GOVERNMENT OF THE REPUBLIC OF HONDURAS
MINISTRY OF NATURAL RESOURCES

AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN

FIELD REPORT

OCTOBER 1977

JAPAN INTERNATIONAL COOPERATION AGENCY

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I. INTRODUCTION

1. Development of the Choluteca river basin was studied previously in the late 1960's. A feasibility study on the development of the Lower Choluteca basin and San Juan de Flores Valley was worked out by IECO in 1968. /1 Nearly a decade has past since that time, a considerable change has been observed in the settings for the agricultural development in the basin as noted by the Preliminary Survey Mission sent by JICA in March-April 1977.

2. To review and update the previous study and to prepare feasibility study report on the agricultural development in the Choluteca river basin, a team of consultants was sent by JICA under the technical cooperation program of the Japanese Government. The Team started the field investigation in mid July 1977. For the field investigation, the Team collaborated with the counterpart experts of the Ministry of Natural Resources, Honduran Government who have been very active in their respective field of works. By the beginning of October 1977, all the field works have been completed, except for geological drillings at the damsites which are scheduled to be completed by the end of October 1977. The member of the consultants' Team and the counterpart experts are listed up in ANNEX-I.

3. During the field investigation, the Team collected all available data and information related to the Choluteca river basin development. The Team also conducted topographic survey at alternative damsites and weir sites, test pitting and analysis for soil check, intake rate measurement and infiltration tests, geological exploration and drilling at damsites and weir sites, construction material survey, interviews with farmers and cooperatives, etc. The works performed in the field are summarized in ANNEX-II, and a list of collected data and reports is appended as ANNEX-IV.

/1 Choluteca Project Feasibility Report, International Engineering Co., Feb. 1968

4. The objectives of this Field Report are to present the Team's findings and observation through the investigation performed in the field and to program the works for detailed analysis and studies and for preparation of the final report to be carried out in Japan. It is noted that the estimate and figures presented in this Report are of preliminary nature, and are subject to modification by detailed analysis and studies in future.

II. BACKGROUND

5. Honduras has remained predominantly in agricultural economy. Agriculture accounts for nearly 65 percent of employment and about 30 percent of Gross Domestic Products. Agricultural products made up about 80 percent of exports. In recent years, the Honduran Government is taking a decisive effort to improve agriculture performance with the two broad objectives; i) improvement of agricultural incomes for lower income groups, and ii) acceleration of agricultural output and export growth.

6. The predominance of steep rugged terrain of the country largely limits the agricultural potential. The potentially cultivable lands are less than 20 percent of all the lands. The major potential for agricultural development extends in the northern coastal plain, the southern coastal plain including the Choluteca Plain, and some major inland river valleys including the San Juan de Flores Valley in the Choluteca basin. The improvement of land use by bringing areas of good potential more fully into the agricultural economy

and by shifting land in use to higher value crops should be a major agricultural development strategy of the country.

7. The Agrarian Reform Law effected in 1975 has the two broad objectives; i) redistribution of lands for landless and small-holding farmers, and ii) increase in land productivity. For instance, land holding over certain limits or land unefficiently utilized are expropriatable, and a land of 5 hectares each is distributed to landless or small holders who are obliged to form a cooperative or other type of farmers' association. The land holding under the state irrigation system is normally limited to 100 hectares. (The lands which had been efficiently utilized for cultivation of banana, sugar cane, coffee, etc. at the time of afectation of the law are excluded from the limitation.). The cattle raising of less than 2 heads per hectare is considered as unefficiently utilized. The Instituto Nacional Agraria (INA) is functioning as executing agency for the land reform, and the Ministry of Natural Resources (MRN) and the Banco Nacional de Fomento (BNF) are cooperating in technical assistance and agricultural credit respectively.

8. The South Region of Honduras has a relatively limited land for cultivation. Flat lands are limited to the Choluteca Plain and the coastal plains in the Department of Valle. The region is more densely populated than the regions in the North, with the average population density of nearly 50 persons per square kilometer. Utilization of the limited arable lands in the most efficient way will therefore be the major target for development in the South Region. In this connection it is noted that the balanced regional development over the country will have to be programed in the future long-term development plan.

9. Another handicap for agricultural development in the South Region is a more severe climatic condition. Rainfall is concentrated

(about 90 percent of annual rainfall) in the wet season from May to October, and during the dry season from November to April the Region has little rainfall. To go through with these major constraints for agricultural development and to attain increase in productivity, it will be prerequisite to first secure water and to provide facilities for irrigation. On the other hand, the Region has relatively well developed infrastructures, like Panamerican Highway and Port of San Lorenzo. The development of the Choluteca river basin has been and will be studied in the macroscopic framework of such economical and technical background.

III. NATURAL CONDITIONS

Physiography and Meteo-Hydrology

10. The Choluteca river drains an area of about 7,000 square kilometers. The basin is, in general, rugged terrain covered with relatively thin soil and vegetation. The terrain is mostly elevated with steep slopes and is utilized for cattle grazing and rainfed maize cultivation. The river runs for about 300 kilometers in length passing through narrow valleys. The river gradient is about 1:200 - 1:500 in the upstream and middle-stream, and it is 1:3,000 in the coastal plain. The terrace and alluvial soils are formed in open valleys between San Juan de Flores and San Francisco, between Apacilagua and Choluteca and the coastal plain. Minor depressions are also formed near at Hernando Lopez bridge, Oropoli and Morolica.

11. The climate of the Choluteca river basin is characterized by the dry season from November to April and the wet season from May to

October with interruption in July-August. About 90 percent of annual rainfall occurs during the wet season. The annual rainfall in the basin varies place to place, some 2,000 millimeters in the coastal plain and normally less than 1,000 millimeters in the elevated land. The average annual rainfall over the basin is estimated at 1,200 millimeters. The coastal plain has an average air temperature of 28°C with daytime temperature rising over 35°C in every month. In Tegucigalpa the average temperature is 22°C with extreme maximum of 36°C.

12. Mean annual run-off of the Choluteca is about 1,300 million cubic meters, of which more than 90 percent discharges during the wet season from May to October. The gauging and flow measurement at the Hernando Lopez station (with catchment area of 1,589 sq. km) has been recorded since 1954 with some interruptions. The annual run-off at Hernando Lopez ranges from 150 to 890 million cubic meters as shown on TABLE - 1 attached hereto. In the lower basin at Los Encuentros (6,370 sq. km), the hydrological measurement since 1956 was discontinued in November 1973. At Los Encuentros the minimum annual discharge was 378 million cubic meters and the maximum 2,907 million cubic meters. (Refer to TABLE - 2.)

Soils

13. Soil conditions in the Choluteca plain and San Juan de Flores Valley have been checked on the basis of ; i) reconnaissance soil survey in 1952 by MRN and FAO, ii) semidetailed soil survey in 1968 by IECO, and iii) semidetailed survey by CONSUPLAN and USAID , for the purposes of defining the irrigable area and planning future land use. In the Choluteca Plain, soils are classified into; i) mountain soil, ii) hill soil, iii) coastal soil, iv) terrace soil, and v) plain

(delta) soil. The soil condition on the right bank and left bank of the Choluteca river is apparently different. The right bank soils are mainly recent alluvial soils (Entisol or Fluvent along the river and Mollisol or Fluventic Mollisol in the plain), which are fertile and used for cultivation of sugar cane, cotton, maize and other crops. The left bank soils are mainly terrace soil of Alfisols (Podzolic soils), except for recent alluvial soils extending along the Choluteca river. The terrace soils are argillated and its subsoil contains heavy clay which impedes drainage condition. Out of the soil units in the Choluteca Plain, cultivation on soil series simbols of MC. SP, Chp-Cr, Ch1 and Ch2 will have to be carefully studied. Soils of MC, SP and Chp-Cr have surface soil of 20-40 centimeters in depth, and they will be irrigable for cultivation of improved pasture grass and wet paddy. Soils of Ch1 and Ch2 have surface soil of 10-20 centimeters and the subsoil contains gravels. Mottling by Fe and Mn is also observed. A part of these soils might be utilized for wet paddy cultivation, but major part will be used for pasture of improved grass.

14. The land classification map prepared by IECO will be reviewed further on the basis of field observation and the results of soil analysis conducted this time. Although the lands on the left bank terrace soils are not classified yet, it might be appropriate to classify MC, SP, Ch and Chp-Cr soils into the 4th class soil of limited arable land. From the viewpoint of soil conditions on such a basis, it will be provisionally estimated that the net irrigable area in the Choluteca Plain will be 25,200 hectares (right bank: 9,700 ha.; left bank 15,500 ha.) out of the gross irrigable area of some 36,000 hectares (right bank: 13,800 ha.; left bank 22,200 ha.). It must be noted that the acreage of irrigable land might be subject to change after detailed study on soil data, topography, salinity effect, drainability, etc.

15. Soils in the San Juan de Flores Valley have been checked on the basis of land classification map prepared by IECO (both irrigable and non-irrigable land). Soils are mainly alluvial soil formed by deposits of the Choluteca river and of outflows from the surrounding mountains. Soils are fertile and have enough surface soil depth for cultivation. From the viewpoint of soil conditions, it is provisionally estimated that a gross irrigable area in the San Juan de Flores Valley will be approximately 1,300 hectares (right bank: 1,100 ha.; left bank 200 ha.). (Topographie map on 1/50.000 scale, aerial photos and soil map are not available for Moroceli district.).

IV. PRESENT SITUATION OF AGRICULTURE

Population, Land Holding and Tenure

16. The Choluteca Department has a population of 193,000 in 1974, and is increasing at the rate of 2.3 percent per annum. Population engaged in agriculture accounted for about 71 percent of the economically active population of 49,000 in total. The Department has households of 36,400 (approx. 5.3 persons per household), out of which about 17,000 are dependent on agriculture. Out of the total households in the Department, the Choluteca Project area encompasses some 2,300 households, and some 1,200 household are engaged in agriculture, except for landless farmers.

17. According to the agricultural census in 1974, the land holding size in the Choluteca Department was about 14.4 hectares per household (cultivated land of 236,000 ha. and farm household of some 16,400.). About 68 percent of the households are small holders of less than 5

hectares, occupying only 10 percent of the total cultivated land. The land tenure in the Department is classified into the private land (66%), national or municipal land (12%), and others.
The private land owned by small holders of less than 5 hectares accounted for some 36 percent, while it is about 80 percent in the case of large holders.

Crops

18. Major crops cultivated in the Choluteca Plain are grains (maize, sorghum, rice, etc.), beans, sesame and such cash crops as sugar cane, cotton, melon and watermelon. Maize , which is the staple food in Honduras, is cultivated twice a year (first crop in May-August and second crop in August-November). The production in the Choluteca and Marcovia Municipios which cover the Project area, was about 5,150 tons (1974 agricultural census). The productivity is relatively small, or less than one ton per hectare. The maize production in the Project area has been largely affected by rainfall during the period of seeding. Sorghum is used for food and livestock feed. It was cultivated in some 4,200 hectares (Choluteca and Marcovia Municipios) and its productivity was small, or some 0.6 ton per hectare. (At the experiemental station at Lujosa, sorghum production attained about 5-6 tons per hectare.). Rice cultivation in the Project area has been promoted in recent years, but only the farms equipped with appropriate irrigation facilities remain cultivating at present. The experiments at Lujosa demonstrated production of 6-7 tons per hectare (variety: CICA-6), and it is considered that the cultivation area will increase and double cropping will be promoted if irrigation facilities are provided. (Suitable land for paddy cultivation is available as noted in Para.13 hereinabove, and there is a shortage of rice production in the country.)

19. Sugar cane is one of the major crops cultivated in the alluvial

soil of the right bank of the Choluteca river. At present, some 7,000 hectares are cultivated. In the Project area, there exist two sugar mills; Azucarera Choluteca S.A. (ACHSA) having mill capacity of 1,500 short tons (1,350 MT) per day operated since 1968 and Azucarera Central S.A.(ACENSA) which is scheduled to be put in operation by the end of 1977 with the mill capacity of 5,000 short ton (4,500 MT) per day. ACHSA has its own cane farms of 1,540 hectares, where irrigation is practised by pumping up the Choluteca river water and by pumping up groundwater (18 wells). Irrigation is a supplementary one, and the major variety is NCO-310 (90% of cultivated land) which is tolerant to driness and early in maturity period. Farms cultivating cane under contract to ACHSA are 1,260 hectares in total scattered on the right bank and have no irrigation facilities. ACENSA has its own farm of 2,640 hectares (incl. 710 ha. in Santa Ana) and contracted farms of 1,430 hectares. The cane production will be far from sufficient to feed the 5,000 ton capacity mill. ACENSA's own farm can not be extended under the Agrarian Reform Law, and efforts have been made to increase productivity, to promote cane cultivation in the INA expropriated cooperative lands and to cultivate cane in the Santa Ana district which is located some 40 kilometers apart from the mill. To have enough sugar cane for ACENSA mill, it will be indispensable to extend cultivation land with irrigation facilities in the order of 2,000 to 3,000 hectares. The productivity of sugar cane, though relatively high at present, will be much more increased by providing irrigation facilities and applying varieties which are more productive under irrigated conditions (like L60-14). The rate of increase in production under irrigated condition will be studied further.

20. Sugar cane production in the San Juan de Flores Valley has been initiated with the construction of 2,000 short ton capacity sugar mill of Azucarera Cantarrana S.A. (ACANSA). The mill is scheduled to be put

into operation in November 1977. The requirement of sugar cane for the mill will be about 270,000 metric tons for 150 days' operation. The land cultivable for sugar cane in the San Juan de Flores Valley is approximately 1,000 hectares and the cane production will be more or less one third of the requirement. The efforts should therefore be first concentrated to increase productivity from the limited land available in the Valley. (Further shortage of sugar cane will have to be supplied from the land outside of the Valley.)

21. Cotton is another cash crop of significance in the Choluteca Plain where climate is favorable for its cultivation. In Choluteca Department, about 1,360 hectares was cultivated for cotton to produce seed cotton of 2,884 tons. The Stonville variety was recommended for 1977/78 cultivation. Quality of lint is fairly good. All the seed cotton are processed at the ginning factory (located at San Lorenzo) of the Cooperativa Agropecuaria Algodonera del Sur, which has a plant of 90 tons per day. (A new plant of 160 tons per day is under construction and is scheduled to be completed in January 1978.)

Livestock

22. Livestock is of vital significance in the Project area. According to the 1974 agricultural census, the livestock lands extended some 143,000 hectares where 171,000 heads of cattles are raised (1.2 head per hectare). There extend large lands depending on the natural grass. Main varieties of pasture cultivated in the region are estrella africana which is relatively tolerant to driness and resistent to weeds. Jaragua, guinea grass and other grasses are also cultivated, but there is no cultivation of leguminous pasture. The cultivation of

pasture and the resultant cattle raising are also affected by driness during the period from November to April. Only a very few livestock farmers have irrigation facilities at present. The production increase of livestock by irrigated pasture will be assessed in further study on the basis of pasture production, total digestible nutrient, digestible crude protain, etc.

Agro-industries

23. For processing of agricultural products in and around the Project area in the Choluteca Plain, there exist 2-sugar mills, 2-rice mills, 1-ginning factory, 1-seed oil factory, 2-slaughter houses and 1-cheese factory. With the completion of ACENSA mill (4,500 MT/day) in end 1977, the supply of sugar cane to the mill will be in absolute shortage as noted in Para. 19 hereinabove. With the extension of the ginning plant of the Cooperativa Agropecuaria Algodonera del Sur, the processing capacity will be much more than the cotton production in the country. During 1969/70 - 1972/73, production of processed cotton was 2,000 - 4,000 tons a year, about a half of which was exported. During 1974/75 - 1976/77, nearly all the cotton was exported (6,300 tons in 1976/77), while local textile factories were importing cotton from Nicaragua. The cotton seeds are all processed at San Lorenzo. The seed oil factory has enough capacity for processing (20,000 tons/year), and has problem in shortage of raw materials.

24. Two slaughter houses (IGHSA and CARNILANDIA) have a capacity of 300 head and 100 heads per day respectively. The cattle slaughtered at IGHSA was about 25,000 heads in 1976 or about a half of the processing capacity. About 90 percent of beef are exported to U.S.A.
A cheese factory has a processing capacity of 2,000 galon per day.
A milk factory is also under construction in Choluteca.

Although a market study has to be made further, it will be possible to say that there exist shortage of raw materials for processing of agricultural products at the existing or on-going factories, and there is a strong need to increase agricultural production in the Project area.

Institution and Supporting Services

25. In the Choluteca Department, more than 150 cooperatives and resettlement associations have been formed, of which about 14 are in the Project area. On an average, a cooperative has 150 - 200 hectares of land, or 5 hectares per farmer, in the name of the cooperative. They have to repay for the land within a maximum of 20 years (2 years' grace period). For the cultivation by cooperatives and resettlement association, extension services have been provided by MRN and the agricultural credits have been extended by BNF. MRN Choluteca Office has, at present, 16 extension offices, of which 3 are located in the Project area (Choluteca, Monjaras and Marcovia). For sugar cane and cotton cultivation, technical services are extended by sugar factory (ACHSA and ACENSA) and Cooperativa Agropecuaria Algodonera del Sur respectively. MRN has an experimental station at Lujosa where variety tests and multiplication of improved varieties are executed for sorghum and sesame (as a national center for experiment), rice, maize and peanuts (as a regional center).

26. BNF has three types of agricultural credits; i) "refaccionario" for acquisition of land, houses and machineries (repayment period of 4-7 years with annual interest rate of 11%), ii) "avio" for inputs and other necessities for cultivation (period: max. 1.5 year; interest 11%) and iii) "hipotecario" for factory construction. For credits for cultivation, BNF has its own criteria and credit limitation. In 1976, a

total of Lp.7.5 million were loaned for cultivation of 9,170 hectares (gross) in the Choluteca Department. BNF is also acting as agency for price control of basic grains (maize, rice, sorghum and beans) for the purpose of price stabilization.

Infrastructures

27. The infrastructures in the Region are relatively well developed. The Panamerican highway is running across the northern part of the Choluteca Plain, and the metaled road is running through the right bank of the Choluteca river. A new port is under construction at San Lorenzo which will have facilities for warehouses for cotton and sugar, as well as piping for molasses loading. A 132 kilovolt interconnection transmission line between Honduras and Nicaragua is crossing the Region with a substation at Pavana located between Choluteca and San Lorenzo.

V. EXISTING AND PROPOSED IRRIGATION

Existing Irrigation

28. In the Choluteca Plain, major irrigation facilities are operated at present by the two sugar companies (ACHSA and ACENSA) on the right bank of the Choluteca. ACHSA farms, located inbetween Choluteca river and its Old river course, have a station to pump up the Choluteca water for irrigation of 880 hectares, and 8 wells (3 wells are operated by electric pumps) for irrigation of 420 hectares. ACENSA farms, scattered around ACHSA farms, have 2 pumping station and 10 wells for irrigation of 900 hectares in total. The existing irrigation facilities of ACHSA and ACENSA cover a total of 2,200 hectares. Furrow irrigation is practised, and the irrigation intervals are once every 15-20 days. In addition, the Lujosa Experimental Station has an irrigation system for its 140 hectare farm.

29. In the San Juan de Flores Valley, there exist irrigation facilities constructed by MRN, including an intake weir located at a site some 3 kilometers to the southeast of San Juan de Flores town, a principal canal of 16 kilometers, 9 secondary canals for irrigation and drainage, and a pumping station located in the middle reach of the principal canal. The facilities are capable of irrigatiing a net area of 800 hectares. A small irrigation scheme (60 hectares) is existent on the right bank of the intake weir, pumping up water from a tributary of the Choluteca.

Between Orocuina town and Choluteca City, there are also several small irrigation schemes pumping up water from the Choluteca, with a total of some 370 hectares. Major crops are rice, sorghum, cotton, melon and watermelon. Other existing irrigation facilities in the Choluteca river basin are few and small in scale.

Possible Irrigation

30. In general, the Choluteca river is running through a relatively narrow and steep sloped valley, and little alluvial plain suitable for irrigation is developed in the middle and upstream of the Choluteca, except for the San Juan de Flores Valley. Such being the situation, exploitable irrigation schemes in the valley will possibly be small in scale and suitable for pumping irrigation system. For instance, in the valley upstream of Morolica town, there is a possibility of irrigating 150-200 hectares on the left bank by pumping up for 15 meters above the Choluteca. The area located between the mainstream and Oropoli has 300-400 hectares for development, but the required pumping head will be over 140 meters and will not be considered as favorable. Other possibilities for irrigation exist in Moroceli, Ojo de Agua, etc.

31. For the San Juan de Flores Valley, there is urgent need to extend irrigation area for sugar cane cultivation as noted in Para. 20. To this end, it is conceivable to develop the area located on the left bank of Paso la Ceiba bridge, some 2 kilometers to the north of San

Juan de Flores town. Some 150-200 hectares will be irrigable by pumping up for 30 meters above the Choluteca (main canal will be about 5 kilometers).

32. There extends a gross area of some 2,000 hectares along the Choluteca river between Orocuina and Choluteca City. About 370 hectares are already irrigated as noted in Para. 29 above, and the possible future extension area for irrigation will be in the order of 200-300 hectares.

33. The Choluteca Plain has a net irrigable area of some 24.340 hectares (right bank 8.840 ha ; left bank 15,500 ha.) irrigable by gravity flow if water is diverted at Las Bases located at about 4 kilometers upstream of Choluteca City. Exclusive of the existing irrigation scheme of some 2.340 hectares, the potential irrigable area will be about 23,000 hectares.

34. Two alternative diversion weir sites for the Choluteca Plain irrigation scheme are being studied; El Papalón site and Las Bases site. The site at El Papalón (located at EL.21 meters AMSL) was planned by IECO to irrigate the right bank and a part of the left bank along the river. The alternative site at Las Bases (located at EL.40 meters AMSL) will enable irrigation over all irrigable areas on the right and left banks. Concrete aggregates for diversion weir structures will be available from the riverbed gravels, though they contains some soft rocks, or alternatively from a quarry of rhyolite rocks available to the north of the Panamerican Highway at a point some 12 kilometers from Choluteca to San Lorenzo.

35. As a result, the technically possible irrigation area by water of the Choluteca will total about 26,000 hectares as follows:

	Existing	Potential	Total
S.J.de Flores	860	150 - 200	1,010 - 1,060
Oropoli	-	0 - 400	0 - 400
Morolica	-	150 - 200	150 - 200
Orocuina-Choluteca	370	200 - 300	570 - 670
Choluteca Plain	1,340	23,000	24,340
Right bank (excl.wells)	1,340)	(7,500)	(8,840)
Left bank	-	(15,500)	(15,500)
	2,570	23,500-24,100	26,060 -26,670

Out of the total possible irrigation area of about 26,000 hectares, the area for development and economic viability will be further studied in detail.

VI. ALTERNATIVE DAM/RESERVOIR SCHEMES

Water Budget

36. In the light of ACANSA sugar mill scheduled to start commercial operation by the end of this year, the area of 860 hectares presently equipped with irrigation facilities in the San Juan de Flores Valley will be dominated by sugar cane cultivation in the near future. The monthly diversion water requirement for sugar cane cultivation in 860 hectares was provisionally calculated by applying the estimate made by IECO, and it was compared with the monthly run-off record at Hernando Lopez which was increased at the ratio of catchment area (1:1.17). As a result, no water deficit was recognizable.

37. The area equipped with irrigation facilities at present in the entire basin is estimated to be 2,570 hectares, exclusive of the area served by groundwater, as noted in Para. 35 above. A similar check as mentioned in the foregoing paragraph was made by means of monthly run-off record at Los Encuentros, with the result that the water shortage in February - April will occur once in four to five years. It will also lead to the implication that the natural flow of the Choluteca river will not be able to stand for further increase in irrigation area in future.

38. The diversion water requirement for possible irrigation of about 26,000 hectares in the Choluteca river basin has been provisionally estimated to be 390 million cubic meters (1,500 millimeters), assuming a sugar cane cultivation in the entire area of the San Juan de Flores , and 70 percent for sugar cane and pasture cultivation and the remaining 30 percent for other crop cultivation in the Choluteca Plain and other areas. The diversion water requirement from December to April is estimated to be 310 million cubic meters (1,200 millimeters), while the river flow in the same period is about 100 million cubic meters on an average. Consequently, a shortage supplement of about 200 million cubic meters every year will be necessary for the future irrigation development in the Choluteca river basin. To secure water required, alternative dam/reservoir schemes have been conceived as described hereunder.

San Fernando Dam/Reservoir

39. Construction of the San Fernando dam was proposed by IECO in 1968. The damsite is located at about 3 kilometers downstream from the Hernando Lopez gauging station, with a catchment area of 1,670

square kilometers. The annual inflow is estimated at 420 million cubic meters. A narrow gorge of compacted tuff appears to favor construction of a concrete arch dam. However, the compression and sharing strength should be carefully studied further for finally deciding the dam type and design. By constructing a dam of about 90 meters in height, it will be possible to create a reservoir of about 380 million cubic meters in gross storage capacity, which will retain water during the wet season and release it for supplement during the dry season. A power station of about 6 mega-Watts in the cascade of the dam will generate 30 - 40 giga-Watt-hours of energy a year. This will be regarded as a running power station which may interrupt power output from time to time.

40. A site alternative to San Fernando dam is the Zorrillo dam located at about 2 kilometers upstream of the San Fernando site. The Zorrillo damsite is also underlain by tuff, similar to the rock at the San Fernando site. Although the site is wider than the San Fernando, about two-thirds of the abutments are steep to vertical, and an arch type dam would be preferred to a rockfill type dam.

41. For aggregate materials for concrete, riverbed gravels of andesite, dacite, basalt, welded tuff and tuff are found between the Zorrillo site and the confluence with the Amarateca river. Alternatively, a quarry of dacite rock is available to the east of the Talanga Highway at a 21 kilometer point. Another quarry of dacite - obsidian is also available at a 27 kilometer point of the Talanga Highway. For rockfill materials, hard tuff within 3 kilometer distance will be available. However, suitable core materials are unavailable near at the site.

Oropoli Dam/Reservoir

42. The Oropoli dam was once studied by American consultants for electric power development about a decade ago. /1 The annual inflow from the catchment area of 4,100 square kilometer is estimated to be 910 million cubic meters. A preliminary study indicated that a rock-fill type dam of about 80 meters in height would create a reservoir capable of supplying irrigation water for 26,000 hectares. With the construction of higher dam, power generation will also be possible.

Morolica Dam/Reservoir

43. The Morolica damsite is located at about 5 kilometers downstream from Morolica town. The annual inflow from the catchment area of 5,900 square kilometers is estimated to be 1,200 million cubic meters. A rockfill dam of 70 meters in height would enable irrigation of 25.000 hectares. If a dam of 90 - 100 meters in height is constructed, it would create a reservoir of 890 - 1,200 million cubic meters in gross storage capacity, which will guarantee a perennial flow of 25 - 30 cubic meters per second. This will exceed the estimated peak water requirement at all time. A power station of 30 - 40 mega-Watts would generate 160 - 190 giga-Watt-hours of energy mostly as the primary power. The Morolica damsite will be underlain by welded tuff and partly by volcanic breccia, though rock outcrops have not been recognized at the damsite. Technical feasibility for rockfill dam construction will be subject to the results of on-going drilling test.

44. An alternative damsite will be selected at a site about 5 kilometers downstream from the above-mentioned Morolica upstream

/1 Ref. Report No.75 in Annex-IV.

site. The site is rather open compared with the upstream site, but rock outcrops are observed. For either upstream site or downstream site of Morolica dam, rockfill materials and core materials will be easily obtainable near at the sites.

VII. BASIS FOR PLANNING AND STUDY

45. The future land use in the Choluteca river basin will be predominantly agricultural as it has been so far. Because of dry spell lasting for half a year, irrigation must be a decisive factor to increase agricultural production with the limited land resources in the South Region and to attain the Government's policies for development as noted in Para. 5. The land should be developed for irrigation to the maximum extent.

46. As described in Para. 35 above, the Choluteca river basin has irrigable lands of about 26,000 hectares, including the presently irrigated and potentially irrigable land. On the other hand, the river flow during the dry season is not more than enough to supply water to the existing irrigation area of about 2,570 hectares. It is indispensable to provide a storage supplement of about 200 million cubic meters every year for the irrigation development in the basin.

47. From the viewpoint of maximum utilization of natural resources,

the Government of Honduras desires the multipurpose development which will involve not only irrigation but flood control, municipal, rural and industrial water supply and power generation. The envisaged dam/reservoir scheme will reduce the floods to a certain extent. The municipal, rural and industrial water demand will be comparatively minor and it could be met by adding a little larger storage capacity than required for the irrigation purpose. Power could also be generated at the dam, but the power installation would be dependent on the demand and supply schedule of power which is quite uncertain at the moment. In the study on the Choluteca river basin development, the dam/reservoir scheme will be taken up with irrigation as the main purpose.

48. It appears that hydro-power development combined with the irrigation in the Morolica dam/reservoir scheme could generate substantial energy with a reasonable cost. Besides, it will be among few hydro-power possibility in the South Region. Therefore, an indicative plan of the Morolica multipurpose dam/reservoir project inclusive of power generation will be studied and presented in the Final Report for reference by the Government.

49. A preliminary study has not determined the priority between the San Fernando scheme and the Morolica scheme, assuming irrigation as the main purpose. The Oropoli scheme has been found to be more costly than the Morolica scheme, because the storage efficiency (storage capacity divided by dam volume) is smaller than that of the Morolica scheme. Consequently the further studies will be concentrated to the San Fernando scheme and the Morolica scheme.

VIII. PROGRAM FOR FURTHER WORK

50. On the basis of the data and information collected, and the findings in the field as outlined in the foregoing Chapters, further study and analysis will be made by the Team in Japan. Major study and work items will include:

- analysis of farm interview results
- analysis of cadastral and land use map
- production cost and crop yield analysis
- determination of cropping pattern
- crop price projection and estimate of production value
- soil physical study and estimate of water requirement
- preliminary design of irrigation facilities
- hydrological analysis and flood study
- water budget study
- geological and foundation study
- power study
- preliminary design of San Fernando dam and Morolica dam
- implementation schedule and organization
- economic and financial analysis

The outline of the respective works, together with the draft outline of the Final Report, is presented in ANNEX-II.

51. With respect to the water budget study, it is noted that the study will be limited to the surface water only, since the groundwater survey is going to be made separately with assistance from IBRD. In the irrigation design, the irrigation network will be designed to include the areas where irrigated at present by groundwater or lifted water from the river as far as they are feasible.

TABLE-1 DISCHARGE VOLUME FOR CHOLUTECA RIVER AT HERNANDO LOPEZ (MCM)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
*1943	10.1	7.5	7.4	7.3	8.0	4.1	14.8	11.0	67.6	224	91.0	14.1	396.9
*1944	9.7	6.6	4.8	4.3	13.9	133.	97.6	32.2	103	59.0	13.0	8.7	485.8
*1945	6.0	5.9	5.8	5.5	36.6	185	36.7	23.5	78.4	87.1	38.8	16.1	525.4
*1946	11.1	8.0	6.6	6.4	16.9	24.6	12.6	18.9	41.0	50.6	29.0	12.4	238.1
*1947	8.6	10.7	10.4	10.6	3.1	24.5	99.6	47.5	45.5	66.0	46:9	24.5	397.9
*1948	16.9	10.6	11.1	11.4	13.0	41.3	35.8	13.0	14.3	35.3	17.3	10.7	230.7
*1949	7.4	5.7	4.0	3.4	3.0	31.0	34.5	22.1	71.5	125	39.2	19.9	366.7
*1950	13.7	9.0	9.2	9.3	3.8	21.8	38.5	26.8	36.2	111	43.5	15.1	337.9
*1951	10.4	12.1	10.3	10.5	9.5	35.4	16.7	20.1	89.0	64.4	8.6	7.4	294.4
*1952	5.1	3.3	7.6	7.6	22.6	194	116	15.2	58.8	56.9	16.0	8.2	511.3
*1953	5.6	4.2	2.7	2.2	24.7	11.5	12.0	12.0	122	93.6	7.6	9.0	307.1
1954	*6.2	*4.8	*3.6	*3.0	*34.5	*342	*76.0	36.3	195	162	19.2	7.9	890.5
1955	6.5	5.8	5.7	5.4	5.0	7.0	120	67.5	129	231	55.1	19.7	657.7
1956	11.4	8.0	5.6	5.3	14.3	88.7	48.6	15.4	39.4	36.2	14.7	12.7	350.3
1957	12.5	7.6	5.5	5.1	28.1	75.5	18.4	19.4	50.5	40.8	10.5	9.5	283.4
1958	5.7	3.8	3.7	3.0	62.4	135	61.5	32.0	25.4	62.8	10.0	7.5	412.8
1959	7.7	5.5	4.5	3.9	23.9	36.1	12.4	23.3	18.9	54.7	16.6	10.5	218.0
*1960	7.2	4.4	4.7	4.2	36.0	186	44.5	35.1	89.6	109	50.4	18.9	591.0
*1961	13.7	11.0	10.3	10.5	3.2	19.5	39.8	18.8	20.6	40.0	61.0	21.2	269.6
*1962	14.6	8.4	6.4	6.2	12.1	25.8	7.2	21.8	19.0	56.5	8.6	7.3	193.9
*1963	5.0	4.7	3.9	3.3	9.0	29.6	35.0	17.5	19.2	53.0	91.7	23.6	295.5
1964	*16.3	*9.8	*7.5	*7.5	5.5	85.2	104	15.1	54.7	70.1	7.1	5.8	388.6
1965	2.6	2.8	1.8	1.5	21.4	43.0	16.5	11.5	247	78.2	35.3	12.5	474.1

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1966	7.4	4.5	4.6	4.4	52.0	87.7	79.3	26.3	41.7	68.0	4.9	7.9	388.7
1967	6.8	5.2	4.5	10.4	3.5	13.3	14.2	9.4	32.8	32.4	10.0	5.7	148.2
1968	4.5	2.7	1.9	1.8	51.8	160.5	27.6	21.9	86.6	64.2	37.6	11.9	473.0
1969	9.6	3.9	3.0	1.9	16.8	203.5	72.4	129.7	180.6	202.8	38.5	21.3	884.0
1970	9.7	6.2	3.9	8.1	15.4	19.9	50.6	91.2	175.9	75.6	28.5	14.5	494.5
1971	6.8	4.6	3.2	2.8	23.5	16.7	16.1	40.8	102.2	96.0	18.5	7.8	339.0
1972	5.5	3.2	2.2	2.4	13.9	37.7	7.7	8.4	9.7	-	-	-	
1973	-	-	-	-	17.3	45.5	43.1	29.2	88.9	175.4	40.4	9.8	
1974	6.0	5.1	4.5	3.2	15	27	12	5	33	26	8	6	150.8
1975	6	4	3	2	14.3	8.0	-	-	-	153.8	-	12.6	
1976	8.5	6.0	5.1	8.9									

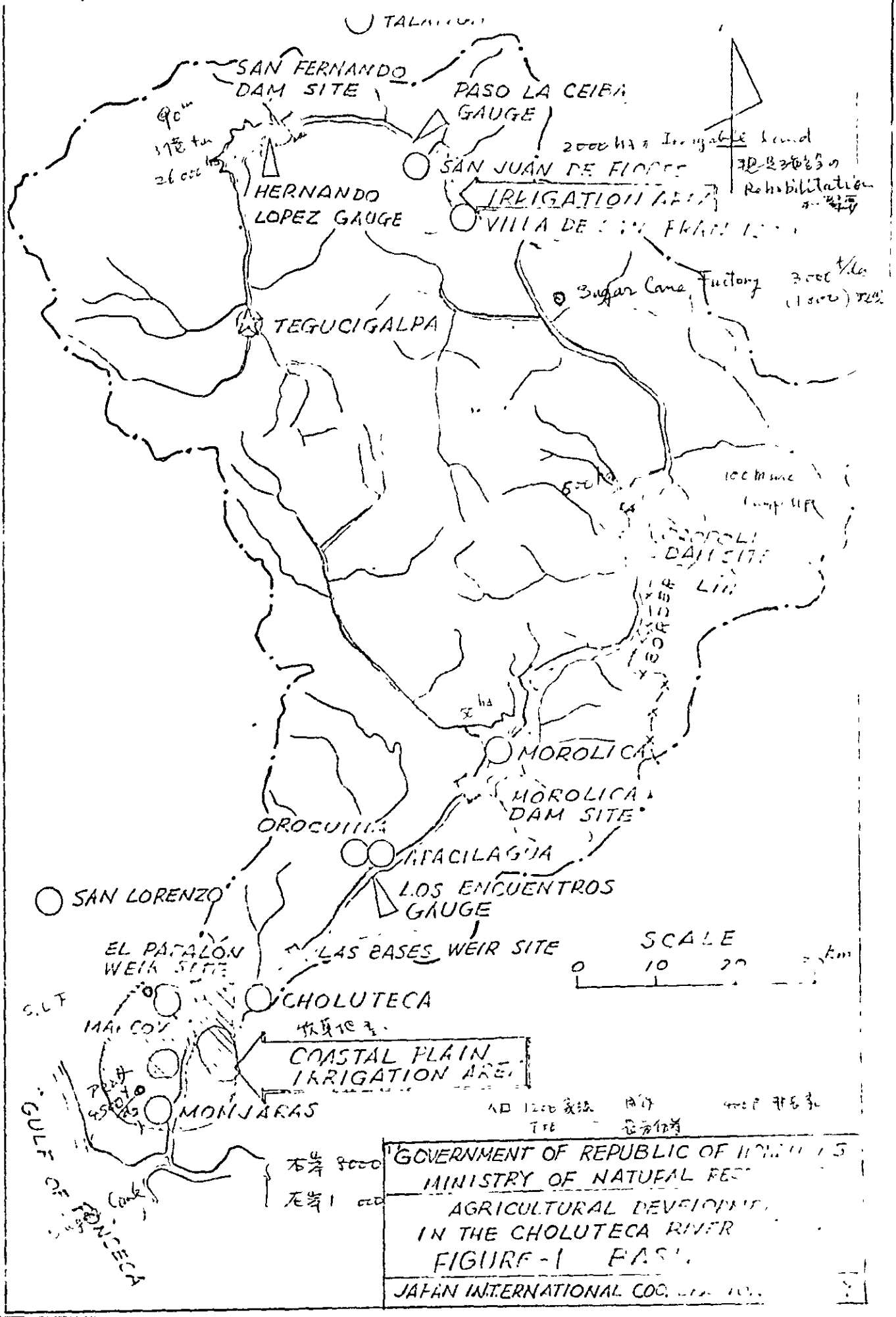
Source: Servicios Hidrológicos y Climatológicos
Note: * estimated discharge by IECO.

TABLE-2 DISCHARGE VOLUME FOR CHOLUTECA RIVER AT LOS ENCUENTROS (MCM)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
*1943	35.9	25.2	20.1	17.0	15.5	37.6	18.8	37.4	126.2	389.0	32.5	19.2	774.4
*1944	13.3	7.6	6.3	8.5	18.9	353.0	238.6	108.0	246.0	315.0	76.7	37.0	1428.9
*1945	26.0	19.1	15.2	7.3	162.6	375.0	135.5	84.1	303.4	445.1	131.6	57.4	1762.3
*1946	40.3	28.3	21.1	6.9	31.9	76.1	45.8	55.9	228.0	360.6	48.7	21.2	965.3
*1947	14.8	13.2	12.2	11.1	8.1	215.6	315.6	150.5	130.6	259.0	171.9	80.1	1382.6
*1948	56.1	38.7	31.2	12.1	100.0	247.3	216.8	103.2	146.3	276.3	29.3	16.0	1273.3
*1949	11.1	6.7	5.5.	3.9	8.0	191.0	109.5	74.1	214.5	381.0	57.5	28.0	1090.8
*1950	19.4	11.1	10.7	9.8	8.8	216.8	204.5	111.6	110.8	286.0	81.3	31.9	1102.7
*1951	22.3	19.0	15.2	14.8	22.5	177.4	135.7	87.9	258.0	352.4	48.9	25.3	1179.4
*1952	17.7	10.7	12.9	35.3	76.6	499.0	354.0	126.2	156.6	256.7	68.3	31.5	1645.7
*1953	22.0	14.6	10.1	6.9	59.7	56.5	16.0	38.4	329.0	429.6	17.6	13.4	1013.8
*1954	9.3	5.8	5.1	9.8	246.5	588.0	232.0	117.5	379.0	467.0	29.2	12.3	2101.5
*1955	9.6	6.8	7.2	14.9	10.0	65.0	402.0	194.5	347.0	577.0	103.3	41.1	1778.4
1956	*26.5	*17.4	*12.3	*13.1	*53.3	*279.7	*190.6	*91.5	*184.4	*294.2	58.9	31.4	1253.3
1957	42.8	29.0	21.4	18.1	144.1	224.5	44.1	61.0	219.5	198.8	38.9	26.8	1069.0
1958	17.7	10.2	8.8	7.6	165.4	370.0	248.5	124.2	81.8	223.8	42.0	21.6	1321.6
1959	18.1	11.7	7.2	4.5	40.8	71.0	19.3	45.2	42.1	205.7	38.1	14.9	518.6
*1960	10.3	5.4	6.2	31.7	164.0	337.0	122.4	88.1	324.6	479.0	99.5	41.7	1709.9
*1961	29.1	20.6	17.2	11.2	8.2	191.5	200.8	101.8	123.6	245.0	204.0	84.8	1237.8
*1962	59.5	40.9	29.6	21.6	19.1	115.8	33.0	56.1	113.5	251.5	80.3	39.2	860.1
*1963	27.5	19.8	14.7	6.1	14.0	88.6	39.0	43.9	93.7	228.0	237.7	88.6	901.6
1964	*62.2	*43.1	*31.3	*11.1	*10.5	*281.2	*260.0	74.5	166.7	292.1	40.7	26.4	1299.8
1965	11.4	4.8	4.3	3.3	83.7	133	54.4	50.8	367	281	94.1	35.8	1123.6

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1966	22.6	13.8	11.9	16.0	138	394	286	128	175	380	65.3	35.2	1665.8
1967	26.2	19.3	17.8	35.0	89.6	86.6	56.4	48.8	153.3	111.3	38.9	21.8	632.7
1968	18.8	12.3	8.7	7.5	144.7	560.3	108.1	74.6	330.4	308.8	117.4	45.1	1736.7
1969	38.2	16.2	13.9	11.6	51.3	581.4	205.9	472.2	533.4	785.6	154.1	43.4	2907.2
1970	17.3	9.0	6.1	6.7	33.8	31.8	137.2	218.2	436.8	330.4	107.0	44.2	1378.5
1971	28.4	17.2	12.1	9.1	71.3	52.7	32.6	111.4	318.8	353.0	67.9	31.1	1105.6
1972	20.9	13.6	9.0	7.6	49.4	134.1	22.8	28.4	28.7	32.8	19.8	11.2	378.3
1973	8.4	5.0	3.4	4.5	33.2	89.2	99.0	70.3	240.4	591.9			1145.3

Source: Servicios Hidrológicos y Climatológico
Note: Estimated discharge by IECO.



GOVERNMENT OF REPUBLIC OF HONDURAS
MINISTRY OF NATUFAL RES
AGRICULTURAL DEVELOPMENT
IN THE CHOLUTECA RIVER
FIGURE-1 PRO
JAPAN INTERNATIONAL COO

ANNEX-I

TEAM MEMBERS

Advisory Committee, JICA:

Mr. J. Ishizaka
Mr. H. Kikkawa
Dr. S. Hirose
Mr. H. Kambe

Consultants (Nippon Koei Co., Ltd. Team):

Mr. I. Kuno	Team Leader
Mr. S. Nishioka	Geologist
Mr. K. Yonemori	Hydrologist
Mr. O. Takahashi	Civil Hydraulic Engr.
Mr. S. Nagatoshi	Irrigation Engr.
Mr. S. Ban	Irrigation Drainage
Mr. M. Shimamura	Soil-Agronomist
Mr. M. Kuramitsu	Agronomist
Mr. T. Murono	Agro-economist
Mr. H. Koizumi	Economist (Coordinator)

Counterparts of Ministry of Natural Resources:

Mr. H. E. Elvir	Director, Unidad de Recursos Hídricos
Mr. J. San Martín	Civil Engr.(Coordinator)
Mr. J. A. Alvarez	Civil Engr.
Mr. J. Lanza	Economist
Mr. F. Paz	Soil Engr.

ANNEX-II

WORK PERFORMED IN THE FIELD

1. Reconnaissance survey:
   - Lower Choluteca river basin
   - San Juan de Flores Valley and Talanga Valley
   - San Fernando - Zorrillo damsite area
   - Morolica damsite area and middle reaches of the Choluteca

2. Topographic survey:
   - Collection of existing topographic maps
   - Collection of available aerial photos, covering Lower Choluteca, San Juan de Flores Valley, San Fernando - Zorrillo damsite and reservoir area, Morolica damsite and reservoir area
   - Topographic survey at El Papalón and Las Bases weir sites (1/1,000)
   - Topographic survey at Morolica damsites (upstream site and downstream site) (1/1,000)

3. Meteo-Hydrological survey:
   - Meteorological data collection in Choluteca river basin, from MRN -Servicios Hidrológicos y Climatológicos, and Servicio Meteorológico Nacional
   - Discharge data collection (Servicios Hidrológicos y Climatológico)
   - Flood data collection, incl. hourly rainfall data and flood hydrograph
   - Preliminary run-off analysis at Hernando Lopez, Paso La Ceiba and Los Encuentros
   - Preliminary flood analysis at Hernando Lopez and Los Encuentros
   - Visit to meteorological stations at La Venta & Paso La Ceiba, and hydrological gauging stations at Hernando Lopez and Paso La Ceiba
   - Preliminary study on hurricane Fifi for estimation of probable maximum flood

4. Pedological survey:
   - Test pitting in the Choluteca plain (31 pits) and profile observation on texture, structure, color, compaction, existence of mottling and gravel, etc. to check the existing soil map
   - Test pitting in the San Juan de Flores Valley (5 pits) and profile observation
   - Soil analysis at MRN Soil Laboratory at El Picacho (51 samples)
   - Preliminary study on soils and soil classification

5. Soil (physical) survey:
   - Cylinder intake rate measurement in the Choluteca Plain (10 tests)
   - Cylinder intake rate measurement in San Juan de Flores Valley (2 tests)
   - Infiltration tests at diversion weir site (El Papalón and Las Bases) and at other 5 sites where drainage conditions are less favorable
   - Collection of available data on intake rate and infiltration conducted by sugar companies

     (Preparation was made for furrow intake rate tests on the right bank of the Choluteca, but it was impeded by heavy showers.)

6. Water quality analysis:
   - Analysis (pH and electric conductivity) of water taken from the Choluteca river and wells (27 samples in the Choluteca Plain and 6 samples in San Juan de Flores Valley)

7. Geological surface exploration:
   - Exploration at San Fernando damsite and Zorrillo damsite
   - Quarry site survey for San Fernando - Zorrillo damsites
   - Exploration at Morolica damsites
   - Exploration at El Papalón and Las Bases weir sites
   - Quarry site survey for the weir sites
   - Exploration for soil embankment materials for canals

8. Drilling: (on-going)
   - Drilling at El Papalón weir site
   - Drilling at Las Bases weir site
   - Drilling at San Fernando damsite
   - Drilling at Morolica damsites

9. Land use survey:
   - Collection of land use map prepared by Programa Catastro Nacional
   - Spot check survey in the field

10. Crop survey:
   - Inspection and data collection at Lujosa Experimental Station
   - Inspection of cane cultivation at ACHSA, ACENSA and ACANSA and study on sugar cane cultivation
   - Inspection of rice cultivation at Montecillo and Las Savilas
   - Interviews with MRN-Choluteca, coordinator for Melon, Watermelon and Cashunuts
   - Inspection of irrigated pasture cultivation
   - Preliminary study on farming cost, alternative cropping patterns, anticipated yields and land use

11. Agro-economic and economic survey:
   - Collection of cadastral map and land tenure
   - Collection of data on demography, education, agricultural census, national statistics, market prices, laws and regulations, etc.
   - Interviews with MRN/Choluteca (incl.PRODAI), INA (Tegucigalpa & Choluteca), BNF (Tegucigalpa & Choluteca), CONSUPLAN
   - Interviews with sugar factories (ACHSA, ACENSA & ACANSA), cotton processing (Cooperativa Agropecuaria Algodonera del Sur & Cotton seed oil Co.), slaughter houses (IGHSA & CARNILANDIA), rice mill
   - Farm interviews with 4-cooperatives, 20-cooperative members and 77 farmers in the Choluteca Plain
   - Farm interview with a representative of cooperative in San Juan de Flores Valley

- Collection of data and information on infrastructures in and around the Project area, incl. power supply (ENEE-Choluteca & San Lorenzo), port facilities at San Lorenzo (ENP), water supply in Choluteca (SANAA-Choluteca), road inventory (SECOPT-Choluteca)
- Price survey for agricultural machineries

12. Power survey:
    - Power data collection from ENEE
    - Preliminary study on growth of power demand and supply program
    - Preliminary study on power installation for each alternatives of the Choluteca project

13. Planning and Study:
    - Planning and preliminary study on irrigable area (Choluteca plain, San Juan de Flores Valley and other middle reach valleys)
    - Planning for diversion scheme and irrigation systems
    - Preliminary study on water requirement
    - Planning and preliminary study on overall basin development plan and alternative damsites (San Fernando-Zorrillo, Oropoli, Morolica)
    - Preliminary comparative study on alternative dam/reservoir schemes

ANNEX- III

PROGRAM FOR FURTHER WORK

1. Analysis of farm interview results:

The farm interview forms will be analysed, and family size, land holding size, production cost, stock farming situation, problems in farming, etc. will be extracted for typical groups of farms.

2. Analysis of cadastral and land use maps:

A study on the cadastral map and land use map will result in the distribution of land holdings and present land use and crop pattern.

3. Production cost and crop yield analysis:

The production costs of crops under with- and without irrigation conditions will be estimated for 1985 at the 1977 constant price level, on the basis of the production cost data . Introduction of new varieties will also be studied.

4. Determination of cropping pattern:

Some cropping patterns will be proposed, taking into account the soils, size of farm, marketability and beneficiality. They will be compiled in an average cropping calender under the with-irrigation condition. The cropping pattern in future under non-irrigated condition will also be projected on the basis of the present land use and expected demand.

5. Crop price projection:

Crop prices in 1985 at the 1977 constant price level will be

estimated on the basis of the historical prices in the domestic and international market.

6. Estimate of production value:

The gross and net production values under with- and without project condition will be estimated on the basis of the estimated crop yields, production costs, cropping pattern and crop prices. This study will result in the agricultural benefit of the Project and the farmers' capacity to pay.

7. Soil physical study:

Soil physical parameters such as the basic intake rate, field capacity, etc. will be determined for typical soils on the basis of the results of the field and laboratory tests. The results will be utilized for determination of irrigation method, recommendable furrow design and application efficiency of irrigation water.

8. Estimate of irrigation water requirement:

Consumptive use and effective rainfall will be estimated on the basis of the rainfall record and other meteorological data. The application and conveyance efficiencies will be estimated in the light of the physical condition of soils.

9. Preliminary design of irrigation facilities:

Irrigation network will be designed to cover the irrigable soils in the coastal plain (by gravity flow to the maximum extent). It will include the areas presently irrigated by lifted water from the river and by groundwater, as far as feasible. The design of irrigation network on the left bank of the Choluteca will be preliminary one, because large scale map is unavailable. (1/5,000 scale map will be prepared by MRN as set forth in the Terms of Reference.)

10. Hydrological analysis:

Design floods will be determined for the San Fernando dam and the Morolica dam with both the probable flood and probable maximum flood concepts on the basis of meteo-hydrological data. Flood reduction by reservoir will also be studied.

11. Water budget:

Water budget in the Choluteca river will be studied with the collected hydrological data, irrigation water requirement of existing and potential irrigation system and other water uses. The intended water budget will be limited to the surface water only. A groundwater survey in the coastal plain will be separately made by MRN with assistance from IBRD.
The water budget study will result in the estimate of water deficit which will have to be supplied by a reservoir.

12. Geological exploration:

The on-going test drilling and water pressure test will be completed by the end of October 1977. The results will be used for design of alternative dams. (Geological maps of the Morolica upstream and downstream damsites will be prepared on the basis of the topographic maps to be prepared this time.)

13. Power market:

Study will be made on the supply and demand balance of electric power on the basis of the collected data. The unit power value will be estimated, and the capacity factor of hydro-power will be investigated.

14. Preliminary design of San Fernando dam:

Preliminary design of the San Fernando dam will be prepared

on the basis of 1/1,000 map and geological exploration results. The design will include reservoir operation study to determine the reservoir storage capacity which will enable supply of irrigation water at an appropriate security. Feasibility of power generation will also be studied. Consequently, the optimum scale of dam and power station will be determined.

15. Preliminary design of Morolica dam:

On the basis of 1/1,000 map and geological survey, preliminary design will be prepared for several height of dam at the upper and lower alternative damsites. The reservoir operation study for each alternative case will result in the optimum scale of dam.

Study will also be made on the Morolica dam and reservoir schemes with power generation.

16. Economic analysis:

Economic analysis of the Project will be made on the basis of economic B/C ratio and IRR criteria. Priority between the San Fernando dam and the Morolica dam will be determined. A sensitivity analysis will be made for the selected alternative.

17. Implementation schedule:

Implementation schedule, including construction timetable, fund disbursement schedule, cost estimate and proposed organization for the construction and operation will be worked out.

18. Financial analysis:

Financial statements will be prepared both from the Project's viewpoint and from the farmers' viewpoint.

DRAFT OUTLINE OF FINAL REPORT

Summary of Conclusion and Recommendation

1. INTRODUCTION
   - 1.1 History of the Project
   - 1.2 Work performed
   - 1.3 General settings of the Project

2. BACKGROUND
   - 2.1 Economy of Honduras
   - 2.2 Agriculture in Honduras
   - 2.3 Policies for agricultural development
   - 2.4 Power development prospect

3. LAND AND WATER RESOURCES PLAN IN CHOLUTECA RIVER BASIN
   - 3.1 General situation
   - 3.2 Agricultural development possibilities
   - 3.3 Water resources
   - 3.4 Rationale of the Project

4. THE PROJECT AREA
   - 4.1 Physiography
   - 4.2 Meteorology
   - 4.3 Hydrology
   - 4.4 Soils
   - 4.5 Present land use and agricultural situation
   - 4.6 Infrastructures

5. PROJECT DESCRIPTION
   - 5.1 Objectives of the Project
   - 5.2 Proposed irrigation development
   - 5.3 Proposed land use
   - 5.4 Proposed dam and power station
   - 5.5 Prospective agricultural production

6. COST ESTIMATE
   - 6.1 Basic costs
   - 6.2 Investment cost
   - 6.3 Operation and maintenance cost

7. IMPLEMENTATION SCHEDULE

- 7.1 Construction schedule
- 7.2 Fund disbursement schedule
- 7.3 Input requirement
- 7.4 Phasing of implementation

8. ORGANIZATION AND MANAGEMENT

- 8.1 Related organizations
- 8.2 Proposed organization for construction
- 8.3 Proposed organization for operation and maintenance
- 8.4 Proposal for research and extension services

9. ECONOMIC ANALYSIS

- 9.1 Benefits (Direct and Indirect).
- 9.2 Costs
- 9.3 Internal rate of return
- 9.4 Sensitivity test

10. FINANCIAL ANALYSIS

- 10.1 Farmers' capacity-to-pay
- 10.2 Financial rate of return
- 10.3 Water charge, credits and subsidies
- 10.4 Cost allocation
- 10.5 Financial statement

11. PROPOSED WORK FOR DETAILED DESIGN

ANNEXES

ANNEX- IV

LIST OF DATA AND REPORTS OBTAINED

Maps

1. Topographic maps
   - scale 1/250,000, IGN (blue print)
   - scale 1/50,000, IGN (all Choluteca basin)
   - scale 1/5,000 IECO (Choluteca, S.J.Flores & San Fernando)
   - scale 1/1,000 IECO (San Fernando, Zorrillo & El Papalón)

2. Aerial photographs, IGN (1/20,000)
   - Choluteca plain
   - San Juan de Flores Valley
   - San Fernando reservoir area (partial)
   - Morolica damsite & reservoir area

3. Cadastral map (1/10,000), covering Choluteca Dept., Programa Catastro Nacional (PCN)

4. Land use map (1/20,000), covering Choluteca Dept., PCN

5. Vegetation map (1/250,000), South Region, PCN

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