-owned State enterprises.

  These areas of economic activity that are reserved for the State:

  - Non-renewable natural resources and, in general, those underground products and all ores and substances the nature of which is different from that of the soil;
  - Services of drinking water supply, electric power and telecommunications; and
  - Strategic enterprises as defined by the Law.

  The State may, as an exception, delegate any of the above activities to private enterprise, in those cases established by the Law.

  For the purposes of preparing and implementing State development plans, the following entities comprise the public sector, pursuant to Article 128 of the Constitution:

  - State agencies and administrative dependencies;
  - entities belonging to provincial or cantonal administration, under the sub-national regime;
  - corporate entities created by law to exercise State power or provide public services or for economic activities undertaken by the State and those created by a sub-national legislative act to provide public services.

- **The mixed economy sector**, comprising enterprises owned by private parties in partnership with public-sector entities. The State will participate in these enterprises to encourage investment in areas in which the private sector cannot invest without public-sector input.

- **The community or self-help sector**, comprising cooperative, communal or similar enterprises, whose ownership and management belong to the community of persons who work in them on a permanent basis.

- **The private sector**, comprising enterprises owned by several individuals or private-law corporate bodies and, in general, companies not included in the other sectors of the economy.

Another political and administrative division of the State is based on the classical theory of the division of functions. Thus, the Constitution establishes the functions of the State: the Legislative Function, the Executive Function, and the Judicial Function (see **Diagram 4.4-1**, page 62).

The fundamental role of the Legislative Function is legislation and accountability for the acts of public administration institutions. Both activities, in environmental management, face limitations that have already been mentioned when discussing law-making processes in this field. These include short-sighted electoral political calculations, which are definitely characteristics that do not go along with adequate environmental management. Within the National Congress, a Special Commission for Environmental Protection has been established.

The Judicial Function is responsible for administration of justice. The Constitution establishes jurisdictional unity, so that any administrative action generated by central, provincial, municipal or recognized autonomous administration may be contested by the corresponding mechanisms of the Judicial Function, according to Law. The difficulties with the administration of Justice in public administration are analyzed below.

The Executive Function is exercised by the President of the Republic and is in charge of State administration. The Vice President is also included.

The Vice President, when not standing in for the President, is the ex officio chairman of the National Development Council (CONADE). As already pointed out, CONADE sets the general, economic and social policies for the State and will prepare development plans for approval by the President.

Moreover, Ministries (headed by ministers) are responsible for dispatching State business.

Part of this system is the so-called "dependent sectional" regime (sub-national government) in charge of representing the president at the provincial level, including the governor of the province and, in each canton, a political chief and, in each parish, a political lieutenant.

Article 120 of the Constitution states that the national territory is indivisible, but "for sub-national governance, provinces, cantons and parishes are established".

In each province, there will be a Provincial Council in charge of "working for the progress of the province and its relations with central agencies". Ecuador has 21 provinces. However, it is currently being discussed whether it is best for the Galapagos Archipelago to be a province as well. Considering the fragile, unique environment of the Galapagos, it would seem best for development to be approached differently than in mainland provinces.

Each canton has a municipality. "The Municipality is the autonomous political entity subordinated to the constitutional legal order of the State, with the purpose of local well-being. Its primary duties are to address the

city's needs, those of the metropolitan area and of rural parishes under its jurisdiction" /85/.

According to the Law of Municipal Governance, municipalities should "satisfy the collective needs of the neighborhood ...". Among its primary functions is that of " ... collection, processing or use of residues".

Article 16 of that Law indicates that, to accomplish their purposes, municipalities shall take into account the orientations set by national and regional economic and social development plans adopted by the State. Therefore, national and sub-national actions require at least a minimum degree of coordination.

Municipalities shall establish commissions of their members in order to better achieve their aims. Two of the so-called permanent commissions are involved with environmental management: the public services commission, which includes, among others, water supply, sewerage, and public cleaning; and the social service commission, which deals with hygiene and cleanliness. However, the permanent Commission on Planning, Urban Development and Public Works can also be considered for the purposes of this study. Their objectives basically have to do with studying the public's needs and studying projects, plans and programs that have to do with their area of work.

Within planning and urban development functions, municipal administration is responsible for formulating physical development plans for the canton and regulatory plans for urban development; zoning; ensuring that administrative norms on land use and urban zoning in the canton's territory are complied with; and regulating cleaning and hygiene for the public.

In regard to public works, the municipality's functions include planning, programming and projecting local public works as required in their municipal area.

As for public services, it must establish public cleaning, collection and treatment of garbage, residues and wastes; regulate the construction of rainwater and sewage water drainage, and process applications for permits to build them.

As for hygiene and social assistance services, the municipality must coordinate with the health authority according to the Health Code. It is also responsible for the canton's hygiene and sanitation, and ensuring proper compliance with legal norms regarding environmental sanitation and especially those involving noise, unpleasant odors, smoke, toxic gases, atmospheric dust, emissions and other factors that could affect the people's health and well-being.

Provincial councils and municipalities both enjoy, under the Constitution, functional, economic and administrative autonomy. The legislative power of these entities is expressed through ordinances.

Additionally, the Constitution establishes the State agencies, including the Supreme Electoral Tribunal, and the Office of the Attorney-General of the State; and Supervisory agencies, such as the Office of the Comptroller-General of the State and the Superintendencies of Banks and of Companies.

A review of the functions performed by each of these institutions shows that only the Office of the Comptroller-General of the State has any duties actually related to environmental management.

In fact, the Comptroller-General is the "technical, autonomous agency that will oversee the handling of public resources and norms and accounting consolidation thereof, supervision of goods owned by public-sector entities ... The Comptroller's surveillance will extend to private-law entities in regard to proper utilization thereof".

Therefore, and pursuant to the Law of Public Contracts /86/ (Article 18), the Comptroller-General will issue reports on pre-contract documents, in the cases of public tenders (if the amount exceeds the value of ten thousand minimum monthly wages) and public competitive bidding (if the amount does not exceed ten thousand but is greater than four thousand minimum monthly wages). That article also stipulates that it will be mandatory to abide by the Comptroller's observations regarding reports.

Similarly, Article 65 establishes that, once contract award has been notified, prior to signing any contracts for an amount equal to or greater than the base value of the public price competition (if the amount is less than four thousand but greater than two thousand minimum monthly wages), prerequisite reports will be required from the Comptroller-General of the State and the Attorney-General of the State.

Article 119 establishes that it is mandatory to maintain records, in the Office of the Comptroller-General, on contractors who have failed to fulfill the contracts that they have made with the State.

Finally, the Comptroller-General's Office is the institution that regulates the listing of the elements and scope of the stages of prefeasibility, feasibility and evaluation, financing, design, mode of implementation, construction and maintenance of public works or services.

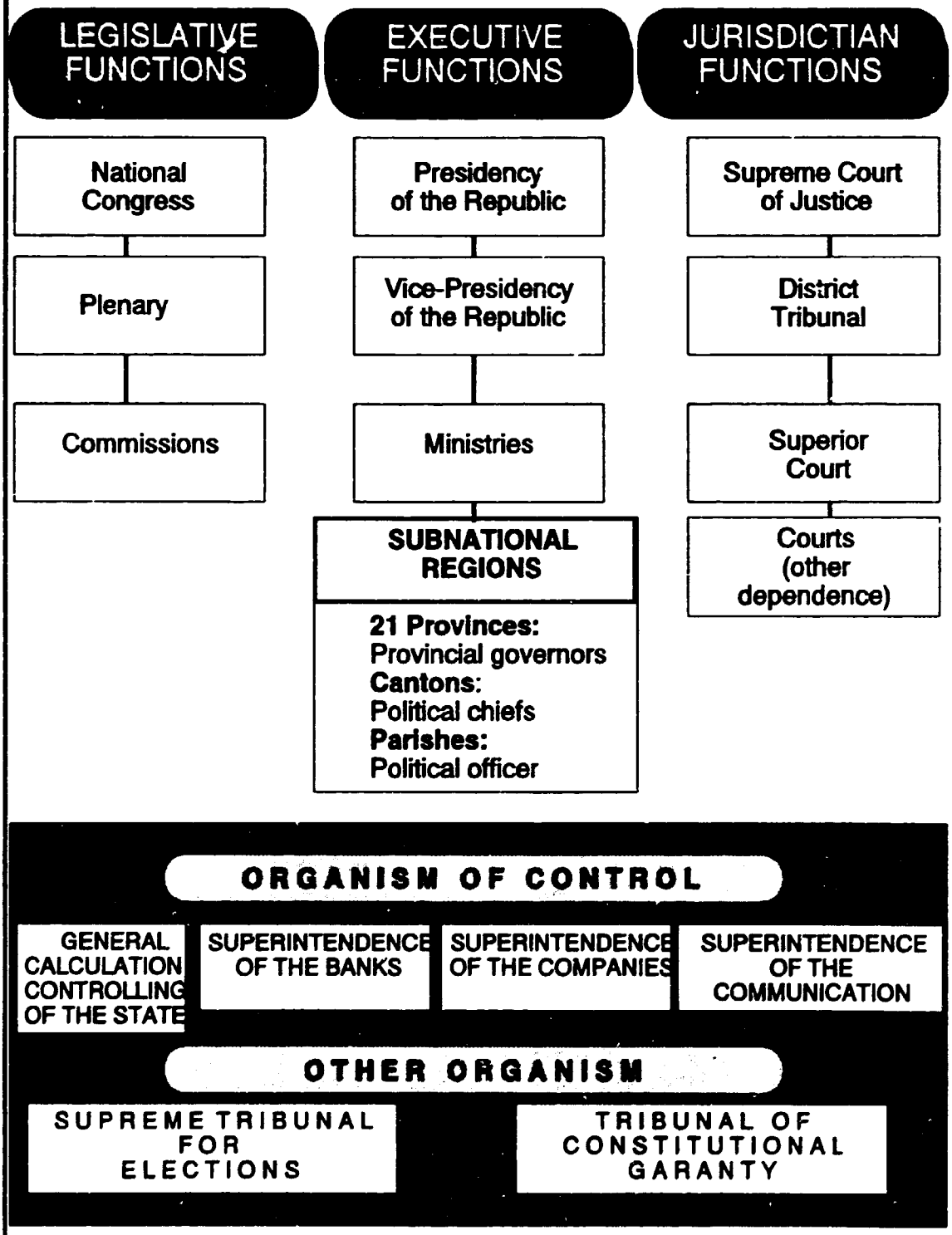
All these provisions grant the Comptroller-General the possibility of incorporating control over implementation of the component of pollution prevention and control, or proper use of natural resources, in those contracts to which the State is a party, through any of its agencies.

Furthermore, an Environmental Unit has already been created in the Office of the Comptroller-General of the State.

Finally, there is the Tribunal of Constitutional Guarantees, which has two fundamental kinds of functions. The first is to "hear and rule on" lawsuits brought regarding instruments the form or substance of which is unconstitutional. It has the power to suspend these instruments' effects, wholly or partially. Its rulings are overseen by the Constitutional Department of the Supreme Court of Justice, whose verdict is final.

Another of its functions is to hear complaints that are formulated by any individual or corporate body against the acts of public authorities that violate rights and liberties that are guaranteed by the Constitution. By exercising this function, the Tribunal can admonish that authority and, if its admonishment is not followed, it may request that the authority be removed. Its resolutions are not mandatory.

DIAGRAM 4.4-1
THE FUNCTIONS OF THE STATE



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4.4.2 Functions and Powers of the Administration and Public Institutions in the field of the Environment

One of the first stages where there is interaction among State institutions comes from what is known as State Theory and the distribution of functions within the State.

Thus, the Executive Function is responsible for acts of State administration, including legislation; whereas the Legislative Function has the power of legislation and accountability regarding the former's actions; and the third function, Judicial, has the power to administer justice.

In regard to environmental policy, there is no apparent clash of jurisdictions, since it is clearly defined that these policies must be established by the Executive Function.

Tasks of legislation are shared by the Executive and Legislative Functions that this may be clearly seen in the country's legislative norms. Proposals for environmental law come from either function. However, a major effort begins with the public institutions that make up the autonomous sub-national regime, comprising municipalities and provincial councils.

However, an issue that is increasingly powerful has to do with judgements. In the Ecuadorian system, administrative courts have often been created for first-level, administrative hearings of legal infractions. Generally, administrative, first-level courts (e.g. the Technical Offices of the National Forestry, Natural Resources and Wildlife Institute [INEFAN], the Water Courts and Tribunals of the Ecuadorian Water Resources Institute [INERHI], or those that used to operate under Agrarian Reform [IERAC]) are all de facto courts of appeal for administrative resolutions.

Although their role is eminently technical, many of them do not have any legal component, which results in certain difficulties with the administrative system for judging environmental infractions.

The power to administer justice is constitutionally found in the Judicial Function, the possibility of administering justice in agencies of the Executive Function comes either from the intention of the legislators when they prepared these laws or a misuse of legal terminology.

In fact, when we speak of the geographical areas within which a public institution that has been created can exercise its functions, the term generally used is **competencies**.

The Ecuadorian Code of Civil Procedure, Article 1(2) states that competency is " ... the measure within which this power is distributed among the various tribunals and courts, on the basis of territory, things, persons and degrees".

"This power" means jurisdiction, i.e. (according to the preceding subsection of that same body of law) "... the power to administer justice, (and) consists of the public power to judge and enforce judgements in a given area, which power belongs to the magistrates and judges established by law".

Within this context, some public institutions exercise, within their functions, the power to administer justice, i.e. competency. However, not all functions nor all public institutions have the power to exercise competency, but only those functions that their respective laws of creation have assigned them.

So, disregarding the principle of jurisdictional unity, a series of administrative entities have been created within which infractions of special laws are judged.

One way to address this difficulty is found in the proposal to restructure the water system, recently presented by the Ministry of Agriculture. That document establishes that the administrative procedure will be used in complaints in which the parties are, on the one hand, the interested party, a private user, and on the other, the State. Such an administrative procedure must be completed prior to the judicial system action. However, for complaints between private parties the judicial procedure should be used.

We should differentiate between these two forms of administering justice. One comes from the administrative domain and the other from the judicial system. The action of either does not prevent action in the other. Especially considering that, in many cases, to bring legal suit it is a prerequisite to have exhausted the possibilities for administrative solution. This makes the system quite complicated, because if the administrative procedure has at least two levels, the first with the ruling by the public official directly responsible for such an institutional area and the second with the appeal thereto, to the top authority of that institution, then come the levels of the judicial system, of which there are several, the number depending on the matter being judged. And then, if we consider that some infractions of environmental laws or provisions grant competency to hear the case to both civil-court and criminal-law judges, the procedure becomes even more complex.

Therefore, the judgement process is quite lengthy and tedious, full of complications, which is all definitely in favor of the infractor.

Finally, within these considerations about the judgement of environmental infractions, we must consider that the Constitution (Article 19), which contains persons' rights, establishes that any person is entitled to "address complaints and petitions, but never on behalf of the people; ... ". Evidently, only the party directly affected by an act or omission that has

entailed damages of an environmental nature may bring suit for the administration of justice, whether administratively or judicially.

A constitutional amendment proposal supported by various societal groups, among them ecological groups, has to do with so-called diffused or social rights. That is, those rights that affect the collective group and not precisely one individual in particular. To defend these rights, the proposal is to incorporate the rights of support and legal guardianship. Thus, not only the party directly affected by an action or omission will be able to complain to competent courts, but any other person as well, on behalf of the defense of collective rights. However, this is no more than a proposal that, to take effect, would first have to be approved as a constitutional amendment.

However, popular action to complain about non-fulfillment of environmental provisions is established in the regulations of the Law for Prevention and Control of Environmental Pollution.

The following are the objectives and functions of the public institutions in the environmental field, which we have already defined as whatever is related to environmental pollution and natural resource use.

E. Pérez, whom we have quoted several times so far, states that "Ecuador has no institution with general pre-eminence in environmental management, but rather institutions that have isolated powers for the management of various resources".

Functions of public institutions in the field of the environment, according to the Law for Prevention and Control of Environmental Pollution.

According to the same author, the institution that could be considered as the leader in environmental matters in Ecuador is the Inter-Institutional Committee for Environmental Protection. However, this institution does not wield any power with the government or leadership with the Ecuadorian public either because of its authority, competency or power, or because of the significance of its activities."

This committee was formed by the Law for Prevention and Control of Environmental Pollution and comprises the Ministers of Health (who chairs it and also is in charge of coordination through the IEOS), of National and Energy Resources, of Agriculture and Livestock, Of National Defense, of Industry, Trade, Integration and Fisheries, and the President of the National Planning and Coordination Board.

The aim of this Law is to preserve air, water and soil resources (Article 10), and therefore to pursue actions and establish supervisory functions and penalties for a number of public entities.

So, the **Ministry of Health**, through **IEOS**, acts in the area of prevention and control of contamination of water for human consumption, of residual water, of air, of noise, by radiation and that pollution caused by solid wastes on the soil.

The **Ministry of Agriculture and Livestock**, through **INERHI**, acts to prevent pollution and control the quality of fresh water, rivers and lakes, according to the Law of Waters.

The Ministry **of National Defense**, through the **Bureau of Maritime Development**, acts to prevent pollution and control the quality of marine water and navigable rivers, according to the Code of Maritime Police; and through the **Bureau of Civil Aviation**, to prevent and control pollution of airspace, in terms of navigability.

The **Ministries of Natural and Energy Resources and Agriculture and Livestock** act in regard to prevention and control of soil pollution.

The **Ministries of Industry, Labor and Social Welfare** act in regard to the establishment of new industries and activities involving labor.

The **Ministry of the Interior**, through the **General Bureau of Transit**, acts in environmental pollution due to the circulation of automotive vehicles.

The **Ministry of Education**, acts in planning and implementation of educational programs regarding environmental pollution.

The **Ecuadorian Atomic Energy Commission (CEEA)** acts in regard to the use of ionizing radiation, or radioactive isotopes in industrial uses, or any other type of activities that entail risks of radiation pollution or exposure.

The **Universities and polytechnic institutes** act in regard to research into environmental pollution whenever they have the technical and scientific means to do so.

Finally, **public or private institutions** that are directly or indirectly involved with regional, provincial or local development programs also deal with environmental pollution problems.

This allocation of functions and competencies is based on those already assigned in the laws governing the public institutions involved, and covers only environmental pollution.

Environmental Units and Dependencies of Competent Public Institutions.-

The data in this section were produced by the research performed by Dr. Cecilia Miño, for the Environmental Advisory Commission of the Presidency of the Republic (CAAM).

The National Development Council (CONADE) has an Environmental Advisory Unit (UNAMA), created as of publication in Official Registry 283 of September 24, 1993.

The Ministry of Education also has the Department of Environmental Education, created by a ministry resolution published in Official Registry 935 of May 14, 1992.

The Ministry of Energy and Mining has had the Under-Secretariat of the Environment, since 1991, and within that, the National Bureau of the Environment.

The Ministry of Urban Development and Housing, created in 1992, has the Under-Secretariat of Environmental Sanitation (SSA) according to Executive Decree 1218 of November 12, 1993. This Under-Secretariat was previously the Ecuadorian Institute of Sanitary Works (IEOS) within the Ministry of Health.

The Ministry of Industry, Trade, Integration and Fisheries has, since publication in Official Registry No. 319 of November 18, 1993, the Environmental Management Unit, responsible for enforcement of the Protocol of Montreal in Ecuador.

The Ministry of Public Works has had the Department of Evaluation and Control of Environmental Impact, since publication of Official Registry 934 on May 13, 1993.

The Ministry of Foreign Affairs has the Environmental Department, under the Under-Secretariat of Bilateral Political Affairs, created through Official Registry 991 of August 3, 1992.

The Ministry of Social Welfare has an Environmental Unit as of April 1, 1993, within the PRONADER Project, in the National Rural Development Program.

PETROECUADOR has an Environmental Protection Unit, created in the Law of Petroecuador and its affiliates, on September 18, 1989.

Resolution 034 of September 7, 1993 created, in the Office of the Comptroller-General of the State, the Department of Environmental Control.

Objectives of the Public Institutions involved in environmental management, according to the Law of the General Budget of the State.-

The Law of the General Budget of the State covers all public institutions whose budgets are in that budget, and establishes the institutional objectives to be achieved with those budgets.

The following listing of public institutions related to the environment, i.e. environmental pollution and natural resource management, and their objectives, based on their respective laws of creation, has been taken from the General Budget of the State.

Institutions of the Administrative Sector

Ecuadorian Atomic Energy Commission (CEEA):
Established by Law on March 8, 1979, as an institution under the Presidency of Ecuador. The law was amended by Law 163, published in Official Registry 984 of July 22, 1992.

Its objectives are: implementation and development of basic scientific and technological infrastructure in nuclear science in Ecuador; introduction thereof in activities such as agriculture, industry, medicine and others; determination of the potentials of radioactive materials in this country. It also cooperates with academic, research and related institutions.

Galapagos National Institute (INGALA):
INGALA was created by a legislative decree on October 26, 1979, published in Official Registry 131 of February 21, 1980.

Its objectives are: to provide technical and economic assistance to government dependencies and agencies in activities involving conservation of nature, provision of services, community well-being, development and ordering of tourism, exploitation of natural resources and training of human resources whose services will be required in the Galapagos Islands; to promote among the native inhabitants, residents and others living there the forms of work that will be compatible with the environment and providing them assistance in making adaptations; to investigate ways to take advantage of natural resources, surface and underground water, to issue norms for urban settlement, substantial use in agriculture and environmental sanitation, disposal of waste waters, agricultural activities, fishing and other actions that must be controlled to maintain the environment.

Program for Management of Coastal Resources (PMRC):
Established by Executive Decree 375, published in Official Registry 117 of January 26, 1989.

Its objectives are: to provide technical assistance, conduct studies and formulate plans on matters affecting the Ecuadorian coastal zone and to

achieve administrative integration for the preservation and development of coastal resources in the provinces located along the coastline.

Environmental Advisory Commission of the Presidency of the Republic (CAAM):
Established by Executive Decree 1107 of September 22, 1983, published in Official Registry 283 of September 24, 1993.

CAAM has the following functions: to provide national policy and strategy orientation in issues regarding the environment, in order to present them to the President for consideration and approval; to ensure involvement of different sectors and institutions in these processes and commit the issue of ministry and inter-ministry resolutions that are relevant; to propose national-scope guidelines on environmental issues including proposals for environmental ordering in administrative and legal aspects; to promote private enterprise and community participation in environmental management; to settle conflicts of competencies that may arise among the different public agencies or institutions in environmental matters; to propose the preparation of studies, norms and implementation of programs and projects regarding the environment; and to coordinate the allocation of resources from foreign or domestic loans, grants or budget allocations, for the achievement of these aims.

Institutions of the Planning Sector

National Development Council (CONADE):
As already stated, CONADE has the power to set general State economic and social policy, and the development plans that are approved by the President of Ecuador. Once this has happened, it will be mandatory to implement and comply with these economic and social policies and plans. CONADE also formulates the country's population policy, within the social and economic guidelines for solving the nation's problems.

Institutions of the Educational Sector

New Cultural Direction Program:
Created by Executive Decree 135 published in the Official Registry on September 23, 1992. Its objective is to improve the country's environmental conditions, by reforesting areas that are considered critical and suited for this purpose, with the participation of the student community, the Armed Forces, owners of private property and members of rural communities.

National Institute of Cultural Heritage:
The Institute was created by Decree 2600 of June 9, 1978. Its objectives are to conserve, investigate, restore, exhibit, disseminate and promote the cultural heritage of the nation, and keep an inventory of this heritage.

Ecuadorian Museum of Natural Science:
Created by Supreme Decree 1777-C of August 28, 1977, promulgated in Official Registry 421 of September 13, 1977.

Its objectives are to inventory, classify, conserve, exhibit and disseminate knowledge about all natural species in this country, attempting to organize, support, coordinate and disseminate, through regional, special and private museums, knowledge and development for this country according to ecological characteristics; to establish and defend national parks and nature reserves.

Institutions of the Agricultural Sector

Ministry of Agriculture and Livestock:
Its objectives include working for rational use of natural resources in the management and conservation of soils, forests and water, in order to guarantee high levels of productivity and protect this heritage for future generations.

Under the Ministry of Agriculture, we find the following institutions:

Ecuadorian Institute of Water Resources (INERHI):
An Executive Decree dated October 20, 1994 replaced INERHI by the National Council of Water Resources, within the framework of decentralization and modernization of the State.

Its objective is to improve utilization and conservation of the country's water resources as an essential condition for its socioeconomic development.

National Institute of Agricultural Research (INIAP):
Created by Decree-Law 165 published in Official Registry 984 of July 1992, its objectives are to plan, direct, implement and evaluate agricultural research, disseminate the knowledge and technologies that are generated, produce and sell seeds, breeding stock, and vegetative material, improving and selecting them, as well as other services to encourage agricultural production, and to foster the creation of an agricultural research system.

National Institute of Agrarian Development (INDA):
Created in the Law of Agrarian Development, published in the Supplement of Official Registry 461 of June 14, 1994, to implement the political direction of the process of promotion, development and protection of the agrarian sector under the Presidency of the Republic, through the Ministry of Agriculture and Livestock.

Institute of Colonization of the Amazon Region (INCRAE):
Created by Supreme Decree 2092 of December 28, 1977, published in Official Registry 504 of January 12, 1978.

Its objectives are to encourage the protection, conservation and management of the Amazon Region environment to hold back processes of ecosystem deterioration and foster sustainable development, properly using the region's potential and respecting the limitations of these natural resources, so as to make it possible to improve the standard of living of the current population and future population; to support projects that will orient, encourage and improve socioeconomic conditions for agricultural production, so farmers can generate resources; to promote the development of forestation in areas where no other possibilities for land use are evident, thus producing economic revenues and strengthening environmental conservation.

Center for Economic Reconversion of the South (CREA):
This entity comes under the Ministry of Agriculture and Livestock. Created in 1973, its objectives include those of working for conservation and management of renewable natural resources and rational exploitation of non-renewable ones, with an eye to achieving sustainable development in the medium and long term.

Center for Rehabilitation of Manabí (CRM):
Created on November 7, 1962 and published in Official Registry 314 of November 23, 1962.

Its objectives are to prepare plans, programs and projects for development of this province in accordance with national plans and in coordination with public and private agencies of the region, in order to achieve optimal utilization of available resources; to implement those projects that regional programming assigns to it, granting priority to the utilization of water resources, irrigation, drinking water supply and environmental sanitation; and to provide advisory support in the area of urban development for municipalities of the province.

Commission for Studies of the Guayas River Basin (CEDEGE):
Created by Supreme Decree 2672-65 in 1965.

Its objectives are to conduct research and studies involving integrated development in accordance with the zone's highest-priority needs; and to unfold a broad system of inter-institutional coordination, in the national and sub-national government and, as necessary, with the private sector, with a view of well-balanced, integrated development of the Guayas River Basin and the Santa Elena Peninsula.

National Institute of Forestry and Natural Resources and Wildlife (INEFAN):
Established in Law 08 published in Official Registry 27 of September 16, 1992.

Its objectives are to plan and prepare plans, programs and projects for sustainable development of the forestry subsector, especially in the fields of forestation, research, exploitation, management and protection of natural and manmade forests, hydrographic basins and wildlife in relation to the adequate use of renewable natural resources and deterioration of the environment; to delimit and administer the forestry area and natural areas and wildlife belonging to the State; to see to the conservation and utilization of existing natural and forestry resources; to promote and coordinate scientific research in the realms of its competency; to manage permanent woodlands to achieve adequate ordering of forests in order to obtain continual production of forestry products and services without unduly reducing the current and future productivity, or causing undesirable effects in the physical and social environment; and to evaluate criteria that can ensure protection and maintenance of biodiversity and stabilization of the climate.

Ecuadorian Subcommission of PREDESUR:
On September 17, 1971, the Ministries of Foreign Affairs of Ecuador and Peru signed the agreement to utilize the binational river basins of Puyango-Túmbez and Catamayo-Chira. Ratification of the Agreement is published in Official Registry 385 of January 4, 1971.

The objectives of PREDESUR are: to coordinate, direct and obtain a concentration of efforts by all Ecuadorian entities with jurisdiction in the provinces of El Oro, Loja and Zamora-Chinchipe, in order to achieve regional development; to fulfill commitments undertaken in the binational agreement; and to program regional strategies that will make it possible to optimize management of the above basins in the Ecuadorian part.

Institutions of the Natural Resource Sector

Ministry of Energy and Mining (MEM):
The Ministry of Energy and Mining includes Environmental Preservation among its activities. The objectives of this activity are to oversee compliance with environmental impact assessments and environmental management plans; supervise compliance with rehabilitation programs for areas affected by these sectors; establish the necessary regulations for environmental protection and the preservation of nature; direct research programs to prevent environmental risks and natural disasters; and coordinate actions to rehabilitate the environment that has been affected by extraction of non-renewable natural resources.

The MEM is also responsible for the administration of hydrocarbons, for which the major objectives are: to guarantee that hydrocarbon operations are carried out under conditions of technical and economic security; to ensure that fuel supply lies within adequate margins of quantity, quality and established prices; assure optimal physical and economic recovery of hydrocarbons; safeguard the State's economic interests in hydrocarbon

operations; guarantee the status of conservation, maintenance and operation of facilities for transport, storage, industrialization and marketing of hydrocarbons. in order to be able to provide good service; oversee compliance with contractual obligations with the State by companies operating in this country; and recommend the imposition of penalties for infractions of legal provisions.

Finally, objectives for mining resource administration are: to encourage development of mining activities; to foster integrated development of mining resources and their rational utilization; safeguard the State's economic interests in mining operations; promote national and foreign private investment in mining projects; provide organized technical assistance for mining activity, at the community, self-help and artisanal levels; and investigate Ecuador's mining potential.

Corporation for Geological, Mining and Metallurgical Development and Research (CODIGEM):
Formed under the Law of Mining, its objectives have to do with research to determine Ecuador's actual mining potential; promotion of this field with private-sector involvement and using foreign capital and techniques; applying relevant laws and regulations to ensure efficient, fair development of mineral resources, and those necessary to protect the ecosystem; technical advisory support for small and artisanal miners.

National Institute of Meteorology and Hydrology (INAMHI):
Formed by Supreme Decree 3438 published in Official Registry 839 of May 25, 1978.

Its objectives include planning, directing and supervising meteorological and hydrological activities in Ecuador, in coordination with other institutions and organizations and with national socioeconomic development programs; and preparing the systems and norms that will regulate meteorology and hydrology programs to be carried out according to national needs.

National Energy Institute (INE):
Created by Supreme Decree 2888-A published in Official Registry 683 of October 2, 1978, INE is responsible for inventorying the country's energy resources; preparing the National Energy Plan taking into account the development of non-conventional energy sources to maintain ecological balance. The goals of the energy planning project are to perform specific supply and demand studies and research the energy-environment relationship.

Institutions of the Industry and Trade Sector

National Institute of Fisheries (INP):
Established by Executive Decree 582 of December 5, 1960, published in Official Registry 105 of January 5, 1961. Its objectives are to conduct scientific and technological research into bio-aquatic resources, based on knowledge of the environment and of organisms that live in it, with an eye to evaluating their potential and diversifying their production; to provide technical assistance in these areas and work to develop fishing activity and achieve optimal, rational utilization.

Institutions of the Tourism Sector

Ministry of Information and Tourism:
Established in Executive Decree 4 of August 10, 1992, published in Official Registry 1 of August 11, 1994.

Its functions that are relevant to this study are those involving tourism, which include: coordinating policies and strategies oriented toward programming, development and preservation of tourism resources at the national level; preparing and implementing norms to promote receptive tourism, ecotourism, domestic tourism and social tourism at the national and international level, to maintain balanced development according to the characteristics of each region; and implementing development projects in the area of tourism.

Ecuadorian Corporation of Tourism (CETUR):
Created in Law 033 of July 6, 1989, published in Official Registry 230 of July 11, 1989.

Its tasks are to promote receptive social tourism and attempt to achieve regionally balanced national development; contribute to conservation, knowledge, protection and rational utilization of tourism resources and attractions; promoting improvement of tourism activities by supporting them, incentivating them, regulation and controlling their operation; coordinate with relevant institutions those activities related to tourist protection and security; and work to coordinate tourism with the other sectors of the economy.

Institutions of the Urban Development and Housing Sector

Ministry of Urban Development and Housing:
Created in Executive Decree 3 of August 10, 1992, published in Official Registry 1 of the same month and year.

Its functions include those of planning, directing, coordinating and building dwellings in the rural and urban zones for social purposes; handling implementation of the national water supply, sewerage and environmental

sanitation plan; establishing coherent planning and urban development policies, in coordination with the country's municipalities.

Under-Secretariat of Environmental Sanitation (SSA):
Established by Supreme Decree 179 of January 29, 1965 as IEOS (Ecuadorian Institute of Sanitary Works), published in Official Registry 430 of February 4, 1965.

Its functions are to plan, coordinate and implement, at the national level, the construction of sanitary infrastructure, sewerage and water supply projects.

4.5 Private Institutions and their functions in the field of the environment

At the beginning of this chapter, we referred to environmental policies. We feel that only the Executive Function can actually establish them. However, we also pointed out that other institutions, such as those belonging to the Autonomous Sub-National Regime, also have, among their competencies, those related to policy-setting.

Now we must add another area which is restricted to the executive and legislative branches of the government, i.e. legislation, or law-making. The Constitution establishes popular initiative to "amend the Constitution and amend and issue Laws ... " but this power has never been regulated and is therefore inapplicable.

Finally, a third power inherent in the so-called "public authority" is the administration of justice.

Returning to policy, we would like to refer to No. 3 of the Basic Policies prepared by the Environmental Advisory Commission (CAAM), which state that environmental management is everyone's responsibility, in their respective fields of activity.

Policy No. 4 adds that the environment is involved in all human activities and that this means that there is inescapably an interaction among stakeholders and their interests. Therefore, according to Basic Policy No. 5, "Environmental management is grounded basically in solidarity, co-responsibility, cooperation and coordination among all residents of the country ...".

Further, Policy 8 involves in the participatory processes of environmental management "those human groups that, for different historical reasons, have not been very directly involved in decision-making and actions of national interest ..". These groups include the least privileged, such as women, children and youth, organizations representing minorities,

indigenous population groups and communities, workers, labor unions and class-based organizations, businesspersons and their firms and organizations, farmers and farm workers, and the scientific and technological community.

They all not only establish shared responsibility with the State regarding environmental management, but also promote the involvement of private parties therein.

Therefore, we must think about the processes of restructuring the State and reformulating its role in handling public administration. Thus, at present, control activities tend to remain in public administration, whereas those involving task implementation tend to be awarded to the private sector.

Within this context, an agreement was recently signed in which a non-governmental organization will be responsible for administering a protected natural area, under prior elaboration and approval and submission of a management plan. Control will be exercised by the National Forestry Institute.

This alternative, quite novel within our system, could become a parameter for measuring private-sector participation in environmental management, especially taking into account cases such as the Chiefs of Natural Areas in INEFAN itself, who are responsible for protected natural areas that are too large to be humanly possible to supervise, much less in view of their limitations in infrastructure and institutional facilities.

Let us also remember that the Law for Prevention and Control of Environmental Pollution of 1976 establishes, in Article 10(i), that for application and implementation of actions to preserve water, air and soil resources, universities and polytechnic institutes are responsible for researching environmental pollution, providing they have access to the technical and scientific means required for that purpose.

Finally, public and private institutions related directly or indirectly to regional, provincial or local development programs entailing environmental pollution problems are responsible for implementing actions that will preserve those resources.

4.6 Conclusions

The findings of this study reveal four fundamental characteristics of the current administrative and legislative system in the area of environmental protection and natural resource use.

1. First is the breadth of national legislation and, accordingly, of the administrative institutions created by these laws. This characteristic evidently leads to the scattering of norms and institutions that, according to the field of their competent action, regulate the same resources.

   Therefore, an effective coordination system is required to dovetail these isolated and even scattered efforts by different institutions in their attempt to apply their own legal norms.

2. This lack of coordination is the second characteristic, both in legislation and in the institutional system. This activity does not require the creation of any institution, but rather the institutionalization could be the Environmental Advisory Commission of the Presidency of the Republic (CAAM) which requires adequate legal backing to perform this function, i.e. a legal basis on the hierarchical level of a law to create it as the coordinating body.

   But more important than this "legal" constitution (by law), it will require determination and establishment of clear functions, so that they can create their own role among Ecuadorian environmental institutions. These functions could doubtlessly include

   - coordination,
   - penalizing, and
   - establishment of general policies and standards of general applicability.

3. The third characteristic is the lack of an institution to take charge of enforcing compliance with legal norms. This institution need not be an actual corporate body such as the Comptroller's Office, Superintendencies, Defender of the People, etc. This characterization of the "control institution" leads us to the final question about what such an institution's functions should be and, what is more, who will be responsible for supervising the supervisor. The term "institution" is used here in a broad sense referring to an adequate control mechanism to address so-called social rights and actions to put these non-individual rights into practice. That is, broadly speaking, the possibility of complaining to competent authorities on behalf of any citizen for infractions of legal norms, although the effects of such infractions are not directly harmful to the party presenting the claim.

4. Finally, as has been repeated throughout this study, the environmental component must be included in development planning processes. However, this component must also be applied by each and every public and private institution that carries out activities affecting the environment. This will be the step from policy statements to committed action, in all fields of environmental management.

These characteristic problems of the legislative and institutional system can be addressed by establishing coordination mechanisms that will involve each and every stakeholder in the system.

5. DESIGN OF AN ENVIRONMENTAL MANAGEMENT SYSTEM

Environmental protection and prevention of environmental damage have become essential responsibilities for every country. Environmental management is being granted an increasingly important role in environmental policy discussions. This means that efforts must be redoubled to maintain or bring under control the growing complexity of environmental policy and the respective measures that authorities must undertake, with the support of an Integrated Environmental Management System that will help organize environmental management in an effective, powerful manner.

Therefore, a National Integrated Environmental Management System must cover all direct and indirect activities within a country, at all levels - political, administrative, economic and social - in order to safeguard and upgrade environmental quality, prevent the occurrence of negative impacts, and keep our priceless natural wealth from being destroyed. The environmental management system is a modular instrument adapted to administrative structures and complementing them, to guide the country's sustainable development under proper management of the environment.

The environmental management system is the set of guidelines according to which environmental management must be carried out, through negotiated agreements with all stakeholders, i.e. joining the forces of all persons, institutions, authorities and companies participating in political, economic and social processes that influence or could influence the environment.

5.1 Environmental Management System (EMS)

5.1.1 Objectives

The main purpose of an Environmental Management System (EMS) is to prevent negative environmental impacts from being caused by human economic activities and mitigate or eliminate existing negative impacts. Only with the assistance of ongoing, broad-based analysis and observations of the environmental situation, along with the adoption of measures for improvement and for the prevention of negative environmental impacts, can we move in the direction of the ultimate objective, which is to maintain sustainable development that is compatible with a healthy environment, and moderate utilization of resources.

5.1.2 Tasks

The tasks of an Integrated Environmental Management System, at the national or regional level, are of various types, and work through the different administrative levels of the country.

The system's core tasks are grounded in:

- Continually preparing and updating national environmental policy, and formulating and establishing environmental objectives,
- Continually formulating and completing a suitable legal framework to support and reinforce institutions and authorities at the various levels of administration, so that they can perform their functions effectively,
- Structuring a legal instrument for effective control of the environmental situation, updating and adapting criminal laws for effective enforcement in the event of environmental crimes,
- Continually preparing, developing and coordinating ordinances, norms and standards as a basis for effective environmental control and in order to provide a clear, accurate document on environmental matters.
- Developing, implementing and overseeing measures to orient sustainable development that will not harm the environment,
- Reinforcing and/or structuring environmental management units in every province,
- Coordinating all situations that arise in public and private life that can support monitoring, analysis, planning, organization and research regarding the environment, in order to guarantee its healthy upkeep,
- Organizing, recording and coordinating, nation-wide, major national environmental activities (studies, concepts and projects),
- Organizing and implementing environmental control with the support of an Environmental Monitoring System,
- Organizing and implementing an Environmental Information System.

In order to materialize the above tasks, the EMS provides a suitable foundation to develop and implement measures at all political and administrative levels, that will make it possible to solve national and international problems, through relevant inter-relationships. Policy, administration and private institutions must collaborate intensively within a system for environmental prevention, improvement and monitoring on the basis of specific functions. Only in this manner, and with the support of the EMS, will it be possible to minimize and partially even out the weak points that arise when shouldering and fulfilling tasks related to the environment.

On the basis of adequate organizational logistics, the EMS can guarantee the magnitude and quality of environmental information and data presentation and, through the administration, make it possible to efficiently perform all tasks in general.

For the administration to work efficiently and coordinatedly within an Environmental Information System, effectively performing its functions, it is very important for the jurisdictions of the different administrative and executive agencies to be well-defined in terms of legislation and implementation, so that the organization will be functional and operational.

5.1.3 Overall Structure

An environmental management system comprises several interlinked components, each of which assumes and fulfills a group of well-defined functions and tasks, as outlined in the following chapters. Each component could operate independently, but will actually work within a systematic overall structure, in which all processes are suitably integrated into a single system. Consequently, the components as a whole make up a Functional, Integrated Environmental Management System.

The components of this system are structured and integrated according to their functions, as follows:

- **Environmental Monitoring System:**
  Oversight of the environment through measurements, observations, controls and data gathering.

- **Environmental Information System:**
  Data processing through data reception, storage, evaluation and documentation.

- **Central coordination and environmental technical advisory support:**
  Coordination, organization, implementation and oversight of technical evaluations and interpretations of environmental data, formulation and choice of measures.

- **Legislation:**
  Formulation and implementation of laws, ordinances, norms and standards.

- **Executive branch:**
  Use of legislation, as well as monitoring of compliance with laws, ordinances, norms and standards, e.g. approval parameters, boundary values and reference values.

Activities within the above fields must be carried out by the respective public and private institutions.

Public agencies include, in general, ministries and their executive sections such as public laboratories, State research institutions, and authorities at lower administrative levels (in the case of Ecuador, the provincial

governors' offices, for instance) which must have a properly-structured environmental department.

Private entities include private laboratories, consulting firms and service companies that work under contract, semi-governmental or private universities, foundations and efficient non-governmental organizations, which must undertake specific functions and/or activities within the environmental management system. Private enterprise involvement is also of fundamental importance to the system, above all the participation of industrialists and agroindustrialists, not only as polluters and penalized parties, but as active members of the environmental management system, preventing environmental impacts and contributing their knowledge, technology and financial input to eliminate environmental damage.

The citizenry in every country also plays a crucial role in the environmental management system. More than just receivers of information, the public must become an instrument for inspecting and correcting decision-making processes that are in the hands of the legislative and executive branches of the State. The people's work must be done together with non-governmental organizations.

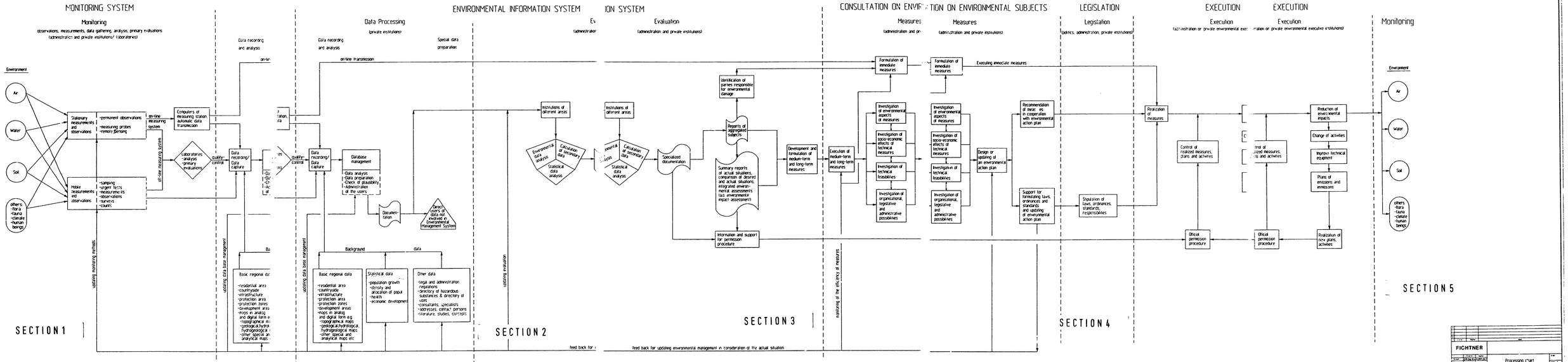
The components of the environmental management system outlined above are the groundwork for environmental administration, observation and planning at all political and administrative levels.

The following **diagram 5.1-1** displays the components of the environmental management system and the overall linkages among them.

The following chapters will describe each system component, establish its boundaries and the inter-relationships among them.

They will also present the minimum staffing and technical requirements for project implementation in the chosen zones, comparing existing capacity and determining additional needs; as necessary, any redundancies in operational and executive capacity will be identified. The primary objective is to present in the following chapters the structure of a functional environmental management system for Ecuador, and to determine the additional capacity required to structure and develop the system.

Diagram 5.1-1: Functional Structure of an Environmental Management System



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Processing chart

5.2 Environmental Monitoring System (EMoS)

Defining an environmental monitoring system is a complex job: its objectives and requirements may be defined on the basis of thorough knowledge of the techniques to be used and the fields in which the work must be done; nevertheless, any plan that does not truly provide for the concrete means of achieving these goals may be frustrated, becoming just another dead letter that cannot be implemented, even though its considerations are urgently needed and indispensable for governmental entities to know about, so that they can provide adequate policies and the necessary basis for decision-making. These decisions must obviously be oriented toward objectives that will make it possible to:

prevert, decrease or mitigate existing environmental impacts and those that may arise in the future, under sustainable development of the country, without harming the life and well-being of present and future generations.

These considerations give shape to the following proposals, which take into account the essential needs of this subject, the reality of the setting and minimal conditions and economic requirements for getting a pilot monitoring system underway, that can be expanded in the future to a national level throughout Ecuador or a regional level throughout the Amazon Region.

Considering that this document outlines broad-based concepts on the issued to be discussed and that the work focusses mainly on the Amazon Region of Ecuador, it mostly addresses oil and gas, mining and agroindustrial activities, which are affecting, one way or another, the natural order that used to prevail or currently exists in that region and, in principle, throughout the whole country.

This means that we must define how effluents from these activities are affecting the atmosphere, water resources and soil; also, how to define interaction among them in relation to living beings who carry out their daily activities within this habitat.

5.2.1 Objectives and Tasks of an Environmental Monitoring System

The main aims of the Environmental Monitoring System (EMoS) involve reconnaissance, data-gathering and analysis regarding major environmental impacts produced by human activities in industry, agroindustry, forestry, fishing, mining and the consequent migrations, technical and roadway infrastructure.

The EMoS's general tasks consider the organization and implementation of environmental control, which entails:

- formation of environmental control units (e.g. fixed and mobile measurement stations, laboratories, observation stations, remote control systems) and continual change and/or adjustment in view of growing needs.
- structuring of control and measurement plans (observation and measurement sites, measurement methods, elements to be measured, methods for analysis and evaluation of data, etc.).
- data-gathering and primary assessment of key environmental data, obtained by measurement, testing, observation, analysis, surveying and reconnaissance of data (censuses).
- organization and implementation of data-gathering, as well as the coordination of institutions participating in the control system and coordination of responsibilities within the system.
- constant quality control over supervisory activities, and the findings of measurements, analyses and evaluations.

The overall functional guidelines for EMoS and the steps for implementing it are shown in **diagram 5.2-1**, and these details will be discussed below.

As stated above while describing the functions and tasks of the monitoring system, it comprises a number of elements and institutions, which gather information on environmental impacts of human activities and evaluate them. The following covers the most important, complicated component of the system, which involves monitoring of physical and chemical processes, and the respective laboratory evaluations.

DIAGRAM 5.2-1
THE MONITORING SYSTEM

Task:

Registration and acquisition of data by

- ☼ recording measured data
- ☼ observations
- ☼ monitoring
- ☼ surveys

Steps to a monitoring system

1. **Definition and delimitation of the investigation**

   Analysis of environmental situation ⇒ definition of measured data ⇒ definition of investigation area

   e.g.: environmental pollution due to mineral oil exploration ⇒ list of all media and hazardous substances to be measured ⇒ delimitation of the investigation area and neighbouring areas

2. **Finalizing measured data and specification of measurement systems**

   e.g.: sampling, on-line measurement system, census, medical investigations

3. **Specification of tasks and accountabilities of the departments and institutions involved in the monitoring system**

   e.g.: MAG, MEM, EPN, CEEA, UPA, CONAIE

4. **Implementation of monitoring system**
   - ☼ priority list of implementation steps
   - ☼ specification and implementation of centres of development to provide impetus to system development

The objectives of the present Environmental Monitoring System, in greater detail, may be grouped under two main aspects:

- Study of the particular features of a given habitat, where a certain type of industrial facilities are going to be established.

  Here it is necessary, first of all, to choose the most suitable site for the kind of facilities to be established. This knowledge will doubtlessly help in designing the facilities so as to reduce or mitigate potential pollution. This is the case of predictive studies in which "site selection theory" (also known as "placement studies") are fully applicable, and must be taken into account especially for energy-related facilities.

  Each type of industry to be established has its own features. Therefore, these studies must be carried out during the different phases: in the petroleum and mining industry it is necessary to have on hand the "baseline studies", as a pre-requisite or co-requisite for the relevant legal documents. In the numerous laws currently in effect, the extraction permit or authorization to begin activities for an industry is invalidated; what is required are the subsequent studies, which are known in the business as effluent "monitoring".

- The objective can also involve evaluating the impacts caused by effluents that did not comply with the relevant specifications, and make it necessary to evaluate impacts; or it may have to do with establishing whether it is necessary to evaluate the impacts of any changes made; in other words, the purpose is to establish whether the change made is the direct consequence of a project or of a given industrial activity.

Therefore, the tasks of a monitoring program may be oriented toward:

- Characterization of the status of the environment (water, air, soil, biota)
- Characterization of wastes (liquid, solid or gaseous) to be discharged into the environment
- Quantification of the amount of pollutants existing in the environment
- Determination of how pollutants are distributed and persist in the air, water, soil and biota
- Determination of the effects of pollutants on humans and their environment.

It is logical to think that carrying out these activities may contribute to the following:

- Identifying, in a timely fashion, dangerous circumstances or trends before it is too late to control or mitigate their effects or impacts.
- Data obtained continuously over time can help expand knowledge about impacts, facilitate prediction thereof, or clarify possible trends that could become irreversible.

To complement the above tasks, it is possible to indicate that implementation of the monitoring plan may comprise the following phases:

- **Knowledge of the area**

The following criteria must be considered:

- Definition of reference stations, i.e. places where no impacts are expected to occur
- Definition/location of control points, where impacts are anticipated
- Sampling activities must begin, as already indicated, during the pre-operation period, and continue during the operational stage.
- Identification of potential pollutants and the impacts on the habitat by each.
- Selection of variables to be monitored continually.
- Setting of levels of the likelihood for impacts to occur, including risk analysis.
- Use of appropriate valuation techniques, frequencies, number of stations, samples and period of time in which the monitoring plan should be carried out.

This should also include the precautions to be observed in handling the samplers to avoid contamination problems that would invalidate the samples taken, as well as how to preserve samples and transport them, and how to deliver them to laboratories.

- Data that are obtained must be treated with the appropriate statistical tools in order to produce the most ample and reliable information possible.

- **Design and Analysis Process**

The monitoring plan can be designed by following these steps:

- Define the objectives, including the hypotheses to be tested.
- Conceptually define the space-time-interest-investments concept.
- Collect information on the physical setting, history of the area, climatic patterns, etc.
- Define sampling parameters (volume, time, etc.) and/or field measurements to be made.
- Develop a quality control and quality assurance program for all phases of the study.
- Examine data from previous studies or baseline studies to correlate with data that is obtained.
- Design sampling campaigns and procedures for sample analysis that will produce representative data.
- Determine staffing, equipment and other needs, as well as the relevant logistics for carrying out the proposed work.

- Conduct the study according to the objectives and plans for sampling and quality control that have been set forth
- Summarize and statistically analyze data in terms of standards set by the regulatory entity and evaluate hypotheses on this basis.
- Evaluate whether the objectives have been achieved.

- Preparation of a Sampling Campaign

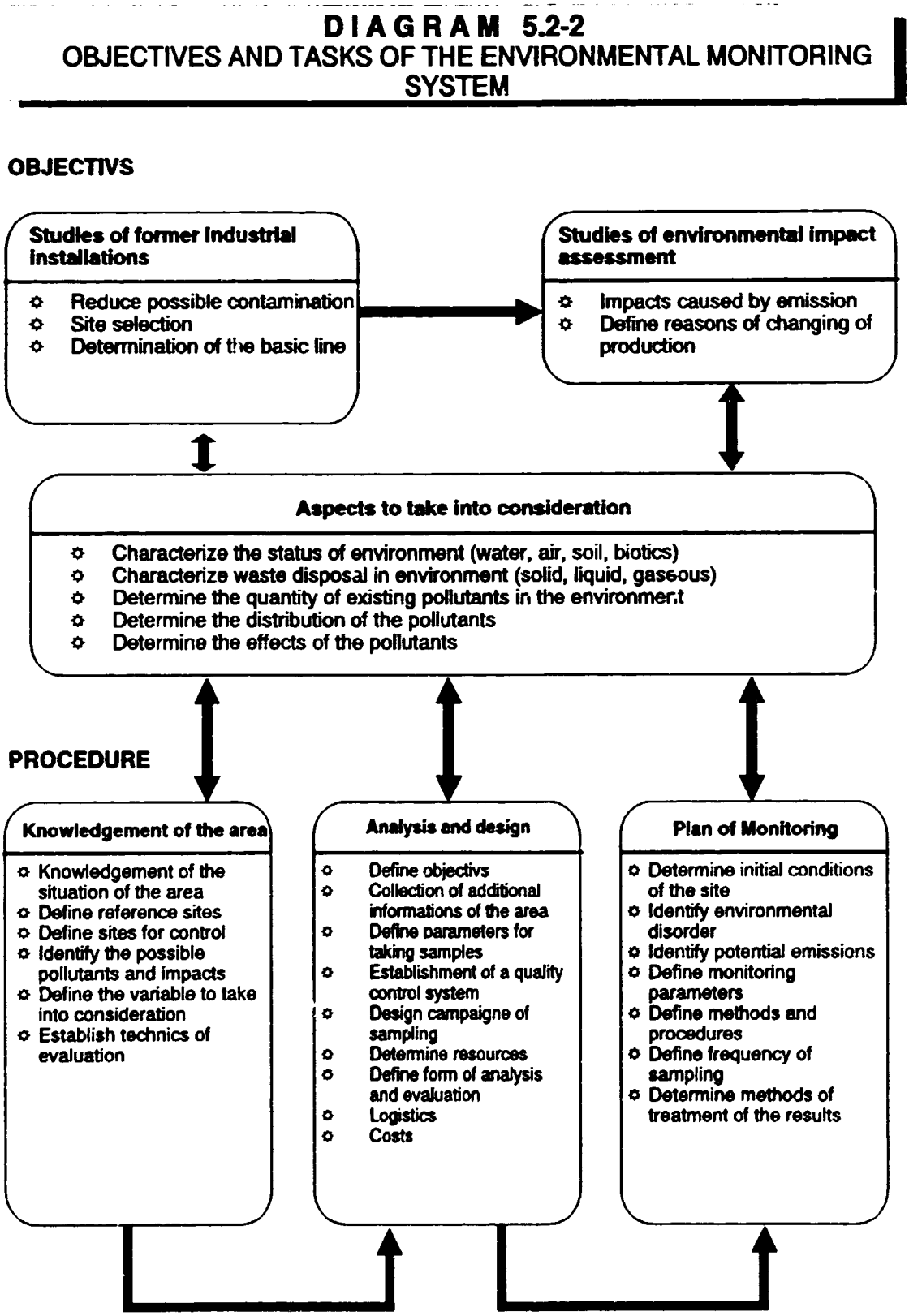
This monitoring campaign may be prepared on the following basis:

- Determination of initial conditions of the status of environmental components to be considered (water, soil, air) on the site(s) where the work is to be done.
- Identification of environmental alterations and pollutant entities, whether permanent or accidental.
- Identification of potential effluents from environmental alterations and pollution (permanent or accidental)
- Definition of the parameters to be monitored
- Definition of monitoring methods and procedures
- Definition of the periodicity of sampling
- Determination of methods for treatment of the results.

Accordingly, it is complex to design a monitoring plan, since new factors must be taken into account and it is necessary now to define their components.

Diagram 5.2-2 shows the sequence and inter-relationships among the objectives, tasks and phases of the monitoring plan, as outlined in this section.

DIAGRAM 5.2-2
OBJECTIVES AND TASKS OF THE ENVIRONMENTAL MONITORING SYSTEM



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5.2.2 Components of an Environmental Monitoring System

Monitoring of the chemical and physical impacts would be geared toward getting to know a habitat or evaluating the damage and effects that could be produced by pollutants that could be spread through the environment (atmosphere, water resources and soil). There is continual interaction among them and living beings and, therefore, in view of the above, the components required in the monitoring system, in general terms, are shown on the **overall flow chart**, namely:

- **Measurement Equipment and Systems**
  These systems will make it possible to obtain data from measurements made at study sites for the respective analyses. These measurements may reach the data compilation center on-line or through laboratories that are qualified to perform the analyses required at this level, which should have analytical equipment in accordance with their specific functions and tasks. Significant data, suitably screened, shall be transmitted to the database that is defined as part of the Environmental Information System (see report 3).

- **Qualified personnel**
  It is very important in making and analyzing measurements to have access to qualified personnel for the tasks of sampling, sample analysis, quality control, and evaluation and delivery of findings. The success of the monitoring will depend on the timeliness and quality of the results obtained.

- **Administrative Organization**
  At the beginning and, obviously, during implementation of the monitoring, it is necessary to have sound organization with the prime functions of supervision, quality control, coordination of measurements and analyses. It will also serve as the pivotal point for determination of standards, norms, regulations and training of personnel from the different laboratories.

5.2.2.1 Measurement Equipment and Systems

Measuring schedule

For sampling to serve the intended purpose, it is necessary to draw up a measuring schedule. This should take into consideration:

- the causes of environmental impacts and
- influences are exerted in which environmental media.

The principal causes of adverse environmental impacts are petroleum, mining- and agroindustry. The most practical approach is firstly to analyse the cumulative parameters in the environmental media air, water and soil.

Should there be any noticeably high values of a particular cumulative parameter, further analysis should be carried out.

In the **petroleum industry** it is necessary to measure the combustion parameters SO_2, NO_x, CO_2, CO and particulates, as well as the cumulative parameters total organic carbon ($C_{org.}$) in the atmosphere. At the same time, the conditions at the instant of sampling are given, like air temperature, atmospheric pressure, wind speed and direction, and air humidity. If high values are determined for $C_{org.}$, aromatic hydrocarbons, chlorinated hydrocarbons and other hydrocarbon species should be measured. In water, firstly the summation parameters total organic halogens (TOX), total organic carbon (TOC), dissolved organic carbon (DOC), biological oxygen demand (BOD) and chemical oxygen demand (COD) shouid be measured. Associated parameters are temperature, conductivity, suspended particulate matter (SBM), pH and oxygen content. Furthermore, the content of anions and cations should be measured as well as, in drinking water, the levels of bacteria and parasites' eggs should be determined. This serves the purpose of utilising the water as drinking water for the personnel there assigned as well as the surrounding population. If the summation parameters are at a high level, aromatic hydrocarbons, chlorofluoro hydrocarbons and long-chain hydrocarbons as well the variation of oxygen concentration over 24 hours should be measured. Falling under soil analysis are water content, water capacity, pH, sulphur content as well the sum of the hydrocarbons. Required flanking measurements are determination of grain size and of temperature. For high measured levels, like for air and soil, hydrocarbons should be determined individually.

In the **mining industry** due to the fact that it need power-generation with gasoline-motors, the combustion parameters quoted above as well as heavy metals in the atmosphere should be measured. Also to be included are the flanking parameters as given above. In water, the above quoted summation parameters, flanking parameters as well as those heavy metals which could be flushed from the soil as well as by using heavy metals in mining (e.g. mercury in gold-mining) could be measured. In drinking water, for hygienic reasons the contents of bacteria and parasites' eggs should be determined. In the soil, the heavy metals as well as the flanking parameters quoted above should be determined.

In the **agroindustry** the contents of pesticides in use in the atmosphere should be determined. The above quoted flanking parameters will also be measured. In water, the above quoted summation parameters, anions, cations, heavy metals as well as the flanking parameters should be determined. For hygienic reasons, where used as drinking water, the content of bacteria and parasites' eggs should be determined. In the soil, anions, cations, heavy metals as well the flanking parameters given above should be measured. To the extent required, measurements should be made of the pesticides in use. The plants growing in the soils in question which are intended for human consumption, should be investigated for the presence of parasites' eggs.

Equipment

- Equipment to monitor air quality

  - sampling (ground level concentration of pollutants and pollutant emissions)
  - chemical analysis (organic and inorganic pollutants, e.g. NO_x, SO_2, CO_2, O_2, CO)
  - investigation of meteorological and physical conditions (wind direction, wind speed, temperature, humidity, air pressure, suspended dust, particulates)
  - mobile sampling equipment in order to determine organic and inorganic gases pollutants as well as suspended dust
  - determination of emission situation:
    - setting up a dust measuring system
    - gas analyses for sampling equipment for heavy metals and organic substances

- Equipment to monitor water quality

  - sampling (at various depths, sediment)
  - chemical analyses (inorganic and organic parameters)
  - physical investigations (temperature, turbidity, pH, etc.)
  - biological investigations (bacteria, flora, fauna)

  Included is field sampling equipment and analysis possibilities as well as facilities for sample transportation and laboratory analyses.

- Equipment to monitor soil quality

  - sampling (at various depth, soil, soil air, groundwater)
  - physical investigation (water-holding capacity, pH, grain size)
  - chemical analyses (nutrients and pollutants)

Sampling

Sampling is undertaken using buses equipped as mobile measuring stations. These shall meet the requirements resulting from the nature of the topography. As a rule, four-wheel drive vehicles will be needed.

For the measurement of ground-level concentrations of air pollutants, in a first step two, for water sampling and analysis likewise two, and for soil sampling one measuring bus(es) should be used.

The air quality monitoring buses should contain:

- a weather station for measurement of
  . temperature

- atmospheric pressure
- wind direction
- wind speed
- 10 m high mast.

- sampling equipment for measuring
  - suspended dust
  - gases
  - heavy metals
  - organic pollutants.

The buses should equipped with accumulators for energy supply in order to ensure that the measuring equipment can be operated and that no exhaust gases from power sources in the measuring bus will be included.

The water monitoring bus should contain the following equipment:

- Equipment for sampling water and sediments at various depths
- Equipment for measuring physical and chemical parameters like
  - temperature
  - pH
  - conductivity
  - oxygen
  - phosphate
  - ammonium
  - nitrite
  - nitrate
  - chloride

A cooling facility should be provided in the bus, so that the samples can be transported cooled or frozen to the laboratory.

The bus for soil sampling should be equipped with an appropriate drilling unit, capable of reaching if needed depths down to 10 m (depending on the nature of the soil). These drilling units should be driven hydraulically, and for this reason the vehicle must be equipped with an appropriate power supply.

Mostly analysis will be performed in the laboratory. Because, however, various parameters become modified following sampling, these will have to be measured directly in the measuring bus. **Table 2.3-1** shows which parameters will be analysed in the field in the measuring vehicle and which in the laboratory, as well as those flanking measurements taken routinely and if required.

Parameter	Preparation					
	Air		Water		Soil	
Physical investigation						
Temperature	m	R	m	R	m	R
Conductivity	-	R	m	R	L	R
Grain size	-	-	-	-	L	i.r.
Dust	L	R	-	-	-	-
Atmosphere pressure	m	R	-	-	-	-
Wind direction	m	R				
Wind speed	m	R	-	-	-	-
Water content	-	-	-	-	L	R
SPM	-	-	L	-	-	-
Humidity	m/L	R	-	R	-	-
Water capacity	-	-	-	-	L	i.r.
Chemical investigation						
pH	-	-	m	R	L	R
O_2/O_2 24 h	m	i.r.	m	R/i.r.	-	i.r.
NO_x, SO_2, CO, CO_2, O_3	m	R	-	-	-	-
Anions/Cations	L	i.r.	m	R	L	i.r.
TOX	-	-	L	R	I	i.r.
TOC/Corg	L	R	L	R	L	R
DOC	-	-	L	R	L	R
BOD	-	-	m	R	-	-
COD	-	-	L	R	-	-
Heavy metals	L	i.r.	L	i.r.	L	i.r.
Aromatic hydrocarbons	L	i.r.	L	i.r.	L	i.r.
CFCs	L	i.r.	L	i.r.	L	i.r.
Other hydrocarbons	L	i.r.	L	i.r.	L	i.r.
Biological investigation						
Bacteria	L	i.r.	L	R	-	-
Parasite eggs	-	-	L	R	L	i.r.

m: mobile measuring vehicles
L: laboratory
R: routine
i.r.: if required

Table 5.2-3: Parameters to be analysed in the laboratory or in the mobile measuring vehicles and flanking measurements performed routinely or if required.

Measurement Systems

The above equipment will be one component of an entire network of laboratories and different measurement systems, which are described below, together with the measurements, parameters and other aspects to be taken into account in each case.

Measurement, acquisition and storage of data concerning major aspects of the environment may be done manually (continually or periodically) or automatically (continually) in such a way as to guarantee the quality of measurements, through constant, secure control.

Manual gathering of major environment data will be done through off-line processes in accordance with local and regional conditions. This means that the data obtained will be conveyed via documents or magnetic media to the node of the network that will compile, store and process the information.

Measurement systems will be suitably distributed around the study site, as a function of the possible areas of emission and pollution deposition. These systems may be stationary or mobile. This off-line procedure will be used for individual testing, measurements with electronic equipment (e.g. spectrometers, noise measurement instruments), measurement of biological indicators (e.g. types of plants and herbs) and to obtain data through observations and conducting surveys.

Systems that work automatically and continuously are called on-line systems. They can report specific physical and chemical parameters, such as conductivity, pH values, oxygen content, temperature and major pollutant gases (SO_2, NO_x, and CO) contained in the environmental components (air, water).

Operation of on-line systems is controlled by a control and command center, which is linked to sensors through a data transmission system. Data is generally stored at the center as it arrives from the network and, should something unusual occur, such as disturbances of service or detection of higher than normal levels of pollution, an alarm is activated at the decision-making site.

Storage of data from measurement systems that have been initially evaluated is done in central or distributed systems, according to the needs, criteria and conditions that have been established for each event.

Additionally, evaluations may be made automatically, using special calculation routines that can perform pre-established analyses.

Laboratory analysis

For laboratory analysis, certain sample preparation equipment as well corresponding analysis equipment is required. **Table 5.2-4** shows the various parameters with appropriate sample preparation and analysis equipment.

Parameter	Required equipment	Preparation		
		Air	Water	Soil
Physical investigation				
Temperature	Thermometer	-	-	-
Conductivity	Conductivity meter		-	Screens
Grain size	Screening sieves			
Dust	Dust measuring equipment (filters, cascade)	Aerated temperature-controlled cupboard		
Atmosphere pressure	Barometer		-	
Wind direction	Wind direction indicator		-	
Wind speed	Anemometer		-	
Water content	Drying cupboard			
SPM				
Humidity	Hygrometer, Drying cupboard	-	-	-
Water capacity	Laboratory vessels			-
Chemical investigation				
pH	pH meter		-	-
O_2/O_2 24 h	Oxygen electrode			
NO_x, SO_2, CO, CO_2, O_3	1-line monitoring instruments (gas analyser)	-		
Anions/Cations	Photometer	Glass equipment		
TOX	Glase equipment, IR detector	-	-	-
TOC/Corg	Glass equipment, Saprometer/FID	-	-	-
DOC	Glass equipment			
BOD	Glass equipment/drying cupboard	-	-	-
COD	Glass equipment/drying cupboard	-	-	-

Parameter	Required equipment	Preparation		
		Air	Water	Soil
Heavy metals	ICP, AAS	Pressurized scruple inspection chamber, glass equipment	Filter	Grinding mill, pressurized sample inspection chamber, glass equipment
Aromatic hydrocarbons	HPLC with fluorescence and MS GC with ECD and FID	Rotary evaporator	Rotary evaporator	Rotary evaporator, Soxlett
CFCs	GC with ECD and FID	Rotary evaporator, glass equipment, filtration equipment	Rotary evaporator, glass equipment, filtration equipment	Rotary evaporator, Soxlett, glass equipment, filtration equipment
Other hydrocarbons	GC with ECD and FID	Rotary evaporator, glass equipment, filtration equipment	Rotary evaporator, glass equipment, filtration equipment	Rotary evaporator, Soxlett, glass equipment, filtration equipment
Biological investigation				
Bacteria	Diverse items of equipment, incubator cupboard		-	-
Parasite eggs	Diverse items of equipment, microskope		-	-

Table 5.2-4: Required analysis equipment and associated equipment for sample preparation

5.2.2.2 Skilled personnel

Considering that the "Central Organization" established for the environmental management system's operational aspects will rely on those entities that have well-established laboratories, the system will need, in general terms, highly qualified personnel to perform the following tasks:

- Oversee and make sure that agreed sampling campaigns are carried out according to pre-established designs.
- Ensure that quality control is observed at all times, in both field operations and laboratory work.
- Be in a position to appraise laboratories and their personnel.

- Be able to rate the quality of laboratories.
- Be in a position to establish and direct training plans for laboratory personnel.
- Make sure that data are delivered punctually, verifiable, and according to stated processing procedures.
- Review, structure and update monitoring standards, norms and procedures according to international regulations.
- Report to the corresponding authorities the outcomes of these data, and the evaluation of effects that could be obtained over time or contingencies that could occur.

Personnel

Two persons should be assigned to manning each measuring vehicle for sampling. These should be trained as chemical technicians.

Laboratory analysis should be conducted by chemists and suitably qualified assistants. Staff as follows are required:

- 1 inorganic chemist for inorganic analysis
- 2 assistants for inorganic analysis
- 1 organic chemist for HPLC
- 2 assistants for HPLC
- 1 organic chemist or analytical chemist for the GC
- 2 assistants for the GC
- 1 chemist and 2 assistants additional

5.2.2.3 Organization

Organization for the EMoS must have a well-grounded infrastructure with a few highly-qualified centers suited to the monitoring functions that they will be assigned, as the pivotal points for performance of the tasks outlined in the preceding section. These centers must be strategically located by zones or regions and in a position to provide the necessary personnel and equipment for monitoring.

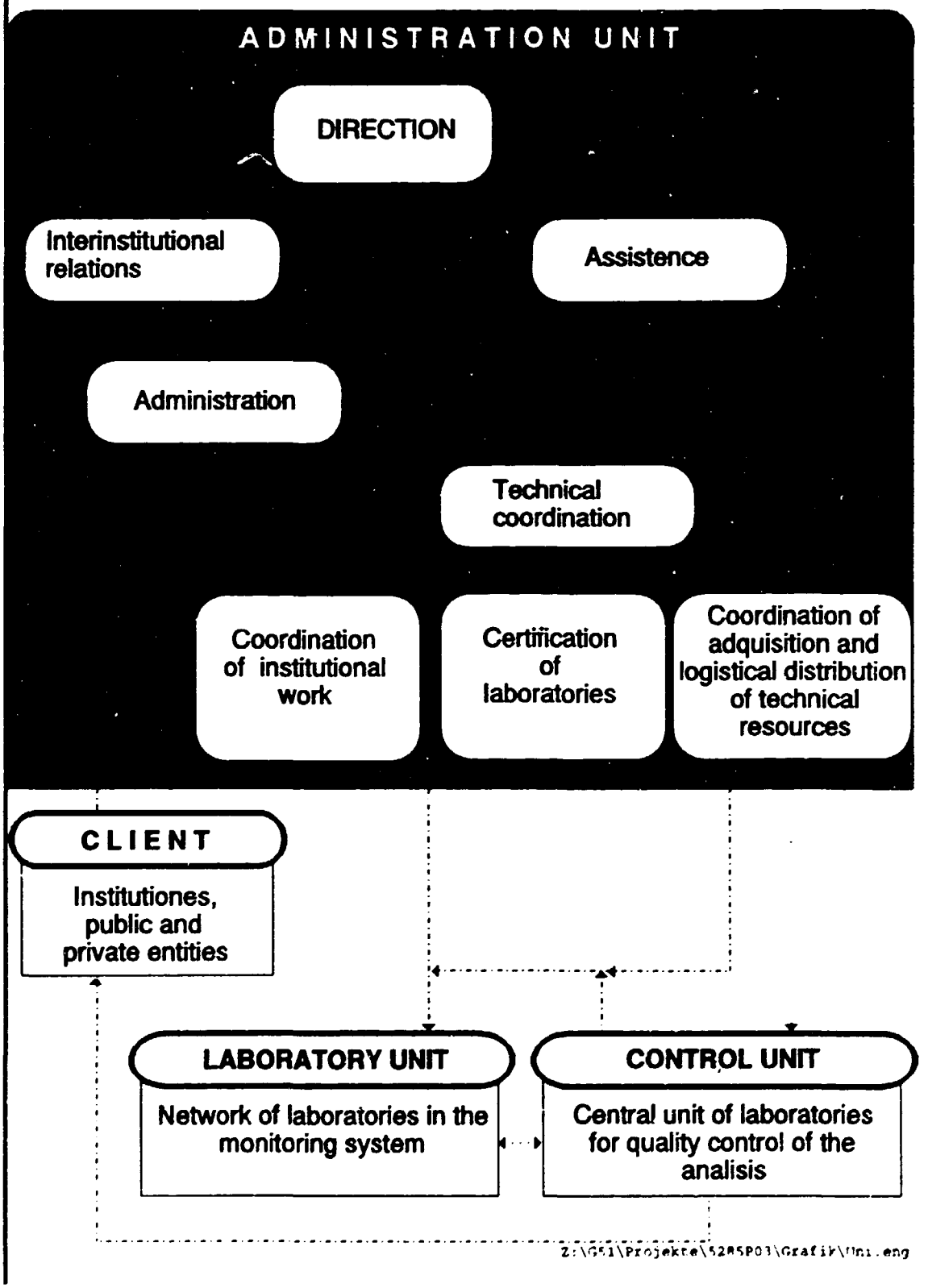
In the case of Ecuador, and considering the national data transmission network explained in report 3, Environmental Information System, it will be most suitable for the future to have a center in Quito, Guayaquil and Cuenca. Each will be backstopped by laboratories that are qualified to make specific analyses and thus to structure a network of laboratories, that will work under a single system of standards, norms and procedures.

Obviously, the process of structuring this type of organization must be undertaken gradually, as the foundation is laid for a center in physical infrastructure and personnel. A detailed analysis of the most suitable organization will be made during the implementation of the initial pilot plan proposed in section 5.2.4.

It is very important to point out that the data and analyses carried out in the monitoring process must be highly reliable, accurate and timely, which can be achieved only with leading-edge technology, in equipment and personnel. This is the only way that analyses may be made that will be of value for accurate appraisal of environmental impacts, their consequences and the measures to be taken to control and mitigate such impacts, as well as to structure legal policies and aspects.

The following scheme is proposed to begin the activities to be undertaken:

DIAGRAM 5.2-4:
STRUCTURE OF THE ADMINISTRATION OF THE SIMOA AND FLOW CHART



5.2.3 Current Situation

Before outlining the details of the procedure adopted to establish the current situation, we feel that it will be advisable to present, first of all, the prior analysis used as a basis for the successive implementation of a complete monitoring system.

5.2.3.1 Prior analysis for the Implementation of a Monitoring System

To implement a monitoring system serving the entire country, as presented in **diagram 5.2-4**, a limited economic framework is foreseen for the pilot plan implementation phase, which will not allow the system as a whole to be structured from the very beginning.

For this reason, the most suitable alternative is presented first of all of creating a system of laboratories under the following conditions:

- Availability of limited economic resources to address the deficit in technology and qualified personnel required by a monitoring system in Ecuador.

- Rapid implementation of an initial system of laboratories to cover the greatest possible number of chemical and physical environmental impacts caused in Ecuador, using existing technical and human resources and, at the same time, avoiding redundance in resource use.

- Establishment of the necessary mechanisms for subsequent autonomous development of the initial system until a monitoring system is completed covering the entire country, on the basis of its own funding, comprising a network of strategically located laboratories according to the zone and the problem to be monitored, taking into account existing resources.

- Establishment of the foundations in laboratory capacity to develop a central quality control system that can provide leading-edge technology in terms of personnel and equipment. This means that the system must be one step ahead of the rest of the system's laboratories in its development.

- Establishment and maintenance of available capacity in additional laboratories to cope with peak situations.

In order to address, insofar as possible, these conditions in the structure and implementation of the system, and to firmly ground its autonomous development, part of which will occur simultaneously and part successively, the following steps will be followed:

1. Structure and develop a system of laboratories that will become the core, considering the capacity of laboratories in Quito (LABORATORY UNIT).

   Laboratories belonging to the system, under the consideration of available capacity, will be so structured that they can undertake all tasks concerning monitoring as required by the different environmental impacts occurring in Ecuador. Peak workloads that arise can be resolved by turning specific tasks (additional tests, partial analyses, etc.) over to other laboratories in Quito and the rest of the country, according to their capacity and the work to be performed.

2. Structure the organization of monitoring system laboratories (ADMINISTRATION UNIT).

   The functions of this organization include coordinating the tasks to be performed by laboratories, guaranteeing suitable, effective advisory support in technical, staffing and financial matters, coordinating procurement and distribution of technical resources, receiving the technical and human quality from all laboratories in the system, through coordination of quality control activities and the issuance of a laboratory certification through a suitable procedure.

3. Structure a national monitoring system, locating laboratories oriented toward existing problems (LABORATORY UNIT).

   Another of the organization's tasks will be to maintain the capacity of all additional laboratories throughout the country and support their development in regard to equipment and staff training according to the tasks with which each is entrusted. This task would be performed with support from the central laboratory system. Subsequently, as the system expands, the tasks initially performed by the central system will be turned over successively to other laboratories distributed throughout the country.

4. Develop a Quality Control System (CONTROL UNIT).

   With the participation of laboratories located throughout the country, the monitoring system will have the necessary redundance in technical and human resources. This will be necessary so that the laboratories comprising the central group may be gradually freed from certain tasks in order to make up the quality control laboratory system. As already explained above, those tasks will be undertaken by the other laboratories throughout the country, in accordance with the location and capacity of each laboratory.

The initial tasks of the system's central group of core laboratories will be transferred in order to free them for the tasks corresponding to the quality control system that they will undertake.

Since the central laboratory system will have participated in developing, structuring and implementing the national monitoring system, they will have the necessary headstart, in experience and expertise, in regard to the other laboratories, which will qualify them for their role in quality control.

At this point, the central laboratory system can also take back specific tasks within the monitoring system, whenever peak workloads arise.

5.2.3.2 Description of the Procedure to Evaluation the Present Situation

The process described to implement a monitoring system that will depend on a survey and analysis of the current situation, but does not require a detailed inventory of all laboratories in Ecuador for this first phase.

The primary objective of the procedure outlined below in summary is to provide an overview of the quality and capacity of the central laboratories. On the basis of this information, it will be possible to activate these laboratories' capacity using available means which, at a minimal financial and logistical cost, can satisfy the requirements imposed by environmental monitoring in order to gather, analyze and deal with environmental impacts occurring throughout the country, which are specifically described in chapter 3 and thereafter.

The following steps have been taken to establish the laboratories that will initially take part in executing the pilot plan to implement the Monitoring System for Ecuador's Amazon Region, in order to be in a position to provide this service initially for the entire country, and to serve as a foundation for any future expansion, depending on the region and type of monitoring to be performed, distributing functions and activities according to existing environmental problems in each region or zone, to be undertaken by other strategically located laboratories, with the required personnel and equipment:

Laboratories surveyed
At the beginning of this study, on the basis of a list of institutions provided by the CAAM, an extensive survey was conducted of the institutions deemed the most important in the country.

A total of 28 institutions were queried, out of which 12 have a total of 20 specialized laboratory units. They were asked about the technical and human resource capacity of each laboratory using a specific form. **Attachment 5.2-1** presents this form **attachment 5.2-2** contains the forms as completed.

Ten of the 12 institutions surveyed (totalling 19 laboratories) replied partially to this survey (see **table 5.2-5**). Surveyors insisted by telephone, but it proved impossible to elicit any further responses.

Below, **table 5.2-5** presents the institutions that received the survey form with questions about the tasks and structure of their respective laboratories.

INSTITUTION SURVEYED	LABORATORIES AVAILABLE	INSTITUTION REPLYING	LABORATORIES IN EACH
CEDEGE			
CEEA	2	X	2
C.I.P.A.			
CLIRSEN		X	
CONADE			
CONFENIAE			
CREA			
CRM			
EPN	3	X	2
INAMHI	1		
INEC			
INECEL	1	X	1
INEFAN			
INERHI			
INIAP			
INOCAR	5	X	5
MAG	3	X	3
MBS			
MECD			
MEM	2	X	1
M.I.C.I.P. (PRNC)			
MSP			
PETROECUADOR	5		
PREDESUR			
PRONAREG			
SSA (TEOS)	1	X	1
UPA	1	X	1
UTP LOJA	3	X	3

Table 5.2-5: Presentation of Institutions and Laboratories Surveyed

Meetings held with executive personnel of chosen institutions

In addition to the surveys, meetings were held with the management of the departments or units with tasks related to environmental protection in the ministries and certain major public institutions that partly report to ministries.

Fundamentally, these meetings addressed issues regarding structures for environmental management in Ecuador and the relationship of each department or public institution within this structure, in addition to the functions that they perform in an executive capacity.

Moreover, meetings made it possible to complete certain information that had been incomplete or unclear on the survey forms from these institutions and their laboratories. The following list gives the ministries and institutions (and contact persons) who were kind enough to talk with us.

ECUADOR

AME	(G. Tapia Nicola, Arq. M. Buendia G.)
Metropolitan District of Quito,	
Environmental Dept.	(Ing. L.A. Gomez MSc.)
EMaseo	(Ing. J. Alvarez T.)
FUNDACION NATURA	(Dr. R. Troya)
San Francisco de Quito University	(Dr. rer. nat. G. Reck)
PETROECUADOR, Coordination of the Seventh Round	(Ing. W. Pástor M.)
PETROECUADOR-UPA	(Ing. P. Maldonado, Dr. F. Chauvín, Dr. W. Mena)
PETROPRODUCCION	(Ing. J. Guerra, Ing. . Medardo Vargas)
Palmoriente	(R. Ordóñez, Ing. M. Orellana)
EPN	
Rector of the EPN	Ing. Alfonso Espinosa
Environmental Consultant	Ing. Efrén Galárraga
CEEA	(Ing. C. Almeida, R. Merino, F. Villalba)
CFN	(Ing. Jorge Jurado)
CONUEP	(Dra. Vizuete)
IEOS	(Dr. Fabián Yánez, Ing. Rafael Ribadeneira)
CLIRSEN	(Major Ing. G. Bustos)
ILDIS	(Peter Schellschmidt)
INERHI	(Ing. J. Araujo, Ing. C. Torres, Ing. R. Armijos, Ing. E. Aragundi)
INAMHI	(Ing. G. Cisneros)

MEM	(Dr. M. Ramos, Dra. L. Solórzano, Ing. W. Rivadeneira, Ing. Alejandro Bodero Quintero)
MAG, National Livestock Bureau and Under Secretariat of the Highlands and Amazon Regions	(Dr. C. Burneo, Dr. C. Narváez, Ing. Arivaldo)
MAG, Animal Health Program	(Ing. Rafael Poveda, Inga. M. Bolaños, Ing. G. Robalino)
M.I.C.I.P., Under-Secretariat of Industry	(Econ. R. Segasti L.)
M.I.C.I.P., National Institute of Fisheries	(Dr. F. Ormaza González)
GTZ, Forestry Policy Dept.	(Dr. U. Vollmer, T. Bünning Kropp)
CAAM	(Ing. L. Carrera de la Torre, Dr. A. Brack Egg, Ing. A. Vallejo, Dr. R. Troya).
CENAIM (National Aquaculture and Marine Research Center)	(Dr. J. Calderón)

BOLIVIA

UNIDO	(Gabriela Avila)
Ministry of the Treasury and Economic Development, National Secretariat of Mining	(Ing. G. Barrientos C.),
Ministry of Sustainable Development and the Environment	(Ing. M. Sc. Waldo P. Vargas Ballester)

PERU

ACT	(Dr. R. Samanez, C. Villacorte A.)
UNIDO	(E. Pretzer-Junek)
INRENA (Natural Resource Institute)	(Ing. O. Cuya, Ing. M. Cabrera)
PETROPERU	(Ing. M. L. Olle, Ing. V. León)

Evaluation of studies regarding the status of these laboratories

There have been very few analyses made of the status and conditions of laboratories in Ecuador that could serve as a basis for describing and structuring a Monitoring System for the country. There is almost a total lack of complete, reliable information on the actual capacity of laboratories in terms of their equipment (inventory) and staffing. There is also no certification of the efficien y of laboratories in Ecuador. Contradictions in statements by experts, data obtained directly by the consultant, and information in studies that have been found make it evident that these studies must be reviewed and brought up to date.

A catalog of universities in Ecuador containing, among other aspects, information on available laboratories will be published, according to CONUEP, possibly within 2 to 3 months. At present, CONUEP does not have any material regarding the study that could be used.

An evaluation of the respective literature that was provided for the consultants' review shows that it is not sufficient to establish the actual existing capacity to be used in a future monitoring system. Studies used for this purpose are listed below:

- Reports on "Monitoring of Environmental Pollution by Petroleum and Mining Activities in Ecuador" (Ing. W. Ribadeneira) /39/;
- "Study of Environmental Pollution Monitoring in Ecuador" (R. Trejos de Suéscum) /45/.
- Information published by Petroecuador (Catalog of Specialized Technical Services, Vol. I & Vol. II) /49/, which may be considered as one of the best studies regarding laboratories for the oil and gas field.

Discussions with consulting firms

In order to complete and verify the information obtained through surveys, discussions with management and studies, consulting firms working in the field of environmental monitoring and studies were also queried.

The aim of these queries was to evaluate these firms' experience in practice, regarding the use of laboratory services in Ecuador, in order to use this additional information to make the actual choice of laboratories that can initially form the core of the system.

The following firms were consulted for this purpose: ECUAMBIENTE, GUPICEMA, RICHTISARM, ASTEC and Maxus Ecuador Inc., which has carried out the most extensive baseline studies on pollution.

Many members of these firms have studied in Europe and North America and also have international consulting experience.

Visits to laboratories

PETROECUADOR and its affiliate companies were visited, as well as several mining companies, which provided quite a clear view of the availability of laboratories in the Amazon Region and in Quito.

- CEEA
- EPN
- CODIGEM
- MAG Tumbaco
- Central University
- PETROECUADOR / PETRO PRODUCCION

The data and information gathered are summarized in **attachment 5.2-3 (1)**.

5.2.3.3 Description of the Present Situation

Taking into account the information obtained as explained in the preceding section, the following is evident:

- Information provided is vague; for example, "water analyses", without indicating what kinds of analyses are performed. This information has been completed through visits to the laboratories and individual interviews with the professionals working there.

- Several laboratories are currently working in physical and chemical analysis of water, and there is great demand for their services. Only one of them committed errors in the data obtained by traditional methods, when 3 or 4 parallel samples were subjected to the same analysis (Central University Chemical Science Department); this laboratory also allows the submission of 50 samples to determine 20-25 parameters, providing services are requested far enough in advance. There is only one laboratory that can provide data on "Total Organic Carbon" (TOC); only one laboratory provides halomethane testing, which is of interest for drinking water (the Department of Civil Engineering, EPN); and only two make total hydrocarbon analyses (EPN & DGA).

- There are several laboratories with instruments (Atomic Absorption AAS), for metal analysis; only two of them have a graphite kiln coupling, which provides 10-100 times greater sensitivity and is quite useful to analyze certain metals such as Pb, Hg and semimetal Se. Only one laboratory had a sequential plasma analyzer (CPS), CODIGEM in its Chillogallo laboratories, which makes "sweep techniques" for simultaneous analysis of several elements possible; this equipment allows analysis of 10-12 elements, with two programming options; because of the time that it has been in operation, it breaks down with some frequency.

- It is regrettable to state that, for analysis of metals in organic matrices, the traditional method is still used whereby the organic material is burned away at high temperatures. This procedure has been considered absurd for over 20 years (US Bureau of Standards 1972). Available literature presents only one case where acid disaggregation has been used to analyze metal traces in human hair (EPN).

- The version of this equipment for analysis of trace elements in the environment costs more than the one used for analysis in the cement industry.

- For all practical purposes, there is no possibility in Ecuador to determine chemical elements in different states of oxidation, and these practices are not covered in environmental studies. The Central University School of Chemical Science has an antiquated version of polarography, which

cannot work in inert atmospheres. No reference has been found, either, of molecular characterization for inorganic substances and environmental chemistry calls for not only characterization of the chemical element *per se*, but its chemical composition and molecular structure.

- There is no characterization of hydrocarbon compounds in Ecuador; all such analyses are done abroad. The only tests performed in this regard are: TOC, Greases and Oils, and Total Hydrocarbons. This is imperative, due to the highly varied toxicity of these compounds. During 1994, the CEEA has provided techniques for analysis of cyclical hydrocarbons (as many as 12) and polycyclical hydrocarbons (up to 7) by GC techniques. It is indispensable for Ecuador to acquire the capacity to perform mass spectroscopy. Eckenfelder Inc., in their baseline study for Maxus, found 68 different hydrocarbon-based organic compounds, as products of evaporation and combustion, in air samples at one of the sampling sites (1971).

- Consulting firms that have been interviewed and which work in sanitation and petroleum engineering send their water analyses (physical and chemical) to the following laboratories: SSA (Ministry of Urban Development and Housing), Departments of Civil Engineering (EPN, UC), School of Chemical Science (U.C). For metal analyses: CEEA and EPN. For sediment analysis (CEEA). Companies working in mining send their samples to CODIGEM. Mining and petroleum companies in general feel that there is no adequate quality control for these analysis; for this reason, foreign firms send their samples abroad when the analyses are considered "delicate".

- Regarding air pollution, for all practical purposes there is no infrastructure at all. Perhaps the Bureau of Hygiene and the Environment of the Municipality of Quito may be able to cope with air pollution problems in Quito at some point. What little data have been obtained with obsolete equipment have never been correlated with atmospheric parameters. INE provides certain services in regard to furnace temperatures and combustion gases from smokestacks and the former IEOS worked with determination of urban particulate SO_2, NO_x and CO, providing services for several industries.

5.2.3.4 Laboratories Available and their Equipment

FOR ANALYSIS OF WATER RESOURCES

In laboratories that have been observed, there is capacity to perform the following:

- Physical and chemical analysis of water - there are laboratories equipped to carry out the traditional analyses outlined, for example, in the manual on "Standard Methods for the Analysis of Water and Waste Water" (1989): SSA, UC (School of Civil Engineering and Chemical Science and Chemical Engineering), EPN (Civil Engineering), SSA and DGA.

- Metal Trace Analysis - the following laboratories have equipment for atomic absorption spectrometry (AAS): CEEA, EPN, UC (School of Geological, Petroleum and Mining Engineering), PUCE, Institute of National Heritage (IPN), CODIGEM; the EPN and CEEA have graphite kilns; CODIGEM has the country's only equipment for metal trace analysis in water by sequential plasma spectrometry (CPS).

- Other analyses - the presence of total hydrocarbons in water is tested only by the EPN and the DGH (Chillogallo). There is only one private laboratory that reports reliable TOC data.

- The use of "kits" for quick field analysis has made it possible for people with very little experience or academic training to work in this field, which eliminates the possibility of any certainty as to measurements taken.

- For physical and chemical studies of water, only UC accepts from 30 to 50 samples and they will provide results for 20 - 25 different parameters after eight working days.

- No laboratory is equipped to maintain water samples refrigerated/frozen prior to analysis. This means that the samples analyzed by different laboratories using the same techniques often yield very different results.

FOR SOIL POLLUTION STUDIES

- Studies of agrochemicals (pesticides, herbicides, etc) in soil have been made, and there is appropriate equipment for such studies: gas chromatographs (GC) and equipment for high pressure liquid chromatography (HPLC) at the laboratories of MAG in Tumbaco, EPN, UC (School of Chemical Sciences). The most sophisticated equipment and personnel with current research contracts with agencies abroad are found at the CEEA.

- Ecuador does not have either the personnel or the technology to evaluate hydrocarbons in the soil. In 1994, techniques for analysis of cyclical and polycyclical hydrocarbons have been implemented in the CEEA. This is the only entity in Ecuador with this capacity at present. It will be necessary to acquire the technology of gas chromatography associated with mass spectrometry.

There are complete laboratories for physical and chemical analysis of soils in regard to productivity at MAG in Tumbaco, CEEA, Central University (School of Agricultural Science). The reports reviewed on these laboratories reveal very little data on minor element contents. For specific studies of the nitrogen cycle (N-15), water cycle (neutron sprinklers), carbon cycle (carbon-14, but carbon 13 is lacking), potassium cycle (indirect Rb method), the CEEA is the only institution in the country with such equipment and staff trained abroad.

FOR STUDIES OF SEDIMENTS

This type of monitoring is not common practice in Ecuador, and water monitoring is preferred, although this is highly uncertain, especially at the headwaters of rivers, due to meteorological factors. Only two consultants use sediment studies in regard to pollution assessment. They both send their samples to the CEEA. Petroleum companies are already requesting analyses of polycyclical hydrocarbons in sediments, and have approached the CEEA for this technique, in order to ensure optimal quality control.

Study of sediments requires, in addition to elementary analysis by X-RF (sweep techniques), the determination of mineral constituents, which calls for X-ray defraction (X-RD) techniques; this is available at the EPN (School of Geology), UC (School of Geology, et al.), and Institute of Natural Heritage, which has the best equipment, but unused because no personnel is available to operate it. The two Geology Departments named above have the same equipment.

FOR ATMOSPHERIC STUDIES

Ecuador is very poorly equipped to carry out these studies, and this area must be completely reviewed. The corresponding chapter suggests basic fundamental equipment for this purpose. Only one institution has equipment for particulate size determination (CEEA); the equipment at the SSAA (Ministry of Urban Development and Housing) is obsolete.

Existing equipment at the INE must be acquired by other institutions. There is no weather station in Ecuador that can experimentally determine atmospheric diffusion coefficients.

5.2.3.5 Selection of Laboratories

In view of the information obtained, several laboratories can be used for water analysis, both for physical/chemical and bacteriological studies, and for metal content. Initially, these could be suggested:

- Physical and chemical water studies: SSA, UC (School of Chemical Sciences), DGH;
- Metal Analysis: CEEA, EPN, CODIGEM
- Sediment Analysis: CEEA
- Soil Analysis: MAG (Tumbaco), UC (School of Agricultural Science)
- Analysis and Characterization of Cyclical and Polycyclical Hydrocarbons: CEEA
- Analysis of Agrochemicals (pesticides, herbicides, etc.): MAG (Tumbaco) and CEEA (if available)

The table below shows the parameters to be investigated, existing and required analysis equipment, as well as the costs of procurement of the equipment required.

Parameter	Required equipment	Existing equipment	Location	Additions	Costs
Physical investigation					
pH	pH meter	pH	UC, EPN, ESA		•
Temperature	Thermometer				•
Conductivity	Conductivity meter				•
Grain size	Screening sieves				•
Dust	Dust measuring equipment (filters, cascade)	Filters, cascade	SSA, CEEA	6 measuring devices	•
Atmosphere pressure	Barometer				•
Wind direction	Wind direction indicator				•
Wind speed	Anemometer				•
Water content	Drying cupboard Scales				•
Water capacity	Laboratory vessels				
Chemical investigation					
Heavy metals	ICP, AAS	AAS	CEEA, EPN, PUCE, CO-DIGEM, UC	ICP IAAS (flame-type, graphite tubular cell and hybrid system)	113.000
Anions	Ion chromatograph				75.000
TOX	Glass equipment, IR-Detektor	-			75.000
TOC	Glass equipment FID				25.000
BOD	Glass equipment drying cupboard				•
COD	Glass equipment drying cupboard				•
Aromatic hydrocarbons	HPLC with X-ray				•
CFCs	GC with ECD and FID	GC	MAG-Tumbaco CEEA (EPN, UC)	GC with ECD and FID	80.000
Other hydrocarbons	GC with ECD and FIS			GC with ECD and FID	25.000
Gases	1-line monitoring instruments (gas analyser)	Discontinuous chemical analyses	SSA, EPN	3xNO_x, 3xSO_2, 3xO_2, 3xCO_2, 3xCO	s.o.
Biological investigation					45.000
Bacteria	Diverse items of equipment	Diverse items of equipment	UC, SSA	-	not
Parasite eggs	Diverse items of equipment	Diverse items of equipment	ETAPA, EPN	-	avai-
Total					413.000

Table 5.2-6: Existing and required analysis equipment, as well as the costs of procurement of the equipment required

Furthermore, complete monitoring units are advisable. For atmospheric pollution, two air quality buses for mobile deployment should be procured.

For monitoring water pollutants, it is also recommended that two mobile measuring vehicles be procured. These provide the possibility of drawing water samples and quickly analysing these on the spot.

If more elaborate investigations are needed, the central laboratory will be available.

For investigations of contaminated land, likewise the procurement of a measuring bus would lend itself for this purpose, which would then be equipped with various sampling devices. With this it should be possible to take samples at a range of soil depths.

The table below shows the costs of the measuring units, and of any structural measures (furnishing and conversion of a laboratory) as well as the estimated annual costs for consumables and any repairs or replacements of equipment.

Material/equipment	Unit costs	Total costs $-US
Laboratory including air-conditioned room, poisons cabinet, solvents cabinet, scales, etc.	50,000.-	50,000.-
Analysis apparatus Titrimeter, flasks, beakers, coolers, burners, rotary evaporators, etc.	25,000.-	25,000.-
3 Sampling equipments for air, probes, pumps, pressure ganges, dryers, heating, cooling, etc.	12,500.-	37,500.-
2 Pollutant deposition measuring scales, vehicles, equipments	93,500.-	187,000.-
2 Water quality measuring scales, vehicles, equipments	62,500.-	125,000.-
1 Vehicle for sampling soils and contaminated land	75,000.-	75,000.-
Consumables	40,000.-	40,000.-
Contingencies	40,000.-	40,000.-
Total		**579,500.-**

Table 5.2-7: Cost of Meassuring units, furnishing and conversion of laboratories and estimated annual costs for consumables, repairs or replacements

5.2.3.6 Personnel available

With the exception of one professional at the PUCE, 4 professionals at the CEEA and one at the UC (School of Chemical Sciences) who have graduate degrees, the lack personnel with higher-level training who work at chemical laboratories that could be used for environmental studies is quite profound.

Only CEEA personnel has (all) received training abroad. There are also isolated cases at the EPN and UC (School of Chemical Sciences) and the School of Geology, Mining and Petroleum. Certain personnel will have to be trained for work of this nature and in the handling of equipment. Suggestions are presented in this regard, especially for higher-level training, in the corresponding section.

5.2.3.7 Other Matters

The observations made and information obtained reveal that the laboratories operating in Ecuador do not know about or practice sampling and laboratory procedure norms in regard to data-gathering and quality control/assurance. This will have to be remedied as the first step toward future actions. The procedures to be implemented toward this end are suggested in the corresponding chapter.

The laboratories of PETROECUADOR, which have been evaluated in the different affiliate companies, are outfitted specifically for process control applications, and it would be quite difficult and even harmful to their own work to attempt to use them for environmental studies. It is suggested that PETROECUADOR should establish, within the coming 1 to 3 years, suitable laboratories for this purpose, providing proper operating facilities and modern equipment, and above all adequate training for their personnel.

At present, the institutions serving consulting firms and other companies in general keep copies of their reports. PETROECUADOR has a huge data file on water studies and pollutants. This information is not available, and there is no law requiring them to divulge these data or use them. The "monitoring system" to be established, initially for the Amazon Region and, when fully developed, for Ecuador as a whole, will need this legal component that will make it mandatory to supply such data to the system, when it is established.

Quality assurance

In order to ensure that the results of laboratory analysis are reproducable, it is necessary that a quality assurance system be put in place. This requires a central laboratory which dispatches defined samples to various investigation laboratories, where they are investigated quantitatively for the previously defined parameters. If the results of the parameters to be investigated agree with those of the cetnral laboratory, the laboratory can be certified for the analysis concerned.

These ring trials have to be repeated on a routine basis, anproximately every year. As errors could also arise during sampling, ring trials will also have to be conducted of this. These should likewise be organised and controlled from a central laboratory. It is recommended that initially two or three laboratories be equipped in line with the above requirements. These should be in a position to conduct all sampling and analysis reproducibly. In a subsequent step, however, these laboratories should be withdrawn from sampling and analysis for the monitoring system. They should then certify other laboratories for the monitoring system. Certification should be open to all laboratories. The two or three laboratories will then be responsible for organising the ring trials and certification.

5.2.4 Initial design of an Environmental Monitoring System for Ecuador

In the Ecuadorian Amazon Region, three main types of activities are carried out that affect the environment with their wastes or effluents: the industry of the hydrocarbon cycle, mining, and agroindustry. First of all, a monitoring plan could be completely designed for these three activities but - due to their particular characteristics, the different places where they are being pursued, and the varying degree of interest in knowing the characteristics and concentrations of their effluents - it will be necessary to initially monitor them separately. This does not preclude those actions that can be performed jointly, with the same working or reporting mode.

5.2.4.1 General Action Plan

For the above reasons, the following steps are proposed as part of the Initial Implementation Plan to be covered within **1 year:**

Selection of areas or sites where CAAM can work in association with Petroecuador, CODIGEM and PALMORIENTE to define places where work will be done (the assistance of a consultant will be required).

Organization of working groups
Once the working area has been selected, the most satisfactory way of meeting logistical and lodging requirements will be sought to backstop fieldwork. Personnel will be chosen to assist the ad hoc consultants.

Design of sampling campaigns
With the assistance of ad hoc consultants and the support of the above institutions, the different sampling campaigns will be designed for each of the selected areas in terms of the parameters of air, soil, water and sediments, taking into account available infrastructure, as described above.

In preparation for these campaigns, a quality control/assurance program must be implemented with the first-level laboratories and their staff who will participate in the program.

Data gathering

Once data have been obtained and analyzed, they must all be processed. Sampling campaign design will provide for decisions regarding statistical treatment favoring the explanation of phenomena and possible study of trends or anomalies that could arise due to unforeseeable phenomena.

Laboratories whose participation will be required

The suggestions presented in this section may be too optimistic, because of doubts about the future of participating institutions, which are listed on a tentative basis.

- For physical and chemical, bacteriological, metal content and other water analyses.

  - Under-Secretariat of Environmental Sanitation and the water laboratories of the School of Chemical Sciences (UC), for physical, chemical and bacteriological analyses.
  - For metal trace analyses, CEEA, CODIGEM
  - Analysis of total hydrocarbons in water (DGH)

- For analysis of sediments, CEEA and the School of Geology, Mining and Petroleum, UC.

- For soil analysis (physical and chemical)
  Laboratories of MAG in Tumbaco, School of Agricultural Science, UC; CEEA and CODIGEM for minor elements.

- Analysis of Hydrocarbons
  For soil, water and sediments, CEEA has techniques and equipment for analysis of cyclical and polycyclical hydrocarbons. There is no equipment for characterization of semivolatile or volatile hydrocarbons. Ecuador has no equipment for sampling of volatile hydrocarbons or determination of volatile or semivolatile ones except by gas chromatography, which is not advisable due to the cost and time required. The corresponding section outlines what is required.

- Air Analysis
  There are no automatic electrochemical sensors in Ecuador that can simultaneously determine combustion gases (CO, SO_2, NO_x, etc.); they must be acquired.

  Samplers for particulate matter, or to retain volatile hydrocarbons in the air are not available. The CEEA does have a cascade impacter to study atmospheric particulate size. It is hoped that INAMHI can lend a complete weather station.

- Agrochemical Analysis
  The laboratories of MAG in Tumbaco can be used initially, along with those of the CEEA.

The above is shown in **diagrams 5.2-8 and 5.2-9**.

It is understood that the activities to be performed, divided as indicated above, will be addressed as three sub-projects, each as a pilot project, to obtain:

- The experience required to cover other areas of work in the future as needed for monitoring purposes. The proposal is a personnel training school to implement standardized techniques, with adequate quality control, in order to be assured of the results obtained.

- Other laboratories must be gradually incorporated into this work, according to the type of monitoring performed and when monitoring activities are extended to other regions of Ecuador. For this purpose, a careful review must be made of equipment (time of usage, maintenance plan, condition, etc.), technical staff (education, subsequent training activities), physical infrastructure (facilities, status of laboratory areas, air conditioning, moisture control, working conditions, etc.), testing methods, quality of analyses, etc. This will make it possible to guarantee the quality of analyses and results according to national and international standards. If necessary, a plan for equipment and personnel training reinforcement will be established.

- Additionally, these monitoring campaigns will not only help identify the origin of pollution and measures for mitigation or elimination, but will also provide the basis for research that may have repercussions for various fields within ecology.

DIAGRAM 5.2-7
ENVIRONMENTAL MONITORING SYSTEM INITIAL IMPLEMENTATION PLAN

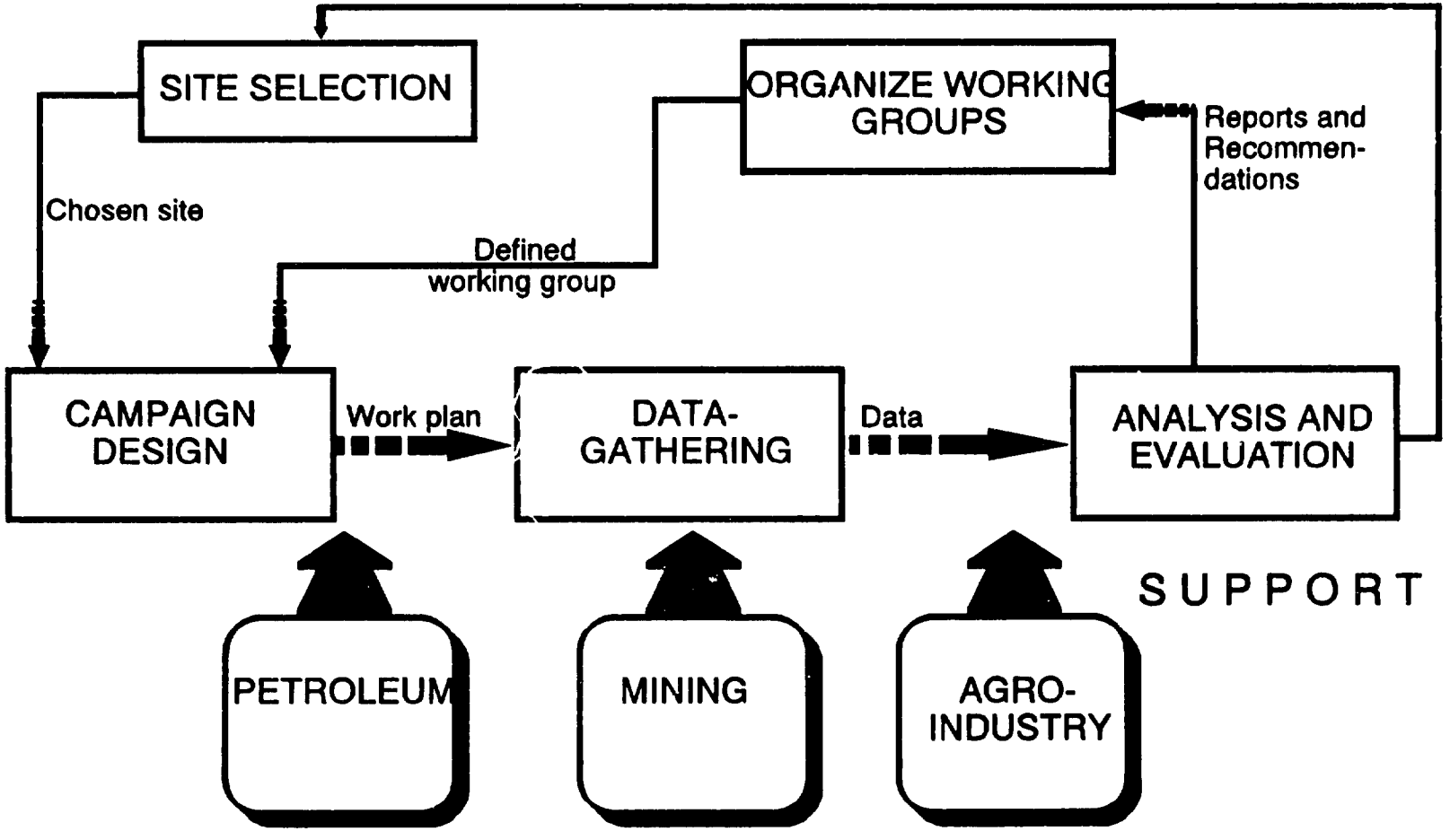


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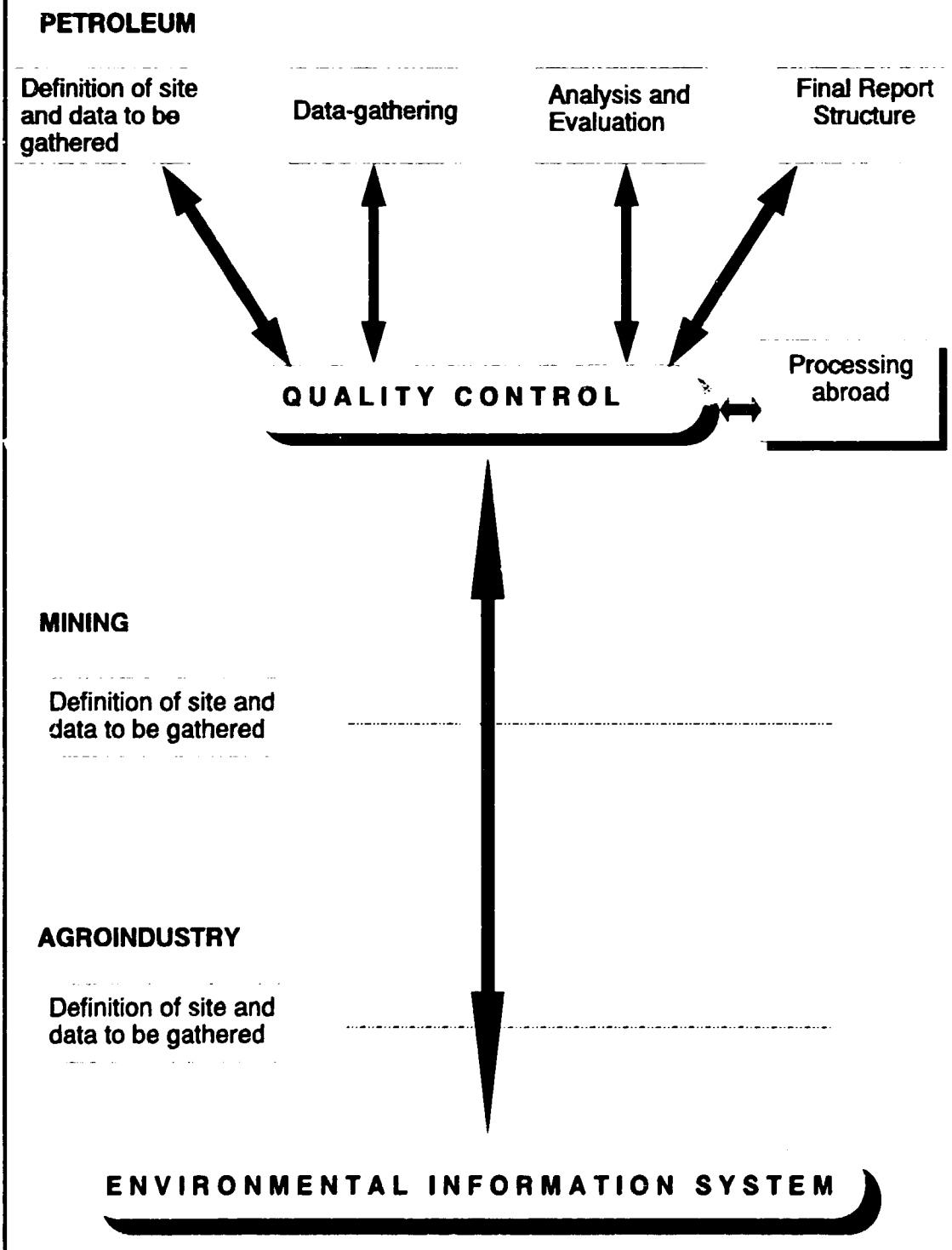
DIAGRAM 5.2-8
FLOWCHART OF THE SAMPLING CAMPAIGN PROCESS



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5.2.4.2 Additional Staffing Requirements

In the near future, it will also be necessary to train staff members at the post-graduate level in Environmental Toxicology, to cover the following fields, as well as molecular spectroscopy technicians.

- General support staff for participating laboratories.
  Introduction to constant flow injection methods that will make possible greater speed and accuracy in analyses carried out by techniques such as ICPS, atomic absorption, visible and ultraviolet spectrometry. Two professionals (they should be chemists) must be sent, for 3 months each, to CENA, Piracicaba S.P., Brazil.

- HPLC, X-ray Fluorescence.
  One professional must be sent for six months to be trained in these techniques, after three months of preliminary training in Ecuador. He or she should be sent to CENA, Piracicaba S.P. Brazil, and should be a chemist with ample knowledge of atomic physics and mathematics, at the minimum level of differential equations.

- Gas Chromatography, ECD and FID.
  - A professional chemist, 12 months with the National Scientific Research Council of Spain. This professional must be well-grounded in Atomic Physics and at least minimal knowledge of X-rays.

  It is foreseen that CEEA staff will be able to care for and maintain equipment in general.

- Personnel to engage in post-graduate study and obtain degrees, preferably at the University of California at Davis, California, USA:

  - Environmental Toxicologist in Agrochemicals, majoring in the study of metabolites and their degradation in the environment, 2 to 2½ years.
  - Environmental Toxicologist in Trace Metals and the formation of chemical species in the environment, changes and toxicity of these compounds, 2 to 2½ years.
  - Environmental Toxicologist in Hydrocarbons, changes and destination of hydrocarbons in the environment, especially studying their degradation and appraisal of the mitigation of effects, 2 to 2½ years.
  - Analytical-Electrochemical Chemist, studies on the appraisal of trace metals using electrochemical assessment methods, 2 to 2½ years. The basic equipment is on hand at the School of Chemistry, Central University.

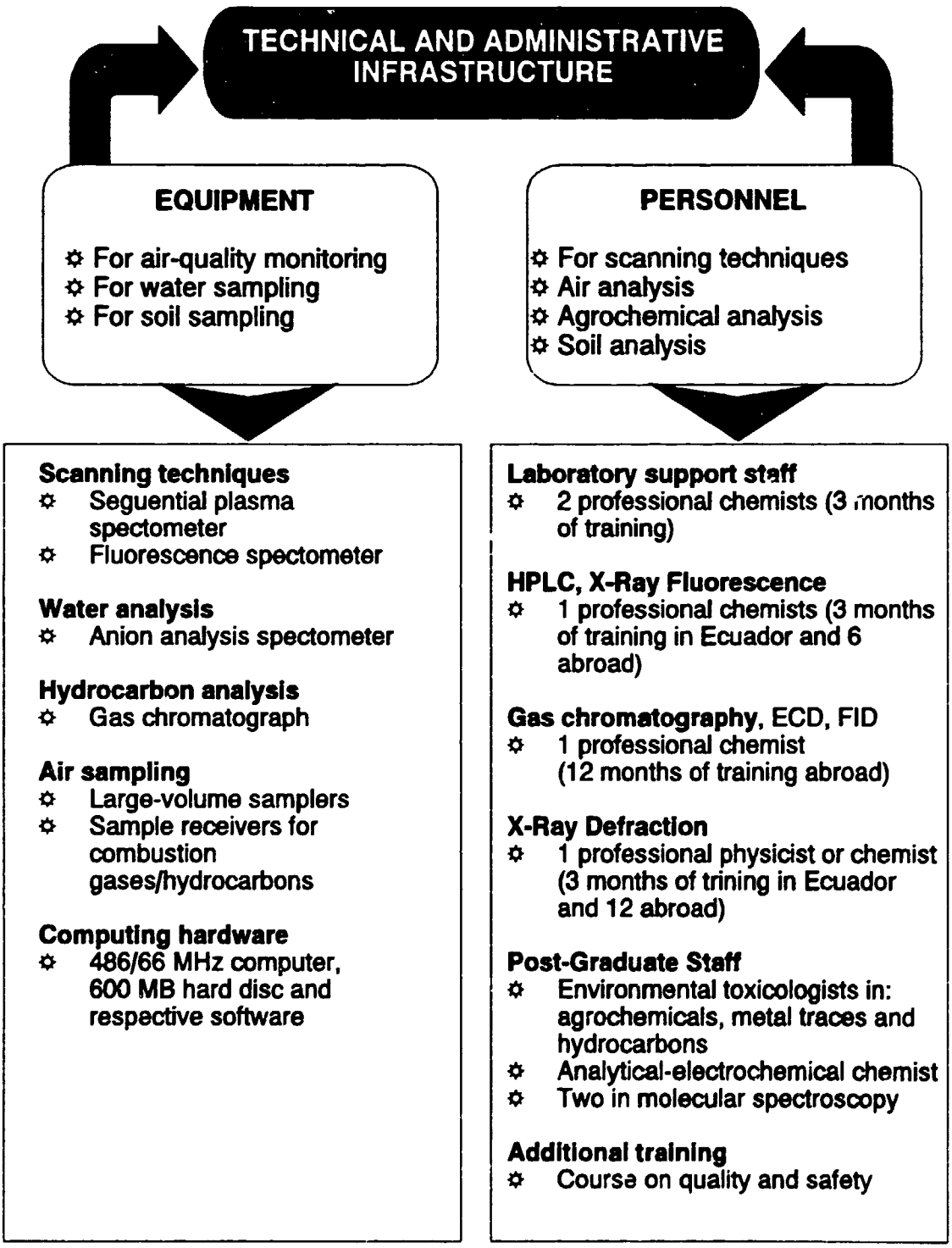
In order to be sent off for these higher studies, candidates must have good command of English and pass the TOEFL test, with high average grades.

All professionals in the first-stage laboratories participating in this program will be involved in the first joint course on **Quality Control/Assurance**. This course will subsequently be repeated whenever new laboratories become involved as service is extended.

A summary of additional equipment and personnel requirements for implementation of the first phase (1 year) of the EMoS is shown in **diagram 5.2-10**.

Environmental regulations that have been considered to prepare these documents are summarized in **Attachment 5.2-4**.

DIAGRAM 5.2-9
COMPONENTS OF A MONITORING SYSTEM



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5.2.4.3 Organization of Ecuador's Environmental Monitoring System

Any arrangements made to organize the System for Environmental Monitoring of the Amazon Region of Ecuador is will depend on the success obtained in the sampling campaign. Experience in operating the System will lay the foundation for future development, and therefore the following suggestions are limited **solely to the first year of operations**.

Alternatives may include:

- Hiring a foreign consulting firm to operate the system during its first year of life.
  This would provide the assurance that work would be properly done, at least toward the end. However, the lack of familiarity with the setting could pose severe problems. Ecuador has already had negative experience in this area in the case of Environmental Audits done lately. There is also the problem of higher costs.

- Hiring an individual consultant.
  None of the above-listed institutions has the capacity or experience to design air, soil and water resource sampling campaigns. Therefore, a professional should be found in Ecuador who has that expertise and is also in a position to provide the logistical capability required for such campaigns. This professional would maintain control and operation of the monitoring system (working groups) during the first year, supported by the computing team as set forth in chapter 3.3 of report 3.

It is suggested, first of all, that CEEA should head the participating institutions. The consultant will work closely with CEEA and the "working groups" that have been defined, to achieve the most suitable transfer of the technology used, including methods and procedures. Considering prior experience of the author of this report, it is calculated that operation of the "working groups" for one calendar year, to carry out the sampling campaigns as planned, may cost from US$ 330 to 350 thousand dollars: samples will have to be taken some 6 to 8 times during the year at the sites determined by the sampling campaigns. According to this design, results will then be mathematically and statistically treated to evaluate results.

Additionally, an internal program to monitor results and data as obtained will be put into place, and samples will be sent abroad regularly for outside third-party monitoring and verification of results. It will be necessary to acquire inter-comparison standards.

According to these considerations, the first phase of project implementation will have scientific and technical staff, technical support staff and administrative/logistical support staff. Those professionals and auxiliary personnel working in the laboratories will not be considered as project personnel, but will be compensated for the costs of different analyses that they perform. It is also expected that the agroindustry, petroleum and mining companies with whom work will be done can provide an additional field assistant for each sub-project. The personnel, then, will be as follows:

Project Leadership
- Project Director
- Project Assistant Manager
- Assistant to the Director

Professionals in charge of work in different sub-projects
- Agroindustry sub-project
  - Director
  - Field Assistant
  - Field personnel

- Petroleum sub-project
  - Director
  - Field Assistant
  - Field personnel

- Mining sub-project
  - Director
  - Field Assistant
  - Field personnel

Administrative Personnel
- Administrative Assistant
- Secretary
- Draftsman
- Messenger
- Driver

Consultants
- Expatriate 1
- National 5

5.2.5 Additional recommendations for establishment and implementation of the EMoS

This document has outlined the components required to establish and develop the EMoS in regard to objectives, personnel, equipment, form and procedures to be observed for each part to fulfill its purpose. On this basis, we now propose the way that the work should be carried out, insofar as possible with an estimate of costs required to pursue these activities during the first year of EMoS operation.

5.2.5.1 Timetable of Activities

On the basis of the pre-established time limit of the first year of EMoS operation, the following timetable is outlined, beginning with the signing of the contract during the first quarter.

- Literature available in Ecuador will be obtained and, on this basis and in cooperation with interested agencies, sites will be chosen and appropriate sampling campaigns will be designed, considering the pollutants of importance for the hydrocarbon, mining and agroindustry. The above-described working groups will be formed.

- As outlined above, the first laboratories that will work on the analysis of water, air, soil and sediment samples must be selected. The quality control/assurance program will begin, covering: sampling, sample transport and preservation, and handling in the laboratory. Greater emphasis will be placed initially on data to be obtained by instrumental analysis, and then on analyses using traditional methods. This course will be mandatory for personnel of the laboratories selected. It will last two weeks, followed by another two weeks of evaluation. Sample standards or reference samples will have to be obtained in advance.

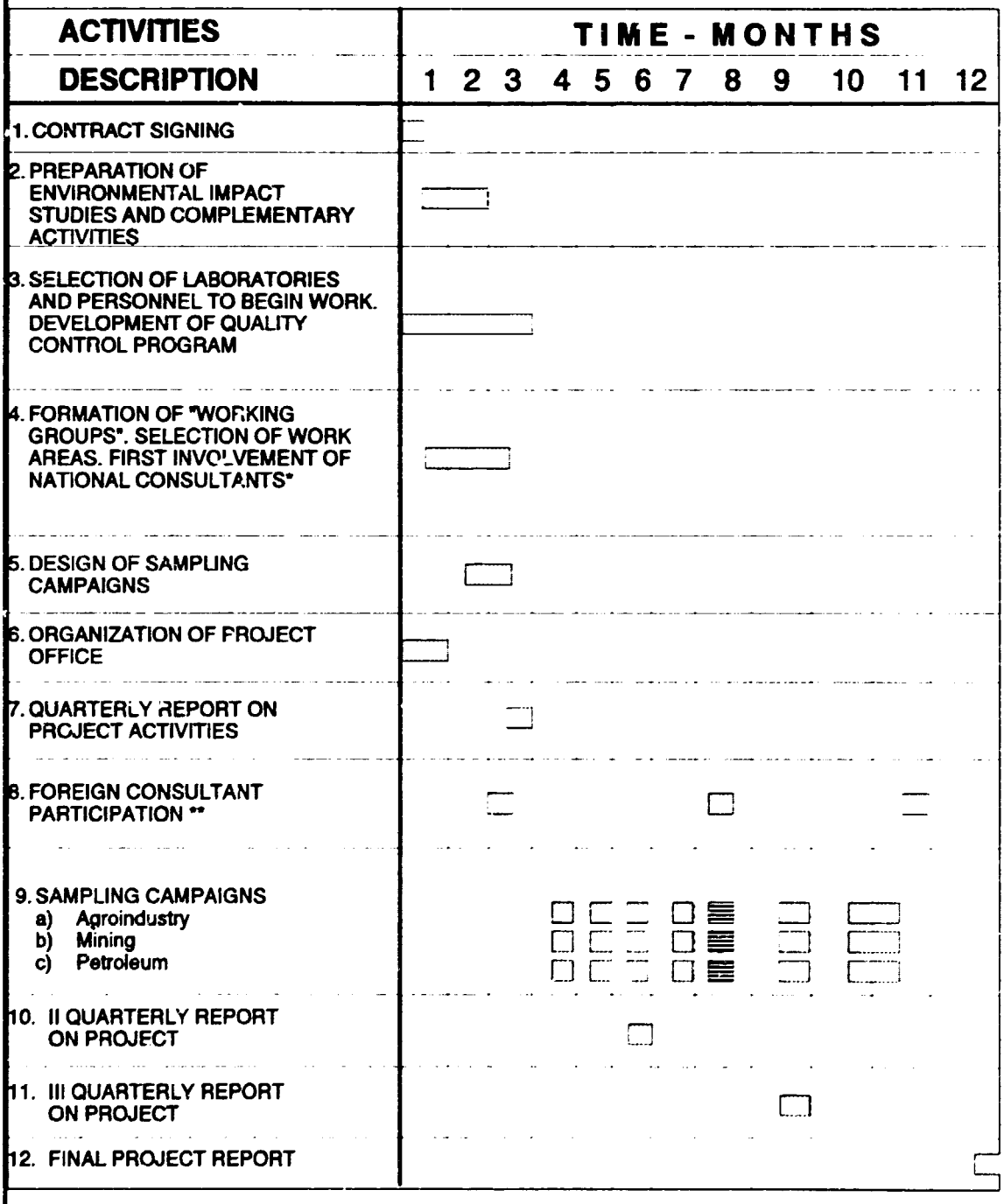
c) During this time, the "project office" will also be organized to handle project activities during the first year of work. The logistical part of sampling campaigns will receive special attention, along with the organization of the reports to be presented on a quarterly basis.

Second, Third and Fourth Quarters

The sampling campaigns will be carried out and continually evaluated by the project office. During the fifth month of operation, the project as a whole will be assessed in terms of its findings and conclusions.

As conditions allow, this review may be public in order to elicit community input, as relevant. In this manner, sampling campaign participants and laboratory staff may, by taking part in this evaluation, obtain a thorough, complete idea of the work being done and its importance for the country.

DIAGRAM 5.2-10
TIMETABLE OF ACTIVITIES TO BE PERFORMED



* National consultants will participate in selecting areas and designing sampling campaigns. They will occasionally oversee campaign implementation. Attendance at the quality control program will be mandatory for laboratories beginning this work and those that join in later.

** Foreign Consultant: He or she will help review sampling campaign designs; regarding the transformation and ultimate destination of pollutants, and will propose possible projects deriving from the work that has been defined.

Evaluation of Sampling Campaigns; search for the origin of pollution; definition of areas for research.

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International Expert

This general name is understood to cover the involvement of one or more experts for a total of up to 3 person/months. Their tasks in general are indicated in **diagram 5.2-10**.

5.2.5.2 Cost Estimation

In order to carry out the Timetable of Activities proposed for the first year of project operation, costs have been estimated, including: basic additional equipment, implementation of the initial plan, including project office operation; foreign advisory support; and local training, including the quality control program and basic literature required. The cost of training personnel abroad is also included, with the expectation that additional cooperation may be obtained in longer-term scholarships.

DIAGRAM No. 5.2-12

ESTIMATED COSTS

ICP	113,000 US$
AAS	75,000 US$
HPLC	80,000 US$
GC/ECD, FID	25,000 US$
TOX	25,000 US§
Gas analyser	45,000 US$
Laboratory	50,000 US$
Analysis apparatus	25,000 US$
Sampling equipments for air	37,500 US$
Vehicles for pollutant deposition measuring scales	187,000 US$
Vehicles for water quality measuring scales	125,000 US$
Vehicle for sampling soils	75,000 US$
Consumables	40,000 US$
Contingencies	40,000 US$
Total Equipment	942,500 US$
EXECUTION OF INITIAL IMPLEMENTATION PLAN	
Execution of Plan	350,000 US$
Foreign Advisory Support and Local Training, including quality control plan and required literature	200,000 US$
Training for Personnel Abroad*	200,000 US$
Total, Initial Plan Execution	750,000 US$
TOTAL, INITIAL PLAN FOR EMoS	**1,692,500 US$**

* It is expected that additional scholarship support will be obtained, especially for longer term professional studies.

5.2.5.3 Quality Control and Laboratory Certification

The commercial success of a product depends on its market acceptance; this acceptance is achieved by product quality *per se* and certification of that quality in terms of external appearance or intrinsic properties achieved through the most economically favorable means; in other words, industrial success is linked to "quality control" and widely varied companies are nowadays applying similar procedures throughout their activities, under the general overall heading of "total quality management".

Quality control has been a general heading since the beginning of analytical chemistry, and terms have been coined such as **method sensitivity**, **"the method's certainty of determination"**, **interferences of the method** in the **sensitivity and certainty of results**, etc.

In Ecuador, the topic of quality control in chemical analysis laboratories does not exist for all practical purposes. It is hard to believe that the same samples, analyzed by the same method and the same equipment, will yield different results; this is doubtlessly due to the sampling and sample conservation techniques and the laboratories' operations. Unfortunately, this state of affairs has spread to other areas. Thus, foreign companies working in Ecuador in the field of petroleum or mining prefer to use analytical services abroad for "delicate" analyses or to determine "baselines".

In view of these circumstances, since activities will involve monitoring campaigns, it is of prime importance to ensure quality control in chemical analysis data, first of all, and of decisive importance for proper development of a national plan for information on environmental pollution. Therefore, it is necessary to introduce the practical application of these concepts, which must necessarily be related to the taking, conservation and subsequent laboratory processing of samples.

SAMPLING AND SAMPLE CONSERVATION

Once a sampling or monitoring campaign has been designed, samples must be obtained accordingly, following the periodicity that has been agreed upon. There must be well-defined protocols for sampling. It is not the same to take surface-water samples as to sample at different depths. In other words, each medium and the purpose for sampling must be pre-defined, and established protocols or norms must be respected. It is also very different to obtain samples to be analyzed for characterization of hydrocarbons and/or agrochemicals.

Another key aspect is doubtlessly the preservation of samples for transportation to the laboratory. Protocols must also define how to conserve samples for a certain critical period of time; therefore, logistics, defined within the monitoring campaign, must consider these parameters.

PROCESSING OF SAMPLES IN THE LABORATORY

The following must be taken into account:

- Sample reception.

  Sample reception conditions must be analyzed in each laboratory so that they can be kept in accordance with protocol specifications, and they must be analyzed within a critical, pre-determined period of time. This makes it obligatory to maintain two conditions:

  - There must be adequate infrastructure in the laboratory/ies concerned to receive the samples;
  - The laboratory/ies must be able to carry out the required analyses within the critical time period during which sample conditions can be maintained;
  - For example, seawater samples that cannot be adequately processed during the next 6 hours (held on ice) must be frozen in situ and kept frozen until they are analyzed. This is critical, for example, for nutrient analysis.

- Laboratory standardization.

  Under this heading, a steady electric power supply must be considered, along with the environmental conditions of the laboratory/ies.

  - Standardization of Electrical Power

    Modern instrumental analysis equipment and especially those instruments manufactured after 1985 that will provide readings including measurement errors, are quite sensitive to electrical current fluctuations.

  So, laboratories that have such equipment must make sure that their power supply will not have voltage fluctuations. They must also be protected against sudden current interruption and instantaneous reconnection of the system.

  - Maintenance of Low Relative Humidity

    Equipment must be in an environment with a relative humidity held preferably between 50% and no higher than 65%.

  Relative humidity control must be maintained even when power supply is interrupted.

  - Preventive Maintenance Program

    This must go on constantly. Every day, proper equipment functioning must be tested by analyzing an internal standard, or by the method recommended by the manufacturer.

  Part of these activities is to immediately have replacement parts on hand so that equipment does not have to be shut down waiting for parts.

- Standardization of measurements.
  The readings taken from a given piece of chemical analysis equipment must be suitably guaranteed. For this purpose, a statistical program must be designed for measurement and certification. This entails the following:

  - Selecting those methods that are of decisive importance, in order to adjust them to the current norm and ensure that procedures will yield the same answer within the variation that the manuals indicate.
  - If the measurement will be taken with instruments, the reading must have a pre-determined certainty. Thus the error in measurements of photon absorption at a given wavelength is not the same if the DO is 0.1, 0.5 or 0.90.
  - To carry out (a) and (b) it will be necessary to take into account the required reagents, certified reference standards, and matrices in which the elements or compounds to be determined are contained.
  - The laboratory must be certified so that results can be trusted.

CONTINUATION OF ACTIVITIES

Experiences in other countries has indicated that about 12 to 14 other laboratories can be certified per year. The policy of "train the trainers" can be well applied and developed in this case. New laboratories can be readied to begin monitoring work with suitable training by those previously operating.

CONCLUSIONS

This paper has present general norms that will help suitably support a monitoring campaign, by establishing quality control in laboratories involved in the campaign.

This concept is really new to Ecuador, and establishing it will doubtlessly make a singular contribution to the reliability of such campaigns.

If this is not achieved, any money and efforts invested would have no real underpinning.

The program for quality control and laboratory certification will necessarily have to begin with no more than 3 or 4 laboratories, at most, and should take from two to three weeks, plus another like period for supervision of data and results. The program will then be repeated for another similarly sized group of laboratories whenever they are ready, during this project's lifetime. The standards will be needed, as well as the respective protocols, at least for data handling and sampling, with the equipment that costs the most and/or works the most, as well in traditional analysis methods as deemed most helpful.

ADVANTAGES OF CARRYING OUT THIS PROPOSAL

A simple, concise work plan has been proposed, that will maximize existing resources and, at the same time, blaze the trail for new techniques to be incorporated into the actual study of the Ecuadorian environment. It is evident even now that, in the near future, studies of "dynamic ecology" may be undertaken. Getting this proposal into operation for Ecuador will yield the following advantages:

- Existing laboratories would apply a policy of quality control/assurance in data sampling and processing, thus ensuring the country that data will be useful locally and credible internationally.

- It will involve those professionals working in these laboratories in a project of national significance, providing them with knowledge of each other's activities and the opportunity to exchange techniques and procedures, thus putting an end to their traditional isolation, and helping them understand, through this cooperative work, that they are part of a whole, which is striving to provide better service for the entire nation.

- Reliable data will be more useful for determination with greater certainty of impacts and determination of the extent and intensity thereof.

- Communities pursuing these activities, when granted access to these data and to information on how they were obtained and processed, will trust the decisions made by the government to control or eliminate pollution. All relevant steps must be taken so that communities will take interest/participate in sampling campaigns in some capacity.

- Proper design of sampling campaigns will make it possible to optimize resources in order to propose the most information possible, with the fewest observations, to provide accurate knowledge about the status of the environment; to evaluate the concentration of pollutants that are continually or periodically present and, after the first experiments, ranking of priorities for pollutant sampling, in terms of which feature the most pressing concentrations in regard to the processes involved.

- The proposed activities will be the first time that an activity of this sort is organized in a concise, efficient manner, taking into account the human infrastructure and available equipment, aiming for appropriate development in terms of extending activities toward the study of other possible areas of pollution in the Ecuadorian Amazon Region or other regions of the country that require this work; it is also an activity for professional staff training, so that other more sophisticated techniques, already commonplace elsewhere, can be incorporated into improving knowledge of the Ecuadorian environment.

- These studies have been proposed in such a way as to make it evident that the concepts of "biochemical cycles and limiting factors" will be

examined, as well as - step by step - the evaluations of "energy flow within a particular ecosystem".

This will be one way to demonstrate that Ecuador, by carrying out these "pilot projects" has undertaken very capable work, with reliable data, introducing modern technologies, as a very good basis for expanding this singular effort, taking advantage of the accrued experience, to other sectors of Ecuador. Working to attenuate, mitigate or annul pollution. This is not only of major economic significance, but is also part of a preventive public health program.

5.3 Environmental Information System (EIS)

5.3.1 Objectives and Tasks of an Environmental Information System

The main objective of the EIS is to compile, process and present as a network system the essential environmental information required to analyze and evaluate the environmental situation, establish relevant measures to eliminate or mitigate damage caused to nature, and provide the necessary foundation to guide coherent, well-coordinated environmental policy.

The system is useful to support environmental functions that must be performed by different political and administrative entities, by providing the information that they require. It must keep environmental information on hand for all national and international institutions comprising the system, or which are authorized and enabled to access the database structured for this purpose.

Accordingly, the environmental information system's main tasks will be to receive, analyze, file, document and present major environmental data and information, suitably structured and evaluated, to support administrative and planning actions for public and private institutions and for industry.

The tasks of the Environmental Information System can be specified as follows:

- To manage a technical and administrative organization in terms of its objectives.

- To establish and administer systems to gather, transmit and process data in all components - hardware, software, special techniques and personnel - which must be dynamic and flexible enough to address any changes and conditions that arise in system use and maintenance.

- In regard to data processing:
  - To organize network members for quick, effective information exchange and transmission among each other and with a central data management unit.
  - To monitor data integrity and security, and provide procedures for analysis and evaluation.
  - To administer databases. This entails defining, structuring, updating and overseeing the integrity of data available at the network's different nodes.
  - To administer, insofar as possible, all environmental information available in Ecuador.
- In regard to data evaluation:
  - To analyze, evaluate and interpret all data available from the different environmental components in the form of technical and scientific studies.
  - To complete major environmental data with secondary data such as basic maps, data from satellite and aerial imagery, statistics (INEC), data from studies and evaluations, medical statistics, etc.
  - To improve such studies through the inclusion of secondary data as required.
  - To analyze, evaluate, classify and structure the data required by ministries and existing sub-national administrative units, as well as those that may subsequently be created.

- In regard to documentation:
  - To bring out regular publications on environmental issues (e.g. a general environmental report on Ecuador or environmental reports from provinces).
  - To provide documents with short descriptions of major environmental data that are available to users of the Environmental Information System.
  - To provide information on the data transmission network, describing the network's objectives and tasks, conditions for usership and active membership in the network.

- To structure a user network:
  - To structure a national network for data transmission and communications with all users of the Environmental Information System.
  - To define, implement and organize interfaces with other local and international systems.

5.3.2 Components of the Environmental Information System (EIS)

5.3.2.1 Data

The basic primary component of the environment is the data which the information system must gather, validate, classify, store, structure, evaluate and document.

The data obtained by measurements, observations, studies, surveys and censuses through the EMoS are structured for processing and evaluation in the following groups:

- **Technical data**
  Technical data are those obtained through measurements, observations, surveys and censuses, including technical explanations.

  The CO_2 content of the air is obtained by measurement, while the structure of a community, demographic and socioeconomic data, are established through surveys and censuses. Data determined, for instance, changes in plant growth or in animal behavior are part of the group of data established through observations.

- **Geographical data**
  Describe the place and area of elements and spaces comprising the territorial area with the support of geographical coordinates. The geographical data are related to maps analogically or digitally.

- **Satellite imagery**
  This is digital information from maps, obtained by digitalization and space surveying (aerial photography and satellite imagery) in reticular or vectorial structures[6].

- **Orientation data**
  Orientation data are used to follow-up on an objective, especially to establish environmental quality objectives. Classical orientation data are indicators, boundary and referential values, and evaluation standards.

- **Documentary data**
  Laws, ordinances, regulations, documents, e.g. environmental protection plans and programs, bibliographic databases for the reception of assessments, national and regional studies and projects, information on

[6] The scanner converts maps and aerial photographs into screen images on a grid system. these are composed of pixels, but without any logical connection being made between them. Qualitative information is provided by the pixels colour or gradations of grey.
In the case of vector representation, the maps are converted into the graphical elements of points, lines and areas, and their locations uniquely defined by coordinates. It is not possible to call up these graphic elements directly in the grid-based images.

foreign databases, bibliographic databases with information on institutions and human and technical resources.

- **Methodological data**
  Descriptions of evaluation methods, statistics, forecasts and simulations to support the functions of planning, advisory assistance and legal advice.

To match up these technical data with the corresponding geographical data and information from digitalized imagery is the basis for Geographical Information Systems (GISs). These systems are increasingly important and have become a basic tool for analysis, data assessment and visualization of results in reference to a geographical field defined in terms of environmental planning and protection. It is very important, in a EIS for a defined domain, for all measured and gathered data to correspond to the geographical data within that domain.

For orientation and documentary data, the relationship with a given geographical area is important when boundary values are valid only for that area (expansion of emissions, cadastral record of immisions).

Together with systems for evaluation of information obtained from a distance (aerial photography, satellite imagery) environmental impact analyses and evaluations may be made in relation to a geographical area. Maps thus obtained may be reproduced to different scales. This kind of evaluation is also useful to model and simulate environmental components in practical and scientific terms.

Scientific studies, control of measures for environmental mitigation and protection and environmental management functions in the form of plans and programs can be performed with the support of documentary, technical, methodological and orientation data.

5.3.2.2 Database Systems

An environmental information system has the function of maintaining current key environmental information and providing it for various operational and decision-making entities according to the needs of each within the information system.

To perform this function, it is very important for the wide variety of data originating at the different nodes of the system to be suitably structured and inter-related, in order to cover all data requirements that users request, in terms of their own functions.

This kind of data management is possibly only by using a database management software package such as ORACLE, SYBASE or INFORMIX.

Since this information is normally scattered over relatively large areas or regions and is of different types, local databases are structured to communicate with each other or with a central database. At each node of a database, data management functions must be carried out (maintenance, updating, integrity control, etc.), which means that skilled personnel must be present at such nodes.

5.3.2.3 Data exchange and transmission network

To exchange information among the different nodes of the system and transmit environmental data from measurement stations and laboratories (monitoring system) to the point where these data are received, it is very important to have an efficient, highly reliable data transmission system.

Because the members and users of the system are scattered, a data transmission network is structured to make it possible for information to flow and data to be exchanged from/among all nodes of the system. This network can be structured along dedicated telephone lines, modems and the respective computing hardware or - and this seems more suitable - by using the infrastructure of national and international networks that provide this type of service. This matter is discussed in detail in report 3.

5.3.2.4 Organization and Administration

The Environmental Information System must be under an organization with freedom to make its own decisions and keep its own budget. It must maintain cooperation and collaboration among the institutions that gather, store, maintain and manage key environmental data, and which are willing to provide selected data for the system (e.g. public evaluation institutions, map-making institutions, and those surveying information using remote sensors, etc.).

If this is judged useful, an association or commission could be formed to establish the norms and procedures for information management, such as definition of service fees, distribution of information to institutions, universities and other users, etc.

In any event, the organization must be able to act quickly, with sufficient power to make rapid decisions regarding the treatment of environmental information.

5.3.3 Environmental Information System for Ecuador

Design of the Environmental Information System for Ecuador is specified in detail in report 3. There, an integrated, modular, functional system is described that covers those functions related to the use and management of software, hardware, communications network and personnel. This is naturally based on an analysis of the present situation in terms of equipment and technical staff available.

That report also proposes the plan for implementation of the pilot project, i.e. the structure of the system for the Amazon Region of Ecuador in regard to environmental impacts produced by petroleum, mining and agroindustry activities. It also establishes referential costs for software and hardware.

To facilitate understanding of the above, a brief summary of the most important parts of report 3 is presented below.

The Environmental Information System (**EIS**) is the functional, technical and organizational foundation that makes it possible:
- to gather data,
- to transmit data,
- to administer data, and
- to present data and information for end users, in regard to the environment, considering as the first phase the Amazon Region of Ecuador.

The system's structure and operation is open so that it will be possible to become part of a regional network involving all Amazonian countries.

This concept of the EIS also makes it possible to add users as the needs, possibilities and political and technical decisions may require in the future. Users will basically include public and private institutions, universities and NGOs, although this does not preclude the possibility of expanding the system in the future to include other types of users.

For this purpose, the structure is proposed of an Integrated Information System, in all possible aspects, as outlined below.

5.3.3.1 Communications Network

The data transmission network is conceived of in a modular form, with the main nodes in Quito, Guayaquil, Cuenca and Loja, by the final phase. Each node can serve a local network to integrate the users of that zone. The network architecture will be structured by phases as the Monitoring System develops (chapter 5.2), consolidating each phase before continuing with the following one.

To structure the communications network, the infrastructure of the existing nationwide network, ECUANET, which is linked to the international network, INTERNET, will be used. This possibility will make it feasible in the future to establish connections with those networks that arise in countries of the Amazon Region and elsewhere.

5.3.3.2 Hardware

The hardware for this system is modular and the minimum characteristics are specified for each network and EIS member. However, whenever the user's equipment is acquired or expanded (computer, modem, hard disk, CD-ROM, etc.) it should do so in terms of the most up-to-date technology that can be obtained.

5.3.3.3 Software

Software, insofar as possible, must also be modular, and above all compatible, to make it possible to transmit and manage data originating from and available on the network in a timely, reliable fashion. Obviously, specific software programs and/or packages must be considered (e.g. GISs, statistical packages, etc.) that are in operation in certain institutions already or available on the market.

Central application software to be used at a main node in Quito, must be designed and implemented by phases, to handle the functions of control, administration, presentation of reports and queries by the different EIS users, and follow-up on the technical and/or legal measures adopted in the event of environmental infractions and/or impacts in general.

5.3.3.4 Data Banks

The main and secondary nodes of the system will work with specific databases for their own functions and activities, in regard to air, water, soil, flora, fauna, etc.

At the main node there will be a database compiling information and data, suitably screened, provided by all network members. This will comprise:

- Specific data structures for access, queries and information from EIS institutions and users.
- Data structure for executive and legislative control and supervision.
- Available data for application in studies and projects.

5.3.3.5 Data Catalog

The data catalog provides the location of specific information that can be used for evaluations or interdisciplinary studies within the framework of the Environmental Information System. It describes the availability of key data through a data model containing a complete, clear description of each entity (e.g. place, contents, format, date of update, data-gathering and analysis method, users with access authorization, etc.)

This catalog must be located at the central node and will be part of the central data bank.

5.3.3.6 Training

Since the institutions that are potential members of the system have personnel trained in computing science, training for these staff members must cover the following areas:

- Network management.
- Use and maintenance of geographical software packages (GISs).
- Structure, operation and maintenance of application software.
- System management.
- Database administration.

It is also important to train scientific personnel who will work with these systems. This training will focus primarily on software package and application software use, and will take place during development of the Environmental Information System. The subjects to be covered include:

- Use of geographical software packages (GISs).
- Operation of application software.
- Operation of general software: word processors, spreadsheets, Windows and electronic mail.

5.4 Organization of the Environmental Management System

The present approach makes no pretension of providing a single solution for the problem of the organization required for total, complete operation of the Environmental Management System, but simply to point out certain aspects that should be considered, analyzed and fleshed out as the system is implemented.

If the project's ultimate aim is to implement an Integrated Environmental Management System, then there must be, as in any properly operating system, well-defined functions and activities at the different levels of execution and operation, under suitable coordination.

This aspect, briefly described, will enable us to establish that --along with the components defined in the Environmental Monitoring System (EMoS) and in the Information System (EIS), which in principle will cover the technical tasks required to monitor and analyze the environment-- other components or subcomponents are required to handle the work of:

advisory support, administration, coordination, planning and implementation.

Under these premises, we may consider, as the subcomponents of the administration component:

- A central coordination unit to monitor, supervise, direct, make general plans and coordinate the system's proper operation.

- Environmental institutions and units in the central government.
- Environmental institutions and units in sub-national governments.
- Environmental units in municipalities and provincial councils.
- Non-governmental organizations to provide support for specific environmental tasks.

Each level must have well-defined functions and tasks, so that their responsibilities and fields of action will not overlap or interfere with each other.

5.4.1 Coordination Unit of EMS

As explained in chapter four, there is a legal foundation and there are environmental institutions or units that perform or can perform the respective functions. However, as also pointed out in that chapter, one of the most critical problems is the lack of coordination for the heretofore isolated and even scattered efforts of institutions that carry out or should carry out activities in regard to the environment.

On the basis of these considerations, it can be seen how important it is for the functions, tasks, responsibilities and legal scope of each unit and institution comprising the EMS, whether administratively or operationally, at all levels, to be well defined, in order to prevent, insofar as possible, duplication or redundancy in functions and responsibilities. This is the only way that actions involving the environment (legislative, executive and operational decisions, for example) can be clearly and accurately carried out, in an orderly, timely fashion, according to the fields or jurisdictions established.

Therefore, we can deduce the need for an agency that will coordinate and support all processes entailed by the EMS, which means that the norms for system operation must be issued and overseen from a central point, even though certain decisions regarding monitoring and implementation may be defined by consensus.

5.4.2 Objectives of the Coordination Unit

The main purpose of the Coordination Unit is to ensure that all processes carried out in the EMS are duly coordinated and interlinked, comprising an integrated system, thereby preventing redundancies in functions and tasks, avoiding loose ends and providing the executive levels with the information and mechanisms they need for management purposes.

Another objective is to maintain the system's technical integrity by coordinating the delivery of information, technical and personnel matters, results of analyses, evaluations and studies generated by the EMoS and placed at the users' disposal through the EIS.

5.4.2.1 Functions and Tasks of the Coordination Unit

In order to fulfill the above objectives, the Coordination Unit, in addition to the administrative coordination function, must perform other functions and tasks related to advisory assistance, support for the tasks of the different levels of the system, planning and research.

The functions outlined below are merely described in a general manner, without detailed specifications, as this would be the subject of another study. It is important to consider these aspects, which must be effective and dynamic according to the constant changes of environmental issues. Report 2, "Institutional Environmental Action Plan for Ecuador" goes further into several of these points.

Political Advisory Assistance

To perform this function, the unit must have technically and scientifically qualified academic staff, as well as representatives of the ministries and institutions that are active in environmental advisory support for legislative and executive purposes, in order to cover the following fields:

- Environmental policy,
- environmental quality goals,
- legal aspects directly or indirectly influencing environmental relations,
- advisory support for questions and objectives related to environmental impacts,
- objectives, guidelines and strategies within the framework of environmental planning in Ecuador.

Advisory support for legislative purposes

- In formulation of laws, norms and regulations related to the environment and environmental management,
- in formulation of suggestions for changes and/or supplementation of environmental laws, norms and regulations,
- in revision of existing laws and their efficient enforcement,
- in making regulations concrete,
- in setting norms and standards,
- in structuring and formulating procedures for approval of industrial facilities,
- in structuring and configuring administrative units for environmental planning and monitoring within the EMS.

Advisory support for executive purposes

- In structuring and defining measures and plans for measures for sanitation in affected zones and to prevent environmental impacts,
- in overseeing measures and plans under execution,

- in environmental planning by the central and sub-national government regarding:
  - formulation of the environmental development plan,
  - development and implementation of the country's overall environmental planning, and the respective sub-national plans,
- in preparation of environmental analyses and studies (environmental audits, environmental assessments, etc.) and the implementation thereof,
- in structuring environmental projects.

Advisory support for the Monitoring System

- In the preparation and implementation of monitoring campaigns regarding strategy and the type of measurements to be made,
- in the organization, and in some cases implementation itself, of quality control over: measurement methods, forms or analysis and evaluation of findings from the monitoring system.

Organization and coordination of the Environmental Information System (EIS).

- Administration of the Environmental Information System (see report 3),
- coordination with the various institutions for exchange and handling of environmental information,
- establishment and implementation of those linkages required within the EIS (internal interfaces) and outside the System (external interfaces),
- definition of the structure and scope of the information to be received and distributed among EIS users,
- training of EIS users,
- support and advice in computer science aspects of the system,
- administration of the data transmission network,
- definition of new computing needs (hardware, software),
- system maintenance,
- coordination with institutions from other countries to structure regional environmental information networks.

Advisory support to enhance research and training activities

- Implementation or hiring-out of research studies,
- coordination and support for joint work with universities and integrating them into the system,
- drafting of training programs in coordination with institutions (ministries, public and private agencies, etc.) for EMS staff,
- training for sub-national government personnel on environmental issues as "censors" to oversee the environment and measures taken to protect it,
- collaboration to structure national and sub-national environmental training programs involving schools (elementary and secondary schools, universities), public institutions and the citizenry at large.

Dissemination work

- Prepare and issue regular environmental reports for Ecuador,
- prepare and publish an environmental information catalogue showing what information is available, where, and how to obtain it,
- organize courses and workshops at the national and sub-national level,
- support the preparation and holding of courses and workshops by other institutions.

Arbitration

- arbitrate or mediate conflicts among stakeholders who are producing environmental damage and those affected,
- mediate among industry and political decision-makers in regard to the country's sustainable development.

5.4.3 Structure of the Coordination Unit

Without any pretense to providing the final solution to the organizational and functional structure of the Coordination Unit of the Environmental Management System, we would just like to present some suggestions to be covered in its organization.

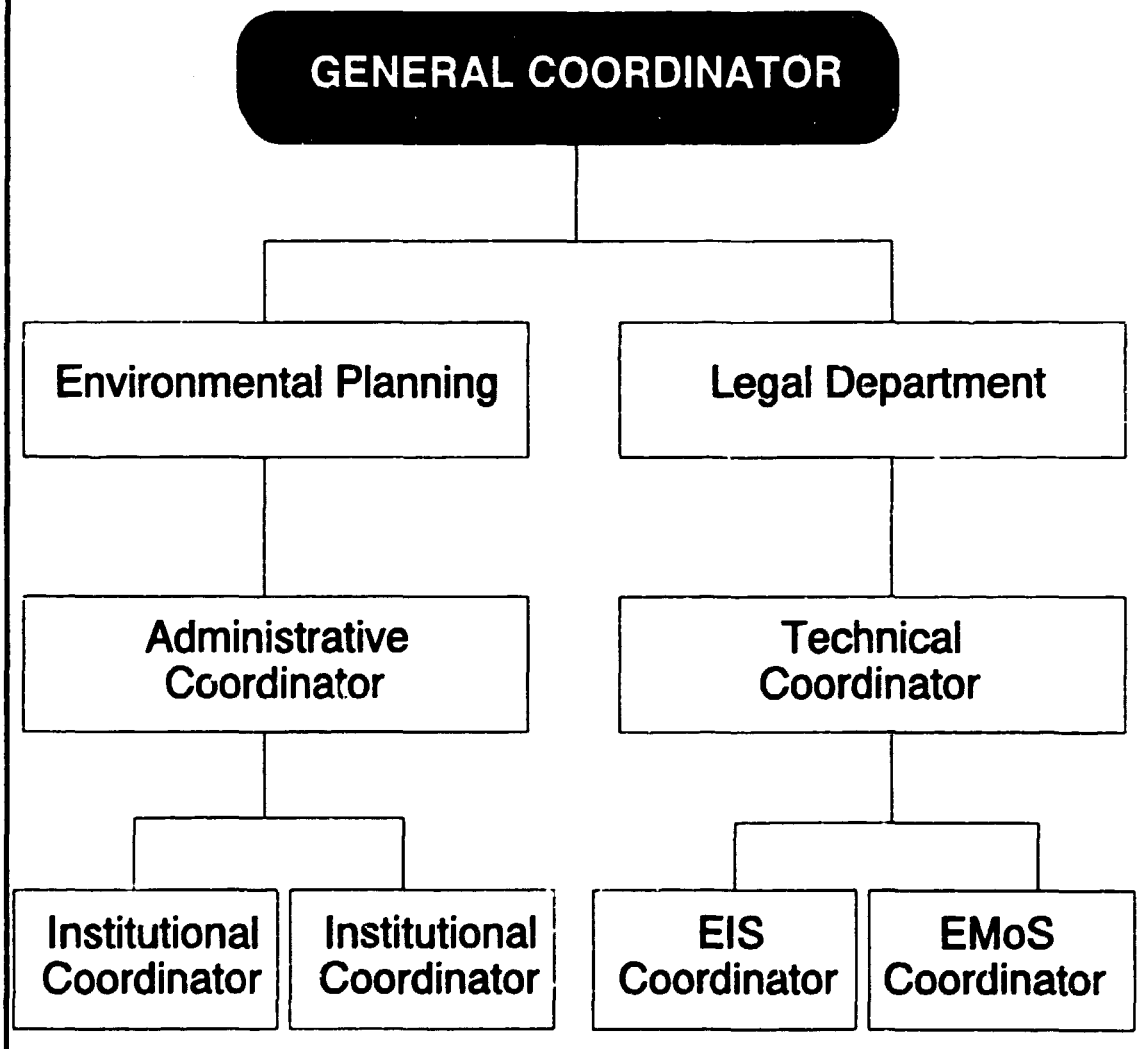
The Coordinating Unit's structure must obviously be equal to the task of performing the functions and tasks outlined above. This means that the unit must have competent administrative units for:

- Decision-making and the power to enforce them, and elicit commitments from institutions to undertake the implementation of decisions that have been made. In other words, this body must comprise top-level officials, both public and private.

- Advisory support for all technical matters involving the development of the Environmental Management System, which will obviously involve the monitoring system, information system and environmental planning. Some of the functions and tasks related to this point could be delegated to one or more institutions, but with adequate coordination.

As a general outline, **diagram 5.4-1** shows the organizational structure of the Unit's basic components.

DIAGRAM 5.4-1
GENERAL ORGANIZATIONAL HIERARCHY OF THE EMS COORDINATION UNIT



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5.5 General Administrative Structure

Chapter 4.4 has the details on the administrative makeup of the Ecuadorian State, underscoring the public institutions involved with the environment and their respective functions.

Diagram 5.5-1 attempts to visualize that chapter's description of the central government, sub-national government and private sector, as they are involved one way or another in environmental management issues. The legal and institutional foundations apparently exist to structure a properly coordinated environmental management system. These aspects are being examined in the research currently conducted by Dr. Cecilia Miño for the Environmental Advisory Commission of the Presidency of the Republic (CAAM).

In this respect, we would just like to provide certain guidelines from an analysis of the problem of coordinating environmental management, from the institutional and legal standpoint.

Establishment of a central coordination system does not ensure in any way its efficiency or effectiveness, if the functions, powers and responsibilities of each element of the system are not taken into account in an integrated manner. In fact, several Latin American countries have failed in this attempt, including Colombia and Venezuela.

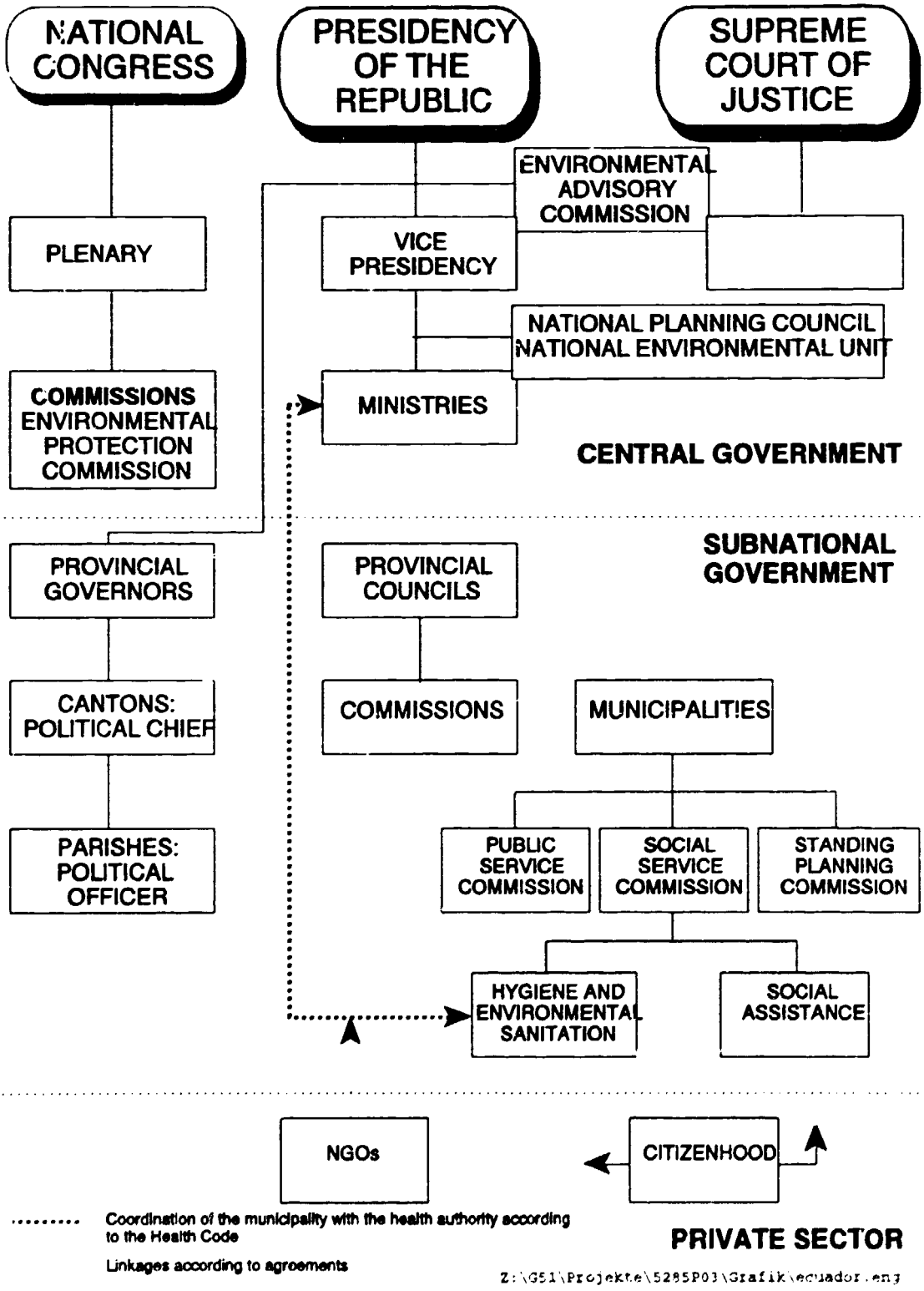
An analogous situation is that of the Inter-Institutional Environmental Protection Commission (CIPA) created by the Law for Prevention and Control of Environmental Pollution and, apparently, of the Environmental Advisory Commission of the Presidency of the Republic (CAAM).

One of CIPA's problems is the lack of representative power of the public officials who belong to the Commission. Although a minister is one of the top officials in the administrative hierarchy, the ministers have delegated their participation in this body to second- or third-level officials, whose decisions are not binding for the institution they represent.

This, then, should be taken into account in creating a Central Unit, whatever it is called: its membership and its own position must be as high-ranking as possible.

The problem that CAAM is apparently facing at present involves its legal basis. Since it was created by an Executive Decree, it is an operational unit of the Presidency of Ecuador and, just as it was created, it can likewise be eliminated. And what is more, it has to deal with other public institutions that have been created by laws, which would apparently give them a higher rank.

DIAGRAM 5.5-1:
GENERAL ADMINISTRATIVE STRUCTURE OF THE ECUADORIAN STATE



However, beyond this formal difficulty, there is another of a conceptual nature, regarding the functions that it must perform. Since these functions are advisory, CAAM is not empowered to force other institutions to implement what it deems best. This places it in the midst of inter-institutional conflicts.

This would lead to a second recommendation: this Central Unit must have clearly defined functions that will not interfere with those currently performed by other institutions.

The scattering and isolation of institutions responsible for environmental management in Ecuador is an outgrowth of the narrow outlook of each of them in viewing environmental problems solely from the angle of their own domain.

The lack of coordination problem is also caused by a similar scattering and isolation among the laws governing Ecuador in regard to environmental issues.

The multidisciplinary approach is increasingly predominant in addressing environmental issues and the use of natural resources in this country.

Each special law on environmental protection and natural resource use makes express mention of the obligation to coordinate among relevant public entities.

However, this coordination has not happened. Indeed, the problem arises because there is actually a sort of institutional jealousy according to which each institution attempts to override others.

So, then, the law calls for coordination activities and there are many institutions, but they do not actually reach any working agreements. Perhaps the laws' declarations are lacking in operational force.

Then this becomes the third recommendation for establishing coordination mechanisms: these mechanisms should be established with accuracy, including if possible penalties for nun-fulfilment.

For an efficient coordination system it is very important to consider the way how to prevent conflicts which might arise due to bad environmental handling.

Prevention appears twice when establishing environmental policies which clearly define objectives and priorities in development and thus in planning processes.