ANNEX IV

ENVIRONMENTAL IMPACT STUDY

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1. INTRODUCTION

This environmental impact study covers three potential hydroelectric power construction sites in the Itajai river basin. They have been selected as a result of initial study on which sixteen potential sites were examined. A run-of-river type was nominated for all the selected sites. The construction works involve a small scale dam with about 20 m in height, 2 km to 9 km long headrace tunnel including penstock, power house and other facilities for hydro-electric power generation and transmission. In this report, environmental impact study was conducted on the sites for dam, power house, access road and other facilities related to the construction works.

Objectives of this study are:

1) to examine present conditions of the environment and the patterns of the use of natural resources,
2) to examine the impact on land, river, vegetation and wildlife and on social environment as a whole;
3) to identify beneficial effects and adverse effects for the society nearby;
4) to recommend counter-measures to mitigate adverse effects on the project;
5) to elaborate further studies on the environment including ways to monitor the environment before and after the implementation of the projects.

These studies were carried out based on result of the fundamental investigation performed by CELESC. Recommendations on some changes to improve or reinforce the government regulations concerning the implementation of the project were made in this report as a result of the study.

2. ENVIRONMENTAL EXAMINATION FOR SALTO PILÃO (1) SCHEME

2.1 Present Environmental Conditions

2.1.1 The natural environment

(1) Topography

a) Methodology

Topographic investigations for the project area as a whole that are the primary task to determine the feasibility for the project has been conducted separately. In addition to the obtained topographic data, additional investigations were conducted with special reference to the environment. The work included the review and analysis of the existing 1:50,000 and 1:10,000 maps, aerial photo interpretation and the field surveys.

b) Present conditions

The river at the damsite runs through the hills whose relative heights ranges from 30 m to 100 m. The low slope gradient of these hills provides better opportunities for agricultural activity. Where slope gradient is high and usually limited to the river banks, the areas were kept intact from agricultural development. River bed slope is generally steep and the velocity of the river flow is rather fast. No water fall or cataract features the damsite. Hard rock outcrops in whole river bed at the damsite.

(2) Aesthetic value of the landscape

a) Methodology

Based on the interviews with the local residents, government offices and others concerned with the aesthetic value of the landscape in the project area, the importance in the aesthetic value of the landscape for the society was identified.

b) Present conditions

There is a tourist resort complex in the upstream area. It is located at the left bank of the river, immediately upstream of the dam axis -A. Overall area of the resort complex is more than 1 km^2. It consists of a hotel, a restaurant, a few picnic areas, barbecue stalls, a swimming

pool, a pond for recreational purposes, camping ground and a motor cycle racing circuit. There are also office building, staff quarters, farmland, pasture forest and some open land. They keep several horses for joy riding. Fishing is popular among the visitors which fill up the place every weekends throughout the year. Summer is the high season for the resort. The main area of the resort including all of their major facilities is subject to submerge if the dam axis-A or -B is selected.

(3) Vegetation

a) Methodology

The survey on natural vegetation including forest areas was conducted around the project site. Interviews with the concerned government agencies were made to obtain information. Their reports on the natural vegetation, although limited, were also collected.

b) *Present conditions*

The characteristics of the natural vegetation in Itajai valley is classified as the lowland dense rainforest, the Atlantic forest, stretching from the northeast corner to the southern end of Brazil. This forest belt creeps hillside of the Itajai valley because of the slow gradient of the basin and the abundant rainfall in the area throughout the year. During the past one hundred eighty years, because of the large concentration of human population in the Itajai valley, and due to their economic activities, mainly clearing the forest for the expansion of the agricultural area, the ecological continuity of the Atlantic forest has been disrupted over time. Felling the trees generated excessive light penetration to the forest floors and the changing temperatures on the ground altered the original conditions for the growth of vegetation in the area. There is an opinion that this has triggered a number of devastating flood to the lower Itajai river basin during the late 1970s and early 1980s. However, no clear substantiation specifically applicable to the area has not been established to date. There are many secondary forests around the damsite. The forest area is large compared with Dalbergia and Benedito Novo schemes. It is one of the important habitat for bird species in the upper Itajai river basin. There are small patches of reforested area on both side of the river and mainly pine trees are planted. The agricultural land is planted with upland crops such as cassava, corn and potato and other crops mainly for family consumption.

(4) Wildlife

a) Methodology

Prior to conducting the field work, available documents pertaining to the existing wildlife were reviewed. Interviews with local people for the possibility of existing wildlife were conducted to collect further information.

b) Present conditions

Some important bird species are found in the area. They are Jacuacu (Penelope obscura) and Araponga (Procnias nudicollis). The former is listed as a threatened species to extinction by the government of Brazil and the latter as an endangered species. In relation to the above two species, a group of pica-pau (Picummus and Veniliornis) species and several other species (Lurochalis, Anthracotorax, Sittasomus, Dysithamnus, Myiornis and Lochmias) are also important bird species living in the forest on the left bank of the damsite and that they are unique in this area.

There are two types of fish in this area: one adapted to rapid streams: the other adapted to still water. The former is Cascudo roseta (Ancistrus multispinis), Cascudinho (Hemipsilichathys), and Mandi (Pimelodus clarias) among many other species. The latter is Joaninha (Crenicichla lacustris), Acara (Geophagus brasiliensis) and others. They are consumed by local residents.Three fish species, Jundia (Rhandia quelen), Mandi (Pimelodus clarias) and Lambari (Astyamax sp., Deuterodon sp., and Bryconamericus iheringi) are the migrating in the river.

Because of a large concentration of human population and the subsequent clearing of the forest in the Itajai river basin during the past centuries, the ecological continuity of the Atlantic forest has been disrupted. Thus, there are a number of isolated "forest islands", which show the remnant of the original lowland dense forest. As a consequence, wildlife habitat has been drastically reduced to its detriment and most of the larger mammals faced extinction in the area. The major predators typical to the Latin American rainforest, such as Jaguar (Panthera onca) and Puma (Felis concolor) have not been observed for long time. It is believed that very few of them are still in the mountain ranges of the region. However, during the field survey, there was no evidence of predators at the time of this study. Neither the herbivorous animals on which the carnivorous animals prey are found.

(5) Water resources

a) Methodology

Data on water obtained from literature review as well as from the government agencies. Review of the surface water hydrology was conducted including the way that water resources are used by the local residents.

b) Present conditions

The entire basin in the upstream of the damsite is well developed for agriculture. Irrigated agriculture in the area demands relatively large amount of water for irrigation during the period between December and March. The quantity of water demand is shown in Table IV.2.2. Most of the rural households obtain water from the shallow wells developed individually. In the area where a community is formed, community water supply systems are developed. A few isolated households obtain water from the streams nearby. Water treatment system is considered to be substandard. Water quality for most of the houses in that area is substandard and spread of water-born diseases among the families nearby the project area is very common.

(6) Mineral resources

a) Methodology

The mineral deposits and their potentials are closely related to the geological formation. The study performed involves aerial photo interpretation, map study and collection and review of available information obtained from the Mineral Resources Department. Field reconnaissance survey was also conducted.

b) Present conditions

There is no mineral resource for which extraction of them could be economically viable.

(7) National parks and wildlife sanctuaries

a) Methodology

Prior to conducting the field work, available documents pertaining to the designation of national parks and wildlife sanctuaries were reviewed. Interviews with local people for the possible sites of values were made to collect further information.

b) Present conditions

There is no evidence of national parks and wildlife sanctuaries to be directly or indirectly affected by the project.

2.1.2 The social environment

(1) Population

a) Methodology

A survey on the number of population was carried out based on the available data obtained from the local government agencies. A field survey to complement the review of the population data was also conducted.

b) Present conditions

The population center directly affected by the Salto Pilão scheme is Lontras, several km upstream of the damsite. More than 87 households in the project area are subject to relocation if the dam axis -A or -B is selected. The size of the population in Lontras is 7,623 in 1989. Of the total population, the urban population is 64% and the rural population is 36%. During the past 19 years, the population of the area shifted from the rural to urban. As a result, the population engaged in industry, commerce and services significantly increased. The population in Lontras is shown in Table IV.2.1.If the dam axis A or B is selected, the tail of the impounded water will reach to Rio do Sul, approximately 15 km upstream of the damsite. The population of this town is 44,108 in 1989. Of the total population, 95% is urban and the rest is rural population. The population in Rio do Sul is shown in Table IV.2.1.

(2) Land use

a) Methodology

The survey for land use was carried out using aerial photographs which were shot in November 1990. A topographic map of 1:50,000 and 1:10,000 scale are also used. Based on the aerial photo interpretation, ground reconnaissance survey was carried out for identification of the types and the surface area of the present land use.

b) Present conditions

Development of farm land is limited to gentle hillside and relatively flat areas, which are usually available on the hill tops around the damsite because of the ragged topography around the damsite. Average rainfall in the area is relatively evenly distributed throughout the year and the average sun light available for the growth of agricultural crops is high during the growing season. The scale of farming is limited to small scale family farming. Livestock rearing is common in the area and two to three cattle are kept every one ha of land. Because of the abundant water supply in the area, no excessive vegetation damage was observed in the area where livestock is concentrated.

In general, land capability is medium to high. However, it is vulnerable as it depends on the amount and timing of the rainfall and the sun light. Average yield of crops in the area is shown in Table IV.2.3.

The areas affected by the project are mainly rural agricultural zone. There are comparatively small area of forest to be affected. Urban areas are also involved according to the land classification of the municipality. The area is no more than a mixture of forested areas on the banks of the river, grassland and abandoned farmland. Present land use areas are shown in Table IV.2.4 and its geographical areas are shown in Fig. IV.2.1. Fig. IV.2.2 shows the zoning plan of the municipality within which the project is located.

(3) Economic activities

a) Methodology

Review of the existing information on the agriculture, commerce and industry and other economic activities available from the government offices was conducted. Based on the field survey, the local economic activities ranging from agriculture to industries were also identified.

b) Present conditions

The economic activity in Lontras is mainly agriculture including livestock rearing. There are 807 property holders in agriculture. Total agricultural area is 10,595 ha and the average size of agricultural holding is 13.1 ha. Cattle and sheep are major livestock and milk is the major source of income for the rural population. Major crops grown in the area are shown in Table IV.2.3 and the agrarian structure in Lontras is shown in Table IV.2.5.

The major industries in the secondary sector in Lontras consist of furniture making, transportation of non-metallic products, textile, and shoe manufacturing. They employ more than 50 % of the workforce of the secondary sector. Other industries are construction material making, maize and tapioca manufacturing and a small scale foundries. They consist of 15 establishments. To a limited extent, timber industry is a part of rural economic activities. However, no logging operation around the damsite is involved. The structure of secondary sector is shown in Table IV.2.6. The commercial and service sectors including urban services and tourist industry increased from 64 establishments to 73 establishments between 1970 and 1980 and then decreased to 35 in 1989. Most of them consist of local shops for food, drinks, clothing, car repairing and maintenance services including petrol stands and the shops for daily necessities. The structure of tertiary sector is shown in Table IV.2.7.

In Rio do Sul, major agricultural crops are oranges, grapes, sugar cane and tobacco. Cattle for milk production and sheep for meat is the major livestock production. The major industries in the secondary sector is Rio do Sul consist of small scale foundry, timber industry, furniture making, clothing, transportation of non-metallic products, tapioca and maize, flour making, construction materials making, and others manufacturing industries such as toys, plastic packing materials. They are 206 establishments in total.

There are 687 establishments for commercial and service sector in Rio do Sul. Types of commercial and service establishments are approximately the same as that in Lontras. Tables IV.2.5 to IV.2.7 show the economic activities in Rio do Sul.

(4) Public health

a) Methodology

Data on public health in the area were collected from local government offices. Review of literatures relating to public health in the project area was also conducted. Interviews with

local residents were also conducted to obtain actual information on increase or decrease of water-born diseases or any other diseases that may be induced by impoundment of the water of the river.

b) Present conditions

Because the accurate data on public health are not available specifically applicable to the project site, no specific study was conducted. However, it appears that the water-born diseases such as diarrhea are common among the local residents. It has been reported that the fish in the upstream area was killed. No clear substantiation has been made to date. However, it is believed that killing fish are caused by excessive use of agricultural chemicals. Also, although the scale is small, industrial waste discharge, which is relatively uncontrolled in the area, is also believed to be one of the factors for killing fish. Table IV.2.8 shows the present use of agricultural chemicals and the sources of pollution of the area.

(5) Historical and archaeological sites

a) Methodology

Prior to conducting the field work, available documents pertaining to history, archaeology, and culture of primitive settlers of the area were reviewed. Interviews with local people for the possible sites of values were made to collect further information. Aerial photos of the area were also interpreted to identify possible sites of cultural value.With the available information, field survey was conducted to identify cultural sites.

b) Present conditions

There are no historical and archaeological sites significant for academic value as well as for tourism.

2.2 Effects of Salto Pilão (1) Scheme

2.2.1 The natural environment

(1) Landscape

The area at the opposite site of the resort complex is planned to be used for quarry site for construction materials. Change of landscape viewed from the resort complex will be a

significant degradation to the value of the resort complex if the project was implemented. Activity in the quarry site will also affect fishing activity in the river to a large extent during the construction period.

There are quarry site, disposal area and areas for construction of power house, access road for construction sites and other ancillary facilities for the project. These facilities are scattered over wide area and most of them are located in the agricultural areas and pasture. Small area of wetland, presently not used, will be used for disposal of the excavated material. Detailed field surveys on vegetation, wildlife, land use, etc., have not been conducted to these areas because of comparatively small areas and the small scale of possible effect to the environment. However, a brief field survey revealed that the impact on the natural and on the social environment is considered very small.

(2) Natural vegetation

There is no significant tract of undeveloped or wilderness areas to be submerged by the construction of the dam. The natural forest area to be submerged by the project is limited to the river bank vegetation area. Such area has already been isolated from the significant ecological continuity of the original natural forest for a considerable long period of time. In general, such isolated area cannot support significant population and kinds of wildlife species at all. Although the riparian forest continues to provide timber, which is one of the important exporting commodities for the state of Santa Catarina, such small portion of forest is not economically viable from the forestry point of view.

The reservoir is not designed to provide irrigation scheme for the downstream and up-stream regions. Thus no increase of population over wild land for cultivation is expected to occur and that there will be no consequences of clearing natural vegetation along the river except which a limited area has to be cleared for construction works.

(3) Wildlife

The important bird species, Jacuacu (Penelope obscura) and Araponga (Procnial nudicollis) and its habitat will be lost if the dam axis -A or -B is selected. With the selection of the dam axis -C, construction work may affect the habitat of these birds.Jacuacu is listed as a threatened species to extinction and Araponga is an endangered species. In relation to the above two species, a group of pica-pau (Picummus and Veniliornis) species and several other species (Lurochalis, Anthracotorax, Sittasomus, Dysithamnus, Myiornis and Lochmias) are also the bird species which will be affected by the project. They are living in the forest in the left bank

of the damsite and that they are unique to this area. Some fish, especially those adapted to still waters, will increase in the reservoir area. Among many species, Acara (Geophagus braziliensis) is the major species. On the other hand, the fish population adapted to rapid streams will decrease to some extent.

The following is the fish species migrating upstream and downstream of the river;

(i) Jundia (Rhamdia quelen)

(ii) Mandi (Pimelodus clarias)

(iii) Lambari (Astyamax sp., Deuterodon sp., and Brycronamericus iheringi)

Their migration route may be disrupted by the construction of dam. Study on these species is important.

The area has been heavily exploited for logging for the past few decades. The logging operation is still very active in the upstream area. Agricultural activities have cleared most of the natural forest areas adjacent the damsite and there is no ecological continuity of forest for wildlife. Thus wildlife have already been eradicated from the area. Only with exceptional cases, increase or decrease of mammals and other wildlife species such as reptiles may occur.

(4) Water resources

Creation of reservoir will generally bring about deposition of sediment in the reservoir, eutrophication and lowering of river bed in the downstream stretch. The reservoir in this scheme is not so large as to vary the duration of the river flow, but the river discharge in the stretch between damsite and tailrace will be reduced due to intaking of a part of river discharge for power generation. DNAEE sets out that the river maintenance flow (RMF) should be 80 % of the monthly minimum discharge (MMD) for the available recorded period. According to the hydrological calculations for this scheme, the relation among MMD, RMF and river discharge to be released in case of the monthly mean discharge for 1941 - 1987 period is as shown in Table IV.2.9. This table shows that the river discharge to be released exceeds the requirement. However in case of the dry season, water release would not always meet RMF. The result of the environmental impact study clarifies that there are no water utilization between the dam and tailrace sites and only several houses are located along this stretch. Considering these situations, it was judged that no influence exerts to the downstream reaches even if the river water is used for power generation.

The rising level of groundwater as a result of impounding the water in the reservoir will be of permanent nature. Depending on the crops grown on the farmland, ground moisture will positively or negatively affect the growth of crops.

Groundwater levels along the reservoir areas may rise with possible improvement of water quality if the dam axis-A or -B is selected. The rising level of groundwater may benefit a large number of local residents living along the reservoir area because the shallow well development may be enhanced in the area where there is no groundwater and it was not tapped in the past. The dam axis-C will affect no part of the residential area around the reservoir area. No agriculture in the upstream or downstream regions will be directly affected by the project. However, the rising level of groundwater may in the long term affect the soil moisture conditions in the farm land along the reservoir area.

(5) *Existing national parks and wildlife sanctuaries*

There are no designated conservation areas such as national parks and wildlife sanctuaries, or the areas of similar nature, which will be affected by the implementation of the project.

2.2.2 The social environment

(1) Population

a) Methodology

Resettlement for the submerged area is needed. Data on the resettlement of residents including their commercial activities were collected. Reviewing the existing information, maps and field survey on the areas to be affected by the project were conducted.

b) Definition of compensation area

According to the interpretation of the federal government's regulations and the current administrative practice of some municipalities of the state of Santa Catarina, the area subject to compensation includes 15 m strip of land along the edge of the reservoir area. However, depending on the locality, there are areas not subject to compensation as the rising level of the river do not change any geographic conditions except on the margin of the river. Cross section of the defined compensation area is shown in Fig.IV.2.3.

c) Present conditions

With the selection of the dam axes-A and -B, 87 units of household are subject to resettlement. For the dam axis -C, 9 units are relocated. If the dam axis-A or -B is selected, the tail of the impounded water will reach to Rio do Sul, approximately 15 km upstream of the damsite. There are no houses to be submerged. However, rising level of the river water from one to two m depending on the locality may submerge a part of the river banks, which is classified as the urban area under the present government regulations. Affected areas, compared with other two schemes, are shown in the Tables IV.2.10 and 2.11, and in Fig.IV.2.4.

d) Probable socio-economic effects

With the possible realignment of the existing road in the upstream of the damsite, a few units of household will also be affected if the dam axis-A or -B is chosen. The dam axis-C will not involve any realignment of the existing road.

It is important that the local residents are correctly informed on the compensation. On the other hand, no residents unrelated to the resettlement scheme should be encouraged to speculate for any unjustified compensation from the project. The strict law abiding of the existing government regulations for compensation of the loss of properties may cause speculative movement for the compensation among the local residents. It may affect the increasing cost of compensation. Thus the assessment for compensation should be carefully conducted with a support of experienced expertise on law.

Hardship may be experienced by the evacuees during the negotiation, evacuation, and the settling process. To avoid this:

- their existing properties should be correctly valued and similar value of properties should be nominated and offered for the best possible solution of the compensation:
- their belongings should be transported without damages:
- evacuees should be able to adapt themselves to the new living conditions with minimum conflicts. Any assistance for this should be provided by the evacuation program.

Therefore the evacuation program should be well planned and organized.

(2) Changes on land use and economic activities

It is presumed that the current patterns of land use are continued even after the completion of the project. There will be very small loss of the available land area for seasonal and annual use whichever the dam site is selected. With the selection of the dam axis-A or -B, the area to be submerged by the impounded water will be 259 ha and 288 ha along the river respectively. It involves removal of 87 units of household. The submerged area will be a mixture of grassland including privately owned resort complex, pasture, bush, cultivated land and residential areas. The resettlement scheme for 87 households can be a comparatively large size operation. The changes on agricultural activities will be minimum although resettlement of 87 households are needed if the dam axis-A or -B is selected. There is no forestry activity to be affected by the project. There will be no increase or decrease of fishery operations in the river within the foreseeable future. No loss of wildlife and forest products will take place. However, pasture in the area will be permanently lost if the dam axis-A or -B is selected. Depending on the area lost to a unit of operation, one may have to change his cattle rearing operation. Subsequently, adjacent agricultural land may be reverted to pasture. However, no severe changes on land use may affect the economic activities of the area as a whole.

The resort complex upstream of the damsite may have to discontinue its operation if the dam axis -A or -B is selected. Loss of income to the local economy may be large if there are no visitors to the area. Full assessment on this should be made before the implementation of the project.

The local residents around the damsite obtain fuel wood for their daily energy. There is a possibility that clearing of forested area for the construction works of the project might damage a part of the area for obtaining fuel wood.

Changes on the existing road may occur if the dam axis-A or -B is selected. The axis-C will not involve realignment of the existing road. There will be approximately 1,500 m of new road construction involved in the project. It may enhance the local communication system after the completion of the project. There will be some increase of navigable portion of the surface water. However, the scale of the impounded water is very small and it will not provide any useful means of transportation for any purpose.

(3) Public health

In view of the use of agricultural chemical in the upstream region, the river water should be carefully examined before it is made available for human consumption and

agricultural use. There was a number of incidents reported in respect of dying fish, although the relationship between the agricultural chemicals and dying fish has not been fully investigated. The use of agricultural chemicals and the sources of pollution, comparing to other two schemes, are shown in Table IV.2.8.

It is probable that the reservoir may trap some amount of agricultural chemicals, as present natural rock outcrop may trap some amount of agricultural chemicals. Thus for use of the impounded water for irrigation or for domestic purposes, sufficient examination for water quality will be needed. Eating fish of the river should be warned by the local government upon detection of pollutant in the river.

(4) Cultural property

No site significant on historical, archaeological and religious values to the local community as well as for the national level was found in the adjacent areas of the damsite.

2.3 Summary of the Effects

2.3.1 Positive effects

(1) The natural environment

No part of the natural environment except for the following water resources is subject to positive effect.

With the dam axis-A or -B, the rising level of groundwater may increase the chance of obtaining water from shallow wells where previously no such development of wells was feasible for obtaining water. The impounded water will be very significant for which the development of irrigation scheme in the upstream area is possible and that the collective use of water is introduced to the area. Besides,it will be able to expand the scheme for further large scale commercial operation. However, it depends on the availability of land and the analysis of economic viability of the area of operation.

(2) The social environment

No part of the social environment is subject to positive effect.

2.3.2 Negative effects

(1) The Natural environment

a) Vegetation

A part of the area subject to submerge is covered with natural vegetation and it is a habitat for bird threatened to extinction. If trees and bushes were cleared, palatable grassland for livestock rearing is obtained. Depending on the slope gradient, value of the grassland is significant. If the dam axis-C is selected, no loss of potential pasture will occur.

b) Wildlife

The important fish and birds will be affected by the project. There is no other wildlife of any significance existing in the area. Thus no negative effect on them is expected.

c) Water resources

With the selection of the dam axis-A or -B, there is a possibility of contaminating shallow well which is the most popular means for obtaining potable water in the area. No downstream region's water supply system will be affected by the project.

With the rising level of groundwater, if the dam axis-A or -B is selected, the existing shallow wells may be contaminated by the domestic waste waters or industrial waste, or a combination of them, depending on the locality and the function of the waste management systems of the area. There may be some amount of agricultural chemical trapped in the impounded water for a long time. Thus careful examination should be made for the use of impounded water. Besides some sort of control mechanism should be introduced for the use of agricultural chemicals if the relationship between the use of agricultural chemicals and dying fish population was substantiated.

(2) The Social environment

a) Population

87 households are involved in the resettlement arrangement with the selection of the dam axis-A or -B. Besides the resettlement arrangement needs for a large area of tourist resort

complex and some 25 different buildings. Assessment of the extent on changes of the existing life style, economic activities, and general standard of living of the evacuees will be difficult.

b) Land use

With the selection of the dam axis-A or -B, moisture content of the soil will cause significant changes on the land use in agriculture. The consequence of resettlement will involve further loss of natural vegetation area. The owner of partially affected agricultural land will have to find separate areas for cultivation in order to fill the deficit on harvest created by the loss of property. The consequence will be that they have to make clear the area with natural vegetation, often adjacent to their farm land. The selection of the dam axis-C will not involve any significant changes on land use.

With the selection of the dam axis-A or -B, some 590 m of realignment of the existing roads will be involved. Depending on the locality, present road network is negatively affected. It also may involve further purchase of land for up-grading the road conditions, which affect agricultural areas, or natural forest.

c) Public health

With the selection of the dam axis-A or -B, there will be a possibility for contaminating groundwater. As a consequence, water-born disease will spread depending on the locality.

2.4 Recommendations to Minimize Negative Effects

2.4.1 The natural environment

(1) Landscape

Since it is anticipated that the aesthetic value of the landscape across the river where a quarry area is located will be lost, an adequate measure to avoid disturbance of the landscape should be considered in the planning.

(2) Vegetation

The remnant of natural forest in the left bank of the damsite should be studied as a habitat for bird species face extinction. As a result of the study, if the area is found to be of prime importance for the bird species, some measures for preservation should be taken. With

the thorough study on the existing plant species, significant wild plant species should be identified. They should be checked against the list of endangered species elaborated by the government of Brazil and/or relevant organizations such as the World Wide Fund for Nature (WWF) of Brazil and others. The check list made by the International Union for Conservation of Nature (IUCN) is also one of the internationally recognized material.

(3) Wildlife

In order to minimize the effect to the bird species living in the forests along riverine areas, it is desirable to minimize the area of forest to be submerged. Unless the schemes with the dam axis-A or B is superior to the scheme with the dam axis-C from the viewpoint of economic viability or other environmental aspects, the dam axis-C should be selected. Besides, fish breeding by increasing the population of fish adapted to still water should be planned. But for its implementation, special consideration of adverse effects such as eutrophication and reduction of the existing fish due to fish migrations should be taken. Further study and observation on ecological structure will be needed.

(4) Water resources

Since sediment load in the river is very few and there are no sediment deposit in upstream and downstream from the damsite, sediment deposit in the reservoir and lowering of river bed in the downstream will be solved by proper operation of gates provided in the dam. Eutrophication problem will be also solved by proper operation of gates. It was judged from the present riverine condition that there are no effect to the river stretch between the damsite and tailrace though the river discharge is reduced. If some disadvantage takes place in future stage it can be solved by gate operation. In this occasion a part of river water to be used for power generation will be lost. An artificial variation of river water level in the downstream from the tailrace will be solved by warning for water release. Regarding rise of groundwater near the reservoir area, its utilization and measure should be planned based on the investigation after impounding of the reservoir. As stated in item for public health, contamination of water quality due to use of agricultural chemicals and industrial waste water may take place. Unless such water contamination due to drainage from cities in the upstream area is properly controlled, eutrophication problem cannot be avoided. Overall management of river environment including observation of water quality will be needed.

2.4.2 The social environment

(1) *Population*

Unless the schemes with the dam axis-A or B are economically superior to the scheme with the dam axis-C, the dam axis-C which is the minimum for resettlement problem should be selected.

The idea of resettlement on a better-off condition and minimizing the changes of existing socio-economic structures as well as the basic policy requirement should be taken into consideration in the investigation and planning for the resettlement site. Available information on the resettlement sites from the local and national government agencies, whichever is appropriate, should be sufficiently examined.

The following should be conducted in order to identify the best possible site for resettlement;

(i) Socio-economic base line study of the residents expected to relocate as a benchmark of social conditions. It consists of a detailed demographic structure, family structure and cultural background of the residents affected by the project;
(ii) Socio-economic survey for the sample families near the resettlement site;
(iii) Land use survey for the proposed resettlement site;
(iv) Reconnaissance for water resources in the proposed resettlement site;

Depending on the availability of the site, a few sites should be nominated for resettlement. Each site is subject to the above survey. Comparison to select the best potential resettlement site should be conducted for planning and further investigations. The planning of a new resettlement sites should be subject to an examination on the possible agricultural development, accessibility, available infrastructures and public services, land tenurial status, socio-economic similarity to the existing conditions in the project area, and preference of the evacuees. Depending on the degree of development of the project, there might be a possibility of attracting the local residents to the areas around the project area. It should be thoroughly studied so that the concentration of the local residents to the project area do not cause any adverse effect on the project.

(2) Land use and economic activities

Unless the schemes with the dam axis-A or B are superior to the scheme with the dam axis-C from the viewpoint of the economic viability and other environmental aspects, the scheme with the dam axis-C should be selected. Since it is a anticipated that the aesthetic value of the landscape across the river where a quarry area is located will be lost, an adequate measure to avoid disturbance of the landscape should be considered in the planning.

Based on the initial survey of the project area, detailed land use map should be prepared. The following information should be contained on the land use map;

- Residential/urban centers
- Mixed agricultural/residential area
- Farming area
- Old clearing area
- Livestock area
- Forest area
- Tourist area

If impound water is planned to be used for the future irrigation scheme, expected land for irrigation scheme should be also included the land use map. The same land use map should be prepared for the resettlement area for planning.

(3) Public health

Overall management of water environment including observation of water quality is needed. In relation to the groundwater level, management of the domestic waste water and the industrial waste should also be examined. Depending on the locality, revision of the domestic waste water and industrial waste management systems may need to be conducted. Reinforcement of the existing government regulations relevant to the public health scheme may also need to be carried out.

3. ENVIRONMENTAL EXAMINATION FOR DALBERGIA SCHEME

3.1 Present Environmental Conditions

3.1.1 The natural environment

(1) Topography

a) Methodology

Topographic investigations for the project area as a whole that are the primary aspect to determine the feasibility of the construction works have been conducted separately. In addition to the obtained topographic data, additional investigations were conducted with special reference to the environment. The work included the review and analysis of the existing 1:50,000 and 1:10,000 maps, aerial photo interpretation and the field surveys.

b) Present conditions

The river at the damsite runs through the hills whose relative heights are ranging from 80 m to 100 m. Low to high slope gradient of these hills provide limited opportunities for agricultural activity. Where slope gradient is steep, usually limited to the river banks, the areas were kept intact and the natural forest, or its secondary forest growth remained to date. River bed is generally flat and the velocity of the river flow is relatively slow. No water fall or cataract features the project site. A series of outcrop of rock forms almost whole of the area of river bed at the damsite.

(2) Aesthetic value of landscape

a) Methodology

Based on the interviews with the local residents, government offices and others concerned with the aesthetic value of the landscape in the project area, the importance in the aesthetic value of the landscape for the society was identified.

b) Present conditions

There was no evidence and no opinion among the local people that the area is of significant aesthetic value to their life style and for the nation as a whole.

(3) Vegetations

a) Methodology

The survey on natural vegetation, including forest areas, was conducted around the project site. Interviews with the government agencies concerned were made to obtain information. Their reports on the natural vegetation, although limited, were also collected.

b) Present conditions

The characteristics of the natural vegetation in the Itajai valley is classified as lowland dense rainforest, the Atlantic forest, stretching from the northeast corner to the southern end of Brazil. This forest belt creeps on to the hillside of the Itajai valley because of the slow gradient of the basin and the abundant rainfall in the area throughout the year. During the past one hundred eighty years, because of the large concentration of human population in the Itajai valley for their economic activities, the forest was cleared for expansion of agricultural area. Thus, the ecological continuity of the Atlantic forest has been disrupted over time. Felling the trees generated excessive light penetration to the forest floors and the changing temperatures on the ground level altered the original conditions for the growth of vegetation of the area. There is an opinion that the clearing the forest on the mountain slopes of the Itajai river basin has triggered a number of devastating flood to the lower Itajai river basin during the late 1970s and the early 1980s. However, no clear substantiation on the cause of the flood was made to date. The vegetation around the damsite is a mixture of riparian forest, which is presumably the secondary natural forest, limited patches of grass land, and agricultural land including pasture. The riparian forest covers the river banks with steep slope. The agricultural land is planted with upland crops for family consumption near the damsite. Pasture land appears to be forming a part of the distant landscape.

(4) Wildlife

a) Methodology

Prior to conducting the field work, available documents pertaining to the existing wildlife were reviewed. Interviews with local people for the possibility of existing wildlife were conducted to collect further information.

b) Present conditions

There is a large number of bird species identified in the project area. All of them are common species in Southern Brazil. Endangered species such as Pato-mergulhador (Mergus octocetaceus) and Soco-boi-escuro (Tigrisoma fasciatum) are expected to record in the area. However, non of them have been identified at the time of the study.

There are two types of fish in this area: one adapted to rapid streams; the other adapted to still water. The former are Cascudo roseta (Ancistrus multispinis), Cascudinho (Hemipsiilichathys), and Mandi (Pimelodus clarias) among many other species. The latter are Joaninha (Crenicichla lacustris), Acara (Geophagus brasiliensis) and others. They have been consumed by the local residents.

No large mammals are found in the project area. Because of a large concentration of people in the Itajai river basin, the ecological continuity of the forest has been disrupted. The fragmented forest patches, the "forest islands", today show the remnant of the old Atlantic forest. As a consequence, wildlife habitat has been drastically reduced to its detriment and most of the larger mammals faced extinction. The major predators such as Jaguar (Panthera onca) and Puma (Felis concolor) were not recorded in the area for long time. It is believed that a very few of them are still in the Itajai mountains. However, during the field survey, there was no evidence of carnivore, which are on the apex of the food chain of wildlife. There has also been no evidences of herbivore, on which the carnivore prey, in the project area.

(5) Water resources

a) Methodology

Data on water supply were obtained from literature review as well as from the government agencies. Review of the surface water hydrology was conducted including the way that water resources are used by the local residents.

b) Present conditions

Most of the rural households obtain water from the shallow wells developed individually. In the area where a community is formed, village and town water supply systems are developed. A few isolated households obtain water from the streams nearby. Water treatment system is considered to be substandard compared with the international standard. The

quality of water being used by most of the houses is substandard and spread of water-born diseases among the families living near the project area is very common.

(6) Mineral resources

a) Methodology

The mineral deposits and their potentials are closely related to the geological formation. The mineral resources study performed consists of aerial photo interpretation, map study, and collection and review of available information obtained from the Mineral Resources Department. Field reconnaissance survey was also performed.

b) Present conditions

There are no mineral resources for which extraction of them will be economically viable.

(7) National parks and wildlife sanctuaries

a) Methodology

Prior to the conducting the field work, available documents pertaining to the designation of national parks and wildlife sanctuaries were reviewed. Interviews with local people for the possible sites of values were made to collect further information.

b) Present conditions

There is no evidence of national parks and wildlife sanctuaries to be directly or indirectly affected by the project.

3.1.2 The social environment

(1) Population

a) Methodology

A survey on the number of population was carried out on the available data obtained from the local government agencies. A field survey to complement the review of the population data was also conducted.

b) Present conditions

The largest population center to be directly affected by the Dalbergia scheme is Dalbergia, a few km upstream of the damsite. 5 units of households in the area will be submerged if the dam axis-A or -B is selected. For the dam axis-C, 8 houses, but different units, are subject to submerge. The size of population in Dalbergia cannot be clearly established because the census data include Ibirama, the administration center of the municipality in which the project site is located. Ibirama is located at 7 km downstream of the damsite. The total population in Ibirama increased to 25,814 in 1989 from 21,000 in 1970. During this period, the urban population increased from 4,180 to 11,470, or from 20 % to 44 % respectively. The increase in urban population is due to the decrease in job opportunities in the agricultural sector as agricultural mechanization was conducted during the period. The population in Delbergia is shown in Table IV.2.1.

(2) Land use

a) Methodology

The survey for land use was carried out using aerial photographs which were shot in November 1990. A topographic map at a scale of 1:50,000 and 1:10,000 were also used. Based on the aerial photo interpretation, ground reconnaissance survey was carried out for which the types and the surface area of the present land use around the project site were identified.

b) Present conditions

Irrigation system in the upstream area has not been well developed compared with the Salto Pilão scheme. As shown in Table IV.2.2, demand of water for irrigation in the area is

less than one-fifteenth of what is demanded for Salto Pilão area. Because of the ragged topography of the area adjacent to the damsite, development of farmland is limited to steep hillside and very narrow flat areas, which is usually available on the river banks. Average rainfall in the area is evenly distributed throughout the year, although it is depending on the recent changes of the global climate. The average sun light available for plant growth is high during the growing season. The scale of farming is limited to family farming and the surplus harvest are sold, or bartered for exchange of other crops. Livestock rearing is common in the area and two to three cattle are kept in every one ha of land. Because abundant water is supplied in the area and small herds are kept in the enclosed pasture, no excessive vegetation damage was observed. In general, land capability around the damsite is medium to high, although it depends on the amount and timing of the rainfall and the sun light. Average yield of agricultural crops in the area is shown in Table IV.2.3.

There are comparatively small scale reforested area adjacent to the damsite. However, a very small margin of it is affected by the project. Present land use area is shown in Table IV.2.4 and Fig.IV.3.1. Fig.IV.3.2 shows zoning plan of the municipality. However, the zoning plan for Dalbergia is not available to date.

(3) Economic activities

a) Methodology

Review of the existing information available from the government offices on the agriculture, commerce and industry and other economic activities was conducted. Based on the field survey, the local economic activities ranging from agriculture to industries were also identified.

b) Present conditions

For the same reason as population data, the data on economic activity in Ibirama and Dalbergia cannot be separated. The economic activity in Ibirama/Dalbergia area is mainly agriculture including livestock rearing. There are 2,462 property holders for agriculture in 1985. Total agricultural area is 11,427 ha, or 31 % of the total area of the municipality, in the same year. The average size of agricultural holding is 4.6 ha. Of the total area of the municipality, some 11,925 ha, or 30 % is left for fallowing every year. The major crops grown in this area are bananas, tangerine, sugar cane, sweet potato and tobacco. Tobacco accounts for 58 % of the gross agricultural production. Cattle, pigs and goat are major livestock. Milk is one of the major sources of income for the rural population. The agrarian structure in Dalbergia is

shown in Table IV.2.5. The major industries in the secondary sector in Dalbergia is timber industry. There are 35 establishments employing 1099 rural population of the municipality. Textile industry, 22 establishments, employs 1,108 rural population. These two industries employ more than 50 % of the workforce of the secondary sector of the municipality. Other industries are shoe manufacturing, brick making, steel and aluminum building material manufacturing, furniture making, food processing, printing, leather article production and the industry related to textiles. The structure of the secondary sector in Dalbergia is shown in Table IV.2.6. The commercial and service sectors in Dalbergia/Ibirama including urban services and tourist industry increased from 170 establishments to 414 establishments for 1970 - 1989 period. The employees increased from 385 in 1970 to 1,642 in 1989. Food shops including restaurant and hotels and clothing shops are the major occupations. The structure of the tertiary sector in Dalbergia is shown in Table IV.2.7.

(4) Public health

a) Methodology

Data on public health in the area were collected from local public offices. Various reports relating to public health in the project area was also reviewed. Interviews with local residents were conducted to obtain actual information on increase or decrease of water-born diseases or any other diseases that may be induced by the impoundment of the river water.

b) Present conditions

Because the accurate data on public health are not available, no specific study on public health was conducted. However, from the general statistical data available for the region, it appears that the water-born diseases such as diarrhea are common among the local residents. The data on parasitology, bacteriology and other causes of diseases shows no evidence of prevailing local diseases.It has has been reported that the fish population in the upstream area has decreased. No clear substantiation has been made to date. However, it is believed that killing fish are caused by excessive use of agricultural chemicals. Industrial waste discharge, which is relatively uncontrolled in the area, is also believed to be one of the factors for killing fish. The consequence of this will be that the water for domestic use, which is obtained from the shallow well will be contaminated over time unless the use of agricultural chemicals is properly controlled.

(5) Historical and archaeological sites

a) Methodology

Prior to conducting the field work, available documents pertaining to history, archaeology, and culture of primitive settlers of the area were reviewed. Interviews with local people for the possible sites of such values were made to collect further information. Aerial photos of the area have also been interpreted to identify possible sites of cultural value. With the available information, field survey was conducted to identify cultural sites. The possibility of evidences of artifacts, monuments, or any forms of arts were attempted to identify.

b) Present conditions

Stone arrow heads were found near the project site in the past. One of the local residents living in the right bank near the dam axis-B, possess 54 stone arrow heads found in his farmland. These arrow heads are not clearly substantiated as to whether they are of archaeological value. No other historical and anthropological sites were recorded in the project area.

3.2 Effects of Dalbergia Scheme`

3.2.1 The natural environment

(1) Landscape

No loss of aesthetic site for relocation, etc is involved with the project. There are quarry site, disposal area and areas for construction of power house, access road for construction site and other ancillary facilities of the project. The areas for these facilities are scattered over wide areas. Location of each area is in the agricultural area, except for a couple of them are in the next to residential areas. Detailed field surveys on vegetation, wildlife, land uses etc., have not been conducted due to its size and the scale of possible effect to the environment. However, a brief field survey revealed that the impacts on the natural and on the social environment are considered very small.

(2) Natural vegetation

There is no significant tract to undeveloped or wilderness areas to be submerged by the construction of the dam. The natural forest area to be submerged as a result of the project is

limited to the river bank vegetation area and it has already been isolated from the significant ecological continuity of the original natural forest. In general, such isolated area cannot support significant number and kinds or wildlife species at all. Although the riparian forest continues to provide timber, which is one of the important exporting commodities for the state of Santa Catarina, and fuel wood to some extent, the forest in the submerged area is very small and isolated. Such small portion of forest is not economically viable from the forestry point of view.

The reservoir is not designed to provide irrigation scheme for the downstream and upstream regions. Thus no increase of population over wild land for cultivation is expected to occur and that there will be no consequences of clearing natural vegetation along the river.

(3) Wildlife

Fish, especially those adapted to still waters, will increase in the reservoir area. Among many species, Acara (Geophagus braziliensis) is the major species which may increase its population. On the other hand, the fish population adapted to rapid streams will decrease to some extent. No bird species and their habitat are adversely affected by the project.

The logging operation is still very active in the Itajai river basin, especially in the up-stream region of Dalbergia. Agricultural development has been responsible for most of the forest clearing operation and that the ecological continuity of the Atlantic forest has been lost during the past two centuries. Thus neither increase nor decrease in wildlife species is expected to occur by the implementation of the Dalbergia scheme.

(4) Water resources

Creation of reservoir will generally bring about deposition of sediment in the reservoir, eutrophication and lowering of river bed in the downstream stretch. The reservoir in this scheme is not so large as to vary the duration of the river flow, but the river discharge in the stretch between damsite and tailrace will be reduced due to intaking of a part of river discharge for power generation.

DNAEE sets out that the RMF should be 80 % of MMD. According to the hydrological calculations for this scheme, the relation among MMD, RMF and river discharge to be released in case of the monthly mean discharge for 1935 - 1987 period is shown in Table IV.2.9. This table shows that the river discharge to be released exceeds the requirement. However in case of the dry season, water release would not always meet RMF. The result of the environmental

impact study clarifies that there are no water utilization between the dam and tailrace sites and only several houses are located along this stretch. Considering these situations, it was judged that no influence exerts to the downstream reaches even if the river water is used for power generation.

Groundwater levels along the reservoir areas may rise with possible improvement of water quality. The rising groundwater level may benefit only a handful number of residents living along the reservoir area whichever the dam axis is selected. Where there is no groundwater and it was not tapped in the past, shallow wells could become one of the easiest ways to obtain water for domestic and agricultural uses.

(5) Existing national parks and wildlife sanctuaries

There are no designated conservation areas such as national parks and wildlife sanctuaries to be affected by the implementation of the project.

3.2.2 The social environment

(1) Population

a) Methodology

Data on the resettlement of residents including their commercial activities were collected. Review on the existing information, maps and field survey on the areas to be affected by the project were conducted.

b) Definition of compensation area

According to the interpretation of the federal government's regulations and the current administrative practice of some municipalities of the state of Santa Catarina, the area subject to compensation includes 15 m strip of land along the edge of the reservoir area. However, depending on the locality, there are areas not subject to compensation as the rising level of the river do not change any geographic conditions except on the margin of the river. Cross section of the defined compensation area is shown in Fig.IV.2.3.

c) Present conditions

With the selection of the dam axis-A or -B, 5 units of household are subject to relocation. With the selection of the dam axis-C, 8 units of households different from the cases of dam axes-A and -B are subject to relocation. Affected areas compared with other two schemes are shown in Tables IV.2.10 and 2.11, and Fig.IV.3.3.

d) Probable socio-economic effects

No significant changes of road network is involved in this project. It is important that the local residents are correctly informed on the compensation. No residents unrelated to the resettlement program should be encouraged to speculate for any justified compensation from project. Hardship may be experienced by the evacuees during the negotiation, evacuation, and the settling process. To avoid this:

- their existing properties should be correctly valued and similar value of properties should be nominated and offered for the best possible solution of the compensation;
- their belongings should be transported without damage;
- evacuees should be able to adapt themselves to the new living conditions with minimum conflicts. Resettlement program should assist their smooth transition to the new settlement area.

Therefore the evacuation program should be well planned and organized.

(2) Changes on land use and economic activities

With the selection of the dam axes-A and -B, 19 and 25 ha of land will be submerged. Most of the submerged areas are undeveloped grassland and small patches of forest. The number of units of household subject to relocation for the both cases are 5 units. The development of new settlement area for evacuees will be as wide as the submerged area, or less. Thus no significant consequences of geographical changes are expected to occur. With the selection of the dam axis-C, the submerged area and the units of households to be removed are the same as the dam axes-A and -B, although they are in different areas and are different units altogether. The submerged area will involve limited area of cultivation for family consumption. The reservoir is located in the valley with steep hills on both sides of the river whichever dam axis is selected. Because only limited flat areas are available for cultivation, irrigation schemes for a large scale operation has not been developed to date. This will not be changed even after

the completion of the project whichever the dam axis is selected. Forestry activity will not be affected by the project. There will be no increase or decrease of fishery operations in the river within the foreseeable future. No loss of wildlife and forest products takes place.

The local residents around the damsite obtain fuel wood for their daily energy. There is a possibility that clearing of forested area for the construction works of the project might damage a part of the area for obtaining fuel wood.

Changes on the existing road is not involved. However, with the selection of dam axes-A and -B, a part of the existing road will be submerged. Since alternative route is available, no realignment of the existing road may be involved. The reservoir will provide no potential for water transportation.

(3) Public health

In view of the excessive use of agricultural chemical in the upstream region and discharge of industrial waste, the reservoir may trap a part of the agricultural chemicals. Table IV.2.8 shows the use of agricultural chemicals in the area, compared with other schemes. For use of the impounded water for irrigation, sufficient examination for water quality will be needed. Fishing in the reservoir may cause severe health damage to individual if contaminated fishes were eaten.

(4) Cultural property

Because the area where a large number of stone arrow heads have been unearthed is subject to submerge, important archaeological site may be affected by the project.

3.3 Summary of the Effects

3.3.1 Positive effects

There is no positive effects on the natural and social environment by the implementation of the project.

3.3.2 Negative effects

(1) The natural environment

a) Vegetation

The submerged area covered with the natural vegetation, mainly unpalatable grassland for livestock rearing and bush land for no commercial value is relatively small.

b) Wildlife

No adverse effect on the wildlife near the damsite will take place.

c) Water resources

With the rising level of groundwater, if the dam axis-A or -B is selected, the existing shallow wells may be contaminated by the domestic waste waters or industrial waste, or a combination of them, depending on the locality and the function of the waste management systems.

(2) The social environment

a) Population

Although the number of the population involved in the resettlement arrangement is small, the evacuees face major changes of their basis of life. The magnitude in changes of existing life style, economic activity, and the general standard of life on the part of the local residents will be very significant.

b) Land Use

The present patters of land use will not be adversely affected. For the selection of the dam axis-A, 950 m of the existing road is subject to submerge. With the axis-B, 1,250 m of road will submerge. Since the existing houses are subject to relocation, the loss of a portion of the road will cause no adverse effect on the part of the general public. The realignment of the existing roads is therefore considered unnecessary as there is an alternative route is available to the north of the damsite. However, the owner of the road should be compensated as a matter of legal procedure. The land owner of the the submerged road site may require new road. Such

case should be individually dealt and the best alternatives ideas should be elaborated. With the selection of the dam axis-C, no realignment of the existing road is considered necessary.

c) Public Health

No adverse effect on the public health will occur.

d) Cultural property

The evidence of the number of stone arrow heads unearthed from the damsite signifies that the possibility of valuable archaeological site is existing in the area. Archaeological investigations should be conducted before the implementation of the project.

3.4 Recommendations to Minimize Negative Effects

3.4.1 The natural environment

(1) Landscape

Although the proposed quarry site and spoil banks are scattering wide areas of waste lands, consideration should be given to avoid disturbance to natural landscape in the planning.

(2) Vegetation

Unless certain plant species are required for preservation in relation to wildlife conservation, no further study on vegetation is required.

(3) Wildlife

Fish breeding by increasing the population of fish adapted to still water should be planned. But for its implementation, special consideration of adverse effects such as eutrophication and reduction of the existing fish due to fish migration should be taken. Further study and observation on ecological structure will be needed.

(4) Water resources

Since sediment load in the river is very few and there are no sediment deposit in upstream and downstream from the damsite, sediment deposit in the reservoir and lowering of

river bed in the downstream will be solved by proper operation of gates provided in the dam. Eutrophication problem will be also solved by proper operation of gates. It was judged from the present riverine condition that there will be no effect to the river stretch between the damsite and tailrace though the river discharge is reduced. If some disadvantage take place in future stage it can be solved by gate operation. In this occasion a part of river water to be used for power generation will be lost. An artificial variation of river water level in the downstream from the tailrace will be solved by warning for water release. Regarding rise of groundwater near the reservoir area, its utilization and measure should be planned based on the investigation after impounding of the reservoir. As stated in item for public health, contamination of water quality due to use of agricultural chemicals and industrial waste water may take place. Unless such water contamination due to drainage from cities in the upstream area is properly controlled, eutrophication problem cannot be avoided. Overall management of river environment including observation of water quality will be needed.

3.4.2 The social environment

(1) Population

Resettlement for the submerged area is needed, though the impact on this problem is almost the same whichever the dam axes are selected.

The idea of resettlement on a better-off condition and minimizing the drastic changes of existing socio-economic structures as well as the basic policy requirement should be taken into consideration in the investigation and planning for the resettlement site. Available information on the resettlement sites from the local and national government agencies, whichever is appropriate, should be sufficiently examined.

The following should be conducted in order to identify the best possible site for resettlement;

i) Socio-economic base line study on the residents expected to relocate as bench-mark of the existing social conditions. It consists of a detailed demographic structure, family structure, economic conditions and cultural background of the residents affected by the project;

ii) Socio-economic survey for the sample families near the resettlement site;

iii) Land use survey for the proposed resettlement site;

iv) Reconnaissance for water resources in the proposed resettlement site;

Depending on the availability of the site, a few sites should be nominated for resettlement. Each site is subject to the above survey. Comparison to select the best potential resettlement site should be conducted for planning and further investigation. The planning of a new resettlement site should be subject to an examination on the possible agricultural development, accessibility, available infrastructures and public services, land tenurial status, socio-economic similarity to the existing conditions in the project area, and preference of the proposed resettles. Depending on the degree of development of the project, there might be a possibility of attracting the local residents to the project area. It should be thoroughly studied so that the concentration of the local residents should not cause any adverse effects on the project.

(2) Land Use

Based on the initial survey for the project area, detailed land use map should be prepared. The following information should be contained on the land use map;

- Residential/urban centers
- Mixed agricultural/residential area
- Farming area
- Old clearing area
- Livestock area
- Forest area

If impounded water is planned to be used for the future irrigation scheme, expected land use in irrigation should be also included in the land use map. The land use map should be also prepared for the resettlement area.

(3) Public health

Overall management of river environment including observation of water quality is needed.

(4) Historical and archaeological sites

Archaeological investigation should be conducted for the project area. The method and organization should be determined based on the preliminary archaeological investigation requirement is Brazil.

4. ENVIRONMENTAL EXAMINATION FOR BENEDITO NOVO SCHEME

4.1 Present Environmental Conditions

4.1.1 The natural environment

(1) Topography

a) Methodology

Topographic investigation for the project as a whole that are the primary aspect to determine the feasibility of the construction works have been conducted separately. In addition to the obtained topographic data, additional investigations were conducted with special reference to the environment. The work included the review and analysis of the existing 1:50,000 and 1:10,000 maps, aerial photo interpretation and the field surveys.

b) Present conditions

The river at the damsite runs through the hills and low mountains whose relative heights ranges from around 80 m to more than 200 m. High slope gradient of the mountains provides almost no opportunities for agricultural activity. Where slope gradient is low at the foot of the mountains, limited agricultural activities are observed. Both river banks of the damsite are very steep slope and that these areas are kept intact from agricultural development. River bed is generally ragged and the velocity of the river flow is rather fast. There are a series of water falls or cataract, and each of them is a few meters high. Hard rock outcrops in whole river bed.

(2) Aesthetic value of landscape

a) Methodology

Based on the interviews with the local residents, government offices and others concerned with the aesthetic value of the landscape in the project area, the importance in the aesthetic value of the landscape for the society was identified.

b) Present conditions

There is no evidence and no opinion among the local people that the damsite and the reservoir area are of significant aesthetic value to their life style and for the nation as a whole.

(3) Vegetation

a) Methodology

The survey on natural vegetation including forest areas was conducted around the project site. Interviews with the concerned government department were made to obtain information. The reports on the natural vegetation, although limited, were also collected.

b) Present conditions

The characteristics of the natural vegetation in the Itajai valley is classified as the lowland dense rainforest, the Atlantic forest, stretching from the northeast corner to the southern end of Brazil. This forest belt goes in to the Itajai valley because of the slow gradient of the basin and abundant rainfall throughout the year. During the past one hundred eighty years, because of the large concentration of human population in the Itajai valley for their economic activities, the forest was cleared for agricultural activity. Consequently, the ecological continuity of the Atlantic forest has been disrupted over time. Felling the trees generated more light penetration to the forest floors and the changing temperatures on the ground level altered the important original vegetation of the area. There is an opinion that this has triggered a number of devastating flood to the lower Itajai river basin during the late 1970s and the early 1980s. However, no clear substantiation specifically applicable to the area has been established to date.

The vegetation around the damsite is a mixture of riparian forest, presumably secondary natural forest, limited patches of grassland and agricultural land including pasture land. The forested area is limited to the river banks. The agricultural land is planted with upland crops for family consumption near the damsite. Pasture land appears to be forming the landscape adjacent to the river.

(4) Wildlife

a) Methodology

Prior to conducting the field work,available documents pertaining to the existing wildlife were reviewed. Interviews with local people for the possibility of the existing wildlife were conducted to collect further information.

b) Present conditions

Many bird species (Lepttotila, Phaetornis, Tytira and others) are identified in the area. They are common species in the Itajai river basin. The families of Dendrocolaptidae, Furnariidae and Formicariidae, typical to the Itajai river basin are not recorded in this area. No presence of them in the area indicates that their habitat has been altered by human activities to a large extent.

There are two types of fish in this area : one adapted to rapid streams; the other adapted to still water. The former are Cascudo roseta (Ancistrus multispinis), Cascudinho (Hemipsilichathys), and Mandi (Pimelodus clarias among many other species. The latter are Joaninha (Crenicichla lacustris), Acara (Geophagus brasiliensis) and others. Both types of fish are consumed by the local residents. Among many species of fish found in the area, two species are unique to this area. They are Cascudinho (Hemipsilichthys cf.) and Lambari (Deuterodon sp.). They have not been scientifically studied yet.

Because of a large concentration of human population and the subsequent clearing of the forest in the Itajai river basin, the forest continuity has been disrupted. There are a number of isolated "forest islands" that are the remnant of the Atlantic forest. As a consequence, wildlife habitat has been drastically reduced to its detriment and most of the larger mammals faced extinction in this area. The major predators such as Jaguar (Panthera onca) and Puma (Felis concolor) were not registered in the area for long time. It is believed that a very few of them are still in the mountain ranges of the region, the Itajai mountains. However, during the field survey, there was no evidence of carnivore, which are on top of the food chain of wildlife in the project area at the time of this study. No herbivore, on which the carnivore prey, has been recorded in the project area.

(5) Water resources

a) Methodology

Data on water supply were obtained from literature review as well as from the government agencies. Review of the surface water hydrology was conducted including the way that the water resources are used by the local residents.

b) Present conditions

Most of the rural households obtain water from the shallow wells developed individually. Although there is a town near the damsite, Alto Benedito Novo, there is no water treatment system of which standard is comparable to that of a large city. A few isolated households obtain water from the streams nearby. Quantity of available water for Alto Benedito Novo is sufficient for their daily use. The quality of water being used by most of the houses in this area is substandard.

(6) Mineral resources

a) Methodology

The mineral deposits and their potentials are closely related to the geological formation interpreted from the geological maps. The mineral resources study performed consists of aerial photo interpretation, map study and collection and review of available information obtained from the Mineral Resources Department and field reconnaissance survey.

b) Present conditions

There are no mineral resources for which extraction of them will be economically viable.

(7) National parks and wildlife sanctuaries

a) Methodology

Prior to conducting the field work, available documents pertaining to the designation of national parks and wildlife sanctuaries were reviewed. Interviews with local people for the

possible sites of values were conducted to collect further information. With the available information, field survey was conducted to identify the site.

b) Present conditions

There is no evidence of national parks and wildlife sanctuaries to be directly and indirectly affected by the project.

4.1.2 The social environment

(1) Population

a) Methodology

A survey on the number of population was carried out based on the available data obtained from the local government agencies. A field survey to complement the review of the population data was also conducted.

b) Present conditions

The largest population center to be directly affected by the project is Alto Benedito Novo, which is immediately upstream of the damsite. 93 units of households in this area are subject to submerge if the dam axis-A is selected. Another 5 units will be affected by the construction of the dam itself. In Benedito Novo, 14 units of households will be affected by the construction works of the power house. The size of the population in Alto Benedito Novo cannot be explicitly established because the census data for Benedito Novo, 3 km downstream of the damsite is combined with those of Alto Benedito Novo. The census data in Benedito Novo shows that the population in Benedito Novo in 1989 is about 10,000. The size of population has never been changed since 1970. Of the total population, the urban population increased from 14% in 1970 to 47% in 1989. The rural population for the past 20 years shows proportionate decrease. The population in Benedito Novo is shown in Table IV.2.1.

(2) Land use

a) Methodology

The survey for land use was carried out using aerial photographs which were shot in November 1990. A topographic maps at scale of 1:50,000 and 1:10,000 were used. Based on

the aerial photo interpretation, ground reconnaissance survey was carried out to identify the types and the surface area of the present land use.

b) Present conditions

Irrigation system in the upstream region has not been well developed to date compared with the area adjacent to Salto Pilão scheme. This is due to the ragged topography of the area. Thus water demand in the upstream area is comparatively low. Comparison of the water demand for irrigation with the other two schemes is shown in Table IV.2.2. Because of the ragged topography of the area, development of farm land is limited to gentle hillside and the relatively flat but narrow areas usually available in the river banks. Average rainfall in the area is evenly distributed throughout the year. The average sun light available for plant growth is high during the growing season. The scale of farming is limited to family farming and it causes soil erosion in the area. Livestock rearing is common in this area and one to two cattle are kept in every one ha of land. Because of abundant water supply in the area, no excessive vegetation damage around the pasture was observed during the field survey. Maintenance of pasture is good in the area. In general, land capability is low to medium depending on the amount and timing of rainfall and the sun light. Average yield of crops in this area is shown in Table IV.2.3. The areas affected by the project are mainly rural agricultural zone where growing agricultural crops are limited to the family consumption. There are comparatively small scale reforested area near the damsite. A small margin of it is subject to be affected by the project. Present land use area is shown in Table IV.2.4 and Fig.IV.4.1. Unlike Salto Pilão and Dalbergia schemes, the zoning plan of Benedito Novo has not been elaborated to date.

(3) Economic activities

a) Methodology

The existing information on the agriculture, commerce and industry and other economic activities was reviewed. Based on the field survey, the local economic activities ranging from agriculture to various industries were also identified.

b) Present conditions

Due to the same reason as the population census data, no separate data between Benedito Novo and Alto Benedito Novo were available. The economic activity in Benedito Novo/Alto Benedito Novo area is mainly agriculture including livestock rearing. There are 872 property holders of agriculture. Total agricultural area is 24,400 ha out of the total land area of

27,148 ha of the municipality. The average size of agricultural holding is 28 ha. Major crops grown in the area are rice, corn, tobacco, potatoes and sweet potatoes. In addition to breeding of cattle and sheep, horses and chicken are major livestock maintained in the area. Milk is one of the supplementary income earner for the rural households. The structure of agricultural sector in this area is shown in Table IV.2.5.

The major industries in the secondary sector in Benedito Novo/Alto Benedito Novo consist of timber, furniture, transportation of non-metalic products and food processing. Due to the recent trend in conservation of natural forest, the present timber industry has been facing severe demand for the reduction of its scale of operation. Thus increase in manufacturing industries in this area are encouraged. Approximately 70% of the workforce in this area is engaged in the secondary sector. The structure of the secondary sector in Benedito Novo/Alto Benedito Novo is shown in Table IV.2.6.

The commercial and service sectors including urban services and tourist industry are not well developed in the area. Although the area has a large portion of natural forest remained, probably one of the largest in the state, tourism related to natural environment is not popular and that the development of tourist accommodation is in its primary stage. The structure of the tertiary sector in this area is shown in Table IV.2.7.

(4) Historical and archaeological sites

a) Methodology

Prior to conducting the field work, available documents pertaining to history, archaeology, and culture of primitive settlers of the area were reviewed. Interviews with local residents for the possible sites of such values were conducted to collect further information. Aerial photos of the area were interpreted in order to identify possible sites of cultural value. With the available information, field survey was conducted to identify cultural sites. The possibility of evidences of artifacts, monuments, or any forms of arts were identified in the field.

b) Present conditions

There are no historical and archaeological sites significant for academic value or for tourism.

(5) Public health

a) Methodology

Data on public health in the area were collected from local government offices. Review of literatures and reports related to public health in the area was conducted. Interviews with the local residents were also conducted to collect actual information of increase or decrease of water-born diseases or any other diseases that may be induced by the impoundment of the river water.

b) Present conditions

Because the accurate data on public health applicable to the project site are not available, no specific study on public health was conducted. However,it appears that the water-born diseases such as diarrhea are common among the local residents. Unlike Salto Pilão scheme, there has been no report that the fish population in the upstream area was killed by agricultural, chemicals and industrial waste.

(6) Others

a) Hydro-electric power stations

There are two hydro-electric power stations in the project river stretch. One is the power station with an installed capacity of 1.12 MW which is owned by the local community and the other is the power station with an installed capacity of 0.15 MW which is owned by a private company.

4.2 Effects of Benedito Novo Scheme

4.2.1 The natural environment

(1) Landscape

No loss of aesthetic site for recreation, etc. is involved in the project. There are quarry site, disposal area and areas for construction of power house, access road for construction site and other ancillary facilities of the project. These areas are scattered over 4 - 5 km of area. Location of each area is mainly in the agricultural area. Detailed field surveys on vegetation, wildlife, land use, etc. have not been conducted due to its size and scale of possible effect to

the environment. However, a brief field survey revealed that the impact on the natural and on the social impact are considered negligible.

(2) Vegetation

There are no significant tract of undeveloped or wilderness areas to be directly affected by the project. The natural forest areas to be submerged as a result of the project is limited to the river bank vegetation area and they have already been isolated from the significant ecological continuity of the original natural forest. In general, such isolated areas can not support significant number and kinds of wildlife species at all. Although the riparian forest continues to provide timber and fuel wood for the local residents to some extent, which is one of the important exporting commodities for the state of Santa Catarina,such small portion of forest is not economically viable.

The reservoir is not designed to provide irrigation scheme for the downstream and up-stream regions. Thus no increase of human population over wild land for cultivation is expected to occur and that there will be no consequences of clearing natural vegetation along the river.

(3) Wildlife

There is no important bird species significantly to be affected by the project. Fish, especially those adapted to still waters, may increase in the reservoir area to some extent. Among many species,Acara (Geophagus braziliensis) is the major species which may increase its population in the reservoir area. On the other hand, the fish population adapted to rapid streams will decrease to some extent.

Less wildlife species and their habitat are not expected to occur. The logging operation is very active in the area, especially in the upstream area of the project site. Thus increase in wildlife or decrease of them will not occur unless there is very unusual circumstances which allow to change wildlife population in the area.

(4) Water resources

Creation of reservoir will generally bring about deposition of sediment in the reservoir, eutrophication and lowering of river bed in the downstream stretch. The reservoir in this scheme is not so large as to vary a duration of the river flow, but the river discharge in the stretch between damsite and tailrace will be reduced due to intaking of a part of river discharge

for power generation. DNAEE sets out that the RMF should be 80 % of MMD. According to the hydrological calculations for this scheme, the relation among MMD, RMF and river discharge to be released in case of the monthly mean discharge for 1934 - 1987 period is shown in Table IV.2.9. This table shows that the river discharge to be released exceeds the requirement. However in case of the dry season, water release would not always meet RMF. The result of the environmental impact study clarifies that there are no water utilization between the dam and tailrace sites except for the small scale power generation and only several houses are located along this stretch. Considering these situations, it was judged that no influence exerts to the downstream reaches even if the river water is used for power generation.

Groundwater levels along the reservoir areas may rise with possible improvement of water quality. The rising groundwater level may benefit a large number of residents living along the reservoir area if the dam axis-A is selected. With the selection of the dam axis-B, a limited number of local residents will benefit from the rising level of groundwater. For the dam axis-C, no local residents will benefit from it in this respect. The rising level of the groundwater may cause pollution to the existing shallow wells, depending on the local system of domestic waste water management. The chances of polluting the ground water by chemicals will be comparatively small in the area. Table IV.2.8 shows the use of agricultural chemical and the sources of pollution, compared with other two schemes.

(5) Existing national parks and wildlife sanctuaries

There are no designated conservation areas such as national parks and wildlife sanctuaries to be affected by the implementation of the project.

4.2.2 The social environment

(1) Population

a) Methodology

Data on the resettlement of residents including their commercial activities were collected. Reviewing the existing information, maps and field survey on the areas to be affected by the project were conducted.

b) Definition of compensation area

According to the interpretation of the federal government's regulations and the current administrative practice of some municipalities of the state of Santa Catarina, the area subject to compensation includes 15 m strip of land along the edge of the reservoir area. However, depending on the locality, there are areas not subject to compensation as the rising level of the river do not change any geographic conditions except on the margin of the river. Cross section of the defined compensation area is shown in Fig.IV.2.3.

c) Present conditions

With the selections of the dam axis-A, 112 units of household are subject to resettlement. For the axes-B and -C, 28 units and 24 units are subject to resettlement respectively. Affected areas compared with other two schemes are shown in Tables IV.2.10 and 2.11, and in Fig.IV.4.2.

d) *Probable Socio-economic effects*

It is important that the local residents are correctly informed on the compensation. No residents unrelated to the resettlement should be encouraged to speculate for any unjustified compensation from the project.

Hardship may be experienced by the evacuees during the negotiation, evacuation, and the settling process. To avoid this:

- their existing properties should be correctly valued. Similar value of properties should be nominated and offered for the best possible solution of the compensation;

- their belongings should be transported without damage;

- evacuees should be able to adapt themselves to the new living conditions with minimum conflicts. Resettlement program should help smooth transition of the evacuees to the new settlement areas.

In view of the above, the evacuation program should be well planned and organized.

(2) Changes on land use and economic activities

It is presumed that the current patterns of land use in this area is continued even after the completion of the project. 112 units of households including some timber producing factories, are subject to relocation if the dam axis-A is selected. This will be very significant changes on the structure of the society. The changes on agricultural activities will be comparatively small. There is no forestry activity to be affected by the project. There will be no increase or decrease of fishery operations in the river within the foreseeable future. No loss of wildlife and forest products will take place. However, a part of dairy and cattle ranching activity in the area will be permanently lost if the dam axis-A is selected.

Depending on their income level, the local residents use cooking gas in addition to fuel wood. However, a limited number of them rely on fuel wood for their daily energy. There is a possibility that the forested area affected by the construction works of the project might damage a part of the area for obtaining their fuel wood.

With the selection of the dam axis-A or -B, changes on the existing road involves some 440 m of realignment within Alto Benedito Novo area. In addition, 980 m of new road should be constructed. With the selection of the dam axis-C, 200 m of roads will be affected.

(3) Hydropower station

There are existing two hydro-electric power stations near the project area. Feature of the power stations and impact on this power station by the project are as follows;

(i) Santa Maria Electric Cooperative power station

This power station is located at 400 m downstream of the dam axis-C. The installed capacity of this power station is 1.12 MW at present and it is scheduled to increase to 3.12 MW by the end of this year. Whichever the dam axis is selected, a sufficient supply of river water for power generation for Santa Maria Cooperative power station would become impossible since majority of river water is used for Benedito Novo hydropower scheme. Thus, compensation for this power station will be needed.

(ii) Privately owned power station

This power station is located at 1,000 m downstream of the dam axis-C. The installed capacity of this power station is 0.15 MW. Operation of this power station would not be affected since power generation can be made by remaining river flow after taking the river discharge for power generation in this scheme.

(4) Cultural property

No site significant on historical, archaeological and religious values to the local community as well as for the national level was found in the adjacent areas of the project.

4.3 Summary of the Effects

4.3.1 Positive Effects

(1) The natural environment

With the dam axes-A and -B, the rising level of groundwater will increase the chance of obtaining water from shallow wells where previously no such development of wells was feasible.

The impounded water will be very significant for the expansion of the future development of irrigation scheme. The collective use of water should be implemented while the organization of existing water rights may have to be reviewed.

(2) The social environment

As mentioned in the section (1) above, the impounded water will be collectively used for the existing irrigation scheme. It will be possibly able to expand the scheme for further commercialization.

4.3.2 Negative effects

(1) The Natural environment

a) Vegetation

The submerged area covered with the natural vegetation, mainly secondary natural forest growth is relatively small.

b) Wildlife

It is very unlike that wildlife is affected by the project because of the historical development of human settlement in the area and there was no evidence of wildlife existing in the area at the time of this study.

c) Water resources

With the rising level of groundwater, if the dam axis-A is selected, the existing shallow wells may be contaminated with the domestic waste water. It depends on the locality and the function of the waste management system.

(2) The Social environment

a) Population

The number of units of household involved in the resettlement arrangement ranges from 24 to 112. The magnitude on the social disturbances caused by the changes on existing life style, on economic activity and on the general standard of life with the local residents will be unfathomable.

b) Land use

The loss of pasture and the residential areas along the bank will cause further pressure to the area hitherto undisturbed. However, because of the ragged topography around the damsite, no alternative areas are available nearby. Developing alternative agricultural and residential areas in the remote areas will cause further inconveniences in relation to the present holdings.

With the selection of the dam axis-A or -B, some 490 m of realignment of the existing roads should be conducted.

c) Public health

There is a possibility of spreading water-born diseases in the area when the groundwater level rises.

d) Hydroelectric power stations

Since one of the existing hydro-electric power stations will be affected by the project, compensation for this power station will be needed.

4.4 Recommendations to Minimize Negative Effects

4.4.1 The natural environment

(1) Landscape

Although the proposed quarry site and spoil banks are scattering wide areas of waste lands, consideration should be given to avoid disturbance to natural landscape in the planning.

(2) Vegetation

Conventional vegetation study before the implementation of the project will suffice for assessment on the impact of the project to the vegetation.

(3) Wildlife

Fish breeding by increasing the population of fish adapted to still water should be planned. But for its implementation, special consideration of adverse effects such as eutrophication and reduction of the existing fish due to fish migration should be taken. Further study and observation on ecological structure will be needed.

(4) Water resources

Since sediment load in the river is very few and there is no sediment deposit in upstream and downstream from the damsite, sediment deposit in the reservoir and lowering of

river bed in the downstream will be solved by proper operation of gates provided in the dam. Eutrophication problem will be also solved by proper operation of gates. It was judged from the present riverine condition that there are no effect to the river stretch between the damsite and tailrace though the river discharge is reduced. If some disadvantage take place in future stage it can be solved by gate operation. In this occasion a part of river water to be used for power generation will be lost. An artificial variation of river water level in the downstream from the tailrace will be solved by warning for water release. Regarding rise of groundwater near the reservoir area, its utilization and measure should be planned based on the investigation after impounding of the reservoir. As stated in item for public health, contamination of water quality due to use of agricultural chemicals and industrial waste water may take place. Unless such water contamination due to drainage from cities in the upstream area is properly controlled, eutrophication problem cannot be avoided. Overall management of river environment including observation of water quality will be needed.

(5) National parks and sanctuaries

There are no national parks and wildlife sanctuaries to be directly or indirectly affected by the project. Thus, no further study is needed.

4.4.2 The social environment

(1) Population

Resettlement for the submerged area is needed. The impact on this resettlement problem is the largest for the dam axis-A and that for the dam axes-B and C is almost the same. The concept of resettlement on a better-off condition and minimizing the changes of existing socio-economic structures as well as the basic policy requirement should be taken into consideration in the investigation and planning for the resettlement site. Available information on the resettlement sites from the local and national government agencies, whichever is appropriate, should be sufficiently examined.

The following should be conducted in order to identify the best probable site for resettlement;

a) Socio-economy base line of the residents expected to relocate as a bench-mark of the existing social conditions. It consists of a detailed demographic structure, family structure, economic structure and cultural background;

b) Socio-economic survey for the sample families near the resettlement site;

c) Land use survey for the proposed resettlement site;

d) Reconnaissance for water resources in the proposed resettlement site;

Depending on the availability of the site, a few sites should be nominated for resettlement. Each site is subject to the above survey. Comparison to select the best potential resettlement site should be conducted for planning. The planning of a new resettlement site should be subject to an examination on the possible agricultural development, accessibility, available infrastructures and public services, land tenurial status, socio-economic similarity to the existing conditions in the project area, and preference of the evacuees.

There might be a possibility of attracting the local residents to the areas related to the project. It should be thoroughly studied so that the concentration of the local residents does not cause adverse effects on the project.

(2) Land use

Based on the initial survey of the projects area, detailed land use map should be prepared. The following information should be contained on the land use maps;

- Residential/urban centers
- Mixed agricultural/residential area
- Farming area
- Old clearing area
- Livestock area
- Forest area

If impounded water is planned to be used for the future irrigation scheme, expected land use in irrigation should be also included in the land use map.The land use map should be also prepared for the resettlement area.

(3) Public health

Overall management of river environment including observation of water quality is needed.

(4) Hydro-electric power stations

(i) Compensation for this power station is needed, but compensation for its power generation will not be needed because power tariff of this power station is very high compared with the tariff specified by ELETROBRAS and consequently CELESC intends to supply electric power to this region instead of power supply by Santa Maria power station in future stage.

(ii) Privately owned power station
Depending on the quantity of water released from the dam, no compensation may need for the power station. But agreement for reliable water release should be concluded.

(5) Cultural property

No further study is required.

5. MONITORING WORKS

5.1 Monitoring the Natural Environment

For all the schemes, monitoring on the water quality based on the national standard should be conducted as usual. In addition, conventional water quality measurement on the water temperatures, clarity, electrical conductivity (EC) and acidity (pH) should be made both at the reservoir area and at the area for agricultural and domestic water intake. If shallow wells are expected to develop after the completion of the impoundment of the river water for which obtaining water is for domestic and agricultural use, the above water quality measurement should be conducted. Any new substance recorded in the water quality examination should be thoroughly examined especially for its possible ways of pollution.

5.2 Monitoring the Social Environment

5.2.1 Population

For all the schemes, monitoring on the resettlement conditions should be maintained until such time that all the evacuees are satisfactorily compensated and resettled.

5.2.2 Social unrest

Because a number of large scale flood occurred in the past decade, residents in the Itajai river basin have become sensitive with which any impoundment of water may cause severe flood to their areas. With the lack of knowledge on which their economic activities are partly responsible to the incidents, and the scientific application of the project to the area, the project may be victimized for further social unrest. It is absolutely necessary that the negative effect and the positive effect of the project should be clearly understood by the people concerning the implementation of the project. Thereby the cause and effect of the project should be explained to the local residents. This is applicable to all the schemes.

5.2.3 Land use

In Salto Pilão scheme, there is a possibility for development of irrigation scheme in the future. Further monitoring on the development of irrigation scheme, its scale, the area, the organization of water use and the possible changes in the government regulations should be examined in relation to the maintenance of the impounded water of the reservoir.

5.2.4 Crop damage

Due to the rise of groundwater level, the present agricultural land including pasture land may become subject to permanently wet land depending on the locality. The changing conditions of ground moisture may occur under such circumstances and, depending on the type of crops grown on the present agricultural land, crop growth conditions may be affected. Periodical checks on the ground moisture should be conducted.

5.2.5 Access to forest for fuel wood

The access to forest for fuel wood for local resident should be monitored for the Salto Pilão schemes since forested areas are submerged by the scheme. Other schemes involve some areas of forest to be submerged. Depending on the use of forested area, monitoring on supply of fuel wood should be conducted. No monitoring for the access to the natural resources for indigenous population is required for all the schemes.

5.2.6 Public health

For Salto Pilão and Benedito Novo schemes, domestic water will be easily obtained due to rise of groundwater level. In relation to this, there will be a great chance of increasing hazardous water-borne disease. This will depend largely on the local domestic waste water and industrial waste management systems in relation to the rising level of groundwater. It is highly recommended that the shallow well development should depend largely on the local regulations on the public health and the permission should be granted on the ground that the maintenance of the public health is ascertained. Through examination of the route of transportation on hazardous substances in relation to the underground water way should be conducted if the incidence threatening the public health was reported.

6. GOVERNMENT REGULATIONS

6.1 Present Regulations Related to Environmental Protection

There are a great number of government regulations related to the control of the development projects and their possible effect to the environment. From federal level to the local level, and different government ministries promulgate various regulations related to the environment. The following is a list of the selected government regulations concerning the environment.

6.1.1 Federal regulations

(1) National policies on environment - enacted on 31/8/1981.

This is the tool for overall policy making on the environment in Brazil. Based on this law, other government regulations related to the environment were promulgated. National Council of Environment (CONAMA) has been established and it defines the National System of Environment (SISNAMA). CONAMA promulgates a number of regulations related to the environment. The following is the selected directives adapted by CONAMA.

No. of Resolution	Date of Resolution	Content
001	2/2/1986	Obligation of environmental impact study in relation to development project
002	5/3/1985	Establishment of ecological reserves
023	18/9/1986	Request on technical information in reference to the alternative studies and possible environmental consequences of the hydroelectric power development
010	14/12/1988	Required information in reference to the establishment of environmental protection areas
011	6/12/1990	The means to prevent the rain forest degradation including the Atlantic Forest
013	6/12/1990	Required information in reference to establishing ecological reserves

(2) Establishment of ecological areas - enacted on 6/7/1990

With this regulation, the Brazilian Institute of Environmental and Renewable Natural Resources (IBAMA) has been established. Under the jurisdiction of IBAMA, the activities of various government organizations and private organizations have been integrated for protection of the environment. Each organization conducts the activities for environmental protection according to SISNAMA.

(3) Brazilian Forest Code - enacted on 15/9/1965

It provides in its article that the forest and other forms of natural vegetation on the side of waterways are protected. It also suggests various means to preserve wildlife, fishes, birds, social and cultural properties and other natural heritage areas such as archaeological and anthropological sites.

(4) Brazilian Code of Waters - enacted on 10/7/1934

It regulates the multiple use and conservation of water resources. It provides for use of water for hydroelectric development .

6.1.2 Local regulations

The environmental protection law of Santa Catarina; The decree no. 14,250, enacted on 5/6/1981, provides for the protection and improvement of the environmental quality. In relation to the regulations for environmental protection, the state organization of the Foundation for Support of the Technology and the Environment (FATMA) acts to enforce the regulations regarding the environment protection. The organization has a police power to defend the environment.

6.1.3 Others

Manual for environmental impact study; ELETROBRAS, the holding company of the major electric companies in Brazil, has produced the "Manual of the Environmental Impact Study" on electric system in June 1986. This is a guideline for which a development project for power generation is obliged to conduct environmental impact study prior to implementation. The project concerning hydroelectric power generation should adapt the manual when the environmental impact study is conducted.

6.2 Other Regulations

The following regulations are considered to be reviewed. The content of them are suggestions that there should be provisions for which the general public are protected from the various effect to be caused by the project.

6.2.1 Public health

The rising level of groundwater may cause significant deterioration on the public health scheme. Due to the rise of groundwater, currently practiced domestic waste water management and the industrial waste water management systems may be affected and consequently, some changes for reinforcing the government regulations may be needed.

6.2.2 Water rights

With the emergence of reservoir in the area, collective use of water for irrigation will become possible. It requires a new regulation concerning the use of water or the existing one should be modified.

6.2.3 Access to forest for fuel wood

The government regulations related to the fuel wood collection by the local people should be reviewed. Where appropriate, provision of the access to the forest for collection of fuel wood should be made since the construction works of the project may disrupt their fuel wood collection area.

TABLES

Table IV.2.1 POPULATION

(1) a. Salto Pilão: Lontras

	1970	%	1980	%	1989	%	Rate of Annual Increase (%)	
							1970-80	1980-89
Urban	1,678	23.95	3,789	51.73	4,884	63.54	8.48	2.76
Rural	5,328	76.05	3,535	48.27	2,779	36.46	-4.01	-2.63
Total	7,006	100.00	7,324	100.00	7,663	100.00	0.44	0.44

b. Rio do Sul

	1970	%	1980	%	1989	%	Rate of Annual Increase (%)	
							1970-80	1980-89
Urban	21,528	78.18	33,362	92.06	41,881	94.95	4.47	2.55
Rural	6,010	21.82	2,878	7.94	2,227	5.05	-7.09	-2.80
Total	27,538	100.00	36,240	100.00	44,108	100.00	2.78	2.20

(2) Dalbergia

	1970	%	1980	%	1989	%	Rate of Annual Increase (%)	
							1970-80	1980-89
Urban	4,180	19.90	8,230	34.99	11,472	44.44	7.01	3.76
Rural	16,828	80.10	15,292	65.01	14,342	55.56	-0.95	-0.71
Total	21,008	100.00	23,522	100.00	25,814	100.00	1.13	1.04

Note: the above figure includes population of Dalbergia and Ibirama

(3) Benedito Novo

	1970	%	1980	%	1989	%	Rate of Annual Increase (%)	
							1970-80	1980-89
Urban	1,638	14.08	3,767	35.17	4,667	47.03	8.68	2.41
Rural	9,999	85.92	6,945	64.83	5,257	52.97	-3.58	-3.05
Total	11,637	100.00	10,712	100.00	9,924	100.00	-0.82	-0.84

Source: (1) "IBGE" Foundation,
Demographic Census of Santa Catarina - 1970 - 1980
(2) "SEPLAN"/SC estimatives - 1989

Table IV.2.2 COMPOSITION OF WATER DEMAND IN THE UPSTREAM AREA

Sub-basin	Irrigated Area (1)	Irrigation (2) Dec to Mar	Irrigation (2) Oct/Nov Apr/May	Urban Supply (3)	Rural (4)	Industrial (5)	Totals Jul/Sep	Totals Oct/Nov Apr/May	Totals Dec/Mar
Salto Pilão	(ha)	(m3/s)	(m3/s)	(m3/s)	(m3/s)	(m3/s)	(m3/s)	(m3/s)	(m3/s)
Itajai do Sul	1,034	1.675	0.186	0.024	0.083	0.028	0.135	0.321	1.810
Itajai do Oeste	8,238	13.345	1.483	0.041	0.111	0.072	0.224	1.707	13.568
Itajai-Acu	435	0.705	0.078	0.103	0.007	0.051	0.161	0.239	0.866
Total	9,707	15.725	1.747	0.168	0.201	0.151	0.520	2.267	16.244
Dalbergia									
Itajai do Norte	680	1.102	0.122	0.028	0.099	0.026	0.153	0.275	1.255
Total	680	1.102	0.122	0.028	0.099	0.026	0.153	0.275	1.255
Benedito Novo									
Benedito Novo	1,165	1.887	0.210	0.003	0.019	-	0.022	0.232	1.909
Total	1,165	1.887	0.210	0.003	0.019	-	0.022	0.232	1.909

Source:
(1) Municipal Agricultural Production (IBGE) - 1989
(2) "CASAN" report, September/1990
(3) "FATMA" - Program of environmental recovery of "Itajai" basin, 1990

Table IV.2.3 AVERAGE YIELD OF CROPS (1/2)

(1) Average Yield of Crops; Lontras

(Unit: ton)

Crops	Year 1982		Year 1987	
	Lontras	Micro-Region	Lontras	Micro-Region
Garlic	-	2,540	3,000	3,365
Rice	2,378	2,953	4,104	3,930
Sweet Potato	-	20,282	22,000	19,629
Potato	8,724	8,044	7,419	6,756
Onion	12,000	10,259	9,000	11,483
Bean	924	947	440	763
Tabacco	1,846	1,837	1,441	1,569
Cassava	18,000	18,632	20,000	20,797
Watermelon (1)	2,000	2,806	2,200	2,470
Corn	2,400	2,361	2,100	2,337
Tomato	20,000	24,902	30,000	27,549
Orange (1)	101,852	145,278	-	37,729

Note: 1. (1) in number
2. Micro-region is a group of municipality.
3. Data for average yield of crop in Rio do Sul is not available.

(2) Average Yield of Crops: Dalbergia

(Unit: ton)

Crops	Year 1982		Year 1987	
	Dalbergia	Micro-Region	Dalbergia	Micro-Region
Rice	1,793	2,953	2,297	3,930
Banana (1)	1,968	-	2,000	2,000
Sweet Potato	-	20,282	20,000	19,629
Potato	-	8,044	8,363	6,756
Sugar Cane	-	-	25,000	22,857
Onion	8,000	10,259	10,000	11,483
Bean	672	947	544	763
Tabacco	1,818	1,837	1,679	1,569
Cassava	16,000	18,632	20,000	20,797
Watermelon (2)	-	2,806	6,000	2,470
Corn	2,080	2,361	2,400	2,337
Tangerine (2)	-	157,656	125,000	115,492

Note: 1. (1) in bunch, (2) in number
2. The above figures includes the data of Dalbergia & Ibirama
3. Micro-region is a group of municipality

Table IV.2.3 AVERAGE YIELD OF CROPS (2/2)

(2) Average Yield of Crops: Benedito Novo

(Unit: ton)

Crops	Year 1982		Year 1987	
	Benedito Novo	Micro-Region	Benedito Novo	Micro-Region
Rice	3,754	3,981	4,460	4,734
Banana (1)	1,240	1,167	1,260	1,415
Sweet Potato	10,000	10,773	-	-
Potato	8,520	7,913	-	-
Sugar Cane	20,000	21,109	-	-
Bean	813	835	850	738
Tabacco	1,759	1,790	1,407	1,688
Orange (2)	156,000	98,772	-	-
Cassava	15,000	15,217	15,000	16,594
Corn	2,350	2,442	2,400	2,565

Note: 1. (1) in bunch, (2) in number
2. Micro-region is a group of municipality.

Source: "IBGE Foundation,
Municipal Agricultural Production - 1982 and 1987

Table IV.2.4 LAND USE (1/2)

(1) Area of Land Use: Salto Pilão

a. Lontras

(Unit: ha)

Use of land	Year 1970		Year 1980		Year 1985	
	Area	%	Area	%	Area	%
Temporary Agriculture	3,065	17.83	3,604	24.61	4,011	26.45
Permanent Agriculture	198	1.19	67	0.48	81	0.53
Natural Pasture	630	3.66	4,255	29.06	(x)	(x)
Planted Pasture	1,977	11.50	57	0.38	(x)	(x)
Natural Forest	6,079	35.37	2,579	17.61	(x)	(x)
Planted Forest	534	3.10	254	1.73	(x)	(x)
Open Land	3,476	20.22	2,535	17.31	(x)	(x)
Unproductive Area	1,226	7.13	1,290	8.81	(x)	(x)
Total	17,185	100.00	14,641	100.00	15,161	100.00

b. Rio do Sul

(Unit: ha)

Use of land	Year 1970		Year 1980		Year 1985	
	Area	%	Area	%	Area	%
Temporary Agriculture	3,616	22.14	3,766	19.02	4,077	21.01
Permanent Agriculture	391	2.39	266	1.34	105	0.54
Natural Pasture	1,379	8.44	5,396	27.25	(x)	(x)
Planted Pasture	2,519	15.42	1,072	5.41	(x)	(x)
Natural Forest	4,670	28.59	4,251	21.47	(x)	(x)
Planted Forest	135	0.83	365	1.84	(x)	(x)
Open Land	2,210	13.53	2,484	12.54	(x)	(x)
Unproductive Area	1,414	8.66	2,204	11.13	(x)	(x)
Total	16,334	100.00	19,804	100.00	19,396	100.00

Table IV.2.4 LAND USE (2/2)

(2) Area of Land Use: Dalbergia

(Unit: ha)

Use of land	Year 1970		Year 1980		Year 1985	
	Area	%	Area	%	Area	%
Temporary Agriculture	9,696	13.33	12,167	17.06	11,427	19.95
Permanent Agriculture	626	0.86	300	0.46	164	0.28
Natural Pasture	2,262	3.11	11,650	16.34	(x)	(x)
Planted Pasture	5,832	8.02	2,102	2.94	(x)	(x)
Natural Forest	32,785	45.09	21,683	30.41	(x)	(x)
Planted Forest	200	0.30	1,968	2.76	(x)	(x)
Open Land	14,790	20.34	11,295	15.84	(x)	(x)
Unproductive Area	6,510	8.95	10,121	14.19	(x)	(x)
Total	72,701	100.00	71,286	100.00	57,253	100.00

Note: 1. the above figures includes the data for Dalbergia and Ibirama townships
2. (x) Data not available

(3) Area of Land Use: Benedito Novo

(Unit: ha)

Use of land	Year 1970		Year 1980		Year 1989	
	Area	%	Area	%	Area	%
Temporary Agriculture	5,958	15.98	5,635	11.99	3,881	14.30
Permanent Agriculture	128	0.34	225	0.48	271	1.00
Natural Pasture	1,360	3.65	10,523	22.38	8,145	30.00
Planted Pasture	6,286	16.86	2,198	4.68	2,715	10.00
Natural Forest	12,051	32.31	13,783	29.32	5,430	20.00
Planted Forest	184	0.49	1,518	3.23	-	-
	-	-	-	-	271	1.00
Open Land	7,386	19.81	6,109	12.99	2,634	9.70
Unproductive Area	3,940	10.56	7,022	14.94	3,801	14.00
Total	37,293	100.00	47,013	100.00	27,148	100.00

Source: (1) "IBGE" Foundation, Cattle Raising - *Agriculture Census of Santa Catarina - 1970 and 1980*
(2) Preliminary Synopsis of Cattle Raising - Agriculture of Santa Catarina - 1989

Table IV.2.5 AGRARIAN STRUCTURE

(1) Salto Pilão

a. Lontras

Area of holding	No. of Establishments			Total Area (ha)		
(ha)	1970	1980	1985	1970	1980	1985
Less than 20	481	462	546	4,889	4,695	5,465
20 to 50	255	244	221	7,278	6,694	6,291
50 to 100	25	30	29	1,505	1,805	1,912
100 to 500	2	10	11	539	1,444	1,493
500 or more	1	-	-	2,974	-	-
Total	764	746	807	17,185	14,638	15,161

b. Rio do Sul

Area of holding	No. of Establishments			Total Area (ha)		
(ha)	1970	1980	1985	1970	1980	1985
Less than 20	596	834	768	6,294	6,733	6,555
20 to 50	223	226	203	6,115	6,135	5,493
50 to 100	28	28	25	1,710	1,744	1,660
100 to 500	7	12	13	1,515	2,746	2,868
500 or more	1	3	3	700	2,442	2,820
Total	855	1,103	1,012	16,334	19,800	19,396

(2) Dalbergia

Area of holding	No. of Establishments			Total Area (ha)		
(ha)	1970	1980	1985	1970	1980	1985
Less than 20	998	1,225	1,454	11,744	12,690	13,791
20 to 50	985	929	818	29,784	27,397	23,151
50 to 100	147	186	144	9,459	11,779	9,260
100 to 500	110	64	40	18,502	11,894	7,220
500 or more	4	10	6	3,213	7,523	3,831
Total	2,244	2,414	2,462	72,702	71,283	57,253

Note: the above figures includes the data of Dalbergia & Ibirama

(3) Benedito Novo

Area of holding	No. of Establishments			Total Area (ha)		
(ha)	1970	1980	1985	1970	1980	1985
Less than 20	883	731	436	10,186	7,141	13,541
20 to 50	476	444	349	14,349	13,201	10,864
50 to 100	79	105	54	5,548	6,713	(x)
100 to 500	25	43	26	4,860	8,416	(x)
500 or more	2	12	8	2,350	11,537	(x)
Total	1,465	1,335	873	37,293	47,008	27,148

Source: (1) "IBGE" Foundation, Cattle Raising - Agriculture Census of SC - 1970 and 1980
(2) Preliminary Synopsis of Cattle Raising - Agriculture Census of SC - 1985

Table IV.2.6 STRUCTURE OF SECONDARY SECTOR (1/4)

(1) Number of Establishments and employees: Salto Pilão

a. Lontras

Name of Industry	1970		1980		1989	
	Establish-ments	No. of employees	Establish-ments	No. of employees	Establish-ments	No. of employees
Mineral Extraction	-	-	1	(x)	-	-
Transportation (Non-Metalic Product)	4	15	7	157	3	150
Foundry	3	8	3	(x)	-	-
Machinery	1	(x)	-	-	2	20
Timber	7	100	6	166	3	30
Furniture	4	(x)	4	37	3	200
Chemistry	4	47	-	-	-	-
Textile	1	(x)	-	-	-	-
Clothing, footwear	-	-	1	(x)	2	200
Food Product	6	7	4	32	2	50
Total	30	190	26	441	15	650

(x): Data not available

Table IV.2.6 STRUCTURE OF SECONDARY SECTOR (2/4)

(1) Number of Establishments and employees: Salto Pilão
b. Rio do Sul

Name of Industry	1970		1980		1989	
	Establish-ments	No. of employees	Establish-ments	No. of employees	Establish-ments	No. of employees
Mineral Extraction	-	-	2	-	-	-
Transportation (Non-Metalic Product)	16	127	18	286	24	447
Foundry	7	121	11	340	9	23
Machinery	13	104	9	247	8	405
Electric Material and Communication	3	57	1	(x)	3	1209
Material of Transport	5	114	6	172	-	-
Timber	25	557	39	716	20	260
Furniture	13	64	12	130	26	221
Paper and card-board product	1	(x)	1	(x)	-	-
Rubber	2	(x)	-	-	1	1
Leather and others	1	(x)	-	-	1	28
Chemistry	6	31	2	(x)	4	56
Pharmaceutical Products and Veterinary Medicines	1	(x)	1	(x)	1	(x)
Perfume, soap and candles	3	11	1	(x)	1	1
Product of Plastic Material	-	-	1	(x)	1	7
Textile	1	(x)	2	(x)	5	558
Clothing, footwear and others textile product	4	21	9	153	59	530
Food Processing	25	184	18	404	31	511
Drinks	1	(x)	1	(x)	1	1
Publishing and printing	4	52	6	81	9	104
Others	-	-	3	236	2	4
Administration Assistance Unit	-	-	2	(x)	-	-
Total	131	1,653	145	3,311	206	4,366

(x): Data not available

Table IV.2.6 STRUCTURE OF SECONDARY SECTOR (3/4)

(2) Number of Establishments and Employees: Dalbergia

Name of Industry	1970		1980		1989	
	Establish-ments	No. of employees	Establish-ments	No. of employees	Establish-ments	No. of employees
Transportation (non-metalics)	7	24	6	51	7	46
Foundry	1	(x)	3	39	4	7
Machinery	4	81	2	(x)	3	230
Transportation of Material	1	(x)	1	(x)	1	4
Timber	48	452	35	1,126	35	1,099
Furniture	10	21	9	66	4	4
Leather and others	2	(x)	1	(x)	3	17
Chemistry	17	169	2	(x)	1	12
Perfume and soap	1	(x)	1	(x)	-	-
Clothings, footwear and other product	1	(x)	1	(x)	-	-
Textile	1	(x)	2	(x)	22	1,108
Food Products	17	53	17	119	13	127
Tabacco Manufacturing	-	-	1	(x)	2	7
Drinks	1	(x)	-	-	-	-
Publishing and printing	1	(x)	2	(x)	2	7
Others	1	(x)	4	139	3	141
Total	113	919	87	2,269	100	2,809

Note: the above figure includes the data of Dalbergia & Ibirama
(x): Data not available

Table IV.2.6 STRUCTURE OF SECONDARY SECTOR (4/4)

(3) Number of Establishments and Employees: Benedito Novo

Name of Industry	1970		1980		1989	
	Establish-ments	No. of employees	Establish-ments	No. of employees	Establish-ments	No. of employees
Minerals Extraction	-	-	1	(x)	2	5
Transportation (Non-metalic Product)	2	(x)	6	16	6	14
Foundry	1	(x)	1	(x)	2	3
Machinery	1	(x)	-	-	1	2
Electric Material and Communication	-	-	1	(x)	1	2
Timber	41	261	54	632	41	469
Furniture	3	8	6	75	6	24
Paper product	-	-	-	-	1	48
Chemistry	6	36	4	33	2	24
Textile	1	(x)	1	(x)	1	2
Clothings, footwear and other product	1	(x)	2	(x)	3	348
Food Processing	8	35	6	27	4	78
Tabacco Manufacturing	1	-	-	-	-	-
Others	2	(x)	2	(x)	1	2
Total	67	361	84	1,568	71	1,021

(x): Data not available

Source: (1) "IBGE" Foundation, Industrial Census - 1970 and 1980
(2) State Secretary of Industry and Commerce - 1986

Table IV.2.7 STRUCTURE OF TERTIARY SECTOR

(1) Number of Establishments & Employees: Salto Pilão

a. Lontras

Name of Industry	Year 1970		Year 1980		Year 1989	
	Establish-ments	No. of Employees	Establish-ments	No. of Employees	Establish-ments	No. of Employees
Commerce	44	89	24	74	20	105
Other Services	20	31	49	90	15	95
Total	64	120	73	164	35	200

b. Rio do Sul

Name of Industry	Year 1970		Year 1980		Year 1989	
	Establish-ments	No. of Employees	Establish-ments	No. of Employees	Establish-ments	No. of Employees
Commerce	360	1,111	296	2,089	687	2,710
Other Services	223	552	442	1,871	1,172	4,077
Total	583	1,663	738	3,960	1,859	6,787

(2) Number of Establishments and Employees: Ibirama

Name of Industry	Year 1970		Year 1980		Year 1989	
	Establish-ments	No. of Employees	Establish-ments	No. of Employees	Establish-ments	No. of Employees
Commerce	106	264	126	435	223	680
Other Services	64	121	136	299	76	962
Total	170	385	262	734	414	1,642

(3) Number of Establishments and Employees: Benedito Novo

Name of Industry	Year 1970		Year 1980		Year 1989	
	Establish-ments	No. of Employees	Establish-ments	No. of Employees	Establish-ments	No. of Employees
Commerce	50	88	39	147	53	134
Other Services	51	79	79	147	36	136
Total	101	167	118	294	89	270

Source: (1) "IBGE" Foundation, commercial Census and and Services - 1970 and 1980
(2) Municipal Prefecture - 1989

Table IV.2.8 AGRICULTURAL CHEMICALS AND SOURCES OF POLLUTION

a. General Use of Agricultural Chemicals in the Upper Itajai River Basin

	Nitrogen (Kg/ha-year)	Phosphorus (Kg/ha-year)	Potassium (Kg/ha-year)
Rice	90	60	20
Tabacco	45	150	60
Onion	37.5	70	35

b. Agricultural Chemicals used in the Project Area

(Unit: ton/year)

	Salto Pilao	Dalbergia	Benedito Novo
Nitrogen	2.179	354	113
Phosphorus	4.050	1.011	97
Potassium	1.691	400	34

c. Sources of Pollution

(Unit: kg DBO/day)

	Salto Pilao	Dalbergia	Benedito Novo
Industry	2,780	11,406	-
Rural	107,100	20,790	6,026
Urban	4,500	1,035	322
Total	114,380	33,231	6,348

DBO: Dissolved Biological Oxygen

Table IV.2.9 REGULATION OF RIVER FLOW

(1) Monthly minimum discharge (MMD)

Scheme	MMD (m3/s)	Recorded period
Salto Pilão	10.2	1941~1987
Dalbergia	2.4	1935~1987
Benedito Novo	2.1	1934~1987

(2) Available river flow

(Unit: m3/s)

Scheme	MMD	RMF	MED	FD	Available river flow
Salto Pilão	10.2	8.2	109.9	50.3	59.6
Dalbergia	2.4	1.9	52.7	19.3	33.4
Benedito Novo	2.1	1.7	14.5	8.4	6.1

Note; MED; Monthly mean discharge
FD ; Firm discharge
RMF: MMD x 0.8 = Required maintenance flow
Available river flow: MED - FD

Table IV. 2.10 COMPARISON OF SUBMERGED AREAS AND COMPENSATION AREAS

Scheme	Water Level (m)	Submerged Area (km2)	Compensation Area * (km2)	Relocation of Houses (Units)			Road Construction in the Reservoir Area			
				Reservoir Area	Construction Areas	Realignment (m)	New Bridge (s) (m)	New Road (m)	Culvert(s) (unit)	Submerged Road (m)
Salto Pilão										
Axis A	330	4.43	2.590	87	0	590	40	1900	2	630
Axis B	330	4.59	2.880	87	0	590	40	1900	2	630
Axis C	319	0.40	0.334	9	0	-	-	-	-	-
Dalbergia										
Axis A	232	0.28	0.193	5	12	-	-	-	-	950
Axis B	227	0.37	0.248	5	12	-	-	-	-	1250
Axis C	215	0.29	0.156	8	12	-	-	-	-	-
Benedito Novo										
Axis A	290	0.229	0.307	93	19	440	50	980	3	490
Axis B	287	0.092	0.166	15	13	440	50	980	3	490
Axis C	277	0.029	0.028	13	10	200	50	-	0	250

* See Table IV.2.11 for details

Table IV.2.11 DETAILED AFFECTED AREAS

SCHEME	COMPENSATION AREA (km2)				DAM, ROAD & POWER HOUSE (km2)			DISTRIBUTION OR TRANSMISSION LINE (m)		
	Agriculture	Forest	Others	Total	Agriculture	Forest	Others	Agriculture	Forest	Others
Salto Pilão										
Axis A	1.450	0.090	1.050	2.590				5,200	1,800	-
Axis B	1.450	0.270	1.160	2.880				5,200	1,800	-
Axis C	0.150	0.100	0.084	0.334				5,200	1,800	-
Dalbergia										
Axis A	0.005	0.056	0.132	0.193				1,800	-	-
Axis B	-	0.065	0.183	0.248				1,800	-	-
Axis C	0.007	0.040	0.109	0.156				1,800	-	-
Benedito Novo										
Axis A	0.016	0.005	0.286	0.307				-	-	18,000
Axis B	0.011	0.003	0.152	0.166				-	-	18,000
Axis C	0.005	0.011	0.012	0.028				-	-	18,000

FIGURES

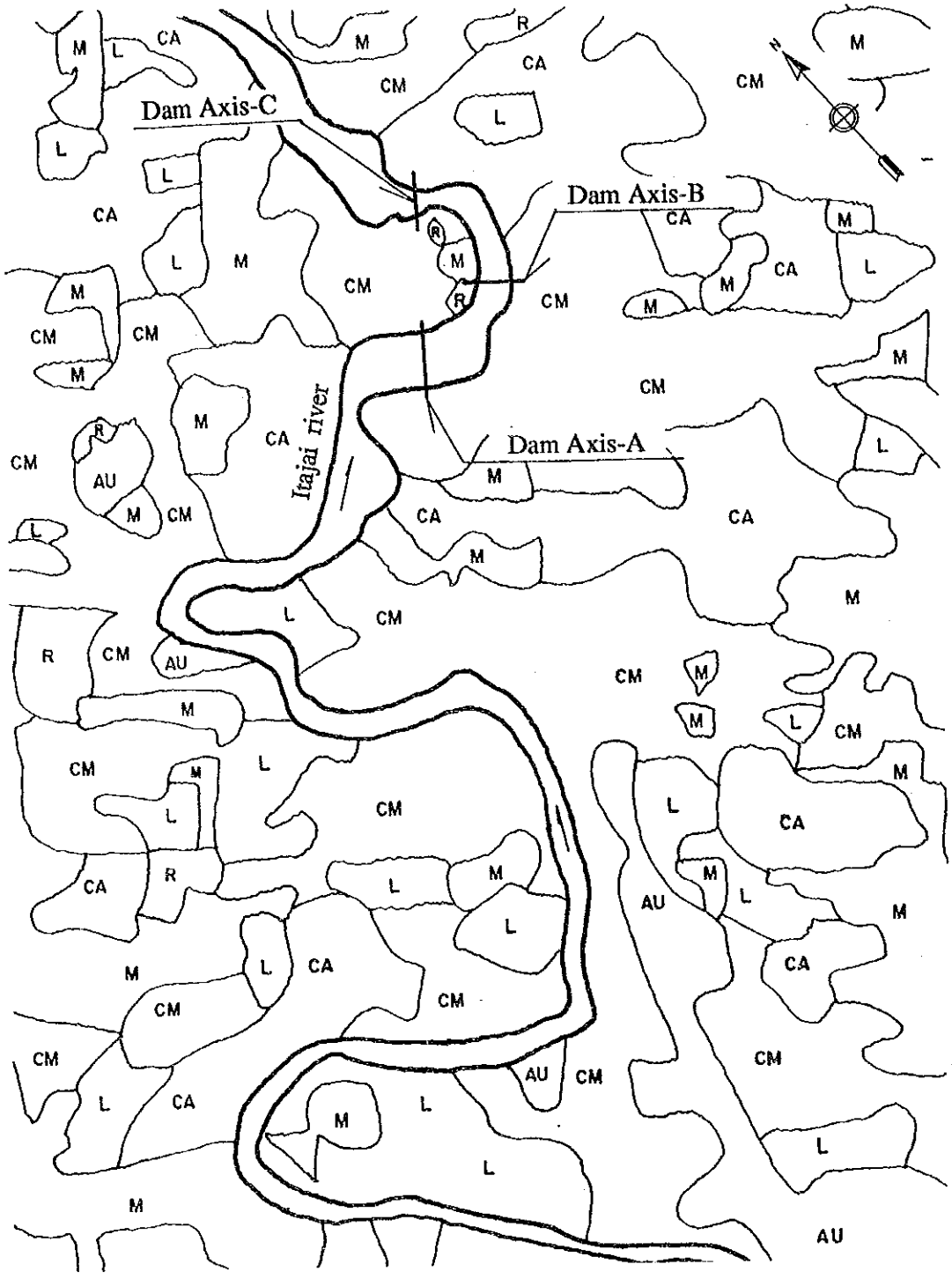
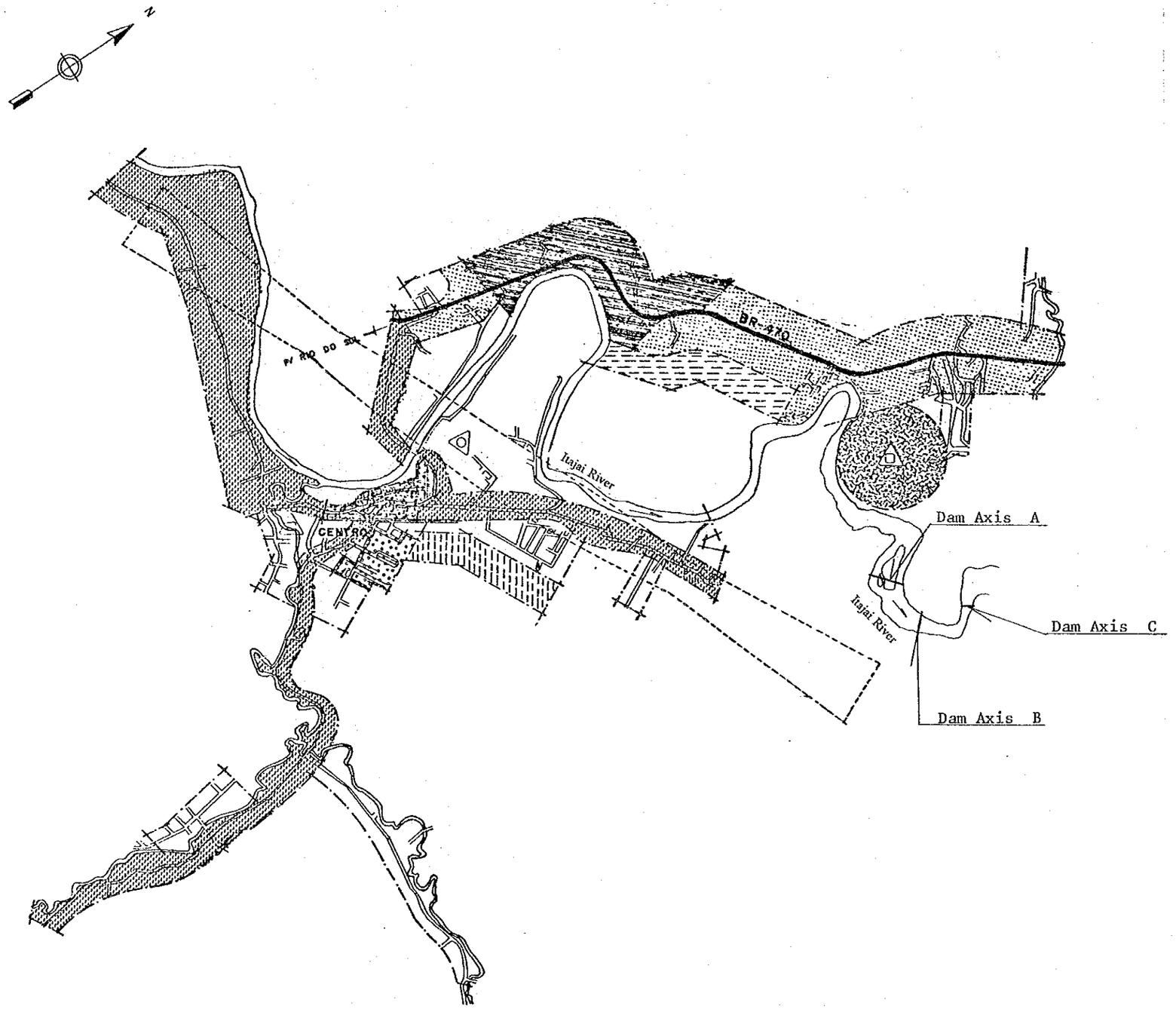


Fig. IV.2.1 LAND USE MAP OF SALTO PILÃO

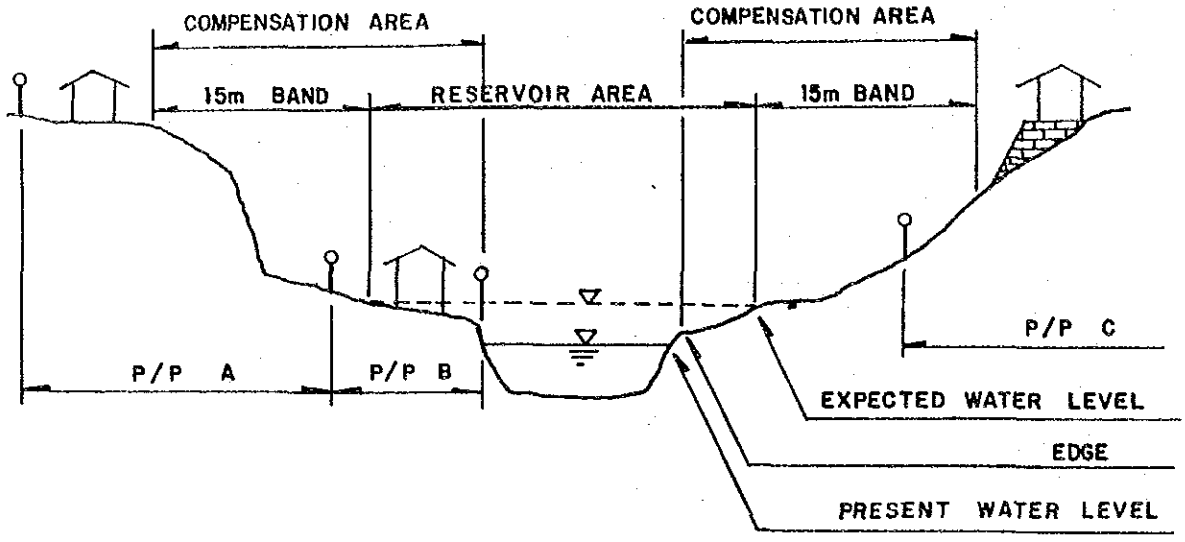


Legend

- Exclusive Residential Zone
- Predominant Residential Zone
- Agricultural & Residential Zone
- Central Zone
- Predominant Industrial Zone
- Recreation Zone
- Forest Conservation Zone
- Extension & Residential Zone
- Exclusive Industrial Zone
- Air Field
- Protected Area for Recreation

Fig. IV.2.2 ZONING PLAN OF SALTO PILÃO

A . COMPENSATED



P/P : PRIVATE PROPERTY

B. NOT COMPENSATED

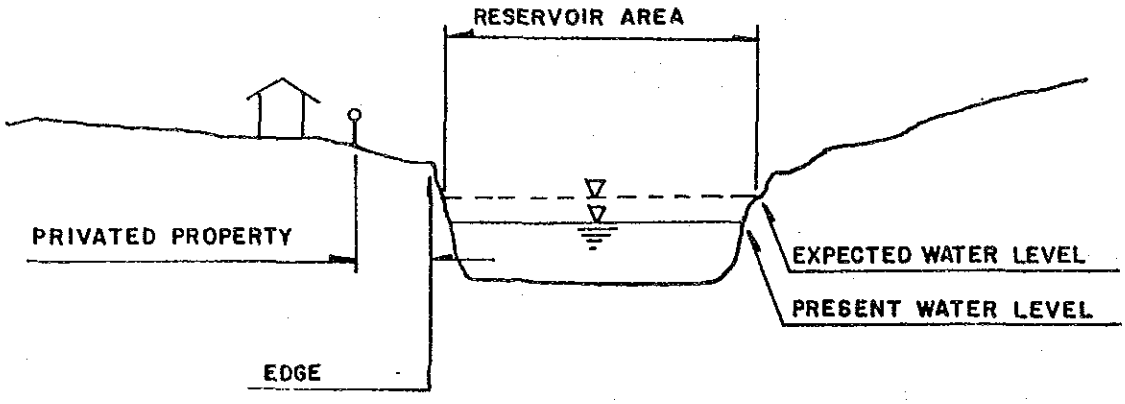
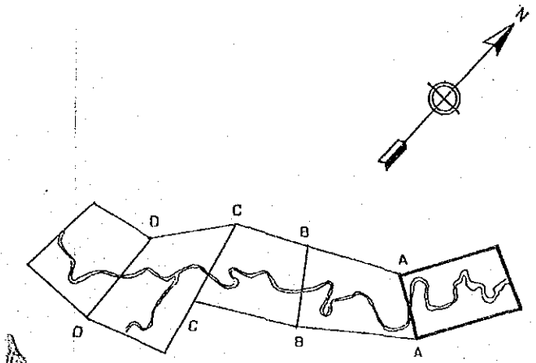


Fig. IV.2.3 DEFINITION OF COMPENSATION AREA

Legend

Submerged Area by
The Dam Axis A & B

Submerged Area by
The Dam Axis C



KEY PLAN

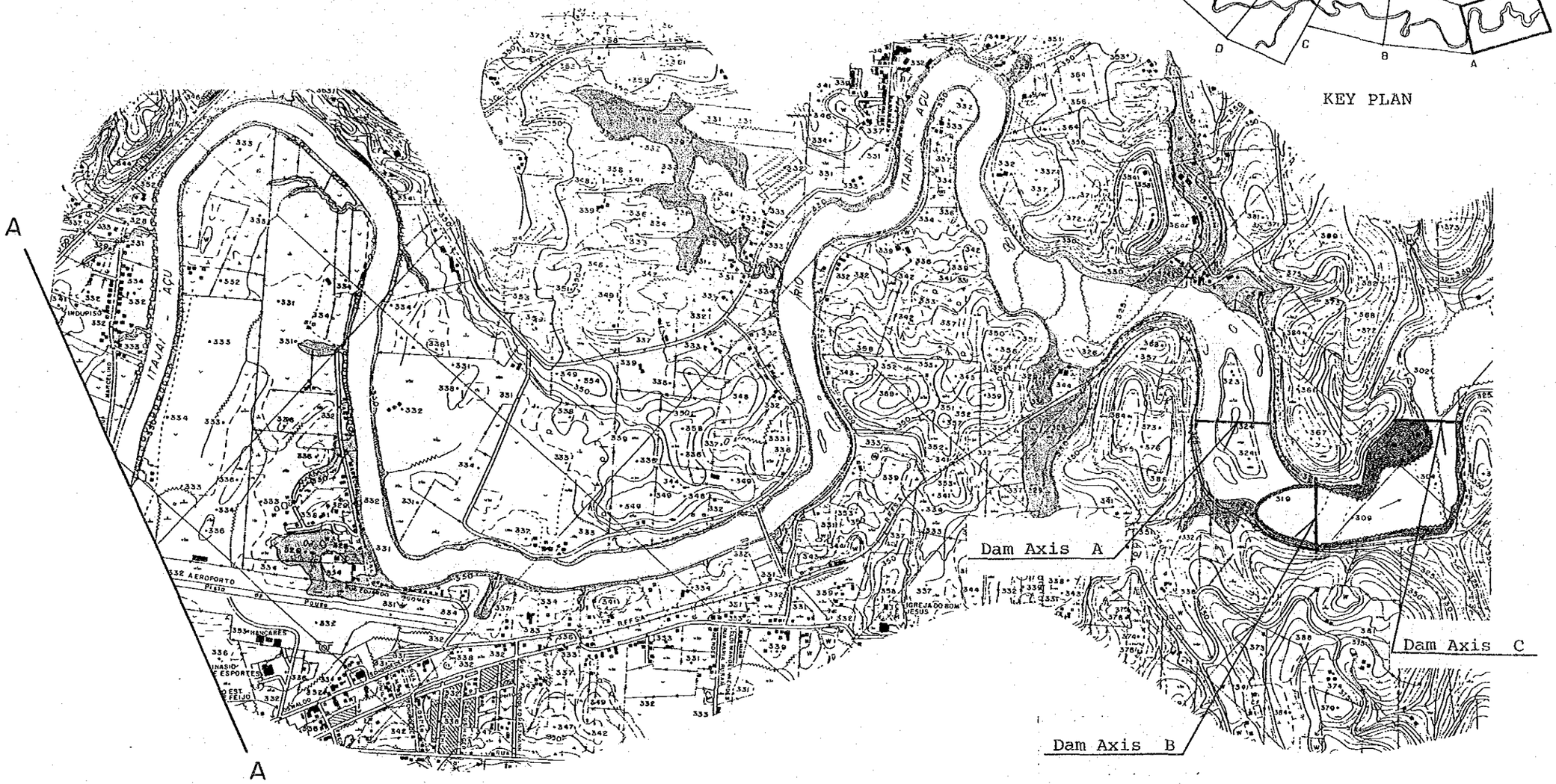


Fig. IV.2.4 SUBMERGED AREA OF SALTO PILÃO (1) SCHEME (1/5)

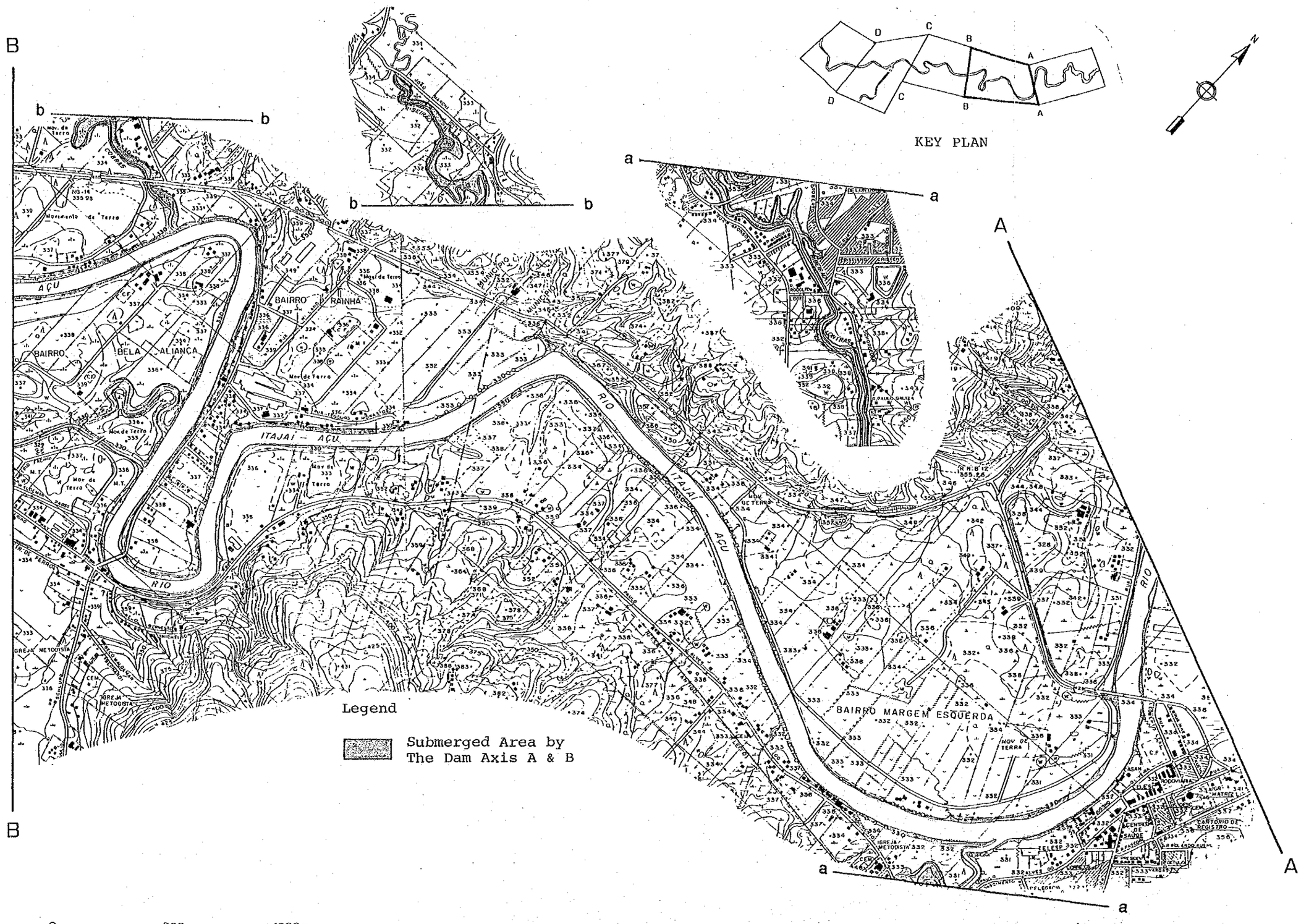


Fig. IV.2.4 SUBMERGED AREA OF SALTO PILÃO (1) SCHEME (2/5)

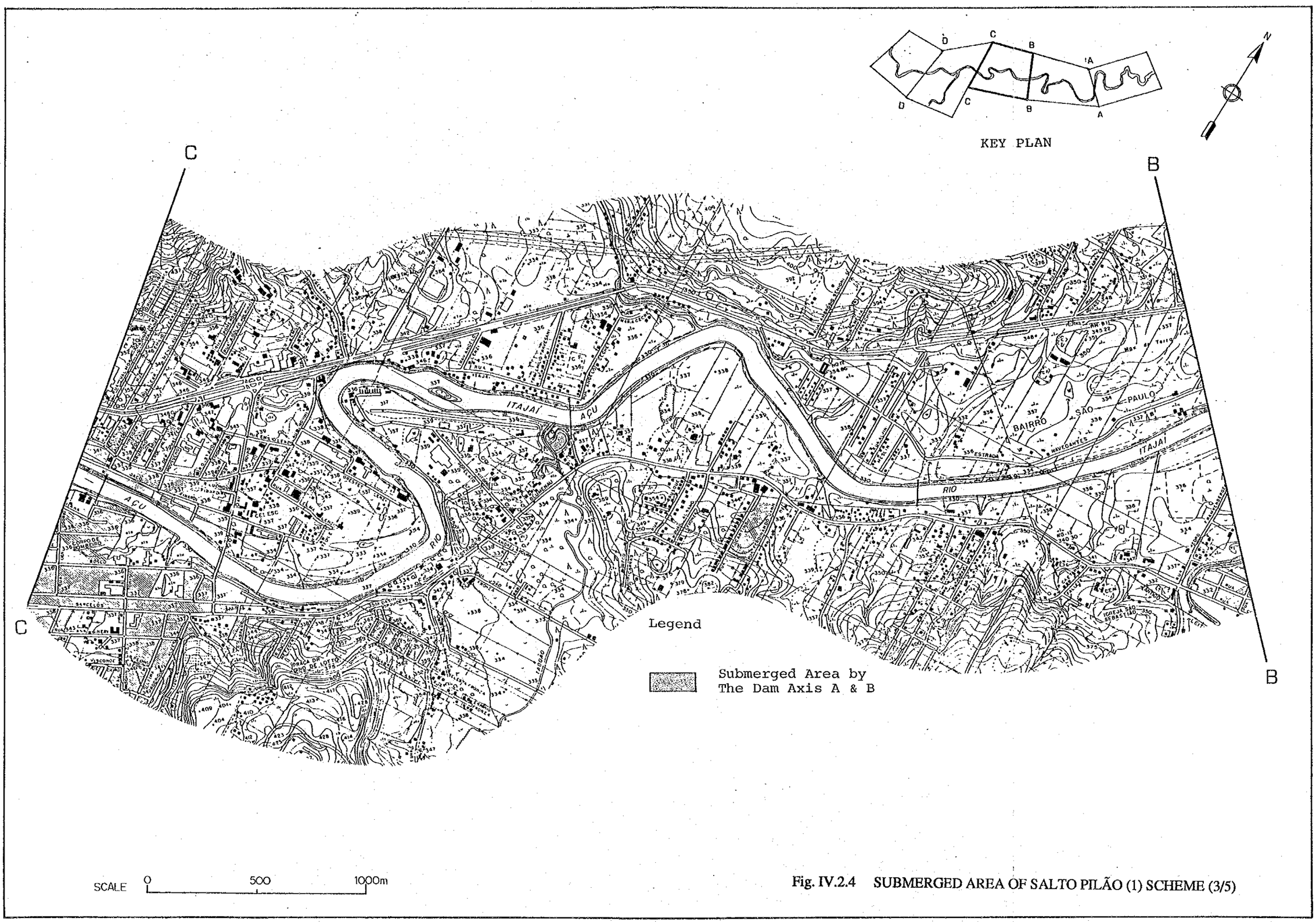


Fig. IV.2.4 SUBMERGED AREA OF SALTO PILÃO (1) SCHEME (3/5)

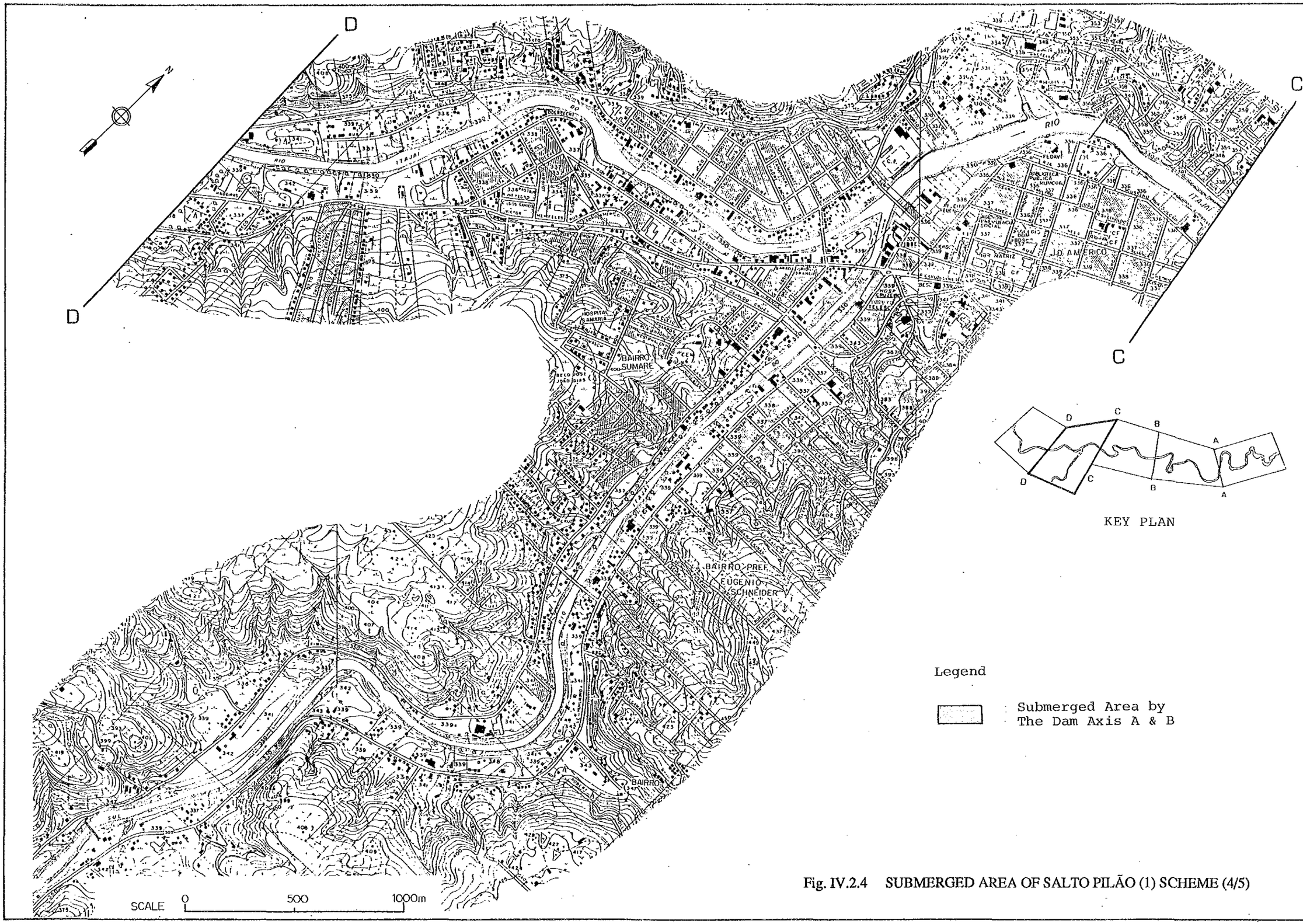
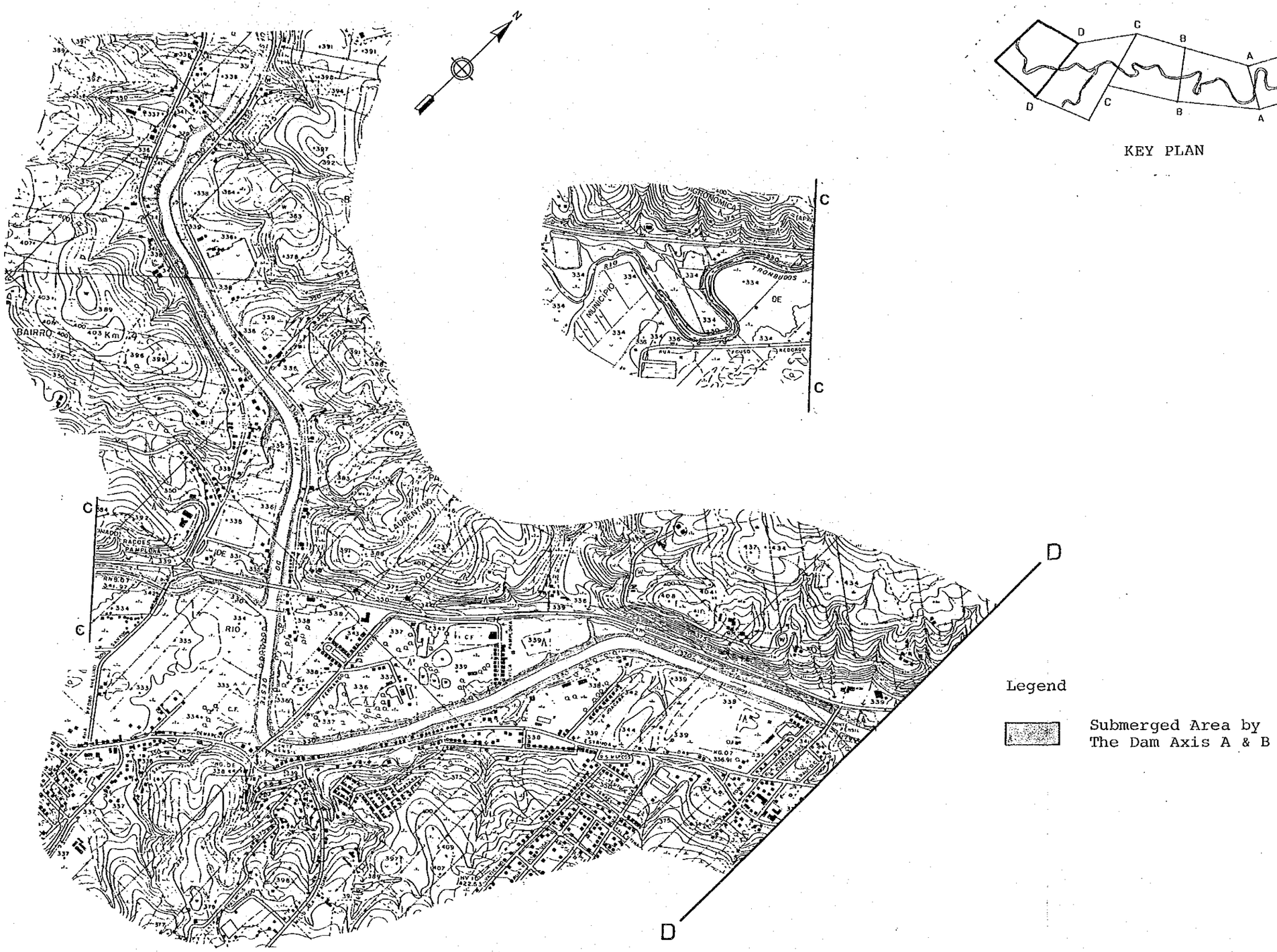
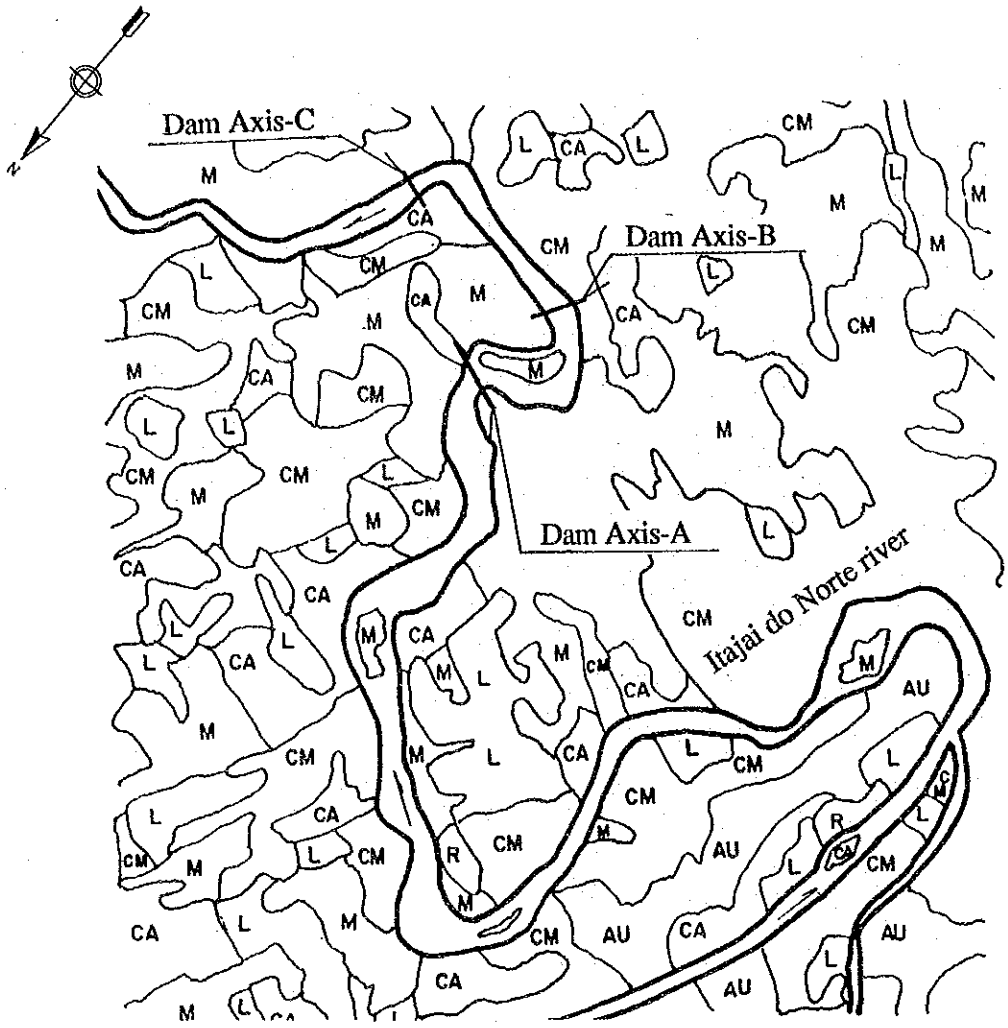


Fig. IV.2.4 SUBMERGED AREA OF SALTO PILÃO (1) SCHEME (4/5)



KEY PLAN

Fig. IV.2.4 SUBMERGED AREA OF SALTO PILÃO (1) SCHEME (5/5)



LEGEND

CA	Bush
CM	Grassland
AU	Urbanized area
L	Agriculture
R	Reforested area
M	Natural forest

Fig. IV.3.1 LAND USE MAP OF DALBERGIA

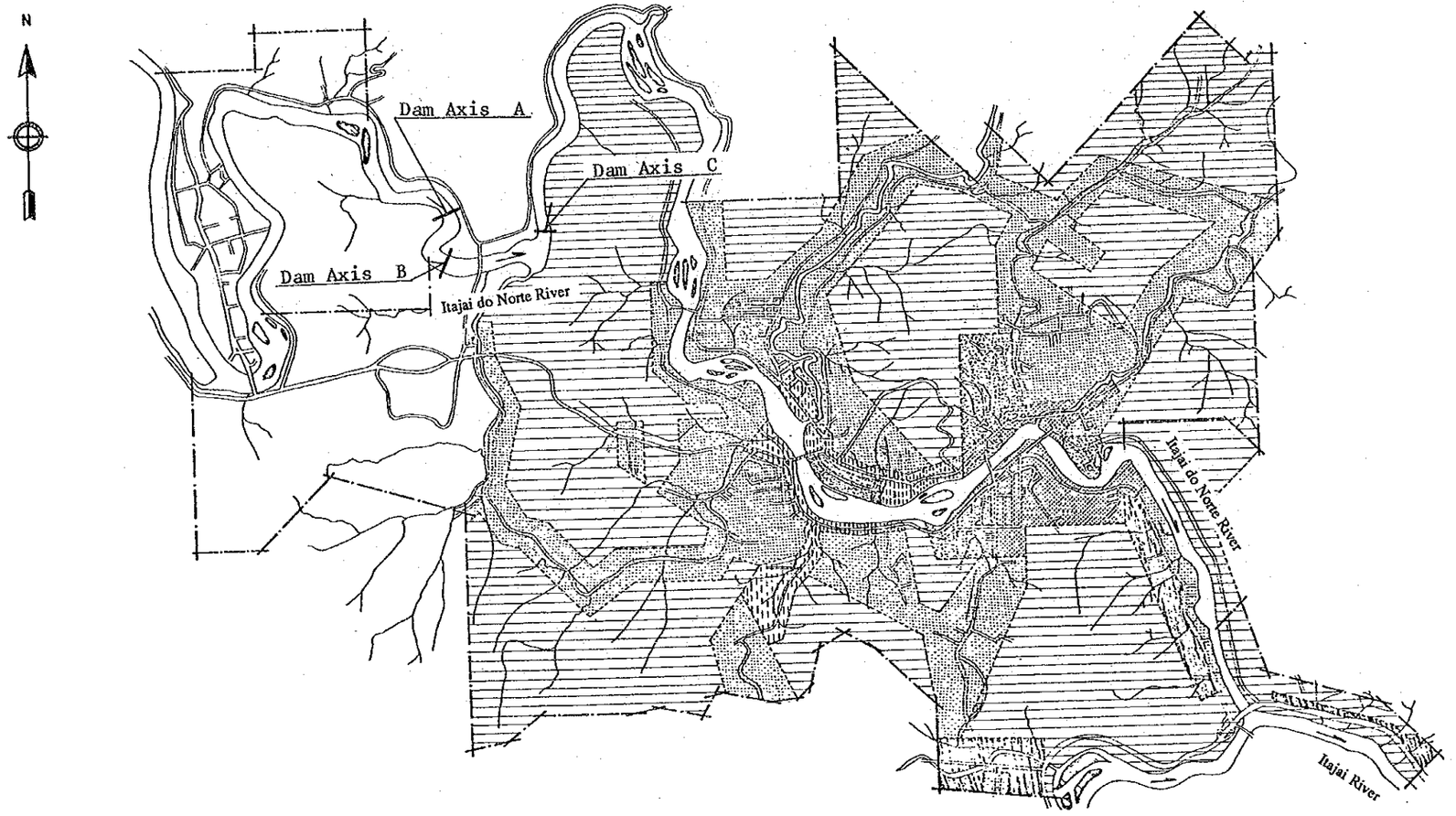


Fig. IV.3.2 ZONING PLAN OF DALBERGIA

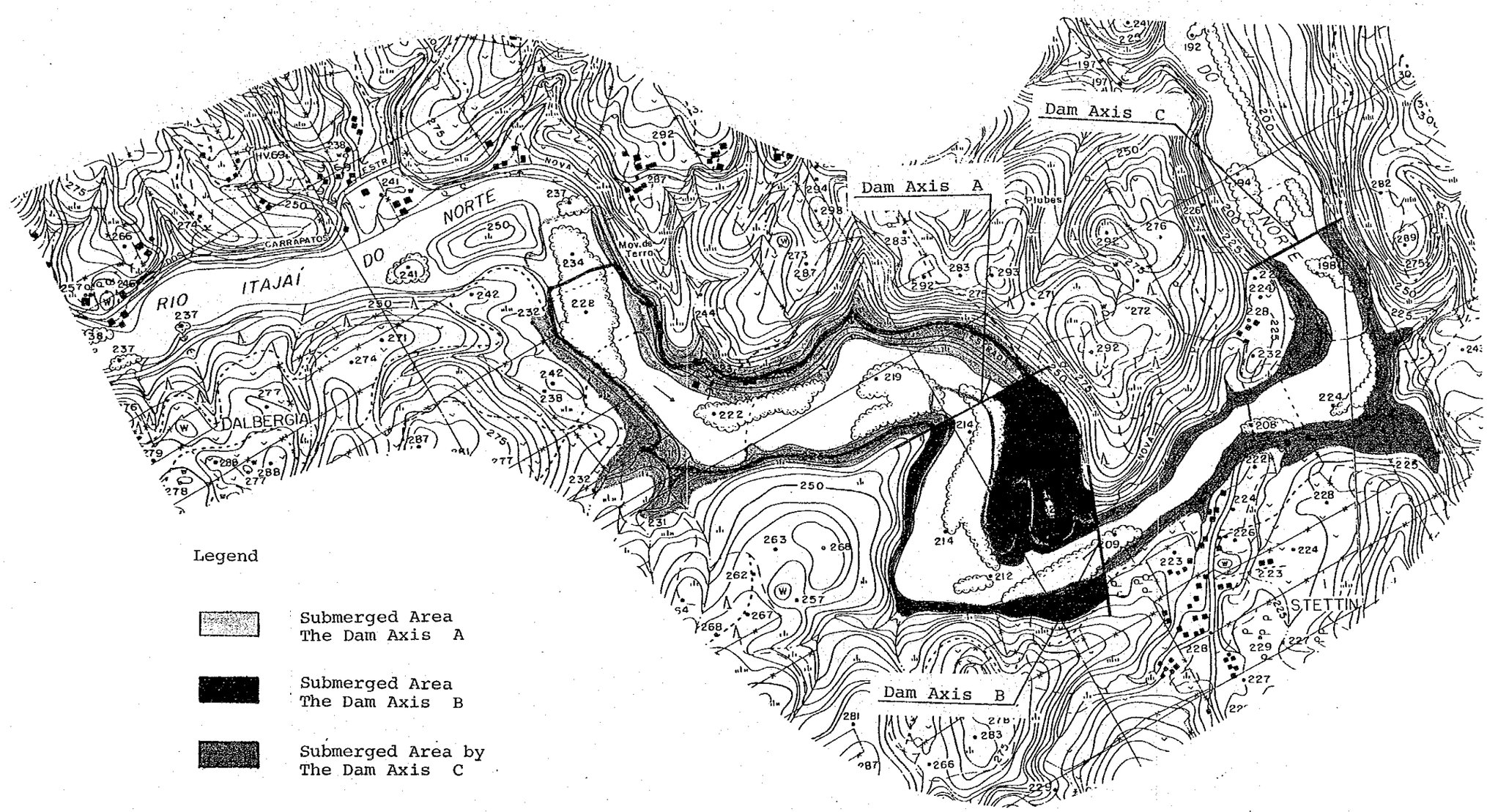
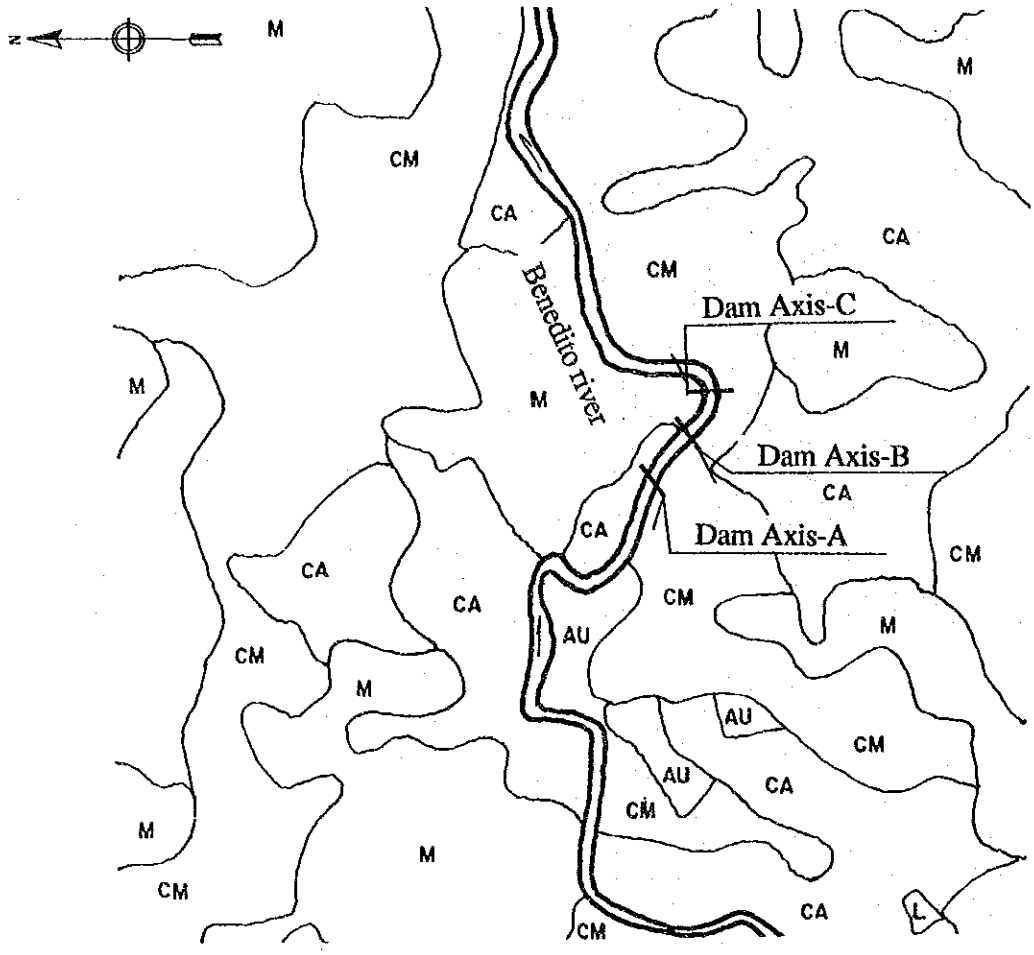


Fig. IV.3.3 SUBMERGED AREA OF DALBERGIA SCHEME



LEGEND

CA	Bush
CM	Grassland
AU	Urbanized area
L	Agriculture
R	Reforested area
M	Natural forest

Fig. IV.4.1 LAND USE MAP OF BENEDITO NOVO

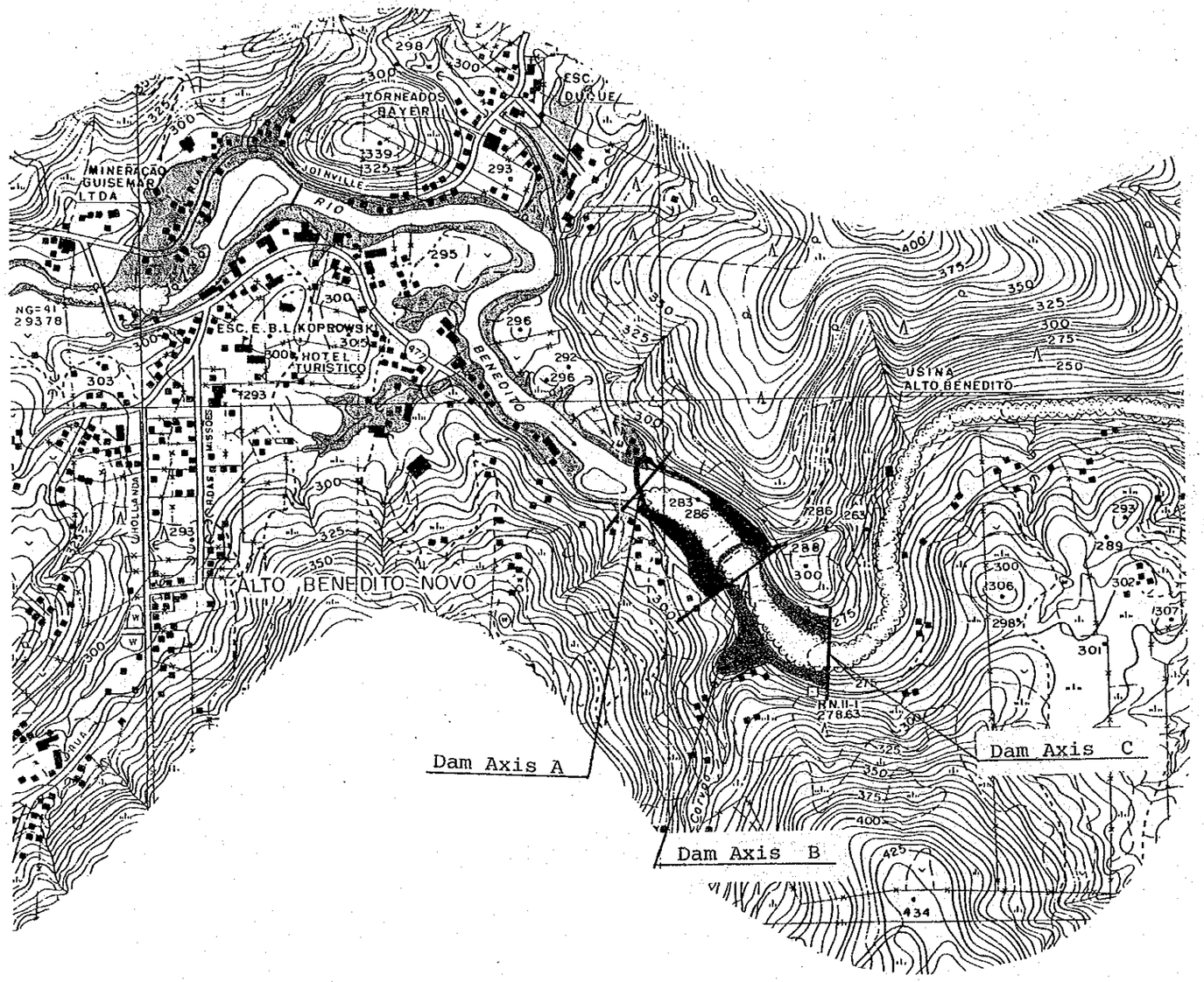


Fig. IV.4.2 SUBMERGED AREA OF BENEDITO NOVO SCHEME