Table 5.5.1 BENEFIT/COST ANALYSIS FOR CHANNEL STABILIZATION (2/2)

- Mid Term Plan -

Unit: US$1000

Year	Benefit	Cost				Net Cash Flow
		Project	Operation	M & R	Total	
	a	b	c	d	e=b+c+d	f=a-e
1	-	3,091			3,091	(3,091)
2	-	3,100			3,100	(3,100)
3	-	10,159			10,159	(10,159)
4	2,086	10,159	417	108	10,684	(8,598)
5	4,173	10,159	835	216	11,209	(7,036)
6	6,259	10,159	1,252	323	11,734	(5,475)
7	8,346	10,159	1,669	431	12,259	(3,914)
8	10,432	10,159	2,086	539	12,784	(2,352)
9	12,518	10,159	2,504	647	13,309	(791)
10	14,605	10,159	2,921	755	13,835	770
11	16,691	10,159	3,338	862	14,360	2,332
12	18,778	10,143	3,756	970	14,869	3,909
13	20,864		4,173	1,078	5,251	15,613
14	20,864		4,173	1,078	5,251	15,613
15	20,864		4,173	1,078	5,251	15,613
16	20,864		4,173	1,078	5,251	15,613
17	20,864		4,173	1,078	5,251	15,613
18	20,864		4,173	1,078	5,251	15,613
19	20,864		4,173	1,078	5,251	15,613
20	20,864		4,173	1,078	5,251	15,613
21	20,864		4,173	1,078	5,251	15,613
22	20,864		4,173	1,078	5,251	15,613
23	20,864		4,173	1,078	5,251	15,613
24	20,864		4,173	1,078	5,251	15,613
25	20,864		4,173	1,078	5,251	15,613
26	20,864		4,173	1,078	5,251	15,613
27	20,864		4,173	1,078	5,251	15,613
28	20,864		4,173	1,078	5,251	15,613
29	20,864		4,173	1,078	5,251	15,613
30	20,864		4,173	1,078	5,251	15,613
31	20,864		4,173	1,078	5,251	15,613
32	20,864		4,173	1,078	5,251	15,613
33	20,864		4,173	1,078	5,251	15,613
34	20,864		4,173	1,078	5,251	15,613
35	20,864		4,173	1,078	5,251	15,613
36	20,864		4,173	1,078	5,251	15,613
37	20,864		4,173	1,078	5,251	15,613
38	20,864		4,173	1,078	5,251	15,613
39	20,864		4,173	1,078	5,251	15,613
40	20,864		4,173	1,078	5,251	15,613
41	20,864		4,173	1,078	5,251	15,613
42	20,864		4,173	1,078	5,251	15,613
43	20,864		4,173	1,078	5,251	15,613
44	20,864		4,173	1,078	5,251	15,613
45	20,864		4,173	1,078	5,251	15,613
46	20,864		4,173	1,078	5,251	15,613
47	20,864		4,173	1,078	5,251	15,613
48	20,864		4,173	1,078	5,251	15,613
49	20,864		4,173	1,078	5,251	15,613
50	20,864		4,173	1,078	5,251	15,613
51	20,864		4,173	1,078	5,251	15,613
52	20,864		4,173	1,078	5,251	15,613
53	20,864		4,173	1,078	5,251	15,613
54	20,864		4,173	1,078	5,251	15,613
55	20,864		4,173	1,078	5,251	15,613
56	20,864		4,173	1,078	5,251	15,613
57	20,864		4,173	1,078	5,251	15,613
58	20,864		4,173	1,078	5,251	15,613
59	20,864		4,173	1,078	5,251	15,613
60	20,864		4,173	1,078	5,251	15,613
61	20,864		4,173	1,078	5,251	15,613
62	20,864		4,173	1,078	5,251	15,613
			IRR (%) =		13.7	
			B/C =		1.46	(at discount rate: 8%)
			B - C =		46,666	(at discount rate: 8%)

FIGURES

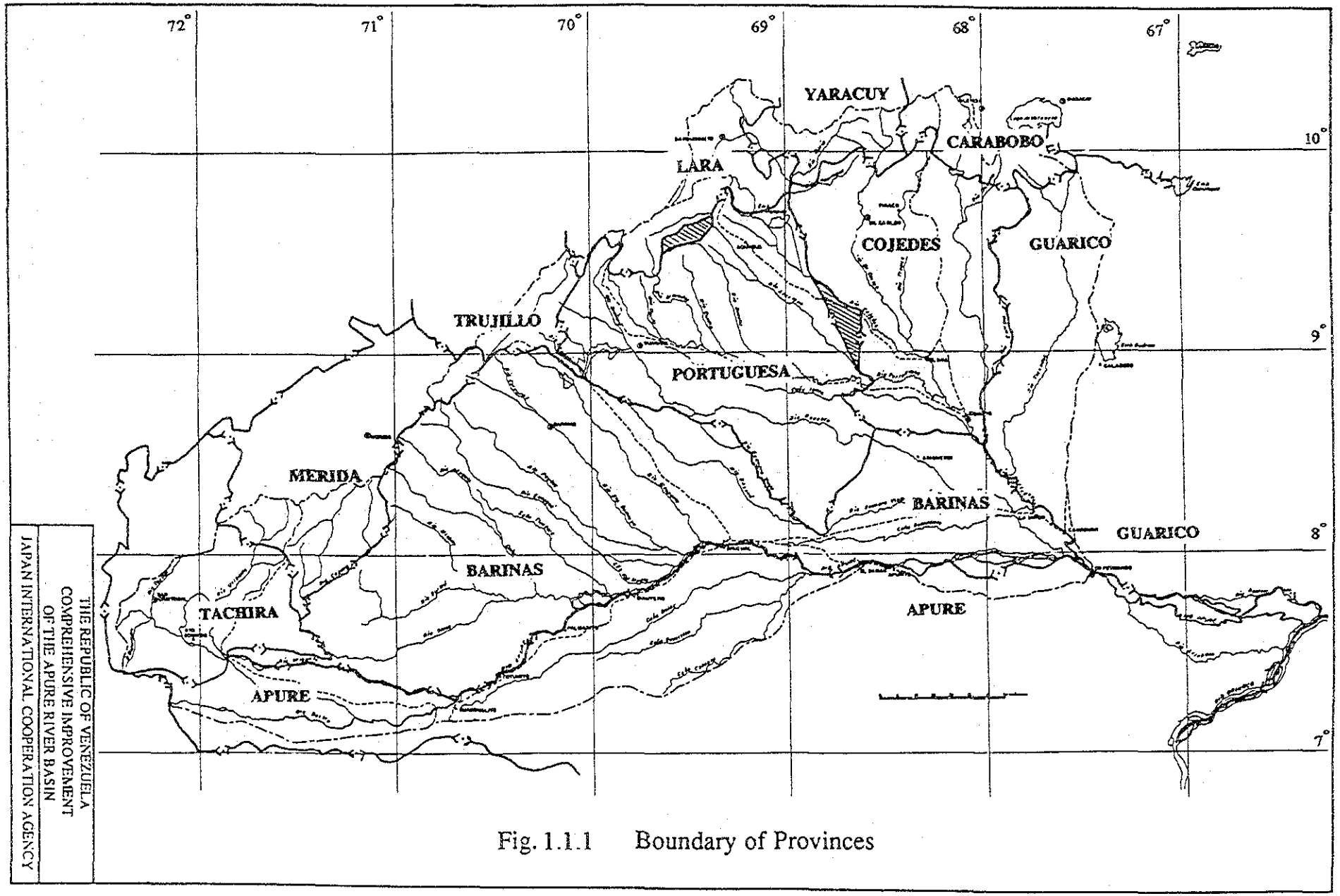

Fig. 1.1.1 Boundary of Provinces

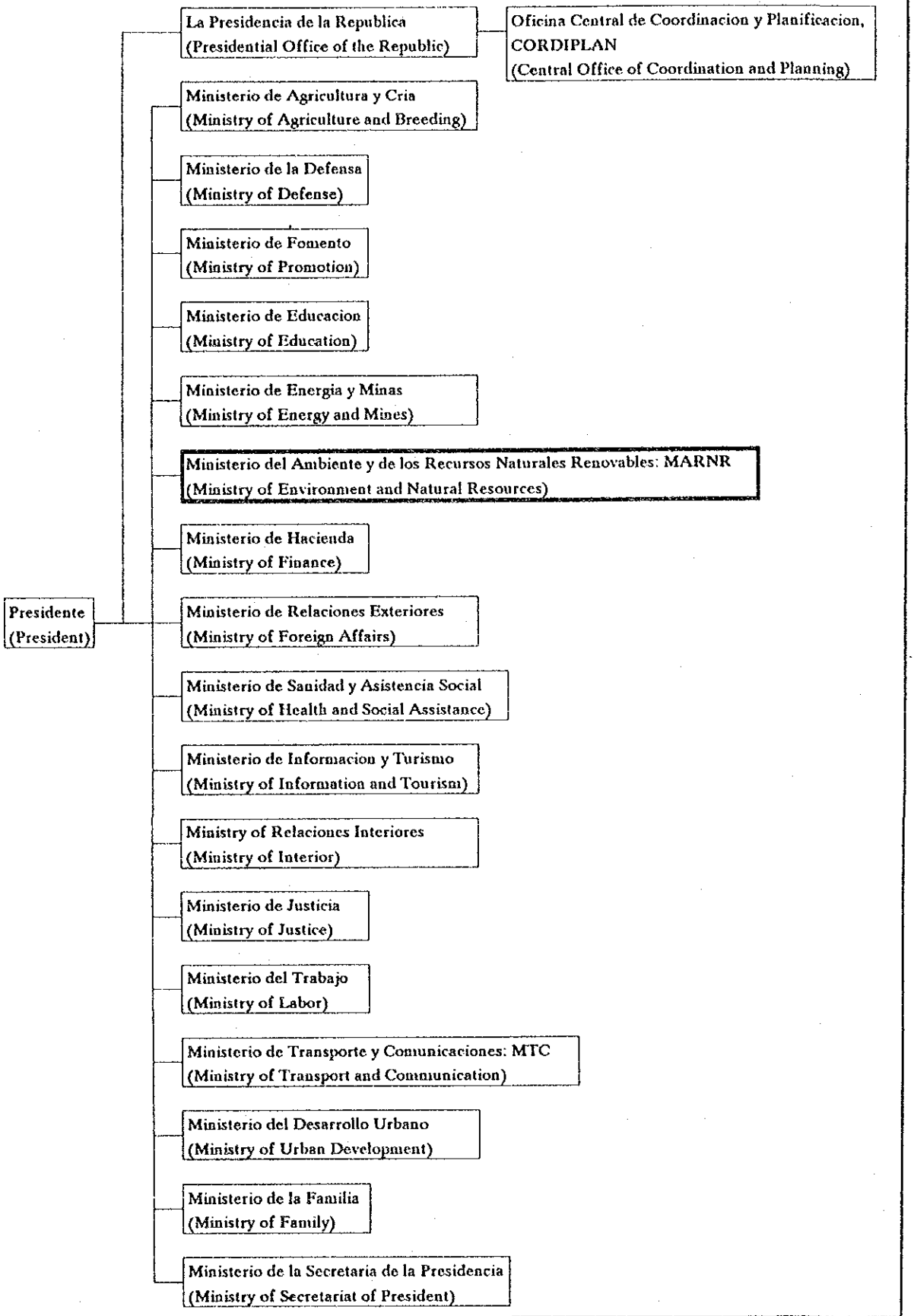

Fig. 3.1.1
Executive Branch of the Central Government

THE REPUBLIC OF VENEZUELA
COMPREHENSIVE IMPROVEMENT
OF THE APURE RIVER BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY

PART-I

ENVIRONMENTAL SURVEY

STUDY ON COMPREHENSIVE IMPROVEMENT OF THE APURE RIVER BASIN

FINAL REPORT

VOLUME III : SUPPORTING REPORT
PART-I : ENVIRONMENTAL SURVEY

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I. ENVIRONMENTAL SURVEY ON THE STUDY AREA

The environmental survey on the study area comprises two main parts:

1) The natural environmental setting, including the physical and biological components; and
2) The human social setting, including the institutional setup and the legal framework.

This chapter briefly describes: 1) the environmental conditions of the study area, and 2) the existing institutional setup within the study area and the regulations on conservation of the environment.

1.1 Environmental Conditions in the Study Area

The particular rain pattern of the area conforms a very strong driving force that rules the behavior of plant and animal communities living in the llanos, specially in the areas subject to periodical flooding. The way water and land interweave changing the space proportions and conditions is of paramount importance to the species of the llanos biota.

In order to be prepared to perceive what we need to do when man interferes with this environment, and be able to avoid or mitigate the impact of development, we first need to have a clear picture and understand the particular conditions of the relationships of animal and plant communities of the llanos wetlands and the ever changing conditions of their surroundings.

Taphorn (1988), observes that in the Apure river basin the rainy season begins in April and ends in November in most years, and that deviations of about three months in either extreme are not unusual. This brings about the fact that in the short term climate is not very predictable, and that this fact makes it difficult to survive for some organisms. Species can count on the rains coming sooner or later, but do not know exactly when (Taphorn, op cit.). This can be specially important for fish which migrate to complete their life cycles.

Of course, not only the local rainfall affects the area. Precipitation in the higher parts of the watershed has a very important effect in sediment carriage and in the apportioning of great amounts of water to the flat lands downstream.

Mean temperature is usually above 24°C in the areas considered, and is relatively stable throughout the year. Daily variation is not very significant, except that during dry months the early morning temperature might be comparatively low during some days.

During the rainy season, the high moisture contents of the air contribute to the high temperature in the area.

The area of the llanos examined in the present study is considered one of the most recent geological formations of Venezuela. Not long ago, the whole llanos area was covered by a shallow inland sea, with deltaic characteristics on its margins, and was slowly transformed into dry land as a consequence of the Andean uplift and the erosional processes which have subsequently produced the sediments to fill it up during Pleistocene times.

The ecological transformation of the area has been, also, one of great change from a deep geosyncline, to a shallow inland sea environment, bordered by increasingly and gradually growing lowland deltas, into the actual area, a huge landfill of very dynamic behavior due to the ever changing micro relief, with meandering rivers and caños, and large inundated areas by the effect of a yearly flood season, and the opposite dry season replacing it time after time, all of it behaving as a great inland delta, in which the sedimentation process of great amounts of material coming from the Andes is slowly and constantly modifying the micro relief of the region (Roa, 1981).

Eisemberg (1978), observes that the llanos contains a fauna which is derivative from the adjacent biogeographic provinces and that the actual conditions seem to be more Mesic than during the Pleistocene, and that it might also have a history of aridity alternating with seasonal inundation.

Consequently, plants and animals have gradually followed such drastic changes in the process of colonizing the newly found territory, and only those species capable of withstanding the gradual changes and the peculiar behavior of the water cycle have endured and conformed the diverse array of species that compose the interesting llanos biota (Rivero Blanco & Dixon, 1979).

The actual seasonal llanos landscapes are a product of the dynamics of sediment deposition of the rivers described by Roa (1981), Vivas (1984) and Tejos, Schargel and Berrade (1990). The resulting topographic pattern described by Ramia (1959, 1974) is normally referred to as the "sabanas de bancos", "bajíos", and "esteros", describing the behavior of the system in relation to the way water occupies the land surface according to the season.

Perhaps one of the most clear descriptions of the dynamics of the seasonal llanos is the one (freely interpreted) from Roa (1981): "...due to the great amounts of material they carry, and to the slow stream velocity, the rivers accumulate sediments in their beds; their marginal dikes or 'albardones' are elevated above the general level and from them, during the high water months, the excess water overflows or breaks the dikes, creating breaches, called 'salidas de madre,' subsequently covering the lower areas, and depositing new materials. This is how the typical relief forms appear in these regions, in the form of deltaic arms, with their abandoned dikes and their 'salidas de madre,' forming the sinuous higher ground locally called 'banco'; these high ground structures dominate the lower terrain for some 1 to 2 meters and are never entirely covered by the water level allowing the llaneros to build their houses and villages on them. The other spaces are the lower 'cubetas' called 'esteros.' Between the 'banco' and the 'estero' lies a transitional gently sloped zone, which takes some water but quickly looses it when the rains and floods cease. These are the bajíos, rather shallow and extensive."

Among the vertebrates, a very important assemblage of species lives temporarily or permanently in the area: 33 species of mammals (Utrera, 1988); 154 bird species (Ríos, 1988); 27 amphibians and 47 reptiles (Rivero Blanco and Dixon 1979); 350 fish species (Taphorn, 1988); invertebrates are represented by a great diversity of species. In the case of fito and zoo plankton, for example, Zoppy and Michelangelli (1981) identified 121 species of copepods, rotifers and cladocerans in their study of the water in Mantecal.

Life diversity is great in the seasonal llanos, but perhaps more interesting than just the number of species is the way the different organisms relate to the seasonality of the climate and specially to the water cycle. When it is dry or wet, or when the water levels go up or down, many interesting phenomena happen to the inhabitants of the llanos. Many species respond to the physical environmental changes with behavioral changes and, for example, species enter courtship or mating periods. For some species it might be the time to build nests and lay eggs, for others it is the time to fly or migrate or aestivate or simply become dormant until the right season period arrives.

It seems that all the autochtonous organisms are well adapted to the classic space assemblage in the seasonal llanos: the "banco", "bajío", and "estero". As these grounds seasonally change from large to small and the living beings of the llanos conform their lifestyle to the relative abundance of water, cover, and food.

1.2 Institutional Setup and Regulations on Conservation of the Environment

In order to understand the institutional and legal framework some comments on both aspects follow:

1.2.1 Main Actors in the Institutional Setup in the Study Area

These include :

- The Ministry of Environment and Natural Renewable Resources (MARNR) which is the main central government organization concerned with the Project. Within MARNR, the office that deals the with the environmental impact of all development projects is the Dirección de Calidad Ambiental (Bureau of Environmental Quality), which has the responsibility of requesting to conduct the Environmental Impact Statements for any project that may influence the environment. This means that this office will request such studies when the Orinoco Apure Program office (PROA) is ready to start designing a specific project within the study area.

- PROA which belongs to MARNR and constitutes a special program for the development of the Orinoco Apure Axis and its areas of influence. In the case of the Environmental Impact Statements necessary for specific projects, PROA must contract a third party –usually a private consulting company -- to do the studies, and then submit the results to the Dirección de Calidad Ambiental of MARNR for its analysis and issuance of appropriate authorizations and/or recommendations.

- The Wildlife and Game Program (PROFAUNA) of MARNR. It is at the same political level as PROA, as has great interests in the study area because of the area's natural richness in animal and game species. PROFAUNA's activities in the area include research, development of wildlife and game management programs with the local ranch owners. Most of the operational budget of this MARNR Office comes from contributions from the farmers and ranchers that exploit the local wildlife.

- PROFAUNA practically sustains itself with the wildlife and game richness of the area, so that any modification of the landscape that would change or damage the natural production of animal species would be strongly opposed by this office.

- The National Institute INPARQUES that plans and manages national parks. These are usually very large areas, comprising mostly portions of undisturbed nature. Protection is maximum and visiting of certain areas is possible and desirable. Many national parks have been declared in order to protect headwaters of watersheds among other resources. At this moment, there are 42 national parks in Venezuela, covering about 15% of the area of the country. There are eleven (11) national parks which protect the Apure watershed and are all contributing to the protection of the headwaters of many rivers draining into the Apure. The majority are in the Andes highlands. The recently created Río Viejo National Park is the closest to the Apure headwaters, lying partly along the Río Sarare, within the limits of the San Camilo Forest Reserve and occupying 500 km^2.

- Other Ministries: Ministerio de Agricultura (Ministry of Agriculture), is in charge mostly of agriculture. Its most important field of administration related to the project, other than agriculture, is the local commercial and subsistence fisheries. Any works that may harm or alter local fisheries production must be in accordance with the decisions of the National Fisheries Office of this Ministry. The Ministry is also responsible for the agricultural projects and their development and management within the area.

The Ministry of Tourism is not so influential in the zone as yet, but since the llanos landscape is becoming more and more important for ecotourism, it should be considered.

The National Agrarian Institute (IAN) is the official institution mandated by law to carry out Venezuela's agrarian reform. This central government office is very influential in defending the local peasants and small farmers.

Local governments (governors, municipal councils and city mayors): The actual political changes and trends, from a predominantly centralized government to a regional one, are very important to consider.

The local governments want more and more power and independence from the central government. Local authorities want to have part in every development project. PROA will have to deal with these factors and coordinate its efforts with the local governments if it wants to promote projects in the area.

Research and teaching institutions such as UNELLEZ and the Venezuelan Central University (UCV) have great influence in the area. They produce the professionals that

will work in the local public offices and private enterprises. Both institutions are leaders in research and local natural resource development programs, and are very interested in becoming important part of development efforts.

UCV has published many study reports on the Apure modules and their ecological impact since their implementation.

UNELLEZ is the largest local teaching and research institution devoted to the study of Western Llanos. It is the local research resource in the region and participates in the development of natural resources management programs. For several years, UNELLEZ has been pushing forward an extension program to develop local farmer interest in working with native species and using the local landscape in its natural conditions with the least intervention. The extension program is growing very fast and will become very useful in a short time.

Civil organizations such as the Cattle Growers and Farmers Organizations are locally very strong and influential. They must be part of whatever development scheme we may want for the area; after all, they own the land and they are the producers.

Farmers or landowners in general are very sensitive to what is done that can modify or alter their property and the functioning of their economic income sources. This fact is very important, because any extensive land works may be cost by and difficult because practically all land in the area is privately owned, except for the land owned by IAN and occupied by farmers.

Some national civil organizations that also have influence in decisions pertaining to natural areas are those called Non Governmental Organizations (NGOs), such as AUDUBON and FUDENA. These are conservation organizations that have great influence in the welfare of nature. AUDUBON is mainly an organization devoted to the conservation of avian fauna, but with a very broad scope of interest and influence. FUDENA is specially interested in protecting flood prone areas called "humedales", just as many wetland areas within the study area, because of the natural capabilities of these lands in the production of valuable wildlife and fish.

1.2.2 Regulations on the Environmental Aspects of the Study Area

- Ley Orgánica del Ambiente (Organic Law of the Environment) 1976: This is the main body of laws promoting national development under environmental guidelines aimed at attaining a better life for the citizens. The general

development of the Orinoco Apure Axis must be planned within the framework of this law.

The following parts of the law are of special interest to the study:

- Chapter I: Articles 2 and 3, items 1), 2), and 4) that deal with the territorial order, planning processes for urbanization, industrialization, population, and dispersion of economical activities involving the environment; the rational use of soil, water, flora, and fauna, including energetic sources and other natural resources of continental or maritime origin with regard to environmental values; the prohibition or correction of those activities that might degrade the environment.

- Chapter V: Article 20, items 2), 3), ... 13) pertaining to the activities that might degrade the environment, such as those that might alter topography or natural water flow, or cause sedimentation in water bodies or negative changes to the river bottom.

- Decree No. 2.831: Reglamento parcial Nº 4, de la Ley Orgánica del Ambiente sobre clasificación de las aguas (Water Classification Regulations) 1978

- Ley Penal del Ambiente (Law for the Enforcement of Environmental Regulations): Promulgated in 1992, this law is a penal extension that regulates punishment for those that violate the Organic Law of the Environment.

  The following parts of the law are of especial interest to this study:

  Title II, Chapter I, Article 30 related to the changes to water flow or sedimentation; Chapter III, Article, 43 on degradation of soils, topography, and landscape; Chapter V on those actions capable of causing damage to flora and fauna, their habitat, and protected areas.

- Decree 2.213: Reglamento parcial de la Ley Orgánica del Ambiente sobre estudios de impacto ambiental (Partial Regulations of the Organic Law of the Environment for Environmental Impact Evaluations) 1992.

  This Decree includes the regulations for Environmental Impact Statements: These special regulations deal with the specific project needs and the timing and procedure to prepare and submit an Environmental Impact Statement to the Dirección de Calidad Ambiental of MARNR. In accordance with these regulations, PROA should make and submit an Environmental Impact Statement

in due time. The following are of particular interest: Chapter I, Article 2: The environmental variable must be incorporated in the development plans and programs since their initial stages, and it must be adjusted to the different stages of pre-feasibility, feasibility, design, construction, initiation, operation, maintenance, closing or dismantling, permitting the transformation of basic or conceptual proposals into development actions compatible with economic and environmental points of view.

Chapter II, Article 7 referring to activities related to infrastructure development including ports, fluvial navigation, and channel works; dams higher than 20 m, etc. which require environmental impact studies.

Since most of the works that may result from this study will be done in rural areas, it is important to conform to Chapter III, where the Basic Environmental Questionnaire necessary for this case is outlined.

- Ley de Reforma Agraria (Agrarian Reform Law): This law creates a framework for the agrarian structure of the country and the way the local peasants and small farmers or producers will fit in the nation's agricultural framework.

  This law will become very important to consider if any development works associated with the studies would have an impact on private property.

- Ley de Tierras Baldías y Ejidos (Law of Public Lands): This law regulates the lands that belong to the nation, and the ways to manage such spaces in terms of national welfare.

  The Law of Public Lands is important to consider whenever works are to be located in such areas.

- Ley de Llanos (Llanos Law) 1936: This is the Apure State Law for the agricultural and farming activities within the state boundaries.

  Specially important to our study are Articles 105 to 108 which deal with water management in livestock and agricultural production.

- Ley Forestal de Suelos y Aguas (Law of Forests, Soils and Waters): This laws is devoted to the conservation and management of natural resources of soils, water, forests, and all the products derived therefrom.

A very important aspect of this law, with regard to the Project is the regulations concerning the protective zones of water bodies like large rivers, medium and smaller streams, and lagoons. In Chapter II, about Protective Zones, Article 17 of Part 5 defines a protective zone as: "A minimum zone of 50 m in width in both sides of navigable rivers, and 25 m in the case of non navigable courses, be they permanent or not." This means that for any river works this regulation should be taken into account, in order to protect the vegetation of gallery forests and to maintain the stability of the river margins.

- Ley de pesca (Fisheries Law), enforced by the Ministerio de Agricultura y Cría and the Oficina Nacional de Pesca, with offices in San Fernando de Apure. Article 8 of this law reads: "Channelizations or any other hydraulic works should be executed in a manner not to affect the aquatic life, and the dams and dikes in general should be constructed in a way to permit the fish migration path by means of special ladders with a maximum slope of 45°."

- Ley de Protección a la Fauna Silvestre (Wildlife and Game Law): This law specifies the management of natural wildlife species for the protection of the species and their products, the rational harvesting of natural populations, and the regulation of hunting. Wildlife refuges are considered in this law as protective areas for important wildlife species.

  Some specific regulations within the wildlife regulations deal with capybaras, crocodilians, and turtles of the llanos. These animal species are highly prized economic resources, harvested by local people. They bring large monetary as income to local peasants and farmers and usually reproduce at the shores of rivers and other water bodies in the study area.

- Ley Orgánica para el Ordenamiento Territorial (Organic Territorial Order Law): This Law regulates all national activities in a territorial sense, for the purpose of using the nation's territory in an orderly and efficient way. The use of the space is planned in Venezuela under the principles of this law.

- Ley de Inparques (National Parks Law): The National Institute of Parks administers all the natural areas defined as national parks and natural monuments. The Special Regulation 276 is at present the legal instrument for managing these areas.

- Wildlife refuges regulations are produced independently by PROFAUNA.

All the above regulations show that there is a complex and valuable legal background on which to base any future actions in the region.

Whenever the projects are to be considered for development in the future, the appropriate Environmental Impact Assessment studies shall be initiated.

1.3 *Survey on Distribution of Objects to be Conserved in the Study Area*

Three kinds of objects to be conserved can be identified within or related to the study area: 1) natural communities, 2) plant and animal species and 3) officially protected areas, such as national parks and wildlife refuges, and all other not officially protected but considered in need of protection.

1.3.1 Natural Communities

Natural communities are species assemblages composing the living portion of ecosystems in the area. These species groups are important as a whole because they conform with the natural landscape of the llanos in the study area. They are composed of species which maintain a coherent functional whole.

The typical natural landscape of the study area is formed roughly by three main plant associations: 1) tall forest along the river beds called gallery forest (bosque de galería), 2) deciduous forests in large areas away from the river, and 3) open grasslands called savannas, which in certain areas can be flooded to certain height and called "sabanas de bancos", "bajíos y esteros". Some areas may look different, probably due to human intervention to the original plant cover, either in permanent form or are now left alone in a successional process, or because they are the natural transitional zones between the main plant formations.

The gallery forest is the plant association with the largest tree species, due mainly to its close association with main water courses and access to plenty of water in the soil. A great area of this type of forest is now gone due to unlawful deforestation along the river sides.

The deciduous forest usually grows at sites where soil water seasonally changes and is rather scarce during the dry periods. The majority of the species of this forest type are deciduous, that is, they drop the leaves during the driest period of the year in order to keep enough water in their body to survive the drought.

The savanna is the lowland vegetation association related to large extensions of land within rivers, usually low lying land, at elevation lower than the river banks. Most of the savannas in the western portion of the study area are at higher elevation, usually under cultivation and seldom flood compared to the eastern portion, of low lying land, with long period of flooding and mostly devoted to extensive cattle grazing during the dry period. Some savannas are natural, some are man made and maintained by the action of periodic fire and constant grazing.

Some of the most delicate systems identified in the areas are the complex flood plain savannas of "banco", "bajío y estero", along with the diverse animal community living in these ecosystems and the food chains that show the complex and delicate relationships between the water, land, and aerial inhabitants of the study area. The reproductive cycles of most river fish species constitute a special issue due to the fact that flooding is determinant in their reproduction and feeding habits, and or course, the economic importance as food that fish represent for local "ribereños".

Plant species are important as components of the plant communities associated to the natural habitats where they grow, and also to the time of the year when they appear or disappear from sight.

Fig. 1.3.2, (modified from Ramo and Ayarzaguena, 1983), depicts the typical micro relief of the floodable Venezuelan llanos. The high, intermediate, and low grounds receive different amounts of flood water and hence the plant associations that grow on them are very different.

The seasonal llanos landscape is the result of water level variations in a very flat surface of recent sedimentary origin. Areas of the llanos under El. 100 m above sea level receive most of the excess river water flowing over the sides of the "banco", or river bed, built with the sedimentary material carried by the river itself. In this fashion, during most of the rainy season, the water flows over the "banco" into the shallow extensive areas along the rivers called "bajíos" and then continue into deeper larger bodies of water called "esteros" which are, in reality, the lower elevations within the rivers.

The resulting landscape mosaic is called "sabanas de bancos, bajíos y esteros". Most of the study area is formed by this type of countryside, which forms the home to an important diversity of plants and animals perfectly adapted to the variations of the water cycle throughout the year.

1.3.2 Plant and Animal Species of Importance

Plant and animal species are the main components of the natural communities and ecosystems of the area under study. Most environmental impact produced by development will eventually act upon the native species not in a direct way, but through modifying the living conditions and finally making it difficult or impossible for the species to live without the appropriate kind of food, water, or shelter.

Some of the most important species in plants and animals in the floodable llanos of Venezuela will be considered in the following paragraphs.

(1) Plants

The most important and common plant species are representatives of several plant groups: the grasses, the Ciperaceae, the herbs, the shrubs, and the trees. All these groups are represented by different species depending on which kind of habitat they are.

Cuello et al (1989), in their study of the vegetation of Portuguesa River, find more than 470 plant species, belonging to 306 genera and 83 families of plants. They also report 9 species of ferns in the area.

For the forested areas, these authors report an upper story formed by trees in a range of 20 - 30 m height, with a moderate epiphytic growth adapted to drought. A second story with species reaching 20 m, and an understory that has an upper limit of 10 m. Most of the species are deciduous, but if living near the rivers, they probably do not need to drop the leaves.

Much of the actual forest is really modified due to extraction of timber producing species. Many of the trees that were of high economic value were felled long ago.

The savannas are mainly covered by various species of grass and some rather small trees and palms.

In Tables 1.3.1 through 1.3.3, we can find the most important plant species living in the savannas of the "estero", the "bajío" and the "banco".

The great diversity of the "bajío" is notorious, perhaps due to the fact that most of the changes in water level and contents are happening in this shallow water logged area. Typically, the bajío is the most extensive of the three.

Among the plants of the area, aside fom some tree species, perhaps none is really notorious for being endangered. The plants of the "estero" are probably some we may consider in vulnerable condition, due to the fact that if a "estero" is permanently dried, the Palma Llanera, *Copernicia tectorum*, is one of species most likely to disappear, due to the conditions of extreme alternate dryness and wetness it needs to survive. At this moment, the "estero" plant community is not endangered, but if the "esteros" were dried, then the plants that need the annual change as the Palma llanera, will certainly disappear.

If conditions in the bank change, and the forests are waterlogged for long time, many of the tree species will also die. The works for river channel must take this into consideration, in order to maintain the tree cover, and in certain way to maintain the river channel itself.

(2) Fish

Some 350 species of fish are known in the study area. Any works that bring about changes in the way water flows or is distributed in the areas have to consider the possible changes in fish behavior or even local extinction of those more sensitive, as the ones that have to migrate through the system.

In Table 1.3.4, 166 of the most common fish orders of the area are presented. These include: Rajiformes, Clupeiformes, Siluriformes, Gymnotiformes, Characiformes, Atheriniformes, Symbranchiformes, Perciformes, and Pleuronectiformes.

Fish diversity is notorious in the seasonal llanos wetlands, because of the adaptation to climatic changes of the fish species of the area. Fish "can count on" rains returning sooner or later, but they can never "know" when exactly to be ready for them.

The dry season is like a "part-time desert" and acts as a bottleneck that imposes great evolutionary restrictions upon fish. Some species of fish have a variety of adaptations to withstand drought. The majority simply die in the process of waiting for the next wet season to arrive and rely only on a few highly fecund individuals that will contribute to the species survival. The author refers to the "founder effect" as the strategy to survive every year that the few individuals that survived in small water deposits from which they have to reclaim 99% of the territory again each year.

Another strategy is to be a generalist and/or an opportunist dietwise, in order to eat whatever is available as conditions change with time. Another one is the urge to "get up and go", that is important because such behavior puts the fish where food is in a very

short time. Some fish tend to spawn in mid river, so the eggs are washed out into the inundated savanna as soon as the water overflows the banks.

Fish diversity is apparently due not to climatic stability but rather to the very unpredictable physical regime to which the fish are subjected every year. In this sense, fish communities seem to decrement in species diversity when areas are flooded and water levels controlled by the effect of dikes or other means that bring about stable conditions.

In this regard, the fish species that may disappear from the area are those in need to migrate for reproduction. Several species are now in problems due to dams that prevent their migration and pesticides which pollute their habitat. Commercial fish, as Coporo, Catfish and Cachamas are among those that must be protected. The Pavón, *Cichla ocellaris*, is the sports fish that is now in most critical situation due to high demand from sports fishermen. Forty-six species of ornamental fish live in the floodable llanos. The economic importance of such species in the European and US markets is high. The field is still developing here in Venezuela, and needs further research.

Perhaps the most common problem of fish species can be illustrated in Fig. 1.3.3, (modified from Morales, 1990) where the food chain relationships of the llanos can be summarized. Solar energy enters the system and is used by green plants to produce tissue that is eaten by zooplankton, insect larvae, and other animals. Fish make up an intermediate size stage, rather high in the water food chain, but in due time subject to be eaten by birds, reptiles, and mammals, which rank high in the food chain.

Food chains that link the aquatic and terrestrial ecosystems of the lower llanos are subject to problems related to pesticides entering the food chains through the runoff water and the insects and other invertebrates.

(3) Amphibians and Reptiles

The Amphibians and Reptiles of the llanos are two groups of organisms well adapted to the water regime of the llanos. In Table 1.3.5, sixty-eight of the most common species are named. The two groups are well represented by frogs, toads, snakes, lizards, turtles, and crocodilians. Among these groups, 9 species are known to be in some degree of danger or threatened. These species are indicated in Table 1.3.6.

Among the most important species is the Orinoco Crocodile, *Crocodylus intermedius*, still known from scarce populations in some of the tributaries as Rio

Cojedes and Portuguesa. Some efforts are being made in Apure, Guárico, and Cojedes States to keep some populations extant. Some animals have been reared in captivity and are released in the wild for research on how they can recover in some areas.

The Orinoco river turtle is very important also, because of its economic importance to people in certain parts of the Orinoco, where they reproduce. The relation of this species with the study area is that after hatching, the small turtles migrate to the "esteros" and there they feed on fallen fruits during the floods. Any dryness in the ""esteros" will imperil such species.

The other very important species is the Baba, *Caiman crocodilus*, a medium-sized crocodilian which has been subject to management programs in the "esteros" and "bajíos" of the study area. This species needs the changing dry-wet conditions to live. Most important, it needs some water level at the beginning of the flooding season to be able to mate, build nests, and lay eggs.

(4) Birds

The 150 most common species of birds of the study area are named in Table 1.3.7. The most endangered bird species are those subject to game or sports hunting, of these the most common are the pauxis and the wildfowl. Some of the large birds as the Garzon Soldado, and the Maguari Stork are also in critical condition due to agricultural influence because of the contents of pesticides in their diet. Most birds that eat insects and rodents, such as the herons and ibises, are under the menace of death through pesticide ingestion and accumulation. The same goes for the group of raptors, such as the hawks and kites (Table 1.3.8).

Some bird species are in problems right now due to the drying of certain areas called "garceros" where they use to reproduce.

These species are those that need to reproduce in colonies, in flooded areas [See Table 1.3.9 and Fig. 1.3.4 (modified from Ayarzaguena, 1981)]. Many of the species are the herons and other species of aquatic birds of great value to the ecotourism and economic activities, since breeding in large colonies is part of their reproduction habits and this makes it very attractive for observation of great numbers of these birds in the flooded terrain's. Flooding is probably the main condition for these birds to constitute the colonies. Flooding gives protection to the young isolating them from terrestrial predators. The scarlet ibis, a species only found in Venezuela and Trinidad, is specially valuable for bird watchers and other naturalists.

(5) Mammals

In Table 1.3.10 most of the mammal species living in the area are named. The eleven most vulnerable species of this group are presented in Table 1.3.11. These include: four felines, one anteater, the giant armadillo, the giant river otter, the tapir, the wild pigs, the almost extinct spectacled bear, and the manatee. All these species have been pursued because of their skin and or meat value, and for many years the hunting pressure has decimated their population in the area.

(6) Invertebrates: Arthropods in general, Insects, Crustaceans, Mollusks

These groups of animals are not well studied in the area. The most important aspect is they constitute an important part of the food chains, specially in the water. Aquatic invertebrates bloom during the early floods and serve as food for larger invertebrates, fish, amphibians, reptiles, birds, and mammals. No information on any species being endangered was found in the literature. One of the main issues pointed out by the fish experts consulted is that many fish feed on insect larvae growing in the bottom of the rivers. These scientists do not recommend extensive river bottom dredging because of the possible destruction of the biological conditions of the river bottom where these organisms live.

1.3.3 Protected Areas

Protected areas directly associated with the study area (Fig. 1.3.1) and the Apure River are two (2) wildlife refuges and one (1) national park:

The following two wildlife refuges, administrated by PROFAUNA-MARNR, exist within the area of influence of the Project:

(1) The Estero de Chirigüare Wildlife Refuge

This covers an area of about 44.500 ha along the Río Guanare between Guanarito and Arismendi, near La Trinidad and La Capilla (Portuguesa and Barinas states). It is the only wildlife refuge actually located inside the study area.

Chirigüare is a wildlife refuge which has been subject to changes in its area and limits as well. Initially it had a rectangular shape, as proposed by FUDECO, and was later transformed into a triangular area as officially published by MARNR. A more

recent study, made by Dr. Gonzalo Medina, proposed more natural limits, taking the course of the Guanare River as part of its northern limit and moving more to the east, following some natural features that would allow more wetland habitat to be included and, at the same time, help improve the actual conditions for guarding the wildlife by providing more natural boundaries. This last limit correction, Decree No. 645 of December 1989 was published in October 1991 in the Official Gazette No. 34.812.

The area is rich in species of fish, reptiles, birds, and mammals associated with the annually flooded savannas. "Esteros" with its typical population of llanos palm and all the savanna vegetation associated with it are present. The gallery forest along the Guanare in this area is still much on its own. A great part of the refuge is located in private land and PROFAUNA has to clear this situation in order to protect the wildlife within.

We have seen the refuge both from the ground and from the air. While much of the savanna of the "estero" has been traditionally a cattle grazing ground, there is a great amount of forest still extant.

We have flown over the area during both the dry and wet seasons, and observed that the contrast is enormous. This accounts for the great variety of wildlife that lives and reproduces within the refuge.

(2) Caño Guaritico Wildlife Refuge

A tributary of the Apure river, originating near Guasdualito, joins the Apure at Santa Catalina. The refuge starts at the bridge on the road between Mantecal and Bruzual, and occupies the bed of the "caño" and the legal protective 50 m wide forested zone on each side. The navigable part of Caño 70 is also part of the refuge.

This refuge is not located within the study area, but will probably be under the influence of water level changes in the Apure River. It is important to consider this possibility because one of the objectives of the refuge is to provide the opportunity for reproduction to shore reproducing species like crocodiles and turtles taking advantage of the great sand banks that form along the caño during the dry months. According to PROFAUNA, young captive bred Orinoco crocodiles have been released annually in the refuge since 1990. This refuge will serve as a protected natural breeding ground for this endangered species.

The one natural condition that allows an Orinoco crocodile to breed and lay eggs successfully, is the existence of sandy river shores during January, February, and March. For such reason, the caño must remain dry during the dry season. The same applies to numerous species of turtles and other reptiles that lay eggs in sandy shores. Measures should be taken to avoid Apure river water from entering the caño if it happens to reach a higher water level during the dry months due to river works that enhance navigation. If water comes back into the caño during the dry season, the sandy shores will be covered and reproductive value of the habitat will be changed.

The caño is also the first fresh water fishing preserve ever decreed in mainland Venezuela. The most recent studies account for 70 fish species living in it. Preserving its reproductive values for fish will be an important part of the management plan PROFAUNA is preparing at the moment.

(3) Río Viejo-San Camilo National Park

Decreed as a national park in 1992, the Río Viejo-San Camilo, is close to the area of influence of the study due to the fact that it is traversed by the Sarare river, a western tributary of the Apure river.

This new national park is actually a portion set aside from the San Camilo Forest Preserve, which was established in 1981. The new park covers approximately 500 km^2 of land. The park lies between Caño La Ceiba or Río Viejo, Río Sarare, and Río Burguita. The decree issued by MARNR did not explain this transformation. It is assumed that some parts of the forests do not have the timber value necessary for it to remain a forest preserve and that part of it is a flood plain or estero, with no forestry value. Anyhow, the natural conditions seem to be valuable enough to justify the creation of a national park, presumably because much of this land is under pristine forest.

This national park lies well outside the study area, but is included in the report due to the fact that it lies along the Sarare river, but before the Uribante reaches the Apure, and up river from Santos Luzardo Port.

1.3.4 Other Areas

There are other areas which have been considered and proposed as special places for wildlife preservation as follows:

(1) Savanna Wetlands

Utrera & Ramo (1989), in their work on wildlife of Apuroquia, proposed several wildlife protection areas for the flood plains of Barinas state, in the Arismendi District. Most of the area is flooded annually and provides a good reproductive habitat for many species of plants an animals. The area is extremely difficult if not impossible to stabilize for monoculture agriculture. Besides, it is probably the most extensive and rich wildlife wetland in the llanos of Venezuela.

These flood prone areas lie within a triangle of land enclosed by a line connecting Apurito - Arismendi - San Fernando. In this area, native wildlife is very much conserved, and conditions for local farmers to get involved in management are promising. UNELLEZ is carrying out several research programs with native wildlife in local farms. Caimans, turtles, birds, capybaras, agouties, deer, and fish are some of the species that are being studied at this moment. The underlying reason is that these and other local species are naturally adapted to the dry-wet cycle and little needs to be done to enhance their populations and to use them for local production of food and other products. Besides, these species can be harvested along with cattle and any other farm animals actually growing in the area.

Caimans, in particular, belong to an important species that needs such annual water floods to live and reproduce properly. The species courtships and mates in the water; so the water has to raise to a certain level for the reproductive season to start. The nests are built with mud and plant material, in the higher and dryer sites, generally surrounded by inundated areas, which apparently act as protective barriers against certain predators.

In the future, some of the areas within this triangle might be conserved as Ramsar areas: For this reason, PROFAUNA and other organizations such as FUDENA and AUDUBON are interested in developing plans for protecting some of the wetlands landscape of this part of the llanos.

Special emphasis must be made for conserving the functional relation between Banco-Bajío and Estero.

(2) Gallery Forests

Utrera and Ramo, 1989, propose to conserve a tract of gallery forest along the Portuguesa, which has good dry season river shores for reproduction of the Orinoco

crocodile as well as for species of turtles and for many species of shore birds. The gallery forest itself would be invaluable for other species associated with such environment.

Since much of the gallery forests along the rivers in this area have been unlawfully felled and the space cultivated, it is very important to plan for the conservation of the still extant gallery forests in the study area as a means of protecting river courses and plant and animal species as well.

(3) Deciduous Forest

Patches of representative deciduous forest should be identified and studied for the purpose of conservation of samples of the original forest cover.

(4) Private Farms

Several reasons justify the consideration of private lands as some of the areas to be preserved. The actual farmland in use in this area is already a diverse production unit. Wood, cattle, caimans, and game are the traditional products. Nature tourism, or ecotourism, is a new and interesting line of development that is slowly taking place in the llanos.

Coming in and watching birds and other animals or plants is a new way to bring some money into the llanos, specially the wetlands where these are abundant species of birds. It is an environmentally sound way of producing income, because the operation is necessarily based on conservation of nature.

The fact that the "Garceros" (flooded areas where most large birds of the llanos build up reproductive groups called rookeries, every year through the flood season) occur on farmland is something very important to consider.

There is no permanent or localized area within the study area that can be said to be important for garceros. Garceros are scattered all over and mostly on farmlands. Utrera and Ramo *op. cit.* propose to recommend the farm owners to register or declare the garceros located in their properties in order to have an official record of the number and size of the reproductive potential of the area.

Both gallery and deciduous forests must be preserved within the farms, as a private action contributing to conservation of natural values of the region.

II. ENVIRONMENTAL RECOMMENDATIONS AND MEASURES

2.1 Habitat Requirements of Species

The diversity of plant and animal species in the llanos of Venezuela appears to be the result of a combination of basic factors: the distribution of relief, the distribution of vegetation cover, and the distribution of water in space and time, caused by the sharp seasonality of the climate.

The gallery forest, the deciduous forest, the savannas, and all the water existing in rivers, caños, lagoons, and temporary or artificial water bodies form a complex arrangement of habitats for the species of animals living in the area.

Some of the relationships between important species groups (reptiles, birds, mammals) and their habitats are shown in Tables 12 through 14.

One important observation from reading these tables is the fact that most species use many habitats at the same time, and few use one exclusive type of habitat. Perhaps the turtles, crocodiles, giant river otter, and manatee are the most aquatic of all. In general, most animal species can withstand all the seasonal changes throughout the year.

When the different habitat types offered to plants and animals in the llanos are analyzed, we can find that in terms of water, food, and shelter availability, they range in a varied number of combinations of two main dimensions:

1) Relief: from higher drier ground usually along the river banks to lower wetter ground that usually is found between the rivers and sometimes is permanently waterlogged.

2) Wetness: from a drier yearly season that peaks around March and April, to a wetter rainy season that peaks around August.

The combination of the two produces a high variety of opportunities and allows many species to live and reproduce in the area.

Ojasti (1990) suggests that the fauna living in these areas is not really dependent on the savanna resources, as in the case of the many species living in African savannas, for example. This author is of the opinion that in Venezuela, many of the "savanna" species of mammals, for example, are very much forest dependent species.

This observation suggests that the Venezuelan llanos savannas are still too young and have not developed yet a fauna of their own, and that the animal species that live in the savanna are primarily forest or forest edge species that live part of their life in the savanna. In this sense, his opinion is noteworthy, because it actually points to a combination of the forest-savanna assemblage, as the producer of resources for maintaining species diversity.

It is important, then, to conceive the faunal assemblage in the llanos as one that needs a rather complicated habitat combination instead of simple one type resource. This is a clear indication that if we want to conserve species in the llanos, we must allow for diversity of habitat and avoid provoking a simplification of the habitat.

For of the above reasons, any agricultural practice that can provide protection to a combination of all types of forests and savannas would be the most ecologically sound strategy for developing the land and, at the same time, conserving nature.

2.2 Conservation Measures Related to Channel Stabilization and Flood Control Plans

2.2.1 Environmental Considerations about the Channel Stabilization Plan

- From the ecological view point, dredging should be done only in those places actually presenting depth problems for navigation. In this regard, we must address the matter to figures F10 through F17 (Apure River) and to F18 through F19 (Portuguesa River) of the Explanatory Paper for Channel Stabilization Plan (Draft). In such figures, the sites having critical depths that need dredging works are specified. Dredging works in these sites should be monitored in terms of space and time in order to evaluate the amount of disturbance of water.

- Channel stabilization, specially in braided sections of the river, may accelerate the flow in the main channel and make slower the flow in other shallower areas. The effects of these actions upon the river life are not clear at this moment. No specific recommendations can be done at the moment on this matter.

- The effects of closing anabranches and building derivation channels are very specific, and should be studied accordingly for each project. From the studies performed, it appears that the only diversion channel that will be proposed is the one on Caparo-Uribante Viejo, as seen in F.3 in the Channel Stabilization Plan.

In both cases, care must be taken to either close the anabranche or open the derivation channel only during the short time when it is really needed.

- Controlling water levels above the normal level during the dry period could impede the reproduction of species that use beaches for the purpose of building their nests. This possible impact has to be looked at very carefully, because depending on the actual increase in water level and the length of time the river stays under such conditions, it could be problematic to some species.

  Most animals that reproduce during the dry season an use the beaches for nest building, usually need to work within very critical timing in order to reproduce. Nest building, egg laying, and incubation take place at the beach, and their offspring must be able to get out of the nesting area before the onset of the wet season when water level starts to rise again and may cover the nesting areas and drown the eggs in the nests.

  Constraints: Article 17 of the Ley Forestal de Suelos y de Aguas (1966), prohibiting the felling of forests within 50 m on each side of navigable rivers.

Another constraint is the one poised by the Caño Guaritico Wildlife Refuge. This matter must be investigated in cooperation with PROFAUNA.

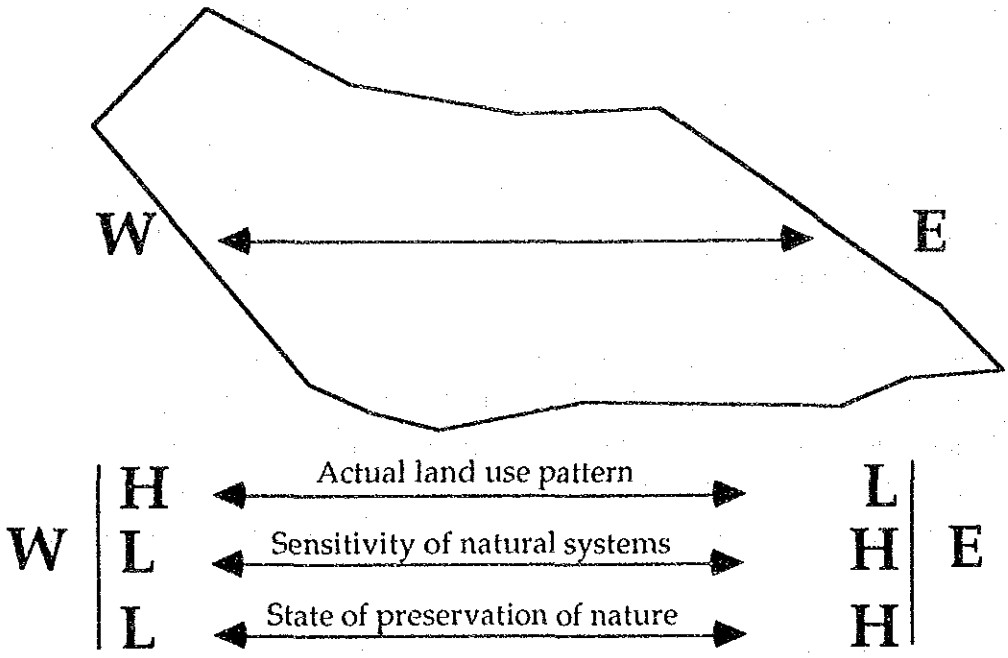
2.2.2 Environmental Considerations about the Flood Management Plan

(1) General

If considered with the following three criteria:

1) Actual land use pattern
   In a value scale from higher to less technified
2) Sensitivity of the natural systems
   To effects of flood management
3) State of preservation of nature
   Actual state of preservation of natural conditions

The study area could be evaluated as follows in a very generalized way:



From the figure above, we can see that:

1) The actual land use pattern in terms of technification is and will be higher to the northwest and gradually less technified towards the eastern sector around the confluence of the Portuguesa and Apure rivers.

2) The sensitivity of the natural systems is higher to the east, because these are the more complex sabanas of bancos, bajíos and esteros. These systems depend heavily on the dry-wet cycle produced by the yearly seasonal changes.

3) The state of preservation of nature is higher to the east because the great cost of developing these areas is an economic constraint. This results in lessened intervention of man in the natural systems, and the adaptation to the extreme situations as in the case preferring water adapted buffalo to cattle.

In all the above considerations there is a gradual continuousness factor that accounts for changes from one extreme situation to the other. This means that in some intermediate zones the technification, the sensitivity, and the preservation factors will have intermediate values and corresponding states.

Considering the above criteria –and using them– the development of the study area would be more naturally or ecologically sound.

This would mean to regulate the percentage of surface dedicated to production in a developed landscape and that dedicated to conservation of the natural landscape.

A general theoretical outcome could be somewhat like this:

Area	Western Area % of weight	Central Area % of weight	Eastern Area % of weight
Developed Land	High	High	Low
Natural Land	Low	Medium	High
Productive Surface	Most	Most	Most

The reason for the productive surface to remain the same percentage in all cases, even when the developed (man made modifications) are few as in the easternmost region, is that in those cases imported adapted species as buffalo or native species as caimans, turtles, capybaras, and other wildlife species are being harvested and produce economic revenues, contributing to the overall productive purpose of the land. In these cases, the value of wildlife and its unmodified surroundings can also provide income from touristic activities.

In the central areas, the module option would provide an intermediate degree of human intervention and the mixed production of cattle and wildlife species. Here tourism can also become an added productive activity.

In the western areas, most of the land surface is modified and made productive by using sophisticated technologies, irrigation systems, aerial treatment of fertilization or other uses.

A plan with such scheme would be easily understood and accepted by those interested in economic development and by those sensitive to conservation of natural resources. It would offer a desired balance between what really can be accomplished in terms of development of agricultural systems and protecting natural systems.

One very important factor here is that we tend to call development only the high technology agricultural products and methods.

We are not normally considering the real potential of the land as it is because in our minds if it is not high technology then it isn't.

During the last 20 years, the Venezuelan llanos have shown several interesting opportunities for creating a technological development of its own, with native species and using local physical features.

The success of caiman harvesting and farming, the productivity of the capybara, the largest rodent on earth weighting up to 50 kg, and the local module technology that can be used to control the use of water for a mixed farming in small scale and produce cattle, capybara and caimans, at the same time, are some of the new trends that will have to be considered in development of the area, along with the new species that are under research at this moment and with the introduction of wetland adapted species like the buffalo.

If this gradual trend of using the natural setting and species is followed, and soft technology is applied seriously, the percentage of land left in a natural or close to natural undisturbed state would be great and we would be producing a variety of economic autochtonous values.

(2) Protection Areas

With regards to the protection areas, some comments follow:

1) Area A

With regard to this area, and from the environmental viewpoint, at this stage, there is no way to decide to protect it by building the levee either on the right side of Caño Igüez, or on the Portuguesa. We do know there are some important tracts of gallery forests on the Portuguesa, and also some important river shores on which live some of the few still remaining Orinoco crocodiles, according to Utrera and Ramo (1989).

The areas that will be inundated by the effect of the dikes will have to bear a higher water level than normal. The effect this change in water level will have upon vegetation cover will probably be a local change in spatial distribution of such plant cover, and also in the proportion of the space used by vegetation. The extent of this changes cannot be ascertained at this moment, but since inundations are a rather common phenomena in the study area, its effect will

not be extraneous to plants and animals of the area, most of which will have to re-arrange their local distribution pattern in order to go with the changes.

By producing more precise relief maps of the areas that will be inundated and contrasting this information to actual vegetation cover, it will be possible to predict how vegetation cover of areas north of the proposed dikes will change with a water level increment. Anyway, these areas are already very modified by agricultural activities and very little land surface is in natural state nowadays.

With regard to the crocodiles, it is widely known that one of the most important resources for the Orinoco crocodile are the beaches needed for nesting and incubation. Since the flood control plan effects would be felt during the rainy season, we believe that the reproduction of the crocodile will not be in trouble.

The other natural feature that relates to this area is the close location of the northern limit of the Chirigüare Wildlife Refuge to the southeastern portion of Area A. The area of the refuge should not receive any impact from the flood control plan.

Constraints: Article 17 of the Ley Forestal de Suelos y de Aguas (1966), prohibiting the felling of forests within 50 m on each side of navigable rivers and 25 m on each side of those not navigable. The same applies to borders of lakes and natural lagoons.

2) Area B

Area B is for the most part the largest area to develop. In this case, the levee is conveniently proposed so as to protect the Chirigüare Wildlife Refuge. The only other feature of importance here is related to the gallery and deciduous forests that may still exist. At this moment, we are plotting the forest areas of the "Fotoplanos" in order to get a more precise look at the distribution of this feature.

The most important consideration here is to protect tracts and patches of forest wherever they are present. The only possible way at this moment is mostly to make the producing unit –the farm– the one responsible for the protection of forests within the properties, specially those forests associated to river sides.

This is something that should be done by law, but has not been duly enforced.

Other forests –those not associated to river sides– should also be cared for, because they have a definite ecological value in providing shelter and food for many species of animals. Some of these species are important predators, that are useful allies of man by feeding on rats and other plagues of agricultural works. Maintaining diversity and a percentage of nature is very healthful for agricultural systems.

Constraints: Article 17 of the Ley Forestal de Suelos y de Aguas (1966), prohibiting the felling of forests within 50 m on each side of navigable rivers and 25 m on each side of those not navigable. The same applies to borders of lakes and natural lagoons.

3) Area C

This area is the most likely to be subject to a more natural way of doing agriculture. In this area, a close to natural agricultural practice would be the module, as the ones used in Apure State.

The module imitates nature in these areas, and while providing a means of controlling water for agriculture, it simulates so well the local natural systems that local species are also favored. This poses a great opportunity to use the technique to produce the mixed farm concept where harvesting of some native species is made parallel to ranching or farming.

Constraints: Article 17 of the Ley Forestal de Suelos y de Aguas (1966), prohibiting the felling of forests within 50 m on each side of navigable rivers and 25 m on each side of those not navigable. The same applies to borders of lakes and natural lagoons. It would be wise to associate the development of this area with the module technique but in small production unitwise scale.

Proximity of the Caño Guatirico Wildife Refuge should be considered. In this protected area, a program for the reproduction of the Orinoco Crocodile –an endangered species – has been in effect since three years ago. As in the case of the Portuguesa river , the sandy beaches that form during the dry season should be guaranteed for the reproduction of the species. Since the flood control plan will be effective during the rainy season, we believe the crocodile

will have no problems. The effects of higher than normal water levels during the rainy season in the refuge should be studied and assessed through a research program coordinated with PROFAUNA.

4) Area D

This area is the one associated to the diversion channel proposed to protect San Fernando from the water excedents of the Portuguesa River. The effects are definitely positive with regard to protecting San Fernando.

The effects of this channel on nature are very localized in time and space, because the diversion is only a few kilometers long and will only function should a given level of water in the Portuguesa is surpassed.

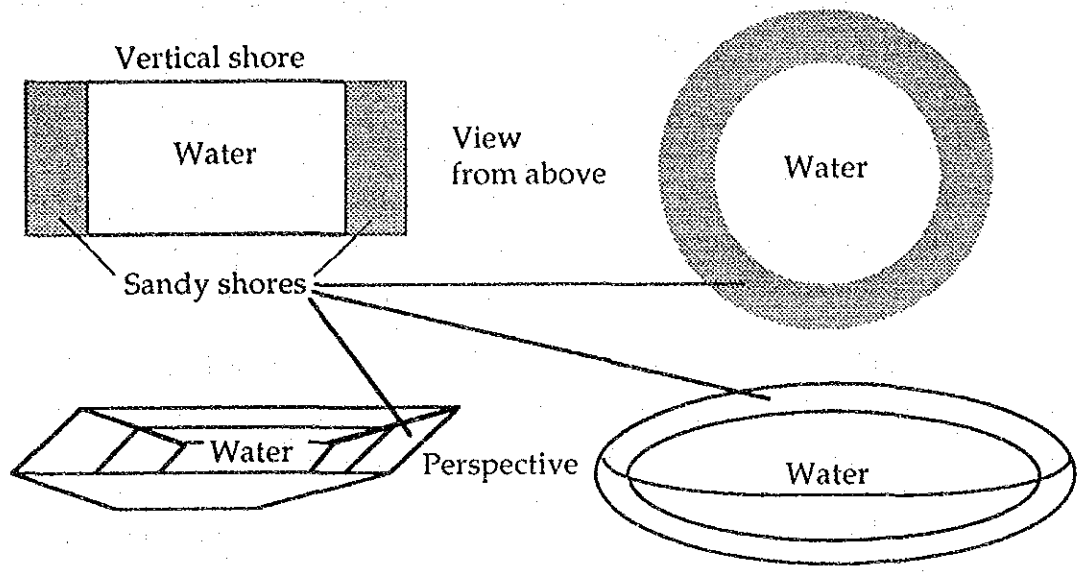
A diversion channel producing an anabranche is a common phenomenon in the course of the Apure, and they have naturally formed and disappeared depending on the history of the river. This is part of the natural functional behavior of the river system in the area, and native species of plants and animals are adapted to changing living places when water courses just merely change waterways. The normal constantly moving river courses in the area makes this small proposition to be a very localized and innocuous alteration.

Constraints: It would be wise to propose to plant a forest along the levees of this canal, in order to make it more stable.

Areas not protected: Much of this area is supposed to act as a retarding basin. The recommendations we can make for this area would be similar to the Area C, using modules and native species for a mixed agricultural system a the scale of the landowner.

(3) Proposed Measures Concerning Dike Construction

1) Specially designed "ecological borrow pits" that produce the material for the levees. These pits should be constructed by digging in the usual manner at the start, but then moving the tractor gradually, in order to form a radial pattern instead of a rectangular one. The product should be a borrow pit with almost circular shape, with optimized 5° - 15° slope shores along the full perimeter, producing a longer high value land-water frontier for wildlife use.



Traditional rectangular borrow pit
(40% shoreline)

Proposed circular borrow pit
(100% shoreline)

2) The provision for some long sections of dike to be designed with special gates, that can be activated to allow water flow to certain areas that need some degree of flooding for nature protection or agricultural management purposes.

2.2.3 Landscape Modifications and Aesthetics

Project development that needs building large structures –such as dikes– can produce changes to natural visual aspects of the landscape and may render an unwanted, unnatural vision to the observer.

If the original visual impression of the landscape is changed by building large structures like dikes, measures must be taken to try to blend and harmonize the structures with the natural features like skylines, object proportions, and colors.

The changes in landscape produced by human constructions can be analyzed with regard to two basic dimensions:

(1) Changes in a Large Scale (Gross Scale)

Any large scale development scheme may produce visual changes in the llanos landscape, and these changes may take the form of:

- High structures such as dikes or levees, for example.
- New water bodies as in the case of borrow pits, or drying of former water bodies.
- Changes in the distribution of surface and ground water as in retaining overflow water or impeding flooding of some land surface.
- Changes in the distribution of plant cover, due to changes in water distribution.
- Introduced straight line structures (dikes, levees, irrigation channels, roads, electric poles and lines, etc.).
- Sharp angle structures, squares, rectangles, and cultivated land reticulation. Cultured land has straight lines, sharp angled figures, and reticulation.
- Temporary color changes while levees are constructed will occur, because the new dikes do not show green plant cover for some time.

(2) Changes in a Fine Scale (Detailed Scale)

Landscape appreciation has a finer, more detailed impression when great changes in the landscape begin to reflect changes in a detailed scale.

- Important local or widespread changes occur in species composition of animal and plant communities; some species will migrate, some will probably come in as new colonizers or invaders; some will move to the next best area after their home has been transformed.

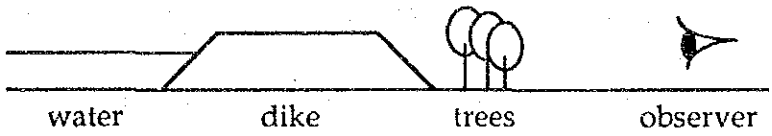
- Some plants are important or characteristic detailed parts of a gross scale landscape. The llanos palm (Copernicia) is one of them, because of the shape and the pleasant visual impact of the isolated plant.

- Some animal species are very diverse and colorful, and always present, specially the bird fauna. In the last ten years this colorful and conspicuous resource has become very important as a touristic attraction. Some "garceros" –the reproductive colonies of wading birds– are very colorful and valuable to nature tourism as part of the llanos landscape during the wet season.

(3) Harmonizing the Structures and the Landscape

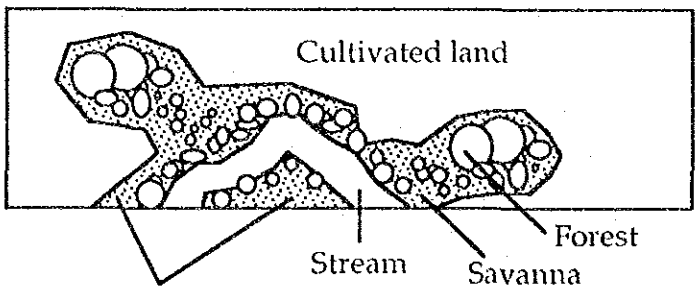
Following are some recommendations to harmonize structures in developed areas within the llanos landscape:

- Avoid producing very straight lines when possible.
- Levees should be hidden from sight by the use of tree curtains planted on the protected side parallel to the dikes. Such plant cover should preferably imitate the height of the forest cover of river banks.



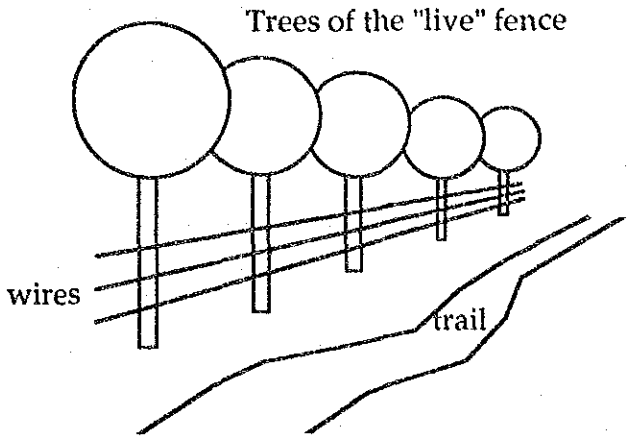
The best botanical composition for such strips of forest would include those plants known to local people as producers of wildlife food and shelter.

- Channels for irrigation, when possible, should follow the contour lines.
- Cultivated land lines should follow contour lines when possible to avoid sharp angle reticulation.
- Keeping and maintaining small patches of forest dispersed within the plantations.



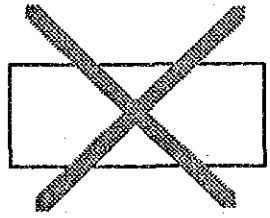
Areas to be protected
by leaving them as they are

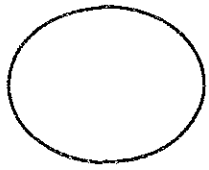
- Use of "live" fences along the borders of plantation plots and properties is also a good general basic practice. There are a number of species that are appropriate and commonly used in Venezuela, such as Rabo de Ratón and Indio desnudo. These will grow vegetatively from planted sticks and develop into protective wind curtains and good wildlife refuges.



- Plant cover for any new areas should be varied, never monotonous. Areas with natural vegetation should be sampled in order to ascertain species composition and prepare transplant strategy and methods.

- The borrow pits needed for the dikes should be built with a circular shape, moving the tractor in a progressive radial pattern to obtain a contour close to a circular shape with gentle sloped shores all around. These shores constitute very valuable wading bird habitats.


Old style borrow pit


Proposed circle shaped borrow pit

2.3 Considerations on The Socio-economic Setting of The Project

2.3.1 Historical Review:

From its beginnings (XV century), the human setting on the area of influence of Apure River Basin was characterized by a nomad pattern of occupation, being adapted to the physical and ecological conditions of the region.

Because of this, the first settlers are mainly established on adjacencies of Portuguesa and Apure Rivers, coexisting, with very precarious technologies, an ambulant agriculture, fishing and hunting. these resources were exploited without generating disturbances on environment.

The beginnings of coffee and tabaco exploitation (XVI century) enhanced the development of coastal and mountainous zones in the country, with detriment of the flatland zone (Llanos), for its natural limitations and cost of adaptation for production.

During XVIII and XIX centuries, the occupation of flatland territory (Llanos), kept the same initial patterns, so arising the Latifundium, whose proprietors did not reside on Llanos but in the most important populated centers of the Country.

The first concentrations of population in the area of Apure Project, arose by the presence of missionaries and were located on the banks of Santo Domingo (Guanarito and Guanare Viejo) and Apure (Puerto Nutrias and Ciudad de Nutrias) Rivers.

The predominating economic activity of those settlers was agriculture and fishing which began to decrease due to the limitations of transportation, communication and finances, as well as by the poor sanitary conditions which caused the depopulation of flatland zones (Llanos).

As a consequence of this situation, the fluvial ways lose influence upon being substituted by land roads which connect the region to the rest of the Country, so favouring a migration process which is strengthened in the first decades of XX Century, induced by the increasing urbanization and economic activities (petroleum and industry).

In the second half of XX Century (50's) agricultural activity had a reappearance based on the inducement of the productive zones in Portuguesa, Barinas and Cojedes States, with a concentration of population in the less inundable and consequently, more utilizable zones from an agricultural point of view.

2.3.2 Characteristics of The Present Situation.

The study area of the Flood Control Project, from a political-administrative point of view, comprises four Federal Entities (Cojedes, Apure, Barinas and Portuguesa) and four Regions (Central, Llanos, Andes, Centro Occidental).

The urban centers of greater population (1990) are located on the periphery of the area (San Fernando de Apure, 72.733 inhab.), (Guanare, 83.380 inhab), (Bruzual 3.480

inhab); in 2000 inhabitants: Ciudad Nutrias, 1.112 inhab., and Puerto Nutrias, 1791 inhab.

In general, it is a disperse, eminently rural population, with little dynamism, presenting internal movements, towards the urban zones in the same area, as well as great gaps of territory occupation.

The support and service activities are provided by the urban centers of greater hierarchy above mentioned, located in the limits of the area and in Barinas City.

Presently, in addition to the traditional agricultural exploitation and extended cattle activity, it is observed from a point of view of economic activity, it is observed from a point of view of economic activity, an adaptation trying to utilize those species which are adapted to the flooding characteristics of the area.

In this sense, the activity has been oriented to the culture of species such as buffaloes, chiguires, babas, which bear flood without troubles.

Aware of this situation, the labors of Technical Assistance and Extension of Universidad de los Llanos have been aimed to the Consulting Service on the breeding of the above mentioned species.
Other aspect to be considered in the Project Area is the Land Tenency, which is presently quite atomized.

III. WORKSHOP ON ENVIRONMENT

3.1 Introduction

A workshop to discuss the possible environmental effects of river and flood control plans was prepared with the purpose of inviting a number of qualified environmental and engineering professionals to contribute their opinion on the issues. It was held in Caracas, on March 5, 1993.

The two objectives of the workshop were:

1) To obtain specific environmental recommendations to minimize the environmental impact of the flood control and channel improvement plans;

2) To bring together, in a formal professional meeting, a number of environmental experts and PROA officials for the purpose of producing thought and discussion about fundamental issues on the channel improvement and flood control plans.

3.2 Preparation of the Workshop

PROA selected and invited a group of ecologists and engineers from universities and ONGs, as well as from MARNR and PROA to participate in the workshop.

A package of informative materials on the workshop procedures and on the river improvement and flood control plans was produced and handed to participants as supporting materials for the workshop (see Annex). These include:

1) Descriptive materials on the flood control and the channel improvement plans.

2) Descriptive materials on the activities and actions necessary to carry out the plans.

These materials were complementary to the presentations of the plans and the environmental considerations made by Mr. H. Sadamura, Mr. N. Jitsuhiro and Mr. C. Rivero at the introductory session of the meeting. The purpose of this presentations was to explain the plans and the environmental aspects.

Work forms were also prepared and handed to participants in order to obtain information on the different aspects to be discussed.

3.3 Workshop Accomplishments

The workshop brought together a group of professionals that discussed basic issues and exposed a variety of opinions and proposed several environmental measures and actions about the proposed plans.

Due to the short time allowed for the workshop, each discussion group selected its own way to tackle the problems and dedicated the available time to those issues of interest to the group members.

In a general way, the outcome of the workshop has been very useful and it forms a basis for looking further into the plans and PROA´s own policies in order to develop a better future for the area.

At the same time, it was an excellent opportunity to gather such talented group of professionals and briefly discuss the issues and get an idea of their opinions on the river and flood plans.

The workshop accomplished the two proposed objectives and produced some of the desired information, but only in a general way, because the plans are still in the basic stage. The information thus obtained is still usable as a guidance to some important environmental aspects the plans must consider.

3.4 Use of Information Produced in The Workshop

The observations and recommendations made by workshop participants about the environmental aspects of the proposed plans have been considered by the planning team for the purpose of using those that are valuable and improve the studies.

At the same time, the team has attempted to clarify or interpret those issues that do not seem to apply to the actual studies because of misunderstanding or misinformation on the part of the workshop participants. The same applies to those that are too vague, or too general to be of use at this moment, and that would rather be useful in the future production of specific projects.

The workshop contributed to the improvement of the plans in a general way. PROA will use the information contributed by the participants to enhance its future plans for the area.

3.5 Synthesis of Main Issues Addressed by Participants

The following is a synthesized and classified list of recommendations made to PROA by participants in the workshop groups.

Recommendations were classified by theme in order to group some that were repetitive because they were produced in different work groups which addressed the same issue with the same recommendations but generally expressed with different words.

The following classification themes were used:

1) Sensitive human activities
2) Sensitive institutional activities
3) Sensitive species or natural communities
4) Endangered species or natural communities
5) Plan-related issues that need to be investigated
6) Environmental Impact Statements that need to be made
7) Possible effects
8) Terminal effects or impacts
9) Preventive or mitigating measures proposed
10) Other possible contributing experts recommended by workshop
11) Research projects or publications that might contribute to the Plan
12) Necessary research proposals

3.5.1 Sensitive Human Activities

PROA should consider different alternatives in addition to navigation in order to attain the objective of spatial ordering of the country and a better and more balanced distribution of population.

One issue considered as an alternative was to improve the present situation of the local populations by providing better basic services and other values, such as enhancing health, medical care, school, access to food, and agricultural techniques and only after that is done, then enhancing navigation.

The riverine communities have developed and adapted to special systems for life support, based on a mixture of farming, ranching, and fisheries. These would be affected by river works. Care must be taken so that the plans affect positively such human activities.

Local human populations can be affected negatively if the local and indigenous people are not introduced adequately to new conditions. This possible problem should be studied early enough.

Works on diversion channels or on anabranches must be well studied regarding their influence on the landowners downstream.

3.5.2 Sensitive Institutional Activities

Protected areas are sensitive. There are two wildlife refuges and one new national park in the area of influence of the plans. In this regard, PROFAUNA and INPARQUES will have to be consulted by PROA.

Other sensitive human activities are: Local subsistence and commercial fisheries; local governments and communities; caiman farming associations; cattle ranch associations; cotton growers; nature or ecotourism activities.

Local university research interests in natural resources management in the area should be promoted and encouraged. The information already produced should be used when necessary.

3.5.3 Sensitive Species or Natural Communities

Commercial and sports fish species can be affected in a negative way, because their populations can diminish by death of eggs and young due to sedimentation, dredging of the main channel, and works on diversion channels. Provisions should be taken in order to check with the ichthyologists the time of the year when the works are to be done, in order to avoid conflicts with reproduction stages.

In the case of river derivation, the specific and local ecological problems must be assessed with anticipation with the necessary studies.

Most of the dike works will affect, on the one hand, the gallery forests along the rivers and, on the other hand, the Paspalum grass savannas that are used locally by cattle. This is an important issue that should be studied carefully before starting the projects.

The closing of anabranches does not need to be permanent, there must be a form of regulating it so that it only works during the dry season. This should be investigated.

The marginal soils of the llanos lowlands do not need protection from flooding, because they can be utilized by particularly adapted production systems, such as buffalo, local fauna, fish, cattle grazing, and tourism.

3.5.4 Endangered Species or Natural Communities

Among the endangered species that live within the study area, the most mentioned one was the Orinoco Crocodile. This species used to be very abundant in the whole watershed, but now only a few remaining populations are holding. The nearest ones known are in the Portuguesa and Cojedes rivers, and those introduced during the last three years in the Caño Guaritico Wildlife Refuge. These three rivers are sensitive areas for this species.

The reason why the crocodile and other riverine species are so sensitive is that many of them use the sand bars and beaches during the dry season for building their nests and laying eggs in the sand. Flooding of beaches may kill embryos in the eggs. This issue should be consulted in specific cases with the biologists that work with these species.

Of the natural communities, the most frequently mentioned were the gallery forests of the Portuguesa, Apure, and Guanare rivers, although no official indication of endangered status exists, it is widely known that deforestation of such areas is progressively done by landowners and settlers, and that few places are still holding. The plans should include some recommendations on treating these communities.

3.5.5 Plan-Related Issues to be Investigated

(1) With Regard to Protection from Inundation:

Both options of dikes on the right margin of the Portuguesa or the right margin of Caño Igüés were commented briefly.

From the analysis, the workshop suggested the possibility of eliminating the alternative of Caño Igüés because of the little effects that it would produce upon protecting poor agricultural lands. The one on the right of the Portuguesa must be carefully studied as it may affect Turén and also the river's gallery forest.

The opinion of a group is that the Area C does not need dikes, nor flood control. The western portion from Chirigüare to Troncal 5 does not need generalized flood control either. There is a need to study carefully the social and economical convenience of protecting the Zone C. In the case of Portuguesa river, the dikes imply better drainage of Turén, specially by Caño El Frasco. The area to the west of Chirigüare, up to Troncal 5, does not need a generalized inundation control plan.

Retarding basins are a consequence of the construction of dikes. This is an observation regarding the area labeled retarding basin in the maps used in the workshop.

The construction of dikes over large tracts of land is probably not justified since much of the land has no agricultural value anyhow. These lands, however, do have alternatives and opportunities of use compatible with the inundation regime.

The dike on the left bank of the Apure river doesn't seem to be viable because of its possible consequences in altering water flow, more sedimentation in the river way, probably because it might form a delta upstream of the dikes.

The subject of agricultural interests and opportunities was also discussed. People from UNELLEZ and PROFAUNA-MARNR expressly pointed out the need to diversify land resource use by harvesting a variety of local animal and vegetable resources instead of turning once more to one or two monocultures.

If subject to extensive flood control, through a large dike system, the savannas of banco bajío and estero in the easternmost portion of the study area are likely to suffer drastic changes in their species composition; the natural aspect of the landscape of that area will totally change.

Natural resources represented by native species of fish, reptiles, birds and mammals may lose their value. At the same time, this would be a very costly way of developing agriculture in the eastern portion of the study area.

PROA should produce a Master Plan for the use of the watershed, including the headwater areas. As an important addition, the overall influence of the construction of dikes on the Río Portuguesa, Igüés, and Apure should be evaluated.

(2) With Regard to Navigation Improvement:

The most general opinion was that PROA has to look back into its basic policies and try to see navigation as one more way of enhancing local human life. The navigation project should be inserted in a more ample context as the comprehensive management of

the whole watershed. The navigation means and methods should be adapted to the natural conditions of navigability of the rivers. With regard to using water from some existing dams, it was pointed out that the Vega Honda Dam did not endure an economic feasibility analysis done by MARNR and contracted to CIDIAT in 1991.

One observation about the navigation plan was that, considering the navigational obstacles for a certain vessel size versus the number of months, it is necessary to take specific treatment measures in order to enable navigation for a longer period. In this case, a recommendation was: Why not design a vessel that would be better adapted to the present conditions of the river instead of designing the river for a particular vessel?

Designing shallow depth vessels adapted to the actual river conditions would be an environmental measure that would help extend the navigation period and avoid dredging or other heavier engineering measures.

A more natural way of taking advantage of such waterway at the moment would be through the use of boats designed with the optimum bottom depth for the Apure river. The hydraulic dynamics of the sediments in the watershed must be assessed. The impacts of closing anabranches and constructing derivation channels should be assessed.

3.5.6 Environmental Impact Statements that need to be Made

It is necessary to make environmental impact studies on how the plans may affect several local productive animal species. Environmental impact statements should be made for each project once the plans start to be implemented.

3.5.7 Possible Effects

Agriculture: positively, because it adds more potential lands to agricultural production, but it is urgent to carry out studies to assess the potentiality of such lands.

Cattle ranching and other local wildlife resource management projects could be affected in a negative way.

Changes in sedimentation regime, water quality, riverine topography; river waste, all with negative effects on fauna and flora.

The expected influence upon navigation through controlling dams would be small. The effect of changing the hydraulic river regime appears to be a potential impact for aquatic fauna.

With regard to ecotourism, enhanced navigation may allow access to former inaccessible places, but the proposed works could change the landscape and local distribution of wildlife, endangering the natural resources for this growing economic activity and lowering the potential of certain areas.

In the case of river works, generalized dredging would affect the aquatic fauna in general and in particular would affect the food sources for the Catfish used commercially.

The "Rio Apure Viejo" National Park was recently decreed by the present Minister of MARNR on the Sarare River, upstream of the Apure river. Researchers should look out for possible incompatibility with the navigation plan.

The effects of dikes tend to be large upon ecosystems. If they dry out areas and ecosystems which need flooding, conditions will probably change too much and natural communities will be changed. The areas to the east of the carretera-dique de Camaguán - San Fernando are a good example of such effects.

Transportation makes possible a desirable commercial competition, permitting lower prices in certain goods and so on.

The use of the dams should not be compromised with the river works, because they have already been assigned to irrigating nearby zones and production of hydroelectricity. Closing of anabranches may produce impacts down stream.

There is no justification to build dikes on long traicts in order to protect lands that may be better used with more natural native alternate methods. There is no economic justification for construction of dams on the Guanare and Portuguesa (Puente Tejera & Vega Honda). They are not necessary and are very vulnerable to sedimentation.

It is suggested to use modules on the lower llanos, taking into consideration the Apure experience.

3.5.8 Terminal Effects or Impacts

Acceleration of currents, making it difficult or impossible for some fish species to migrate and specially to complete the reproductive cycle.

Among the positive aspects we find: more agricultural land, balance of the national land occupation trends; better transportation and commerce; better socioeconomic conditions; ease of navigation for small vessels;

Filling of derivations with the consequential changes and loss of habitat for some species.

- Loss of floodable savannas and possibly gallery forests
- Loss of habitat for local fauna
- Loss of opportunities to diversify landuse with native species

3.5.9 Preventive or Mitigating Measures Proposed

Closing of anabranches: the sites treated for this purpose must allow a minimal water flow in the affected branch by means of simple structures that should function without human intervention.

Dams upon Guanare and Portuguesa are not found to be justified (Puente Tejera y Vega Honda). According to some workshop members, there is no demand for such water, the dams are subject to fast sedimentation and their filling can damage lands with high soil potential like in the case of Río Guanare and Vega Honda.

Closing of anabranches could imply high costs of construction and nil benefits for navigation. Again, it was said that the river should be used by adjusting to the natural conditions as much as possible.

Instead of building new dikes, PROA should concentrate in consolidating areas that actually have an important agricultural development such as Guanare Masparro and Turén.

Modules were commented as the alternative for water control in the lower llanos. Their implementation should be promoted through small local private or cooperative endeavors, considering the experience gained by the actual existing larger Apure modules.

Programs must be designed for consultation and explained to the affected human communities; reforestation of the riverine forests; constant monitoring water quality of physico-chemical water conditions.

Establishing strict legal regulations; planning a controlled territorial occupation; planning for basic services;

The use of existing dams for irrigation, hydroelectricity, etc., must not be burdened with new or additional functions because it can compromise the future of the dams.

The construction of dikes should be only utilized to protect existing agricultural facilities or populated areas.

The dredging, when necessary, should be restricted to specific or localized sites, by promoting navigation by the use of the natural channel, adapting the vessels to the natural characteristics of channel width and water level throughout the year. Final disposition of sediments has to be evaluated.

The local land use must be assessed so as to know to what extent rice and pasture can grow without dikes.

It is necessary that a plan be made to explain the projects in due time to all interested parties of the zone or those with interests in the zone.

Plans for regional development must be produced, as well as an economic and social study of the products of the area and their potential markets.

Workshops directed to the different population segments must be prepared in order to establish their necessities and suggestions in order to incorporate them in the project.

There should be a permanent consultation strategy with the local communities.

With regard to management of dams or reservoirs, it should be the outcome of an integral management approach which should include the environmental variable as well.

3.5.10 Other Possible Contributing Experts Recommended by Workshop

With regard to this question, most answers related back to MARNR, PROA, PROFAUNA, INPARQUES, and UCV and UNELLEZ universities, where most of the researchers that are experts in the area actually work and can be easily located.

3.5.11 Research Projects or Publications that Contribute to the Plan

Following is a list of papers contributed by the participants, that are available in the UCV libraries:

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3.5.12 Necessary Research Proposals

Completion of the studies on the fauna and flora of Ríos Apure and Portuguesa.

Other aspects that must be studied are: Influence of river transportation in the cost; structure of agricultural production; human population movements; basic aspects of reproduction; food habits and physiological adaptations of important economic species.

In the case of closing of anabranches, the specific and local ecological problems must be assessed with anticipation with the necessary studies.

PROA must study and make clear its objectives and strategies for enhancing the population trends in the Orinoco Apure Axis.

Resumption of the studies on sediment that were formerly made by the Division of Hydrology.

The effects of closing of anabranches or derivation channels should be evaluated.

The gallery forests must be studied in regard to the environmental impact of their possible flooding when a given river has two dikes.

It is necessary to design a basic research plan within a global or master plan, with an emphasis in defining priorities.

The sediment behavior should be investigated as well as the apportionment from the higher parts of the watershed and mitigation measures designed and implemented.

High parts of the watershed must be evaluated and plans for conservation produced and implemented.

Analysis of transportation alternatives, for example the navigation up to Bruzual and from there on by train.

Cost-benefit analysis for the optimal navigation strategy.

3.6 List of Attendants to the Workshop

Groups 1 and 2

1.	Dr. Donald Taphorn	UNELLEZ	Ictiología
2.	Dr. Glenda Medina	FUDENA	Conserv. Humed.
3.	Dr. Luis Barreto	UNELLEZ	Ing.
4.	Dr. Antonio Esclapés	MARNR	Ing.
5.	Ing. Noel Javier	MARNR	Ing.
6.	Dr. Daniel Novoa	CVG	Biología Pesquera
7.	Dr. Santiago Ramos	UCV	Ecol. Sistemas
8.	Arq. Héctor Bracho	ECODIPLA	Planific. Ambient.
9.	Ing. Jesús Silva	PROA - MARNR	Ing.
10.	Ing. J.L. Méndez Arocha	PROFAUNA	Ing. Agr.

Group 3

1.	Dr. Antonio Machado	UCV	Biol.
2.	Sra. Mary Lou Goodwin	AUDUBON	Avifauna
3.	Geogr. Adelina Andressen	PROA - MARNR	Geógrafo
4.	Lic. Delfina Rodríguez	MARNR	Biól.
5.	Ing. Helios Silvestre	CTI	Ing. Agr.
6.	Ing. Esther Molina	MARNR	Ing. Rec.Nat.
7.	Dr. Edgard Yerena	INPARQUES	Biol.
8.	Ing. For. Casilda Ramírez	PROA	Ing. For.
9.	Ing. Richard Schargel	UNELLEZ	Ing. Agr.

Group 4

1.	Lic. Carmen A. Carrasquel	PROFAUNA	Biólogo
2.	Dr. Andrés Eloy Seijas	UNELLEZ	Biólogo
3.	Ing. Oscar González Pozo	CTI	Ing. Civil
4.	Ing. Luís A. Mirabal	PROA - MARNR	Ing. Civil
5.	Dr. Críspulo Marrero	UNELLEZ	Biólogo
6.	Lic. Virginia Park	CAURA	Biólogo
7.	Dr. Mauricio Ramia	UCV	Ecol. Sabanas
8.	Ing. Angela González	Hidroven	Ing. Hidromet.
9.	Sr. Yokito Sugimura	MARNR	Asesor Técnico
10.	Lic. Alejandro Luy	AUDUBON	Biol.

Dr. Carlos Rivero Blanco (Environmentalist, JICA); Ing. Noboru Jitsuhiro (Channel Stabilization, JICA); Ing. Hirofumi Sadamura (Flood Control Plan, JICA); Arq. Carmen Delgado (Director of PROA); Ing. Yoichi Takeuchi (Japanese Team Leader); Ing. Oscar Mirabal (PROA Counterpart)

3.7 Organizations Represented in the Workshop

AUDUBON: Venezuelan Chapter of the Audubon Society

BID: Interamerican Development Bank

CAURA: Caura Engineers; Environmental Consultants.

CTI: Integral Technical Consultants; Environmental Consultants.

CVG: Venezuelan Guayana Corporation

DIRECCION DE CARTOGRAFIA - MARNR: Bureau of Cartography - Ministry of the Environment and of the Renewable Natural Resources.

FUDENA: Foundation for the defence of Nature

HIDROVEN: Water Works of Venezuela

INPARQUES: National Institute of Parks

POA - MARNR: Environmental Planning Office - Ministry of the Environment and of the Renewable Natural Resources.

PROA - MARNR: Orinoco Apure Program - Ministry of the Environment and of the Renewable Natural Resources.

PROFAUNA - MARNR: Wildlife Project - Ministry of the Environment and of the Renewable Natural Resources.

UCV: Central University of Venezuela

UNELLEZ: National Experimental University of the Western Llanos " Ezequiel Zamora"

IV. NECESSARY FUTURE STUDIES

4.1 General

Some species require special attention and research effort in the near future, namely:

(1) Plants

Apparently, there are no plant species considered as endangered in the study area. This may be due to lack of published information or research. In a rather intensive study of vegetation of the mid-watershed of the Portuguesa River, (Cuello et al.,1989), did not report any species considered endangered for the area.

We suspect that some species –specially timber producing trees– can be in a rather difficult situation. The clearing of land space for cattle growing of agriculture and in the mean time cutting the forest trees for timber has been done for several centuries in the llanos. The most valuable timber species are rare at this time, and the actual species composition of the remaining forests is not anymore like when man was not yet in the area.

This leads us to believe that it is urgent to investigate the status of the remaining gallery and deciduous forests within the area, in order to be able to recommend the identification and conservation of those in better shape.

(2) Animals

The most endangered groups of animals, of which lists of species have been published, (Utrera and Ramo, 1989) are the amphibians, reptiles and mammals. Some bird species, specially those belonging to species that congregate in rookeries for reproduction may be also in a critical situation. See Tables 6, 8, 9 and 11.

Individual species studies must be performed for those species of amphibians, reptiles and mammals known to be endangered or threatened in the study area. In the case of the birds that congregate in rookeries, mixed species studies must be performed in order to ascertain their relation to the wetland behavior of the study area, and be able to identify and protect those areas that have the most rookeries every year.

4.2 Required Environmental Assessment

The proposed terms of reference for environmental impact assessment in the feasibility study phase will be as mentioned hereinafter.

(1) Assessment for Channel Stabilization Plan

Required environmental assessment will be as follows:

1) Physical assessment

- Water quality, specially relevant with regards to turbidity and sediment load/volume/time downstream from the sites for periodic dredging. Assessment of stream velocity variations derived from alignment works.
- Proper disposal of dredged material

2) Biological assessment

- Effects of river works, specially of water level changes, on species of plants and animals associated to river water and shores, specially those species using beaches for nest building and egg lying during the dry period.
- Effects of river works, specially of water level changes, on the species that live in the Guaritico Wildlife refuge.

3) Social assessment

- Effects of river works, specially those of closing or reducing flow through anabranches on private land along the reduced streams.
- Possible conflict over use of dam water.
- Effect on people living along the rivers.

(2) Assessment for Flood Management Plan

Required environmental assessment will be as follows:

1) Physical assessment

- Soil characteristics and quality, in the protected and unprotected areas.

- Sedimentation cycles and processes in the protected and unprotected areas.

2) Biological assessment

- Effects of water level changes, on species diversity of plants and animals associated to the natural savanna communities of Banco, bajío and estero.
- Changes from wet to dry or dry to wet surface of land and upon wildlife resources.
- Study on plant and animal diversity and carrying capacity of water and land surfaces within the area
- Possible pest development through favoring mono culture in the protected areas.
- Effects of water level changes, on the wildlife species that live in or near the wildlife refuge.
- Monitoring of the wildlife refuge for identification and study of any possible impact of the plans.

c. Social and economical assessment

- Effects on private land along the areas favored by protection and those covered by excess water during wet season.
- Possible conflict over private land agricultural practices.
- Advantages and disadvantages of stabilization of agricultural land practices over actual trends in policultural practices.
- Effect on people living in the areas concerned in terms of social, economical and political relations
- Aesthetic problems caused by constructions of large dike structures.

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TABLES

Table 1.3.1 COMMON PLANTS OF THE ESTERO

Group	Scientific Name
Gramineae	Hymenachne amplexicaulis
	Leersia hexandra
	Luziola spruceana
	Panicum elephantipes
	Panicum laxum
	Paratheria prostrata
	Paspalum orbiculatum
Ciperaceae	Cyperus articulatus
	Cyperus luzulae
	Eleocharis interstincta
	Eleocharis minima
	Eleocharis mutata
Herbs	Alternanthera crucis
	Echinodorus paniculatus
	Euphorbia dioica
	Heliotropium indicus
	Heliotropium lagoense
	Heliotropium procumbens
	Ipomoea asarifolia
	Neptunia prostrata
	Salvinia radula
	Staurogyne leptocaulis
	Trichospira verticillata
Shrubs	Borreria verticillata
	Hydrolea spinosa
	Mimosa dormiens
	Salanum sacupanense
Trees	Mimosa pigra

Table 1.3.2 COMMOM PLANTS OF THE BAJIO

Group	Scientific Name	Group	Scientific Name
Gramineae	Andropogon bicornis	Shrubs	Barreria verticillata
	Andropogon brevifolius		Cassia aculeata
	Axonopus compressus		Elephantopus mollis
	Axonopus purpusii		Hydrolea spinosa
	Cynodon dactylon		Hyptis conferta
	Eragrostis acutiflora		Hyptis pulegioides
	Hymenachne amplexicaulis		Hyptis suaveolens
	Imperata contracta		Melochia parvifolia
	Leersia hexandra		Melochia villosa
	Panicum junceum		Mimosa pigra
	Panicum laxum		Pavonia sessiflora
	Panicum versicolor		Sida acuta
	Paratheria prostrata		Sida serrata
	Paspalum chaffanjoii		Salanum mammosum
	Paspalum convexum		Vernonia brasiliana
	Paspalum millegrana		
	Paspalum orbiculatum	Trees	Annoa jahnii
	Paspalum plicatulum		Coccoloba caracasana
	Sorghastrum parviflorum		Fagara pterota
	Sporobolus indicus		Randia aculeata
Ciperaceae	Cyperus ochraceus		
	Eleocharis minima		
	Eleocharis mutata		
	Fimbristylis complanata		
Herbs	Caperonia palustris		
	Desmodium barbatum		
	Desmodium scorpiurus		
	Eclipta alba		
	Egletes florida		
	Euphorbia dioica		
	Heliotropium indicus		
	Hymenocallis venezuelensis		
	Ipomoea asarifolia		
	Phaseolus gracilis		
	Teramnus votubilis		
	Trichospira verticillata		
	Spilanthes uliginosa		
	Wedelia brasiliensis		

Table 1.3.3 COMMON PLANTS OF THE BANCO

Group	Scientific Name	Group	Scientific Name
Gramineae	Andropogon selloanus	Shrubs	Borreria verticillata
	Axonopus affinis		Cassia aculeata
	Axonopus anceps		Helicteres guazumaefolia
	Axonopus compressus		Hyptis mutabilis
	Axonopus purpusii		Hyptis suaveolens
	Cenchrus pilosus		Melochia parvifolia
	Cynodon dactylon		Melochia villosa
	Imperata contracta		Mimosa orthocarpa
	Leptocoryphium lanatum		Mimosa pudica
	Paspalum chaffanjoii		Pavonia sessiflora
	Paspalum plicatulum		Sida acuta
	Sorghastrum parviflorum		Scoparia dulcis
	Sporobolus indicus		Salanum mammosum
			Urena sinuata
Ciperaceae	Cyperus diffusus		Vernonia brasiliana
	Cyperus flavus		
	Cyperus luzulae	Trees	Annoa jahnii
	Dichromena ciliata		Coccoloba caracasana
			Vitex orinocencis
Herbs	Blechun brownei		Hymenaea courbaril
	Calopogonium mucunoides		Croaton fragans
	Centrosema pubescens		Tabebuia rosea
	Croton glandulosus		Tabebuia chrysanta
	Desmodium barbatum		Ochroma piramidale
	Desmodium scorpiurus		Triplaris caracasana
	Elephantopus mollis		Erythrina glauca
	Merremia umbelata		Sterculia apetala
	Ruellia geminiflora		Cordia coccoloba
			Cassica moschata
			Swietenia macrophylla
			Ceiba pentandra
			Inga spp.
			Bursera simaruba
			Guazuma ulmifolia
			Ficus maxima
			Pithecellobium saman
			Cordia alliadora
			Coccoloba caracasana

Table 1.3.4 COMMON SPECIES OF FISHES OF THE VENEZUELAN LLANOS (1/2)

Scientific Name	Scientific Name
Adontosternarchus devenanzi	Geophagus surinamensis
Abramites hypselonotus	Gephyrocharax venezuelae
Acanthicus hystrix	Cichla temensis
Acestrorhynchus falcatus	Cichlasoma festivum
Achirus lineatus	Colossoma macropomum
Adontosternarchus sachsi	Copeina arnoldi
Aequidens pulcher	Copella nattereri
Agamyxis albomaculatus	Corydoras aeneus
Anostomus fasciatus	Crenicichla geayi
Aphyocharax erythrurus	Ctenobrycon spilurus
Apistogramma hognei	Curimata argentea
Apistogramma ortmani	Curimata cerasina
Apteronothus bonapartii	Curimata spilura
Apteronotus albifrons	Cynilebias dolichopterus
Argeneiosus brevifilis	Cynodus gibbus
Astronotus ocellatus	Cynopotamus bipunctatus
Astyanax bimaculatus	Chaetobranchus favescens
Astyanax fasciatus	Characidium fasciatum
Astyanax metae	Charax gibbosus
Austrofundulus transilis	Cheirodon pulcher
Brachyglamis magoi	Distociclus conirostris
Brachyplatystoma filamentosum	Eigenmannia limbatus
Brachyplatystoma juruense	Eigenmannia macrops
Brachyplatystoma rousseaxi	Eigenmannia virescens
Brachyplatystoma vaillanti	Electrophorus electricus
Brycon whitei	Entomocorus gameroi
Bunocephalus amaurus	Epapterus blohmi
Callophysus macopterus	Ernstichthys anduzei
Catoprion mento	Farlowella accus
Cetopsorhamdia molinae	Gasteropelecus sternichla
Cichla ocellaris	Geophagus jurupari
Gosilinia platycephalum	Paragoniates alburnus
Gymnotus carapo	Parauchenipterus galeatus
Hemigrammus unilineatus	Parodon apolinari
Hoplerithrynus unitaeniatus	Patenia kraussii
Hoplias malabaricus	Paulicea luetkeni
Hoplosternum littorale	Pellona castelneana
Hoplosternum thoracatum	Pellona flavipinnis
Hydrolichus scomberoides	Phractocephalus hemiliopterus
Hyphesobrycon minimus	Phyrrhulina brevis
Hypophthalmidae edentatus	Piaractus brachypomus
Hypoptopoma thoracatum	Pimelodella gracilis

Table 1.3.4 COMMON SPECIES OF FISHES OF THE VENEZUELAN LLANOS (2/2)

Scientific Name	Scientific Name
Hypostomus plecostomus	Pimelodus blochii
Lebistes reticulatus	Pimelodus ornatus
Leiarius marmoratus	Pimelodus pictus
Leporellus vitatus	Pinirampus pinirampus
Leporinus fasciatus	Plagioscion squamosissimus
Leporinus friderici	Platynematichthys notatus
Leptodoras linnelli	Potamorhina altamazonica
Loricariichthys typus	Potamotrygon hystrix
Markianna geayi	Pristella maxilaris
Megalodoras irwini	Pristobrycon medianai
Metynnis hypsauchen	Pristobrycon striolatus
Metynnis luna	Prochilodus mariae
Moenkhausia dichroura	Pseudoceptopsis plumeus
Mylossoma aureum	Pseudohemiodon laticeps
Ochamacanthus alternus	Pseudopimelodus apurensis
Opsodoras leporhinus	Pseudopimelodus raninus
Orinocodoras eigenmanni	Pseudoplatystoma fasciatum
Oxydoras niger	Pseudoplatystoma tigrinum
Panaque nigrolineatus	Pterengraulis atherinoides
Papiliochrimis ramirezi	Pterigoplichthys multiradiatus
Pterolebias hognei	Sorubimichthys planiceps
Pygocentrus notatus	Sternachella sima
Pygopristis denticulatus	Sternarchogyton nattereri
Pyrrhulina filamentosa	Sternarchogyton porcinus
Rachovia maculippinis	Sternarchorhamphus mulleri
Raphiodontichthys vulpinus	Sternarchorhynchus curvirostris
Rhabdolichops troscheli	Sternarchorhynchus mormirus
Rhamdia sabae	Sternopygus macrurus
Rhamphichthys marmoratus	Sturisoma festivum
Rhamphichthys reinharti	Synbranchus marmoratus
Roeboides dayi	Tetragonopterus argenteus
Salminus hilarii	Tetragonopterus chalceus
Schizodon issognathum	Toracocharax stellatus
Semaprochilodus kheri	Triportheus angulatus
Serrasalmus altuvei	Triportheus elongatus
Serrasalmus elongatus	Triportheus rotundatus
Serrasalmus fernandezi	Vandellia plazaii
Serrasalmus marginatus	Xenagoniates bondi
Serrasalmus rhombeus	Xiliphius lepturus
Sorubim lima	Xiliphius melanopterus

Table 1.3.5 COMMON SPECIES OF AMPHIBIANS AND REPTILES OF THE VENEZUELAN LLANOS

Scientific Name	Scientific Name
Amphisbaena alba	Leimadophis reginae
Amphisbaena fuliginosa	Leimadophis typhlus
Anolis auratus	Leptodactylus bolivianus
Boa constrictor	Leptodactylus fragilis
Boa constrictor	Leptodactylus fuscus
Bufo granulosus	Leptodactylus macrosternon
Bufo guttatus	Leptodactylus wagneri
Bufo marinus	Leptodeira annulata
Caiman crocodylus	Leptophis ahaetulla
Clelia climlia	Lygaphis lineatus
Cnemidophorus lemmniscatus	Masticophis mentovarius
Corallus enhydris	Mastigodryas bifossatus
Crocodylus intermedius	Micrurus isozonus
Crotalus durissus	Oxybelis aeneus
Crotalus vegrandis	Oxyrhopus petola
Chironius carinatus	Phimophis guianensis
Dendrobates leucomelas	Phrynohyas venulosa
Drymarchos corais	Phyllodactylus dixoni
Elachistocleis ovalis	Phyllodactylus ventralis
Epicrates cenchria	Phyllomedusa hypocondrialis
Eunectes murinus	Physalaemus enesefae
Geochelone carbonaria	Physalaemus pustulosus
Gymnophthalmus speciosus	Pipa pipa
Hemidactylus palaichthus	Pleurodema brachyops
Hyla crepitans	Podocnemis expansa
Hyla microcephala	Podocnemis unifilis
Hyla rostrata	Podocnemis volgi
Hyla rubra	Pseudis paradoxus
Hyla wandae	Pseudoboa neuwiedii
Iguana iguana	Spilotes pullatus
Iguana iguana	Thamnodynastes strigilis
Imantodes cenchoa	Tropidurus troquatus
Ketropyx striatus	Tupinambis nigropunctatus
Leimadophis melanotus	Tupinambis teguixin

Table 1.3.6 ENDANGERED OR THREATENED AMPHIBIAN AND REPTILE SPECIES

Scientific Name	Common Name
Hyla wandae	Tree frog
Pleurodema brachyops	Painted pond frog
Anolis auratus	Golden anole
Corallus enhydris	Tree boa
Crocodylus intermedius	Orinoco crocodile
Epicrates cenchria	Ground boa
Eunectes murinus	Anaconda or water boa
Podocnemis expansa	Arrau turtle
Podocnemis unifilis	Small river turtle

Table 1.3.7 COMMON SPECIES OF BIRDS OF THE VENEZUELAN LLANOS

Scientific Name	Scientific Name	Scientific Name
Agamia agami	Dendrocygna autumnalis	Odontophorus gujanensis
Agelaius ictercephalus	Dendrocygna bicolor	Opisthocomus hoazin
Ajaia ajaja	Dendrocygna viduata	Ortalis ruficauda
Amazonetta brasiliensis	Donacobius atricapillus	Oxyura dominica
Anas discors	Egretta alba	Pandion haliaetus
Anhima cornuta	Egretta caerulea	Penelope argyrotis
Anhinga anhinga	Egretta thula	Penelope purpuracens
Ara macao	Eudocimus albus	Phaetusa simplex
Aramides cajanea	Eudocimus ruber	Phalacrocorax olivaceus
Aramus guarauna	Eurypyga helias	Phimosus infuscatus
Ardea cocoi	Fluvicola pica	Pilherodius pileatus
Arundinicola leucocephala	Gallinago gallinago	Pitangus lictor
Bubulcus ibis	Gallinago undulata	Pitangus sulphuratus
Burhinus bistriatus	Gallinula chlorppus	Plegadis falcinellus
Busarellus nigricollis	Geotrygon montana	Podicepis dominicus
Butorides striatus	Heliornis fulica	Porphyrula flavirostris
Cairina moschata	Himantopus himantopus	Porphyrula martinica
Calidris sp	Hirundo rustica	Progne tapera
Cercibis oxycera	Hoploxyoerus cayanus	Riparia riparia
Certhiatix cinnamonema	Jacana jacana	Rosthramus sociabilis
Ceryle torquata	Leptotila rufaxila	Rynchops niger
Ciconia maguari	Leptotila verreauzi	Sarkidiornis melanotos
Cochlearius cochlearius	Mesembrenibis cayenensis	Stelgidopteryx ruficollis
Colinus cristatus	Mitu tomentosa	Sterna superciliaris
Columba speciosa	Molothrus bonariensis	Tachyneta albiventer
Columba subvinacea	Muscivora tyrannus	Theristicus caudatus
Columbia cayenennsis	Mycteria americana	Tigrisoma lineatum
Craz daubentoni	Neochen jubata	Tinamus tao
Crypturellus soui	Netta erythrophthalma	Tringa flaviceps
Charadius collaris	Nyctanassa violacea	Tringa solitaria
Chloroceryle amazona	Nycticorax nycticorax	Vanellus chilensis
Chloroceryle americana	Nycticorax violacea	Zenaida auriculata

Table 1.3.8 VULNERABLE SPECIES OF BIRDS OF THE VENEZUELAN LLANOS

Scientific Name	Scientific Name
Agamia agami	Gallinago gallinago
Ajaia ajaja	Gallinago undulata
Amazonetta brasiliensis	Gallinula chlorppus
Anas discors	Geotrygon montana
Anhima cornuta	Leptotila rufaxila
Anhinga anhinga	Leptotila verreauzi
Ara macao	Mitu tomentosa
Aramides cajanea	Mycteria americana
Ardea cocoi	Neochen jubata
Cairina moschata	Netta erythrophthalma
Ciconia maguari	Nycticorax nycticorax
Cochlearius cochlearius	Nycticorax violacea
Colinus cristatus	Odontophorus gujanensis
Columba speciosa	Ortalis ruficauda
Columba subvinacea	Oxyura dominica
Columbia cayenennsis	Penelope argyrotis
Craz daubentoni	Penelope purpuracens
Crypturellus soui	Phalacrocorax olivaceus
Dendrocygna autumnalis	Phimosus infuscatus
Dendrocygna bicolor	Plegadis falcinellus
Dendrocygna viduata	Rosthramus sociabilis
Egretta alba	Sarkidiornis melanotos
Egretta caerulea	Sterna superciliaris
Egretta thula	Tinamus tao
Eudocimus albus	Zenaida auriculata
Eudocimus ruber	

Table 1.3.9 AQUATIC BIRD SPECIES WHICH BREED IN COLONIES IN THE WETLAND "GARCEROS"

Scientific Name	Scientific Name
Phalacrocorax olivaceus	Nycticorax violacea
Anhinga anhinga	Cochlearius cochlearius
Ardea cocoi	Mycteria americana
Egretta alba	Ciconia maguari
Egretta thula	Phimosus infuscatus
Egretta caerulea	Eudocimus ruber
Agamia agami	Plegadis falcinellus
Nycticorax nycticorax	Ajaia ajaia

Table 1.3.10 COMMON SPECIES OF MAMMALS OF THE VENEZUELAN LLANOS

Scientific Name	Scientific Name
Scientific name	Mazama americana
Agouti paca	Mazama rufina
Agouti taczanowski	Myrmecophaga tridactyla
Cerdocyon thous	Nasua nasua
Coendu prehensilis	Nasuella olivacea
Dasyprocta aguti	Odocoileus virginianus
Dasyprocta fuliginosa	Potos flavus
Dasypus novemcinctus	Priodontes maximus
Dasypus sabanicola	Procyon cancrivorus
Didelphis marsupialis	Pteronura brasiliensis
Eira barbara	Sylvilagus brasiliensis
Felis concolor	Sylvilagus floridanus
Felis onca	Tapirus terrestris
Felis pardalis	Tayassu pecari
Felis yaguarondi	Tayassu tajacu
Galictis vittata	Tremarctos ornatus
Hydrochaeris hydrochaeris	Trichechus manatus
Inia geoffroyensis	

Table 1.3.11 ENDANGERED OR THREATENED LLANOS MAMMAL SPECIES

Scientific Name	Common Name
Felis concolor	Puma
Felis onca	Ocelot
Felis pardalis	Margay cat
Felis yaguarondi	Jagouaroundi
Myrmecophaga tridactyla	Giant anteater
Priodontes maximus	Giant armadillo
Pteronura brasiliensis	Giant river otter
Tapirus terrestris	Tapir
Tayassu tajacu	Peccary
Tremarctos ornatus	Spectacled bear
Trichechus manatus	Manatee

Table 1.13.12 HABITAT FOR REPTILES OF ECONOMIC IMPORTANCE

Scientific Name	Gallery Forest	Deciduous Forest	Savanna	Water	
Podocnemis expansa				X	River shores
Podocnemis volgi				X	Lagoon shores
Podocnemis unifilis				X	River shores
Caiman crocodilus				X	Lagoon shores
Crocodylus intermedius				X	Orinoco tributaries
Geochelone carbonaria		X	X		
Iguana iguana	X	X	X		

Table 1.3.13 HABITAT REQUIREMENTS FOR BIRD SPECIES

Scientific Name	Gallery Forest	Deciduous Forest	Savanna	Water
Tinamus tao	X	X		
Crypturellus soui	X	X	X	
Dendrocygna spp		X	X	X
Neochen jubata		X	X	X
Anas discors		X	X	X
Amazonetta brasiliensis		X	X	X
Netta erythrophthalma	X	X	X	X
Sarkidiornis melanotos		X	X	X
Cairina moschata	X	X	X	X
Oxyura dominica	X	X	X	X
Mitu tomentosa	X	X		
Crax daubentoni	X	X		
Penelope purpuracens	X	X		
Penelope argyrotis	X	X		
Ortalis ruficauda	X	X		
Colinus cristatus			X	
Odontophorus gujanensis	X	X		
Aramides cajanea	X	X	X	
Gallinula chlorppus	X	X	X	
Gallinago gallinago			X	
Gallinago undulata			X	
Columba speciosa	X	X	X	
Columbia cayenennsis	X	X	X	
Columba subvinacea	X	X	X	
Zenaida auriculata			X	
Leptotila verreauzi	X	X	X	
Leptotila rufaxila	X	X	X	
Geotrygon montana	X	X		

Table 1.3.14 HABITAT REQUIREMENTS FOR MAMMAL SPECIES

Scientific Name	Gallery Forest	Deciduous Forest	Savanna	Water	
Didelphis marsupialis	X	X	X		
Dasypus novemcinctus	X	X	X		
Dasypus sabanicola			X		
Priodontes maximus	X	X			
Myrmecophaga tridactyla	X	X	X		
Sylvilagus floridanus			X		
Sylvilagus brasiliensis	X	X			
Hydrochaeris hydrochaeris			X	X	
Dasyprocta aguti	X	X	X		
Dasyprocta fuliginosa	X	X	X		
Agouti paca	X	X	X		
Coendu prehensilis	X	X	X		
Cerdocyon thous	X	X	X		
Procyon cancrivorus	X	X	X	X	
Nasuella olivacea					
Potos flavus	X	X			
Galictis vittata	X	X			
Eira barbara	X	X	X		
Pteronura brasiliensis				X	Rio Apure
Felis pardalis	X	X	X		
Felis concolor	X	X	X		
Felis onca	X	X	X		
Felis yaguaroundi	X	X	X		
Trichechus manatus				X	Rio Apure
Tapirus terrestris	X	X		X	
Tayassu tajacu	X	X	X		
Tayassu pecari	X	X			
Odocoileus virginianus			X		
Mazama americana	X	X			
Mazama rufina		X			

FIGURES

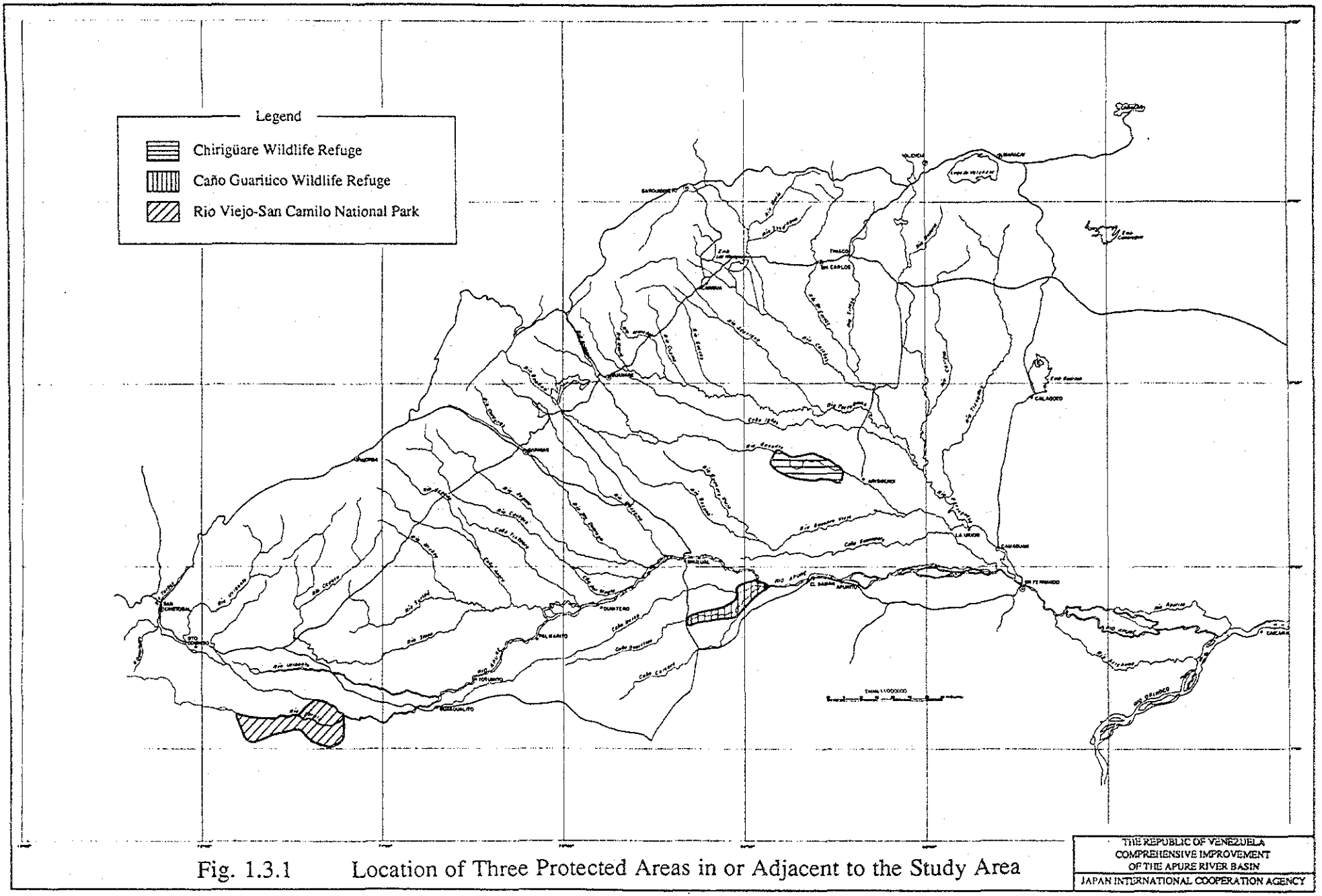
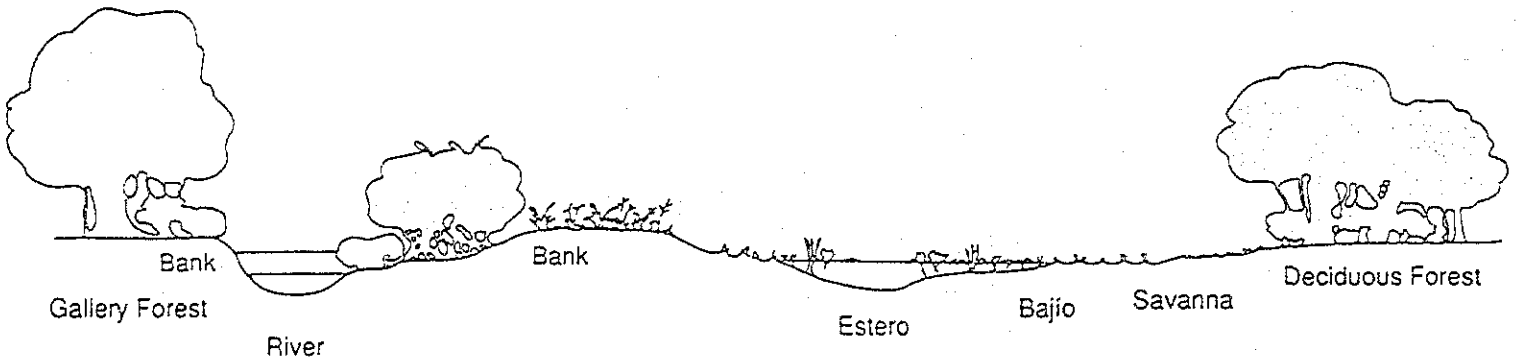
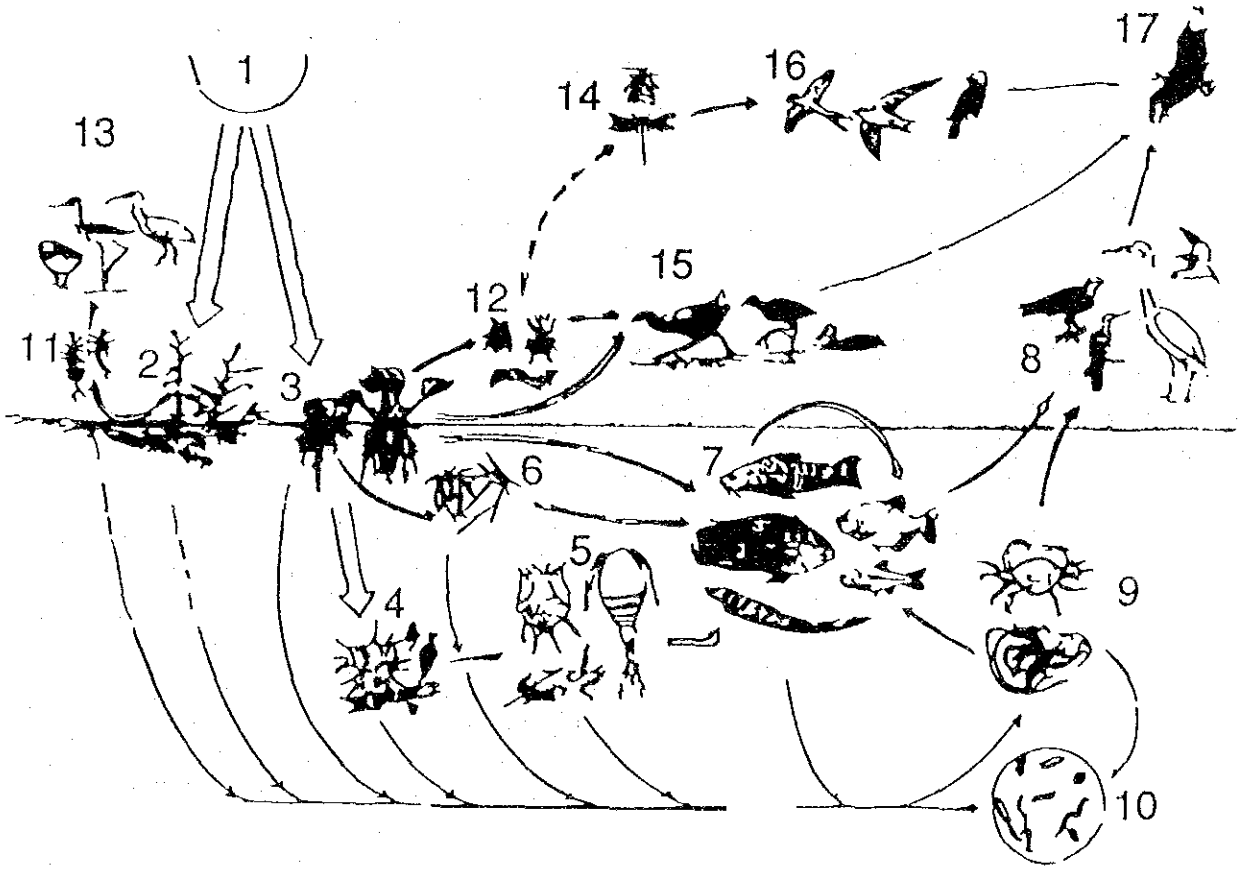


Fig. 1.3.1 Location of Three Protected Areas in or Adjacent to the Study Area



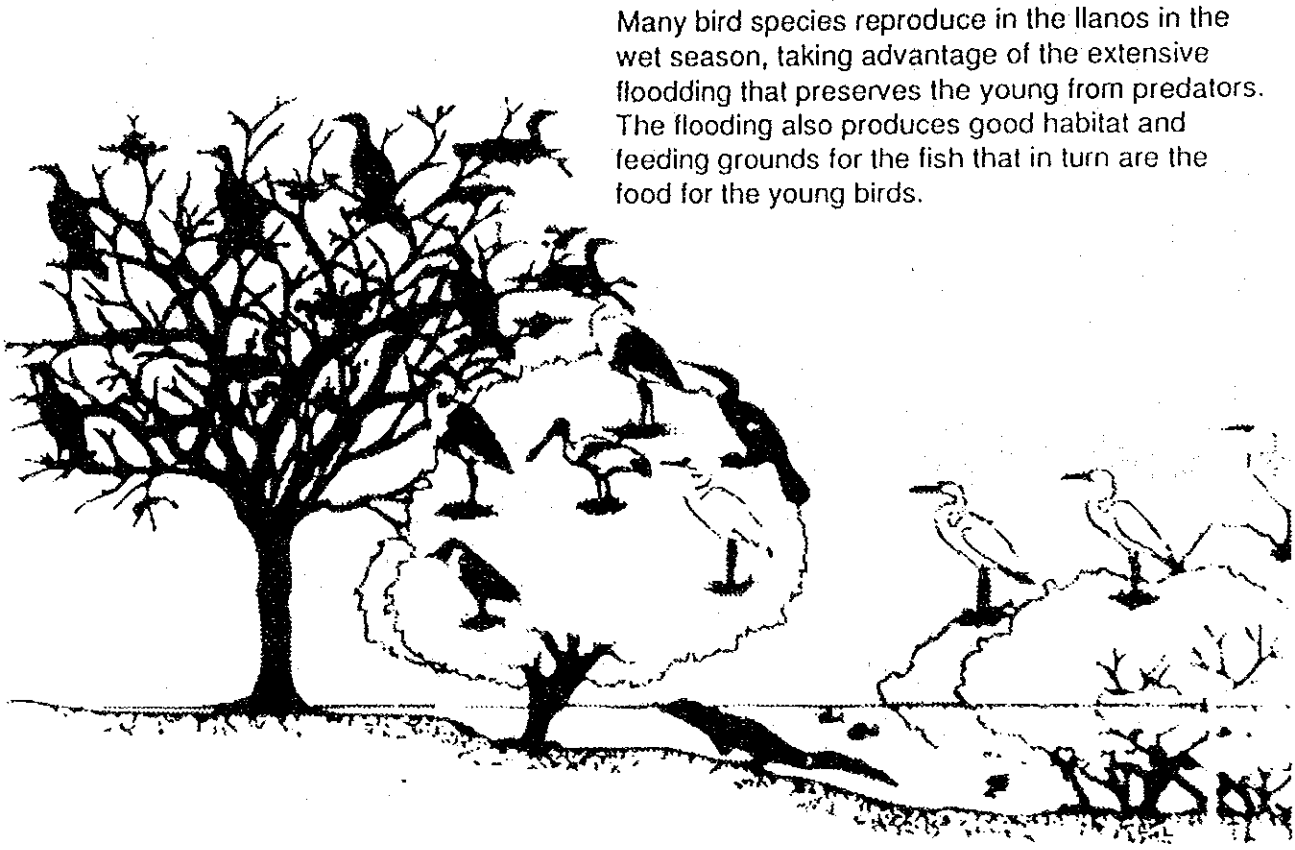
IF.2

Fig. 1.3.2 Typical Micro Relief of the Floodable Venezuelan Llanos in the Study Area



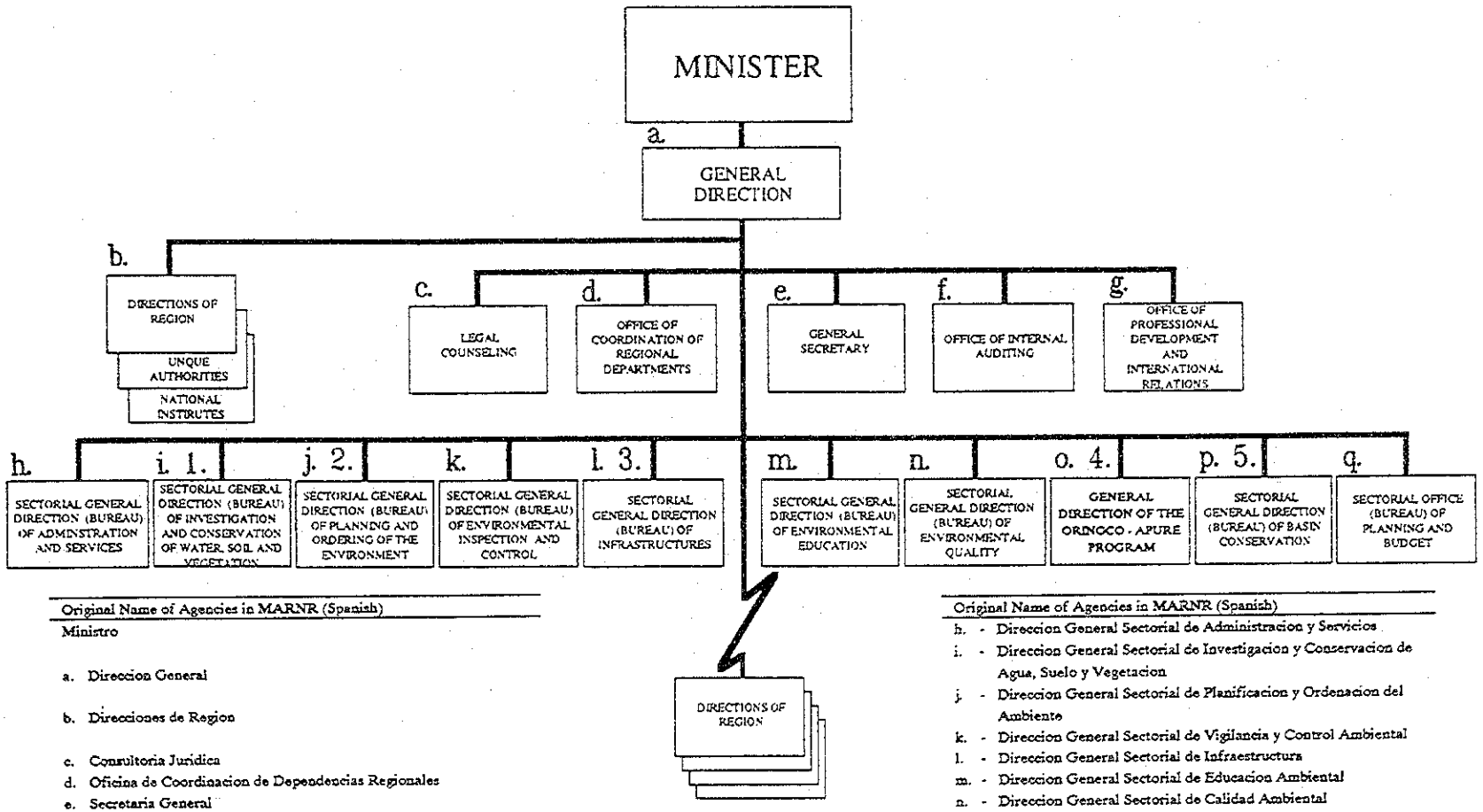
1. Solar Energy
2. Aquatic Plants
3. Aquatic Plants
4. Fitoplankton
5. Zooplankton
6. Aquatic Insects
7. Fish
8. Fishing Birds
9. Crustaceans
10. Bacteria
11. Insect Larvae
12. Insects
13. Shore birds
14. Insects
15. Seed eater birds
16. Insectivorous birds
17. Birds of pray and carrion eaters

Fig. 1.3.3 Food Chain Relationships Among Llanos Aquatic Organisms



"Garcero" or Rookery, are reproductive places where flooding is the protecting factor that allows young birds to survive from predator species

Fig. 1.3.4 Garceros or Bird Rookery



Original Name of Agencies in MARNR (Spanish)

Ministro

a. Direccion General

b. Direcciones de Region

c. Consultoria Juridica
d. Oficina de Coordinacion de Dependencias Regionales
e. Secretaria General
f. Oficina de Contraloria Interna
g. Oficina de Desarrollo Profesional y Relaciones Internacionales

Original Name of Agencies in MARNR (Spanish)

h. - Direccion General Sectorial de Administracion y Servicios
i. - Direccion General Sectorial de Investigacion y Conservacion de Agua, Suelo y Vegetacion
j. - Direccion General Sectorial de Planificacion y Ordenacion del Ambiente
k. - Direccion General Sectorial de Vigilancia y Control Ambiental
l. - Direccion General Sectorial de Infraestructura
m. - Direccion General Sectorial de Educacion Ambiental
n. - Direccion General Sectorial de Calidad Ambiental
o. - Direccion General Programa Orinoco - Apure
p. - Direccion General Sectorial de Conservacion de Cuencas
q. - Oficina Sectorial de Planificacion y Presupuesto

Note: Refer next page for the organization of the agencies numbered.

Fig. 3.1.2 Organization of MARNR (1/2)

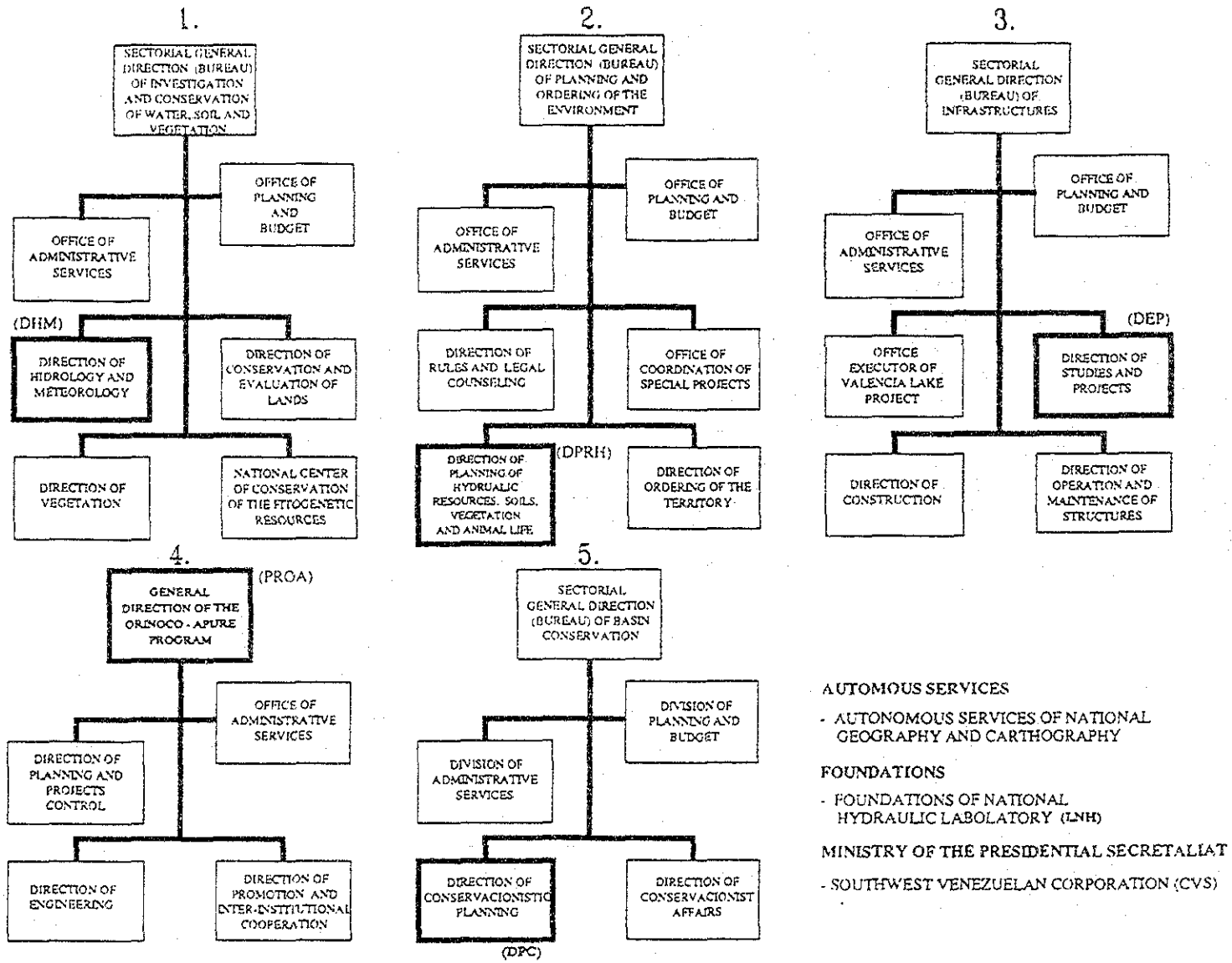
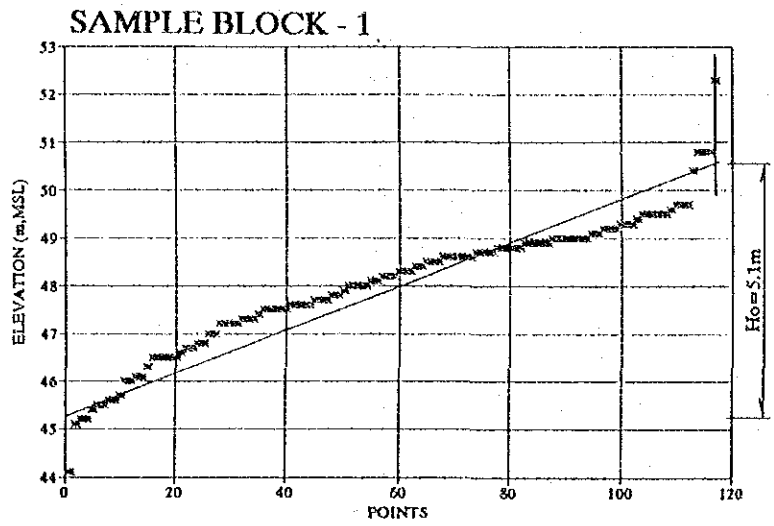
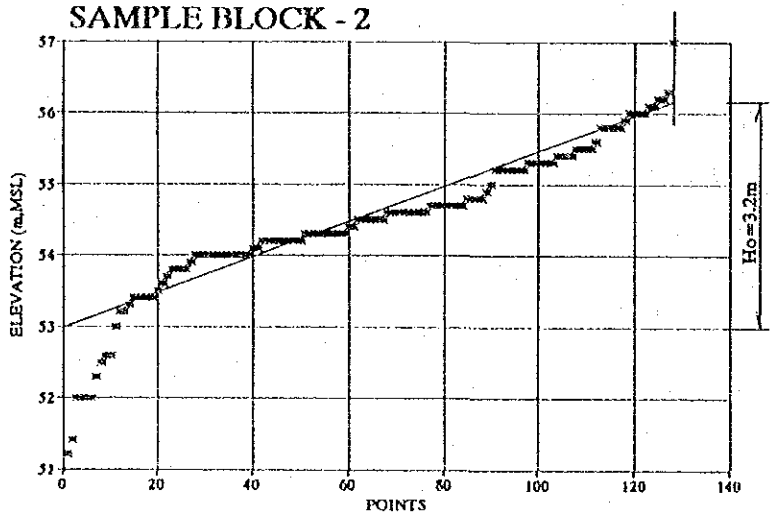


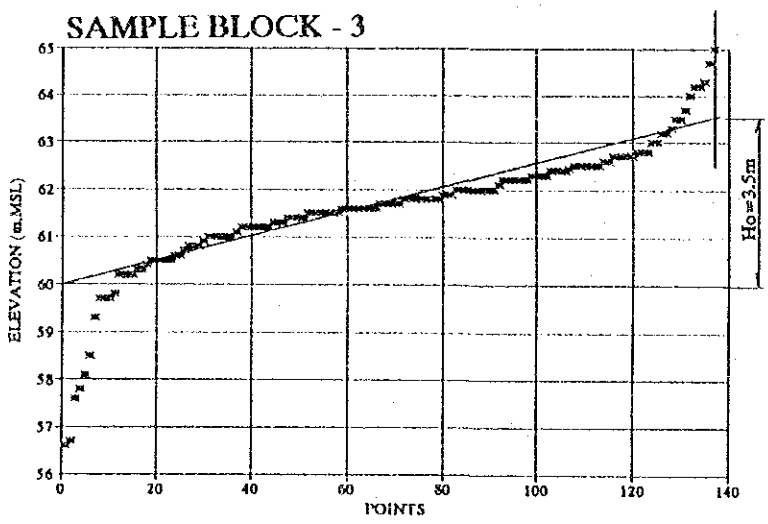
Fig. 3.1.2 Organization of MARNR (2/2)

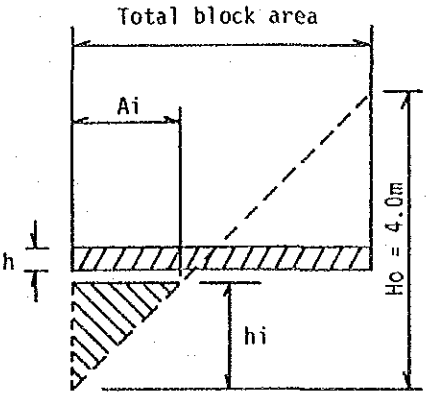
Fig. 4.2.1 Block Division for Project Evaluation

THE REPUBLIC OF VENEZUELA
COMPREHENSIVE IMPROVEMENT
OF THE APURE RIVER BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY









$hi = (2h \times Ho)^{0.5}$

$Ai = (2h / Ho)^{0.5}$

5.1m
3.2m
3.5m
3.9m : Average
(≒4.0m)

Fig. 4.2.2 Maximum Height of Undulation

THE REPUBLIC OF VENEZUELA
COMPREHENSIVE IMPROVEMENT
OF THE APURE RIVER BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY

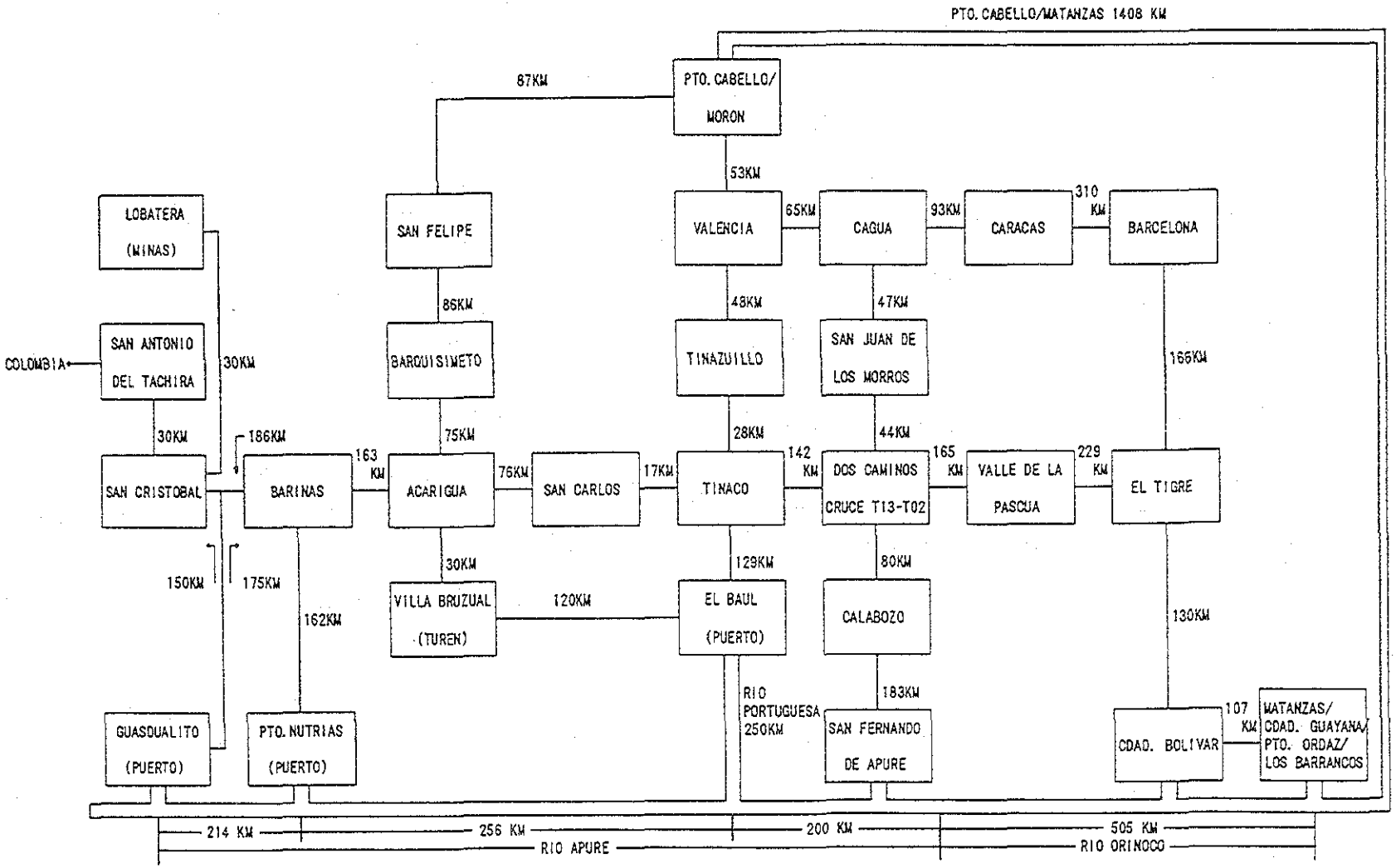


Fig. 5.3.1 Schematic Location and Distance