PART - II

SUPPLEMENTAL INFORMATION

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Land Management of the Paquita and Naranjo Watersheds
(Universidad de Costa Rica)

Informe General de Avance a la Factibilidad del P.H. Los Llanos
(Dpto. Ingeniería Geológica/Geotécnica, ICE)

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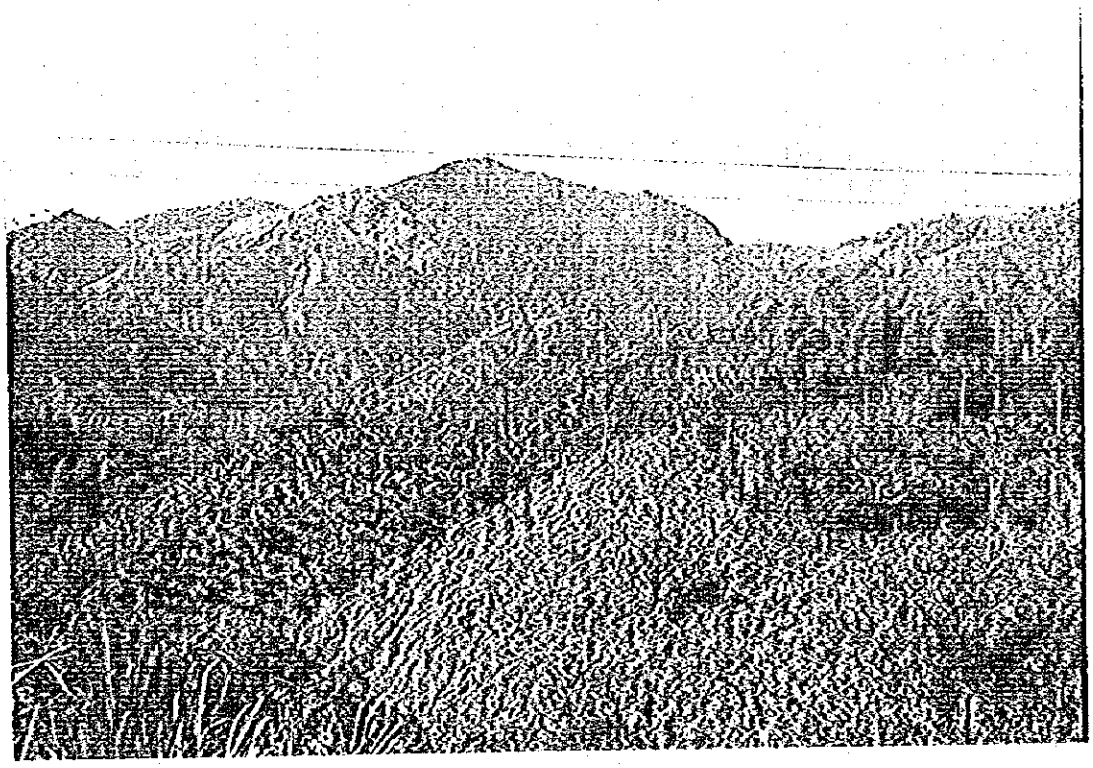
UNIVERSIDAD DE COSTA RICA
DEPARTAMENTO DE GEOGRAFIA

LAND MANAGEMENT OF THE PAQUITA AND NARANJO WATERSHEDS



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MANAGEMENT PLAN OF THE PAQUITA AND NARANJO RIVER WATERSHEDS

1. Background

The Geography Department completed a diagnosis on the watersheds for the Japanese Cooperation Bureau in the year of 1994. At the end of that work it became necessary to extend the studies to an Arrangement and Management Plan of both watersheds, leading to an exploitation of the water resource of the Naranjo river watershed for electricity generation and to the mitigation of the environmental aspects post-exploitation.

2. Methodological Strategy

The Arrangement Plan for the management of the watersheds has been elaborated based on the works of Tricart and Kilian (1952), OEA's Regional Development Department, FAO (1977) and CAURA (1982).

The study of both watersheds requires three main phases:

1.- Initial knowledge of the actual state of the space, situation of the biophysical component, localization and dynamics of human activities.

2.- Diagnosis. Nature and severity of the natural and human limitations are evaluated here. The results of this analysis are maps of conflicts or use conditions, a map of equiproblematic regions and a proposal of corrective actions.

3. Search for solutions: different options are proposed for each equiproblematic area and interviews and small workshops with the communities are held to select the corrective actions or

those with the most feasible development. Likewise, a proposal for the execution of these actions is elaborated based on the institutional and local responsibility. The end is an outlining of a Strategic Planning for the execution of the project's actions.

The methodological strategy that has been designed for the purposes of this research requires the selection of descriptors or indicators of the actual state of the natural resources and its dynamics that allow their evaluation. The diagnosis on the biophysical phase will consider the following variables:

3. Variables for the biophysical phase definition and its diagnosis:

Natural and ecological resources

Variables

Geomorphology

Geology

Life Zones

Land use capacity

Watersheds diagnosis

The chosen variables enter into the analysis in two phases: first, in a descriptive section that defines the actual state of the resource, existing information is used, as in the case of life zones or unpublished information updated and standardized at a 1:50 000 scale. In a second phase, those variables are spatially correlated to produce original maps from the research.

Primarily, the geological and geomorphological maps are combined to obtain a synthesis of geomorphical landscapes, whose goal is to define the base of natural landscapes. A second spatial correlation includes the Life Zones map and the Actual Land Use Capacity, with the purpose of presenting the actual state of the Life Zones or potential vegetation with regard to the exploitation

made of the geographical space included in them. Finally, a determination of the conflictive areas and overutilization is made, making a Zone Life comparison of the Actual Land Use.

4. Variables for the socio-economical space definition and its diagnosis

The spatial approach requires the use of socio-economical variables that determine such aspects as:

1.- Space occupation, viewed through the Land Use and life sorts.

2.- Types of habitats, scattered, concentrated. Ranking of the communications net.

3.- Determination of the inhabitants perception with regard to their space and the interventions related with the hydroelectricity generation projects.

5. Recommendations for the Management of the Watersheds.

The diagnosis on biophysical and human aspects allows to establish the big lines of Land Management applied to the watersheds management, keeping as its main objective the exploitation of the water resource, and observing the limitations pointed by the Environmental Law of November 13, 1995, which exposes for the first time a general outlining on Land Management and natural resources exploitation.

6. Solutions Proposal and Strategic Planning

This phase includes the whole of the team and constituted a process of reasoning and discussion on the conclusions of partial reports, communities expectations, environmental perception studies and the integral diagnosis.

7. Land Management and Watersheds Management

In the contemporary concept of Development, the whole of the interpretation of the man-environment relationship along with the necessity of adequating the future use of social and natural resources, led to the utilization of two macrocategories: Land Management and Sustainable Development. Both implicitly carry the need to transform society behavior with regard to its territory and to the land as humanity heritage. Thus, it is considered that a way to reach the goals of Sustainable Development is the arranging of society activities, since it is defined as a change tool as "... the transformation by man of a system - extension of terrain as a production unit or any complex group - with the objective of a more rational and efficient utilization" (Lamote, 1986:2). In agreement with the latter, one cannot conceive a Sustainable Development proposal without a previous **Rearranging** of human activities and, therefore, it is also important to know the situation and tendencies of change of the physical base of resources to which human activities associate, to define the use of territorial space as a social product.

The concept of Land Management, perhaps a new way to define integral development, has evolved in State Universities and has penetrated in the decision making circles, political groups and organizations oriented to resources conservation. The Interamerican Bank of Development and the World Bank strengthen the evolution of these ideas inside their own financial conception.

In the national level there are two initiatives in this way: the first one includes the Conservation Strategy for Sustainable Development in Costa Rica (Quesada, C. 1990). A diagnosis of the environmental situation of Costa Rica within the perspectives of Land Management and Sustainable Development. That means that there exists an objective, real base and political conscience to impulse concrete actions towards Land Management.

In the Legal Order, the Environmental Law and Natural Resources Center has proposed a law pre-project of Integral Land Management (CEDARENA, 1992), that tries to impulse the necessary juridical base so that the Land Management will be a State Obligation. Both initiatives have perhaps contributed to think about planning and arranging all exploitation in an integral way.

Integration should be done at two levels, considering, in one hand, all the environmental, social and economics factors (e.g., the repercussions of the many economical and social sectors on the environment and the natural resources), and on the other hand, all the components of both the environment and the resources (air, water, "biota", land, natural and geological resources).

The integral consideration provides options and adequate compensations, taking to a maximum level productivity and sustainable utilization. The possibility of dedicating land to different uses is established in the course of important projects of assent or development or, in a consecutive way, according to the offer of lands in the market. This offers the possibility of reinforcing the traditional ways of sustainable arrangement of the lands or worth their protection for the conservation of the biological diversity or critical ecological services.

Many techniques can be combined, settings and processes to facilitate such an integral study. They compose the indispensable support of the planning and arrangement process, in the national, local level and in the ecosystem or zone level, as of the development of concrete action plans.

The global objective consists in facilitating the dedication of land to the uses that assure the greatest sustainable benefits and promote the transition to a sustainable and integral arrangement of the land resources. Also, it must improve and reinforce planning, arrangement and land and its resources evaluation systems for the year 2000. It is also required to adapt planning and arranging systems that facilitate the integration of environmental components such as air, water, land and other natural resources using the **ecological planning of the landscape** and other methods that concentrate in units such as the ecosystem, the watershed or the community.

Politic orientation towards Sustainable Development and Land Management

The Sustainable Development as a political action must be analyzed through four fundamental parameters: the distribution of the economical returns view, in function of the social system stability and of the base of the resources, without affecting its quality nor its ability for

future generations. Sustainable Development must also be based in a productivity criteria; productivity that the use of these resources reaches to satisfy necessities at a national level.

From the economic point of view, the quest for a Sustainable Development through Land Management and Regional Planning must be displayed as an elastic process; the programs that are executed, in order to reach a national development, must be able to stand any stress or shock situation in national or international economy, due to internal adverse circumstances such as natural catastrophes, or external ones such as variations in exchange terms. With regard to the distribution of the benefits that it produces, the Sustainable Development must be equitative, the equity principle obliges to acknowledge the participation of each one of the social sectors in wealth production, but also in the fair cost distribution of this Sustainable Development.

It's out of question that world-level political events have had a spin from unlimited development without considering the environment load capacity and environment recovery to sustainable development. In Latin America, the political compromise since the preparation for the Earth's Summit in Rio de Janeiro has been explicit and recorded in important documents for the environment management of third-world countries. In Central America, peace processes and the quest for democracy took first the environmental subject and then the one on sustainable development to the political agendas. Whole summits are today dedicated to this topics, when before the environmentalists considered the casual reference to terms as "environment" or "ecodevelopment" as a great success.

The paradigm of a sustainable development is today defined in all possible conceptions and interpretations. Sustainable development is defined from social, economical or environmental perspective and some try to show that the three are interdependent. Others try to explain why the human being assume particular attitudes towards the environment and why others are totally indifferents or ignorants.

Land Management in all its dimensions, from the economical, legal, social to the environmental one, offers an opportunity to apply sustainable development. The exercise cannot

be the rhetoric of an elite or to sustain a few status quo. The arrangement must allow the transcendence of the sustainable development to the practice through the Territorial Action.

The communitarian organization and participation, the generation of installed capacity and of self-management must be basic instruments of the arrangement and the territorial action. The coordination for conflicts solution and races for the use of geographical spaces and the aggression to the environment imposes itself as a necessity that cannot be postponed.

The accessible and democratic science and knowledge must be the base to generate real alternatives for the decision makers, in the selection of those that quest the sustainable development.

The scales and detail level of sustainable development must be adjusted and its applications oriented toward life quality improvement in the society, and to obtain that a change of attitude from the decision makers at every level is needed, from scientists and technical people to citizens in general. It is necessary to show with facts that sustainable development is possible in practice (Lücke: 1995).

The Land Management, as a feasible instrument of the social and economical politics of the country, must consolidate internally the relationship of the costaricans with the base of their resources, for it can open itself later to the new perspective of globalization and integration strategies in greater spatial groups. Those are the imperatives of the new international order.

8. Landscape analysis

The geographical analysis where studied based on the Theory on Landscape, exposed on the Environmental Impact Studies Guide from the Ministerio de Obras Públicas of Spain (1991).

This guide establishes a taxonomy of landscapes that differentiate from lesser to greater: homogeneous, functional and regional units. In this spatial units the dynamic aspect was

established interpreting the relation between the biological potential and the biological exploitation, between what the life zones or the potential vegetal associations determine and the actual use of land related with the use of land capacity.

The landscape analysis in Environmental Impact studies is a methodological resource that allows to observe groups where biophysical and social and economical variables integrate. The landscape appears as temporal data over the earth's surface that specify the observable aspects of the natural and human ecosystems' behavior.

The observation of the landscape is a subjective act whose shades are defined by the physiological state of the environmental perception's organs, intentional or unintentional toward the stimuli that the environment gives to the beholder, always liable to some physical and psychological distance from the landscape. The qualities of the landscape can be interpreted from three perspectives: visibility, scenic quality and visual fragility.

The **visibility** is the property that the landscape has of being watched from one or several places. This quality can be subjected to a quantitative evaluation when it includes characteristics such as altitude, height and density of the vegetal covering, topographic gradients, atmospheric diffusion and others.

The **scenic quality** contains three perception elements: the place's own characteristics that result from the holistic expression of the elements that form the landscape integration, let them be natural, cultural or technological. The quality results from the balance of forms, color, and the harmony in the disposition.

The **visual quality of the immediate surroundings** is placed at a distance between 500 and 700 meters. There, value is given by groups and their aspect as a background from the study place (vegetal formations, crags, big mirrors of water).

The scenic background quality is the possibility of the place of being a hillock, or final point among a background rich in variety and chromatism, by geomorphology, great units of visible vegetation.

The fragility or adaptability of the landscape is its capacity to react using self-adjustments to changes and adapt to them without losing qualities.

"The fragility is conceptually tied to the attributes formerly described. The factors that integrate it can be classified as biophysicals (lands, vegetation structure and diversity, chromatic contrast, etc.) and morphologicals (size and shape of the visual watershed, relative height, singular spots and zones, etc.)" (MOPT: 1991,54).

This exercise allowed to initially deduce which are the topographic characteristics of the many modified environments by the civil works. This graphic tools allowed to establish a field work procedure, which was based on the execution of a routine process for the observations, which include land measurements: slope, "cantos rodados" measurement, superficial formations sampling, mostly in places where the greatest impacts are expected.

Field work also facilitated the processing of a descriptive chart of the punctual landscape, most of all in those places where conditions of instability exist, associated to the natural environment and to already built sites. In these visited places the dynamics of the natural processes was described and, moreover the dynamics that is induced or propitiated by the "antrópico" use that exists and that is directly related to the road. A description on the local impact associated to hydrographical elements, topography, road infrastructure and the settling of cities and towns is also given.

The spatial correlations attained by this procedure determine the conflict or threatened zones for the project or from the project to the areas located inside its surroundings or influence areas. The projective part of the study is attained building scenarios in which the civil work constitutes the main cause of the future transformations.

9. The watershed, a management region

The definitions of what a watershed is go from the very simple, e.g. "topographic division that limits water slope areas", to others more technical, e.g. "a unit of land where, due to its geomorphological characteristic, rainfall joins and unloads through a possibly composed exit".

However, whatever the definition is, the essential elements for a geographical study are going to be present, having a defined geographical space (site) and being subject to the "antrópica" intervention, that is, to the exploitation of the existing resources, as water, land, vegetation, etc. (situation).

A watershed is a geographical space composed by a fluvial system and the drained lands by it. The watershed has as main physical components the talwegs, the flowing waters and the water divisors. Water, the dynamizer element of the watershed is present in the vertical crossing aerial spaces, vegetation, land and rocks, feeding in a complete cycle waters of superficial flow as the subterranean, and oblique, responsibles for the emerging and the maintenance of the base flow during the low water.

But the watershed is also an organized, lived and felt space. The watershed is also the settling of the man and of the activities and processes that generates his interaction with the environment. This way, the elements of the watershed are subject to some arrangement that obeys to the cultural development of the society that occupies this space (Brenes and Lücke, 1994).

10. Los Llanos Hydroelectrical project

The main reason of this report is the hydrological exploitation of the Naranjo river waters for the generation of electricity according to the specifications contained in the following table:

Project characteristics

Works Description

Dam site

Tributary watershed area 143,7 Km^2. Total waterhed area: 332 Km^2.

Dam

The dam, of flowing gravity, has its base level at 435 m.a.s.l. and its crown at the height of 488 m.a.s.l. Its got a crest length of 105 m.

The excess pourer, whose crest is at a height of 474 m.a.s.l., is designed to evacuate a "avenida" of 1:10 000 (1675 m^3/s) and its equipped with 2 steamers 10 m wide and 12 m tall. It ends in a springboard.

Deviation works

The deviation designed for a "avenida" of 583 m^3/s, is done through a tunnel with a diameter of 7,5 m and an average length of 160 m, excavated under the right bank.

Reservoir

The reservoir is operated between the heights of 485 and 475 m.a.s.l., which allows a profitable volume of 1,5 hm^3, enough for the daily supplies regulation. The dead volume is 3,5 hm^3.

Water capture

It is an integral part of the dam and is situated on the right bank. It is designed to collect 31,0 m^3/s. The "compuertas" area is 12,5 m^2.

Oscillation Tank

The oscillation tank has a diameter of 8 m and a height of 75 m, all of it subterranean. Figure 3 shows a detail of the works.

Power House

The power house is superficial, situated on the left bank of the Paquita river, venting water at a height of 84 m.a.s.l. It will give shelter to 2 vertical axis Fulton turbines with a total capacity of 99 MW. The natural design fall is of 361,5 m. It will connect to the national net with 25 km of 250 kV transmission cable.

Due to the nature of the project, it basically affects the Naranjo river watershed and the Paquita river low watershed, where there is expected an increase of 31 cubic meters above the ordinary flow in any season. This water "trasvaso" origins all the negative impacts of the project that have already been pointed out on the ICE and the Geography Department studies.

From a macro approach, the project does not have to be watched as a simple insertion in the landscape, the evolutive dynamics of the latter is really important for the project development

and profitability and contains the whole of both watersheds when it goes from the short to the median to the long term, time dimensions more appropriate for the development of the watersheds management plan.

The diagnosis of the actual state of both watersheds, as it will be seen, will demonstrate that the project has impacts that have to be controlled, but also acts in a double fluvial system that already presents strong spoils in its resource use and conservation.

11. Geology and geomorphology

For the purposes of this project, it became necessary to count with a compilation of the geological and geomorphological aspects. With regard to the Geology it became necessary to bear in mind two aspects: one related with the superficial litology and the one related with structural order problems.

The superficial litology (Geologycal map) is extremely important to determine the characteristics of the superficial formations, that is, the "lateración" thickness above the healthy rock, due to biochemical and physical processes, and the structural aspect to show the susceptibility of the rock to the alteration by mechanical predisposition, or tectonism that favors the contours modeling. The geological map shows a terraced shifting of the terrain, as a result of the shifting originated in the Cocos Plate shifting respect to the Caribe Plate, associated to a principal group of inverted plates and a folding of the rocky structures. Both stresses produce, in consequence, a contour shifting and, therefore, an increase in the wearing processes and sediments transportation assisted by gravity, and on the other hand, rock fractures and microfractures, which facilitate its erosion.

In agreement with these aspects, data from the National Seismological Net allow to observe the intense earthquake behavior of the area. A visual and a frequency analysis of the earthquakes allows to determine that their magnitude has been mainly around 3, shallows and of a constant movement mechanism. (Fig. 1, 2, 3, 4. Anexe 1).

PGm ANASIS ver 2.0

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Guillermo A Avila R

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M=6 △ M=7 ▽ M=8 ○

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REDSISMOLOGICA NACIONAL, ICL UCR

PERFILES

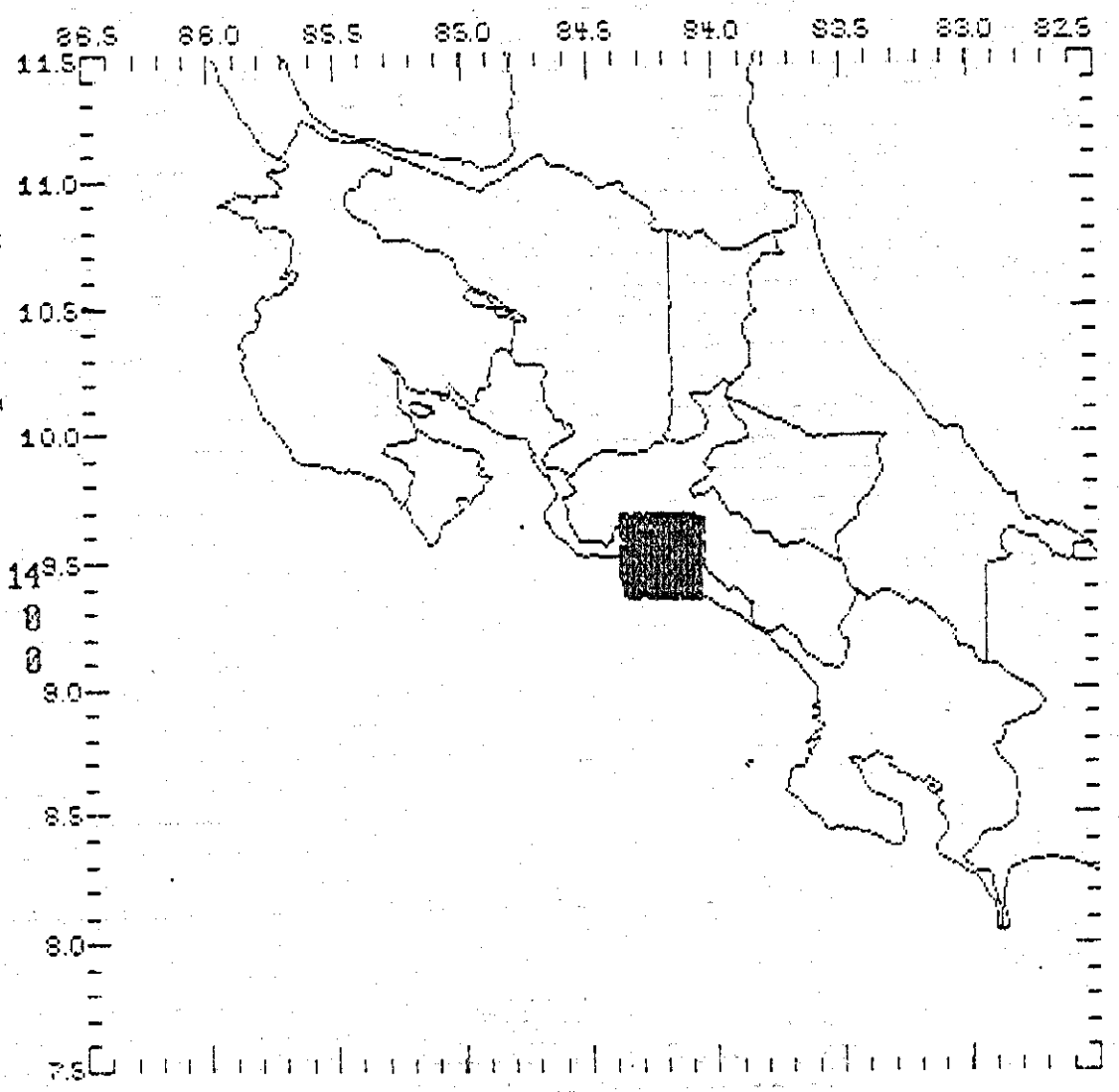

FIG. 1

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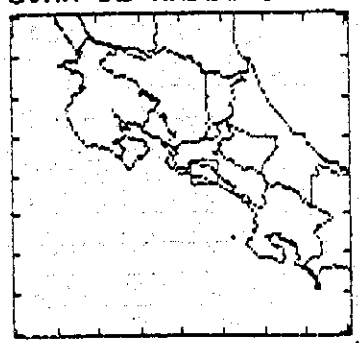

FIG. 2

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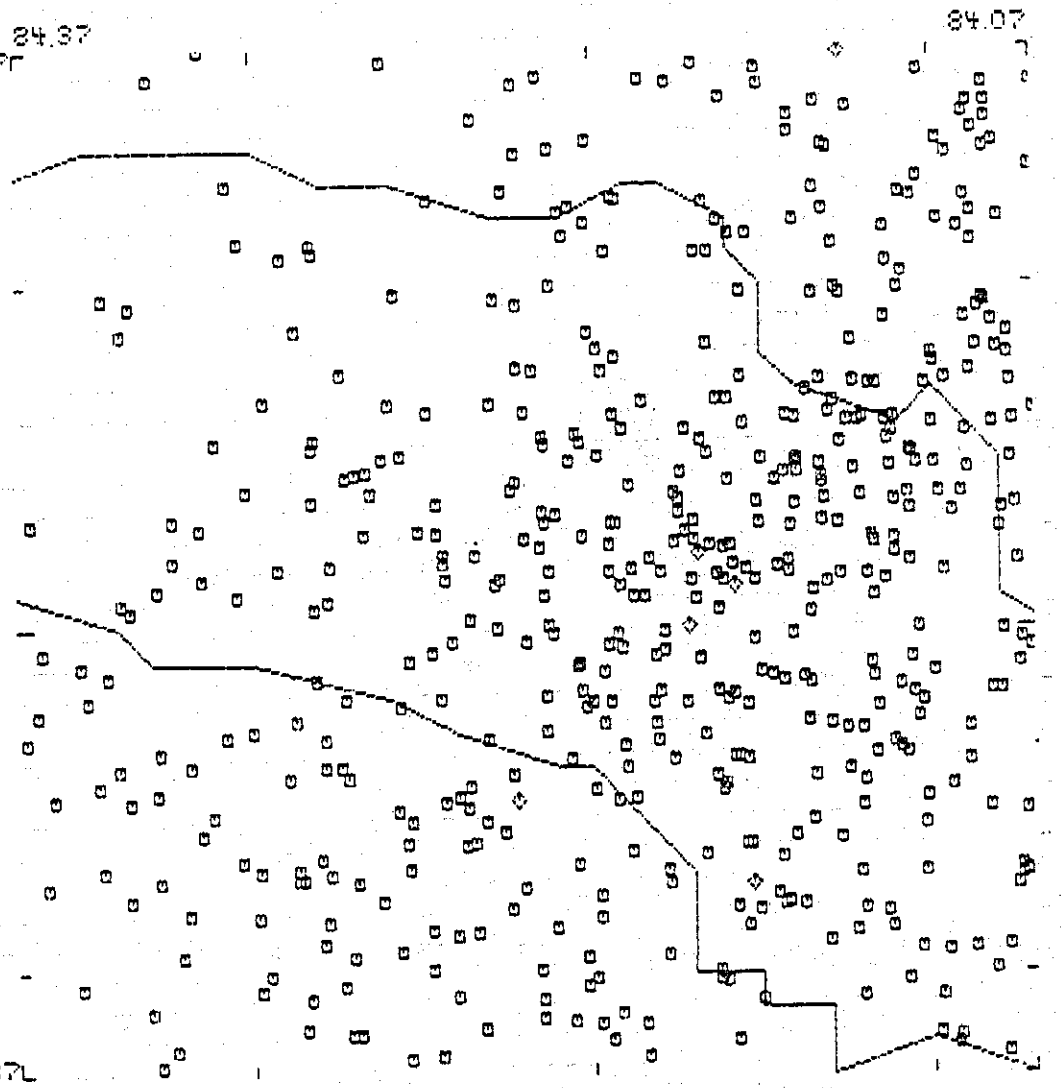
MAPA DE EPICENTROS DE COSTA RICA
AMPLIACION



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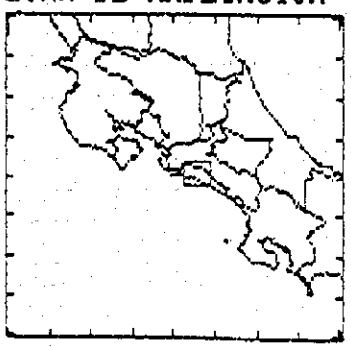
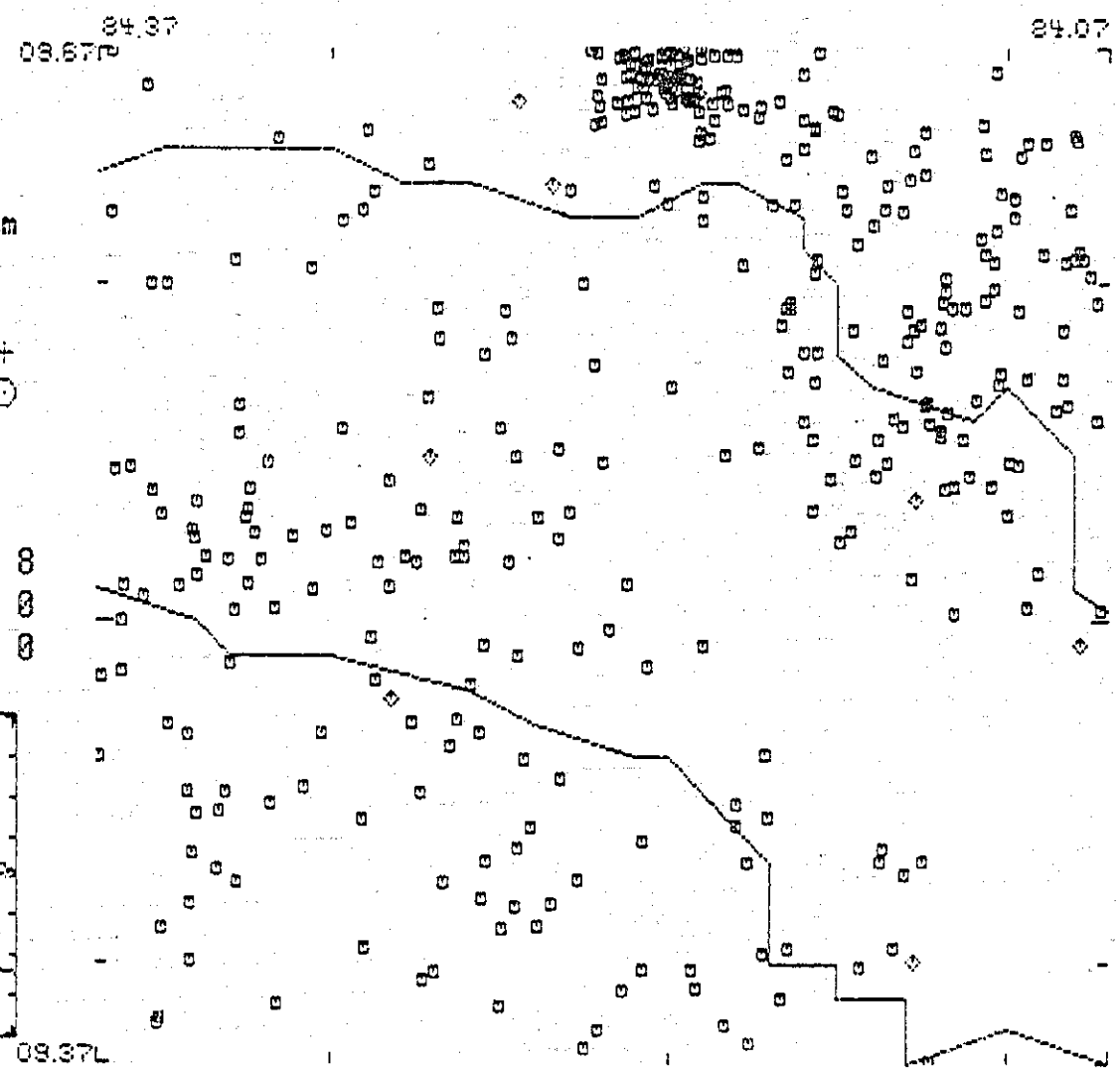


FIG. 3

RED SISMOLOGICA NACIONAL, ICE UCR
MAPA DE EPICENTROS DE COSTA RICA
AMPLIACION



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M=6 △ M=7 ▽ M=8 ○

STA ✳

F 4=INICIA PERFIL

F 5=ANCHO PERFIL

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LT: 9.52° LN: 84.22°

ZONA DE AMPLIACION

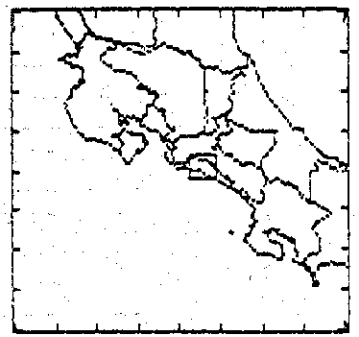

FIG. 4

RED SISMOLOGICA NACIONAL, ICE JCR

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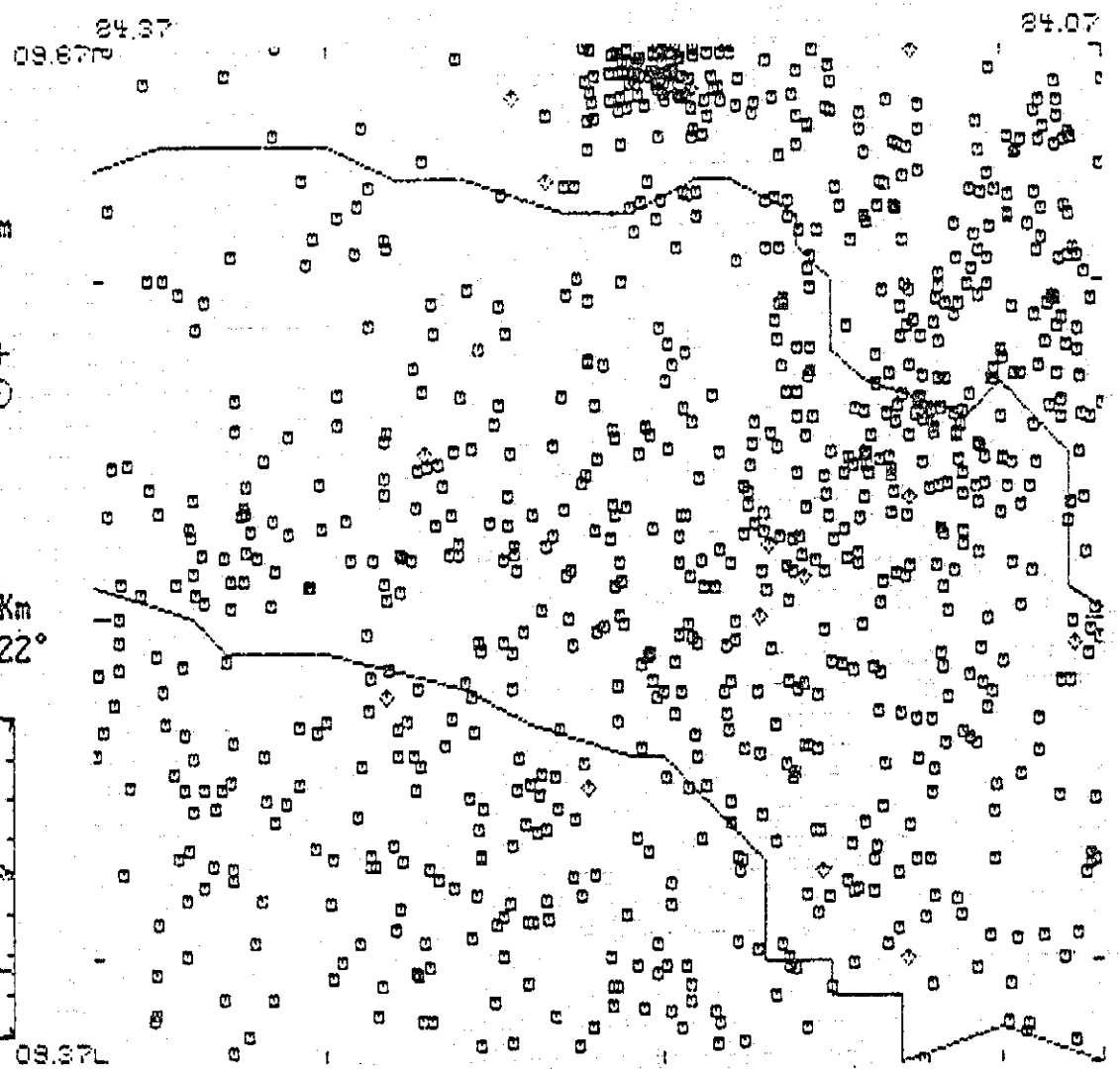


The permanent tectonic activity in the case region is an element to consider in the watershed management due to its association to very strong slopes and to the aggressivity of the weather.

Field observations corroborate this relation of aspects and emphasize the presence of superficial formations strongly erodables. The geomorphological map establishes that the greatest part of the region is included in the classification of dissected contours on a slope, developed over rocks of easy alteration and that provide a cut of fine materials on a first and second erosion cycle. Such is the case of the "clásticas" rocks of the Terraba formation, associated to most of the unstability cases observed, "laminar" erosion and mass removal processes and to the strong "basales" and dissected debris cones of the Paquita and Naranjo rivers, as much as the alluvial flatlands and terminal fluviomarine levels of both rivers.

From this relation between contributions and sedimentation the make-up of the littoral in the Naranjo-Paquita area has always depended, an aspect that will be considered later.

12. Weather (ICE)

The rain regime over the Pacific Slope is characterized by presenting a strong dry season from December to April, a rainy season from May to November and a decrease of rain from the "veranillo" (short summer) from July to August. This behavior matches with the variations of the trade winds flow velocity, which increases from December to April and from July to August. This variations are related with the seasonal displacements of the subtropical "antitición" from the North Atlantic.

Other important wind flows in the behavior of rain in the Pacific Slope are the synoptical west and the equatorial west ones. Those winds are the consequence of the presence of disturbance of cyclonical origin (hurricanes of tropical storms) in the Caribbean Sea, under the

influence of this field of winds there can be storms or short summers, depending on the thickness of the humid layer.

Finally, an important mechanism in the rain production over the Costarican Pacific slope is the Intertropical Convergence Zone (ZCIT), an extensive line of influence of the Northwest winds on the North hemisphere and of the southeast winds on the South Hemisphere. The ZCIT is situated in the surroundings of the equatorial line, its association with big cloud masses is subject to seasonal variations, its average position ranges between 3 and 9 latitude North, reaching its most northern position from May to September, being thus an influence in the rain production during those months. During the months from November to Mars, it moves towards the South, reaching its southern position in February, coinciding with the dry season on the Pacific Slope.

The tropical cyclones on the Caribbean Sea affect indirectly the Costa Rica Pacific Slope. By indirect effects it is meant the long-distance action and in the peripheral of the cyclone long-scale circulation. This long-distance action is one of the causes of the traditional storms in the Pacific and it shows itself as a deep current of winds from the southwest, that besides being part of the disturbance, also transports humid air masses from equatorial latitudes pouring them like rain on the watersheds of the Pacific Slope. The rains generated by this flow from the southwest last for several days, recording large amounts of rain. The spatial distribution of rain sets the effect of the Central Mountain Range and the Coastal Line, directly exposed to the persistent humid flow from the Southwest.

Weather classification

The contours of the watershed show elevations that go from sea level up to approximately 2900 meters, causing different kinds of climates in relatively short distances. According to Koppen's weather classification, the Naranjo river watershed presents the following climates:

In the upper part, between 1500 and 2900 m.a.s.l., -Mild Rain Climate- Cw'a.' With a northern dry winter (December to April), the rains of the rainiest month during the northern

summer (June to September) are at least 10 times bigger than the rains of the driest month during the northern winter. The average temperature of the coldest month is lower than 18°C but higher than -3°C; the hottest summer reaches temperatures above 20°C.

In the middle and lower part, between sea level and 1500 m.a.s.l., -Tropical Rain Climate-Amw'. Its got a short dry season, but the total of rain allows the development of the Tropical Forest; rain on the driest month is lower than 60 mm; the temperature of the coldest month is higher than 18°C, the highest amount of rain happens during the northern autumn (September to December). (ICE,1993).

Rainfall

In the Naranjo river watershed there are three meteorological stations: Bartolo (1970-1989), Llorona (1970-1980) and Naranjillo (1981-1991); the latter situated in the area of the high watershed, and the other two on the area of the lower watershed.

In the Paquita river watershed area there are no meteorological stations, making it impossible to obtain data on the watershed local weather characteristics.

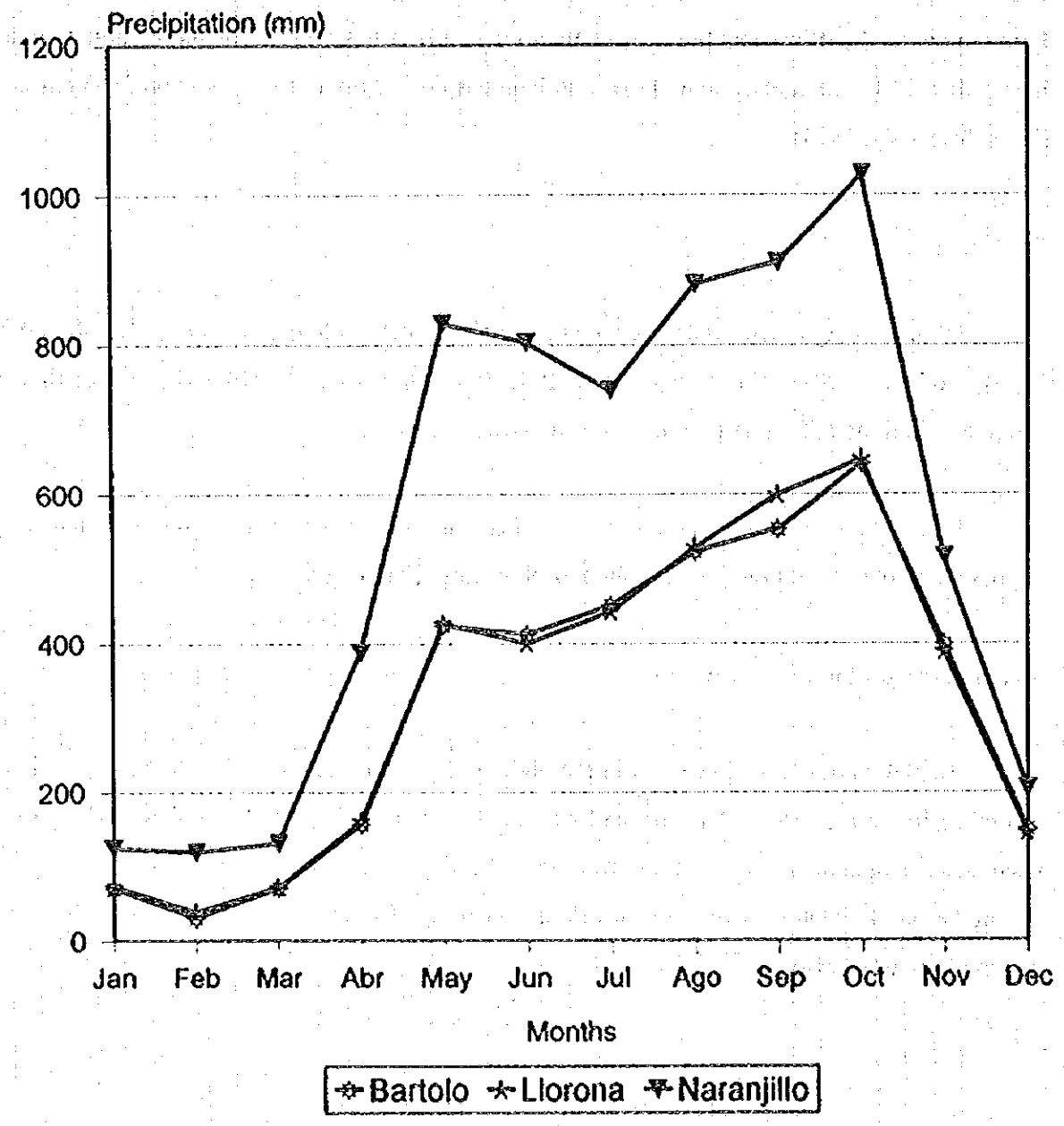
Spatial distribution of the rainfall

Rainfall varies from 2400 mm in the highest region on the Northeast, to 8000 mm in the central region in the surroundings of the Los Llanos dam site. This maximum obeys in part to the wind channeling in the mountain range with normal orientation to the humid flow coming from the Pacific Ocean. Rainfall decreases toward the lower parts of the watershed where it reaches 4000 mm in the coastal region.

FIG. 5

Monthly Average Precipitation

Stations of Naranjo Watershed



Source: ICE, 1993

Seasonal rainfall distribution

The figure enclosed (Fig. 5) shows the rainfall distribution in the three stations situated on the watershed, from which it can be observed a same pattern in rain distribution through the year.

From the rainfall regime that exists, it is possible to differentiate two maximum points of rainfall, one in May and the other one in October, which is typical of the Pacific slope. These rainfalls are produced with the arrival of the equatorial winds of the west or the southwest, as the weakening of the trade winds from the Northwest.

There is a long dry season that goes from December to Mars, a rainy period from May to October and the months of April and November are of transition. In the stations close to the coast (Bartolo and Llorona), there are two maximums during the rainy season, one in May and the other one in October and a secondary minimum in June. In the dry season that goes from December to Mars, February represents a dry month, where rainfall is lower than 50 mm. At the Naranjillo station, situated near the site of the dam, the maximums during the rainy season are in May and October and a secondary minimum in July, coinciding with the so called "short summer of San Juan". The dry season happens between December to Mars, but there are no dry months where the Naranjillo station is, since the monthly distribution presents rainfalls higher than 50 mm. The rain regime that exists in the watershed is influenced by the existence of the Talamanca Mountain Range, which functions as a barrier to the trade winds, being this a covered region where the dry season is less longer than in the rest of the Pacific slope.

12. Hydrology

The hydrological aspects have been well covered in the ICE report of 1993, where aspects as important as the calculation of the highest probable storm and the determination of a historical maximum at the Londres station were covered. With that on mind, it was noted that "the behavior of the Naranjo river during the event (Hurricane Joan from October 17 to 22, 1988) was measured

by the station 28-01 Londres, situated at a height of 170 m.a.s.l. The maximum value was on the 22nd at 15:30 hours with a scale of 3.40 m. and a flow of 387 m^3/sec."

Apart from this extraordinary but probable event, the relation of the flows with the rainfall shows a little gap (Fig. 6). The first peak of the rainfall occurs in May; however, the increase in the flows appears until June, when rainfalls show a perceptible decrease. This can be explained naturally by the fact that land has not yet reached a saturation level and the response for instant flows is slower. Between August and October the amount of rain increases as do the flows, which means that the system has quick responses in matters of draining and that soils are saturated. During November a response velocity of 3 hours was proved for rainfalls in the upper part and a flow increase at the Londres station.

The transportation analysis of the suspension sediments is given in a similar way, with a lower load in the first part of the year and a notorious increase between August and October with the maximum in the last month (see graph enclosed).

The latter explains the importance of control that lands in balance and with an adequate covering can achieve in the flow regulation and load supply. On the other hand, it is evident that yet in conditions of relative conservation, the production of suspension sediments is violent and of quick transportation on the second part of the humid season. This conditions make the watersheds management imperative. In a certain way, the presence of the project could regulate the dynamics of sediments transportation to acceptable levels for the environment.

13. Life Zone Systems and biological aspects

The basins of the Naranjo and Paquita rivers go from sea level to 1500 masl approximately allowing several climatic conditions on a very irregular topography. As a result, five Life Zones (Holdridge's 1967 classification) occur on the region under study (Land use and Life Zones map):

NARANJO RIVER. MONTHLY AVERAGE FLOW

STATION 92-28-1 LONDRES. 1970-1992

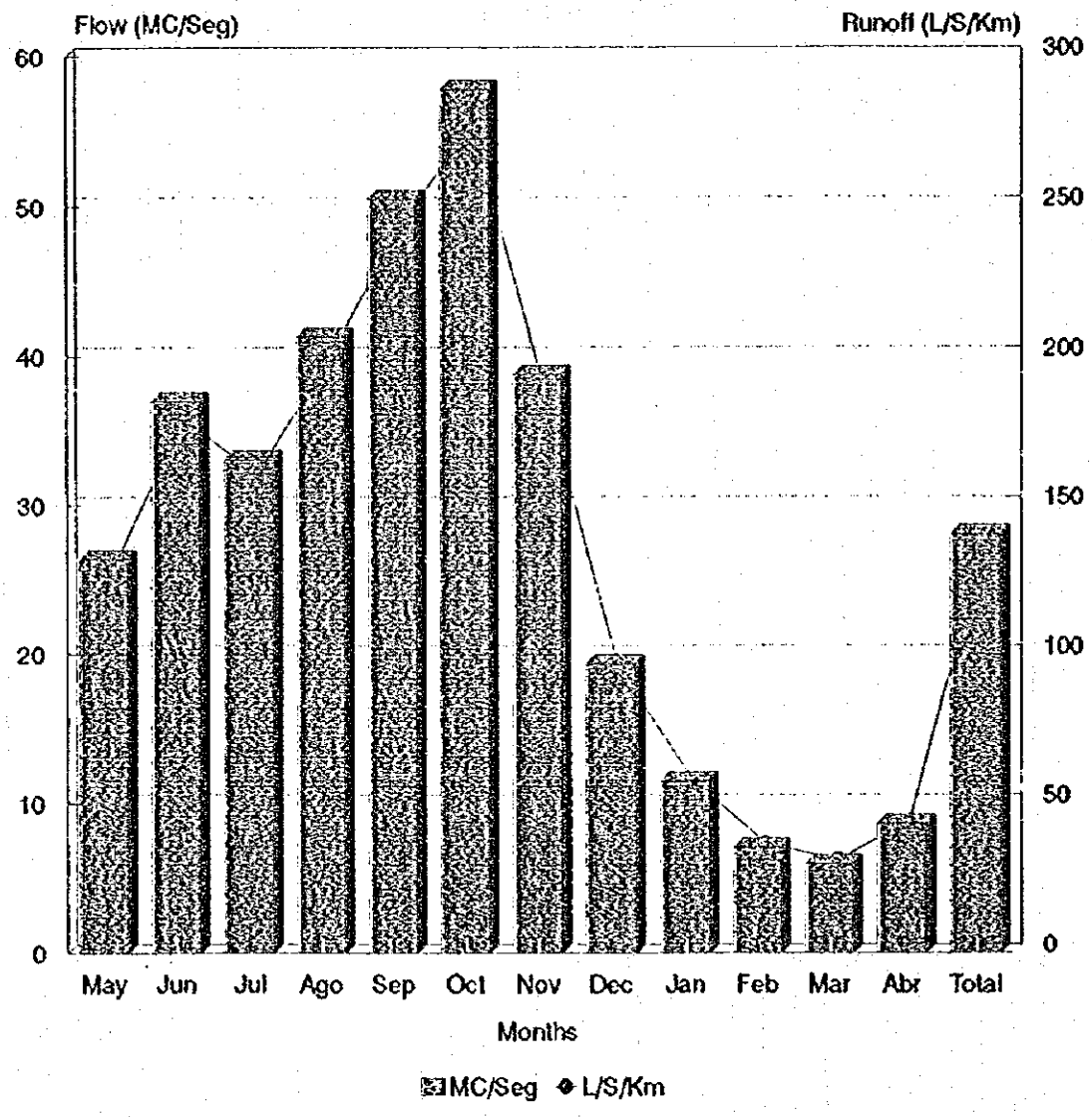


FIG. 6

Source: ICE, 1993

1. Tropical Wet Forest
2. Premontane Wet Forest, warm transition
3. Premontane Rain Forest
4. Lower Montane Rain Forest
5. Lower Montane Wet Forest

1. The Tropical Wet Forest is the second most extensive Life Zone in Costa Rica. There are two main blocks at opposite ends of the country but it also extends up from Golfo Dulce to Golfo de Nicoya on the pacific coastal lowlands (Hartshon 1983). This belt is not continuos as in the Quepos region where the Premontane Wet Forest, warm transition is the Life zone at the lowlands sorrounding the area with the exception of a small patch by the Manuel Antonio National Parck . Most of the Tropical Wet Forest Life Zone is near the climatic association in Costa Rica with a brief effective dry season in the Pacific side. It rains between 4000 and 6000 mm each year at this Life Zone which is not very appropiate for agriculture due to the land is susceptible to erosion. The mean temperature varies between 24 and 27 centigrades (Bolaños and Watson 1993).

Tropical Wet Forest is tall, multistratal, evergreen forest with some briefly deciduos species. Tallest trees are up to 55 m with round to umbrella-shaped crowns and attaining 100-200 cm dbh. Some species present high buttresses. Second layer trees are 30-40 m tall with round crowns, slender trunks and generally without butresses. Following layer have species 10-25 m tall with narrow conical crowns, often twisted or crooked, occasionally cauliflorous. Palms are common at this level, as well as dwarf ones in the shrub layer which is 1.5-2.5 m tall. Some ferns and Selaginella exist at the almost bare ground layer. Epiphytic species, woody lianas and strangling trees are rare (Hartshon 1983).

The original Tropical Wet Forest of this region has been converted to pasture although some small patches remain. There are some remanents of tropical wet forest in: Manuel Antonio National Park, Zona Protectora Cerro Nara and some not protected areas close to the towns of Paso Real and Esquipulas and toward the upper part of the basins. Due to the previous fact the original fauna of this forest is almost gone, especially large species of mammals and birds and predators that require large areas. However, some species exists, especially in the forest patches or species adapted to disturbed

habitats. The most common species are coatis, racoons, squirrel, howler and white- faced monkeys. Aquatic bird species at the bottomlands include snowy egret, green-backed heron, great egret, little blue heron. Species like wood stork, roseate spoonbill, white ibis and black-bellied whistling-duck are common at the river mouths, mangroves and even small wetlands at the palm plantations.

2. The Tropical Premontane Wet Forest is restricted to three areas in Costa Rica. However, Premontane wet forest, warm transition occupies larger areas in several parts of the country. One of those areas is an arc from Río Turrubaritos of Quepos (Hartshon 1983). Most of the Tropical Premontane Wet Forest Life Zone can be considered near to the climatic association (atmospheric association also occurs in this Life Zone). There could be a dry season in the Tropical Premontane Wet Forest Life Zone that varies between 0 and 5 months. The precipitation, in the warm transition, varies between 3000 and 4000 mm and the temperature between 24 and 27 centigrades (Bolaños and Watson 1993).

Tropical Premontane Wet Forest is medium to tall, semievergreen forest with two or three strata, with a few canopy species dry-season deciduos. Canopy trees are mostly 30-40 m tall, with mostly round to spreading cronws and relatively short clear boles. Buttresses are commmon but small. Understory trees are 10-20 m tall with deep crowns. Stilt roots and long, strap-sharped leaves are common. Tree ferns are occasional. The shrub layer is 2-3 m tall and often dense. The ground layer is generally bare except for ferns. Epiphytes are present but not conspicuos. Climbing herbaceous vines are abundant. Most trees are covered by a thick layer of moss (Hartshon 1983).

The Tropical Premontane Wet Forest is the most extended Life Zone on the study region. However, it is almost completely devastated due to the original forest has been changed to pasture and agricultural uses (mainly oil palm). There still exists some forest patches in the Manuel Antonio National Park, north of the park and some small patches on the Paquita basin especially at Sitio Gallega. The fauna found here is quite similar to that mentioned for the Tropical Wet Forest. Aditionally, several species, especially bats and birds ocurr in this Life Zone in this region. There are many bird species adapted to open areas which are abundant here like white-winged dove, ruddy ground- dove, white-tippped dove, Inca dove, cattle egret, turkey and black vulture, roadside hawk, black-shouldered

kite and several passeriforms. Many of the aquatic species pointed as present in the Tropical Wet Forest are found also in the Premontane Wet Forest. Other species in this category found here are Gray-necked wood-rail, white-throated crake, purple gallinule and the northern jacana.

3. Although disperse, the Tropical Premontane Rain Forest is extense in Costa Rica and it is found in several areas including relatively narrow bands on the Pacific slope of the Talamanca Cordillera and the Fila Costeña as is the case of the upper parts of the Ríos Naranjo and Paquita basins. The Tropical Premontane Rain Forest Life Zone is near the climatic association (Hartshon 1983). It rains over 4000 mm each year approaching close to 7000 mm at some places of this Life Zone which means too much rain for agriculture. The mean temperature varies between 17 and 24 centigrades (Bolaños and Watson 1993). Tropical Premontane Rain Forest is an evegreen forest, intermediate in height, with two or three strata. Canopy trees are 30-40 m tall, with round or umbrella-shaped cronws and straight branches. Buttresses are common but small. The subcanopy is very dense, with trees 15-25 m tall, having slender trunks often unbranched for most of their length; narrow, round to conical cronws. Understory trees are 8-15 m tall, often with leaning, crooked, or twisted trunks and relatively long cronws with horizontal branches; many trees have stilt roots. Tree ferns are common in the understory. The shrub layer is 2-3 m tall and very dense. Dwarf palms are uncommon in the shrub layer. The ground layer consist of a nearly complete cover of ferns, Selaginella and broad-leaved herbs, often with blushing leaves. Epiphytes, woody vines, and herbaceous climbers are very abundant. Moss and epiphytes cover practially all surfaces (Hartshon 1983).

The area occupied originally by the Tropical Premontane Rain Forest at the study region is very hilly and, maybe because of that, there still are some large forest patches at the Paquita and Naranjo watersheds. However, there are large farms and coffee plantations in the region.

Quercus spp and Lauraceae are abundant in the area. Several species of forested areas can be observed in this Life Zone mainly birds including mixed bands. We observed some species at 800 msnm at the east side of the Naranjo basin. One of the species observed was the red-headed barbet, a bird that prefers wet forests and the adjoining thickets, and semi-open areas. The bay- headed tanager was also observed at this point; this species frequents upper and middle levels of humid forest and

nearby clearings with scattered trees, semi-open and tall second growth (FUNDEVI-JICA-ICE 1994). These observation are important because they ilustrate the importance for conservation of the existence of forest patches and the importance of protect them. Other species observed at the region were the lineated woodpacker, dotted-winged antwren and some species of open areas such as thhe yellow-bellied elaenia, boat-billed flycatcher and the house wren.

4. The Tropical Lower Montane Rain Forest occurs on the slopes of several mountains in Costa Rica. It exists on both flanks of the Talamanca Cordillera as on the upper parts of the region under study. The forests are mostly in the climatic association for this Life Zone (Hartshon 1983). It rains over 3600 mm each year but it can get to 8000 mm at some points. The mean annual temperature is 12-17 centigrades (Bolaños and Watson 1993).

Tropical Lower Montane Rain Forest is an evergreen forest of low to intermediate height, with two or tree strata. Canopy trees are mostlly 25-30 m tall, but some my be higher, having short, stout, often twisted trunks. Branches are thick, sinuous, and relatively short. Cronws are relatively small and compact. Buttresses are uncommon. Understory stratum is often dense, with trees 10-20mm tall. Trunks are slender, straight or sinuous, with small, brushlike crowns of twisted branches. The Shrub layer is very dense, 1.5-3 m tall, often with flat sprays of small leaves. The ground layer is very well covered with ferns, sedges, trailing herbs, and moss. Epiphytes are common. Ericaceae and Melastomataceae are abundant shrubby epiphytes. Large-leaved vines are occasional, but large lianas are uncommon (Hartshon 1983).

5. The Tropical Lower Montane Wet Forest is restricted in Costa Rica to a several small areas including part of the Dota valley which is the point where this Life Zone occurs on the study region. These forest are considered to be the climatic association for this Life Zone (Hartshon 1983). The precipitation oscilates between 1850 and 4000 mm a year and the mean annual temperature is 12-17 centigrades (Bolaños and Watson 1993). Tropical Lower Montane Wet Forest is an evergreen forest of intermediate heigh with two or tree strata. Canopy trees are mostly 20-25 m tall, but some are taller, with short, stout trunks diving into numerosous long, heavy, twisting, ascending branches, producing wide, umbrella-shaped, billowing crowns. Buttresses are uncommon. The understory is fairly open,

with trees 5-10 m tall, with spreading cronws. The shrub layer is relatively dense, 2-3 m tall, and palms are uncommon. The ground layer is well-covered with ferns, Begonia, vines, and a thick layer of moist, rotting leaves. Small orchids, bromeliads, and ferns are common epiphytes. A thin layer of moss grows on tree trunks. Herbaceous vines, especially Araceae, are common at and near ground level. Large, coiled lianas are occasional to common (Hartshon 1983).

The Tropical Lower Montane Rain Forest and the Tropical Lower Montane Wet Forest besides they are a small proportion of the study area they are totally disturbed, although some forest remanents persists. There are several villages on these life zones: Santa Rosa, San Francisco, Santa Cecilia, La Ardilla, Napoles, Guaria, San Joaquin and others. Around these villages are extense pasture and coffee plantations. Melastomatacea and asteracea are common along the roads on this region. Many species adapted to open areas, manly birds can be observed in this areas. Groove-billed ani, great kiskadee and the tropical kingbird are common here as well in general in the region under study. Tha plain wren, clay-colored robin and the black-and-white warbler are also common in this area. Between the cited villages and the dam site there is still good forest. It is imperative to protect this forest for the good of the project and the ecology of the region in general.

A brief revision of the conditions of the Life zones of the region shows that the original habitat has been altered and occupied by diferent land uses as it was explained. It is very little what remains from the original forest of this region. Most of study area is pasture (Land Use Map). There also agriculture, some Tropical Wet Premontane Wet and Premontane Rain Forest. Additionally, there are several important forested areas like the mangrove patches at the Naranjo and Paquita, mouths. These sites (the patches mentioned before and the mangroves) contain wildlife species of a less disturbed condition and some of them have specialized requirements, like those living at mangroves. In fact, many of these species are protected by law (FUNDEVI-JICA-ICE 1994).

The region as a hole habitat can be used by several species besides the one mentioned for each Life Zone. These basins under study occupied, originally, a zone of great biodiversity where many wildlife species found their habitat. Many of these species were predators, like big and small cats, and

raptors, which are key species. It is probable that some of these species are still present in the region or some of them may occur occasionally, especially at the forested patches already mentioned.

The only two protected areas on the region under study are the Parque Nacional Manuel Antonio and the Zona Protectora Cerro Nara. Even though, several areas on the lowlands as well on the upper parts of the basins are strongly damaged. The Parque Nacional Manuel Antonio is in the basins under study but is small. The Zona Protectora Cerro Nara is highly relevant to the project because its eastern limit is the Naranjo river. Another protected area in the region is the Reserva Forestal Los Santos which is not actually in the Paquita or Naranjo basins. However, an appropiate management of the reserve is necesary to protect several watersheds and as a buffer zone for the Río Naranjo basin. Mangroves have high importance because they are a refuge to many plant and animal species, they contain a high wildlife diversity. Additionally, mangroves play an important role on the regulation of coastal processes, and on maintaining the landscape quality (FUNDEVI-JICA-ICE 1994).

Mangroves reduce coast erosion and regulate the entrance of sediments to the sea. Additionally, many animal species that have marine and terrestrial affinities, breed, feed or find cover in the mangroves. These animal species are the first step of many feeding webs that are based on detritus and herbivory. Mangroves are one of the most important forested habitats of the region. The canopy is the habitat of several bird species, some restricted to mangroves, like the mangrove vireo, the mangrove hummingbird, and the yellow mangrove warbler. Others species use the ground mud during the day, like the great egret, the little blue heron, the white ibis and sleep at the mangrove canopy at night. Some do the contrary, like the boat-billed heron, and the yellow-crowned night heron (FUNDEVI-JICA-ICE 1994).

Some studies have shown a high variation on the species abundance of species of commercial interest living in mangrover. Examples of these variations are the mollusks Prothothaca asperrima and Anadara tuberculosa. Also, there is a variation on the species distribution at the level of the mangrove area. Some mollusks are resricted to the inner part of the mangrove (e.g. Theodoxus luteofasciatus, and Melampus carolineaus) while others are located at the outer part of the mangroves (e.g. Grandiarca

grandis, and Anadara tuberculosa). Some of the observed variations are due to individual daily patterns and individual seasonal movements (FUNDEVI-JICA-ICE 1994).

Some arboreal mollusks and crabs such as Cerithidea pulchra or Aratus pisonii move between the substrate and the trees following the tide cycle, predation pressure or microclime variation on each site (FUNDEVI-JICA-ICE 1994).

Some species, mainly crabs, shrimps and fish, are associated to floating material as debries and leaves. As a general rule, few dominant species are of a higher abundance in all Central American mangroves. This pattern is true in groups as crabs and fish. Despite the previous sentences, there is a high number of species of high commercial value, like shrimps, that have several larval stages which depend on the mangroves (e.g. Penaeus spp and Trachypenaeus spp). Other important groups are fish, with large number of species living in the mangroves. These arguments (as well as many others) support the idea of the great value that mangroves play on the mantainance of coastal fisheries (FUNDEVI-JICA-ICE 1994).

Due to the dinamic of the coast and the water, there is no doubt the project will have some impacts. However, it is difficult to predict the kind and magnitude of the impacts. Probably, in some way, the marine species will not suffer a lot with the change of the amount of water in each river. However, species adapted to brackish water, those living a the mouth of the river, will have probably a stronger impact. Also, it is very difficult to predict what will happen to the vegetation of these areas, especially mangroves. One expected impact is a relocation of the mangrove species in the sense of the way they are found from the front to iland or just where they will be in relation to where they are now.

The coral reef close to the coast is the most diverse of the littoral communities. It is formed by a solid base of basalt that contain reef algae and others. Over this base there are sponge, tunicates, and others. All them form a shallow system of photosynthetic organisms or organisms feeding by filtering particules. There are many fish species on the coral reef on a specific distribution, some of them of commercial value (Dubois and Hatziolos 1982). The second most diverse marine habitat is the rocky shore (between the low and high tide) with several invertebrate species and some small fish. It is

dominated by mollusks (79%) of which eight species occur quite regularly. There are also crabs and other crustaceans, polychaetes, and sea urchins. The dynamic of this habitat is different from other areas where there are some predators (gastropods, sea stars) that avoid the establishment of any dominant species. The dominant species here are producers. The composition of the two habitats (coral reef and rocky shores) probably will not change directy due to the different amount of water coming from the two river (except maybe very close to the mouth of the rivers).

The wind pattern of this region produce calm water during early morning. Afther 10 am the wind is stronger and produce a choppy sea; waves can be strong at mind afternoon. These water can be influence even by the North Ecuatorial Current. The salinity varies between 13.8% and 30% with lower values close to the mounth of Naranjo River. This is the same for temperature being of 27 °C close to the Naranjo River wich are 2°C less that other sites. In general, all these water is very turbid (Dubois and Hatziolos 1982).

Having a different amount of water at the mouth of the Naranjo River, it is expected a change on the values of the variables mentioned. However, we ignore the magnitude of these changes and how they can influence the dynamic or species composition of the littoral communities. We do not know either how the mangrove at the Naranjo river will behave after the decrease in the water level or how all associated communities to the Paquita River mouth will behave after the increase in the water level.

Most of the observed species (especially at bottomlands) are aquatic or require water. Many of them probably will not suffer with the change of courses of the two rivers. However, some of them will need to move because they need to forage at specific depths. However, most of these species use these habitats only temporarily and may be not affected strongly. Small non-flying wildlife species that migrate between sites will not be able to cross the Paquita river any more with a higher water level. However, these species can mantain population interactions at some points (or times). Consequenty, it seems the water level change not to be a real worry at least at this level.

14. Land Use Capacity

The Land Use Capacity was determined according to the Official Methodology, some of it was executed by the Ministerio de Agricultura y Ganadería at two reference scales, 1:50 000 and 1: 200 000. The information was used to elaborate the map of conflicts by Life Zones, where a compilation is presented.

The ruling classes on the upper region are VI and VII, with limitations by land erosion, while in the lower watershed of both watersheds all classes are represented, but in restricted surface units. The more severe limitations are caused by soil erosion and climate.

15. Actual Land Use

The actual land use was executed through aerial pictures photointerpretation of the National Geographic Institute, scale 1: 60 000 from 1992, referenced and with field control. Areas were measured by weight in the 5-decimal analytical balance to exclude as possible all measurements errors, and the use was referenced by Life Zone, in a way that it is possible to observe clearer the ecological disorder caused by the use in function of the potential vegetation for the site. (Table 1)

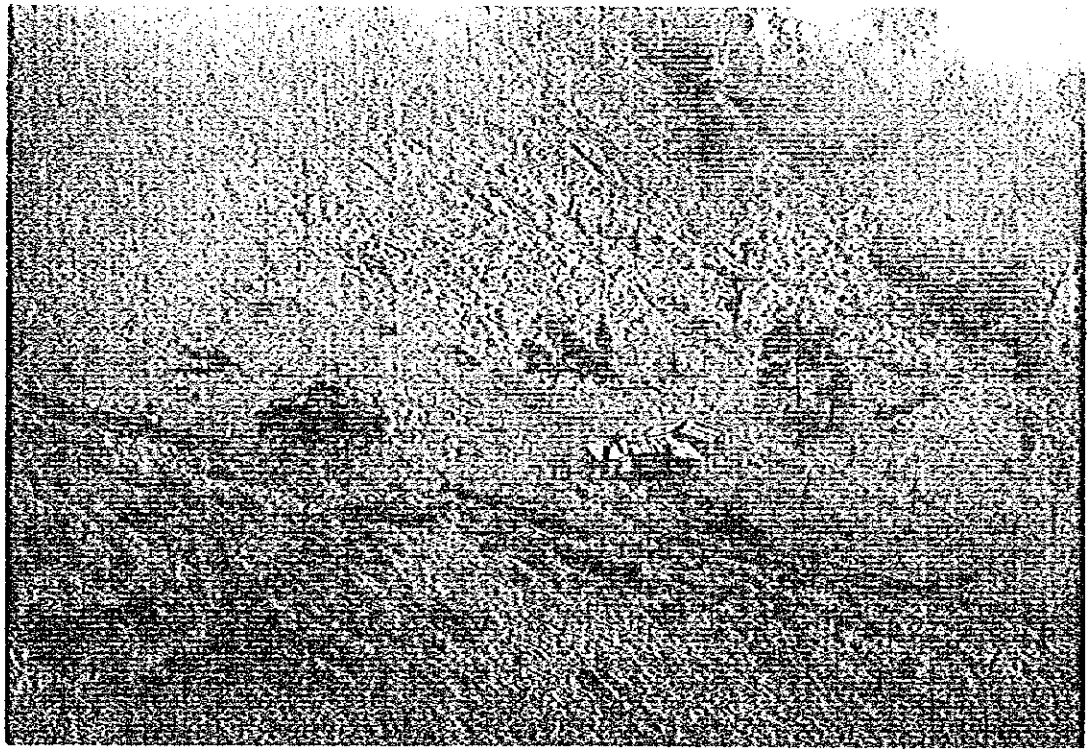
The enclosed chart (Table 2) contains the information referring to uses contrary to the forest one. The field observation allowed to determine that, comparatively, the Naranjo river watershed is more affected in its higher and middle watershed than the Paquita river watershed. (Lamina 1) This is mostly because of the change of use of forest and paddocks to coffee, stimulated by the international prices of the latter and because of the relative block of Land Use in the Valle de los Santos compared to the population increases in this geographic regions.

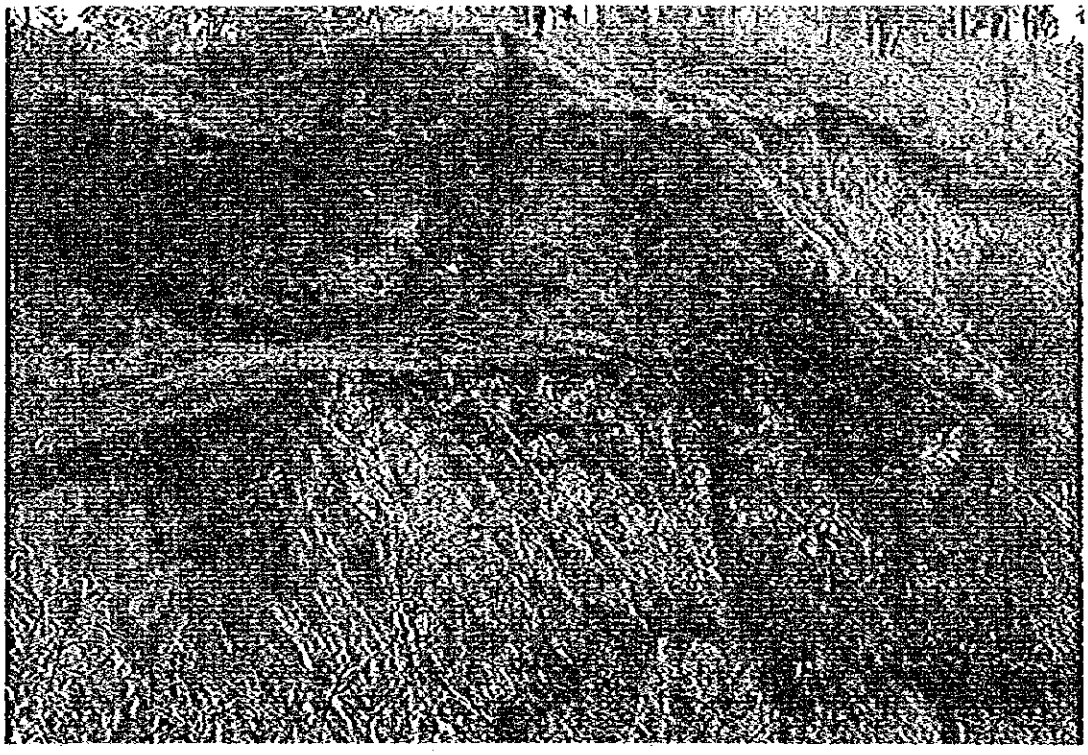
TABLE 1

NARANJO AND PAQUITA WATERSHEDS

Life zones and Land uses
(in hectares)

Uses:	bp-P	bmh-P	bp-M	bp-MB	bmh-MB	bmh-T
P (Pastures)	3481,61	2423,56	0,00	932,83	764,86	586,94
Pa (Pastures with trees)	1428,54	2826,93	0,00	224,35	60,32	3314,24
C (Coffee plantation)	91,08	0,00	0,00	0,00	403,46	0,00
B (Forest)	5245,78	2424,90	783,03	1932,16	2209,16	4374,07
Ba (Open forest)	1771,00	164,69	0,00	1099,06	0,00	524,22
T (Scrub)	0,00	137,30	0,00	0,00	0,00	17,66
Tp (Scrub with pastures)	0,00	74,51	0,00	0,00	0,00	0,00
M (Mangrove)	0,00	208,25	0,00	0,00	0,00	0,00
Vb (Beach's low vegetation)	0,00	86,65	0,00	0,00	0,00	28,40
Pl (African palm)	0,00	401,22	0,00	0,00	0,00	0,00
A (Rice)	0,00	1456,34	0,00	0,00	0,00	0,00
Subtotal:	**12018,00**	**10204,35**	**783,03**	**4188,41**	**3437,80**	**8845,53**
TOTAL:						**39477,12**





LAMINA I

The land use modification destroy the forest ecosystems and therefore the erosion phenomena beging its activity and a big sediments yield occur on the steep unstable slopes.

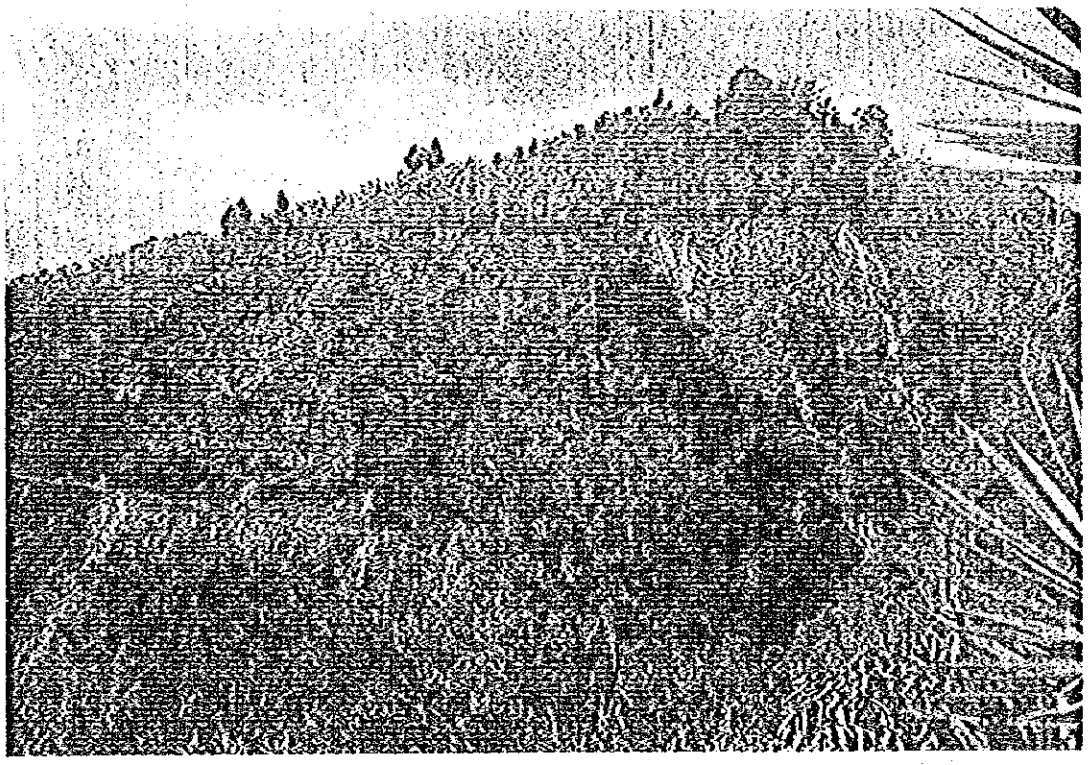
An important fact to remember is that all the present Life Zones correspond to high humidity conditions and that, except for the Tropical Montane Rain Forest, the rest present a change in the potential forest use.

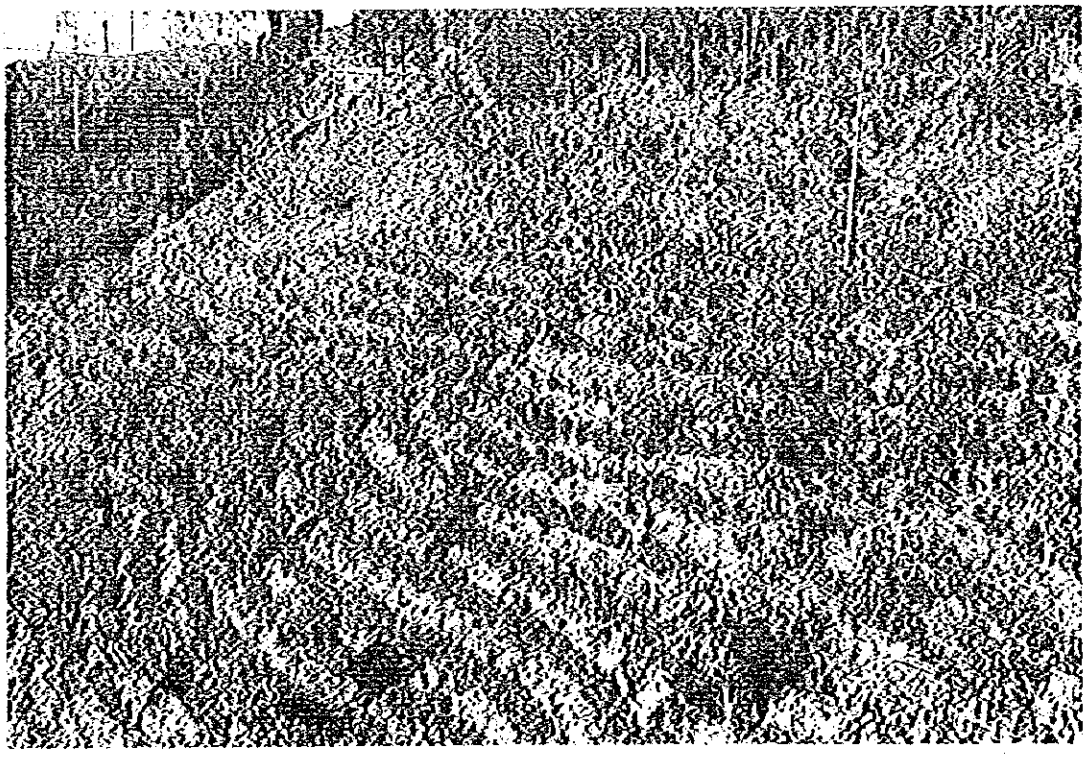
16. Land Use conflicts analysis

The Land Use analysis (Table 1) with regard to Life Zones, led to a comparative analysis with regard to the Land Use capacity, determining the conflicts of use by Life Zone, as a meaningful tool for the orientation of the watershed management. (Conflicts of use by Life Zone Map).

The following chart contains the information of the Life Zones Conflictive Uses, establishing that the major conflicts are present in the Tropical Wet Forest, the Tropical Premontane Pluvial Forest and the Tropical Premontane Wet Forest. This is very bothering, because these units are situated mostly upstream from the affected sites by civil works. This mean that they could have negative sediment effects on the project, due to changes on the hydrological cycle and in the potential increase on the load supply for the hydrological system.

The following table 2 offers the absolute and percentage relation of these conflicts by Life Zone, and gives the information on the type of use that the conflict generates, in a way that the grouped orientations on management focus to the specific nature of every activity. (Lamina 2).





LAMINA 2

The agricultural uses as the coffee plantation are the most important activitis in the upper Naranjo watershed. It`s necessary soil conservation program to control the erosion processus.

NARANJO AND PAQUITA WATERSHEDS

Relation between conflict areas and life zones

TABLE 2

Life Zone:	*bp-P*		*bmh-P*		*bp-M*		*bp-MB*		*bmh-MB*		*bmh-T*		Total	
	Absolute	*%**	*Absolute*	*%**	*Absolute*	*%**	*Absolute*	*%**	*Absolute*	*%**	*Absolute*	*%**	*Absolute*	*%**
Extension (ha)	12018,00	30,44	10204,35	25,85	783,03	1,98	4188,41	10,61	3437,80	8,71	8845,53	22,41	39477,12	100,00
Unsuitable Uses (ha):														
Pastures (P)	3462,00	8,82	657,00	1,66	0,00	0,00	933,00	2,36	765,00	1,94	492,00	1,25	6329,00	16,03
Pastures with trees (Pa)	1429,00	3,62	1682,00	4,26	0,00	0,00	224,00	0,57	60,00	0,15	2988,00	7,57	6383,00	16,17
Coffee plantation (C)	91,00	0,23	0,00	0,00	0,00	0,00	0,00	0,00	403,00	1,02	0,00	0,00	494,00	1,25
Total	5002,00	12,67	2339,00	5,92	0,00	0,00	1157,00	2,93	1228,00	3,11	3480,00	8,82	13206,00	33,45

*The percentage are in relation with the watershed's surface.

Legend:

bp-P	Tropical Premontane rain forest
bmh-P	Tropical Premontane wet forest
bp-M	Tropical Montane Pluvial forest
bp-MB	Tropical Lower Montane pluvial forest
bmh-MB	Tropical Lower Montane wet forest
bmh-T	Tropical wet forest

	Forest Class:	*Conflicts:*
VI P	Class VI	Pastures
VI Pa	Class VI	Pastures with trees
VI C	Class VI	Coffee plantation
VII P	Class VII	Pastures
VII Pa	Class VII	Pastures with trees
VII C	Class VII	Coffee plantation
VIII P	Class VIII	Pastures
VIII Pa	Class VIII	Pastures with trees

17. Los Llanos Hydroelectrical Project in the socio-economical context of the Central Pacific Region

Social Aspects

a. Demography

According to the projections of the Dirección General de Estadística y Censos (DGEC), for January, 1990 there was an estimate in the Central Pacific Region (RPC) a population of 166.514 inhabitants. This supposes a density of 42,5 hab/km^2, lower than the national average at a 57,9 hab/km^2 (Table 3)

TABLE 3
CENTRAL PACIFIC REGION
TOTAL POPULATION BY CANTONES, AND DENSITY. JANUARY 1990.

CANTONES	POPULATION NUMBER	%	DENSITY (Inh/Km^2)
Puntarenas	90 355	54,3	49,0
Esparza	18 010	10,8	81,2
Montes de Oro	8 845	5,3	36,1
Aguirre	16 629	10,0	30,2
Parrita	11 835	7,1	24,7
Garabito	4 014	2,4	12,7
San Mateo	4 364	2,6	34,7
Orotina	12 462	7,5	87,8
TOTAL REGION	166 514	100,0	42,5
COSTA RICA	2 959 177		57,9

SOURCE: DGEC. POBLACION A ENERO DE 1990.

The Aguirre y Parrita cantons have an immediate influence on the Los Llanos-HP, represent as a whole the 17,1% of the Region population. This percentage relation is the equivalent to 28.464 inhabitants, showing an individual density of 30,2 hab/km^2 at Aguirre and 24,7 hab/km^2 at Parrita.

Despite that the population density is lower than the national average (57,9 hab/km^2), the experimented population growth in the past years in both cantons is significant.

The latter can be proved by observing Table 4. In the periods between the census and the projection made for 1990, there is an important recovering on the population number that impacts in the density by km^2, increasing 6,0 in Aguirre and 4,3 in Parrita.

TABLE 4
CENTRAL PACIFIC REGION
TOTAL POPULATION BY, AND DENSITY,
YEARS: 1973, 1984, 1990

	1973		1984		1990	
CANTONES	N	Inh/ Km²	N	Inh/ Km²	N	Inh/ Km²
Puntarenas	62 603	33,9	74 135	40,2	90 355	49,0
Esparza	12 095	54,5	14 998	67,6	18 010	81,2
Montes de Oro	6 779	27,7	7 444	30,4	8 845	36,1
Aguirre	14 473	26,3	13 319	24,2	16 629	30,2
Parrita	11 901	24,9	9 774	20,4	11 835	24,7
Garabito	2 959	9,3	3 144	9,9	4 014	12,7
San Mateo	2 969	23,6	3 783	30,0	4 384	34,7
Orotina	8 479	59,7	10 494	73,9	12 462	87,8
TOTAL REGION	122 458	31,2	137 138	34,9	166 514	42,5

SOURCE: DGEC. CENSOS DE POBLACION 1973 Y 1984. POBLACION A ENERO DE 1990.

Apart from these considerations, there is also the fact that the Central Pacific Region has a high negative migration rate (Table 5), especially in the Aguirre and Parrita cantons.

TABLE 5
CENTRAL PACIFIC REGION
MIGRATORY BALANCES AND MIGRATION RATES (/100 Inh)
1968-1973, 1973-1984

CANTONES	MIGRATION BALANCES		MIGRATION RATES	
	1968-73	1973-84	1968-73	1973-84
Puntarenas	-3 278	6 337	5,00	7,88
Esparza	-791	204	-6,54	1,31
Montes de Oro	-1 159	-1 013	-16,61	-13,08
Aguirre	-3 616	-5 039	-24,98	-36,38
Parrita	489	-4 802	4,11	-47,24
San Mateo	-580	457	-19,54	11,62
Orotina	-817	813	-9,64	7,45

SOURCE: MIDEPLAN. Migración Interna en Costa Rica. 1973-1984.

b. Health

According to the reference system of the health system structured in Costa Rica, the Central Pacific Region has 2 hospitals, 13 clinics, 9 Health Centers and 44 Health stands (MIDEPLAN, 1989). The basic level that forms this structure is the Health Stand. From this, the reference levels are organized according to the complexity of the required attention, being the hospital the most complex level.

Apart this structure, assistance services are given through Mobile Units, the EBAIS and other particular programs (dentistry, nutrition, feeding). These programs are done using the infrastructure given by the CEN and the CINAI and their emphasis is on health prevention.

It is maybe because of this disposition that the behavior of the child mortality rate of 13, 5 can be explained -among others-; this number is close to the national average (13,9). However, if

this indicator can be considered as an effective achievement of the programs and the health system structure in the Zone, it is also true that the Region shows satisfaction parameters heterogeneous. This situation has been demonstrated by a MIDEPLAN study, where Garabito, Parrita and the peripheral Puntarenas appear as cantons with a "very low" satisfaction level on health necessities; at the same time, Aguirre can be found in the "middle" level. (MIDEPLAN/DIRECCION DE PLANIFICACION GENERAL).

A possible explanation can be found in the concentration of resources of the health sector in the most important populations. Added to this the gradual deterioration of the primary attention and home visit services given between the eighties and the beginning of the nineties, it is not surprise to find that all this has caused a uneven behavior.

c. **Education**

In this field, the Central Pacific Region shows negative behaviors in two basic indicators: illiteracy and desertion.

According to the Population Census of 1984, 10,5% of the population of 10 years old and up was illiterate, situating the highest percentages in Aguirre (12,2%), Garabito (18,7%) and Parrita (19,9%).

On the other hand, the phenomenon of desertion reached a 21,2%, concentrating in night schools and high schools (see Table 6).

If one pays attention to the column of desertion, it is possible to realize the big difference between day high schools and schools. Desertion in high school is almost doubled. However, the magnitude of the problem can be observed at checking that the absolute difference between both inscriptions is notorious. That is, one can suspect that there is a soon incorporation to the work market, mostly among teenagers who cannot pursue their studies.

There is no doubt that this particular aspect is the reflect of the socio-economical situation of the Region. The situation obeys to the low profitability of family exploitations, unemployment and the few possibilities that the zone offers to absorb high school graduates. This is the reason why a large amount of young people migrate in search for an employ at an early age, which reflect in a negative migration rate. Of course, the little qualification or this labor limits its localization in stable, well-paid sources, duplicating the problematic in more complex levels that always affect the definition of social problems of more difficult solution.

TABLE 6
CENTRAL PACIFIQ REGION
EDUCATIONAL CENTER NUMBER, MATRICULATION AND DESERTION BY EDUCATIONAL LEVEL. 1988.

LEVEL	EDUCATION CENTERS	MATRICULATION INITIAL	MATRICULATION FINAL[2]	% DESERTION
Preescolar	20	1 669	—	—
I-II Ciclo (diurno)	280	23 251	20 281	12,8
I-II Ciclo (nocturno)	2	105	62	41,0
III C/Diversificada[1]	15	6 118	4 685	23,4
Colegios Nocturnos	3	1 487	890	40,1
Enseñanza Especial	9	245	—	—
TOTAL	341	32 875	25 918	21,2

[1] Incluye Académica y Técnica

[2] Preliminares

SOURCE: MIDEPLAN, Estadisticas de Educación por Regiones, 1988.

d. Life Levels

In order to characterize life levels, is necessary to consider the basic necessities indicators in the different socio-economical regions of Costa Rica, used by MIDEPLAN (MIDEPLAN, 1991).

In the case of the Central Pacific Region, the average of the indicators of the considered variables was the only one that showed negative variations.

Among other aspects, this behavior can be interpreted as an indicator of the life levels ruling the Region. In this sense, the study that was consulted affirms that the obtained result can be considered as one of the "... effects that the crisis from the beginning of the eighties had over budgets and services quality given by most social field institutions" (MIDEPLAN, 1991:95).

The evaluation of the indicators[1] of the considered variables also allowed the ranking of the studied cantons. For our case study, the basic necessities satisfaction level according to the used methodology ranked the cantons of the Region among the "Very Low" group (Parrita and peninsular Puntarenas) and Low (Aguirre, Garabito and peripheral Puntarenas). This corroborates the comment already quoted, in the way that the life levels that rule the Region allow to qualify it as a majority living under low life conditions.

Economical aspects

a. Economical activities

According to the Regional Development Plan, Central Pacific Region 1990-1994, the African oil palm, bean, sugar cane and coffee were the cultures that occupied the greatest sowing

[1] The indicators considered in the variables were: Health & Nutrition: child mortality, mortality by infectious and parasite diseases, low height for children on the first grade; Education: population without any level of education, population with at least one year of secondary education, assistance to a regular education center; Housing: overcrowding, index of type and condition of housing; index of basic services.

area. Other products as rice, corn and "sorgo" have been losing relative importance. Instead, so-called "non-traditional" products have been introduced, such as the mango culture. Importance-wise, it is followed by marañón, papaya, melon, water melon, ayote, pepper, achiote and vanilla (MIDEPLAN/DIRECCION DE PLANIFICACION REGIONAL).

The other important economical activity is fishing. All over this Region there are coastal settlements that depend on this resource and that exploit it in a craftsman way. Besides this small-scale way, there is intense exploitation infrastructure concentrated in Puntarenas and Quepos.

Because of the dominion of agricultural and fishing activities, the Region has had an agroindustrial development of some relative importance. However, the vulnerability of the installed agroindustries is manifested if one bears in mind that "this kind of industry maintains a fragile balance from the changes given in the internal and external market and, in general, from the dependency of machinery, equipment and necessary inputs in the process of these products" (MIDEPLAN/DIRECCION DE PLANIFICACION REGIONAL: 15). In this sense, one cannot talk yet of a vertical integration between sector, which can be considered as a development level attained in the Region. For the same reason, the industrial activity is isolated and of lesser relative influence. It has basically been the result of the state promotion and its weight in job generation is not significant.

The activities addressed to the local market, as a product of population concentration in urban centers, has allowed a development of light manufacture and the small industry.

Lastly, the tourist activity has increased in the last years, but shows a disorganized development without any clear aims. This can be explained by the lack of an institutional policy in the Region (MIDEPLAN/DIRECCION DE PLANIFICACION REGIONAL), which has come to a subutilization of the resources and a degradation of those used in an intensive way. Nowadays, along with the potential that the traditional and the scientific tourism offer, there is an out of control, predatory exploitation that cannot yet articulate the concepts of profitability and sustainability.

This marked contrast that can be observed in the Region, has allowed a stereotyped judgment of the tourist activity to become deeply rooted, giving place to the concept of earning over the one of conservation. The most important characteristics are manifested in profit expectations, improvement of the personal socio-economical situation and opportunities for a better life. However, as far as those expectations do not articulate with a development strategy from the tourism sector of the Region, the possibilities of crystallizing those yearnings will reduce to the domain of a minority. In fact, the social problems that this dynamics generate are already visible and, without any doubt, their repair cost in the long term will generate a limitation of the possible resources that could be assigned to impulse the dynamics of tourism as a rational economical activity.

b. Land occupancy

According to the Agricultural Census of 1984, the Central Pacific Region had 6.959 exploitations that occupied a surface of 292.468,9 Has. (Table 7).

Most of the lands were adequate for agriculture, but there existed a very marked subutilization. As an example, a study of the MIDEPLAN affirms that "the available area for agricultural use has been totally subutilized, and only a 22,8% is used for that activity. On the other hand, as a contrast, we found that the area used for intensive cattle sums up 187.143,6 Has. This means a 47,7% of the regional total area, opposed to a 5,6% which is the real capacity of the Region for this activity" (MIDEPLAN/DIRECCION DE PLANIFICACION REGIONAL: 11).

TABLE 7
CENTRAL PACIFIQ REGION
LAND USE BY: EXPLOITATIONS NUMBER
AND EXTENSION IN HECTARES

CANTONES	EXPLOT. NUMBER	EXT	CULTIVATION LANDS	PERMANENT CUL.	PASTURES	CHARRAL Y TACOTAL	OTHERS	TOTAL
Puntarenas	3225	14719,2	4767,8	98694,5	9897,0	9434,3	1660,1	139172,9
Esparza	589	1533,7	650,6	14205,8	798,5	797,5	126,4	18112,5
Aguirre	786	8281,1	6817,1	18265,8	6377,4	2216,8	1350,7	43308,9
Parrita	744	11059,8	4060,1	17337,0	1875,9	1277,0	1060,4	36670,2
Garabito	212	1932,1	184,0	10081,3	1928,7	915,1	232,7	15273,9
San Mateo	403	588,6	581,2	5944,5	270,1	371,3	344,8	8100,5
Orotina	550	15269,2	725,3	10858,3	545,0	539,3	274,7	15269,2
TOTAL REGION	6959	54536,1	18432,8	187143,6	23538,9	16257,5	5502,6	292468,9

SOURCE: DGEC. Censo Agropecuario de 1984

With regard to the occupancy regime, there are high indicators of land occupancy in the zone. This situation explains the negative migratory rate that dominates in the Region, especially in the Aguirre and Parrita cantons and that can be explained by the sale of unproductive small properties owned by countrymen that migrate to look for fortune in other employment sources.

Inside this panorama, the mixed and indirect ways of occupancy have a significant relative weight. This supposes an excessive pressure on the land and, probably as a counterpart, the existence of idle and subutilized lands (DGEC; Censo Agropecuario).

Basic services

With regard to basic services, in general terms there is an adequate drinking water system. The distribution starts to be insufficient in places of population concentration, especially in those places where the pressure of tourists and the settling of precarious people surpass the forecasts for the attention and increase the demand substantially.

The telecommunications service complies with the purpose of avoiding the isolation of most of the rural communities. However, the lines deficit is starting to show in an increasing way. The Region has electricity in its majority and there are only some isolated settlements, with a very low population concentration without electricity.

With regard to the communications net for transports, in the Central Pacific exist 4.334,2 km of roads. Of those, 21% correspond to the National Net of Roads; a 79% to the cantonal net and a 60% are traffic penetration roads (MIDEPLAN/DIRECCION DE PLANIFICACION REGIONAL). The communities are practically communicated in their totality. Only a few ones remain incommunicated during some periods of the rainy season.

Basic characteristics of the populations situated on the immediate socio-economical contour of the Los Llanos Hydroelectrical Project

The immediate socio-economical contour of the Project is formed by an assorted group of populations, which more important characteristics are the dispersion and the relative isolation. (Fig. 7).

These particularities cause very low infrastructure development levels, which probably are associated to the satisfaction of the most basic necessities of the population. For this reason, in the immediate socio-economical contour of the Project, there are deficiencies in public transportation services, in the state of the roads, in an insufficient amount of supplies to cover all the health

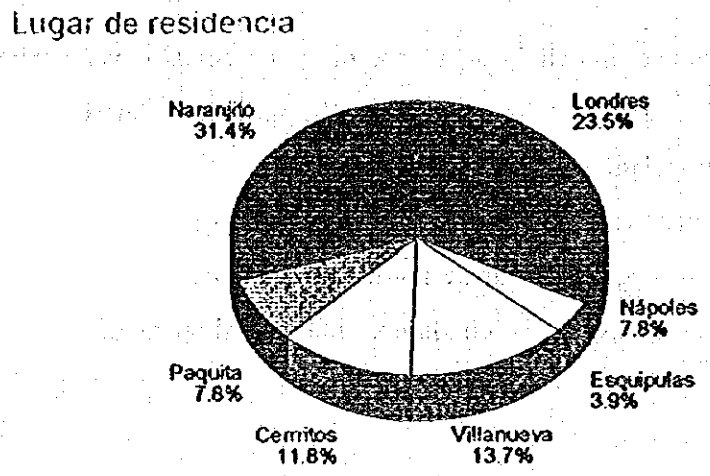
demands, in the limited access to the middle and upper levels of the formal education system, minimum telecommunications equipment, inadequate waste disposal systems and limited access to a chlorine water supply. On the contrary, and as a common feature of the impact of general policies of inversion in infrastructure, it exists an adequate access to the electricity and aqueduct services, that assure the intradomiciliary water supply.

The relatively homogeneous situation of the observed social development obeys to the spatial distribution of the communities. In this aspect, the settlements more distant and isolated from the most important population centers show more depressed features (MIDEPLAN, 1994). This particularity is associated in a direct way with other problems observed in the region, such as the unemployment, which can be explained by the mobilization difficulties to the centers where employ is offered, determined by roads conditions and the absence of public transportation services.

With the purpose of offering an approximate characterization of the population situated on the contour, and to know its perception on the Project, a survey was carried in the towns of Naranjito, Londres, Villanueva, Cerritos, Paquita, Napoles and Esquipulas.

The absence of basic processed information forced to take a very high random sample of 38,5% of the population. In absolute terms, that meant to prepare the study with the data given by 125 householders, whose proportional representation was the following:

Figura 7

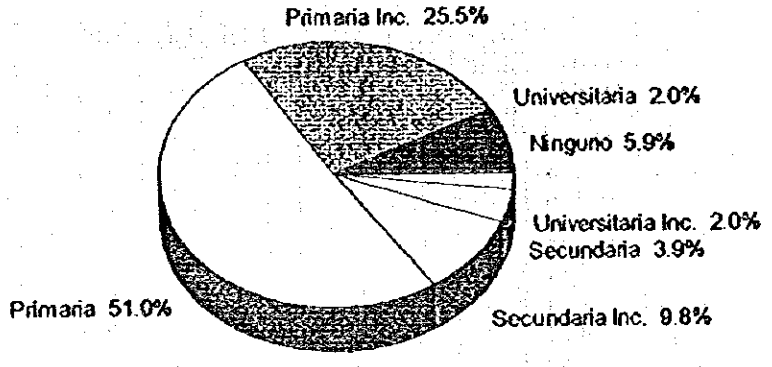


Fuente. Encuesta Socioeconómica
PH-Los Llanos. 1995

The surveyed have a very homogeneous educational level (Fig. 8) that coincides with the characteristics shown by the distant rural populations segments of Costa Rica. In this case, the greatest group was formed by householders with complete Primary education (51%). The part of the population that went through the basic education levels (complete and incomplete Primary education) represented 76,5%, which contrasts with the 17,7% that followed some studies after completing Primary school and a 5,9% that did not attend the education formal system.

Figura 8

Nivel educativo del informante



Fuente. Encuesta Socioeconómica
PH-Los Llanos, 1995.

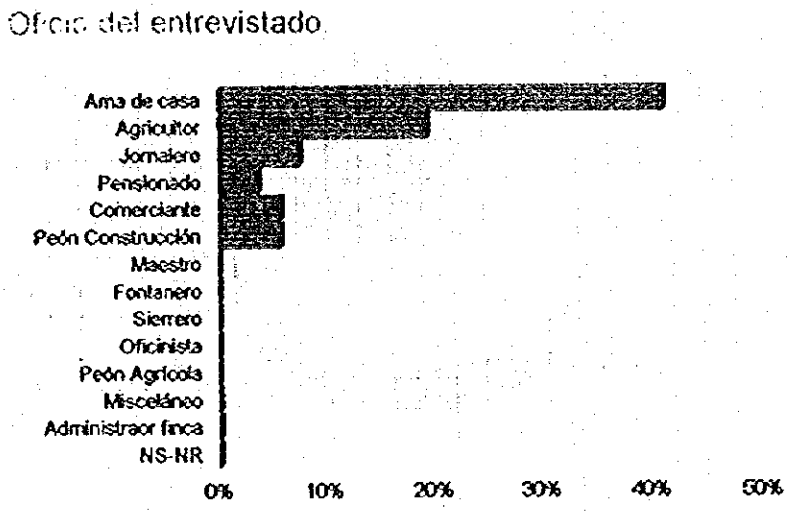
These characteristics coincide with the prevailing at a regional level, and are probably the answer to the factors stated where the behavior of the education variables in the Central Pacific Region was described.

Coinciding with these same statements, the prevailing of activities that require few training is another one of the characteristics that the sampled population shows. (Fig. 9).

With regard to that, the results of the survey allowed to establish that 41,2% of the surveyed population are women working at home, following in order of importance, farmers and day laborer, who in group represent 27,4%.

These particularities mark the prevailing of traditional production relations, where the woman participation in the wide reproduction process supposes higher levels of exploitation of their productive force, since the work at home reaches from domestic works to the participation in agricultural works that lead to an earlier weakening.

Figura 9



Fuente Encuesta Socioeconómica
PH-Los Llanos, 1995

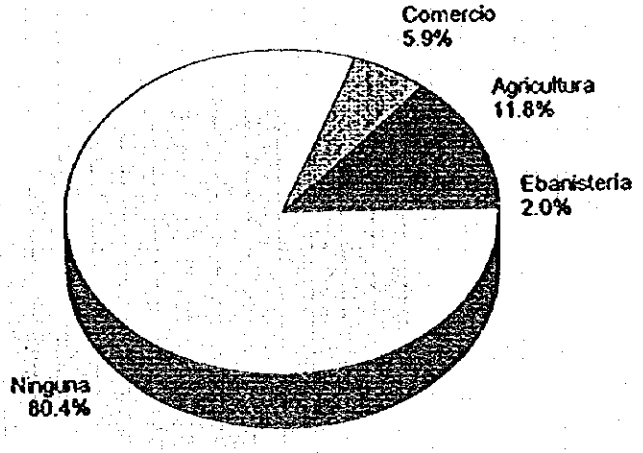
The main explanation of these phenomenon is based on the circumstance that the lesser employ opportunities and land concentration, are manifested in the practice in work occupation patterns where all the members of the country family participate, most of all during the time of coffee harvesting. (Fig. 10).

This is particularly true in contexts where there are evident limitations to obtain alternative incomes exploiting alternative economical activities.

In the case of the immediate socio-economical contour of the Los Llanos-HP, the derived limitations of the lack of own economical activities are particularly evident.

Figura 10

Actividades económicas propias.



Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995.

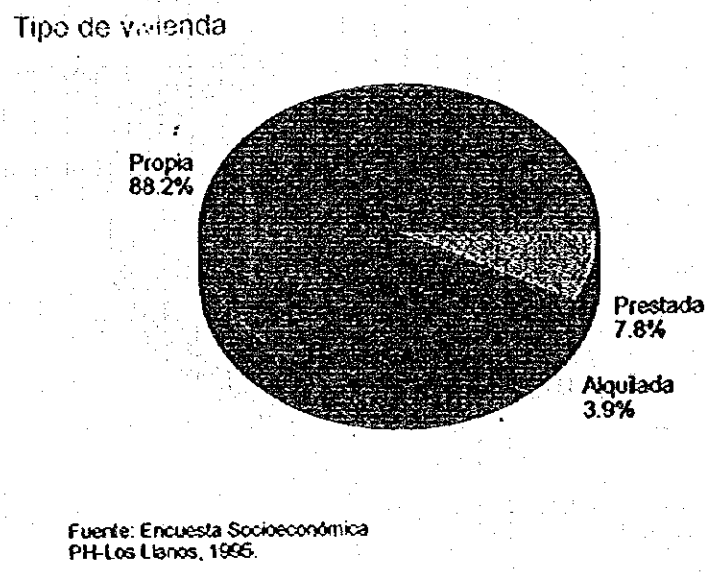
From the whole of the surveyed families, 80% does not execute any economical activity derived from the exploitation of their own goods. The other 20% supports the obtaining of resources and income, mainly in the occupancy of farms dedicated to agriculture (12%) and small-scale commerce (6%).

The corollary of all these features is the predominance of very limited life conditions, which, according to what it was analyzed, offer low average values.

These circumstances have obligated the State to execute compensatory actions from the weakening of the life conditions.

A close idea of the terms that this particularity is manifested was obtained when analyzing the results corresponding to the indicated specifications in the state of some housing indicators. (Fig. 11).

Figura 11



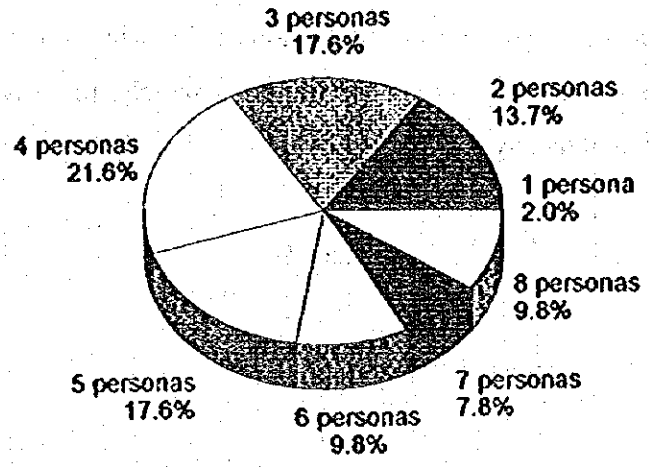
For example, in spite of the depressed socio-economical conditions, 88% of the surveyed own their house, in contrast with a 4% that lives in rented houses.

Likewise, it was possible to confirm that the greatest proportion of inhabitants by house is 4 people, which is equal to 22% of the whole sample.

This particularity evidences that the overcrowding levels associated to depressed life conditions not only do not comply in the study case, but also express the effect of the implemented compensatory measures. (Fig. 12, 13)

Figura 12

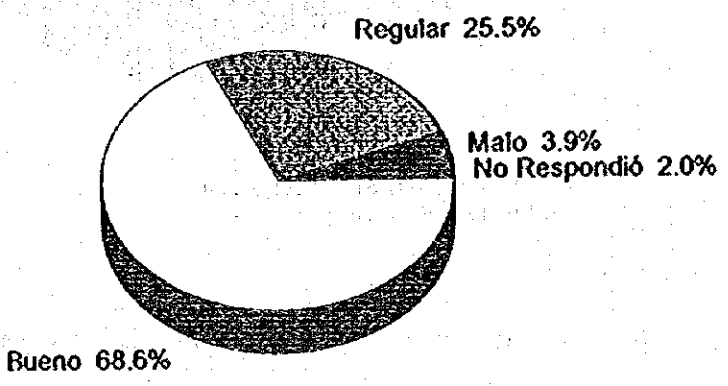
Número de personas que habitan la vivienda



Fuente Encuesta Socioeconómica
PH-Los Llanos, 1995.

Figura 13

Estado de la vivienda



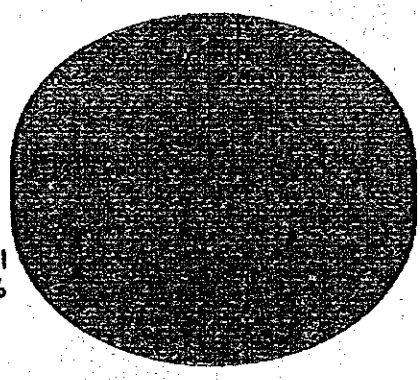
Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995.

The most complete example of this is the fact that 69% of the houses are in good conditions, which contrasts ostensibly with the 4% of houses that are in a poor state.

Nevertheless the compensatory effect on housing policies, other indicators reflect the prevailing of adverse socio-economical conditions. For example, there is a high percentage of family members not covered by any means of insurance.

Figura 14

Número de miembros de la familia que están asegurados



Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995.

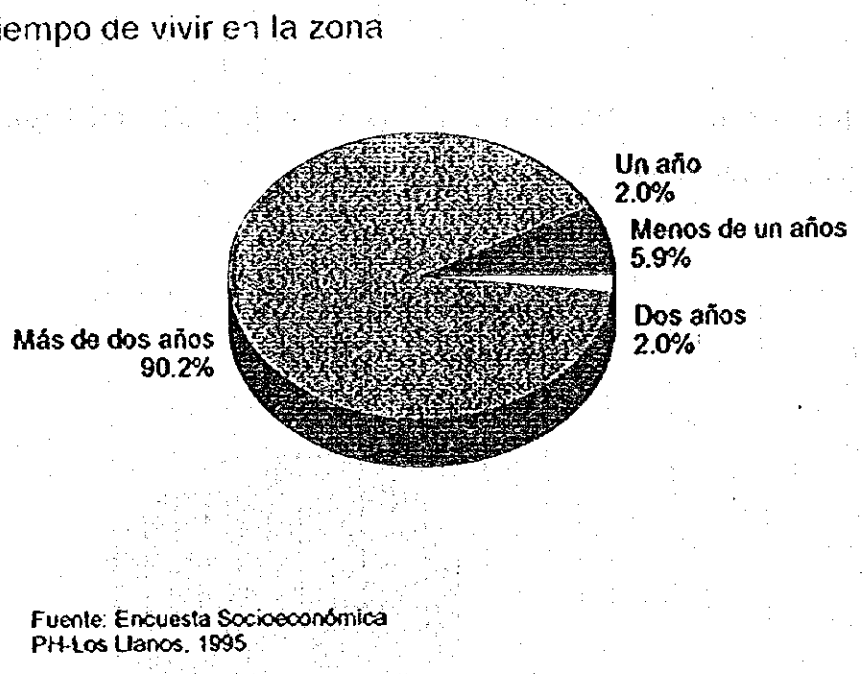
The effect of this situation, probably helps the maintenance of the depressed socio-economical indicators, and at the same time partially explains the conditions that determine the negative migratory rates, according to what it was explained to its regard.

Perceptions toward the Project

Inside the described context, it was important to establish which were the prevailing perceptions toward the Project.

For this purpose, the survey included a set of variables that allow an approximate establishment of the most important characteristics of those perceptions, which were expressed mostly by surveyed that have been living for more than two years in the region.

Figura 15

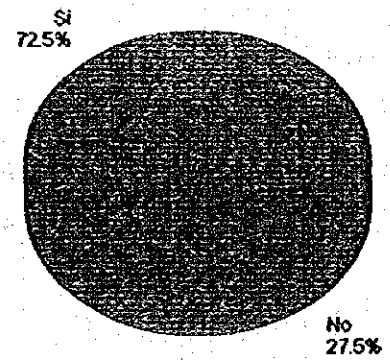


Fuente: Encuesta Socioeconómica
PH-Los Llanos. 1995

This characteristic allowed to rate the answers in terms of the higher or the lesser knowledge that the surveyed have about the Project. (Fig. 15)

Figura 16

Conocimiento del Proyecto

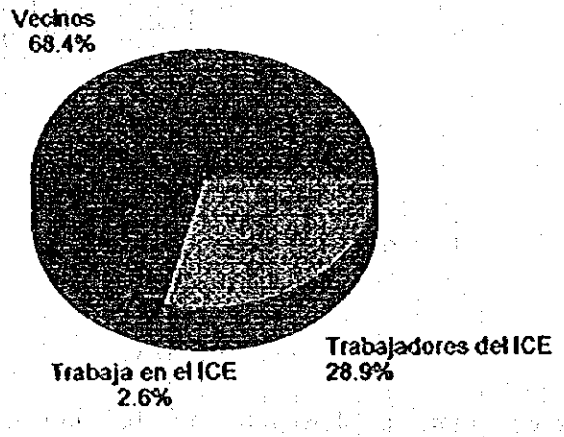


Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995.

With regard to that, 73% claimed to know about the Project (Fig. 16), from which they were introduced mostly by neighbors and ICE workers. (Fig. 17).

Figura 17

Forma de enterarse acerca del Proyecto.

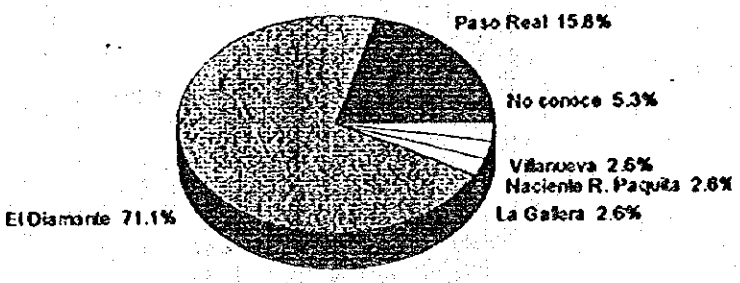


Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995

In order to know the degree of certitude with regard to the knowing of the Project, one of the questions was to name the site of construction. (Fig. 18). 71% claimed El Diamante was the construction site, 16% answered Paso Real and 5% accepted they did not know where the site was.

Figura 18

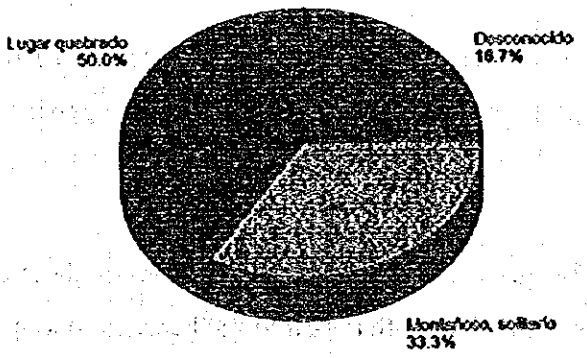
Conocimiento del sitio de construcción del Proyecto



Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995

Figura 19

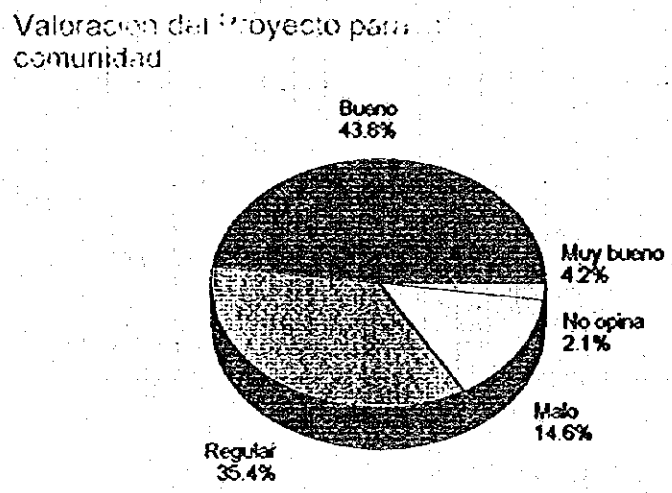
Descripción del sitio de la presa



Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995.

Finally, when asked about a description of the construction site, 17% answered they did not know the place. On the contrary, the rest of the surveyed described it as a place of broken topography, mountainous and lonely. (Fig. 19)

Figura 20



Fuente Encuesta Socioeconómica
PH-Los Llanos, 1995.

The perception of the Project was not homogeneous for the community. Only 44% considered the Project will do some good, 35% thought it will be neither good nor bad. (Fig. 20).

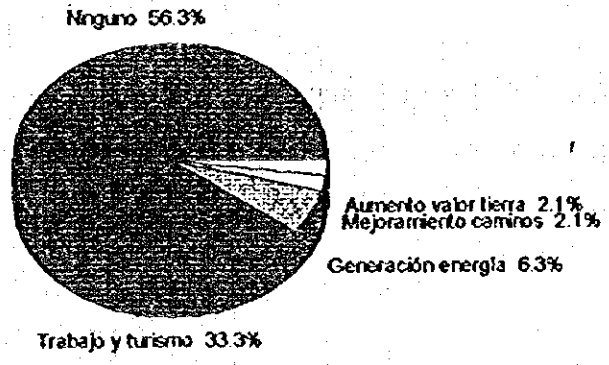
With the purpose of having a more specific idea about the terms this perceptions were manifested, there were questions about the pros and the cons supposedly derived from the Project. (Fig. 21).

To this question, 56% agreed on pros while 59% on cons, without expressing any judgment at all. However, the biggest agreement with regard to the benefits concentrated on the stimulation on work and tourism.

On the side of the damages, the judgments stated a significant dispersion, which had as the biggest relative observation the reduction of the river flow. (Fig. 22).

Figura 21

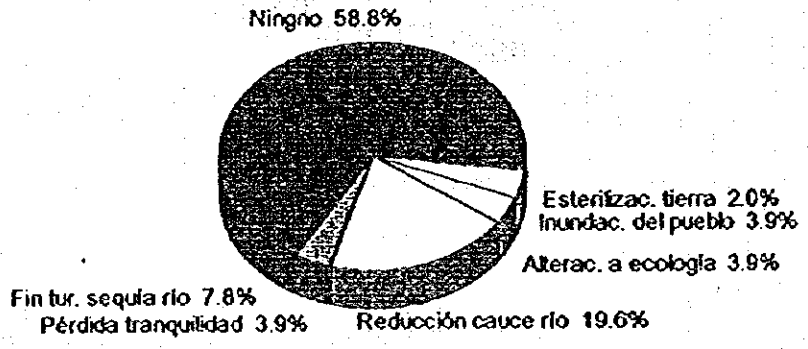
Beneficios de la construcción de la planta



Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995.

Figura 22

Perjuicios de la construcción de la planta



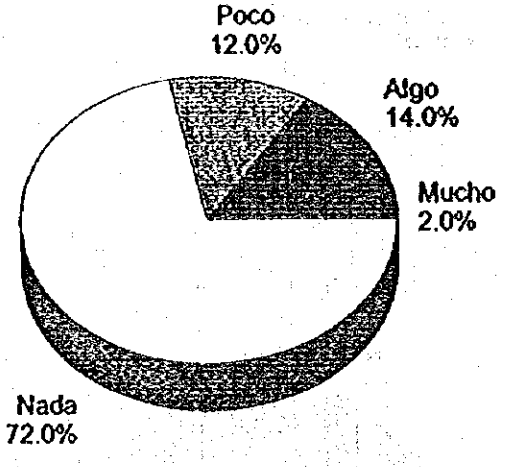
Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995.

The expectations generated around the damages are justified in the fear that the tourist activity can significantly decrease because of the reduction of the river flow. With that on mind, the Tourism Chambers have lodged appeal before the Defensoria de los Habitantes (Ombudsman) and asked the ICE for details (see documents in the Appendix). These actions, without a doubt, obey to expectations based on the incertitude that the tourist activity can face.

The latter is deduced partially from the perceptions toward the alteration on the everyday life that the Project will cause.(Fig. 23)

Figura 23

Expectativas de alteración de la vida cotidiana



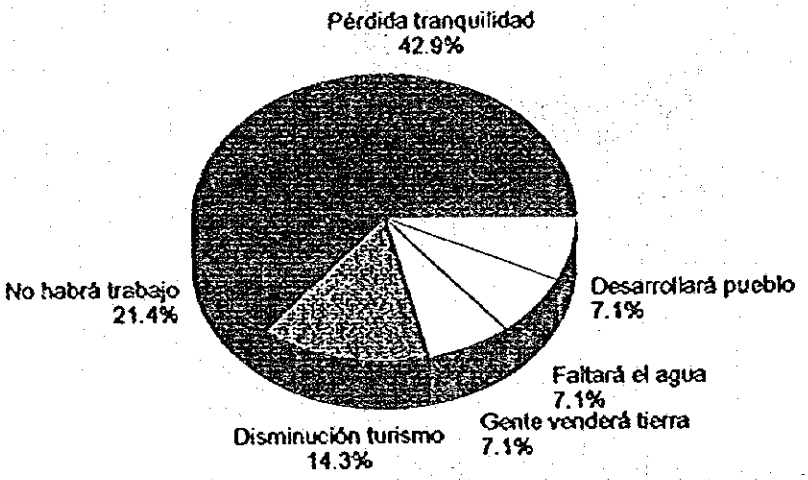
Fuente: Encuesta Socioeconómica PH-Los Llanos, 1995.

In this case, 72% of the surveyed consider that their everyday life will not be affected, a percentage that ostensibly contrasts with the 2% who thinks that it will be affected in large amounts.

On the other hand, 28% of the surveyed population that think that there will be negative effects in their everyday life, think that the greatest change will be the lost of tranquillity (43%) and work decrease (21%). This 21% along with the 14% that mention tourism decrease is probably directly associated with the fear that the tourist activity will be affected.

Figura 24

Aspectos de la vida cotidiana que se verian afectados



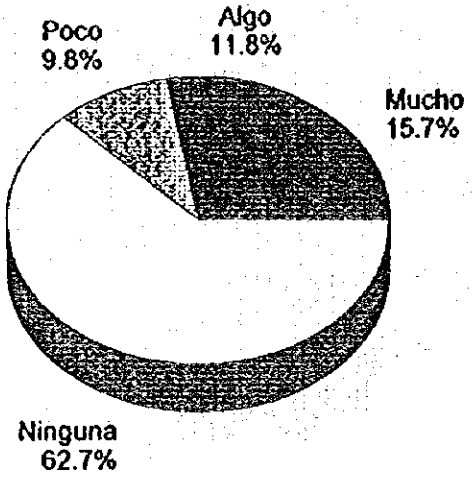
Fuente. Encuesta Socioeconómica PH-Los Llanos, 1995.

In a similar way, to the question of what would be the economical aspects on which the Project will impact, (Fig. 25), 69% did not point any expectations to that regard. On a second place, 16% considered to have many expectations.

The hypothesis that are base for these judgments are contradictory: 47% consider that incomes will improve, while 41% think the contrary.(Fig. 26).

Figura 25

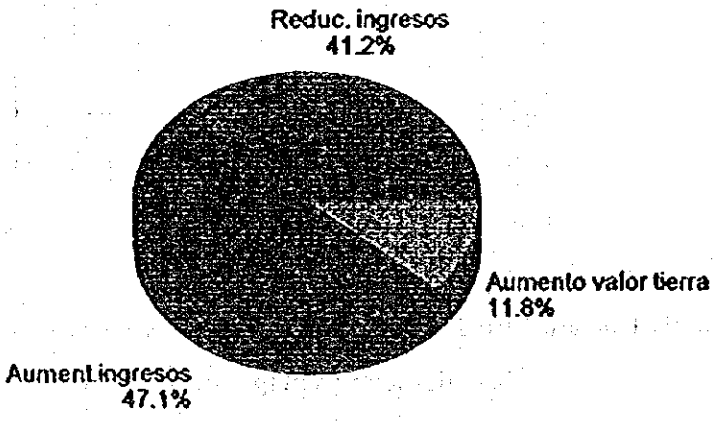
Expectativas de impacto del Proyecto en la economía de la comunidad



Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995.

Figura 26

Supuestos aspectos de la vida económica de la comunidad que se verán afectados

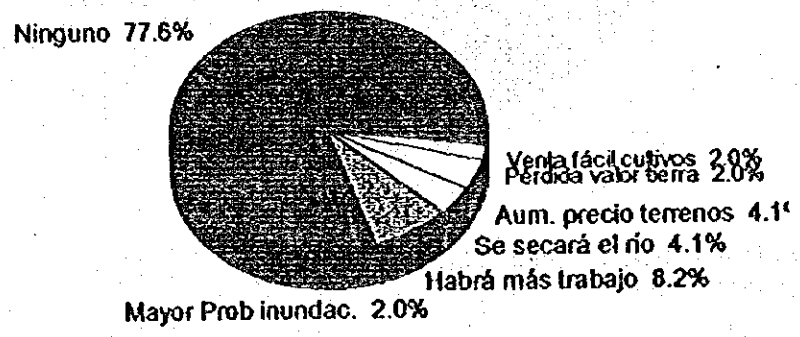


Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995

This peculiarity does not allow to univocally clarify the reasons that motivate the expression that there will be an increase in land value. This judgment is confirmed by observing that the expectations in personal economy do not show important concentrations around the non null criteria.(Fig. 27).

Figura 27

Expectativas del Proyecto sobre la economía personal.



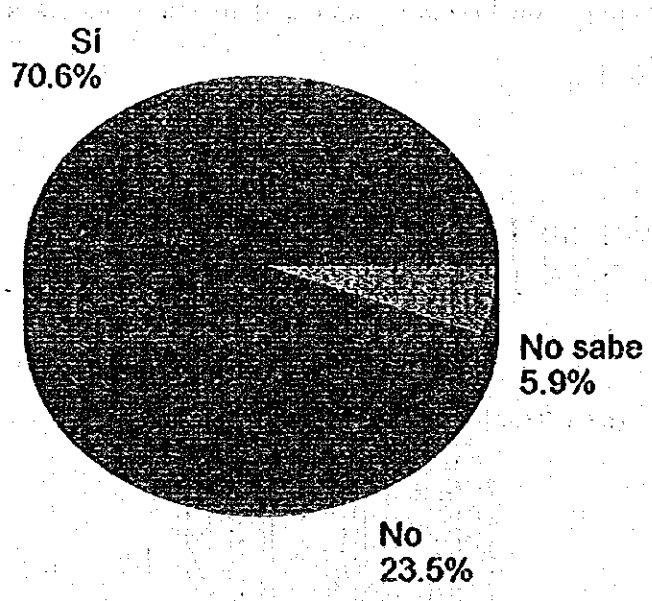
Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995.

From there it is no surprise that 71% (Fig. 28) of the population agrees with the making of the Project, basing their criteria in the fact that the Project would be good for the community and the country (65%) (Fig. 29).

Finally, the alternative proposed projects concentrate in observations that point the necessity of improving the basic infrastructure, which is considered as normal, in the context of minimum benefit described at the beginning. (Fig. 30).

Figura 28

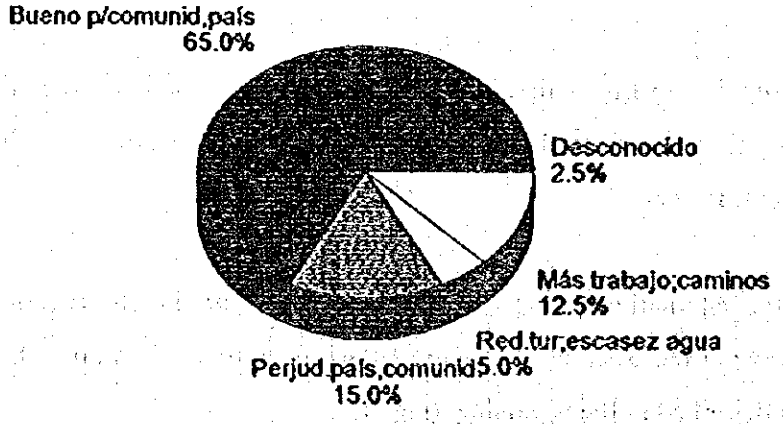
Avenencia con realización del Proyecto.
Proyecto



Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995.

Figura 29

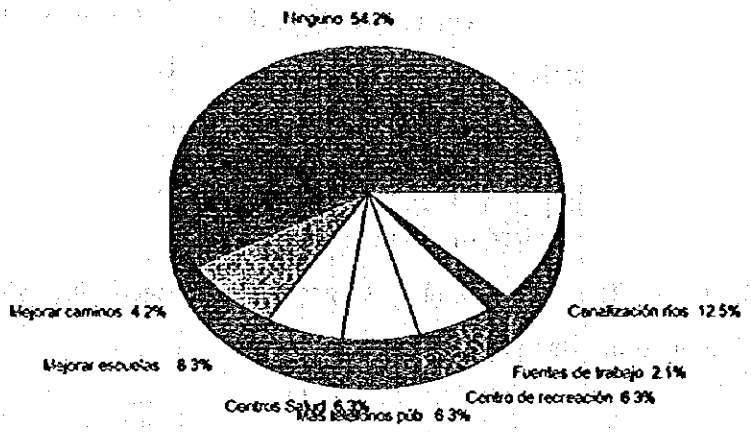
Razones de acuerdo o desacuerdo con
realización del Proyecto



Fuente: Encuesta Socioeconómica
PH-Los Llanos, 1995

Figura 30

Proyectos alternativos al Proyecto necesarios para comunidad



Fuente: Encuesta Socioeconómica PH-Los Llanos, 1995.

The socio-economical contour of the Los Llanos Hydroelectrical Project is characterized by being depressed and by showing low development indicators.

This particularity generates expectations in activities of recent development in some settlements, especially those connected to the tourism, which are able to cause greater dynamisms in local economies.

Perhaps this is the main reason why the derived fears of significant reductions in the Naranjo river flow are associated to the negative impacts. Nevertheless, as it was proven, the fears are not homogeneous, but they concentrate in contradictory and very concentrated values.

Because of these particularities, it is wise to suggest to explain all the doubts to the communities and to implement actions that tend to incorporate their interests during the formulation, making and continuation of the Project.

18. Legal order limitations that affect the project

Watersheds management has its shelter in several laws of the country, e.g., General Health Law, Water Law, Costarican Electricity Institute constitutive Law, that act as legal supports for a possible application of the Watershed Management project. It is the execution of the project that finds legal order restrictions, clearly and specifically in the Ratification of the RAMSAR Convention (Convention related to the "humedales") by the Costa Rica Legislative Assembly in June, 1991. The application of the article 7, section h of the Wild Life Conservation Law that establishes the legally binding to the State of "Manage, supervise and protect the "humedales"..." and the reaches of Law No. 7554, Environment Organic Law, specifically what is pointed by section e) that reads, among other things:

"Any harm to the environment constitutes an offense of social character..."

The Law refers specifically to the case of energy projects in section a) of article 29 that reads:

"To Locate in an optimal way, inside the national territory the productive activities, human settlements, public and recreational use zones, transportation and communication nets, wild life areas and other vital infrastructure works, as energy units and irrigation districts and "avenamiento" ".

Chapter XII of the alluded Law is totally binding in its articles 50, 51 and 52, sections a, b, and c. Anexe 2.

Therefore, the subjection to the precepts of Land Management and to the water resource management are not petitions or recommendations anymore, to now constitute lines of action pre-established giving place to sanctions in case of non-completion.

With regard to the Management of both watersheds, the environment protection embraces all the components of the watersheds and the Costarican Electricity Institute is the designated one

to execute what it has to do in order to not subjecting to what it is described in articles 98 through 101 of the alluded Law.

19. Management plan

1. The attached map (Amenagement Assesment map) contents an evaluation of the necessery management conditions for the planning and explotation regarding:

   a. Electricity generation
   b. Environment impact control
   b. Conservation of the tropical rain forest and protected areas
   d. Conservation of the high quality of the natural landscape

2. Management of the upper basin of the Naranjo River
   The management of the upper basin of the Naranjo River is of high priority for:

   a. An improvement of current land use
   b. To improve the superficial draining behavior
   c. To operate on flow regimen and to control the flow, supply and transportation of sediments

The category U.C.F. on the map means and appropiate forest use. 1.C. indicates devastated areas and coffee plantations with a severe erosion. It is suggested the improvement of the vegetation cover as a high priority for the areas 1.c. in the map. It is jurisdiction of the Direcion de Planificacion del Uso de la Tierra of the Ministerio de Agricultura y Ganaderia and regional agencies of the Los Santos valley, to conduct the programs for soil conservation on this sector. The same is true for the IIP category (pastureland), which composition and distribution must be improved by both agencies. (Lamine 3).

3. The Area de Conservacion Pacifico Central has the jurisdiction for the control of the management of any protected forest in the region. At the same time, the Area de Conservacion Pacifico Central must be aware of restrictive uses of the Brujo River basin. This area must include all forest (even the Cerro Nara reserve) to guarantee the constant water flow to the Naranjo River bed.

The upper basin of the Paquita River must achieve some protected status to avoid any flood threat for the bottomlands and the coast erosion.

4. All forest sorrounding any creek and river draining to the Naranjo river at any point downstream from the dam site must be declared protected forest. The landowners should receive all benefits of the forestal incentives to create private biological reserves or wildlife refuges in concordance to the current legislation.

5. The wetland protection in both watersheads is linked to amount and quality of the fresh water supply. This amount must be higher than the average flow of March after the records of the Instituto de Electricidad.

6. The I.C.E. will commit itself for the good conditions of the road connecting Los Santos valley, the dam site and the towns of Quepos, Londres and Cerritos. This will encourage the landowners to protect the forest.

7. The present study has showna litle resistance of tha commuties to the project due to missleading information. To gain support to the project we suggest :

- To integrate a commission with members of I.C.E., A.C.P.C., Aguirre tourist bureau, Municipalidad, Londres and Cerritos local organization for:

- To know the necessity, implications, control and mitigation of the project environmental impacts.

- Local benefits of a tourism project, electrical supply, etc..

- Road maintenance benefits.

- Granting policies of forestal incentives form the M.I.N.A.E. - Ministerio de Ambiente y Energia -, for all those juridic and civil people who are under the wildlife protection regimen (Refugios de Vida Silvestre).

- To inform the local community about a contingency plan and its achievements. This plan will be made to control and mitigate natural threats.

8. The I.C.E. will make a monitoring program in order to :

a. Keep the roads in good conditions.

b. Plan and execute the appropiate programm for soil and forest conservation.

c. Grant of the forestal incentives and a wildlife regimen of protection from the Ministerio del Ambiente y Energia.

d. Control the regulated flow in the Paquita and Naranjo River bed, downstream from the basin site and power house.

e. Alluvion control of the Rio Naranjo bed due to a possible flow decrease.

f Supervice the Naranjo River flow and the wetlands (mangroves) dynamics.

The program results must be presented quaterly to the commission to discuss and generate recomendations for the appropiate institutions involved in the Basin Management Plan.

20. Strategy for the Watersheds Management

1.- The Study for the Naranjo and Paquita river watersheds Management constitute a legal requirement for the development of the Los Llanos Hydroelectrical Project. The actual design of the project has implications on both watersheds and both watersheds on the project.

2.- The Study has determined disorders in significant Life Zones for the project in the case that it might affect the quality and the amount of water that the watersheds can supply in the future to the project. It also points which uses establish the actual conflict, which suggests the design of conservation practices for each one of those uses, since it is almost impossible to radically change the Land Use.

3.- The design of the Project affects the water regime downstream from the dam site and downstream from the machine room. The conflicts are established by a decrease in the Naranjo river flow and its consequences in the wetlands or mangroves of the Naranjo river and the increase of the Paquita river flow because of the turbinated water. The environmental impact should consider this points and give feasible solutions for them.

4.- The decrease of the Naranjo river flow causes the main opposition to the project in its influence area. This, according to the study, is caused by misinformation and to the activity of opinion sectors (Tourism Chamber) that exaggerate the consequences of the project, even though their criteria must be considered as a base for the technical solutions that will be given to the problem of decrease in the Naranjo river.

5.- The ICE can to improvide his presence in the regional dynamics, and extend the institutional cooperation benefits and even though the state and the opening of roads is contrary to the stability of both watersheds, at least it should guarantee the maintenance of one of them for a safe and permanent communication between the Valle de Los Santos and Quepos.

21. Conclusions and Recommendations

The socioeconomic environment of Los Llanos Hydroelectric Project, is characterized by a low development. This particularity have generate expectations around the possibility of increase the incomes of the inhabitants by promoting activities of recent development, especially those bound to the tourism, that they consider are capable of provoking new improvements in the local economies.

Maybe this is the principal reason why they're some kind of fears derived of significant reductions in the bed of the Naranjo river, thay they mentally associate with negative impacts. Nevertheless, according to the mentioned aspects , these fears are not homogeneus, but rather they are concentrd in contradictory values and very concetred values..

Due to these particularities, is recommend that the ICE Authorites clear the doubts of the communities and begin with institutional and social works to incorporate the interests of these, during the formulation, realization and pursuit of the Project.

Apart from these considerations, it was mportant. to probe. that a significant percentage of the population is not acquainted with the dam site of , to which they describe like a mountainous and solitary site with steep slopes. This particularity attracted attention, due to it supposes that the negative valuations with concerning the project, are support mainly in the effect provoked by the decrease of the [caudal] of the waters of the Naranjo river.

Curiously, the 14.6% of the interviewees that considered that the Project is unsuitable for the community, in appearance have no association with the valuations of the damages occasioned by the eventual construction of the dam. In this case, the 42.2% that considered that the Project would cause some damage, highlighted the reduction of the river and the end of the tourist activity.

In so much the greater proportion of the negative percepctions are related with the evaluations expressed in interviews with the members of the local Chamber of Tourism, that is presumably that an important sector of the population has been identified with the interests of the tourist managers. Due to this circumstance, it is suitable that the ICE reports to the inhabitants of the zone of influence, the characteristics of the Project, so that they don't prevail the criterions and point of view of a small group of interest.

The evaluation of the previous recommendation, leans on in the fact that [paradójicamte] the 33.3% of them consulted, an opinion that the Project will generate employment and tourism. This perception of the common sense of the [pobladores], reflective that the expectations of economical grow links to the tourism are not only high, but rather prevail the perception of that there can be a profit of the new landscapes with purposes of tourist exploitation.

The solidity of the arguments of them consulted that consider that the tourist activity will be seen harmed, was evidenced in the graph of the daily life aspects, that they would be affected negatively. In this case, the 14.3% that affirmed that there will be a decrease of the tourism, almost coincided with the 14.6% that considered that the Project is wrong for the community. From there that is presumably indeed, that the groups of related interest to the tourism, are influencing with their opinions the local population criteria.

Although it is imprudent to relate the negative valuations with the impact of the actions of a particular group, it was interesting to observe some polarizations in the outputs of other variables. For example, it attracted attention the fact that the 47.1% considered that the economical activity will be seen strengthened by the Project, due to that the revenues will increase. In contrast, the 41.2% considered that the revenues will be reduced.

More curious still, it was to confirm that the 62.7% of the population didn't consider expectations tied to the Project. These apparent contradictions expressed by them consulted, could be consider like an indicator of incertitude respecting the project benefits.