iii) The dumping of earth and muck in the river and in the storage reservoir should be avoided as much as possible, and special attention should be paid to the levelling of spoil banks on slopes and their protection by means of sodding and other methods.

3.6.3. Influence on the Biological Environment

(1) Ground life

The ground life is broadly classified into green vegetation, which is the original producer of the food chain, and the fauna which uses it as food.

The influence upon the green vegetation, i.e., inundated flora is caused by the appearance of the dam and the topographical changes due to the construction of the powerplant and transmission line. These factors are restricted in very limited areas, and in general they have effects of minor importance. However, as a result of the construction of roads for transportation of materials and equipment for construction in mountainous areas, tall trees in the secondary forests and evergreen areas retrocede, bringing as a consequence the appearance of buffer vegetation bands composed of low trees, shrubs and grass. Especially in natural forests it is possible for formation of a new flora to occur, in response to new ecological conditions determined by factors such as mixing, sunlight, humidity, etc.

Lumbering is authorized in the project area, and the effects of this lumbering seem to be more important than the direct effects caused by the construction of roads. Thus, special attention should be paid to the relationship between the lumbering and the flora.

As for the fauna, influences are naturally expected to

occur, in view of the effects upon flora which works as a source of food for the fauna. The noise, vibration and presence of workers during the construction work will naturally have influence upon the fauna, but these factors are restricted to the construction period only. In addition, since the animals can move to areas not affected by these factors, their influence is only temporary on a long term basis, and can be considered negligible from a global point of view.

(2) Aquatic life

The influence upon aquatic life forms is caused by the changes in the quantity, quality and level of water during the construction work and after completion of the dam.

1) Effect of changes in water quality

Changes in water quality are caused by the flow-out of silt during the construction work, flow-out of filthy water coming from the quarters of the workers and nutritional enrichment of the water due to the appearance of the storage reservoir.

a) During the construction work

The flow-out of silt during the construction work temporarily has an important influence on life at the bottom of the river downstream of the dam construction site, and on a long term basis it has influence upon the environment in general of aquatic life. If silt flows into the river during the dry season, when the quantity of water flowing in the river is small, the dilution of silt will be poor, and as a consequence the highly concentrated silt will have a considerable influence upon the basin. During

the rainy season, when the quantity of water flowing in the river is large, the silt dilution effect will be pronounced, and the recovery will be rapid even in case of any influence.

b) After completion of the construction work
The water quality of the storage reservoir is determined by the water balance and the quantity of waste matter dumped therein.

The factors related to the water balance are those listed below:

(1) Renewing process of water stored in the reservoir.

(2) Percentage of precipitation falling on the reservoir surface compared with the total inflow water into the reservoir.

(3) Percentage of underground water fed to the reservoir compared with the total inflow water into the reservoir.

(4) Percentage of trans-evaporation with regard to total flow of water.

The waste matters are those listed below:

(1) Home waste water
(2) Agricultural waste water
(3) Fertilizers in excess
(4) Agricultural insecticides.

The water balance of the dam lake of this project is of the type where water is accumulated during

the rainy season in order to attain the balance of flow throughout the year, with an almost uniform water consumption. For an annual inflow quantity of water of one billion m^3, the annual consumption is 100%, and renewing of the stored water occurs during the annual cycle. During the construction work a sudden temporary increase of filthy water coming from the quarters of the construction workers is anticipated. However, after completion of work, no fundamental changes are expected to occur unless in case of sudden increases in population, in cultivated area or changes in the farming system. Consequently, the effects of the present project are expected to be of minor importance.

If filthy water processing facilities are used instead of leaving the waste water generated by the workers quarters to flow directly into the river, and if the remnant of trees and other living things and muck is adequately handled in the reservoir area, the generation of algae and the effects on aquatic insects can be restricted, minimizing as a consequence the influence upon fish.

2) Effects of the change of water quantity and water level.

The changes of water quantity and water level are different depending upon the place. Thus, it is necessary to carry out study dividing the project area into the part located upstream of the dam, the part between the dam and the power plant, and the part located downstream of the power plant.

At the upstream area the flowing water of the river becomes still, and in addition the area suited for

proliferation of aquatic life is suddenly increased. Consequently, the storage reservoir is converted from a flowing water ecological medium to a static water ecological medium. In addition, there is possibility of change of the storage reservoir water level from HWL 648m to LWL 620m, i.e., 28m throughout the year. As a consequence of this change, the living environment of shore algae and aquatic insects which used to live on the shallows will become very unstable. However, as a consequence of the expansion of the static water ecological medium the types of fish suited to static water areas may be increased.

Since the section of the river located between the dam and the power plant, with an extension of approximately 15km, is fed with water exclusively by the small tributaries located therein, the life is expected to show considerable change. In addition, after the construction of the dam, migration of fish along the river becomes difficult, and the ecology will suffer an intersection at this point. Downstream of the power plant, the water level will suffer daily changes based upon the peak operation of the power plant, and that change will be pronounced especially in the dry season.

A daily water level change of the order of 0.5m is expected to occur in the neighbourhood of the outlet, but it will be dispersed along the river with increase in distance in the downstream direction. In addition, as a consequence of the confluence with the Dumatalto River and other tributaries, the changes in water level will be further reduced. On the other hand, since in the neighbourhood of Aglipay and areas located further downstream there is no agricultural facility taking water directly from the river and it is expected that no trouble of importance will occur.

The living environment of the aquatic life at the banks and on the bottom of the river becomes unstable, but in view of the fact that there life are coping with the situation during increases of water level, flood, etc., occurring during the rainy season, the effects of the changes in water level and quantity are supposed to be of minor importance.

Actually in this area the fishing activity is negligible, and the actual effects on the fishery can be considered insignificant. Rather, there is a possibility to contribute to the supply of fish protein and to the promotion of local fishery by utilizing the results attained at neighbouring fish farms and the plan for breeding of fry at the Bureau of Fishery (Region II) in the lake which will appear in the future.

3.6.4. Effects on the Social Environment

(1) Effects on the composition of villages

As a consequence of the storage reservoir, the land and residences located up to the HWL 648m (slightly above that level, depending upon the effect of waves caused by the wind) in the neighbourhood of Kasibu will be submerged. The inhabitants of the submerged areas will be forced to move losing their arable land and homes. As a result of moving the inhabitants of the Kasibu village and other submerged areas, the composition of the villages they move to and the composition of the villages of the remaining inhabitants will change. That is an important change, in view of the fact that the inhabitants of this region do not belong to the same tribe, have different traditions, customs, languages, religions, life styles, education, etc., but instead, compose a conglomerate of various tribes. Thus, careful studies and considerations

are required with regard to the problems of migration and formation of new communities. Especially, the moving of communities, which means the mutual relationship between each individual, is expected to suffer an important influence.

Even during the construction work, problems of noise, dust and safety are expected to occur, due to the transportation of construction materials. In addition, living waste water, night soil, etc., will be generated in large quantities from the quarters of the construction workers, and if they are left without solution, the self-cleaning capacity of the river will be surpassed and contagious diseases can be expected in the worst case.

In addition to the facts mentioned above, the presence of a large number of construction workers in the project area will have an effect upon the interests and way of living of the local population, and the occurrence of changes in profession and means of living are evident in historical cases.

It is very important to have a general view of these global social effects.

(2) Effects on activities of the villages

1) Agriculture

The most important influence from the point of view of agriculture is the inundation of the fields which are presently cultivated. The arable land inundated will be the flat areas located close to the river. These areas are very rich because they receive the

nutritive elements carried by the water from the mountainous areas during the rainy season, and the utilization of the water of the river makes possible two annual rice crops resulting in a considerably higher productivity compared with the fields located in the hilly districts. Inundation of such areas due to the construction of the storage reservoir will mean the loss of living base of the local population, and this implies social effects of considerable importance. These losses should be covered by means of an adequate migration plan and means to stabilize the life of the population.

As a result of the presence of large numbers of construction workers during the construction work, there is the possibility of a shortage of agricultural products and general consumption goods, resulting in temporary inflation, in addition to the reduction of the working will of the farmers due to the large cash income obtained as a result of temporary jobs at the construction site.

It is also necessary to take into consideration the possibility of effects caused by the outflow of silt into the fields located downstream of the dam construction site if adequate countermeasures are not taken.

2) Fishery

After construction of the dam, the migration of fish which conventionally occurs will become difficult. On the other hand, the appearance of a large lake will contribute to an increase in the production of fish if fish farming is carried out in the new lake. Naturally, the changes in type of fish and the changes

in the condition of the river will require some modifications in fishing methods, but generally speaking, positive effects can be expected in fishery.

3) Forestry

It is assumed that the effects on forestry will be negligible, except in the case of sudden changes in the flora. Actually, planned reforestation and seeding are under way, under the responsibility of the B.F.D. (Bureau of Forest Development) and lumbering companies, and this project is not expected to have significant influence upon forestry. Rather, the construction and arrangement of roads intended for dam construction purposes are expected to have a positive effect in view of their utilization for forestry purposes also.

4) Economic activities

Presently between Kasibu and Bambang there is only a narrow local road, and the communication in areas located upstream of Kasibu depend upon a primitive woodland paths and logging tracks, and the transportation capacity has suffered drastic reduction during the rain season.

As a consequence of the appearance of the construction roads, the project area will be directly connected to Route 5 from both the East and West sides, through the Bambang -- Kasibu -- Siguem -- Dam -- Powerhouse -- Dibibie -- Cordon route.

Conventionally, the agricultural products of this area used to be marketed only at Bambang, but after opening of the new roads, it will be possible to send

them to large markers such as Cordon, Santiago, etc., being expected the diversification and activation of the economy.

The following conclusions can be made from the considerations above. As for production activities of the villages, the arable land, which is the base for production, will be lost as a consequence of the inundation, resulting in considerable effect. However, the continuity of the production base can be ensured if adequate countermeasures such as migration to substitute arable areas are taken. As for the transportation of agricultural products and consumption goods, improvement in roads will result in diversification and more activity, contributing to better living conditions.

On the other hand, factors such as the presence of large numbers of construction workers during the construction work will contribute to increases in commercial facilities, inflation, large cash incomes due to indemnifications, etc., lack of familiarity with the new living conditions after migration, etc., will cause many problems in the economic and social aspects of life of the mountainous area farmers.

However, these problems can be resolved by taking measures to prevent fundamental modifications in the way of life and standards of the population compared with their status before construction of the dam, and measures intended to allow further improvements in the future.

5) Other activities

As a result of large scale construction activities lasting for a long period, the local population will have frequent opportunity for contact with the construction workers. This will contribute to improvements in the life of the village inhabitants through employment chances and learning of technical skills.

On the other hand, the facilities for communication, transportation, marketing of daily necessities, education, medical services, recreation, etc., constructed for dam project purposes will be very useful also for village inhabitants.

In addition, the demand for large quantities of food will be related to the local purchase of locally produced agricultural products, and will contribute to the economy of the local villages. The effort actually required to transport agricultural products to distant markets can be considerably reduced, making it possible to dedicate more time to production activities.

(3) Effects on utilization of water

With regard to the utilization of the river water, the fluctuations in water level will have the most significant effect. Thus, the problem must be studied by dividing the project area into the part located upstream of the dam, where variations will occur on an annual scale, and the part located downstream of the power plant, where water level variations will occur on a daily scale.

The maximum annual fluctuation of water level in the

storage reservoir located upstream of the dam will be 28m between HWL and LWL. Actually there are very few cases of direct utilization of the waters of the Diduyon River, and consequently, no trouble is expected with regard to the irrigation of fields. In addition, since water for daily life, such as for washing of tableware and clothes can be continued, by taking water from mountain streams, so the effect will be of minor importance.

The daily fluctuation of water level in areas located downstream of the power plant are expected to cause no trouble in the daily life of the population, because there are no cases of direct use of the river water. Flood will be controlled by the Diduyon storage reservoir, resulting in a constant discharge throughout the year. However, there is concern about the possibility of trouble in facilities located downstream, due to peak operation of the power plant. Downstream of the power plant the Diduyon River joins the Dumatalto River which has a considerable riverflow, and as a result, the fluctuation of water level will be considerably attenuated. In addition, since there are very few water utilization facilities taking water directly from the river located downstream of the Addalam River, the effects of the water level fluctuation will be negligible. However, at places located immediately downstream of the power plant, where the effect of the peak discharge is very pronounced, any person fishing, excavating gravel, swimming, grazing water buffalo and pigs, etc., will face the risk of being carried away by the water. However, with regard to this aspect, the problem can be solved by making adequate modifications in the power plant operation method, installing alarms to notify the start of discharge of water of the power plant, the start of discharge from the dam spillway gates, etc.

(4) Other remarkable problems related to the area

In the inundated areas and in the areas related to the construction work there are no cultural assets of importance. Thus, the project does not have any effect with regard to this aspect. During the present survey we obtained information about the existence of mineral resources in part of the inundation area. However, since this information cannot determine precisely the location of any mine in the neighbourhood of Malabing Village, it is not possible to come to a correct judgement on the influence of the present project. In addition to the location of the mine and its economic importance, it is necessary to make detailed studies on the possibility of inflow of poisonous minerals into the storage reservoir, because it may result in serious problems.

Besides those mentioned above, there are no other articles which might cause problems.

(5) Aesthenic aspect

This problem will be studied by dividing it into aspects occurring during the construction work and those occurring after completion.

During the construction work the excavation of overburden soil, rock, sand and gravel, the excavation for construction of structural components of the project, the cuttings for construction of roads, etc., will cause exposure of the ground, turbidity of rivers, and other negative aspects caused by the temporary facilities and construction of facilities. However, after the completion of the construction work, it is possible to restore nature by removing the temporary facilities, carrying out reforestation, etc., in order to integrate the constructed facilities into the natural view.

After completion of the construction work, many artificial structures will appear, creating considerable modification in the natural view. At first, a concrete dam more than 100m in height and a storage reservoir with an area of 27km^2 will appear. The dam is composed of a huge, gray concrete block constructed in the natural view, in addition to steel structures like gates, etc. Thus, in addition to a simple engineering function, the dam itself has the possibility of becoming an element offering a magnificient view within nature, by creating a design taking into consideration aspects such as the structure, form, color (coating), etc.

Another element as important as the dam itself is the storage reservoir, but the reservoir itself can offer a view similar to a natural lake. However, the water level of the reservoir is subject to annual fluctuations reaching a maximum value of 28m (occurring once or twice in periods of 10 years, in drought periods). In the water level fluctuation areas located on the shores of the lake the vegetation will die and the ground will be exposed. Special attention should be paid to the removal of trees and residual materials resulting from the construction work in order to prevent negative influences on the view.

Roads, bridges, transmission lines, etc., will be constructed in relation to the implementation of the project. However, since these elements are linear structures and not of large scale in most cases, their influence can be minimized by restoring the topographical changes caused by their construction. A brief discussion of the effects of the items listed in Table 3-6-2 are presented above. There are items with considerable effect and others with negligible effect, influences of permanent character and others of short duration, composing a wide variety, and some problems with eacy

solution are also included. In the next paragraph will be described methods to minimize these effects, referring to items of major importance.

3.6.5. Environmental Protection Measures

(1) Items of the counter measures

Problems will be analyzed by division into those occurring during the construction and those occurring after the completion of the project.

1) Problems occurring during the construction

a) Flow-out of silt caused by the excavation of soil, sand, gravel and rock, excavation and washing of aggregate, and concrete placing.

b) Possibility of occurrence of contagious diseases due to the presence of large numbers of people from outside areas, including the construction workers, and concentrated dwelling in quarters.

c) Occurrence of local inflation due to a temporary increase in the population.

2) Problems occurring after completion of the project

a) Effects of the daily fluctuation of water level on the flora, fauna and lives of human beings.

b) Similar effects due to annual fluctuation of the water level.

c) Restoration of the construction site.

3) Inundation and resettlement

4) Problems caused anew by the increasing possibility of development, with this project acting as the trigger

Among the problems mentioned above, 4) is excluded from discussion because it is very complicated and has wide ranging implications. Problem 3) will be discussed separately because it is a very important item.

(2) Measures to be taken during the construction work

1) Measures to prevent the flow-out of silt

Large quantities of silt and cement milk will be generated by the dam construction work, quarry and aggregate plant, concrete plant and so forth, and if left untouched, the ecology of the river will suffer serious influences, as described before. Thus, it is necessary to take the following measures to prevent the flow-out of silt.

a) In case of excavating deposited materials from the riverbed and in case of making modifications in the configuration of the river, it is necessary to shift the flow of the river or construct temporary coffer dams to avoid execution of excavations in the flowing water.

b) As for the waste water and turbid water-like silt generated by washing aggregate in aggregate plant and concrete plant, and cement milk resulting from concrete placing, those which could have effects downstream should be treated by constructing

turbid water treatment plants in order to avoid their direct flowing into the river (Refer to Figure 3-6-1).

2) Sanitary problems

As for the sanitary aspects, importance should be attributed to preventive measures, instead of countermeasures after the occurrence of disease. Thus, it is necessary to pay the utmost attention to preventive measures referring to human beings, sources of occurrence and medical systems.

a) Medical inspection and vaccination against contagious diseases should be carried out when recruiting personnel for the construction work and related services.

b) Natural and artificial puddles should be eliminated as much as possible, and extermination of carriers of pathogenes should be attempted as much as possible by means of disinfection, etc.

c) A large scale sewerage facility will be required because a large number of workers will be present for the construction work. This facility should be effectively planned, taking into consideration the residences of the personnel at the power station and their families, and the resettlement welfare facilities.

d) An adequate monitoring system will be required, and an emergency countermeasure system comprising early discovery of contagious diseases by means of periodic medical examination, isolation of the

patients, disinfection, etc., will be required. Medical and sanitation facilities intended to maintain such a system in working condition will also be required.

3) Measures to cope with inflation

A large number of outsiders will be present in the project area for the construction work, resulting in a considerable increase in food demand. On the other hand, there is a possibility of temporary shortages of goods and increase in prices due to the reduction of the arable land caused by inundation. The following measures will be required in order to cope with such a situation.

a) The necessary consumption goods should be supplied to the project area in a planned way, in order to minimize influences upon local small-scale shops.

b) Purchase of goods from a wider market should be planned utilizing the roads constructed for the project, with special considerations to prevent the occurrence of shortages of goods and increases in prices.

c) If possible, arable land should be prepared prior to execution of the resettlement plan, in order to make possible the supply of agricultural products from such arable lands. This solution, if realized, would bring the most effective results.

(3) *After completion of the project*

1) The effects of daily fluctuation of water level on

the flora, fauna and life of human beings, and the effects of water level fluctuation are restricted to areas located upstream of the confluence with the main stream because the flow of the main stream of the Cagayan River is 4 times larger than this river. Consequently, countermeasures will also be restricted to the same area.

There is an intimate relation between the daily life of the population and the river. Activities such as crossing of the river, fishing, washing, cleaning, grazing, etc., are carried out by or in the river in most cases. If these activities coincide with the arrival time of discharge from the power plant, accidents may occur. Thus, it is necessary to provide an announcement system to notify people of any increase in water level due to discharge of water from the power station.

In general, an alarm system should be planned as shown in the table below, according to the state of utilization of the various sections of the river.

Alarm systems according to state of utilization of river.

	State of utilization of river	Alarm system
1.	Easily accessible places, used very often for fishing, washing, etc.	Combination of siren, loudspeakers, publicity cars and monitors.
2.	Places which are not easily accessible, but used occasionally for fishing and in case of work.	Combination of siren and loudspeakers.
3.	Places which are practically inaccessible according to common social sense.	Siren

2) Effects of annual water level fluctuation on the fauna, flora and human life

The storage reservoir is operated in accordance with the annual operation plan and the reservoir water level changes from HWL 648m to LWL 620m throughout the year, with a maximum variation of 28m. In view of the characteristics of the power plant, the reservoir is kept as close as possible to the high water level in order to operate the power plant at high efficiency. Thus, under normal situations, the storage reservoir water level is kept within several meters below H.W.L. However, in drought years (occurring once or twice every 10 years according to the existing hydrological data presently available) the stored water is totally used by reducing the water level of the reservoir close to L.W.L. Thus, in extreme drought years, the lake shore will possibly be exposed down to the low water level.

If dry trees and residual materials used in the construction of the dam are left when the lake shore is exposed, they will have not only a negative effect on the view, but will create problems from the sanitary point of view due to the decomposition of trees, shrubs, etc. These trees and residual materials should be removed as much as possible and should be dumped to adequate places during and after the construction.

In addition, in view of the topographical characteristics and elevation of the inundation area, it is possible for places to occur of relatively reduced depth of water at the fringe parts of the reservoir contained between H.W.L. and L.W.L.
Depending on the state of the detained water and the meteorologic conditions, deterioration of water quality,

generation of algae, occurrence of disease, etc., will be possible. Especially when living quarters are located close to such areas, serious sanitation problems may occur.

Since the storage reservoir is of considerable scale, the wind fetch becomes long on the reservoir surface, and waves of considerable height are expected to occur. Thus, houses, arable land, roads, etc., should be protected against the wave with an adequate margin above H.W.L.

At the projected drawdown of storage reservoir the vegetation, growing between H.W.L. and L.W.L. will die, and the protection and covering effect of the slope will be reduced. In the storage reservoir, water level reduction speed is low in view of the relation between storage capacity and quantity of water used for power generation and consequently the risk of occurrence of landslides is reduced. However, impoverishment of ground covering conditions due to the death of trees and vegetation on the slopes of parts corresponding to the utilization depth will occur as mentioned previously. Thus, adequate countermeasures will be required at places which show risk of landslide, slope errosion, etc., in view of the topographical and geological characteristics of the sites.

The problems mentioned above require further detailed study by means of topographical and geological survey as well as assessment of future effects. Concrete measures should be taken in future. However, as a whole, it is expected that these problems will not become serious obstacles to the present project.

(3) Restoration of the construction site

In this project many structures such as the storage reservoir dam, waterways, surgetank, penstock, powerhouse transmission lines, etc., will be constructed over a wide area, and their construction will require large scale work. As a result, considerable modification will necessarily occur to the landface. Restoration will have a decisive influence upon the view and other characteristics of the area, therefore. Thus, a construction site restoration plan (Table 3-6-3) should be prepared corresponding to each item of the main work sites and structures, and the actual construction plan, design and execution of work should be carried out in accordance with the said restoration plan.

As a result of the discussion presented above, referring to the effects of the project on the environment and the measures intended to minimize such effects, it is concluded that there is no decisively negative elements which stand in the way of the project itself. However, it is necessary to state clearly that this is a conclusion conditional on the execution of the countermeasures mentioned above.

Many of the items above were discussed only qualitatively, but in future stages it will be necessary to carry out further detailed quantitative discussions in order to develop a better definition of the problems.

Table 3-6-1 Environmental Factors and Their Importance Grades

In Diduyon Dam Project

Environmental Factor	Importance Grade	
	Damsite & Upstream	Downstream
1. Physical Factor		
1.1. Atmosphere		
a) Temperature	C	
b) Rainfall	C	
c) Wind		
d) Humidity	C	
e) Sunshine		
f) Contamination		C
g) Noise, Vibration	A	
1.2. Hydrology		
a) Water Quality	A	A
b) Water Temperature	A	B
c) Water Discharge and Water Level	A	A
d) Water Velocity	C	B
e) Underground Water	B	
f) Flood	C	C
g) Sediment Transport and Deposit	B	B
1.3. Topography		
a) Cave-in and Land Sliding	A	
b) Erosion	A	B
2. Biological Factor		
2.1. Land Plants and Animals		
a) Natural Forest	A	
b) Man-made Forest	B	
c) Grass Lands	C	
d) Agricultural Products	B	B
e) Birds	B	
f) Wild Animals	B	
g) Insects	B	
h) Soil Animals	B	
i) Valuable Species	Unknown	
2.2. Aquatic Plants and Animals		
a) Micro-organisms	C	
b) Aquatic Plants	C	
c) Fishes	A	
d) Animals Living on the Bottom	C	
e) Valuable Species	Unknown	

Environmental Factor	Importance Grade	
	Damsite & Upstream	Downstream
3. Social Factors		
3.1. Human Life and Culture		
a) Health	A	A
b) Safety	B	B
c) Amenity	C	
d) Convenience	B	
e) Mode of Life	A	
f) Recreation		B
3.2. Production in Village		
a) Agriculture	A	A
b) Stock-breeding	C	
c) Fishery	B	B
d) Forestry	C	
e) Industry		
f) Commerce	C	C
g) Service		
3.3. Water System		
a) City Water	B	
b) Sewage	B	
c) Sanitary Facilities	A	
d) Transportation by Water	A	
e) Water Supply System	B	
3.4. Natural Conservation		
a) Natural Parks		
b) Disaster Prevention Forest	B	
c) Historical Places and Scenic Spots		
d) Valuable Natural Monuments, Flora & Fauna	Unknown	
e) Academically Valuable Species		
3.5. Aesthetic Aspects		
a) General View of River Course	A	B
b) Animals and Plants		
c) Transparency of Water	B	C
d) Colour of Structures & Landscape	B	
e) Components of Structures & Landscape	A	

Legend :

A - Very Important, B - Important, C - Slightly Important

Table 3-6-2 (1) Relation Between Project and Environment Factors

Environment Factor			During Construction				
			Gathering Soil & Materials	Materials Trans-portation	Concrete Placing	Inflow Laborforces	Dwelling Quaters
Physical Factor	Atomosphere	Noise	(A) (Sh) Δ	(R) (Sh)			
	Hydrogy	Water Quality	(D) (Sh) Δ (Dn)		(D) (Sh) o		
		Water Temperature					
		Water Discharge & Water Level			(Dn) (Sh)		
	Topography	Cave-in & Land Sliding					
		Erosion					
Biological Factor	Land Plants & Animals	Natural Forest	(T) (Sh) Δ		(D) (Sh) o (Dn)		
	Aquatic Plants & Animals	Fishes	(D) (Sh) Δ		(D) (Sh) (Dn)		
Social Factor	Living in Village	Health	(D) (Sh) Δ	(R) (Sh)	(D) (Sh) (Up)	(A) (Sh) o	(A) (Sh) o
		Mode of Life				(A) (L)	(A) (L)
	Production in Village	Agriculture	(D) (Sh) Δ (Dn)		(D) (Sh) (Dn)	(A) (L)	(A) (Sh) o
	Water System	Treatment Facilities				(A) (L) o	(A) (L) o
	Transportation	Road Traffic & Navigation		(R) (Sh)			
	Aesthetic Environment	Scenery at Waterside	(D) (Sh) Δ (Dn)				
		Components of Structures & Landscape			(D) (Sh)		

Evaluation of Influences

Area of Influence	Duration of Influence	Assesment of Influence
(A) : Whole Area	(L) : Long Time	o : Big
(D) : Damsite	(S) : Short Time	Δ : Slight
(Up) : Upstream of Dam		
(Dn) : Downstream of Dam		
(R) : Road		
(P) : Partially		

Table 3-6-2 (2) Relation Between Project and Environment Factors (Continuation)

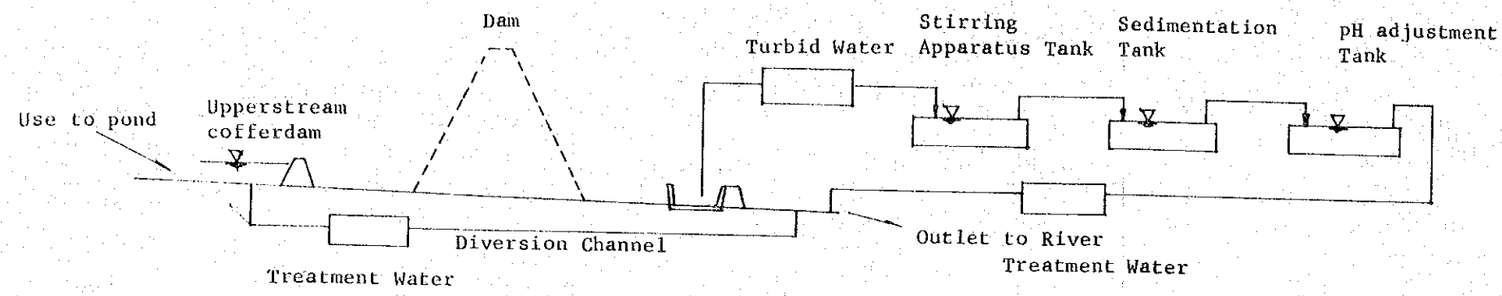
Environment Factor			After Completion of Project									
			Operation Power Plants			Appearance of Artificiality				Others		
			Electric Generation	Erosion & Water Control	Water Use	Reservoir & Service House	Reservoir Lake	Road & Bridges	Trans-mission Line	Cleaning away of Job Sites	Tourism Development	Resettle-ment Area
Physical Factor	Atomosphere	Noise							Ⓟ Ⓛ			
	Hydrogy	Water Quality			Ⓐ Ⓛ		Ⓤp Ⓛ o					
		Water Temperature					Ⓤp Ⓛ					
		Water Dis-charge & Water Level	Ⓟn Ⓛ o			Ⓟn Ⓛ	Ⓤp Ⓛ					
	Topography	Cave-in & Land Sliding					Ⓤp Ⓛ o	Ⓡ Ⓛ		Ⓟ Ⓛ o		Ⓤp Ⓛ
		Erosion	Ⓟn Ⓛ	Ⓤp Ⓛ			Ⓤp Ⓛ o					
Biological Factor	Land Plants & Animals	Natural Forest					Ⓤp Ⓛ o	Ⓡ Ⓛ	Ⓟ Ⓛ	Ⓓ Ⓛ		
	Aquatic Plants & Animals	Fishes			Ⓟr Ⓛ	Ⓤp Ⓛ	Ⓤp Ⓛ o					
Social Factor	Living in Village	Health	Ⓓn Ⓛ o					Ⓐ Ⓛ		Ⓓ Ⓛ		
		Mode of Life					Ⓤp Ⓛ o	Ⓐ Ⓛ				
	Production in Village	Agriculture					Ⓓ Ⓤp Ⓛ o	Ⓐ Ⓛ			Ⓤp Ⓛ	
	Water System	Treatment Facilities					Ⓤp Ⓛ					
	Trans-portation	Road Traffic & Navigation					Ⓓ Ⓤp Ⓛ	Ⓐ Ⓛ o				
	Aesthetic Environment	Scenery at Waterside				Ⓓ Ⓛ	Ⓓ Ⓤp Ⓛ	Ⓡ Ⓛ	Ⓟ Ⓛ	Ⓓ Ⓛ		
		Components of Structures & Landscape				Ⓓ Ⓛ o	Ⓓ Ⓤp Ⓛ	Ⓡ Ⓛ	Ⓟ Ⓛ			

Table 3-6-3 Recovering Measures of Diduyon Project Job Sites

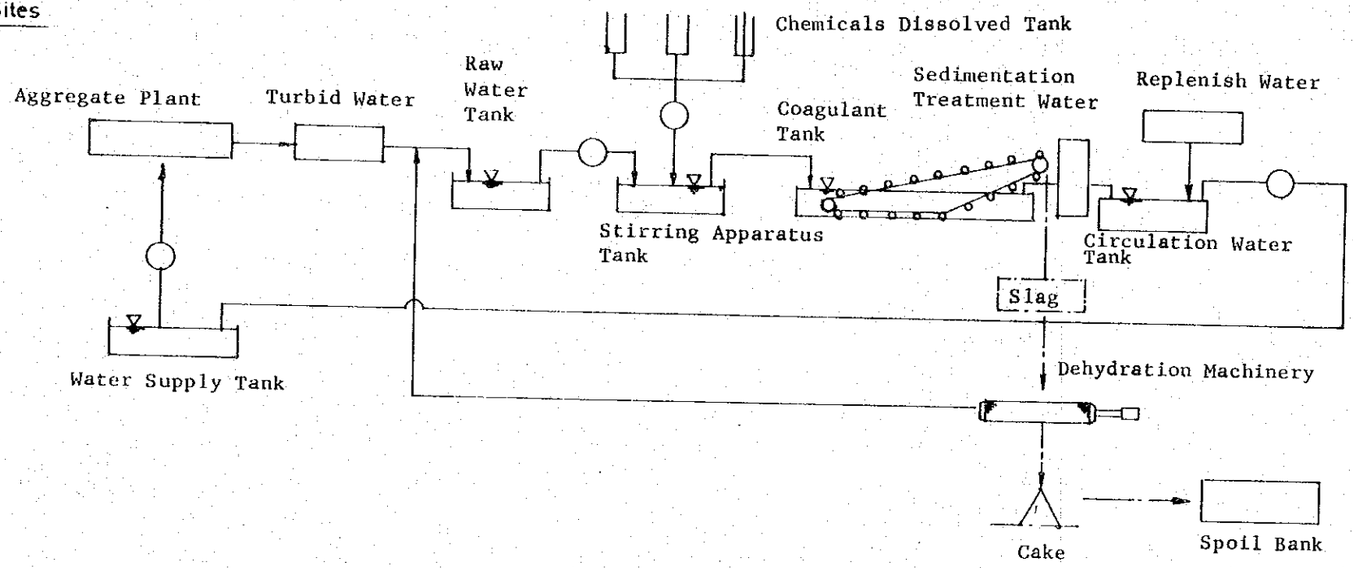
Structure	Actual Ground Condition	Treatment and Measures
1. Dam Structure		
1.1. Both Banks of Dam	Exposed naked ground/rock accompanying fall of rocks.	Advance treatment of detached rocks. Provision of safety net against falling stone. Surface covering with sodding and Seed spraying.
1.2. Quarry	Exposed rocks in terraced condition (If aggregates are available in the reservoir, the exposure will have little problem.)	Advance treatment of detached rocks. Provision of safety net against falling stone. Surface cover with sodding and seed spraying.
1.3. Aggregate Site	Remaining cofferdam, excavated pits and remaining aggregates.	Removal of cofferdam. Levelling of remaining aggregates.
2. Powerhouse		
2.1. Open-type Powerhouse	Exposed rocks around powerhouse site.	Green planting and slope protection.
2.2. Underground Powerhouse	Mucks, left in disorder on the ground.	Slope protection. Levelling of mucks. If necessary, seed spraying, sodding/spray spreading.
3. Headrace Tunnel	Spoil banks at valley Portions, with rugged fragments of rock materials of high percentabe voids.	- ditto -
4. Construction Roads	Naked ground surface, especially at the steep slope of roads.	Sodding of exposed ground surfaces. Slope protection and appropriate cutting arrangement of cut slopes. If necessary, execution of drainage.
5. Temporary Facilities, Temporary Lodges	Jobsites and dwelling sites, left in disorder.	Clearing of site and covering with sod & lawn. Provision of recreation facilities for plant employees and residents, if required.

Flowsheet of Turbid Water Treatment at Damsite and Quarry Sites

Damsite



Quarry Sites



Diduyon Hydroelectric Project Upper Cagayan River Republic of the Philippines
Japan International Cooperation Agency
Flowsheet of Turbid Water Treatment at Damsite and Quarry Sites
October 1980 | Fig. 3-6-1

3.7. Resettlement Plan

3.7.1. Basic Policy

Conventionally, the worldwide tendency for indemnification of local inhabitants in case of public projects such as dams, used to be monetary indemnification based upon the direct conversion at the market price. This caused dissatisfaction in the population in many cases. Consequently, the most recent tendency is the comprehensive considerations by "arranging the living environment, economic base, etc., so as to stabilize the life and improve the welfare of the affected population". The same new policy is expected to prevail also in the Philippines, and instead of simple monetary indemnification, global countermeasures including indemnification in kind, providing a new economic and living base taking into consideration the development of the local area will be required.

In the present project the basic policy of the indemnification program will be set up as follows:

(i) Indemnification will be done by means of assets as much as possible equivalent to that lost.

(ii) The project will be prepared in such way as to bring merits to the surrounding area of the project, and to improve the possibility of area development.

(iii) Efforts will be made to promote and obtain the comprehension of the local population regarding this development project, and the indemnification plan will be prepared taking into consideration the opinion and the will of the population, and with their understanding and agreement. For such purpose, it will be necessary to carefully study the characteristics of the population, and to prepare a really convincing plan.

(iv) The development of resettlement plan should be carried out, as far as possible at a pace in accordance with the labor force, technical skill and economic capacity of the local population.

The resettlement plan refers not only to planning of the new substitute land, but comprises also the reconstruction of the area used before, and should take into consideration countermeasures for both environmental and social problems.

Generally speaking, the problems with the new substitute land are those mentioned below.

(i) The development of substitute land is intimately related to destruction of the forest.

(ii) In case of collective migration, there is a risk of occurrence of serious sanitation problems.

(iii) There is a risk of the occurrence of trouble due to the differences in customs of the newly resettled people and the people already living in the region surrounding of the resettlement area.

The following problems are expected to occur in the neighbourhood of areas used before.

(i) Risk of occurrence of excess or shortage of public facilities.

(ii) Risk of occurrence of disputes over rights to arable land and houses.

(iii) Risk of occurrence of sanitation problems referring to arable land and houses.

Thus, checks should be carried out in advance in order to prevent the occurrence of these troubles, and a system able to resolve the expected problems should be provided.

3.7.2. Object of Resettlement and Compensation

The areas subject to resettlement are those mentioned below:

(i) Arable land and houses located at the inundation area upstream of the dam.

(ii) Arable land and houses located in the area ranging from the headrace tunnel surgetank, powerhouse and tailrace outlet.

(iii) Arable land and houses located in the areas for construction of roads and transmission lines.

(iv) Arable land and houses with any relation to other temporary buildings and temporary facilities required in the project.

As can be seen from the above, the land subject to resettlement and compensation occupy a considerable surface area.

The area occupied by the inundation zone of the storage reservoir mentioned in (i) is the largest and most typical one, and therefore discussions on this item are first presented below.

An estimation of the scale of the object of resettlement and compensation corresponding to the inundation level EL 648m is made as follows.

This area shows an annual population growth rate of 8.9%, and the number of families living in the project area is

also expected to increase in the future. On the other hand, it is not clearly known where they will settle in future within the area in question, and changes of occupation of the population due to the construction work are also expected. As a consequence, the actual population (number of families) will be taken as a basis for estimations.

In Kasibu Village located in the inundation area, 90% of the population is occupied in agriculture, and 10% in other professions. However, since they all live in the same village, it is assumed that the whole population is occupied with agriculture in broad concept. It is difficult to make a correct estimate of the number of houses which will be inundated, because the boundaries of the village and the distribution of houses are not clearly known. In addition, there is frequent migration of the population. Thus, taking as a reference the results obtained from the field survey, hearings at the site and aerophotographs, it is assumed that 50% of the houses existing in 1977 and 50% of the arable land will be inundated.

Making the estimate based on the considerations above, the number of houses which will be inundated is approximately 450 according to Table 3-7-1, and the arable land which will be inundated will be approximately 350ha. As described above, this estimate is quite rough; rounding it off, it is expected that approximately 500 houses and 400ha of arable land will be inundated.

3.7.3. Selection of the Resettlement Area

(1) Policy for selection of the resettlement area.

Taking into consideration the actual lifestyle of the population and future improvements, the resettlement area should basically fulfill the following requirements:

(i) An area suited for reconstruction for a society basically oriented toward agriculture.

(ii) An area making possible the construction of a base for mutual relations between areas and zones.

(iii) An area making possible the construction of a more developed, open economy society.

Taking into consideration the basic requirements mentioned above, there are three possible alternatives for selection of the resettlement area, which are mentioned below, according to the order of priority which would make possible a standard of living as close as possible to the present one.

(Case I) Land in the neighbourhood of the inundated village in the Kasibu M.P. (Dispersion type resettlement).

In this alternative, resettlement will be done as close as possible to the actual houses.

(Case II) Alternative of resettlement in several areas in the Kasibu M.P., with houses arranged as concentrated as possible (Concentrated resettlement).

In this case the resettlement areas are not necessarily located close to the location of the actual houses. The resettlement areas will be provided with houses concentrated at several places, and part of the existing villages will be joined together.

(Case III) In this case a new resettlement area will be

developed in one lot in areas other than the Kasibu M.P. (Total resettlement type). All inhabitants will be resettled together, based upon the pemise that the government will make an agricultural redevelopment plan having as a background the provision of agricultural water resources as a consequence of dam construction and the arrangement of irrigation facilities.

(2) Required resettlement area

The area required to develop resettlement should be equivalent to the inundated arable land, and should be sufficient to compose a village having an agriculture as economic base.

The average area of arable land possessed by each family in the Kasibu M.P. at present is presented below:

- Irrigated palay field	0.28ha
- Non irrigated palay field	0.50ha
- Uplands or Kaingin	0.20ha
- Corn	0.08ha
- Cropland absoluted area	1.55ha
Total	2.61ha

In neighbouring areas there is land suited for development, and new arable land is being developed every year. In some villages the average arable land possessed per family reaches a large scale of the order of 9.44ha, 7.25ha, etc.

On the other hand, in other dam projects developed in the Philippines, the following facts and opinions have been reported.

(1) In the Magat River Project the indemnification for the arable land is composed of compensasion depending upon the type and area of arable land lost and the offer of 3ha of new land.

(2) In the Chico River Project the indemnification is composed of the following:

- irrigated palay field - 3ha, or - non-irrigated palay field - 5ha.

However, in this case the contents of the indemnifications seem, according to the opinion of some people, too much compared with the arable land possessed before.

(3) The central government is adopting a policy of favourable treatment in case of resettlement projects.

Indemnification in the resettlement areas will be in principle done in kind, but taking into consideration the precedents mentioned above and the fact that the contents of the present study are very rough, the three alternatives below will be studied as resettlement areas fulfilling the conditions prevailing in Kasibu M.P.

Irrigated palay (paddy) field		non-irrigated palay field		Upland or Kaingin	
1 ha	+	1.4ha	+	1.6ha	= 4.0ha

In case of selecting resettlement sites at places other than Kasibu M.P., it is assumed that well-organized irrigation system will be possible in the said area, and arable land with the following composition is assumed to be prepared.

Irrigated palay field		non-irrigated palay field		
1.5ha	+	2ha	=	3.5ha

Assuming that the resettlement will be done within the Kasibu M.P., the estimation of the income resulting from production of rice brings the following data:

Irrigated palay field		Rain-fed palay field		Upland or Kaingin	
1ha	+	1.4ha	+	1.6ha	= 4.0ha

The production of rice from the arable land above can be estimated as follows:

- Irrigated palay field: 50 cavan/ha x 1ha = 2,200kg
- Rain-fed palay field : 26 cavan/1hax 1.4ha=1,602 kg
- Upland or Kaingin: 17 cavan/ha x 1.6ha=1,197 kg

Total 4,999 kg ≒ 5,000 kg

(1 cavan is equivalent to 44 kg)

Since rice selling price at the farmers field is ₱1.7/kg, total income resulting from rice production will be ₱5,500.

According to the 1971 census, the income from rice production of each family in the prefecture of Nueva Vizcaya was ₱2,254. Thus, the figures mentioned above indicate that the income from rice production in the resettlement area will be approximately double the average present value.

The income per family as a result of all crops,

including rice, was ₱2,871. The production of other crops, fruit, etc., as secondary and intermediate crops by the resettled people is also perfectly possible, and it will ensure them a richer life.

Rice consumption by the people is as follows:

- Annual rice consumption per capita - 130 kg
- Assuming 7 persons/family, a family consumes rice 130kg x 7 = 910 kg.

Thus, assuming an annual production of 5,000 kg per family, self-sufficiency in rice is perfectly possible, and furthermore, most of the production can be sold in the market to earn cash.

The area of arable land required for resettlement of the 500 peasant families will be as follows:

For Case I and Case II

(i)	Irrigated palay field:	1ha x 500 = 500ha
(ii)	Non-irrigated palay field:	1.4ha x 500 = 700ha
(iii)	Upland or Kaingin:	1.6ha x 500 = 800ha
	Total	2,000ha

For Case III

(i)	Irrigated palay field:	1.5ha x 500 = 700ha
(ii)	Non-irrigated palay field:	2.0ha x 500=1,000ha
	Total	1,700ha

(3) Selection of resettlement area

Initially we studied a 1:50,000 topographical map in order to find areas suited for development of arable land neighbouring the inundated area within the Kasibu M.P. The various candidate areas present the following characteristics (descriptions of each individual area are presented in Figure 3-7-1 and 3-7-2 and Table 3-7-2):

(i) The subject areas are distributed at the points marked A-J in the figure.

(ii) At elevations up to EL 800m there is approximately 3,700ha of slope land with inclination of less than 1/10 (Approx.6°).

(iii) At elevations up to approximately EL 850m there is approximately 3,400ha of slope land with inclination ranging from 1/7 (pprox. 8°) to 1/10 (6°).

The subject area of Case III refers to areas adequate for utilization as arable land as a result of introduction of irrigation facilities and regulation of the water flow of the river, located at places other than Kasibu. An example of a candidate area corresponding to this case is located on the right bank of the Addalam River, approximately 5 km upstream of the confluence of the Cagayan River with the Addalam River (Agricultural development study subject zone - Subject No.2; Refer to Figure 3-7-3).

Topographically, this area has an elevation of approximately 130 m, slope of approximately 7° and the development of an irrigated arable land of approximately 2,000ha is assumed to be possible.

The economic study of irrigation plan in this area do not necessarily present favourable conclusions as discussed in "Study of Irrigation. But it is located downstream of the present power development project, and has an intimate relation from the regional point of view. In addition, at the present it is practically waste land, and has relatively few inhabitants. Looking for resettlement areas not directly related to the present project, it might be possible to find a number of candidate sites, but in the present study the area in question will also be studied as a candidate area related to this project.

3.7.4. Characteristics of Resettlement Alternatives

A comparative study of the dispersive type resettlement alternative (Case I), concentrated type resettlement alternative (Case II) and total transfer type resettlement alternative (Case III) will be made here.

(1) Dispersive type resettlement alternative (Case I)

(i) Out of the 9 villages to be inundated 6 villages, can find adequate areas at places located behind the existing villages.

(ii) The remaining 3 villages are Siguem B.R, Catarawan B.R. and Camamasi B.R.

(iii) Siguem B.R. will be resettled by dividing it into Siguem B.R. (Candidate area B) and Muta B.R. (Candidate area C).

(iv) Since Catarawan B.R. has few adequate areas in the neighbourhood, it can be resettled either by

dividing into Dine B.R. (candidate area D) and Biyoy B.R. (Candidate area J) or as a group to Muta B.R. (Candidate area C).

(v) Since Camamasi B.R. has also few adequate areas in the neighbourhood, it can be resettled as a group at Capisaan B.R. (Candidate area H).

As a result of the distribution described above, it is possible to resettle all villages in hilly districts with a gradient less than 1/10.

(2) Concentrated type resettlement alternative (Case II)

In case of seeking several relatively concentrated resettlement areas within Kasibu M.P., the following areas fulfilling the conditions of elevation of less than EL 800m and slope less than 10% can be found: Muta (candidate area C), Capisaan B.R. (candidate area H) and Malabing B.R. (candidate area I).

(i) Each of the 3 areas mentioned above present the possibility of development of 500-800ha respectively, totalling 1,940ha, beyond the actually existing palay field.

(ii) As for the irrigated palay field and non-irrigated palay fields, there is a sufficient area for their development in hilly districts with less than 1/10 inclination. The required area of irrigated and non-irrigated palay fields is approximately 1,200 ha.

(iii) As for the upland or Kaingin, there is an area of approximately 250ha in hilly districts with less

than 1/10 inclination and there are other parts of the slope with 1/10-1/7 inclination which can be perfectly utilized for development of the required remaining area of approximately 550ha.

It is not clearly known if the areas mentioned above belong to private owners or to government authorities, but in the present study it is assumed that they belong to the government.

(3) Total transfer type resettlement alternative (Case III)

The candidate area located on the right bank of the Addalam River, selected as an area directly related to the Diduyon Project, has the following characteristics:

(i) It is possible to develop an arable land area of approximately 3,000ha in one place at elevations between 100m and 150m.

(ii) This area is composed mostly of approximately 2,000ha hilly areas with gentle slopes between 1/20-1/7, on an average less than 1/10.

(iii) The remaining parts at higher elevations, approximately 1,000ha can be utilized as non-irrigated arable land.

3.7.5. Resettlement Plan and Construction of the Village

As mentioned above, there are 3 possible alternatives for resettlement. The construction of the new village and the construction of the remaining village should be studied from many points of view.

In the village to be constructed anew, the configuration of the community, the layout of the arable land, the living quarters, and the service facilities should be analyzed as follows:

(1) From a dispersive type community to a concentrated type community.

The conventional community has used to be composed of a family and some of its relatives, which dwelled dispersed along a stream and in a valley, developing arable land in the neighbouring areas. The communities planned here will have the arable land and the dwelling area mutually separated, and the dwelling areas will be provided with small vegetable gardens making possible the production of small quantities of vegetables around the buildings. The vegetable gardens will be sized approximately 600m^2 per house, which is in accordance with the standard proposed by the government.

(2) Provision of service facilities in accordance with the new dwelling area.

Since presently the houses are located distant from each other, accessory services are provided at will, in the neighbourhood of each house. However, when a group of houses of a certain scale is constructed, it is indispensable to provide the corresponding service facilities. Especially with regard to potable water, it is necessary to ensure a water source able to supply approximately 150-200 liter/man/day, being furthermore required to construct a simplified water service system. On the other hand a sewerage system should also be constructed.

(3) Construction of residences in accordance with the new environment

In order to make the conversion from actually existing houses constructed at will to a hygienic and civilized life, the houses should be provided with separate kitchens, bathrooms and lavatories. The cost for construction of each house should be ₱50,000 according to instructions issued by the government.

(4) Supply of electric lighting and power

Supply of electric lighting to each house is indispensable in order to make possible a hygienic and suitable life style. However, the introduction of electrification should be decided in such a way as to bring positive effects on the population, taking into consideration the income and living standards. The introduction of electricity should be carried out gradually, based upon a long-term view.

(5) Improvement of communication routes

The communications network can be classified into the local network, located within the project area, and the network for communication with external areas. As for the network for communication with external areas, roads for construction work which will be developed within the Diduyon Project area will be interconnected at two extremities with Route 5, through Bambang -- Kasibu -- Sigeum -- Diduyon -- Debibie -- Cordon route, bringing as a consequence a remarkable improvement in traffic conditions. The local communications network will be composed basically of roads which will be opened at the construction site, and branches which will be connected to the various villages. This local network will make possible the traffic of automotive vehicles even during the rainy season.

(6) Improvement of Community Facilities

Since the inhabitants of the new villages will have their lifestyle converted from the dispersive type to the concentrated type, facilities such as a public hall, collective workshop, public square, sports facilities, etc., will be required. Other tribes have been living in the neighbouring areas of the resettlement villages, and it will be necessary to live in harmony with them. Construction and operation of these community facilities will help to promote this harmonization.

(7) Construction of technical orientation center

It is required to construct a facility intended to provide technical orientation in agriculture, fishery, etc., to the population and personnel for operation of the said center.

(8) Soft service system

It is necessary to create a credit system intended to provide financial aid to the population, and also soft service systems intended to aid independence and harmonization of the various villages, taking restrictive measures against the unlimited intervention of outsiders, etc.

(9) Construction of educational and cultural facilities

As a consequence of the construction of dwelling areas, increases in school attendance of children are expected to occur. It is necessary to construct schools in accordance with the needs of the area, studying carefully the actual rate of school attendance of the children living in the project area. In addition to the children,

young people and women will have new employment opportunities differing from the conventional ones as a consequence of progress in the construction work. The organization of a system promoting and mediating the employment of local people in such jobs will contribute not only to the improvement of the living standards of the local population, but also be useful to create a consciousness of participation in the project, and to promote a better understanding of the importance of the project. As for cultural and recreational facilities, it will be interesting to let the facilities related to construction work be for use by the local population, or to offer them such facilities depending on the case.

(10) Other Facilities

Public facilities in the broad sense, such as churches, chapels, shops, rice refining plants, medical facilities, etc., will be indispensable elements in the construction of new villages. Thus, it is necessary to take into consideration aspects like their transference, layout, contents, etc., within the global plan. As for medical and communication facilities, it is necessary to take into consideration their use in common with the village inhabitants not only during the construction work, but also after the start of operation of the power plant.

(11) Recognition and comprehension of the will of the local population.

The present study evidences that the local population is not composed of a single tribe, but there are various languages, religions, customs, living standards, etc., with many small tribes mixed together. In addition, the fact that each group seems to have settled in the

project area in a different epoch, not only within each tribe, but also with regard to the whole population, is an important characteristic.

Among tribes which settled at later epochs there are tribes which had lost their land in various other projects developed in northern Luzon. If they face a new development project again, it is expected that they will demonstrate considerable antipathy and caution. Consequently, the most important point of the preparation and execution of the resettlement project will be a careful study to comprehend perfectly the characteristics and peculiarities of the situation in the project area, followed by detailed explanation to the local people starting from the planning stage, and smooth and gradual execution of the resettlement plan, having the complete understanding as cooperation of the local people.

It is necessary to take into consideration the peculiar situation occurring within the population of the project area, which is composed of many small tribes, paying attention to the tribal idiosyncracies of each group resulting from a long history and traditions. When carrying out migration, reconstruction, change of job, etc., it is necessary to take concrete measures in accordance with the actually occurring situation, which could as a whole produce adequate results for each tribe, displaying at the same time impartiality for both emigrants and the people remaining, although this could be very difficult to put into practice.

The resettlement is not a problem which can be solved alone by the National Power Corporation, which is the authority directly concerned, but also requires work in perfect harmony and cooperation with other authorities.

In order to make possible prompt and smooth solutions to the problems faced, NAPOCOR should organize an adequate system not only within NAPOCOR itself, but for contact with other related authorities, in order to carry out discussions and negotiations required in advance. Within the Corporation it will also be necessary to assign specialists who will work exclusively with this problem.

Those who will be engaged in this problem should bear in mind the content of the following letter.

October 9, 1979

The Barangay Captains, Tribal Chief
and People of Barangays Katawaran, Biyoy,
Dine, Kamamasi, Belet, Malabing and Siguem

Thru: The Honorable Mayor
Municipality of Kasibu
Nueva Viscaya

Subject: NPC's Assurance on Resettlement of Families and/or Individuals and Compensation on Improvements that may be affected by the Diduyon River Development Projects

Gentlemen:

Pursuant to your desire, as you had expounded during the public dialogues attended by your goodselves and our representatives on August 18 and September 2, 1979 at NPC sub-office in Kasibu, Nueva Viscaya, we are confirming the Commitment of the National Power Corporation (NPC) for the resettlement of all families and/or individuals that may be affected and for the compensation of their improvements which may be damaged in the development of the Diduyon Project.

The National Power Board has approved and adopted the following basic principles and policy guidelines which formed the basis for the Resettlement Program:

Basic Principles

1) Relocation shall be designed to bring progress to the people living along the rivers whose houses, farm lands and/or other properties shall be adversely affected by the project.

2) The people to be relocated shall be represented and shall participate in the decision-making process for their resettlements and

3) The resettlement program shall be implemented within the context of existing laws.

It is stressed, however, that the present phase of the project development is only the pre-feasibility study. This completion of the final feasibility study will the Corporation be able to know whether the project is feasible or not. Thereafter, when to implement the Project will be decided, at which time the operational plan for resettlement will be implemented.

I am taking this opportunity to appeal for your assistance and cooperation for the early completion of the present phase of studies. We assure you that we will consult you and your affected constituents about our relocation plans should the project prove to be feasible before we decide on its construction.

Very truly yours,

G. Y. ITCHON
President, NAPOCOR

In accordance with the basic principles above, NAPOCOR commits itself to discussing in advance the resettlement plan when it is concluded that the present project is feasible.

Actualization in accordance with these orientations and procedures will be the best way to achieve a smooth solution of this problem.

Next, the following measures will be required in order to maintain and reconstruct the remaining portion of the divided villages.

1) Measures related to the correction of excess and/or shortage of public facilities

It is expected that part of the actually existing public facilities will also be inundated. On the other hand, since most of the houses will be resettled, it is possible that part of the remaining public facilities will become either excessive or inconvenient for use. It necessary to take measures to solve these problems referring to the public facilities, in order to facilitate their utilization by the remaining population.

2) Measures referring to the houses and arable land left by the resettled population

In most cases, the arable land and houses of the resettled population will be either abandoned or handed over. When handing over the rights to these arable lands and houses, it is necessary to take measures which will result in advantages to the remaining population. On the other hand, for abandoned arable land and houses (including the service areas), adequate measures should be taken in order to prevent the occurrence of sanitation problems.

3) Measures referring to the condition of subsistence of the communities

As a result of the formation of the storage reservoir, the remaining houses will face conditions in the formation of communities completely different from those prevailing before. It is desirable to construct a center responsible for the activities of administration of roads, communications, medical care, public workshop, fluvial transportation, bridges, etc. It is necessary to study in advance possible problems in the life of the remaining population and the measures required with regard to this matter.

3.7.6. Comparison of Resettlement Plan Alternatives

The various alternative resettlement plans will be compared with regard to the following items:

(1) Future potentiality of development of Agriculture

(2) Future potentiality of improvement of living standards

(3) Protection of the natural environment

(4) Administrative problems

(5) Social consciousness, maintenance of living standards, and other problems.

The contents of the comparison are presented in Table 3-7-3. The characteristics of each alternative are summarized as follows:

(1) Case I (Dispersive type)

This is the most adequate alternative if it is desired to maintain the actually prevailing living standards.

Among the 3 possible alternatives the development of arable land is done in the most dispersed way in this case. Since concentrated development is difficult in this case, the grade of development will be inevitably low. However, since the newly developed arable land will be neighbouring each house, there is margin for further development of arable land.

The living standards of the village will not suffer radical modification compared with the presently occurring situation,

but communications between the communities and with the center of the village located at Kasibu B.R. (Poblacion) will be done by means of the roads constructed for the project (trunk road) and its branches, and will require a considerable improvement.

With regard to the natural environment, this is a dispersive type development, and the countermeasures and control in the neighbourhood of the storage reservoir will be difficult. In addition, the investment efficiency will be poor compared with the other alternatives because of the dispersion.

From the administrative aspect, the problems of division, amalgamation, etc., will be less pronounced compared with the other alternatives. The facility of resettlement of minority race groups of various tribes compared with the other alternatives is an aspect of special importance in the present case.

(2) Case II (Concentrated type)

This is an alternative located midway between Case I and Case II, when it is analyzed taking into consideration the presently prevailing situation and the future.

If priority is attributed to the development of the Kasibu M.P., the construction of a village which will work as a core, with a scale classified next to a Poblacion, will be an important point, and the concentrated type resettlement of this alternative corresponds exactly to this idea.

The development of arable land will be done in a relatively concentrated way, and it can be put forward as an improvement of the presently available agricultural techniques.

Since the communities will be concentrated, the improvement of public facilities such as roads, etc., will make possible the concentrated transportation of agricultural products and living necessities.

However, the presence of various tribes of different race, language, customs, religion, etc., may result in problems of communication and harmonization, which are essential elements for the construction of a new village.

As for protection of the natural environment, a perfect monitoring system will be required in the areas used before, because a considerable quantity of houses and arable land will be abandoned in this case. Since the development will be concentrated in a restricted area, this is the alternative which will result into the most pronounced effect upon the natural ecology among the three possible choices.

From the administrative point of view, there is the problem of division and amalgamation of communities within the Kasibu M.P., but if this problem is solved and a new village is constructed, the administration will become easier.

This is the alternative which will bring the most effective results if priority is attributed to the future development of the Kasiby M.P.

(3) Case III (Total transfer type)

If only the resettlement area is taken into consideration, this is the alternative which presents the best possibility of offering well-organized agriculture and modern life.

In the resettlement areas, measures for harmonious use of the land with the farmers already living in this region and the solution of social and administrative problems as to the borders of the M.P., counties and prefectures will be required.

As for the development of arable land, this is the alternative which makes possible the highest grade of concentration, with the smallest slopes and highest grade of development among the 3 possible choices.

The living standards will be modernized compared with the present situation, and the potentiality of development is high. On the other hand, resettlement by constructing an entirely new village is subject to antipathy from the conservative natures. In the new village it is necessary to make divisions and reorganizations taking the races and languages as units, and considerable difficulity can be expected with regard to this point.

As for protection of the natural environment, the whole resettlement area is a gently sloped district without deep valleys and consequently few problems are expected.

As for communications, the new village will be connected to the trunk road by means of the Aglipay-Madera road. Construction of local communication roads will be required.

From the administrative point of view, the resettlement area extends over the province of Quirino and Isabela, and difficulties are expected with regard to this aspect. If this resettlement plan is materialized, some territorial exchange will be required between the two provinces.

Since the resettlement area is composed one land mass,

the administration can be made more simple, and the introduction of subventions from the national and prefectural government will be easier. However, as described above, the peoples living in the Kasibu have a complicated composition, and there are concerns over to the possibility of perfect unification.

The key point for materialization of this alternative will be the agreement of the residents to the proposed contents, because it will mean the migration of part of the population of the Kasibu M.P. to an area located a considerable distance downstream.

3.7.7. Resettlement Cost

An approximated calculation of the costs required for materialization of the resettlement, with the exception of the soft services and operational costs, is made, by taking into consideration the discussion presented above.

Calculations are made for each individual case, taking as a reference data on other projects in northern Luzon such as the Abulug Project.

The required costs are summarized in Table 3-7-4.

Summarizing the data obtained at the actual stage of this study, the costs required by the various cases are approximately as follows:

- Case I 94×10^6 ₱
- Case II 101×10^6 ₱
- Case III 127×10^6 ₱

It is necessary to bear in mind that the figures above are

rough approximations intended to make possible a rough comparison of the 3 cases, because the number of houses and arable land area to be resettled is just an estimation, exact figures are not known, and studies on the soft services, operational costs and cost of the land are not included in the present discussion.

This study is based on presently available data, and adopts very rough hypothesis in order to make a broad comparison of the costs for each case. Especially the figures on the houses inundated and arable land inundated are very difficult to obtain from the presently available data. In addition, there is possibility of reduction/increase of persons subject to inundation, besides the possibility of changes in professions by the occasion of materialization of the Diduyon Project. Consequently, it is very difficult to calculate the exact number of persons who will be interested in resettling.

As mentioned at the beginning of this discussion, the present study refers only to the resettlement of the inundated villages, which is the largest and most difficult problem in indemnification and resettlement plans. There are other indemnification cases in the neighbourhood of the powerhouse, the headrace tunnel addits and tailrace outlet, the transmission line, the land for temporary buildings, temporary facilities and living quarters. But both the quantity and the affected area are restricted, and since the influence is of a temporary nature, these can be considered of minor importance, compared with the villages which will be inundated by the storage reservoir.

In this study the costs are calculated simply by adding up the various individual costs for each item. Aspects such as the scale merit of the construction cost in a project of this magnitude, phenomena such as the reduction of unit cost due to

the moving of so many houses, etc., are not taken into consideration.

As a consequence of the discussions presented above, a cost of approximately 110 million Pesos in total will be required in Cases I and II for the dam, power plant and other indemnification and resettlement costs. The costs for the development of resettlement, arable land and irrigation waterways are calculated as follows:

(1) Case I

1) Irrigated palay field (1 ha)

The cost for development of 1ha of arable land per family, including approximately 10% margin (taking into consideration losses, etc.) will be: ₱30,800
The construction of irrigation waterways, etc. within the arable land will be: ₱9,900
Total: ₱40,700

2) Non-irrigated palay field (1.4 ha)

The cost for development of 1.4ha of arable land per family, including approximately 10% margin (taking into consideration losses, etc.) will be: ₱53,900

3) Upland and Kaingin (1.6 ha)

The cost for land improvement such as removal of roots, etc., of 1.6 ha, taking into consideration approximately 5% magin will be: ₱16,800

Consequently, the cost for development of arable land corresponding to one family will be:
₱40,700 + ₱53,900 + ₱16,800 ≒ ₱111,400

On the other hand, the required water supply facilities will be as follows:

- Intake
  Installation of intakes at 9 places, at the upper extremity of mountain torrents: ₱4,500,000
- Waterways
  Construction of 9 waterways of approximately 5km: ₱4,050,000

  Totalling the items above, the cost required in Case I will be as follows:
  ₱111,400 x 500 families + ₱4,500,000 + ₱4,050,000 = ₱64.25 x 10^6

(2) Case II

1), 2) and 3) are identical to Case I, i.e., ₱111,400/family

4) Intake

Installation of intakes at 4 places, at the upper extremity of mountain streams: ₱6,000,000

5) Waterways

Construction of 4 waterways of approximately 15km from the intake to the arable land: ₱9,000,000

Totalling the items mentioned above, the cost required in Case II will be as follows:
₱111,400 x 500 + ₱6,000,000 + ₱9,000,000 = ₱70.7 x 10^6

(3) Case III

The cost corresponding to each family will be as follows:

1) Irrigated palay field (1.5ha) (including a margin of 10%): ₱57,800

Construction of facilities such as waterways, etc.; ₱14,800

Total ₱72,600

2) Non-irrigated palay field (2 ha): ₱77,000

The cost for development of arable land corresponding to each family will be:
₱72,600 + ₱77,000 = ₱149,600

The required irrigation facilities will be as follows:

3) Weirs (2 places) 4,468,000₱

4) Pump-up systems (2 systems) 16,480,000₱

Totalling the items presented above, the cost required in Case III will be as follows:
₱149,600 x 500 + ₱4,468,000 + ₱16,480,000 = ₱95.75 x 10^6

In addition to the individual costs mentioned above, there are additional costs which are common to all alternatives. Summing up all these cost items, the amount of the resettlement and indemnification costs will be as follows:

- Case I ₱ 94 x 10^6
- Case II ₱101 x 10^6
- Case III ₱127 x 10^6

3.7.8. Appraisal and Selection of the Resettlement Alternative

The economic activity presently developed at the Kasibu

M.P. is slightly beyond self-sustaining life based upon agriculture, i.e., it is at an underdeveloped stage, where part of the production is sold at the market, and the earned money is used to purchase daily living needs. With the completion of the trunk road which will pass across Kasibu in the future, and the construction of roads for communication between the various villages, traffic of automotive vehicles will be possible also during the rain season. As a consequence, the adoption of measures to improve the legel of living, with the actually prevailing life pattern left unchanged, it is expected that further development of the economical activity based upon the agriculture is perfectly possible. There are areas with relatively favourable characteristics for development of agriculture, and the presently available agricultural production methods and techniques are sufficient to cope with the situation. In view of these facts, Case III, which assumes the resettlement to a newly developed area seems difficult to be materialized, due to aspects like actual improvement of the welfare of the population and difficulty of its acceptance by the population, even when the problem of the largest required cost is neglected.

Case I and Case II have the following points in common, in spite of some differences in their degree.

(1) The population subject to the resettlement plan have imigrated to the Kasibu M.P., and have just finished the construction of a base for their life, and are getting accustomed to this region.

(2) Both alternatives are suited to attain characteristics and community configuration similar to those prevailing in the project area, and the acceptance of the resettlement plan by the population seems to be relatively easy.

(3) Both alternatives make possible the solution of tribal problems peculiar to this area, and the construction of new hamlets and villages.

(4) Both alternatives ensure the development of the Kasibu M.P. as a whole.

The comparison of Case I and Case II evidences that the required cost is almost equivalent, being therefore difficult to decide which one is more advantageous. However, Case I presents the following merits:

(1) It is possible to materialize a lifestyle most similar to the presently prevailing one.

(2) Since the development scale is dispersed, it is possible to conceive a development in accordance with the presently prevailing situation. In addition, it facilitates the division of living areas according to racial groups and familiar groups.

(3) The development pitch suited to each place can be adequately selected, and the participation of the population seems to be easier.

(4) The required construction cost is the cheapest one, and large one time investments are not required.

(5) The arable land can be further expanded, depending upon the efforts of the population.

In view of the considerations above, Case I and Case II will be analyzed more concretely and with further details in future stages of the study, in order to select one of them or to propose a compromise between the 2 alternatives.

3.7.9. Feasibility Study of Irrigation Project

(1) Outline

Since 1973 the Philippine government has promoted the campaign called "Masagana 99", intended to increase the production of rice.

Upon completion of the power generation project on the Diduyon river, a discharge of 22m^3/sec will be possible, even during the dry season. By constructing an adequate irrigation system in the basins of the Addalam River and Cagayan River utilizing this discharge water, it will be possible to plant rice twice a year. This will be an important fact from the point of view of the nation, and if the reservoir can contribute to an increase in rice production, the project will have considerable added value.

The possibility of development of rice paddies utilizing irrigation facilities in the area located downstream of the dam will be studied based upon the considerations above.

(2) Actual situation of irrigation facilities and determination of the study area.

The project which will compose the core of the irrigation facilities and irrigation development at the mid-stream of the Cagayan River will be the Magat multi-purpose project which comprises a vast area of land suited for agriculture on the left bank of the Cagayan river. This project will have the purposes mentioned below by constructing irrigation facilities at various places, in addition to the generation of electric power, by constructing storage reservoir dam and power plant.

(i) Expansion of irrigated land from 40,000ha to 52,200ha.

(ii) Construction of new irrigation facilities to serve an area of 49,800ha.

As a result of these facilities, the total area served by this project will be 102,000ha.

In other words, the area served by this project will be a vast fertile plain having as its borders the Cordon-Diffun-Saguday line in the south, and the Echague-Cawayan-Gamu line in the east (left bank of the Cagayan River). The areas not within these borders are hilly districts of high elevation, not suited for irrigation.

The area covered by the present study comprises that around Aglipay where the Addalam River flows out onto the plain, part of the left bank excluded from the Magat project and the area located on the right bank, bordered by the eastern hilly districts.

(3) Selection of possible areas for irrigation.

Based upon observations made on the map, we selected the 7 areas mentioned below as possible candidate sites for irrigation, taking into consideration factors such as contour lines, gradient, inclination, etc.

(1) Approximately 1,000ha south of Cabarroguis (EL 115 - 138m)

(2) Approximately 2,000 ha on the right bank of the Addalam River and east of Aglipay (EL 110 - 130m).

(3) Approximately 300 ha in the Dipangit barrio district,

on the right bank of the river, approximately 3km downstream of the confluence of the Cagayan River and the Addalam River (EL 83-100m).

(4) Approximately 2,000ha between Pangal Norte and Garit Norte, on the left bank of the river, 15 km downstream of the confluence of the Cagayan River and the Addalam River (EL 75-90m).

(5) Approximately 700ha on both sides of the road connecting Dalibuban located on the right bank of the Cagayan River to Jones (El 70-90m).

(6) Area of 2,200ha, with an extension of 15km in the north-south direction and 2.5km in the east-west direction, between the Cagayan River and the mountain foot (EL 70-110m) of the area mentioned in (4) above.

(7) Area of 8,000ha of long landstrip 3km wide between the right bank of the Cagayan River and the mountains located on the east side, between Angad and Cawayan (EL 42-58m).

These areas are shown in Figure 3-7-4 (1) and (2).

The following are results of the field investigation of these areas observed on the map.

(4) Principle for study of proposed sites

The following presents the basic principle referring to the study to determine the selection priority of the various proposed sites.

In order to enhance the beneficial effects of downstream

irrigation resulting from construction of the Diduyon storage reservoir, importance will be attributed to normal discharge during drought periods, and if possible, priority will be attributed to the utilization of Addalam River water. However, if the natural gravity system is impossible in view of the restrictions imposed by topographical conditions, it will be forced to take into consideration an irrigation system taking water by means of direct pumping up from the river.

The proposed No.1 and No.2 sites, which have direct relationships with the Addalam River will be discussed individually later. As for the proposed areas No.3-No.7 located downstream of the confluence point of the Cagayan River and the Addalam River, plantation of rice twice a year will be possible in view of the flow of the Cagayan River main stream and the utilization of the flow of the Addalam river during the dry season. Assuming that a quantity of water of 2 liter/ha/sec will be required in correspondence to an irrigation area of 13,200ha, it will be possible to set up the irrigation with a flow of 26.4m^3/sec.

The problem lies in that, generally speaking, the 5 proposed areas in question are regarded as utilizing mainly water coming from the Cagayan River mainstream, and therefore there are doubts about the possibility of considering it an irrigation project directly related to the Diduyon project in view of the long distance from the damsite.

Since the plan to adopt these 5 proposed areas No.3 - No.7 which are all under the same conditions as a part of the Diduyon power generation project has not been agreed upon yet by the governments of Japan and the Philippines, it seems meaningless to present individual discussions on each of the proposed areas No.3 - No.7.

Consequently, in this study the No.4 proposed area will be taken as a typical example, and calculations will be made with regard to the land creation plan and the investment effects in this area. Data referring to the other proposed sites will be calculated in proportion to their surfaces area compared with the proposed area No.4. (The individual study of areas No.3 - No.7, after the decision to take them into consideration as a part of the Diduyon Project, will be meaningful in the future).

(5) Study of individual proposed areas

Assuming that the proposed areas No.1 and No.2 are both irrigated with water taken from the storage reservoir constructed in the valley of the Addalam River (riverbed EL 125m, storage depth 60m), it will be necessary to construct waterways with extensions approximately 25km for No.1 area and 35km for No.2 area respectively.

Assuming that $3m^3$/sec of irrigation water is taken from the reservoir, it will be possible to irrigate an area of approximately 1,500ha, because the flux required for cultivation of rice is 2 liter/sec/ha.

(1) Waterway construction cost

- Let us assum a flow of $3m^3$/sec.
  Cost for construction of 25km long waterway for the proposed area No.1: ¥1,750 x 10^6
  Cost for construction of 35km long waterway for the proposed area No.2: ¥2,450 x 10^6

It is necessary to add the cost for construction of branches and terminal waterways in addition to the main waterway. In case of long distances, the water-

way maintenance cost assumes an unnegligible proportion.

(2) Intake dam construction cost

The normal daily peak riverflow will be $22m^3/sec$, at the power plant. Assuming a loss of approximately 30%, the discharge will be $15m^3/sec$, and as a consequence, the quantity of water stored per month will be $15\ m^3/sec \times 3,600\ sec \times 6 \times 30\ days \fallingdotseq 10 \times 10^6\ m^3/sec$.

The water storage dam required for this purpose will be of 60m high fill dam with an embankment volume of $0.4 \times 10^6\ m^3$ provided with flood spillway. The cost for construction of this dam is estimated at approximately $¥3.1 \times 10^9$ or US$75 million.

(3) Study of the proposed area No.1

This is an area of approximately 1,000 ha, with a few small hills, and there are already small scale rice paddies taking water from the nearby streams. However, utilization of water taken from the Addalam River located downstream of the dam will be very difficult and unfeasible both from the economical and technical points of view.

As described previously, a long distance irrigation waterway from the storage reservoir and intake should pass through large hills with EL 170m before reaching the irrigation area.

(4) Study referring to the proposed area No.2

Even on the map, the proposed area of approximately

2,300ha located on the right bank of the Addalam River downstream of the dam has a complicated topography, with considerable fluctuation in the elevation. There are small mountain streams within the area, and even after creation of arable land, the irrigation area available for practical use is expected to be of the order of 2,000ha.

Restricting the elevation of the area of this project below EL 130m, and assuming that the average inclination within the area is of the order of 7°, it will be necessary to carry out stepwise creation of arable land (using the contour farming method and the strip farming method).

As for the irrigation method, 2 intakes should be constructed along the river, because the site in question is located on the right bank of the Addalam River.

The area in question will be divided into 3 parts, i.e., A-600ha, B-400ha and C-1,00ha. Since the B-400ha is located at higher elevation, it will require secondary pumping in order to make possible irrigation. Consequently, it will be necessary to interconnect the 3 pumping stations by means of pipes, taking into consideration the elevation (Figures 3-7-5 and 3-7-6).

Unlike the paddy and fields of the other proposed areas such as No.3-No.7, this area will require the development of virgin land located in hilly districts, and consequently the created arable land should be divided in various steps depending upon the local topography. Therefore, agricultural development of this area will mean further additional costs.

(5) Study on the proposed areas located along the Cagayan River (No.3 - No.7).

The proposed areas No.3 to No.7 are located on the right and left banks downstream of the confluence of the Cagayan River and the Addalam River. Since the Cagayan River thereabout has a large water depth and considerably high banks of 15m - 20 m on both sides, the construction of pump stations will be indispensable for taking water from the river. According to our reconnaissance, irrigated rice paddies are found only in very restricted areas, and most ofthe remaining area cultivated as rain-fed paddies, which are cultivated only once a year. Such rice paddies occupy only 20 - 30% of the total area, and the crops cultivated in the remaining areas are corn, tobacco, beans, etc. Crops being in such poor conditions, the local farmers whom we met all wanted to meet the day when two crops a year will be made possible as a result of the construction of irrigation facilities.

The proposed areas No.3 and No.4 are located on the left bank of the Cagayan River, but they are excluded from the Magato Project. All other proposed sites are located on the right bank of the Cagayan River, composing narrow strips located between the hilly district on the east side and the river bank. (Figure 3-7-7).

The total area suited for irrigation of the proposed areas No.3 - No.7 is approximately 13,200 ha.

(6) Costs required for construction of the irrigation facilities.

The costs for development of virgin land and construction of irrigation facilities with pumping up of the river water can be divided into the 5 main items listed below:

(1) Cost for creation of arable land.

(2) Cost for construction of pump station facilities.

(3) Cost for construction of waterways.

(4) Cost for construction of weirs and sedimentation basins.

(5) Cost for construction of roads.

Since the proposed areas No.1 and No.2 are virgin lands, construction cost items (1) - (5) will be required, while the proposed areas No.3 - No.7 being of non-irrigated arable land, require only the arable land creation cost (1). Since the proposed areas No.2 and No.4 have practically the same area of 2,000ha, calculations on the quantity of facilities required and the unit cost will be first made in cases of No.2 and No.4, with reference to the other projects now underway.

(1) Construction cost required for creation of arable land per ha is given as follows, in case of mechanical development with 11-ton bulldozer:

		In case of 5° slope	In case of 7° slope (estimation)	Incase of 10° slope (Abulug Project)
A.	Cutting, filling, elimination of roots and stones	$2,613	$3,600	$5,100
B.	Elimination of foreign matters & improvement of land	$1,400	$1,400	$1,400 (≒ ₱10,000)
	Total	$4,013	$5,000	$6,500

Thus, in case of No.2 area with 2,000 ha land of 7° gradient, the cost required per ha will be $5,000 x 2,000ha = $10 million, or approximately $70 million.

(2) Pump station construction cost

Approximate calculation of the cost required for construction of the pump station will be carried out taking the proposed area No.4 as example. (Figure 3-7-8).

The quantity of water to be handled, which will be the reference data for the pumping station, will be calculated initially. The procedure for calculation of the quantity of irrigation water is determined by the NIA, based upon the planned cultivation system and the soil conditions, taking the specifications of the existing projects into consideration.

The quantity of irrigation water depends upon the conditions prevailing in the cultivation system, plowing, surface soil puddling period, and ordinary period, but in the proposed site it will have the following values:

- Plowing 130 mm/day
- Surface soil puddling period 130 mm/day
- Ordinary period 8.4 mm/day
  (evapotranspiration in June 6.4 mm + infiltration 2 mm)

The quantity of water mentioned above refers to the field capacity, but when dimensioning an actual irrigation facility, it is necessary to take losses into consideration. The following losses are assumed in this case.

- Field ditch loss	20%
- Branch waterway transportation loss	15%
- Trunk waterway transportation loss	20%
Total	55%

From the considerations above, the quantity of irrigation water at the planting field is assumed to be 1 liter/sec/ha Consequently, the unit quantity of water at the pump station, taking into consideration the various losses, is 1.84 liter/sec/ha.

Next, study of the required capacity of the various facilities presents the following results.

- Quantity of pumps	3.68 m^3/sec
- No. of units of pumps:	3 units
- Inner diameter of the pump:	0.72m
- Total head :	42m
- Motor power :	1,650kW
- Pump station cost (per unit):	₱8.2 x 10^6

(3) Waterways, drain facilities, roads, and water control centers.

The following data can be obtained as a result of utilization of the basic data of "Summary of Cost Estimates/ha, Magat III," issued by NIA:

i) Construction of canals, laterals, sub-laterals and structures.

Approx. ₱6,300/ha

ii) Construction of terminal facilities.

Approx. ₱1,350/ha

iii) Construction of drainage

Approx. ₱600/ha

iv) Construction/improvement of access roads

Approx. ₱550/ha

v) Water management station:

Approx. ₱150/ha

Total ₱8,950/ha

Consequently, the total cost will be: 8,950₱ x 2,00ha
= ₱17.9 x10^6

(4) Cost for construction of weir and sedimentation basin

At the proposed site (example of 2,000ha), the Cagayan River at the intake site has a river width of 100m - 120m, and water depth at the center of the river is estimated to be of the order of 2-3m. In taking water under these conditions, it is necessary to construct a weir in the river in order to intercept water, and a sedimentation basin should also be constructed at the river bank.

The cost for construction of these facilities will be as follows:

- Weir with 100 m extension		¥62.3 x 10^6
Sedimensation		¥4.73 x 10^6
Total		¥67.03 x 10^6
	or	₱2.23 x 10^6

(5) Road construction costs

1) Standards for the road facilities

The standards for road facilities actually adopted by Sanyu Consultants (Japan) at the irrigation area (total) of 13,200 ha at the 3 sites) downstream of the Cagayan River seem to be adequate, and will be adopted also in the present case.

	Density	Width
- Trunk roads	2m/ha	6m
- Branch roads	31m/ha	2-5m
- Cultivation roads	17m/ha	2m

2) Assuming that the area in question has an area of 2,000ha we have:

- Trunk roads: 4km
- Branch roads 62km
- Cultivation roads: 34km

3) Cost

- Trunk roads: 4,000 m x ¥4,170 = ¥16,680,000
- Branch roads: 62,000 m x ¥2,200 = ¥136,400,000
- Cultivation roads 34,000 m x ¥1,500 = ¥51,000,000

Total ¥204 x 10^6

or ₱6.8 x 10^6

(6) Construction costs for the various proposed sites

The total construction cost, calculated for the proposed areas No. 2 & No. 4 taking as a base the cost required for construction of the irrigation facilities, will be as follows:

1) Construction cost of the proposed area No.2 (for 2,000ha)

(i) Cost for creation of the arable land = ₱70,000,000

(ii) Cost for construction of pump stations (3 stations)
3 x 8,250,000 = ₱24,720,000

(iii) Construction of waterway canals
Taking into consideration a unit construction

cost approximately 2 times larger than other areas in view of the pipes for interconnection of the pump stations and accessory facilities peculiar to this area, we have:

Unit cost : ₱15,000/ha

₱15,000/ha x 2,000ha = ₱30,000,000

(iv) Cost for construction of weir and sedimentation basins (2 units)

2 x 2,230,000 = ₱4,460,000

(v) Cost for construction of roads ₱6,803,000

Total ≒ ₱135,983,000

2) Construction cost for the proposed site No.4 (area of 2,000ha)

(i) Arable land creation cost None

(ii) Pump station construction cost (1 unit) = ₱8,240,000

(iii) Waterway canal construction cost 8,950 ₱/ha x 200 = ₱17,900,000

(iv) Cost for construction of sand precipitation facilities (1 place) = ₱2,230,000

(v) Road construction costs = ₱6,803,000

Total ₱35,173,000

3) Estimate of total construction costs for the proposed areas No.3-No.7 (area of 13,700ha). Calculation made based upon the proposed area No.4, by extending the area to 13,700ha.

(i) Cost for creation of arable land : 0

(ii) Cost for construction of pump station (6 units):

6 x 8,240,000 = ₱49,440,000

(iii) Cost for construction of irrigation and drainage facilities :
₱8,950 x 13,200 = ₱118,140,000

(iv) Cost for construction of weir and sedimentation basins (6 units):
6 x 2,230,000 = ₱15,480,000

(v) Road construction costs
6,803,000 x 5 routes = ₱34,015,000

Total ₱217,075,000
or ≒ $31 x 10^6

The total period for construction of the irrigation system will be 5.5 years, with 4 years for the construction work and 1.5 years as the preparatory period for the construction work.

(7) Economic appraisal

Calculation of the investment efficiency is made, taking into consideration the various costs which are generally required, in addition to the costs for construction of the irrigation facilities, and the internal interest rate is also calculated.

(1) Benefits of proposed area No.2

The benefits of the proposed area No.2 are listed in Table 3-7-5, Table 3-7-6 and Table 3-7-7. The internal interest rate is 2.71%, and if the irrigation is taken into consideration as an independent project, it cannot be considered economical in the common sense.

(2) Benefits of proposed areas No.3-No.7

The benefits of proposed areas No.3-No.7 are pre-

sented in Tables 3-7-8, 3-7-9, 3-7-10, 3-7-11, 3-7-12 and Figure 3-7-9, and the internal interest rate is 13.57%. Consequently, the irrigation project for this area can be considered appropriate from the economical point of view. The period of time required for construction of the various facilities is listed below.

(i) Irrigation and drainage facilities ₱118,140x10^3
(4 years, extending over the 2nd to the 4th year.)

(ii) Pump station (6 units) ₱49,440x10^3
(Completed in the 1st year and 2nd year)

(iii) Weir and sand precipitation facilities (6 places): ₱15,480x10^3
(Completed in the 1st year and 2nd year)

(iv) Road construction (5 estates): ₱34,015x10^3
(Completed in the last year)

Total construction cost : ₱217 x 10^6

(8) Conclusion

Study and investigation of the areas located in the midstream of the Cagayan River, which can be irrigated utilizing the regulated discharge water from the Diduyon Reservoir and building the necessary dam and other facilities, bring us to the following conclusions.

For the proposed areas No.1 and No.2, the construction of a water storage dam will require a huge investment, and thus, this alternative was discarded. We carried out studies into the possibility of irrigation of the proposed area No.2, which still presents some possibilities, based upon irrigation by means of a pumping system, but it was concluded that the internal profitability of this project is very low. Consequently an irrigation project, if taken into consideration individually, is not feasible in this areas of No. 1 and No. 2.

Next, we tried an economical appraisal of a plan to irrigate by means of a pumping system the presently non-irrigated area of the proposed sites No.3-No.7. The results of these studies indicate, as shown on Fig. 3-7-9., that the internal profitability is relatively high, being therefore economically appropriate in the future.

As it is easily seen from the discussions above, the numerical data on this irrigation project are estimated based upon general data obtained from the agricultural census, etc., because detailed data obtained by field investigation, etc. for each individual area are not available. Thus, in the next step of the study, if needed, a detailed appraisal should be made, taking into consideration detailed data on each individual area and the agricultural policies, development projects, etc. of the national and regional governments.

Summarizing the conclusions above, it can be said that in the areas not comprised in the Magat Project the global project of the Addalam River and the Cagayan Main River, irrigation projects for the proposed areas No.3-No.7 are expected to result in comparatively satisfactory agricultural results in the future.

However, since the area in question is excluded from the Magat project, it will require a considerable amount of investment. Thus, the final conclusion should be obtained by making a comparison with the agricultural projects throughout the entire Cagayan River region. In this sense, it is considered appropriate to make a detailed study of future agricultural projects using increases in the flux of water during the dry season resulting from the Diduyon storage reservoir.

As the final conclusion of the present study, it seems appropriate for the time being to materialize the Diduyon project as an independent power generation project, without taking into consideration the agricultural benefits which might be expected in the future in the downstream areas.