from Ene Paquitzapango is approximately 210 km) would be suitable as the location of the switchyard.

7.2.2 Transmission Line Routes

The transmission line routes in this Project may consist of two routes such as line for the two power stations of Ene Paquitzapango and Tambo Puerto Prado and the transmission line for Ene Sumabeni Power Station. Selection of the routes of the two transmission lines at the stage of this Master Plan Study was done approximately as described below taking into consideration the results of field reconnaissance (including aerial survey in part) and discussions with ELECTROPERU.

(1) It will be suitable for the route of the transmission line for the two power stations of Ene Paquitzapango and Tambo Puerto Prado to be selected along the access roads for construction works of the two power stations, while for the route of Satipo-Merced-Tarma-La Oroyo-Lima, it would be desirable for it to be selected along existing roads.

(2) The location of Ene Sumabeni Power Station is approximately 100 km upstream from Ene Paquitzapango Power Station. Accordingly, the transmission line for Ene Sumabeni Power Station would be of great length and uneconomical if the same route as for the transmission line for the two power stations of Ene Paquitzapango and Tambo Puerto Prado were to be adopted, and the plan is to be for interconnection to be done independently with the Lima district by a separate route.

With regard to the Ene Sumabeni Power Station-Lima route, it is considered most suitable for it to be installed along the Rio Mantaro through Concepcion. From Concepcion to Lima, the same route as for the transmission line in connection with the existing Mantaro Power Station is to be taken. However, the route must pass through a mountain range of 4,000 m class between Ene Sumabeni Power Station and Concepcion, and a detailed study will be necessary in the next-stage including the examination of crossing this mountain range.

(3) The approximate routes of these lines selected in the Master Plan Study are shown in Fig. 7-1, and whichever route is taken it will pass through steeply-sloped mountainland abovementioned, and it will be necessary for aerial photographs and detail topographical maps to be used in combination for the detailed study to select finally the most appropriate routes.

7.3 Results of Studies

The transmission line and substation facilities adopted in this Report based on the study of the above individual items are as follows:

7.3.1 Transmission Line Facilities

Sector	Ene Paquitzapango P.S. – Tambo Puerto Prado P.S. – San Ramon S.Y.	San Ramon S.Y. – Substations (Zapallal S.S., San Juan S.S.)	Ene Sumabeni P.S. – San Juan S.S.	Zapallal S.S. – San Juan S.S.
Nominal Voltage	500 kV	500 kV	500 kV	500 kV
Number of Circuits	1 cct, 2 routes	1 cct, 2 routes	1 cct, 1 route	1 cct, 1 route
Conductor	ACSR410$^{\square}$ x 4	ACSR410$^{\square}$ x 4	ACSR410$^{\square}$ x 4	ACSR410$^{\square}$ x 4
Length	approx. 210 km	approx. 260 km	approx. 380 km	approx. 55 km

7.3.2 Substation Facilities

(1) San Ramon Switchyard

Construction of switchyard facilities for two incoming and outgoing 500 kV circuits.

(2) Zapallal Substation

Installation of 1 circuit each of incoming facilities for a 500 kV transmission line from San Ramon Switchyard and a 500 kV interconnecting transmission line with San Juan Substation, one 500 kV/220 kV (1,000 MVA) transformer, and other equipment.

(3) San Juan Substation

Installation of incoming facilities for a 500 kV transmission line, 1-cct, from San Ramon Switchyard, a 500 kV transmission line, 1-cct, from Ene Sumabeni Power Station, and a 500 kV transmission line, 1-cct, for interconnection with Zapallal Substation, a total of 3 circuits.

Installation of two 500 kV/220 kV (1,000 MVA) transformers and other equipment.

7.3.3 Approximate Construction Costs

The approximate construction costs of the abovementioned transmission line and substation facilities estimated in this Master Plan Study are US$436 x 10^6 for the Ene Paquitzapango line, US$12 x 10^6 for the Tambo Puerto Prado line, and US$224 x 10^6 for the Ene Sumabeni line, a total of US$672 x 10^6.

7.3.4 Problems to be Further Studied

The greatest problematic points about the transmission lines planned for this Project are the long distances and the fact that it will be unavoidable for the routes to cross the Andes Mountains with altitudes of 5,000 m class.

A voltage of 500 kV is being planned for the transmission line facilities in this Master Plan, but such high altitude design for 500 kV is without any experience in the world. Consequently, in the study of the next stage, detailed examinations will be necessary concerning design conditions such as insulation design, corona countermeasures, etc. in areas of high elevation, appropriate transmission line and substation facilities, and transmission line routes.

7.4 Power System Analysis

7.4.1 Preconditions for System Analysis

In electric power system analysis for the power transmission plan concerning the Ene River Hydroelectric Power Development Project, approximate studies were made of the system from the hydroelectric power stations of Ene Paquitzapango, Tambo Puerto Prado, and Ene Sumabeni to the receiving substations on the Lima side of Zapallal and San Juan.

The Survey Mission made the analysis based on the particulars of the Central-North Power System centered at Lima, that is, data furnished to the mission by ELECTROPERU on power generating facilities, transmission lines, and substation facilities, the principal particulars being as follows:

(1) Years of System Analysis and System to be Studied

(a) 2004: Peak load hours and all units of Ene Paquitzapango Power Station in full operation (Paquitzapango Line, 500 kV, 2-cct).

(b) 2008: Peak load hours and all units of Ene Paquitzapango, Tambo Puerto Prado, and Ene Sumabeni Power Stations in full operation (Paquitzapango Line and Tambo Puerto Prado Line, 500 kV, 1-cct 2 routes, Sumabeni Line 500 kV, 1-cct. Lima side interconnection of Zapallal S.S. - San Juan S.S., 500 kV, 1-cct).

(2) Analysis Conditions

(a) Since this was an preliminary study for preparation of the Master Plan, both demand and supply necessary for the study of the existing system of Lima and its surroundigns (220 kV), were simplified as an intensive system. The power flow diagram as of the years of 2004 and 2008 are shown in Figs. 7-2 and 7-3, respectively.

(b) Line Constants and Equipment Constants

For the various constants of the existing 220 kV system at the Lima side the values furnished by ELECTROPERU were used, while for the 500 kV system planned for this Project, constants were calculated and used taking into consideration the elevation.

(c) Power Flow Calculations

For the ranges of operating voltages of buses and generators 100% $\pm$ 5% was targeted. As for power factor, 0.85 and 0.9 were selected for load and generator, respectively.

(d) Stability Calculations

1) Disturbance Conditions

A fault of 3LG-0 (fault clearing off time 0.1 sec) was applied to the shortest point to Ene Paquitzapango Power Station of the 500 kV line.

2) Stability Judgment

Verification of transient stability was made in this study. The stability was checked on condition that after occurrence of disturbance, stability can be maintained without the generator stepping out for several seconds.

7.4.2 Results of Calculations

(1) Stability for the system in the year of 2004 were obtained without applying series condensers (Sr. C) to the receiving substation side by providing thyristor type AVR (automatic voltage regulator) with PSS (power system stabilizer) to be equipped with the excitation system of generators for Ene Paquitzapango.

The dynamic stability swing curve is shown in Fig. 7-4.

Since this system is composed of long-distance transmission lines, it is expected there will be a problem about overvoltage, and in the study of the next stage, it will be necessary for further exa-

minations to be made including countermeasures against the over-voltage.

(2) Application of Sr. C will be indispensable for improvement of stability for the power system in the year of 2008. As a result of calculations by applying Sr. C, it was found that stability can be obtained as shown in swing curve of Fig. 7-5. The compensation ratio of the Sr. C in this case is 10 percent of line impedance. However, the compensation ratio obtained in this study was an approximate value for the purpose of discerning whether the system will be stable or not, and accordingly detailed examinations will be required in further studies.

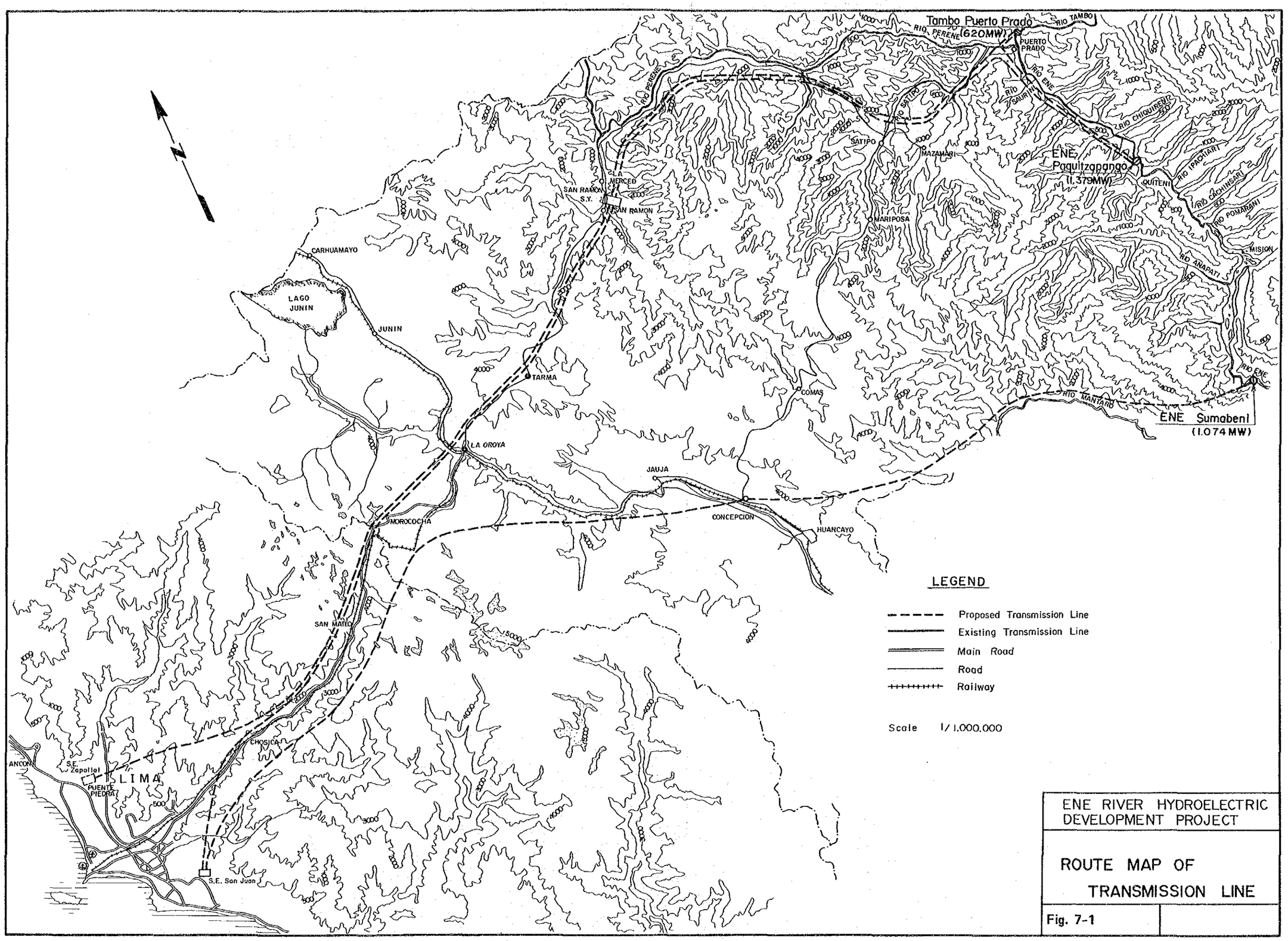
7.5 Transmission Lines for Construction Work

(1) The electric power for construction required for the construction of the three Ene River projects is estimated to be 40 to 50 MW for each project.

Adoption of diesel engine generators to meet these power supply requirements is not appropriate from the aspects of scale and fuel transportation, and it is desirable for supply to be done from existing power facilities.

(2) Consequently, in this Master Plan, power supply from Pachachaca Substation owned by ELECTROPERU, from the viewpoints of topography and capacities, is suitable to meet the requirement for the construction works among power sources to be considered.

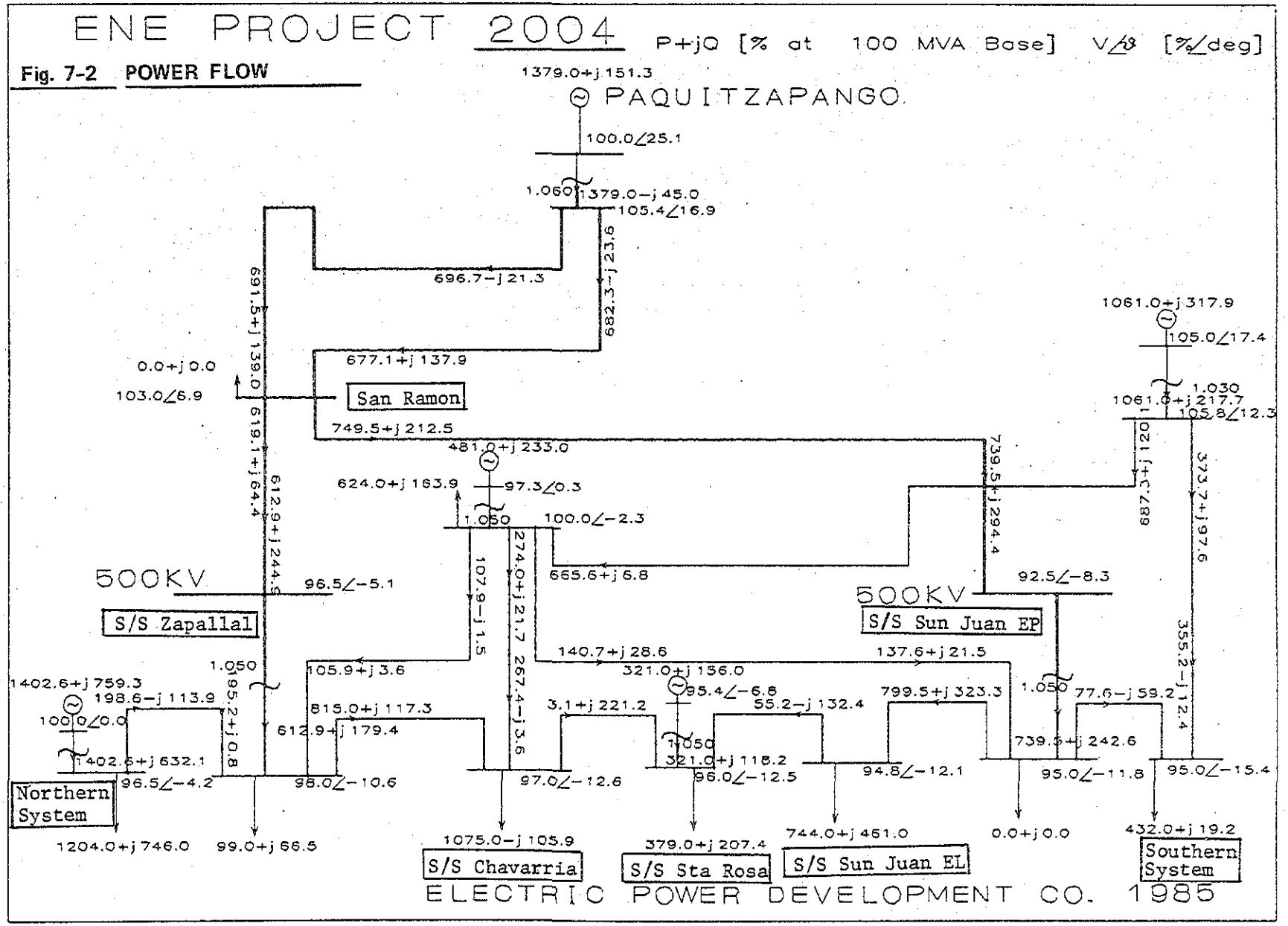
This power supply line for construction will have voltage of 138 kV scale in view of the transmission distance, and in the future, it will be possible to utilize it for power supply to the Satipo area in order to contribute to the development of regional industry.

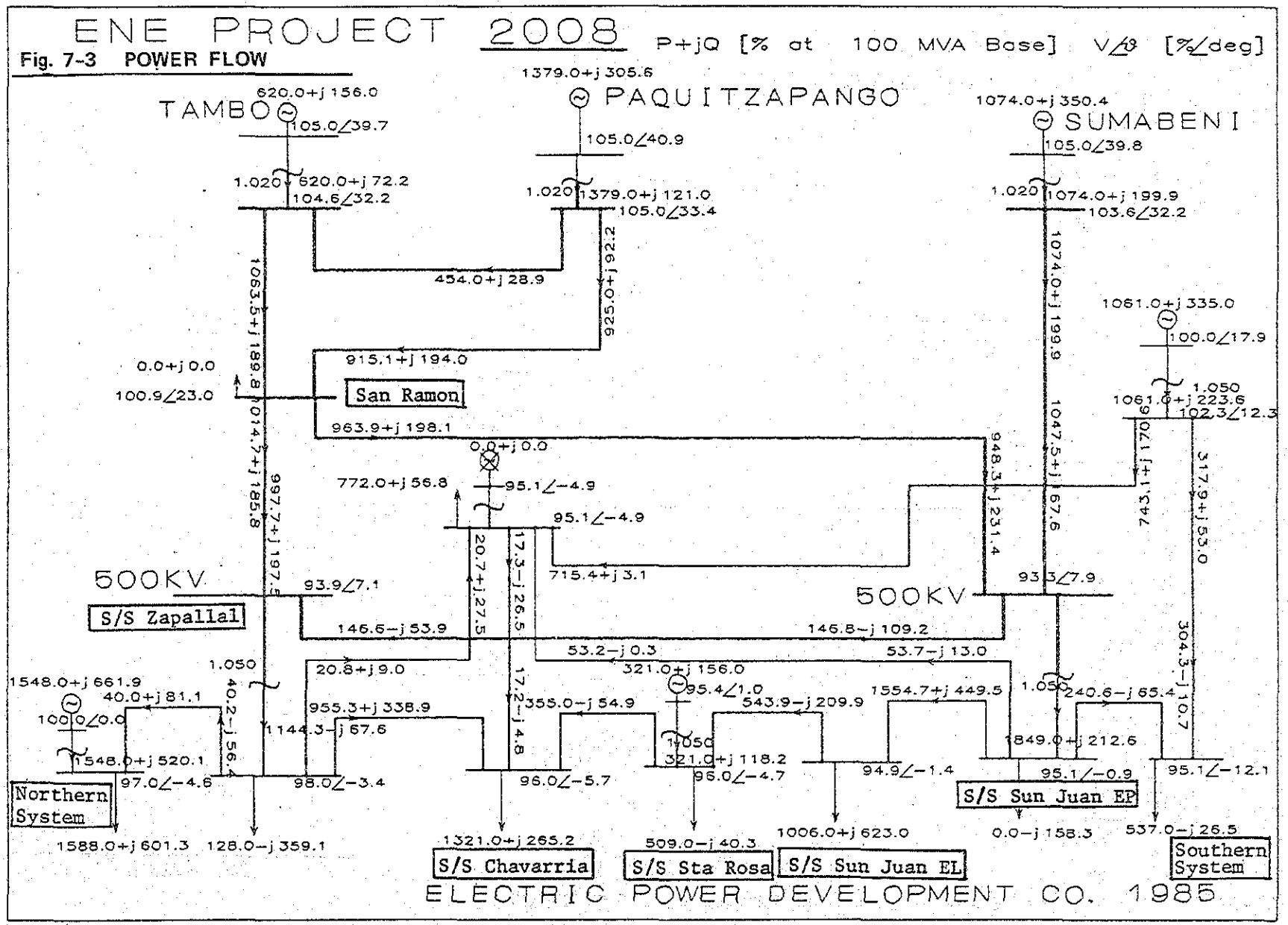


ENE RIVER HYDROELECTRIC DEVELOPMENT PROJECT

ROUTE MAP OF TRANSMISSION LINE

Fig. 7-1


ENE PROJECT 2004
P+jQ [% at 100 MVA Base] V∠δ [%∠deg]
Fig. 7-2 POWER FLOW
1379.0+j151.3
PAQUITZAPANGO
100.0∠25.1
1.060
1379.0−j45.0
105.4∠16.9
696.7−j21.3
682.3−j23.6
691.5+j139.0
0.0+j0.0
103.0∠6.9
San Ramon
677.1+j137.9
619.1+j64.4
612.9+j244.9
749.5+j212.5
481.0+j233.0
624.0+j163.9
97.3∠0.3
1.050
100.0∠−2.3
665.6+j6.8
274.0+j21.7
267.4−j3.6
107.9−j1.5
500KV
96.5∠−5.1
S/S Zapallal
105.9+j3.6
140.7+j28.6
321.0+j156.0
95.4∠−6.8
1.050
195.2+j0.8
1402.6+j759.3
198.6−j113.9
100.0∠0.0
1402.6+j632.1
96.5∠−4.2
Northern System
1204.0+j746.0
815.0+j117.3
612.9+j179.4
98.0∠−10.6
99.0+j66.5
97.0∠−12.6
1075.0−j105.9
S/S Chavarria
3.1+j221.2
1.050
321.0+j118.2
96.0∠−12.5
379.0+j207.4
S/S Sta Rosa
55.2−j132.4
94.8∠−12.1
744.0+j461.0
S/S Sun Juan EL
799.5+j323.3
739.5+j242.6
95.0∠−11.8
0.0+j0.0
1061.0+j317.9
105.0∠17.4
1.030
1061.0+j217.7
105.8∠12.3
687.3+j120.1
739.5+j294.4
373.7+j97.6
355.2−j12.4
500KV
92.5∠−8.3
S/S Sun Juan EP
137.6+j21.5
1.050
77.6−j59.2
95.0∠−15.4
432.0+j19.2
Southern System
ELECTRIC POWER DEVELOPMENT CO. 1985


ENE PROJECT 2008
P+jQ [% at 100 MVA Base] V∠θ [%∠deg]
Fig. 7-3 POWER FLOW
TAMBO
620.0+j156.0
105.0∠39.7
1.020
620.0+j72.2
104.6∠32.2
PAQUITZAPANGO
1379.0+j305.6
105.0∠40.9
1.020
1379.0+j121.0
105.0∠33.4
SUMABENI
1074.0+j350.4
105.0∠39.8
1.020
1074.0+j199.9
103.6∠32.2
454.0+j28.9
925.0+j92.2
1063.5+j189.8
915.1+j194.0
1074.0+j199.9
1061.0+j335.0
100.0∠17.9
1.050
1061.0+j223.6
102.3∠12.3
0.0+j0.0
100.9∠23.0
San Ramon
963.9+j198.1
1014.7+j185.8
997.7+j197.5
948.3+j231.4
1047.5+j67.6
743.9+j170.9
317.9+j53.0
0.0+j0.0
772.0+j56.8
95.1∠-4.9
95.1∠-4.9
715.4+j3.1
20.7+j27.5
17.3-j26.5
500KV
93.9∠7.1
S/S Zapallal
500KV
93.3∠7.9
146.6-j53.9
146.8-j109.2
53.2-j0.3
53.7-j13.0
321.0+j156.0
304.3-j10.7
20.8+j9.0
1.050
1548.0+j661.9
40.0+j81.1
100.0∠0.0
1548.0+j520.1
40.2-j56.4
955.3+j338.9
1144.3-j67.6
17.2-j4.8
355.0-j54.9
95.4∠1.0
543.9-j209.9
1554.7+j449.5
1.050
240.6-j65.4
1849.0+j212.6
1.050
321.0+j118.2
96.0∠-4.7
97.0∠-4.6
98.0∠-3.4
96.0∠-5.7
94.9∠-1.4
95.1∠-0.9
95.1∠-12.1
Northern System
S/S Sun Juan EP
1588.0+j601.3
128.0-j359.1
1321.0+j265.2
509.0-j40.3
1006.0+j623.0
0.0-j158.3
537.0-j26.5
S/S Chavarria
S/S Sta Rosa
S/S Sun Juan EL
Southern System
ELECTRIC POWER DEVELOPMENT CO. 1985

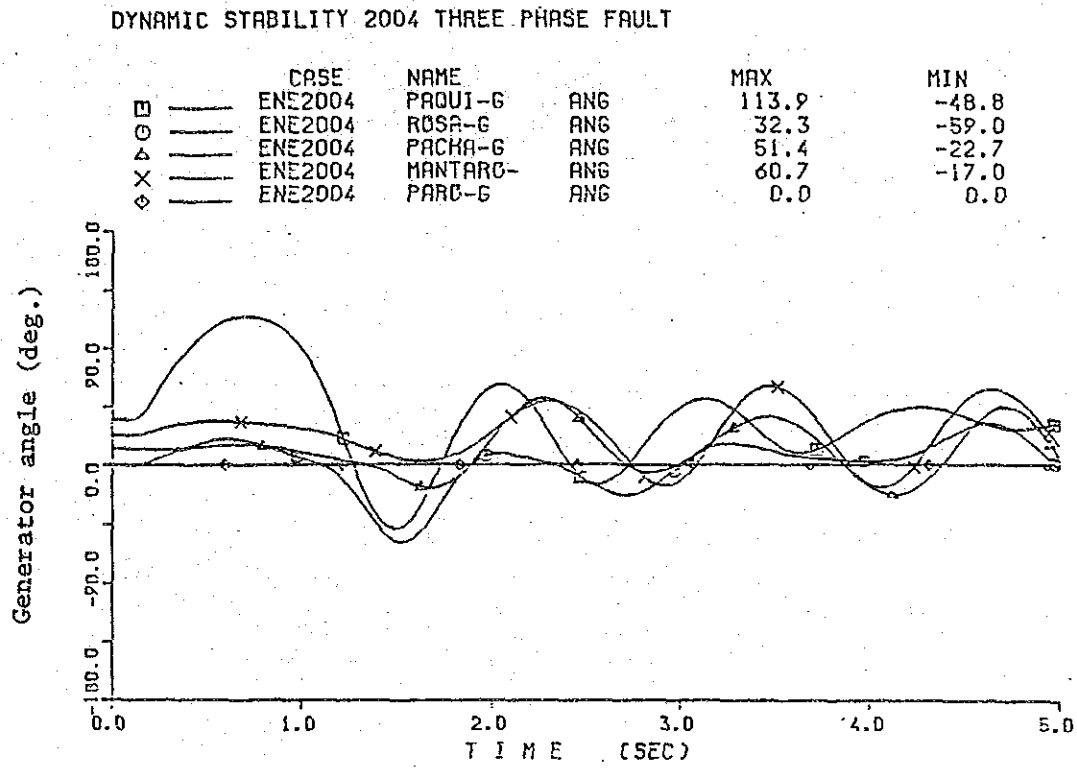
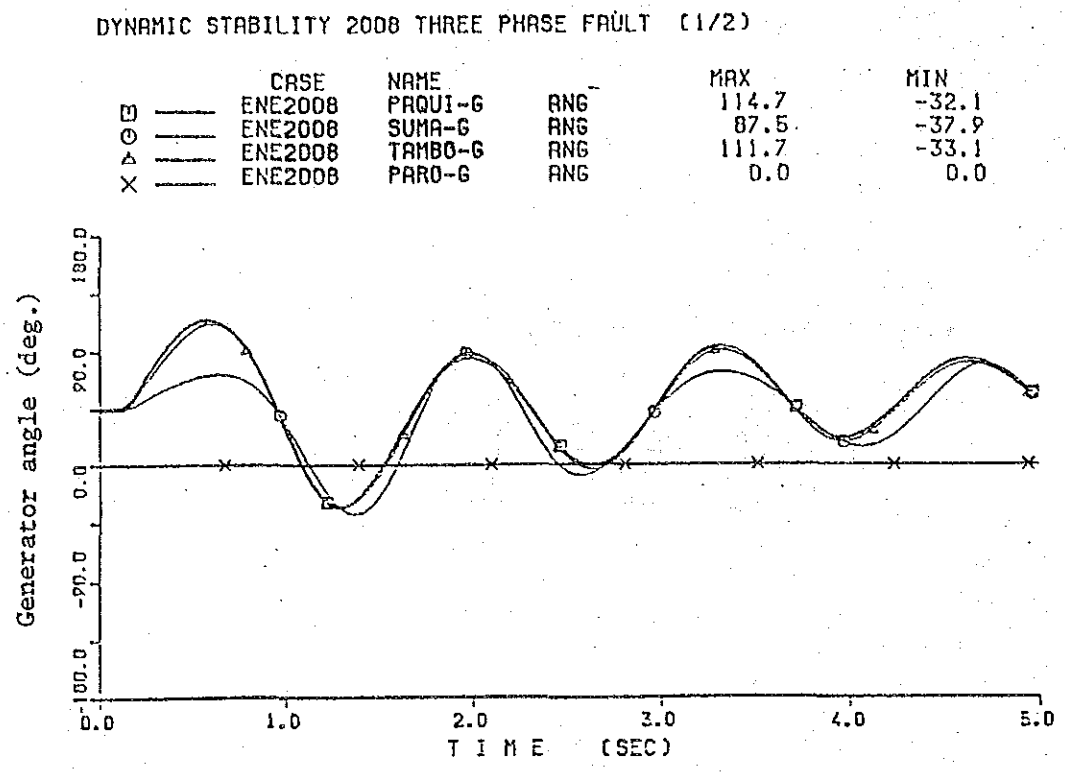


Fig. 7-4 DYNAMIC STABILITY SWING CURVE (2004 PEAK)



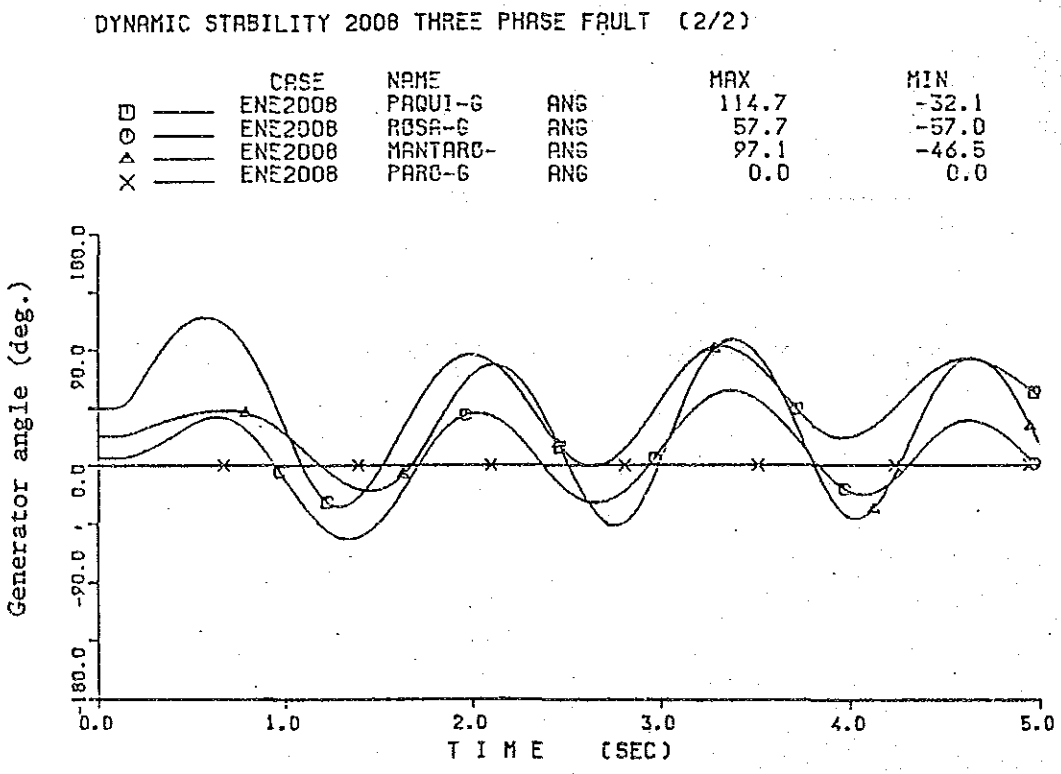


Fig. 7-5 DYNAMIC STABILITY SWING CURVE (2008 PEAK)

CHAPTER 8 INVESTIGATIONS ON ENVIRONMENT

CHAPTER 8 INVESTIGATIONS ON ENVIRONMENT

CONTENTS

	Page
Introduction	8–1
8.1 Present State of Environment	8–1
8.1.1 Geographical Location	8–1
8.1.2 Meteorology	8–3
8.1.3 Topography and Geology	8–3
8.1.4 Vegetation	8–3
8.1.5 Animal Life	8–7
8.1.6 Regional Society	8–9
8.1.7 Transportation	8–14
8.1.8 Land Utilization	8–18
8.1.9 Utilization of River Water	8–19
8.1.10 Historic Relics and Cultural Assets	8–20
8.2 Laws and Regulations for Conservation of Nature	8–23
8.3 Effects of Dam Construction on Environment	8–25
8.3.1 Viewpoint and Way of Thinking	8–25
8.3.2 Direct Effects of Reservoir	8–26
8.3.3 Effects of Reservoir in Wide-area	8–28
8.3.4 Effects on Regional Development	8–30
8.3.5 Construction and Future Aspect	8–31
8.4 Items to be Investigated in Feasibility Study	8–32

CHAPTER 8 INVESTIGATIONS ON ENVIRONMENT

Introduction

These environment-related investigations have the objectives of grasping the present situation regarding the natural and social environments of the Ene River Hydroelectric Development Project area, and of gaining a basic outlook on the influences that the construction of the dam may exert on the environment and society.

Further, in this Chapter, a proposal is made by which the Ene River Hydroelectric Development Project will more harmonious with nature as it is constructed, while the explanation will be given for the matters about which adjustment with the environmental policies or Peru are expected to become necessary.

The field investigations made this time at a preliminary study level and there were time and physical limits. So they were extremely generalized. In order to contemplate more concrete measures for environment based on the results obtained through the investigations, a more detailed investigation for the environmental conditions of the Ene River Hydroelectric Power Development Project area will be necessary to make at the next stage.

8.1 Present State of Environment

8.1.1 Geographical Location

The national territory of the Republic of Peru can be divided into three major regions having extremely contrasting natural conditons - the Costa (coastal region), the Sierra (mountainous region), and the Selva (jungle region). The Costa is situated in the west of the Andes Mountain Range, and the Selva in the east.

The Selva, where the project area is located, is the largest part of Peru taking up 59 percent of the land area of the country. It consists of Selva highland region of 500 m or more above the sea level and Selva region lower than the level and is the least developed of all areas in Peru.

The Ene River Hydroelectric Power Development Project area is located at a transition zone of the highland and lowland of Selva, and is on the opposite side of Lima, the capital city, through Andes Mountains at approximately 74° to 74°15' east longitude, and 11°10' to 12°10' south latitude, comprising the basins of the Tambo River, Ene River, and Perene River at the upstream part of the Ucayali River which is a tributary of the Amazon River. Except for the river flats and very small patches of cultivated land, the basin is covered by virgin forest.

The project area, as shown in Fig. 8-1, extends over departments of Junin, Ayacucho, and Cuzco, but is mostly in Junin Department.

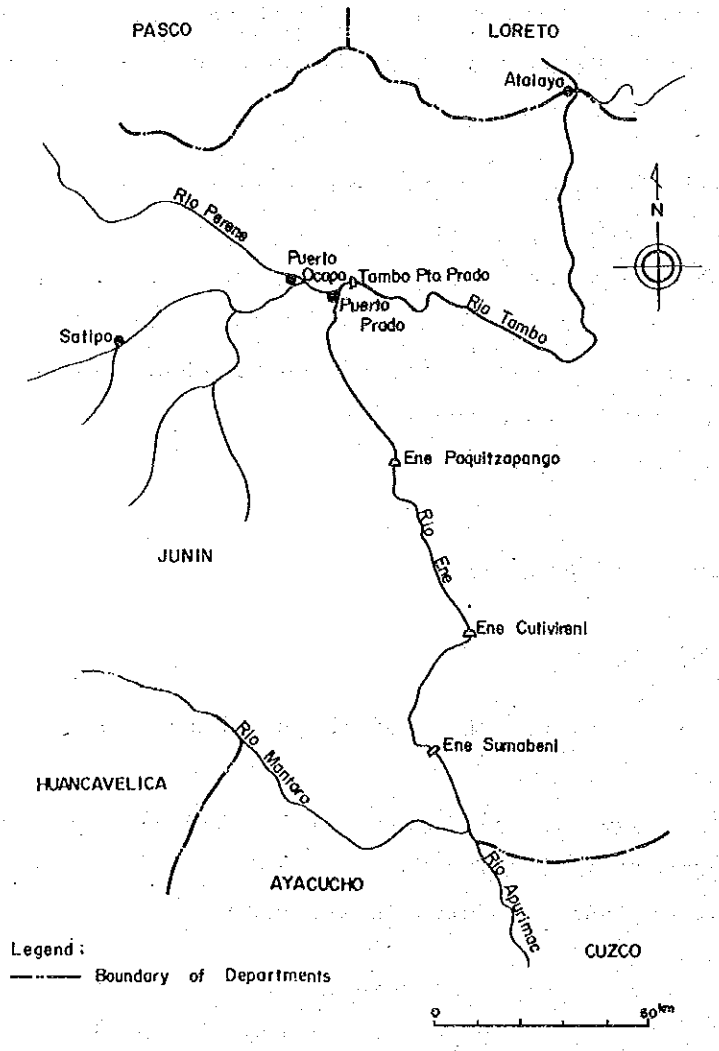


Fig. 8-1 Boundary of Departments

8.1.2 Meteorology

The meteorology of this project area is described in Chapter 4, "Hydrology".

8.1.3 Topography and Geology

The topography and geology of this project area are described in Chapter 5, "Geology".

8.1.4 Vegetation

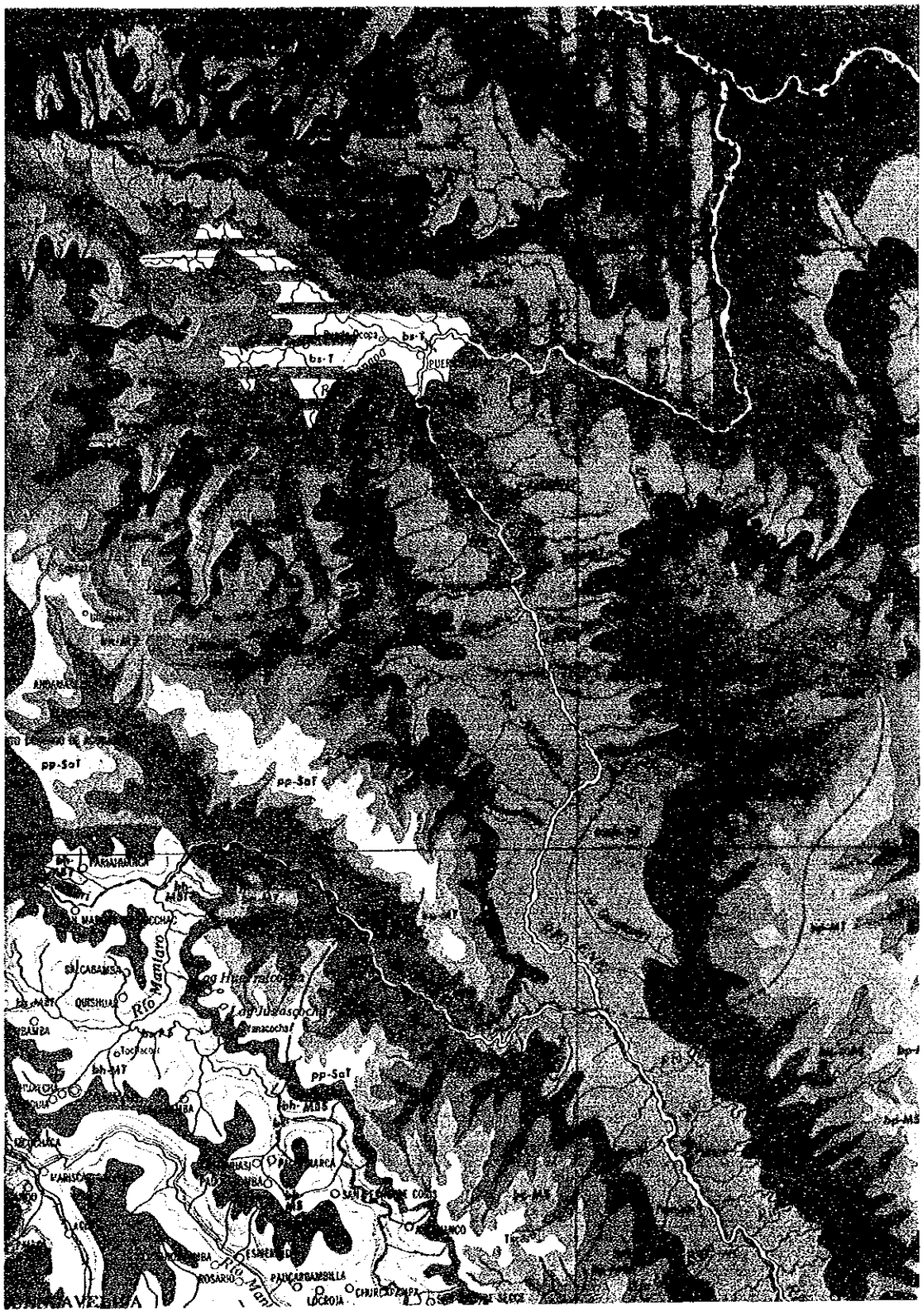
The greater part of this project area is covered by so-called "Selva", or jungle.

The Satipo district is situated at the elevations of 600 to 800 m, and is a transition zone of subtropical humid forest and submontane tropical humid forest according to forest classifications. The forests of the project area, as shown in Fig. 8-2, comprise tropical submontane humid forest (bh-PT), subtropical very humid forest (bmh-S), tropical submontane pluvial forest (bp-PT), tropical submontane very humid forest (bmh-PT), and subtropical pluvial forest (bp-S). Along the Ene River, from downstream to upstream, they are in the order of tropical submontane humid forest, submontane tropical very humid forest, and subtropical very humid forest.

The trees in this area are generally evergreen, and the forests are usually formed of four layers. The first layer, at times called "giant tall-tree layer", has dicontinuously emergent trees as tall as 35 m, with trunks sometimes exceeding 2 m in diameter. The second layer is about 30 m in height with tree trunks around 0.6 to 1.4 m in diameter. These trees have branches only at the upper parts of their trunks, with forest floor not developed very much. Quantitatively dominant species of trees are quina quina, palo peruano, ishipingo, moena, and sedro.

According to a survey of the species of standing trees carried out in a forest of 20,000 ha. at the left bank of the Perene River close to the project area, there were 44 species recorded, of which 20 species were deemed to be suitable for lumber.

According to inquiries made in the project area, there are at least three species (palo de rosa, ore, leche caspi) distributed in the area out of the ten kinds listed in Appendix A-6 [1] Table 1 feared of extinction and to be protected under Reglamento de Conservacion de Flora Y Fauna Silvestre, Government Ordinance 158-77-AG.



Legend

bh-PT	:	Tropical Submontane Humid Forest
bmh-S	:	Subtropical Very Humid Forest
bp-PT	:	Tropical Submontane Pluvial Forest
bmh-PT	:	Tropical Submontane Very Humid Forest
bp-S	:	Subtropical Pluvial Forest

Fig. 8-2 Summary of Vegetation

8.1.5 Animal Life

The Selva has fauna which is the most abundant and varied in Peru. However, large animals have not developed because almost the entire region is jungle.

Almost no survey data concerning the fauna in the project area exist, but an investigation of wild animals has been made in connection with road construction in the central part of the Selva including the project area. The following is an outline of the animal life inhabiting in the area according to that survey.

(a) Mammals

It is estimated that there are about 200 to 250 sepcies of mammals inhabiting in the central Selva Region, and it is expected that approximately 190 species of mammals live in the project area and its neighborhood. The breakdown of the classification includes 14 species of marsupials, 50 species of chiropterans, 9 species of primates, 7 species of edentates, 1 species of lagomorph, 85 species of rodents, 14 species of carnivores, 1 species of perissodactyl, and 5 species of artiodactyls.

The principal mammals estimated to inhabit in the project area and its surroudnings are as follows:

Sajino	Carachupa
Huangana	Añuje
Venado	Machetero
Sachavaca	Ronsoco
Majaz	Maquisapa

(b) Fowls

It is said that the variety of fowl life in Peru is the greatest in the world, and it is estimated that more than 820 species inhabit in the central Selva Region including the project area.

The principal fowls having commercial value for decorative or food are 58 species including Picidae, Accipitridae, Rallidae, and Columbidae families.

The principal species are as follows:

Pucacungas	Taurilla
Manacaraco	Peraices
Gallaretas	Palomas

(c) Reptiles

The reptilian life estimated to inhabit in the central Selva Region, as shown in Appendix A-6 [1] Table 2, comprise 3 species of turtles, 10 species of lizards, and 3 species of crocodilians, more than half of which rarely inhabit. The principal reptiles estimated to inhabit in the project area are as follows:

Charapas	Bothrops
Anaconda	Micrurus
Yacumama	Lachesis
Boa	

(d) Fishes

The principal fishes inhabiting in the Perene River and Chanchamayo River are those 16 species (bagre, dorado, carachama, caracha, simiracu, carachita, etc.) as listed in Appendix A-6 [1] Table 3. It is thought that more or less the same species inhabit in the Tambo River and Ene River also, while it is heard that sabaro (scientific name; brycoa), brquichico o chupadour (scientific name; prochilodus), anchoveta (scientific name; colossma), pez perro o fasaco (scientific name; hoplias), zungaro, dorado, salton, etc., also inhabit in the waters of the area.

It is generally said there are fishes that move upstream to spawn in the Tambo River, Ene River, etc. in April to June after the rainy season. But it is not clearly known whether they actually inhabit or not.

(e) Protected Animals

According to the aforesaid Reglamento de Conservaciõn de Flora y Fauna Silvestre and Resoluciõn Ministerial No. 159-77-AG, hunting and catching all species of wild animals belonging to the mammals, birds, reptiles, and amphibians in the Selva Region are prohibited indenfinitely. However, 15 species (venado rojo, sajino, huangano, palomas de selva, motelos, etc.) in Appendix A-6 [1] Table 4 which have been traditionally hunted by the inhabitants of the region, abundant in number, and not in the process of becoming extinct are excepted. Valuable animals estimated to inahbit in the project area and its vicinity are as listed in Appendix A-6 [1] Table 5. The principal species among them are as follows:

1. Pteronura brasilienis
2. Ateles paniscus
3. Saimiri sciureus
4. Cebus apella
5. Cebus albifrons
6. Dinomy branickii

8.1.6 Regional Society

(a) Population

According to the results of the national census conducted in July 1981, the total populations urban populations, non-urban populations, and the growth rates of these populations in the entire Republic of Peru, Junin Department, and Satipo Province are as shown in Table 8-1.

Table 8-1 Population and Increase Rate in the Republic of Peru, Junin Pref. and Satipo District

(As of Jul. 1981)

	Population			Recent Averaged Increase Rate per Year (%)	
	Total	Urban Area	Areas other than Urban Area	Urban Area	Areas other than Urban Area
Republic of Peru	17,031,221	11,085,892	5,945,329	3.6	0.9
Junin Pref.	848,993	499,774	349,219	2.1	2.7
Satipo District	64,595	15,158	49,437	7.4	5.7

As of July 1981, the population of all of Satipo Province was 64,595, and about 77 percent were living in the areas other than urban areas. The average annual growth rate of this area was high at 5.7 percent.

The Selva Region has numerous communities of indigenous Indians with their total population estimated to be several hundred thousand, but this population is not included in the results of the national census. The communities of these inhabitants have their origins in the various tribes that had lived in the Selva Region from pre-Inca times. These communities are composed of families speaking their own languages and dialects, and have distinct cultural and social features. These indigenous people are left behind in enjoying the fruits of regional development and their standard of living is low.

It is thought that the Campas is the main tribe among those in the project area.

According to the existing investigation data other than the above-mentioned national census and our field investigations, the indigenous and immigrant people in the project area and its

surroundings are living along the Ene and Perene Rivers forming their respective communities (see Fig. 8-3).

The populations and number of communities in the project area and its surroundings are estimated to be as shown in Tables 8-2 and 8-3, respectively.

Table 8-2 Populations and Communities of Native and Immigrant along Ene River and Perene River

	Area from Tambo pto. prado upto Ene paquitzapargo		Area from Ene paquitzapargo upto San Francisco down-stream	
	Population	No. of Communities	Population	No. of Communities
Native	1,020	2	4,769	12
Immigrant	1,000	2	3,105	11

Table 8-3 Population of Major Communities

	Area from Tambo pto. prado upto Ene Paquitzapargo		Area from Ene paquitzapargo upto San Francisco down-stream	
	Name of Community	Population	Name of Community	Population
Native	Puerto ocopa	840	Tres unidos de Matarni	972
	Shima	180	Quempiri	639
			Cutivireni	639
			Potsoteni	447
			Other Communities	Total 2,072 (about 60-380 per community)
Immigrant	Puerto Prado	650	Santo Domingo	1,000
	Puerto Ocopa	350	La Primavera	750
			Segundo Maveni	300
			Other Communities	Total 1,055 (about 75-250 per community)

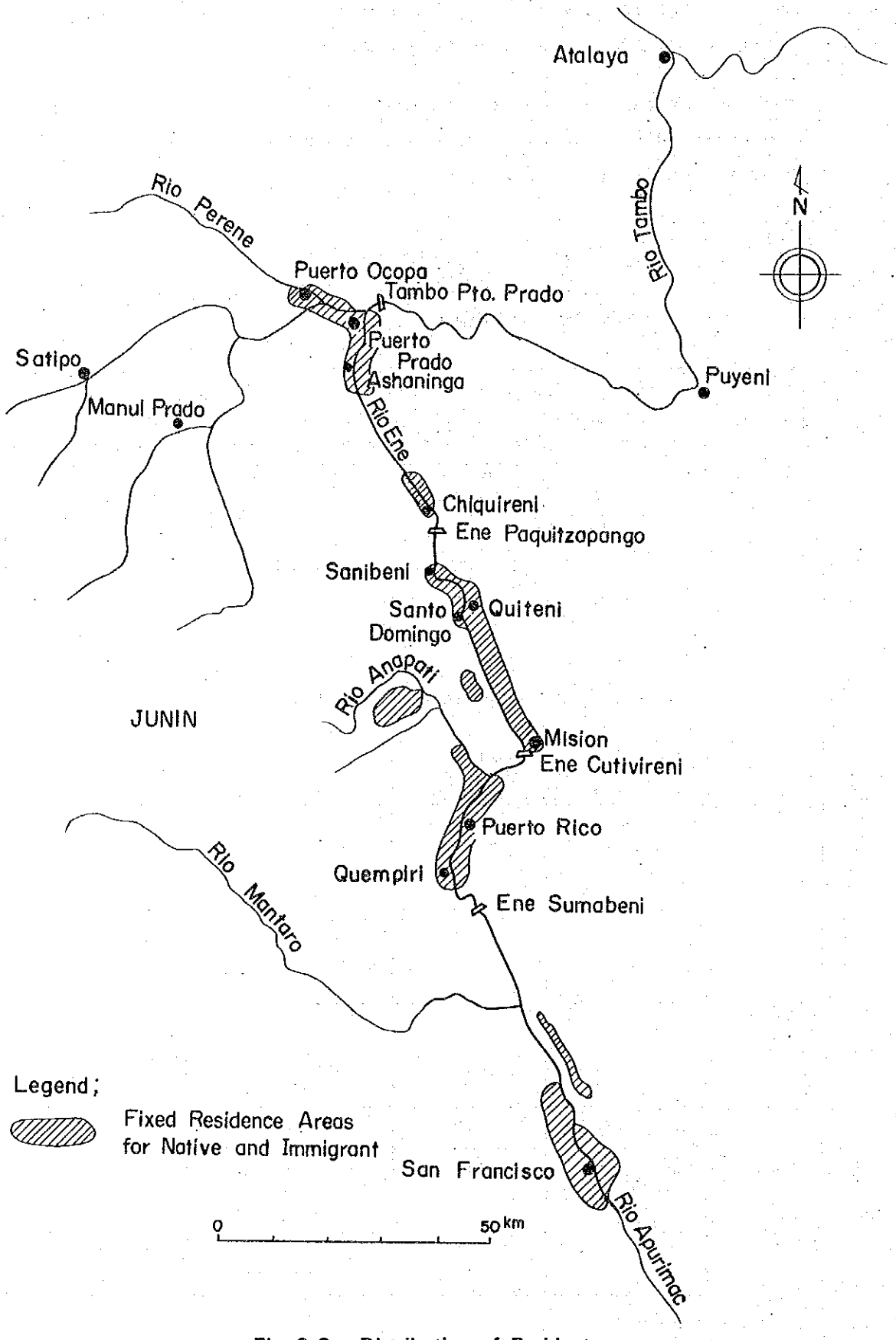


Fig. 8-3 Distribution of Residents

(b) Industrial Activity

The main industries of Satipo Province are agriculture and forestry.

Coffee shows the largest proportion among the agricultural products of Satipo Province, and other principal products include beans, rice, maize, orange, banana, yucca, avocado, papaya, lemon, and tobacco.

The indigenous and immigrant peoples living along the Perene and Ene Rivers raise agricultural crops and make almost a self-sufficient living. Concrete details are not clearly known about immigrants, but the followings have been learned for the indigenous people. The area cultivated by the 12 communities of the indigenous Indians in the Ene River basin is 5,497.24 ha, with agricultural crops being tapioca, maize, banana, rice, peanut, cacao, coffee, beans, palm, papaya, avocado, mango, citruses, and pineapple etc. Besides the above, livestocks such as chicken, duck, guinea pig, sheep, cattle, and swine etc. are raised.

With regard to forestry, this project area is in a state-owned forest and is included in the Satipo Forest District. The lumber production of this forest district in 1981 was 62,343 m^3 as shown in Appendix A-6 [1] Table 6, and the main useful species of tress are roble, corriente, tornillo, and moena etc.

The scale of the fishing industry is small. The fishing season is around June to October. The fishing is mainly by the fixed-net method for such fishes as zungaro, dorado, and salton etc. According to inquiries, the prices of fishes are approximately 2,500 Sol/kg locally, and about 4,000 Sol/kg by wholesale at Satipo. These fishes are transported to the market at Satipo by light airplanes from Atalaya, Puerto Ocopa, etc., but in small quantities. Further, there are no fishing rights established in this area.

Factories and business establishments are not existing in this project area.

8.1.7 Transportation

The means of reaching this project area, as shown in Fig. 8-4, are a main road and railroad from Lima to La Oroya or Concepcion from where there are two road routes to Satipo. One route goes from La Oroya through Tarma and San Ramon to Satipo, while the other one goes from Concepcion through Comos and Carriza to Satipo. The former is a comparatively well-maintained and improved road, while the latter contains many dangerous spots and is not used frequently compared with the former.

In the vicinity of the project area, a road is planned to go from Satipo to Atalaya via Mazamari, Puerto Ocopa and Puerto Prado. The section from Satipo to Puerto Ocopa has already been constructed and the remainder is now under planning.

At the places along the Perene and Ene Rivers as shown in Fig. 8-5, there are small-scale airstrips for airplanes of Cessna class. The airstrips other than at Puerto Ocopa and Puerto Prado are only strips of land obtained by clearing jungle so that Cessna class airplanes can utilize them. And some of them have not been used at all for these several years. However, there is a possibility that they can be used, if improved, as transportation bases for the materials of dam construction.

There are no roads at present in the Tambo River and Ene River areas, and boats are being used as means of transporting and moving materials. Nearly all the boats are wooden-made and the larger ones have the lengths of 12 to 13 m, and the width of about 2 m, while those about 6 to 7 m in length are most commonly used. The base for boat navigation in the project area is Puerto Ocopa as shown in Fig. 8-6.

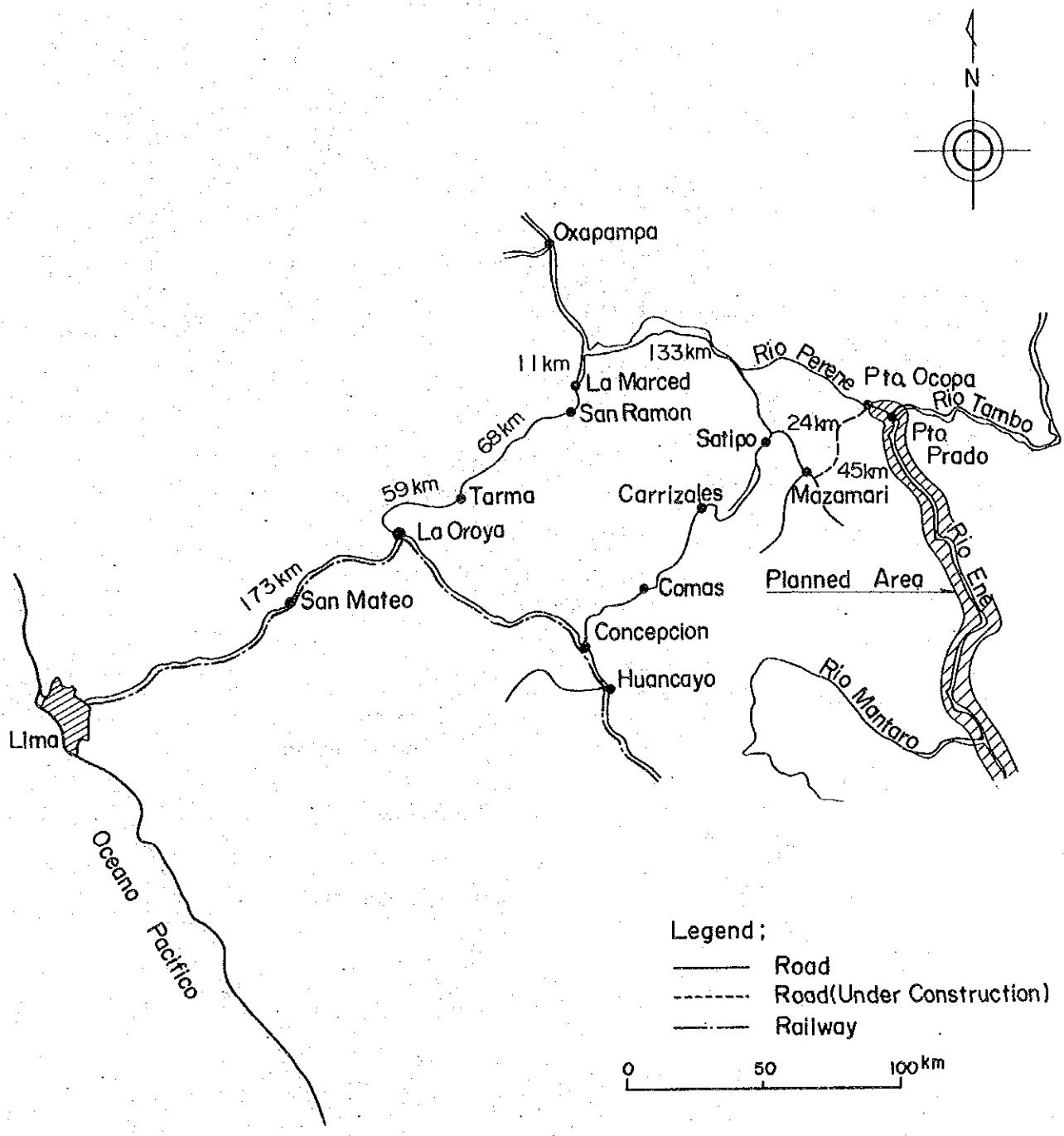


Fig. 8-4 Road and Railway

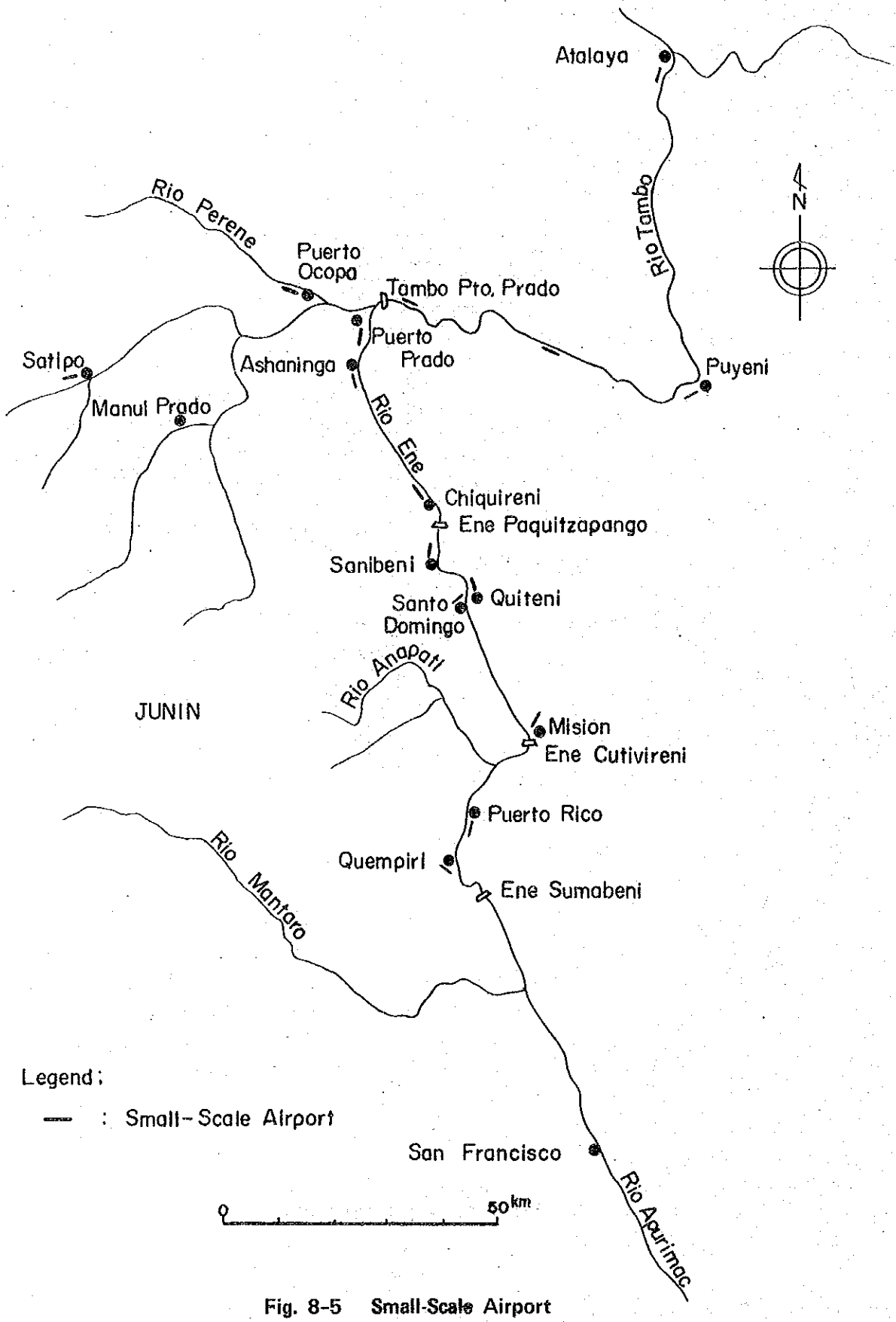


Fig. 8-5 Small-Scale Airport

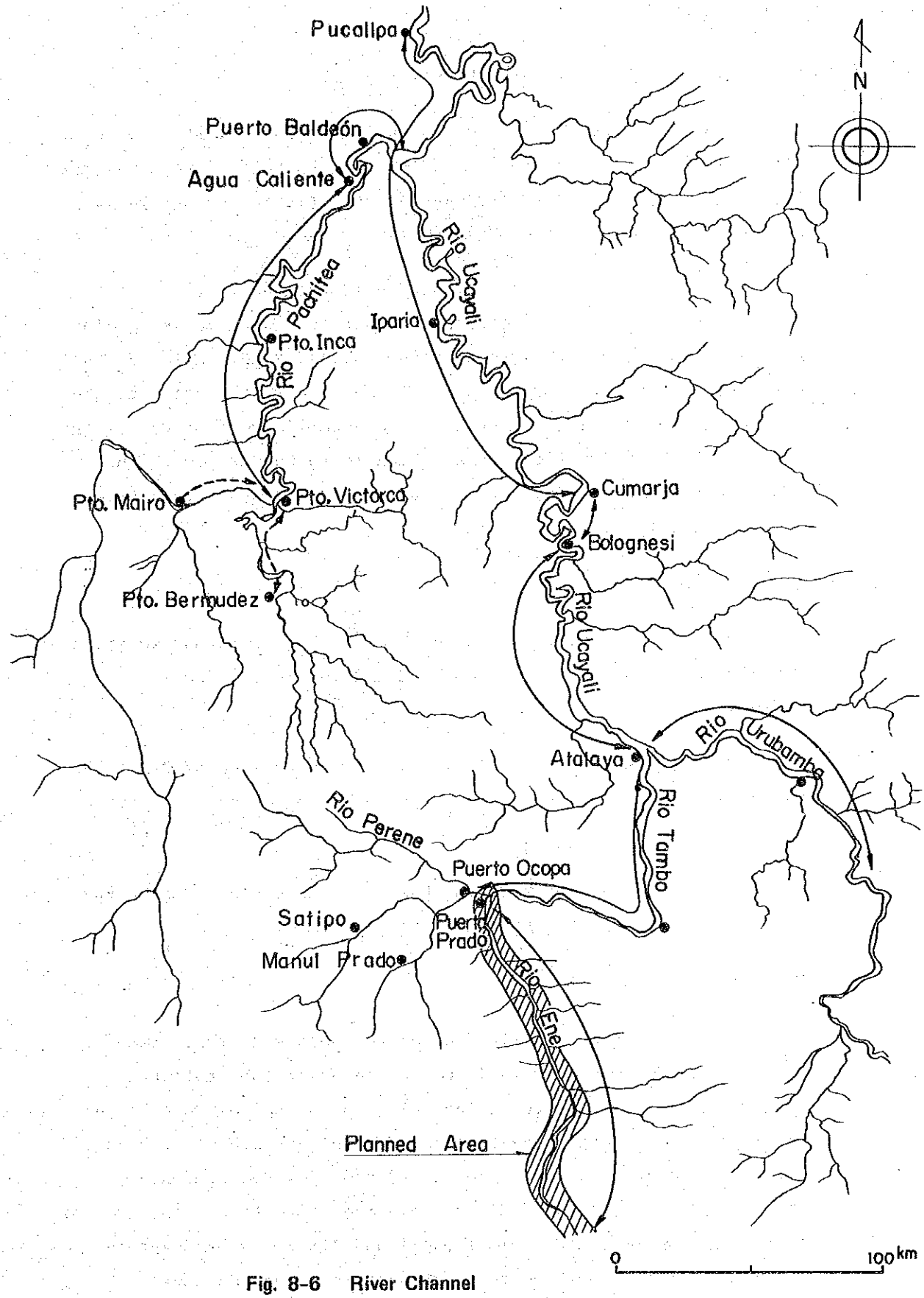


Fig. 8-6 River Channel

8.1.8 Land Utilization

(a) National Park, Special Park and Others

The areas preserved as national parks, scenic spots, etc. in the Republic of Peru amount to 4.2 percent of the total land area, but there are no places designated as national parks, special parks, scenic spots, etc. in the project area.

It likely exists a plan to designate a large area in the Vilcabamba Mountain Range at the right bank of the Ene River extending over Junin and Cuzco Department as shown in Fig. 8-7 as a national park, but details are unknown. It is necessary to confirm at the initial stage of this project that the establishment of Cutivireni National Park will not become an obstacle to the Project. The agency concerned is considered to be the Forest and Fauna Bureau of the Ministry of Agriculture.

(b) National Forest

As shown in Fig. 8-8, this project area except for a narrow strip (free forest and others) along the Ene River is the Apurimac National Forest.

This National Forest is so large-scaled with an area of 2,071,700 ha. from Satipo Province, Junin Department to Convencion Province, Cuzco Department.

The area in the left-bank of the Ene River is called "Sector Ene" and that in the right-bank is "Sector Apurimac."

(c) Protected Forest

It is not clear from the field investigations made this time and the data collected if there is any designation for protected forest in the project area. According to the survey data on the technical and economic feasibility of logging at the left bank of the Perene River and the Negro River area (investigated area; about 20,000 ha), it has been recommended that steep slope area of 80 percent or more with thin topsoil and liable to be severely eroded by water should be designated as reservations where no

logging should be allowed. The area is 16.8 percent of th total investigated area.

(d) Cultivated Land

Indigenes and immigrants engaging in burn-farming are living in the project area, but the actual state of land use is difficult to grasp. Almost all of this area is national forest with only small patches of cultivated land distributed along the Ene and Perene Rivers. Both immigrants and indigenes are engaging in agriculture and the states of land use (cultivated area) by the 12 communities of indigenes are as shown in Appendix A-6 [1] Table 7. Land registered as agricultural or grazing land totals 47,492 ha, but only about 10 percent (5,497.24 ha) is being used.

8.1.9 Utilization of River Water

(a) Domestic Water

The inhabitants of the project area utilize ground-water and water from mountain streams for drinking. The water of the Ene and Perene Rivers is not considered to be used for drinking because of high degrees of turbidity.

(b) Industrial Water

Since factories and business establishments are not existing in the project area, the water of the Ene and Perene Rivers is not being utilized for industrial water.

(c) Agricultural Water

According to the investigation made this time by boat, there were no situations of water being taken from the Ene River for agricultural purpose. Judging from the conditions of the agricultural plots of hamlets along the Ene, Perene, and Tambo River areas, the water of the rivers is not considered being utilized directly for agriculture.

(d) Boat Navigation

As stated in the clause on transportation, the Tambo, Ene, and Perene Rivers are being utilized as passageways for small boats to transport people and material and around the area.

(e) Fishery

As stated in the clause on regional society, fishes are caught by inhabitants at the Tambo, Ene, and Perene Rivers, but this is mainly for food of the inhabitants of the area. But it is so small-scaled that we cannot call it as fishery.

8.1.10 Historic Relics and Cultural Assets

It is considered that there are no historic relics or cultural assets in this project area.

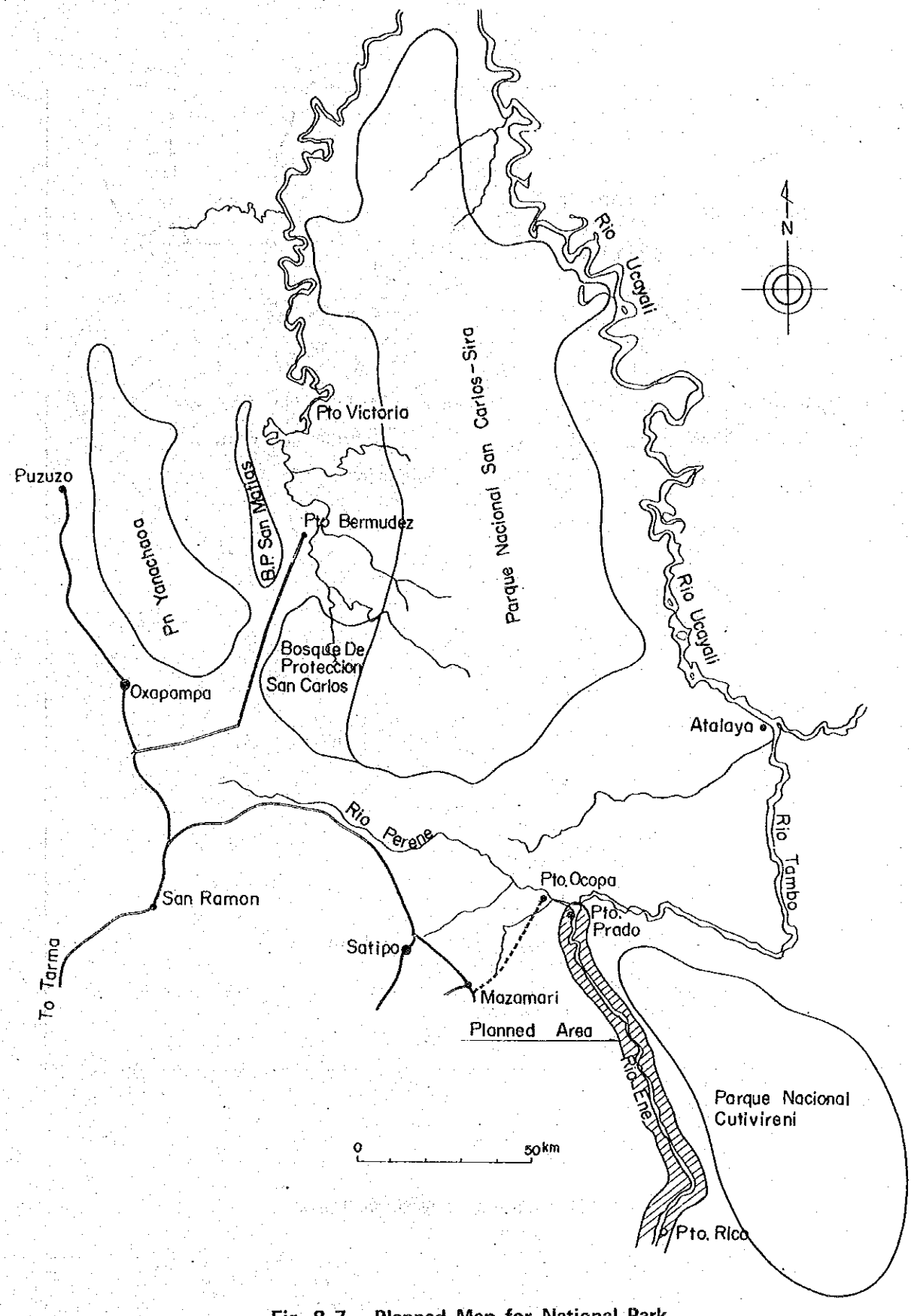


Fig. 8-7 Planned Map for National Park

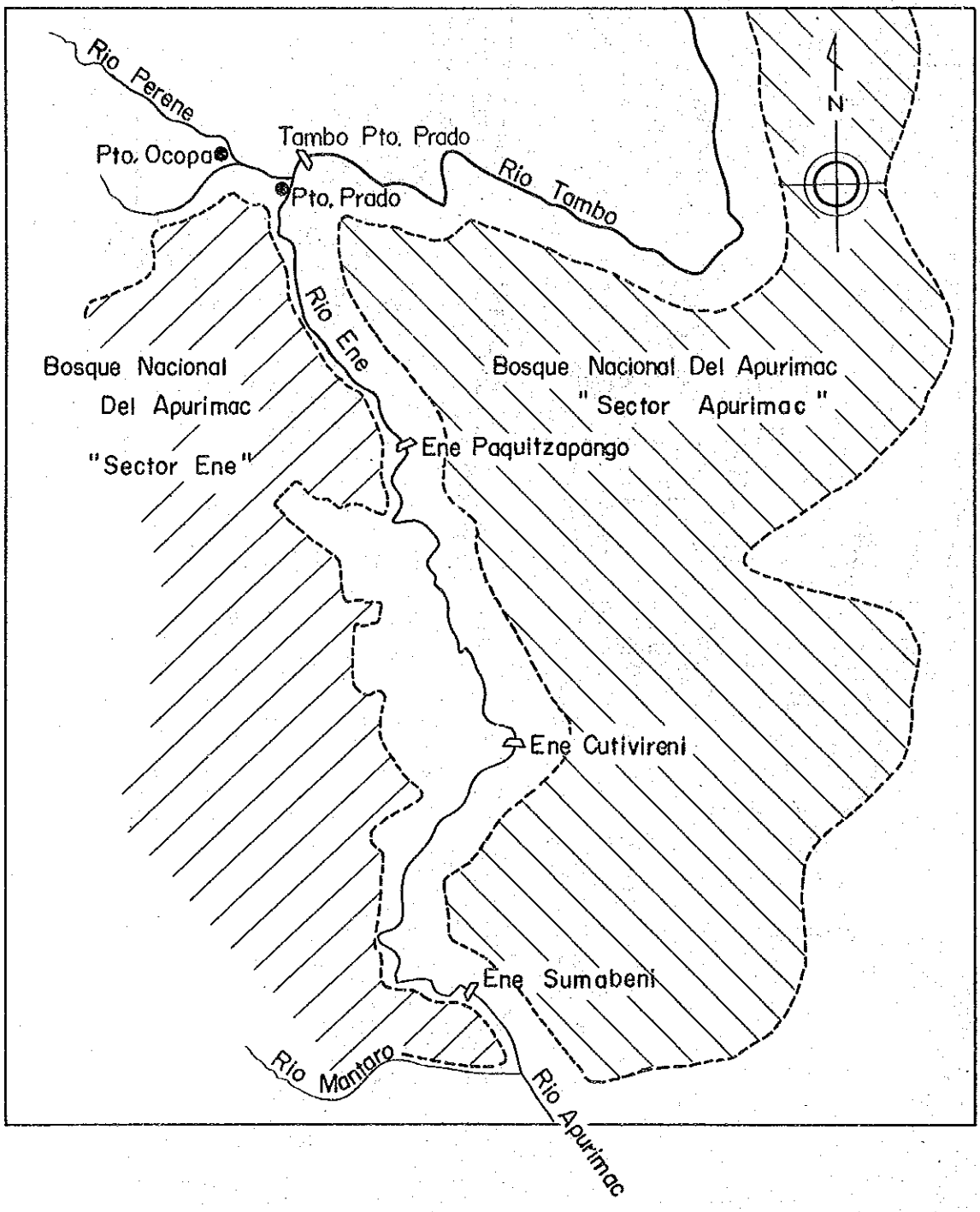


Fig. 8-8 Distribution of National Forest

8.2 Laws and Regulations for Conservation of Nature

Junin Department have no statutes for conservation of nature. Unless Junin Department establishes such statutes in the future, the laws and regulations of the Republic of Peru on conservation of nature would be applicable to the Project.

The laws and regulations concerned collected in this investigation are as given below. There seems to be other Government Ordinance like No. 20653 stipulating for communities of indigenous people and promotion of agriculture and livestock in the Selva Region.

° Ley Forestal y de Fauna Silvestre (Government Ordinance No. 211473)

° Reglamento de Conservación de Flora y Fauna Silvestre (Government Ordinance No. 158-77-AG)

° Ordinance for Indefinite Prohibition of Capturing Wild Animals in the Selva Region (Government Ordinance No. 934-73-AG)

° Law on Classifications of Wild Fauna and Flora (Ministry Ordinance No. 01710-77-AG)

° Ordinance for Indefinite Prohibition of Capturing (13 Species) of Wild Animals (Ministry Ordinance No. 5056-70-AG)

° Reglamento de Ordenación Forestal (Government Ordinance No. 159-77-AG)

° Reglamento de Aprovechamiento Forestal en Bosques Nacionales (Government Ordinance No. 002-79-AA)

° Reglamento de Extracción y Transformación Forestal (Government Ordinance No. 161-77-AG)

° Reglamento de Unidades de Conservación (Government Ordinance No. 160-77-AG)

(a) National Parks

A national park is set up to protect wild animals and plants or scenic views and the Ministry of Agriculture has the authority for preservation, administration, utilization, and penalties against

violations. Therefore, in promoting the Project, it may come to be necessary to make adjustment with the Ministry of Agriculture.

(b) National Forest

It is stipulated that a national forest can be utilized through a public enterprise for agricultural, industrial, commercial and tourism purposes for the public benefit. In other cases, it is also stipulated that a national forest can be utilized upon concluding a forest logging contract with the Government in accordance with laws and regulations.

Each national forest has their own administrative system, and Chairman of Administrative Commission authorized by a ministerial council upon recommendation by the Forest and Fauna Bureau of the Ministry of Agriculture is responsible for such administration. It may come to be necessary to make adjustment with the Chairman of Administrative Commission in promoting the Project.

(c) Protected Forest

A protected forest is provided for securing drinking water, agricultural water as well as industrial water, for protecting cultivated land, roads, hamlets, etc., and for conserving soil and rivers. It is stipulated that a protected forest should not be used without permission. Accordingly, it may come to be necessary to make adjustment with the authorities concerned similarly to (a) and (b).

(d) Wild Animal and Plant Life

It is stipulated that wild animals and plants are to be classified into the five categories below depending on their states of existence, degrees of rarity, etc. in order to provide protective measures:

o Species under extinction

o Species in danger of extinction

o Rare species

o Unconfirmed species

o Species in no danger of extinction

For the same reasons as above, it is considered necessary to hold thorough discussions with the Ministry of Agriculture and follow its directions.

8.3 Effects of Dam Construction on Environment

8.3.1 Viewpoint and Way of Thinking

Needless to say, the construction of the dam along with the Ene River Hydroelectric Power Development Project will contribute greatly to development of the national economy and society of Peru through its direct objective (hydroelectric power generation). On the other hand, it may also be said that the development effect will be quite large in that the construction of the dam in the deep Amazon Basin would act as a trigger for development of the region in order to contribute to the progress of the economy and society, and to the stabilization of livelihood of the people.

In case of a possibility that the construction of the dam will exert influences on the environment, it would be through the two process as below:

° Change in the water flow pattern of rivers
° Impoundment of water on ground surface in a certain area (reservoir)

There are also the direct (primary) effect of the existing ground surface becoming a reservoir as a result of construction of the dam and the indirect (secondary) effect of influences appearing through the wide-area ecosystem and natural circulatory system.

Here, the following items must be checked as a preliminary survey of the effects on the environment:

(a) The economic and social environmental values of the area to be a reservoir by construction of the dam which is nationally important providing much benefit to the nation.

(b) Even though no economic value can be evaluated, academic or historical values of the area, if any.

(c) The change caused by construction of the dam in the ecosystem and the natural system, and the the effect thereof on the livelihood of the people in this area.

8.3.2 Direct Effects of Reservoir

As stated in the preceding section, the society of this area is based on the river. And a subsistence type of self-sufficiency is formed based on agriculture and fishing at a certain low and flat area along the river. Off this area, the land gets hilly or mountainous which is national forest area.

The greater part of the land to be submerged is wilderness or forest, but some of them are cultivated plots and hamlets as aforesaid.

The direct effects due to construction of the reservoir are estimated as follows:

(a) Effects on Economic and Social Environments

1) Transmigration

In case of the Tambo Puerto Prado dam project, 4 communities and approximately 2,000 persons are necessary to be transmigrated, and in case of the Ene Paquitzapango dam project, 23 communities and approximately 8,000 persons will be required to be transmigrated. This may be a social effect.

The stronger that the livelihoods of the indigenes and immigrants are rooted in this land, the greater the effect will be. Although the present base of living of these people is extremely primitive, the transmigration is considered to be comparatively easy if their economic base is secured and uneasiness for the future is eliminated.

2) Effect on Industrial Resources

Those as considered to be industrial resources of this area are cultivated plots, woodlands, and fisheries, but as previously stated, they cannot be regarded as having high economic value from a national standpoint. They only comprise a base for self-sufficiency livelihood of the riparian people.

(Forestry Resources)

The area excluding the strip along the Ene River approximately 7 to 23 km in width as shown in Fig. 8-8 comprises a national forest. The maximum width of the reservoir area resulting from construction of the dam is estimated to be approximately 10 to 15 km. However, in view of the entire national forest, the reservoir area is insignificantly small, and so this area will not result in a loss of forestry resources of the country.

(Agricultural Resources)

It is not known precisely how much of the 5,500 ha of cultivated area along the Ene River will be submerged in the reservoir, but it is extensive agriculture and not particularly of high productivity or of high-quality varieties of crops. The importance as their livelihood base will be lost be transmigration of the indigenous and immigrant peoples.

(Fisheries)

There are no particular fishery resources to be left. However, there are also some people who take fishes for their base for livelihood, so it will be necessary to provide them with the means of livelihood such as lake fishing.

(b) Effects on Natural Environment

In Peru, national parks, national reservations, national scenic spots, and historic areas are to be designated for conservation of nature.

They are designated as precious areas of nature from a national viewpoint. The project area concerned is not designated at present but there is a plan for designation of a national park at the east of the Ene River. The area is not considered as an especially important area from the viewpoint of environment.

It is said that there are 3 species of plants and 28 species of animals inhabiting in the project area and its vicinity which are designated as precious fauna and flora because of rarity and being in danger of extinction.

However, it is not clearly known how many of them are inhabiting in the areas scheduled to be reservoirs by dam construction. And there are no survey results or particular local information if they are forming a number of gregarious zone or habitats. It is not confirmed if there are any animals or plants existing only in this area.

8.3.3 Effects of Reservoir in Wide-area

(a) Change in Waterflow Pattern

A part of the waterflow of the Ene River will be regulated at the reservoir as a result of construction of the dam. Basically, a part of the water in the rainy season would be stored and discharged in the dry season so that the waterflow in the dry season would be increased, thus river conditions will be improved throughout the year. During the times of flood, the floods would be cut by the reservoir, and the effect of flood control for downstream areas can be expected. These changes would contribute greatly to the stabilization of settlements along the river, and to agriculture, fishery, and boat navigation.

(b) Formation of Reservoir Area

The construction of the dam and formation of a reservoir area of a certain width could possibly exert effects on circulation as follows:

° Upward movement of fish for spawning
° Movement route of land animals
° Boat navigation being the only means of transportation in the area

These effects, however, are not limited to the dam construction on the Ene River, but are experienced in the construction of any other dams. The various practical measures are existing to maintain the continuity of such circulation. In the Ene River development it can be possible to take amply reasonable measures according to the results of environmental investigations hereafter, and the scale and type of the planned dam. Some examples are as follows:

1) Development of New Fishing Industry in Reservoir

A new fish ecosystem would be created in accordance with the new environment produced by construction of the dam and the appearance of the reservoir thereby. Development of lake fishery or aquiculture fishery would be possible which could new industries.

2) Provision of River Crossing Route and Points

As a result of dam construction, the dam itself can be used by men and animals for crossing the river, and it will also be possible to provide river crossing points. (dam crest road)

3) Provision of New Habitats

New habitats can be considered to provide for animals for preservation. If there exists a broad space of virgin forest, the reservoir area is a mere point but not something intercepting the migration route.

4) Provision of Connecting Facilities for Upstream and Downstream Traffic of Dam and New Boat Navigation

The present boat navigation on the Ene River is only for small boats and short distances, and only a few long-distance navigation beyond the dam is estimated. For the navigation beyond the dam, providing a connecting road or installing a lift can be considered as measures to take.

In view of the present conditions of the Ene River (seasonal fluctuations in depth, discharge, flow velocity, etc.), the river traffic is not considered to function as a stable, and major means of transportation for this area in the future. (In fact, the Peruvian Government is planning roads to connect the principal hamlets.)

Consequently, in the long range, roads would be main system for transportation for comparatively long distances. Access roads for construction of the dam will be highly beneficial constituting a part of the road network.

On the other hand, for short-distance traffic, the reservoir area will make boat navigation easier and safer through reduction in flow velocity (or stopping of flow), and will bring in constant water level so navigation can be stabilized and feasible throughout the year. By securing sufficient water depth, transportation units can be made larger (large vessels) and large merit can be expected for the regional water traffic.

8.3.4 Effects on Regional Development

Construction of a dam in the Ene River basin which has been left completely undeveloped will contribute greatly to the promotion of the area.

Besides the direct economic effect brought about by construction of the dam, (utilization of regional resources, employment of local residents, etc.), (1) land transportation would be greatly improved by

construction and improvement of main road routes to the damsite, (ii) utilizing electric power would be possible for rural electrification and (iii) supply of water in large quantity will be possible.

Further, the base for regional development will be strengthened by these factors, and it will be possible for the resources development of the region to be actualized. For example:

(a) Development of new lakeside settlements centered around the lake (reservoir) and improvement of livelihood and welfare for inland dwellers (the above-mentioned construction of roads, supply of electricity and water, stable transportation utilizing by reservoir, and development of lake fishing industry).

(b) Natural Resources Development

Development of the natural resources potential of the area, namely, agriculture, forestry and fisheries, minerals, tourism, etc. would be facilitated. And the development of these undeveloped resources will contribute largely not only to the regional development, but also to the economic development of the whole national land of Peru.

8.3.5 Construction and Future Aspect

(a) Judged from the various data obtained and the field investigation carried out this time, we cannot say that the economic and social environmental values of the Ene River region are absolute. Although there are problems such as relocating and resettling of the present dwellers etc., these problems should be resolved in relation to the national benefit of Peru to be brought by the Ene Project.

(b) There are little possibilities of existance of rare or unreplaceable academic and cultural value, or a notable resources in this area, and it is judged that this is not an area for the Peruvian Government to give a priority to environment preservation rather than development.

(c) Needless to say, construction of the dam will bring about many benefits, while a number of problems would also arise in connec-

tion therewith. And such problems are possible to be solved by taking amply reasonable measures.

(d) Although we can conclude that implementation of the Project will not greatly affect the economic, social and natural environment of the project area and its surroundings, it will be necessary to give thorough consideration for the followings:

° Any development plan or construction work must be given a thorough consideration for harmony with nature.

° Besides confirming the items investigated this time, the various investigations listed in 8.4 should be carried out.

° For environment management, studies, and assessment after completion of the dam, the present environmental conditions of the project dam, reservoir sites, and the surrounding area must be investigated and recorded in detail.

8.4 Items to be Investigated in Feasibility Study

The following items are desired to be investigated at the stage of the Feasibility Study:

(1) Additional Investigations

o Cultivated land area and its distribution and land ownership

o Land use plan

o Water quality investigations

o Investigation of vegetation and forest

o Investigations of state of animal life including fishes

o Investigations of water utilization (fishery, boat navigation, raft driving and other water uses)

o Population and distribution of immigrant and indigenous dwellers

o Investigation of livelihood of immigrant and indigenous dwellers

o Study on transmigration problems

o Survey of mining resources

(2) Supplemental Investigations

o Multipurpose effects to be brought about by dam construction