6.3.5 Initial Environmental Examination of Major Projects in the Tibagi River Basin

(1) Water Intake Locations

The water intake locations of the Tibagi river basin are summarized in the following table:

Table-6.17 Location of Water Intake Locations Population Serviced, and Main Problems Associated

Municipality	Population	% Serviced	Intakes	Problems
Apucarana	94,745	98.9	Caviuna & Pirapo rivers	Domestic & Industrial Pollution
Arapongas	67,055	100	Riberão dos Apertados	Domestic, Industrial & Agricultural Pollution
Rolandia	41,781	100	Riberão das Emas & Ribeirão Bandeirantes	Pollution from Riberão Bandeirantes
Cambe	76,701	98	Tibagi River	Turbidity
Londrina	405,058	100	Tibagi & Cafezal Rivers	Turbidity
Ibipora	36,530	100	Jacutinga River	Domestic Sewerage & Agricultural Residues

Source: COPATI (35)

Other foreseen environmental problems that could affect the water supply sources in the basin are summarized as follows by COPATI:

1) Urban expansion tendency towards water supply areas and springs, as it is the case for the municipality of Arapongas, since the Riberao dos Apertados, Apucarana caption spring, and spare caption springs for Rolandia and Londrina are located in Arapongas.

2) Industrial expansion without proper environmental impact assessment studies could have a negative impact on water sources and springs, as it is the case in the Bandeirantes do Norte river, which acts as industrial effluent recipient for the Rolandia industrial zone.

The industrial expansion of Eastern Cambe and Londrina towards the north, near the borders of Londrina and Ibipora, attempt against the water quality of Riberao Jacutinga and the water supply spring of Ibipora.

3) Urban and population growth without adequate sewerage treatment system could affect water sources and springs.

(2) Hydroelectric Projects

The existing hydroelectric projects in the Tibagi river basin are lacking on environmental impact studies, and according to COPATI (35), little or no study was carried out before the construction of the existing hydroelectric projects, with a loss of important data concerning the ichthyofauna of the basin. The existing projects were implemented between 1911 (Pitangui) and 1964 (Papelão Apucarana), where no EIA studies were required.

The planned hydroelectric projects for the years 2003-2010 are summarized below, and the terms of reference being put out by COPEL for the environmental impact study contracting contain a comprehensive approach as in the case of the Salto Caxias environmental impact study referred previously. This approach should follow future environmental studies for hydroelectric projects.

Fig.6.11 show the proposed location for future hydroelectric projects in the basin, and Fig.6.5 show the approximate area to be inundated with the future Jataizinho hydroelectric project in the Tibagi river, other indicative areas to be inundated by planned hydroelectric projects in the Tibagi river can be found in Fig.6.12 through Fig.6.17.

Table-6.18 Existing Hydroelectric Projects in the Tibagi River Basin

Project	Company Responsible	River Location	Drainage Area in km^2
São Jorge	COPEL	Pitangui	520
Pitangui	COPEL	Pitangui	606
Pres. Vargas	Klabin	Tibagi	15,100
Papelão Apucarana	P. Apucaraninha	Apucarana	-
Apucaraninha	COPEL	Apucaraninha	580
Três Bocas	COPEL	Três Bocas	468
Mecano Fabril	M. Fabril	Congonhas	-
Caratuva	COPEL	Caratuva	-

Source: COPATI/COPEL

The most significant impact attributed to the existing projects was the inadequate resettlement of affected families, although the lands and properties where paid, no sociological program was implemented to reconstruct social and community values.

Table-6.19 Inventory of Proposed Hydroelectric Projects in the Tibagi River Basin

Project	Expected Operation Year	Inundated Area (km^2) Total	Inundated Area (km^2) Excluding River	Reservoir Length (km)
Santa Branca	>2010	28.3	18.4	120
Tibagi	>2010	9.4	5.0	28
Tel. Borba	2010	16.3	9.0	40
Maua	2010	114	97.4	ND
São Jeronimo	2004	96.5	85.3	ND
Cebolao	2003	25.7	15.4	38
Jataizinho	2003	31.7	21.7	31

Source: COPEL

Note: All of the above projects are to be implemented in the Tibagi river.

Most of the projected projects are of small to medium scale, taking advantage of the river course morphology, and thus inundating a rather reduced area along the river course. The following summary reflects the main environmental issues for each project, see also Fig.6.14

1) Santa Branca

The area to be inundated is composed approximately by 80% fields with some residual forest patches, 24% agriculture crops, and 1% reforestation. There are no urban areas in the area to be inundated. See Fig.6.12

2) Tibagi

The only municipality affected by inundation is Tibagi, and the vegetation affected in 5 (Km^2) though a 28 Km distance is basically river margin vegetation. See Fig.6.13

3) Telemaco Borba

The area to be inundated (9 Km^2) along 40 Km upstream the River would inundate an approximate 250 m wide belt along both sides of the river. this area is mainly composed of 88% natural forest, 7% reforestation, and 5% crop lands.

This condition has to be further studied in detail through the environmental impact study to be performed. See Fig.6.14.

4) Maua

The area to be inundated (97.4 Km^2) is composed of approximately 57% natural forest, 6% crop land, 14% reforestation, and 23% pastureland. The human presence is restricted to a rather small number of properties located in the left margin. See Fig.6.15

5) Sao Jeronimo

The area to be inundated (85 Km^2) is composed of approximately 41% forest, 2% crop land, and 57% of open fields.

One of the main impacts foreseen is the inundation of an area of approximately 6.9 Km^2 belonging to the indigenous reserve of Apucarana. The area in question has very high slopes and is considered inadequate for crop production. the human presence in this area is very reduced. See Fig.6.16.

The foreseen problems are related to the use of the water by the indigenous people, where the 3 indian reserves affected traditionally carry out artisanal fishing in the area.

The number of indians affected are approximately 1,000, according to 1992 census.

Further studies have indicated that by reducing the water level of the reservoir by 25 m the total cost of the project will be reduced by US$50 million, sacrificing 8.2 MW and reducing the inundated area from 85 to 49 Km^2

This alternative is being evaluated by COPEL.

6) Cebolao

The area to be inundated (15.4 Km^2) along 38 Km upstream the River is characterized by open fields 73%, and crop land 27%, there are no urban areas and very few population exists. See Fig.6.17

7) Jataizinho

The area to be inundated (21.7 Km^2) along 31 Km upstream the River includes 50% of the area in open fields and forest patches, and 50% in crop land. See Fig.6.5

The following table summarizes the foreseen impacts in the natural environment of the proposed areas to implement the projects.

Table-6.20 Summary of Environmental Impact Context of the Proposed Hydroelectric Projects in the Tibagi River

Project	Inundated Area			
	% Fields	% Crops	% Forest	% Reforestation
Santa Branca	80	24	-	1
Tibagi	ND	ND	ND	ND
Tel. Borba	-	5	88	7
Maua	23	6	57	14
São Jeronimo	57	2	41	-
Cebolão	73	27	-	-
Jataizinho	50	50	SCARCE	-

Source: COPEL

(3) Municipal Solid Waste Disposal

Major MSW producer is Londrina, with 250 MT/day (40% of the basin volume) disposed of in the open. Hospital disposals are estimated in 1.38 MT/day, disposed of in incinerators and septic holes, except for Curiuva and Sao Jeronimo da Serra which dispose hospital solid waste in open air.

The following table summarizes the situation:

Table-6.21 Location and Solid Waste Management System for the Urban Areas of the Tibagi River Basin

Number of Municipalities	Metric Tons per day	MSW Management System	%
22	597	Open Air Disposal	83
2	33	Landfill	5.3
9	39.5	Incinerate	6.3
3	36	Covered	5.8

Source: COPATI(35)

MSW = Municipal Solid Waste

MT = Metric Tons

Main problems reported and related with the municipal solid waste disposal are summarized hereunder:

1) Water pollution of adjacent water sources by leaching of the landfill.

2) Offensive odors for the nearby populations

3) Proliferation of flies and mosquitos

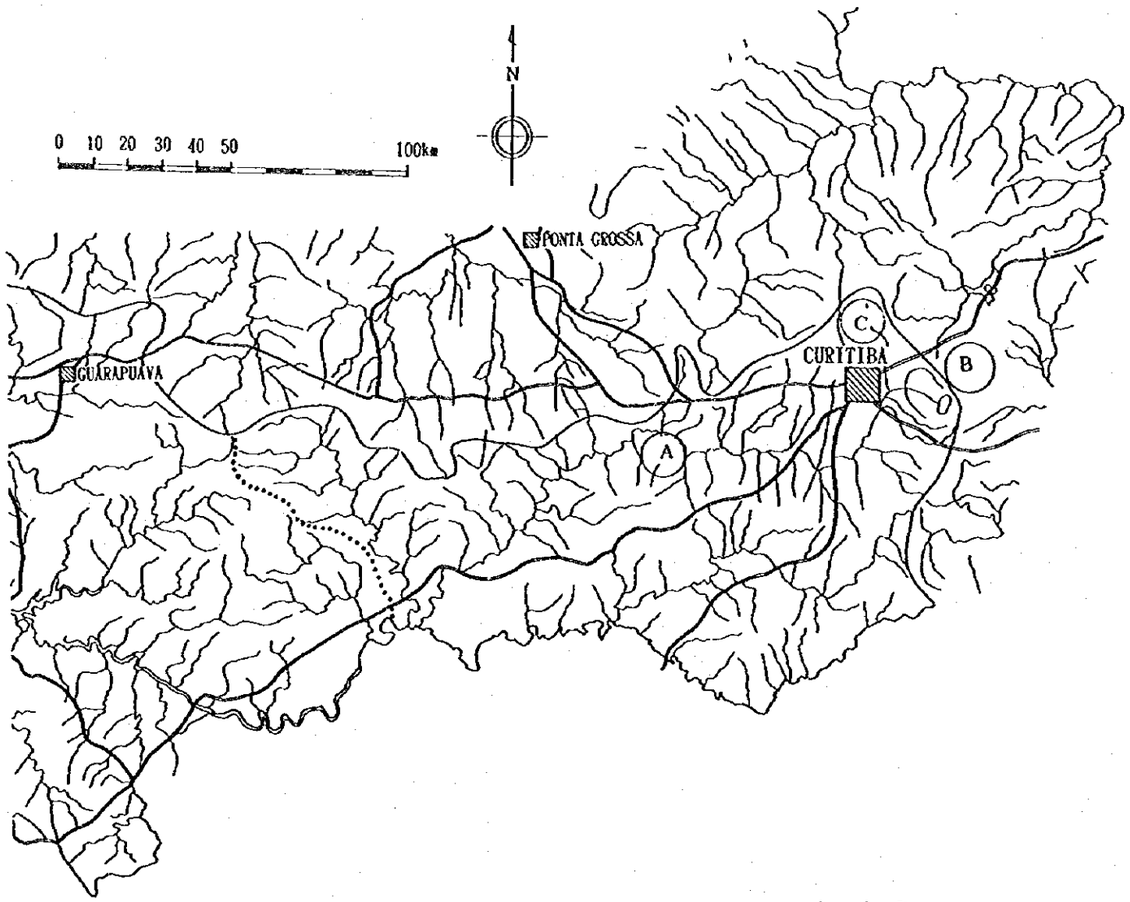
4) Domesticated animals searching for food in the open air dumps

5) Proliferation of vector insects transmitting diseases.

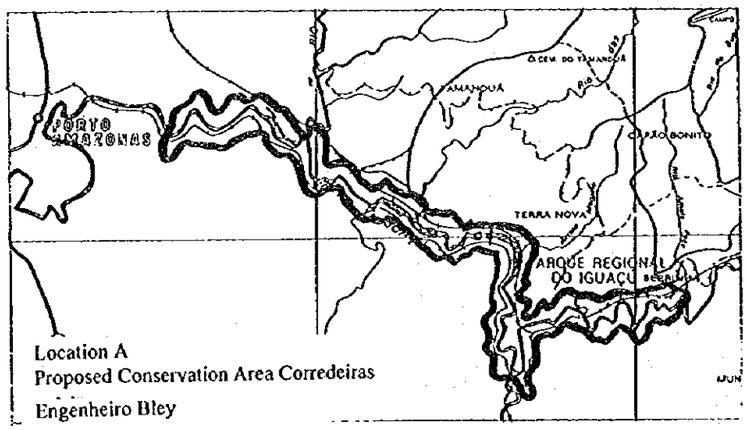
6) Landscape degradation

7) Devaluation of adjacent lands

No environmental impact studies are reported for landfill operations in the Tibagi river basin.



Location C
Palmital River



Location A
Proposed Conservation Area Corredeiras
Engenheiro Bley

Location B
Proposed Conservation Area Serra da Baitaca
Irai Reservoir

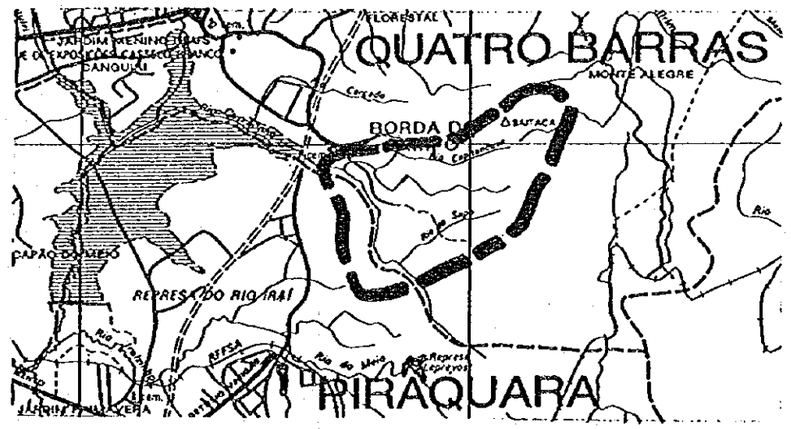
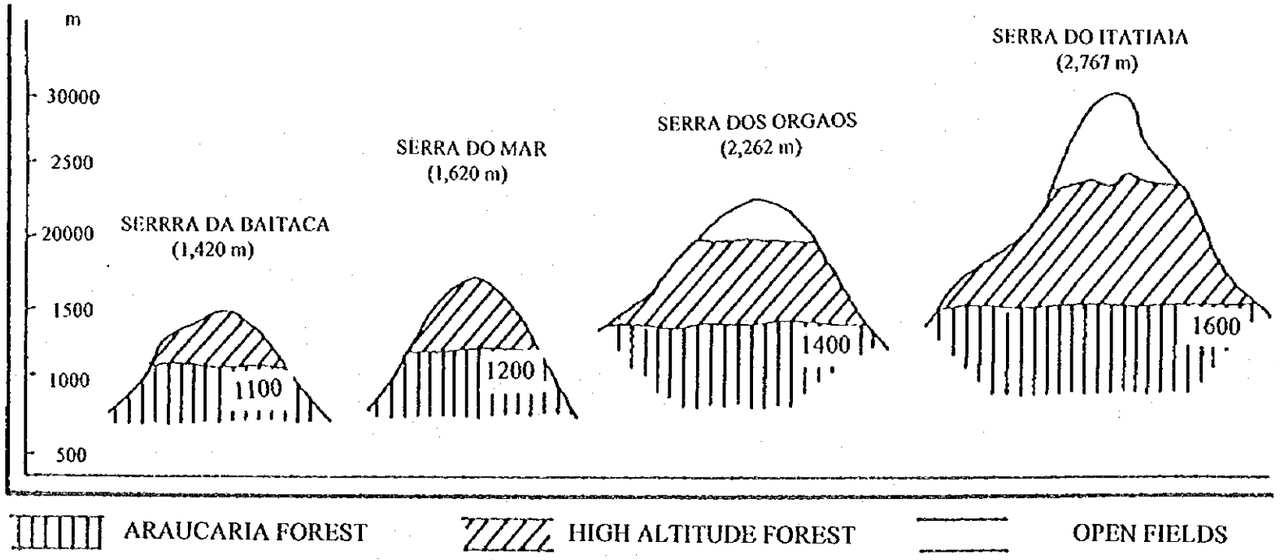
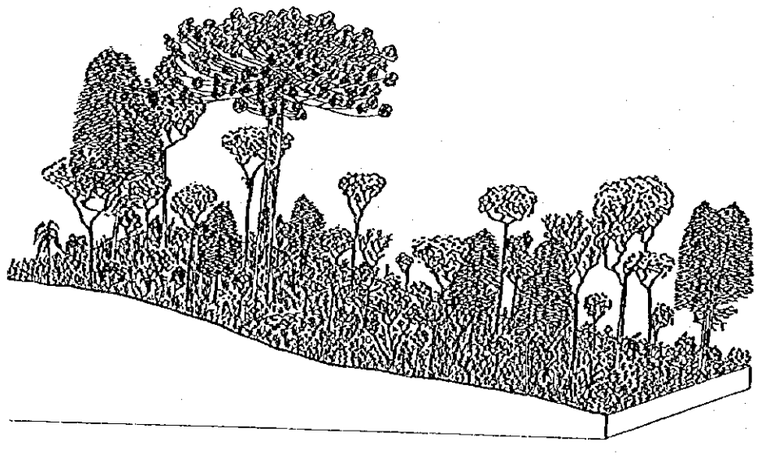


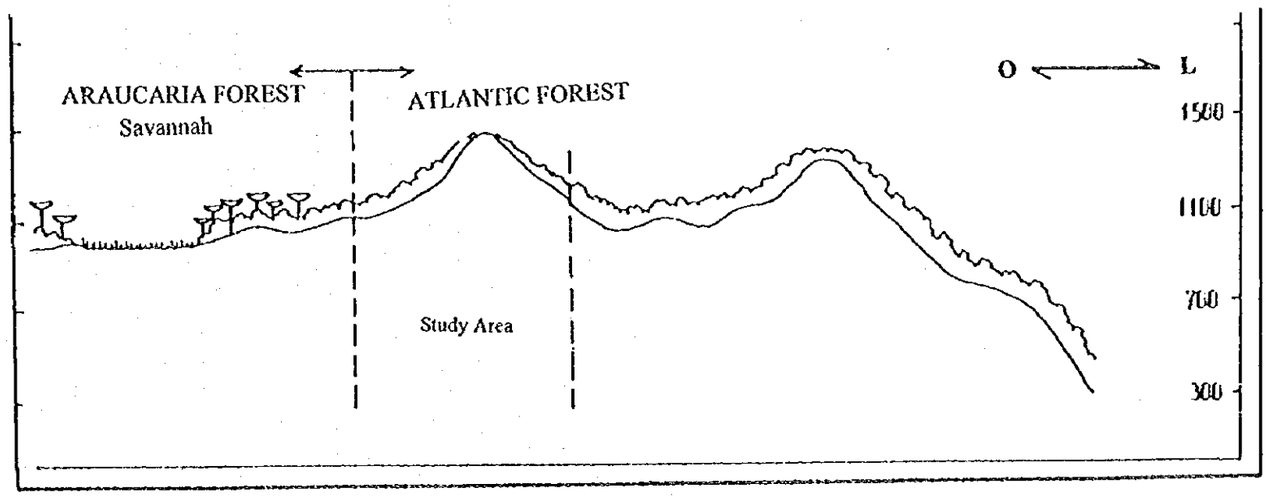
Figure-6.1 Location of Areas Considered for Preservation and Rehabilitation
Source: COMEC, 1995, Botanical Museum and Ziller, S. R. (40)



Elevation Limits Compared with Similar Areas
Source: Roderjan C. V. et al, 1990 (38)



Ideal Profile of the Araucaria Forest
Source: Ziller, S. R. & Hatschbach, G. (1993) (40)



Indicative Profile of the Natural Vegetation Areas in the Serra da Baitaca Region
Source: Roderjan C. V et al, 1990 (38)

Figure-6.2 Vegetation Limits by Altitude in Serra da Baitaca

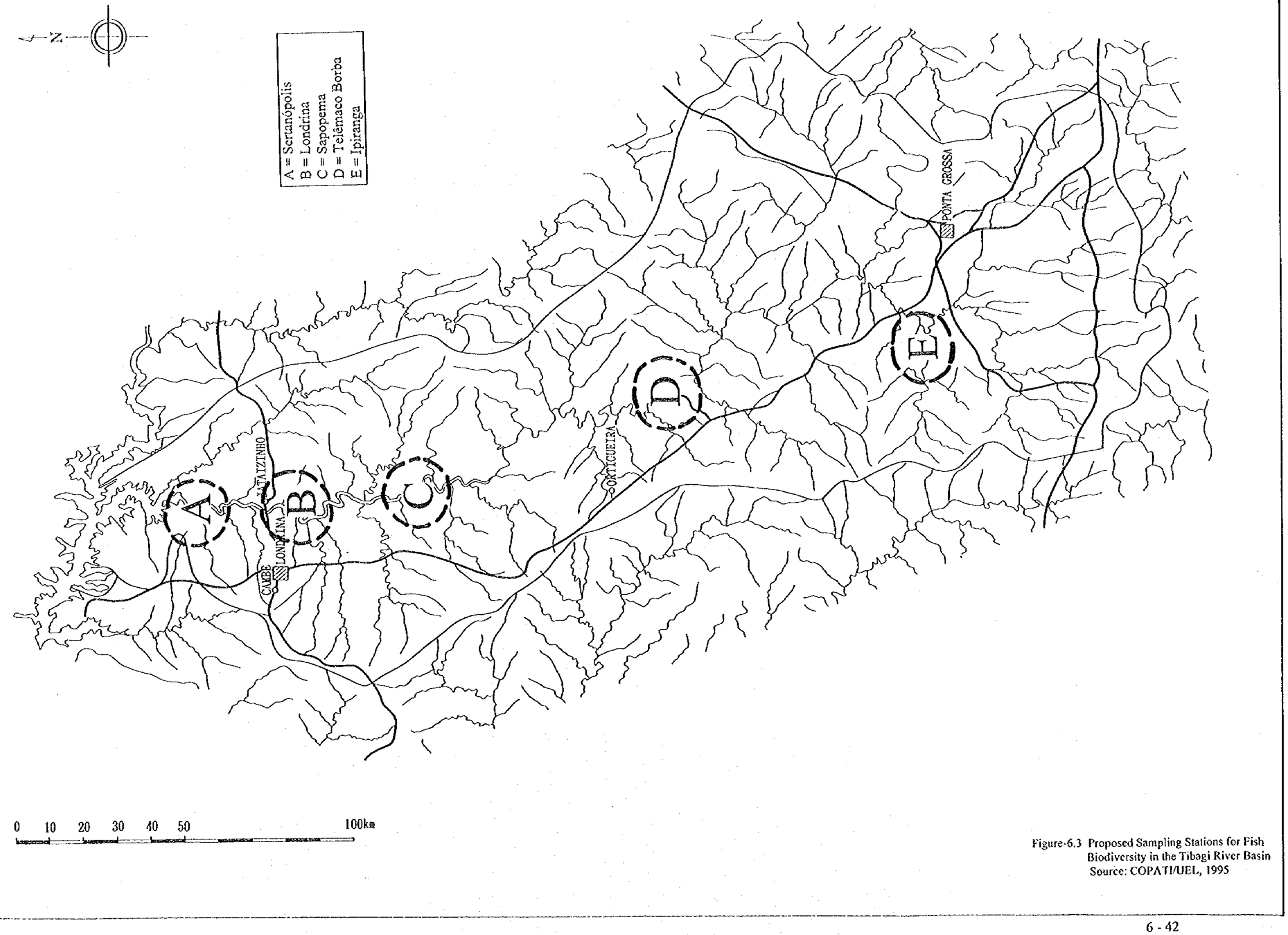


Figure-6.3 Proposed Sampling Stations for Fish Biodiversity in the Tibagi River Basin
Source: COPATI/UEL, 1995

LOCATION OF THE CONSERVATION UNITS	
FEDERAL CONSERVATION UNITS	
CONSERVATION UNITS	LOCATION
1. Irati National Forest	Teixeira Soares
2. Indigenous Reserve of Apucaraninha	Londrina
3. Indigenous Reserve of Barão de Antonina	São Jerônimo da Serra
4. Indigenous Reserve of São Jerônimo da Serra	São Jerônimo da Serra
MUNICIPAL CONSERVATION UNITS	
5. Mata Boca da Ronda	Ponta Grossa
6. Chácara Dantas	Ponta Grossa
7. Ribeirão Erna's APA	Rolândia
8. Municipal Forest "Manoel Júlio de Almeida"	Cornélio Procópio
9. Municipal Biological Reserve of Arapongas	Arapongas
10. Colônia Mineira Municipal Park	Apucarana
11. Raposa Municipal Park	Apucarana
12. São Francisco Park	Irati
13. Arthur Thomas Park	Londrina
14. Imbituva Municipal Park	Imbituva
STATE CONSERVATION UNITS	
15. Caxambu State Park	Castro
16. Geraldo Russi Tree Farm	Tibagi
17. Córrego da Biquinha State Forest	Tibagi
18. Saltinho Forest Reserve	Telêmaco Borba
19. Córrego Maria Flora Forest Reserve	Cândido de Abreu
20. Vila Velha State Park	Ponta Grossa
21. Ibiporã State Park	Ibiporã
22. São Domingos ARIE	Roncador
23. Mata dos Godoy State Park	Londrina
24. Penhasco Verde State Park	São Jerônimo da Serra
25. Cerrado State Park	Jaguariaíva
26. Guartelá State Park	Tibagi
27. Escarpa Devoniana State APA	Tibagi
28. Mina Velha Arco da Gruta State Park	Ibaiti

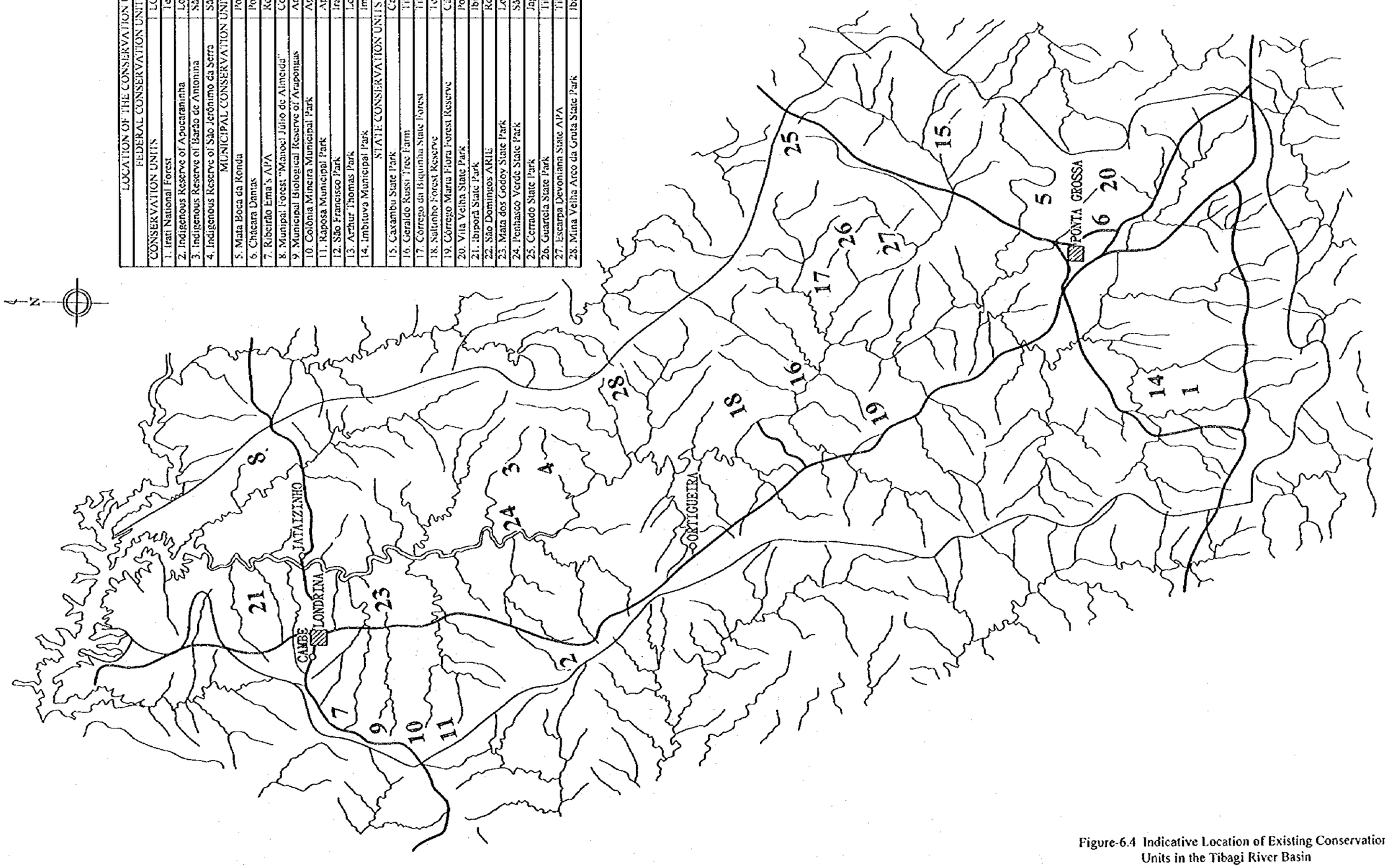


Figure-6.4 Indicative Location of Existing Conservation Units in the Tibagi River Basin
Source: COPEL, 1995

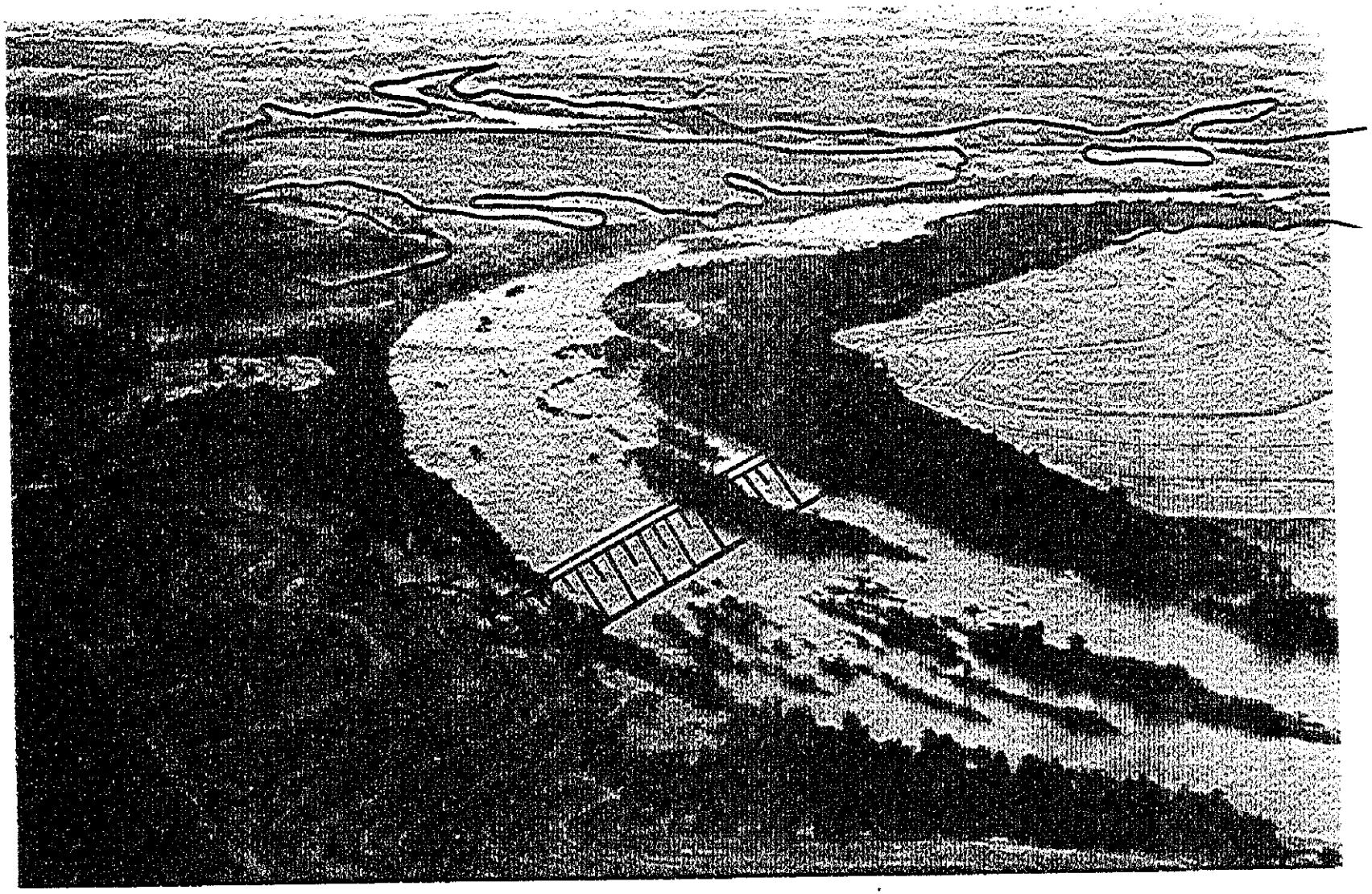


Figure-6.5 Indicative Area to be Inundated with the Jataizinho Hydroelectric Project for the Tibagi River

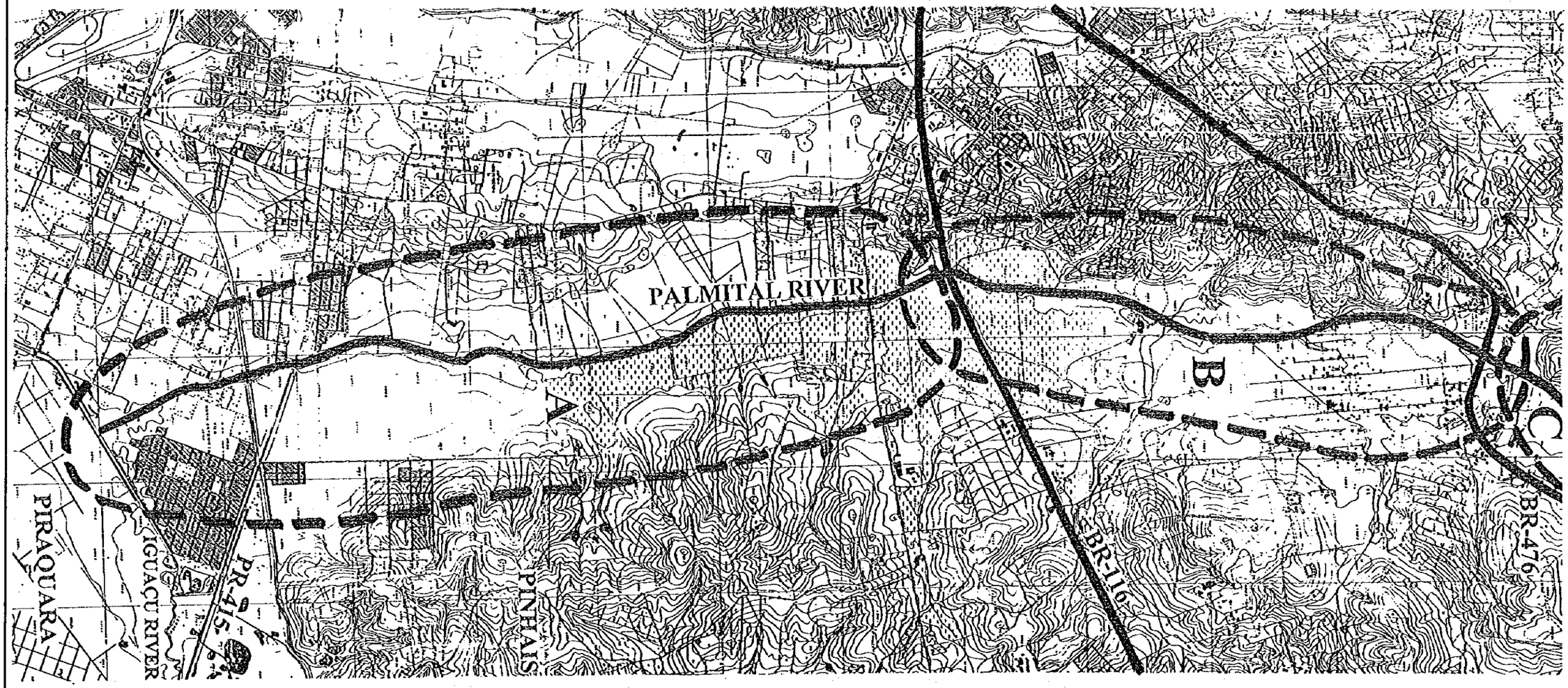
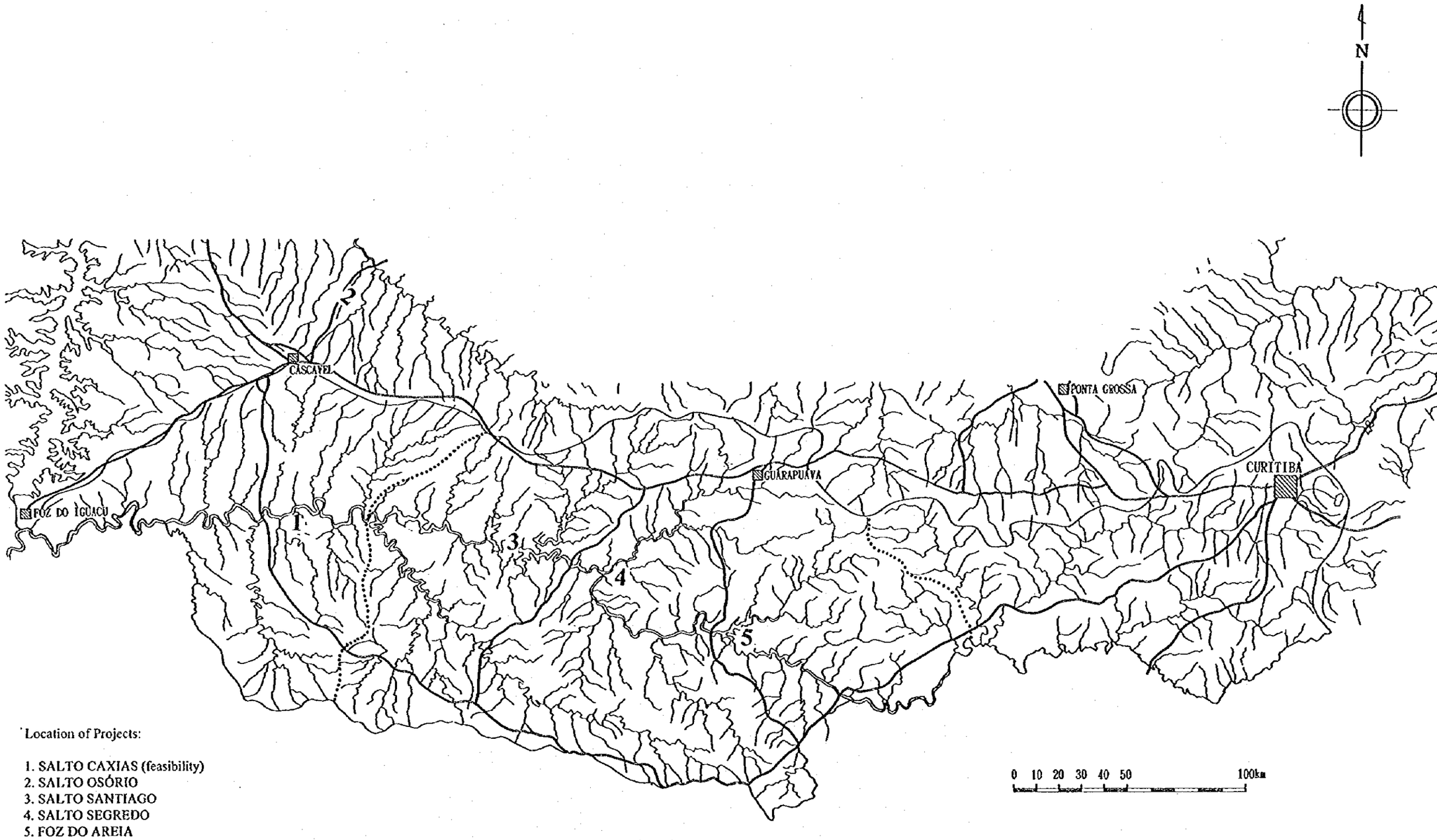


Figure-6.6 Detail of Palmital River
A = Lower Palmital
B = Upper Palmital
Source: COMEC



Location of Projects:

1. SALTO CAXIAS (feasibility)
2. SALTO OSÓRIO
3. SALTO SANTIAGO
4. SALTO SEGREDO
5. FOZ DO AREIA

Figure-6.7 Indicative Location of Major Existing and Planned Hydrolectric Projects in the Iguaçu River
Source: COPEL, 1995

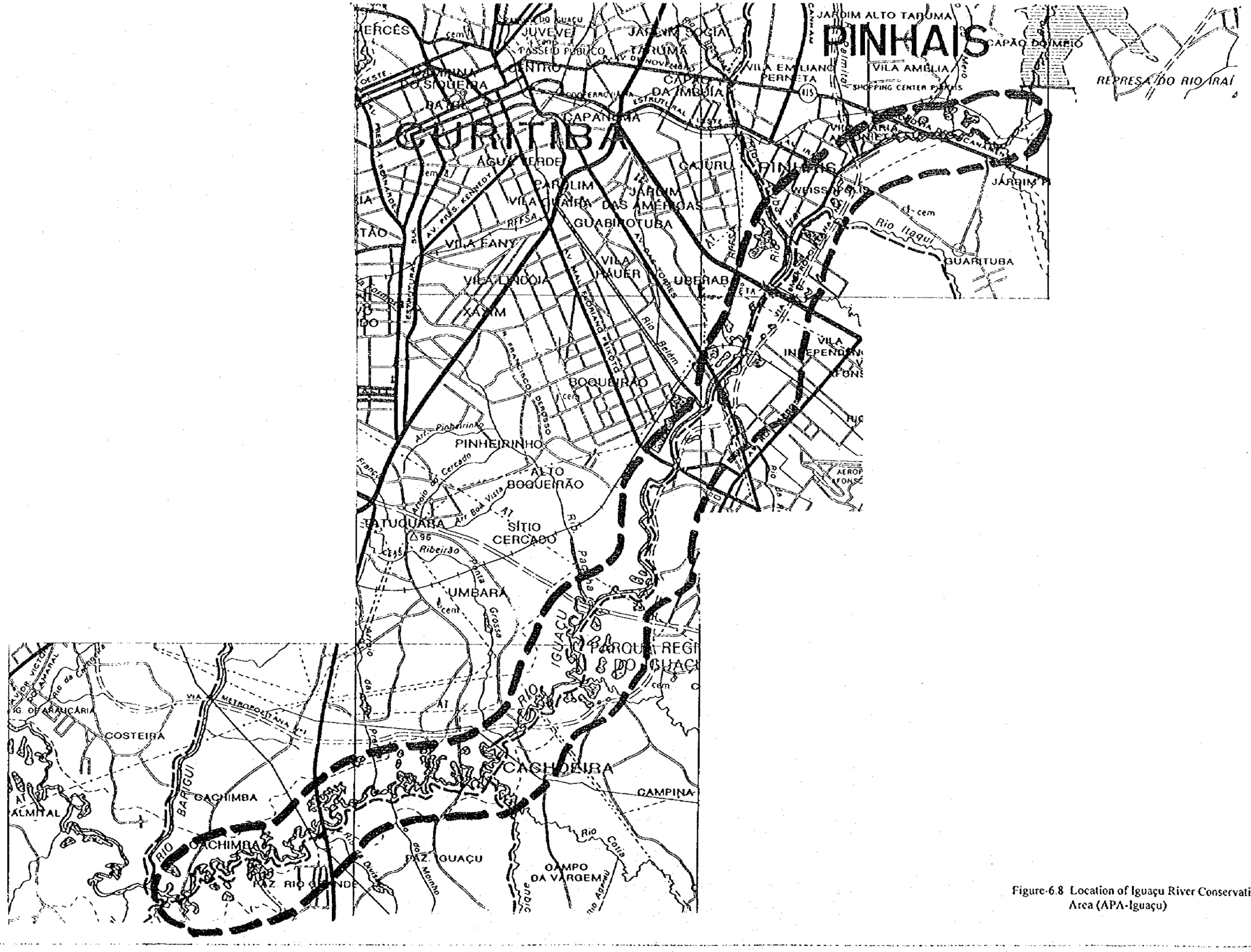
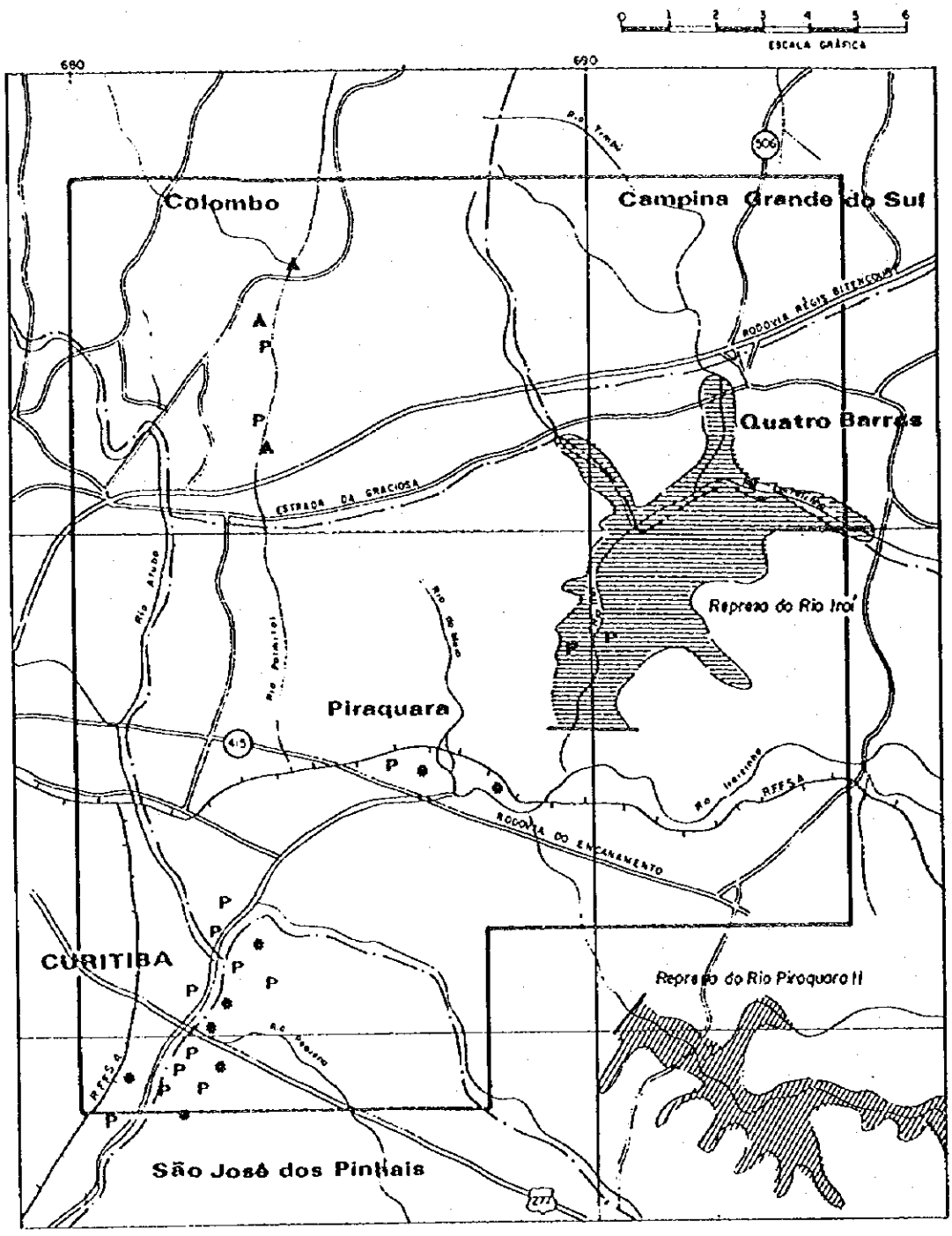


Figure-6.8 Location of Iguaçu River Conservation Area (APA-Iguaçu)



Legend:

—— Area Analyzed by MINEROPAR
▲ Clay Extraction
● Sand Extraction
P Paralized Extraction

Figure-6.9 Sand mining Locations in Higher Iguaçu
Source: Pellenz, E. and Luciano Cordeiro, MINEROPAR (42)

STATE CONSERVATION UNITS
1. Metropolitan State Forest
2. Mananciais da Serra
3. Passaúna State APA
4. João Paulo II State Park
5. do Monge State Park
6. Passa Dois State Forest
7. Escarpa Devoniana State Forest
8. Serra do Tigre ARIE
9. Santana State Forest
10. Serra da Esperança State Forest
11. Pinhão Forest Reserve
12. Rio dos Touros Ecological Station
13. Buriti ARIE
14. Palmas ARIE
FEDERAL CONSERVATION UNITS
15. Iguaçu National Forest
16. Indigenous Reserve of Rio das Cobras
17. Indigenous Reserve of Mangueirha

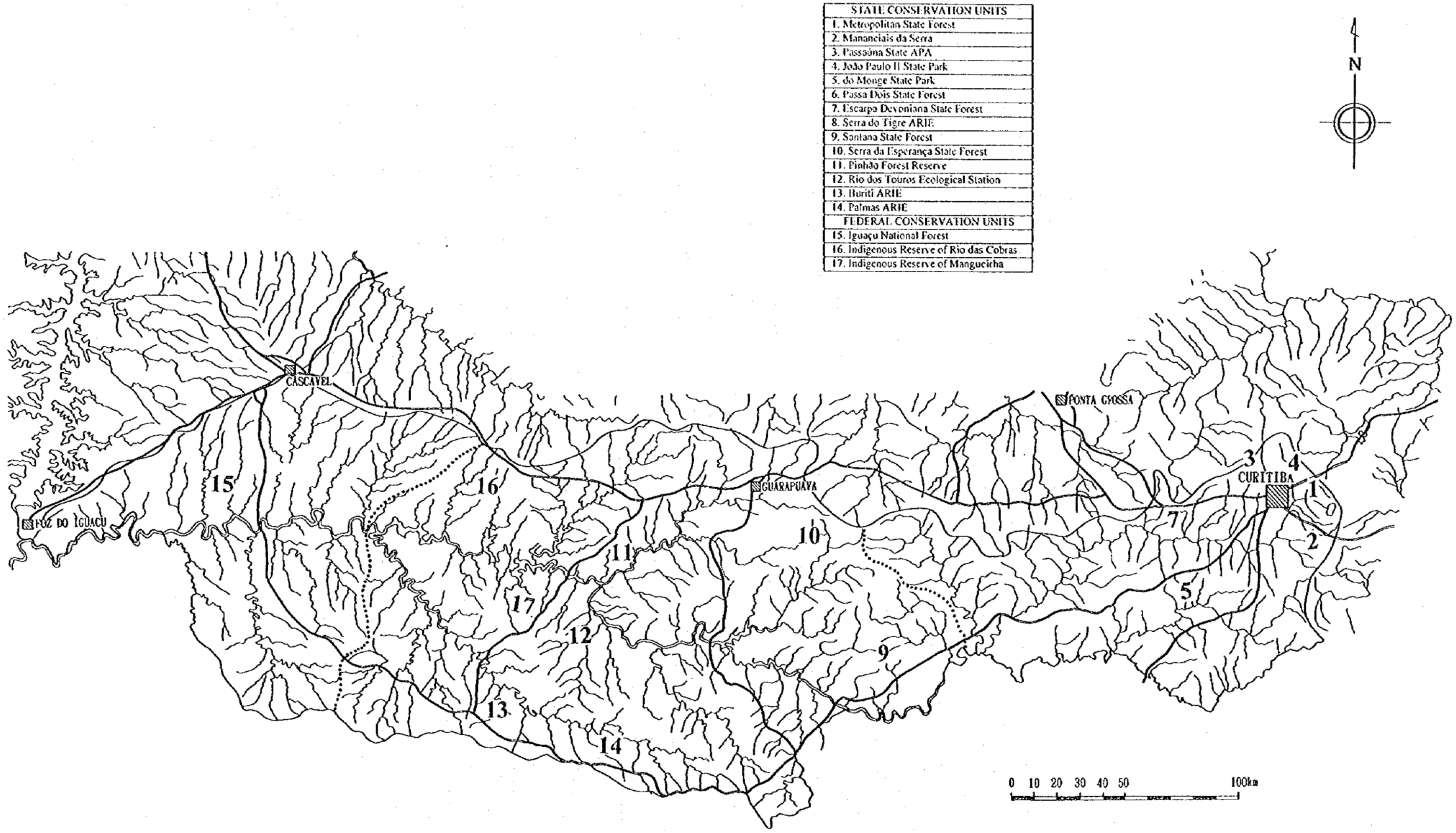


Figure-6.10 Indicative Location of Existing Conservation Units in the Iguaçu River Basin
Source: IAP

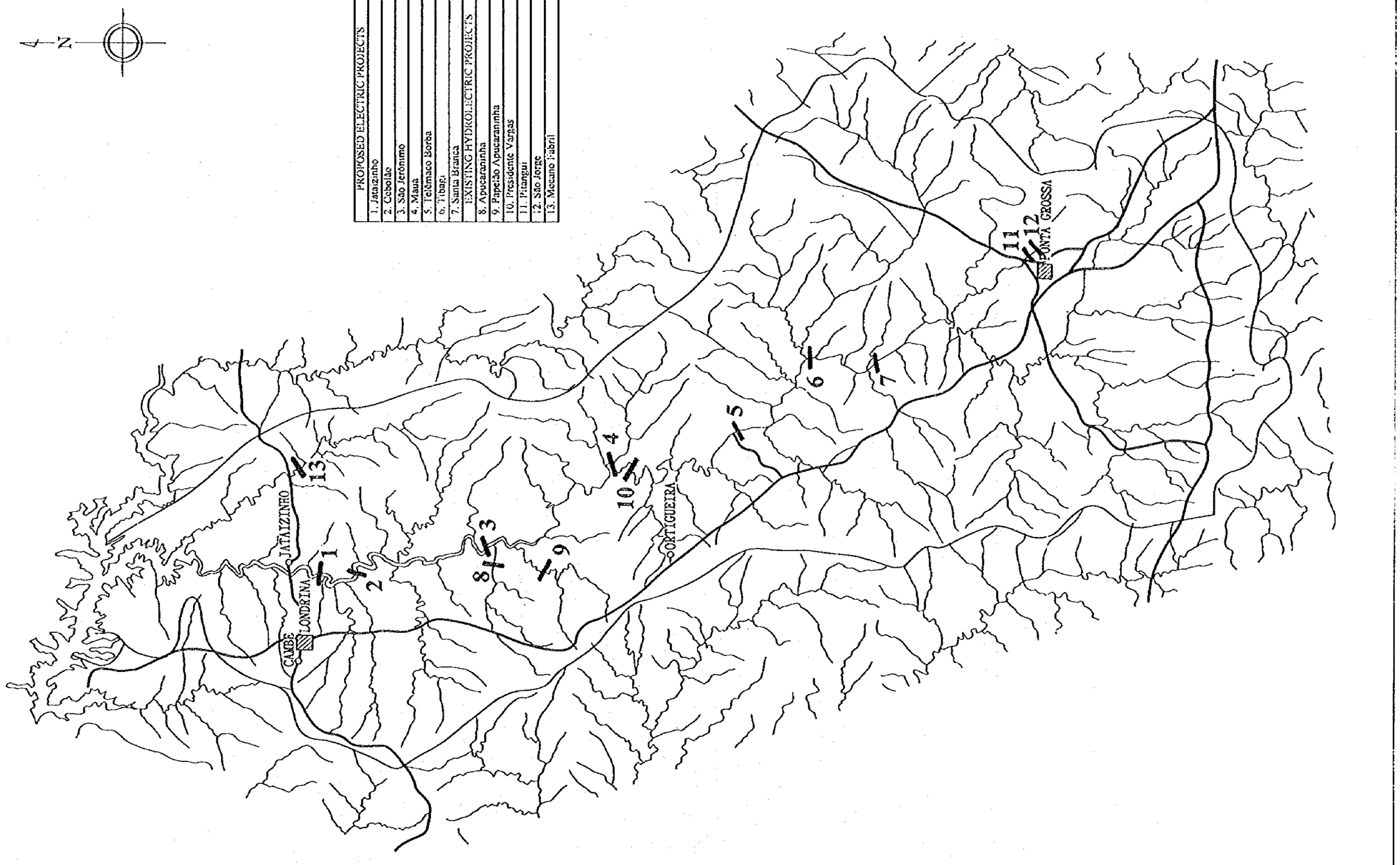


Figure-6.11 Location of Existing and Major Proposed Hydrolectric Projects in the Tibagi River Basin
Source: COPEL, 1995

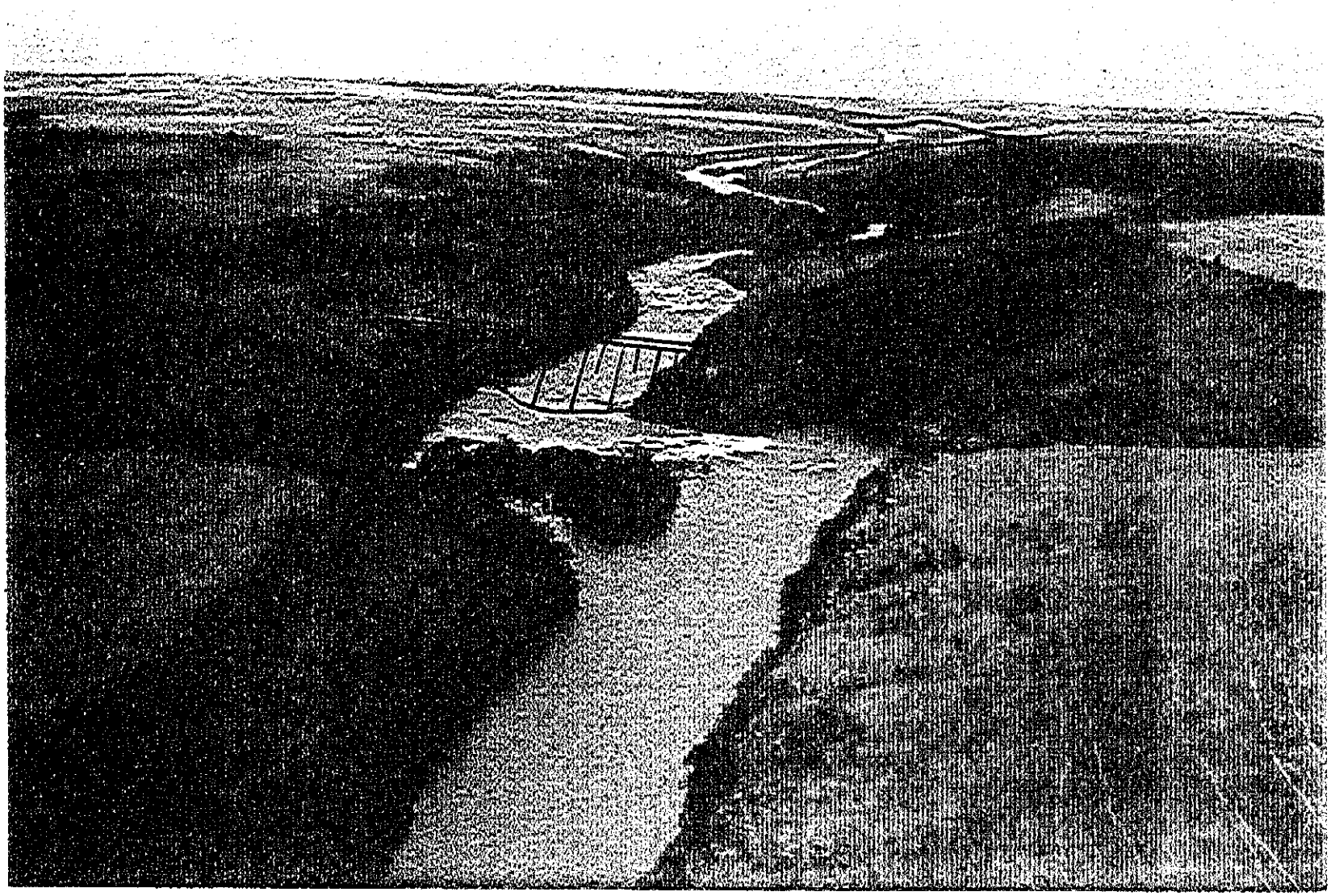


Figure-6.12 Indicative Area to be Inundated with the Santa Branca Hydroelectric Project for the Tibagi River

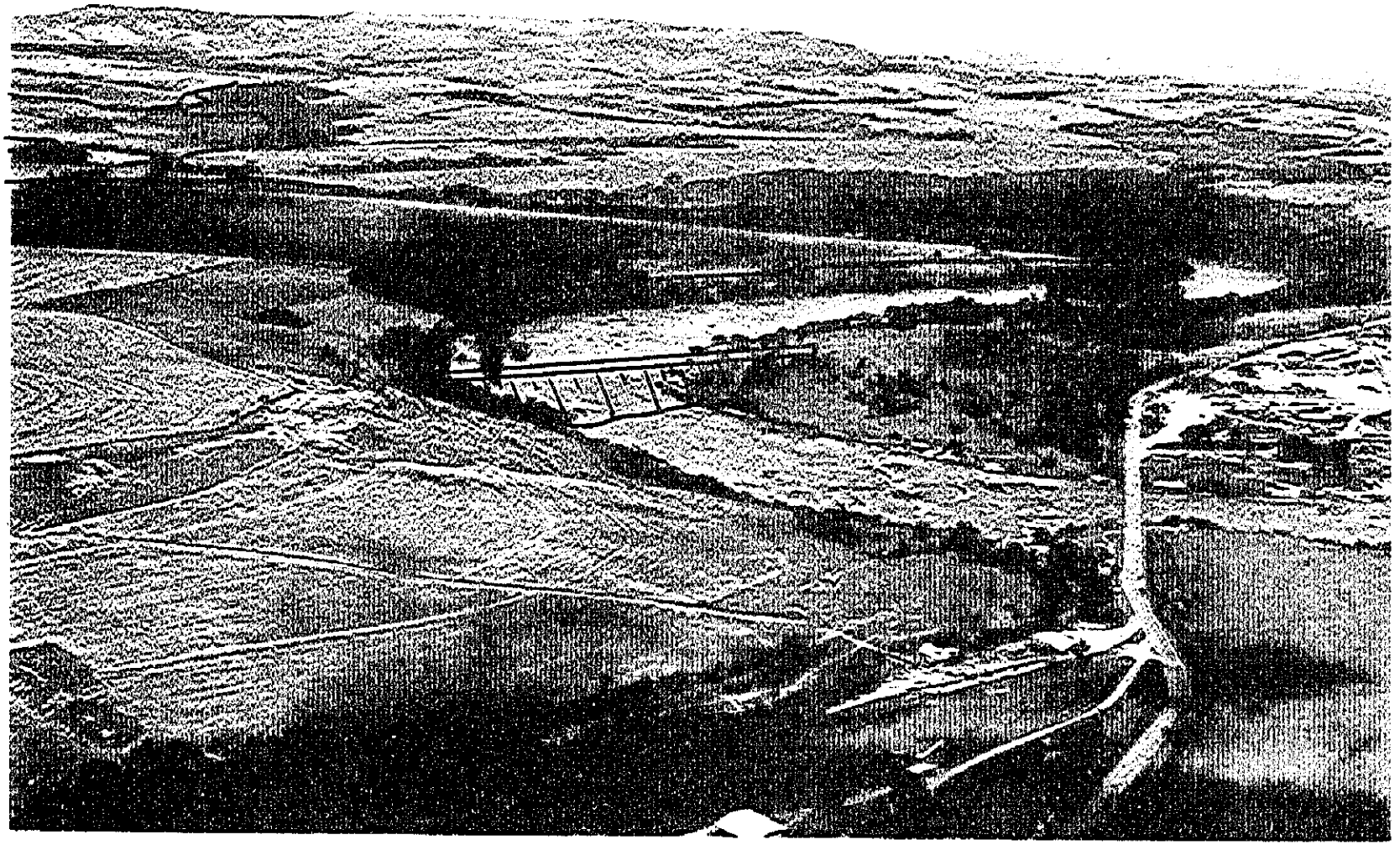


Figure-6.13 Indicative Area to be Inundated with the Tibagi Hydroelectric Project for the Tibagi River
Source: COPEL, 1995

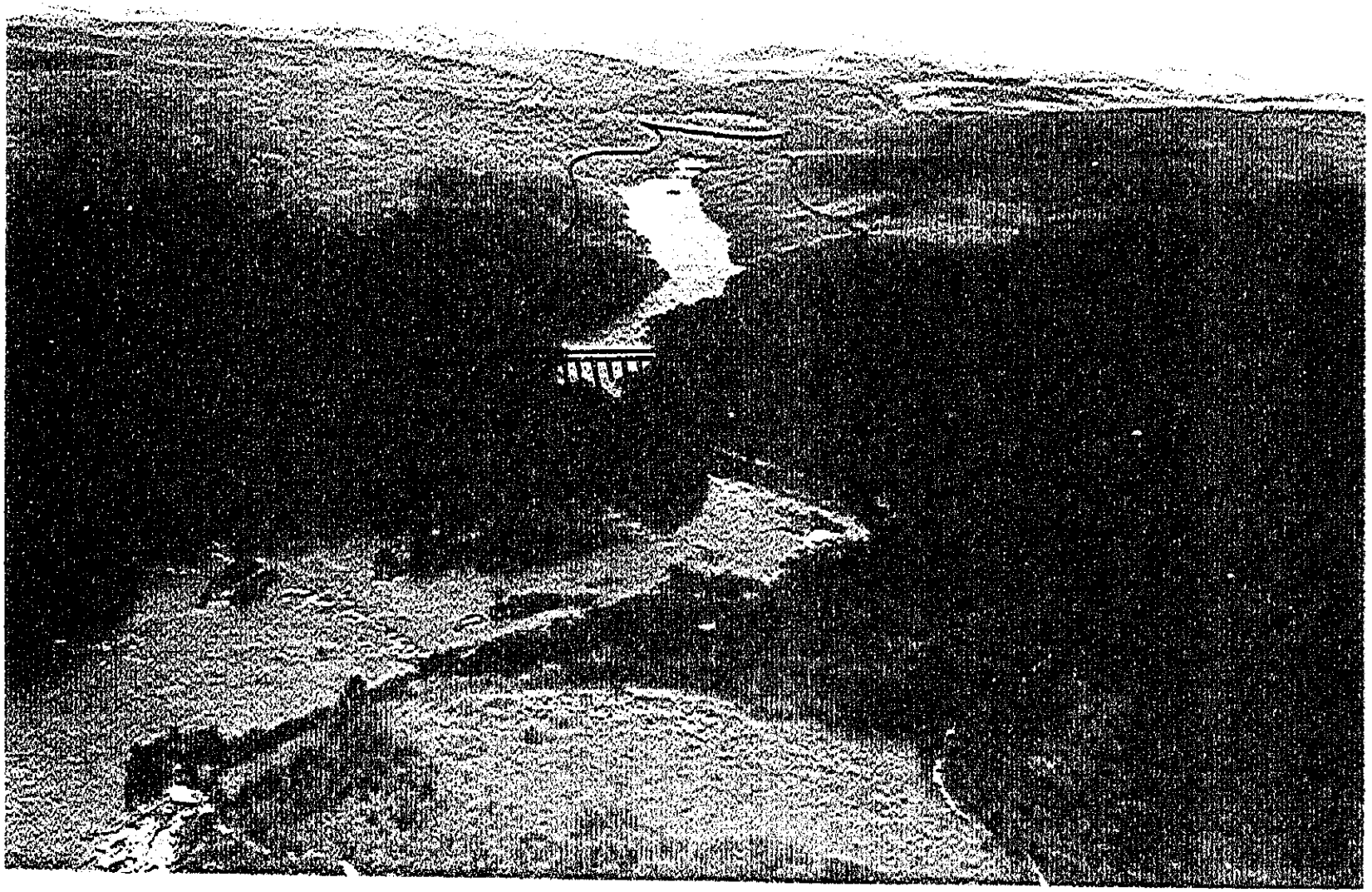


Figure-6.14 Indicative Area to be Inundated with the Telêmaco Borba Hydroelectric Project for the Tibagi River

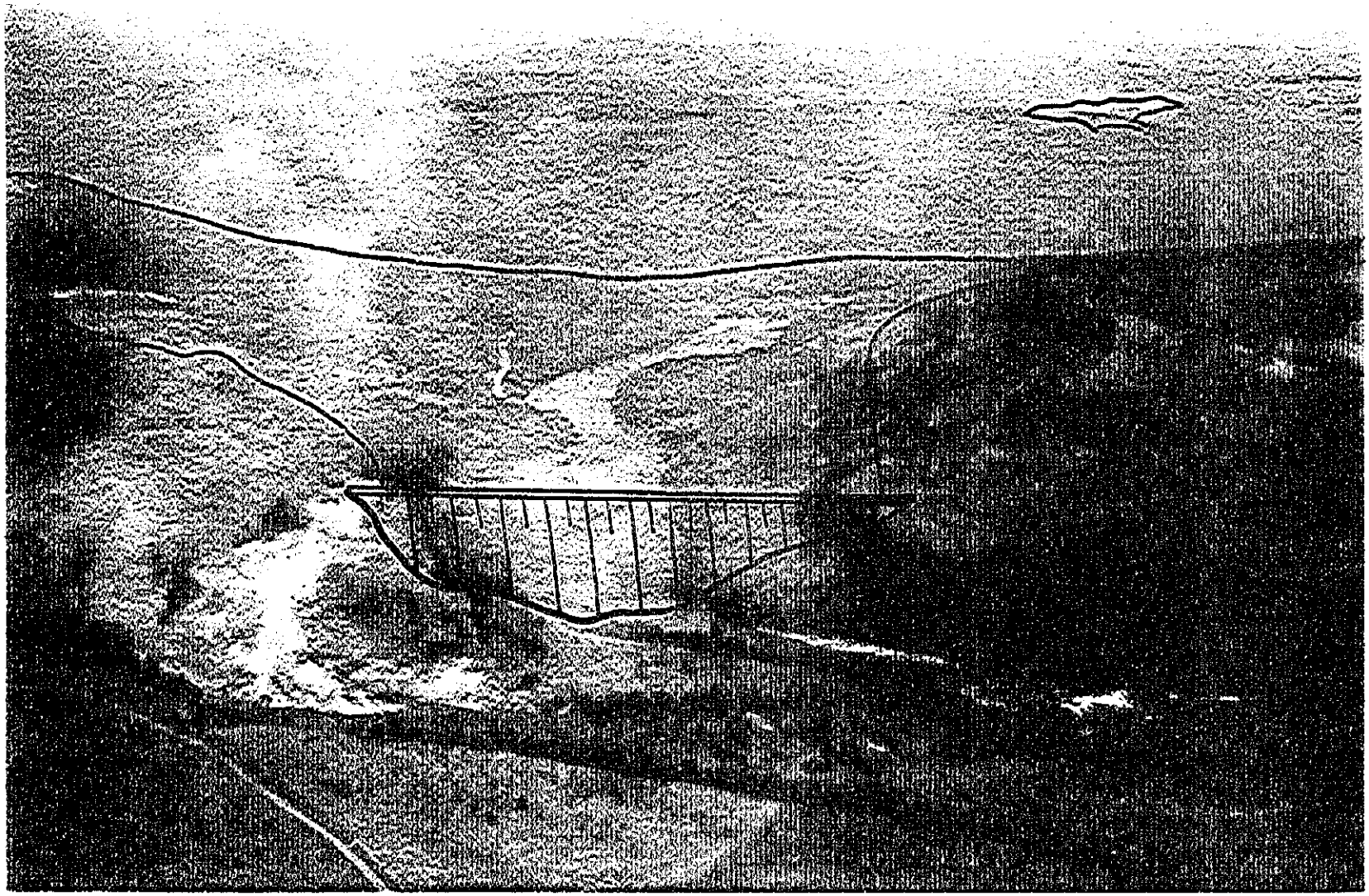


Figure-6.15 Indicative Area to be Inundated with the Mauá Hydroelectric Project for the Tibagi River
Source: COPEL, 1995

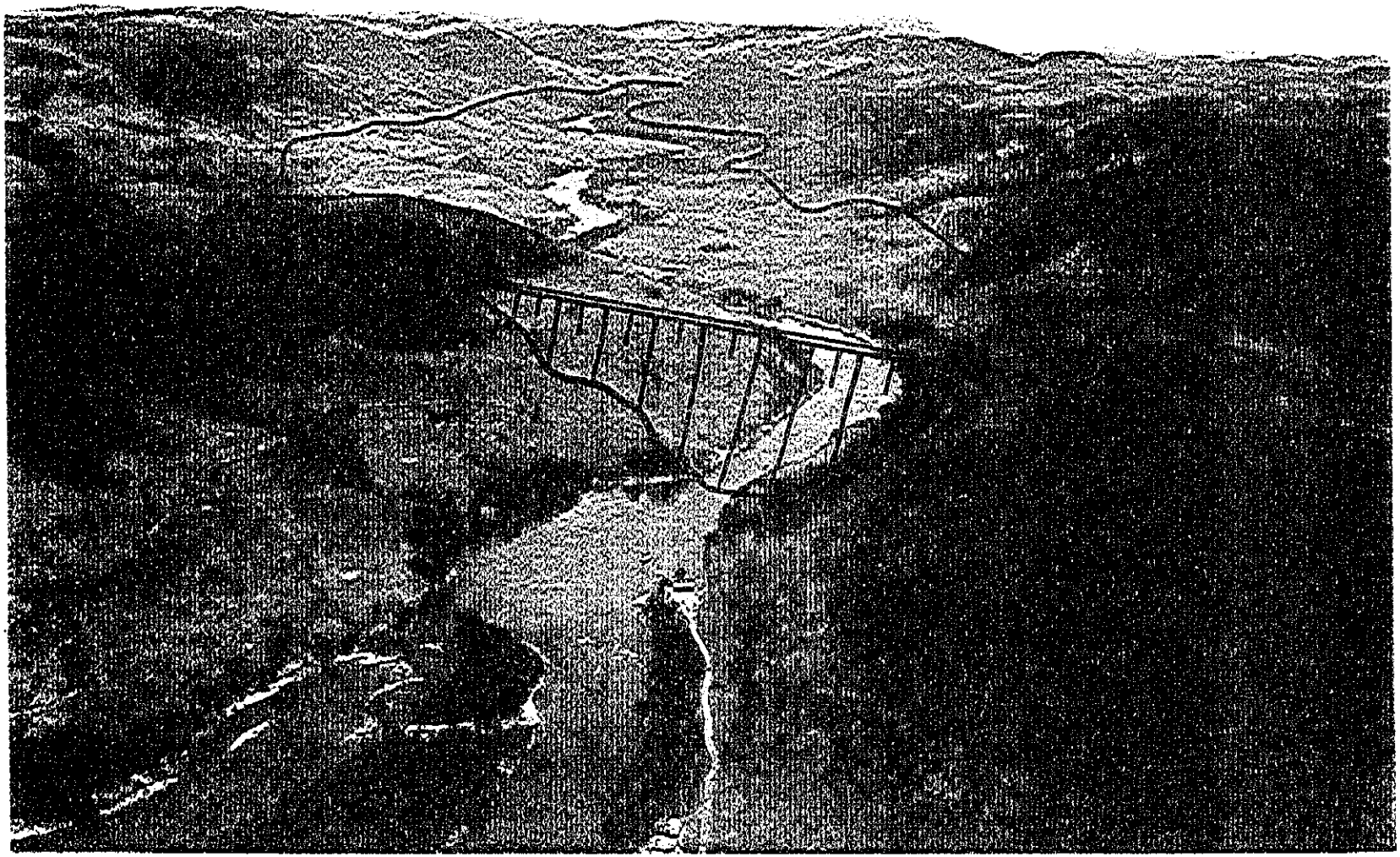


Figure-6.16 Indicative Area to be Inundated with the São Jerônimo Hydroelectric Project for the Tibagi River

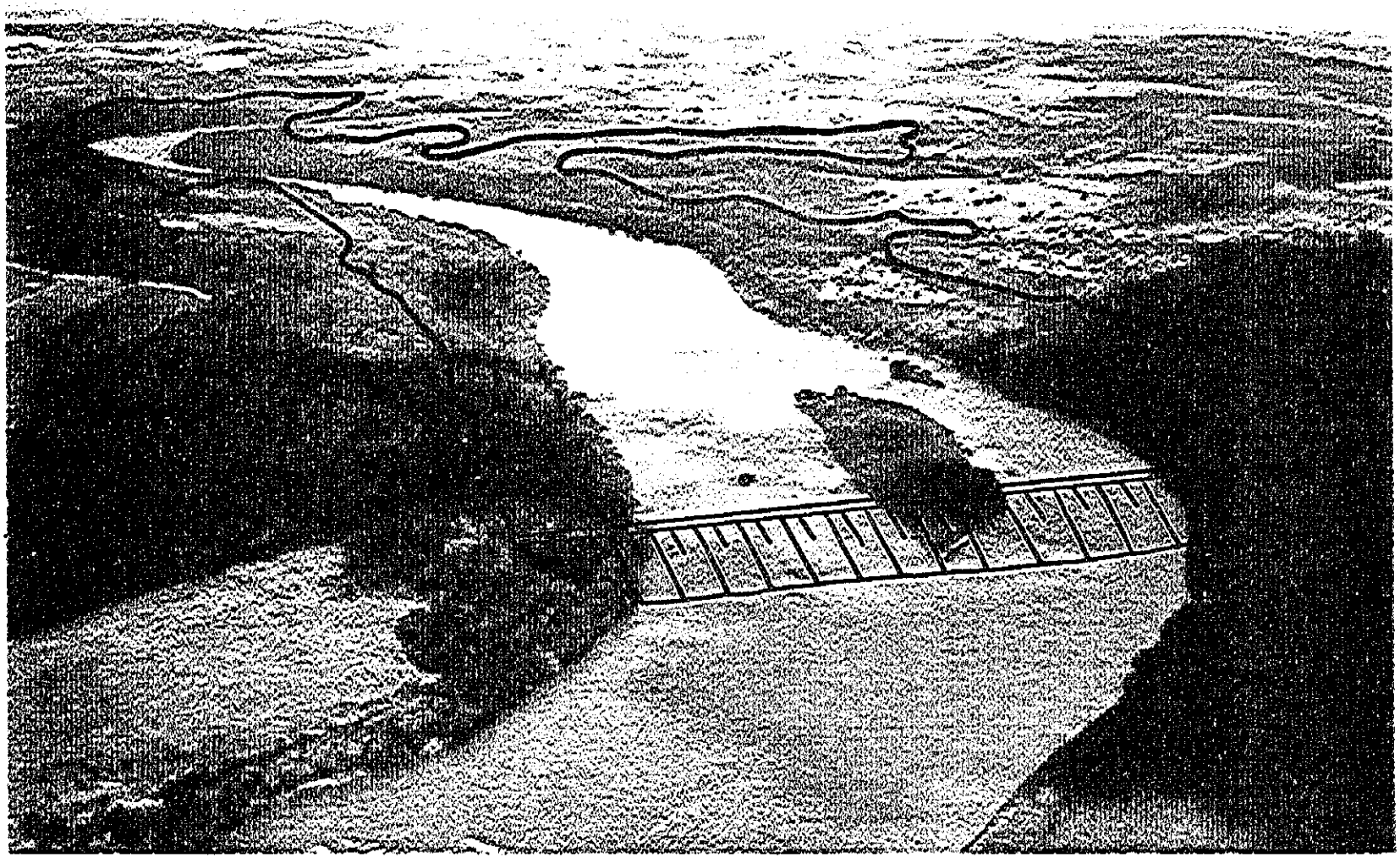


Figure-6.17 Indicative Area to be Inundated with the Cebolão Hydroelectric Project for the Tibagi River
Source: COPEL, 1995

CHAPTER 7 MASTER PLAN FOR PILOT RIVER BASINS

7.1 Introduction

The Master Plan is conceived as an integrated series of environmental programs, derived from the explicit requirements found in the alterations of the different components of the aquatic ecosystem.

Environmental degradation can be improved, ameliorated and/or prevented by the implementation of pertinent assessment studies and programs along with the regular monitoring component as a means of feedback to the responsible authorities to maintain adequate water environment conditions through the implementation of the law.

The specific programs presented for each of the pilot basins selected are to be understood as model programs that can be modified and applied to other basins as well. The purpose of the study is to address the main significant environmental problems of the chosen pilot basins, and to propose a series of programs organized and interrelated in a comprehensive plan. See Fig.7.1

The present study was possible because of the cooperation of the IAP Limnological Laboratory personnel, The Museum of Natural History of Curitiba, The Botanical Museum of Curitiba, COPATI, The State University of Londrina, and Dr. William Severi, fisheries expert from the University of Mato Grosso who cooperated with the study on his own initiative.

7.2 Preservation Programs for Iguaçu River Basin

7.2.1 Program for the Inventory of Fish Populations

(1) Introduction

The main fish inventory work done in Parana state was performed by IAP/GTZ on the Iguaçu river (1), the areas in this river left behind in this study are adjacent to the Iguaçu National Park and in the main tributaries of the Iguaçu river. See Fig. 7.2 and Fig.2.15.

Being this river of exceptional endemism, and subject to severe anthropic impacts, it is of utmost importance to continue and finish the fish inventory. The information provided will be the baseline data for the determination of the fish population dynamics, and subsequently, the amelioration and prevention of impacts caused by existing and planned projects on the river.

The purpose of this program is to suggest critical areas considered of risk by the Museum of Natural History, and that should be sampled and inventoried in the medium and long terms.

(2) Objectives

1) To continue and finish the total fish population inventory of the Iguaçu river.

2) To provide the baseline information to continue with the fish population dynamics study of the river.

3) To provide the necessary information to prevent future negatives impacts caused by anthropic activities.

(3) Sampling Stations

Sampling stations are concentrated in the Iguaçu National area and the main tributaries of the Iguaçu river, where no collections have been systematically done by previous efforts. The indicative location of the sampling stations is given in Fig.7.2

The totality of the sampling stations can be subdivided into the following regions:

1) High Iguaçu (From Mananciais da Serra up to Porto União)
   a) Mananciais da Serra
   b) Future SANEPAR reservoir areas in the Curitiba metropolitan area
   c) Tributaries located between Porto Amazonas and São Mateus do Sul
   d) Potinga river
2) Medium Iguaçu (tributaries to the hydroelectric reservoirs)
   a) Areia river system
   b) Iratim river
   c) Jordão river
   d) Cavernoso river
   e) Chopin river
   f) Guarani river
   g) Cotegipe river
3) Medium lower (Iguaçu national park before the falls)
   a) Gonçalves Dias river
   b) Floriano river
   c) Silva Jardim river
4) Lower Iguaçu (Iguaçu Park after the falls)
   a) Tributaries within the Iguaçu park.

   A total of 60 stations for collection are to be identified where no systematic collections have yet occurred in the above mentioned areas.

(4) Sampling Frequency

Sampling frequency will be at least every 3 months per station to cover all seasons, during 2 years. It is estimated that 2 years will be required to identify all species collected, and the total working time is estimated in 4 years.

After this 4 years study, monitoring in critical areas is to be done every 5 years during an estimated study period of one year.

(5) Staff Requirements and Indicative Cost

Staff Requirements	Indicative Cost (US$/year)
Ichthyologist Consultant 30 days/year	17,000
Assistant Ichthyologist (2x) @ $27,500/year/person	55,000
General Assistants (10x) @ $6,900/year/assistant	69,000
Traveling costs	42,000
Total	US $ 183,000

(6) Equipment and Supplies and Indicative Cost

Equipment Supplies	Indicative Cost (US$)
4 WD-Vehicle	27,000
Boat, motor, trailer (2x)	23,000
Laboratory material	54,000
Collection materials	13,000
Hardware, software	4,000
Laboratory infrastructure	100,000
Other costs	10,000
US $	231,000

Total estimated cost for the program during the 6 years is estimated by:

- 2 years collecting	$ 368,000
- 2 years identifying	282,000
- Equipment, materials, infrastructure	231,000
Total	US $ 881,000

(7) Source

PhD. William Severi, Fisheries Specialist University of Mato Grosso

Biol. Adelenyr Cordeiro, Ichthyologist, Museum of Natural History.

7.2.2 Program for the Assessment of the Fish Population Dynamics.

(1) Introduction

Fish population dynamics studies are required to attain knowledge in the way fish reproduce and eat, and grow, what type of habitat they occupy, their migration needs, and how they relate to the rest of the fish community among other issues.

The knowledge obtained from this study will have a direct application in mitigating and preventing anthropic impacts, as well as in the artificial reproduction and growing of species with commercial interest, or endangered status, and in need of repopulating efforts. See Fig.7.2

(2) Objectives

1) To study the population dynamics of the main fish species.

2) To define among the main species those in need of reproduction and repopulating because of their endangered or rare status.

3) To define among the main species those which offer positive conditions for commercial reproduction.

(3) Items to be covered

1) Feeding habits and diet according to season

2) Reproductive habits, habitat, sexual maturity and seasonality

3) Territorial habits and habitat

4) Social and migratory habits

5) Growth curve of main species

(4) Sampling Stations

Sampling stations are the same indicated for the fish population inventory, since out the inventory, selected species will be studied on their population dynamics. See Fig.7.2

(5) Sampling Frequency

Sampling is done at the same time sampling for population inventory is done, this is 4 times per year to cover all stations (every 3 months) for selected fish species identified under section 7.2.1.

(6) Staff Requirements and Indicative Cost

Assuming 20 stations (33%) of the 60 stations sampled for population inventory show fish species which are rare, endangered or of economic interest to be further studied in their population dynamics, the following costs are extrapolated from similar experiences by COPEL and the University of Maringa in the Salto Segredo reservoir.

Staff Requirements	Indicative Cost (US$/year)
Laboratory Personnel for Limnology and Ichthyology	124,149
Total	US $ 124,149

(7) Equipment and Supplies and Indicative Cost

Equipment & Supplies	Indicative Cost (US$)
Laboratory Materials	39,000
Larvae/Egg analysis	80,168
Total	US $ 119,168

The estimated cost for the 2 year program is US $ 486,634

(8) Source

Extrapolation of real costs from NUPELIA/COPEL on reservoir limnological and ichthyological studies performed in Salto Segredo reservoir.

7.2.3 Program for the Artificial Reproduction of Endemic Fish with Ecological and/or Economic Interest.

(1) Introduction

The artificial reproduction of fish for commercial or ecological purposes is a viable means of producing vast amounts of offspring under controlled conditions by taking advantage of the natural abundance of eggs generated by the female fish.

The population dynamics data will provide the baseline information to replicate the species requirements in the hatchery, and allow the experimental and eventually massive production of fingerlings.

The resulting production could repopulate endangered species in critical areas, and/or provide the technology and seed for the aquaculture or fisheries of endemic and commercially viable species to be stocked.

(2) Objectives

1) To experimentally culture the main species of fish considered endangered, rare or of economic interest.

2) To locate the sites suitable for broodstock captures

3) To systematize the hatchery techniques required for the artificial and massive reproduction of the above mentioned species.

4) To massively produce the above mentioned species in a regular basis.

(3) Items to be Covered

1) Geographic location of broodstock of interest

2) Mating, spawning and larval development of fish species of interest.

3) Definition of physical and chemical parameters crucial for the closing of the reproductive cycle in captivity.

(4) Staff Requirements and Indicative Cost

Staff Requirements	Indicative Cost (US$)
Aquaculture Consultant for 30 days/year x 2 years	30,000
Aquaculture Manager @ $ 30,000/year	60,000
Aquaculture technicians (5) @ $ 3,000/year x 2 years	30,000
Per-Diem	30,000
Training Courses	5,000
Total	US $ 155,000

(5) Equipment and Supplies and Indicative Cost

Equipment & Supplies	Indicative Cost (US$)
4 WD-Vehicle	20,000
Boat, motor, trailer	12,000
Field & laboratory Equipment	35,000
Reproduction facility Equipment	23,000
Sampling Materials	15,000
Computer & Software	4,000
Feeds, Chemicals, Drugs, Fuel	172,000
Infrastructure Reforms at the IAP/Toledo Research Center (CPAA)	57,000
Total	US$ 338,000

(6) Implementation Schedule

Once the previous stages of fish population inventories, and fish population dynamics are completed, it is estimated that a 2 year interval should allow for the experimental artificial reproduction and production of fingerlings in the hatchery to be operational.

(7) Source

Dr. William Severi, University of Mato Grosso, and

IAP/CPAA, Aquaculture and Environmental Research Center in Toledo.

7.2.4 Program for the Assessment of the Fish Fauna and Experimental Aquaculture in the Major Iguaçu River Hydroelectric Reservoirs

(1) Introduction

Damming of rivers induces severe alterations on the aquatic environment and the fish population, on the other hand, the economicist tendency to generate a product out of the newly created water environment has been traditionally oriented towards the introduction of exotic species which are well known in their population dynamics and artificial reproduction strategies.

The special condition of the Iguaçu river, with a highly endemic population of fish, and virtually half of it's length dammed calls for a more responsible approach. The inventory of the existing fish population and it's limnological conditions, followed by a fish population dynamics study in the various reservoirs will provide the baseline information for future aquaculture potential to be pursued in terms of commercial and/or repopulation strategies. See Fig.6.7, and Fig.2.15

Traditional approaches for aquaculture production trials in the Parana river basin have introduced approximately 20 species of fish endemic to other basins and other parts of the world, while today only one exotic species with economic importance has predominated. In general, the stocking of exotic species is done without the knowledge of the natural potential, and in many cases the approach is conducive to significant failures.

(2) Objectives

1) To establish the potential and limitations of the reservoirs for the development of native species.

2) To determine the population dynamics of the main species living in the different reservoirs.

3) To determine the measures to be taken to preserve and increase endangered fish stocks.

4) To determine the fisheries potential and the exploitation risks as related to a sustained fisheries activity.

5) To determine the fisheries techniques to be used while promoting a sustainable use of the resource.

6) To determine which species should be stocked and how many.

7) To determine the reproductive viability of the specie(s).

(3) Methodology

The methodology and preliminary results obtained from the studies performed by NUPELIA, University of Maringa, and COPEL on the Salto Segredo reservoir in this direction can be used as an ongoing model to be applied in the other reservoirs of the Iguaçu river.

The material is analyzed in the field, and pertinent laboratories and specialists, who will statistically summarize the data and the reservoir resources.

(4) Reservoirs to be Studied

1) Foz do Areia

2) Salto Osorio

3) Salto Santiago

4) Salto Caxias

(5) Items to be Covered

1) Population Inventory

2) Population Dynamics, Including:

a) Feeding habits and diet according to season

b) Reproductive habits, habitat, sexual maturity and seasonality

c) Territorial habits and habitat

d) Social habits

e) Growth curve of main species

3) Limnological Characterization, Including

a) Water quality

b) Light penetration

c) Temperature and oxygen distribution

d) Trophic levels

4) Artificial Reproduction Potential of Main Species

a) Breeding behavior

b) Broodstock requirements (quantity and quality)

c) Larval development and requirements

d) General hatchery techniques

e) Juvenile nutritional requirements

(6) Sampling Stations and Frequency

During the first year, monthly sampling during 11 days/month with a 12 person staff in 10 predetermined stations for each reservoir.

During the second year samplings will be done every 3 months (covering every season), maintaining the same activities of the first year.

After this study period, monitoring every five years for a one year period is recommendable.

(7) Staff Requirements and Indicative Cost

Staff Requirements	Indicative Cost (per Reservoir US $/year)
Ichthyologists/Limnologists including per-diem	86,544
Laboratory Personnel for Limnology/Ichthyology	248,334
Total	US$ 334,878

(8) Equipment and Supplies and Indicative Cost

Equipment & Materials	Indicative Cost (US$/Reservoir)
Laboratory Materials	77,813
Larvae/Egg Analysis	160,370
Total	US$ 238,183

Total estimated cost per reservoir is US$ 573,061 for the first year. All 4 reservoirs will have a cost of US$ 2'292,264 for the first year.

Second year cost per reservoir is estimated in US$ 143,266. Total cost including 4 reservoirs is US$ 573,064.

Total estimated cost for 2 year program and 4 reservoirs is

US$ 2'621,337.

(9) Implementation Schedule

1) First year: Every month sampling during 11 days/month

2) Second year: Every 3 month sampling during 11 days/month

(10) Source

Eng. Luis Benedito da Silva (COPEL), and

NUPELIA branch of the University of Maringa.

7.2.5 Program for the Upgrading of Management Plans for Existing Conservation Units

(1) Introduction

Existing conservation units in the Iguaçu river basin have a total area of 564,676 ha divided in municipal, federal, state conservation units, the main area is the Iguaçu National Park (170,086 ha), compromising 30% of the total conservation area. See Table-2.8

Main problems reported by IAP and affecting the conservation status of the areas are summarized under Table-6.4, most of the conservation units in the basin reflect

problems related to management strategies, lack of personnel, deterioration by tourists, and other problems requiring an overall assessment of the existing conditions and management plans.

The location of the existing conservation units is shown in Fig.6.10.

The purpose of this program is to assess the existing conservation units, and to elaborate a detail action plan for each one of the units.

(2) Objectives

1) To assess the specific problems being faced by the different conservation units of the basin.

2) To evaluate the ecotourism potential and the required management and infrastructure required for this purpose.

(3) Items to be Covered

1) Infrastructure needs, such as:

a) Fences,

b) Housing,

c) Potable water,

d) Solid waste disposal

e) Sewerage treatment

f) Trail conditions

g) Incompatible use of the land

h) Infrastructure maintenance status

i) Tourist facilities

j) Accessibility

2) Management and Personnel needs

3) Support infrastructure for ecotourism in the adjacent communities

4) Legal constitution and existing problems

5) Budgetary requirements

(4) Equipment, Supplies and Indicative Cost

Equipment & Supplies	Indicative Cost (US$)
4 WD-Vehicle rental @ $80/day x 90 days	7,200
Various camping Equipment	2,000
Fuel and Per-Diem	5,000
Total	US$ 14,200

(5) Staff Requirements and Indicative Cost

Staff Requirements	Indicative Cost (US $)
Technician (Superior Level) @ $3,500/month x 3 months	10,500
Assistants (2x) @ $1,000/month x 3 months	6,000
Total	US$ 16,500

(6) Implementation Schedule

It is estimated that 3 months are required to complete the assessment. Revision of management plans and existing conditions is recommendable to be done every 5 years in the following 18 years.

(7) Source

Eng. Evandro da Silva Pinheiro, IAP, Conservation Areas Department

Eng. Wilson Laureiro,IAP, Conservation Areas Department

7.2.6 Program for the Preservation of the Serra da Baitaca and the Proposed Irai Reservoir Area

(1) Introduction

The Serra da Baitaca offers a distinctive recreational area 30 Km from Curitiba were botanical, scenic, leisure and cultural resources combine. The geographic continuity of the Serra do Mar, and the possible fauna corridor enhancement towards this area are some of the issues previously discussed under section 6.2.4 of this report. Location of the area can be found in Fig.6.1, and vegetation types according to altitude is shown in Fig.6.2

The preservation of the proposed Irai reservoir area in Piraquara -Quatro Barras, as a sanctuary for rare, endangered, and endemic species of plants and animals, and as a bank of genetic diversity typical and unique for the region, as well as being an area of scenic and landscape values, are some of the reasons to consider it's continuity as preserved area along with the Baitaca-Serra do Mar areas.

Nesting areas for endangered bird species, endangered species of orchids, coppices of Araucaria, and preservation of water resource areas and their marginal vegetation are also considered as valuable reasons to consider these areas into the conservation system of the basin.

(2) Objectives

1) To protect undisturbed botanical associations endemic of the Baitaca mountain complex above the 1,100 m elevation

2) To allow natural regeneration of forest fire affected areas

3) To Manage already existing tourism allowing hikes, climbing, leisure, delta wing flying, avoiding solid waste disposal, trail deterioration, water sources pollution, forest fires, cattle grazing and granite extraction.

4) To define the limits of a vast corridor comprising the foothill of the Serra do Mar, the Baitaca complex, and the proposed Irai reservoir area

5) To preserve and protect from indiscriminate occupation the open fields subject to inundation, the river margin vegetation and the coppices of endemic species located in proposed reservoir area.

6) To continue the bird population inventory started by Dr. Scherer of the Museum of Natural History to assess the main habitats of endangered populations.

(3) Items to be Covered

1) Geographic definition of the area

2) Legal issues

3) Forest fire prevention

4) Rehabilitation of granite mining areas

5) Monitoring of the natural regeneration process

6) Management plan for tourist influx, and definition of tourist areas and those of absolute protection for research purposes only.

7) Trail rehabilitation and maintenance

8) Bird population inventory and habitat assessment.

(4) Equipment, Supplies and Indicative Cost

1) Botanical and Geographic Assessment:

Equipment/Supplies	Indicative Cost (US$)
Maps, Aerial Photos	4,000
Topographic Aid	10,000
Drafting Equipment	10,000
4 WD-Vehicle	20,000
Fuel, Oil	10,000
Overflying	10,000
Film	2,000
Communications	5,000
Per diem @ $50/day	18,000
Binoculars	2,000
Camera	2,000
Others	20,000

2) Bird Population Assessment:

Binoculars, camera, recorder	3,000
Radiotelemetry receptors	3,000
Nets, Film	4,000
Microcomputer	4,000
Kombi-Vehicle	20,000
Total	US$ 149,000

(5) Staff Requirements and Indicative Cost

Staff Requirements	Indicative Cost (US $/year)
1) Botanical and Geographical Assessment:	
Botanist (2x)	48,000
@ $12,000/year	54,000
Assistants (6x)	
@ $9,000/year	
Geographer	24,000
@ $24,000/year	
Draftsman	14,400
@ $14,400/year	
Planner	24,000
@ $24,000/year	
Lawyer	24,000
@ $24,000/year	
Zoologist	24,000
@ $24,000/year	
2) Bird Fauna Inventories:	
Consultant	15,000
Ornithologist	24,000
Assistants	5,000
Per-Diem, fuel	13,200
Total	US $ 269,600

Subsequent 2 years requiring US$ 83,000/year for the bird inventory.

Total program cost is estimate in US $ 584,600

7.2.7 Program for the Geographic Definition of the Conservation Area Corredeiras Eng. Bley

(1) Introduction

Important scenic, touristic, and recreational values are being left without any conservation criteria in the planning process for the area known as Corredeiras Engenheiro Bley, downstream the Iguaçu river from the locality of Serrinha up to some 15 Km upstream from Porto Amazonas, see Fig.6.1

This river sector maybe the last one resembling the original Iguaçu river condition of rapids, with fairly well preserved river margin vegetation, natural open fields with coppices, and retaining habitats for endangered species of orchids, as referred under section 6.2.4

(2) Objectives

1) To preserve the last river sector in the Iguaçu river resembling the original hydrological features of the river.

2) To secure a significant landscape value for the present and future generations as the last remain of the original rive environment.

3) To preserve the habitat of endangered botanical species such as orchids

4) To preserve the last remaining natural habitat conditions for the endemic fish population.

(3) Items to be Covered

1) Geographic definition of the are to be preserved

2) Legal aspects concerning it's declaration as protected area

3) Evaluation of the extent and cost of possible land areas to be purchased in view of their natural state for conservation purposes.

(4) Equipment, Supplies and Indicative Cost

Equipment & Supplies	Indicative Cost (US$)
Maps, Aerial Photos	4,000
Topographic Aid	10,000
Drafting Equipment	10,000
4 WD-Vehicle	20,000
Fuel, Oil	10,000
Overflying	10,000
Film	2,000
Communications	5,000
Per diem @ $50/day	18,000
Binoculars	2,000
Camera	2,000
Others	20,000
Total	US $ 113,000

(5) Staff Requirements and Indicative Cost

Staff Requirements	Indicative Cost (US $/year)
Botanist @ $24,000/year	24,000
Assistants (3x) @ $9,000/year	27,000
Geographer @ $24,000/year	12,000
Draftsman @ $10,000/year	5,000
Planner @ $24,000/year	12,000
Lawyer @ $24,000/year	24,000
Zoologist @ $24,000/year	24,000
Total	US $ 128,000

(6) Implementation Schedule

One year is estimated to complete the studies

(7) Source

The present program was elaborated with the cooperation of the following professionals:

1) Dr. Gert Hartschbach, Director of the Botanical Museum of

2) Dr. Jose Tadeu, botanist, Botanical Museum

3) Dr. Pedro Scherer Neto, ornithologist, Museum of Natural History

4) Dr. Marcos Ricardo Bornshein and Dr. Bianca Reinert, ornithologists, Museum of Natural History

5) Dr. Silvia Ziller, forestry engineer, EMBRAPA

7.2.8 Program for the Establishment of a Biodiversity Institute

(1) Introduction

The Rio 1992 Conference and Biodiversity Convention have called the attention to the world about the required effort that the different countries must engage into the preservation of biodiversity.

The finding of solutions for a sustained development approach is interrelated with the intelligent use of the biodiversity resource available, for this reason, it should be at the service of society for the present and future generations, becoming an instrument for the intellectual, spiritual and economic development.

Research and development for the obtention of chemical compounds useful to the pharmaceutical, agrochemical, and medicinal industry, aiming for the treatment of typical diseases of the developed and underdeveloped world, such as cancer, cardiovascular, mental illness, malaria, diarrhea etc., starts with the identification, prospection and isolation of chemical compounds available mainly in the tropical and sub-tropical biodiversity.

The implementation of the Biodiversity Institute concept in Latin America is an ongoing reality since 1993 in Costa Rica, where the INBio has presently developed projects with more than 20 institutions, published 82 publications, attended 2,300 students in 1993, and attain 3 international environmental awards from Spain, Switzerland and Italy. Among the institutions involved in joint research ventures with INBio are the Merck pharmaceutical Co., Bristol Meyers-Squibb, British Technology Group (BTG) and the National Cancer Institute (NCI).

The INBio participates in the royalties derived from drugs or pharmaceutical developed trough the joint research, and part of this funds go directly for the preservation of the national parks of the country.

(2) General Objectives

1) Establishment of a complete inventory of the biodiversity of the Iguaçu river basin, and their local distribution

2) To obtain new sources of chemical compounds, genes, proteins, macro and microorganisms, as well as other useful components that could generate financial resources.

3) Promote research and development activities for the prospection of biodiversity which are oriented towards the market (chemical, agrochemical, pharmaceutical and the biotechnological industry)

4) To effectively contribute (generate an income), with the costs of conservation and biodiversity management, through research, and with the supply of technical services and materials coming from the biological diversity in a non-destructive manner, an in accordance with the sustained development principle.

5) To provide a data base bank to support research, education, training of students, and to integrate the knowledge of biological diversity into the society through public relations and educational programs.

(3) Items to be Covered

1) Biological Diversity Inventory

a) Botanical inventory

b) Arthropods inventory

c) Fish inventory

d) Benthic macroinvertebrates inventory

e) Mollusc inventory

f) Data base

2) Biological Diversity Prospection

a) Project development & cooperation

b) Research and development in natural products and biotechnology

c) Data base

3) Social Component

a) Public relations

b) Relations with rural communities and other basins

c) Environmental education

d) Inter-institutional relationships

e) Biological conservation database

f) Publications

4) Computer System Network

a) Nets & internets communication

b) Data base development

c) Geographic information system (GIS)

d) Technical services

5) Support Units

a) financial department

b) Human resources

c) Administrative support

d) External auditing

(4) Indicative Staff Requirements

1) General director, biologist, chemist or the like, with experience in research management, international relationships, and institutional administration.

2) Computer system specialist

3) Taxonomists

4) Para-taxonomists

5) Biologists for field collection

6) Chemist, botanist, ichthyologist, Eco-chemist, microbiologist, and arthropod specialist for the coordination of specific programs.

7) Laboratory assistants

8) Administrative staff

9) Miscellaneous

(5) General Equipment Requirements

1) Computers, software, printers, INTERNET system, for the storage and manipulation of massive information.

2) Geographic Information System Support

3) 4WD Vehicles

4) Specimen collection equipment

5) Dissection equipments

6) Specimen storage equipment, cabinets etc.

7) Fax, telephones

8) Office supplies

9) Coolers, freezers

10) Microscopes, stereoscopes

11) General laboratory equipment

(6) Possible Fund Sources

1) International Development Agencies from developed countries with cooperation programs with Brazil.

2) Funds generated from agreements between the institute and pharmaceutical and/or chemical-biochemical industries.

3) Funds generated from research agreements between the institute and universities from developed countries.

4) Donations from environmentally oriented foundations like Mc.Arthur, Rockefeller, National Science Foundation, botanical gardens, The Nature Conservancy and the like.

5) International organizations such as United nations Environmental Program (UNEP) and World Resources Institute.

6) Royalties derived from the commercialization of drugs, medicines, agrochemicals or the like, generated through bilateral agreements between the industry and the Institute.

7.2.9 Program for the Environmental Education on Potable Water Source Development

(1) Introduction

Preservation of the natural resources without environmental education and awareness has a limited life span. The involvement of the community, and specially of the new generationts can secure the continuation of the preservation effort.

The present program is oriented towards the integration of cultural, architectonic, historic, sanitation, and water environment values and components for the education and trainning of the population in the context and processs of potable water source development.

(2) Objectives

1) To organize an environmental education program along an existing historic water flow line between Mananciais da Serra and the Sao Francisco storage tank built in 1900's, and located in the Curitiba historic center.

2) To include a museum physical area in the Taruma disactivated treatment plant, where biological, technical, sanitary, and environmental concepts are developed through audi-visuals, permanent collections and regular seminars and courses.

3) To implement physical areas in the Mananciais da Serra area, where school groups can spend weekends at workshops, and will have the opportunity for hikes along the water intakes and old reservoirs still existing in a pristine forest area available for ecological awareness of the water environment that should prevail.

4) To follow the water flow from the Serra to Curitiba urban center, and compare the environmental degradation between the two areas. The tour is approximately 40 Km.

(5) Items to be Covered

1) Mananciais da Serra

Including well preserved forest areas and the water springs. Still existing reservoirrs from 1900's which still are piped to Piraquara reservoir.

2) Piraquara Reservoir

Shows the technological advance implemented, located in a more degraded area is an example of habitat modification by man and it's consequences. Degradation of river margins and water quality dterioration can be exemplified here

3) Irai Water Intake

Located along green areas and gardens shows the technology used for water intakes

4) Taruma Water Treatment Station

Shows a type of water treatment technology and quality control. The cost involved in treatment as related to the sourranding environmental degradation, and compared to the Mananciais da Serra habitat could be exemplified here.

5) Cajuru Distribution System

Can provide an idea of the magnitude of the water distribution system for Curitiba, Colombo and Sao Jose do Pinhais.

6) Sao Francisco Water Storage

Located in the historical center of Curitiba, with architectural values of the 1900's, and historical patrimony of the city shows the evolution of the potable water system for the city.

(6) Items to be Managed

1) Mananciais da Serra

a) Definition of trails, signs, and significant habitats for programed hickes

b) Restoration of old (1940's) SANEPAR's housing facilities for workers to allocate students, conference room and museum area.

2) Piraquara Reservoir

a) Allocation of picknic tables disposed of for the open air discussion of items.

3) Irai Water Intake

a) Allocation of picknic tables disposed of for the open air discussion of items.

4) Taruma Water Treatment Station

a) Design, planning and construction of main water environment museum and conference room in the existing area of the desactivated treatment plant

5) Cajuru Distribution System

a) Allocation of distribution model to exemplify the overall distribution system.

6) Sao Francisco Water Storage

a) Restoration of original architecture, context and surroundings of the station with museum allocating equipments, documents and photographs of the 1900's

b) Description of the proposed 40 Km tour with maps and photographs.

(7) Indicative Costs

Item Description	Indicative Cost (US$)
Visual aids	14,280
Audio-Visual programs	271,430
Trainning	2,850
Other Consulting	12,380
Microbus	53,000
Audio-visual equipment	28,000
Educational materials	214,000
Physical infrastructure	186,640
Main museum building	77,410
Total	US$ 860,000

(8) Source

Roderjan, C.V., SANEPAR Environmental Coordination Division, 1995

7.3 Monitoring Programs for Iguaçu River Basin

7.3.1 Program for the Assessment of the Aquatic Environment through the use of Bioindicators

(1) Introduction

Results with bioindicators are complimentary to chemical analysis. The presence of acute toxicity in a water body proves the degradation level of the water. The organism Daphnia magna (microcrustacean) is the microcrustacean standardized (Clone #5, European Economic Society) for such tests.

Only the living organisms or their organs can detect toxic effects upon the living organisms themselves, therefore fish liver pathology and biochemistry can be used as indicators of environmental pollution through histopathological analysis, and biochemical determination of MFO (Mixed Function Oxigenases).

Biodiversity of benthic macroinvertebrates will also provide a pollution criteria at the population dynamics level, by when polluted conditions prevail, biodiversity is reduced, number of individuals per specie increased, and indicator organisms prevail.

(2) Objectives

1) To provide a pollution effect on the aquatic benthonic community.

2) To provide a pollution criteria based on the pollutant effect upon living aquatic biota.

3) To assess water pollution where punctual chemical analysis may overlook chronic deleterious effects on the biota.

4) To detect in situ the arrival of toxic substances through Daphnia monitoring at the existing potable water treatment plants.

(3) Items to be Covered

1) Benthonic macroinvertebrate community sampling and biodiversity assessment.

2) Acute toxicity tests with zooplankton using Daphnia magna clone #5-EEC

3) Initial research efforts for the detection of suitable endemic fish species susceptible enough to environmental stress and liver tissue histopathology.

4) Data correlation with chemical analysis performed in the same sampling areas.

(3) Sampling Stations

Figure-7.3 shows the approximate location of stations selected.

The sampling locations for this program are divided into 2 main sub-programs:

1) Pilot microbasin study

a) Higher Iguaçu

With 12 benthos monitoring stations for industrial pollution assessment.

b) Middle Iguaçu

With 12 benthos monitoring stations to be allocated

c) Lower Iguaçu

With 12 benthos monitoring stations for agricultural pollution assessment

2) Water intake locations study

Sampling and monitoring stations upstream and downstream of the water intake locations in the following rivers:

a) Iguaçu river water intakes
   i) 8 benthos monitoring stations
   ii) 1 Daphnia monitoring stations

b) Passauna water intake (dam-site)
   i) 4 benthos monitoring stations
   ii) 1 Daphnia monitoring station

c) Irai water intake
   i) 4 benthos monitoring stations
   ii) 1 Daphnia monitoring station

d) Francisco Beltrão water intake
   i) 4 benthos monitoring stations
   ii) 1 Daphnia monitoring station

e) Cascavel water intake
   i) 4 benthos monitoring stations
   ii) 1 Daphnia monitoring station

(4) Sampling Frequency

1) For the selected microbasins:

a) Benthos monitoring stations are to be monitored @3 months during the first 2 years

b) Benthos monitoring stations are to be monitored @6 months during the following 2 years

c) Benthos monitoring stations are to be monitored once a year during the following 9 years until 20015

2) For the water intake locations:

a) Benthos monitoring stations are to be monitored @3 months during the first 2 years

b) Benthos monitoring stations are to be monitored @6 months for the following 2 years

c) Benthos monitoring stations are to be monitored once a year for the following 9 years until 2015

d) Daphnia monitoring is continuous with fixed biomonitor in each water treatment station, see Fig.7.6

(5) Equipment Requirements and Indicative Cost

Equipment Requirements	Indicative Cost (US$)
1) Integrated Ecotoxicology Laboratory	
Laboratory area, 70 m^2 construction	
@ $ 700/ m^2, for Toledo	49,000
Laboratory Equipment	200,000
4 WD-Vehicle (2x)	60,000
Fuel (one year)	5,000
Computers (5x)	20,000
Chemical Analysis	40,000
2) Biomonitor equipment	
Biomonitors (5x)	
@ $110,000/each,	
with grapher and microprocessors	550,000
Lab.Equipment Support	30,000
Total	US $ 954,000

Note:

1) Integrated Ecotoxicological Laboratory comprehends the following areas:

a) Daphnia bimonitoring support lab.

b) Benthic macroinvertebrate lab.

c) Microalgae lab.

d) Bacteriological lab.

e) Fish toxicology lab.

2) Laboratory Centers are conceived in:

   a) Curitiba/IAP (existing)

   b) Toledo /IAP

   c) Londrina (see section 7.5.1)

3) Biomonitor equipment is to be installed in the water treatment plants. See Fig.7.6

(7) Staff Requirements and Indicative Cost

Staff Requirements	Indicative Cost (US $/year)
1) Integrated Ecotoxicology Laboratory (Toledo)	
5 professionals, 1 per area mentioned, @ $ 24,000/year/each	120,000
10 Assistants @ $ 9,600/year/each	96,000
Training 5 persons @ $ 10,000/each	50,000
Per-Diem 126 days @ $ 50/day	6,300
2) Daphnia Monitoring	
Training 5 persons @ $10,000/each	50,000
Daphnia Culture Staff (4x) 2 hours/day=3months/year/each @ $ 800/month/each	9,600
Total/Year	US $ 331,900

Additional years will have a staff cost of US $ 231,900/year

(8) Source

Dr. Vivianne Toniollo, IAP Limnological Laboratory.

Dr.Maria Lucia Vizcalla Medeiros, IAP Limnological Laboratory.

Dr.Ana Marcia da Silva, IAP Limnological Laboratory.

7.3.2 Program for the Identification and Monitoring of the River Margin Vegetation and Lowlands Along Water Courses.

(1) Introduction

River margin vegetation and lowlands along water courses are the interface environment between water bodies and mainland. according to Eng.Segundo Diapp from IAP, some 16,000 ha of lands located along the Iguaçu river margin have been deforested.

According to SUREHMA, in Parana state 83.6 % of the population receives potable water from surface sources, and the vast majority of these rivers and springs do not have adequate marginal vegetation. This condition enhances suspended soils and agrochemical leaching into the water source, affecting its quality.

Nourishment of juvenile fish, reproduction habitat, resting areas for bird populations, river water temperature control, nutrient supply and buffer area for pesticides and erosion are some of the relationships found between these areas, their vegetation, and the river.

Anthropic pressure upon these areas is based on the expansion of the agricultural and cattle raising areas, through drainage and deforestation. As a consequence, increased water temperature and turbidity, influx of pesticides, and disappearance of fruit and nut eating fish are some of the detected consequences upon the water environment.

The identification of remaining areas, and their subsequent monitoring is a basic consideration to maintain control upon this habitat. Future regeneration practices could benefit from the study of the remaining areas and their biological communities.

(2) Objectives

1) To geographically define the existing areas on the basin allocating the river margin vegetation coverage on pertinent maps.

2) To monitor in a regular basis the extension (increase/decrease) of river margin vegetation.

3) To provide the data base for the implementation of the existing regulations, conservation, and rehabilitation projects.

(3) Methodology

The Remote Sensing Laboratory available at SEMA/IAP could be used to provide the service. Eighteen months are estimated to complete the assessment, and after it's done, regular monitoring of the area is to take place every 5 years.

(4) Areas to be Covered

Areas to be covered should be at least the following:

1) Main course of the Iguaçu river

2) Margins of existing reservoirs

3) Main tributaries of the Iguaçu river

4) Water intake locations

(5) Equipment, Materials, and Indicative Cost

Equipment & Materials	Indicative Cost (US$)
SPOT Images (Pan/XS)	142,500
4WD-Vehicle	20,000
Fuel/oils	2,500
Plotter	4,000
Total	US$ 169,000

(6) Staff Requirements and Indicative Cost

Staff Requirements	Indicative Cost (US$)
Digitator	9,000
Medium Level Technicians (2x)	18,000
Forestry Engineers (2x)	72,000
Per Diem	7,500
Total	US$ 106,500

Each subsequent monitoring @ 5 years has an estimated cost of

US$ 257,500 per monitoring effort.

(7) Implementation Schedule

The initial monitoring is estimated to be concluded in 9 months. Subsequent monitoring are to be done @ 5 years.

(8) Source

Eng. Donivaldo Pereira, Projeto Água Limpa, IAP.

7.3.3 Program for the Monitoring and Control of Blackflies (Simulium sp) in the Iguaçu River Basin

(1) Introduction

Massive population outbursts of the blackfly Simulium sp (Borrachudo) are inflicting severe damage to humans and domestic animals located in the vicinity of the water environment, causing stings, pain, skin rash, inflammations, dermatitis and fever.

The present program is oriented towards the integrated control of the blackfly populations, based on previous studies carried on the basin such as:

1) Identification and spatial distribution of the blackfly Simulium sp in the Iguaçu river basin.

2) Allocation of reproduction areas of the blackfly Simulium sp.

3) Allocation of breeding areas of the specific blackfly Simulium pertinax, an anthropophilic species, in the river basin.

(2) Objectives

Eradication, monitoring and control of the blackfly populations adjacent to urban settlements.

(3) Integrated Control Strategies

1) Mechanical control of larvae by removal of substrate

2) Biological control of the larval stage with crystals of Bacillus thuringiensis var. israelensis as a formulated larvicide.

3) Chemical control of adults by use of Pyretroids

(4) Monitoring Stations

Control and monitoring stations are shown under Fig.7.4

(5) Monitoring Items

1) pH

2) BOD

3) QOD

4) Total Solids

5) Suspended Solids

6) Dissolved Solids

7) Conductivity

8) Turbidity

9) Dissolved Oxygen

10) Temperature

11) Total Coliforms

12) Simulium sp population

(6) Monitoring Frequency

1) The monitoring frequency should be twice a month for each of the seasons for the evaluation of populations.

2) Chemical and bacteriological parameters to be monitored once a month for each season

(7) Staff Requirements and Indicative Cost

Staff Requirements	Indicative Cost (US$)
Biologist/Director	25,000
Assistant	6,000
Secretary	6,000
Trainees	1,400
Total	US $ 38,400

(8) Equipment/Supplies and Indicative Cost

Equipment & Materials	Indicative Cost (US$)
Vehicles (2x)	30,000
Thuringiensisvar israelensis formulated @ 6,800 liters	190,000
Pyretroids @ 3,000 liters	
Glassware	5,000
Others	8,000
Computer, software, printer	3,000
Office Supplies	1,000
Laboratory Analysis	18,000
Total	US $ 375,000

(9) Implementation Schedule

Twice a month during every season throughout the year.

(10) Source

Dr. Edson Guimaraes, IAP.

7.4 Preservation Programs in Tibagi River Basin

7.4.1 Program for the Inventory of Fish Populations

(1) Introduction

Partial fish inventories in the Tibagi river have been accomplished by the State University of Londrina, non the less a complete survey is to be made to gain comprehensive knowledge of the existing fish populations.

Seven hydroelectric projects are being sought for the Tibagi river between 2003 and 2010, although land and human settlement impacts are considered small, a significant portion of the river is to be modified in its hydrological regime, directly affecting the ichthyofauna. See Fig.6.11, Fig.6.5, and Fig.6.12 through Fig.6.17

The present study should be achieved before these projects start, so that comparative studies can be performed once the projects are installed, and to attain the basic data to mitigate and/or prevent mayor impacts on the resource.

The present study will also be the baseline study for the continuing study of the population dynamics of the main fish species.

(2) Objectives

1) To establish an inventory of the existing fish populations in the Tibagi river while no hydroelectric project are installed.

2) To establish the data baseline to continue with a population dynamics study of the main fish species found.

(3) Sampling Stations

Indicative location of stations for the inventory of fish is shown in Fig.6.3

(4) Sampling Frequency

Sampling should be repeated at least twice (beginning and ending) in every season, and in each station for a period of 2 years. Another 2 years are estimated for the identification of fish species.

After this study is finished, monitoring in critical areas should be repeated every 5 years for an estimated duration of 1 year.

(5) Equipment, Supplies, and Indicative Cost

Equipment & Materials	Indicative Cost (US$)
4 WD-Vehicle	27,000
Boat, Motor, Trailer (2x)	23,000
Laboratory Equipment	35,000
Sampling equipment	15,000
Hardware, software	4,000
Other costs	10,000
Lab. Construction	100,000
Total	US $ 214,000

(6) Staff Requirements and Indicative Cost

Staff Requirements	Indicative Cost (US$) (per year)
Consultant 30 days/year	15,000
Ichthyologyst @ $ 2,200/month	26,400
Assistants (6x) @ $ 600/month	43,200
Per-diem per/year	23,000
Training	5,000
Total	US $ 112,600

Total staff requirements are estimated in US $ 450,400 for a 4 year period.

Total program cost including equipment and infrastructure is estimated in US $ 664,400.

(7) Sampling Schedule

Sampling should be done every season in each station, twice per season during 2 years

Identification of fishes is estimated to take 2 more years in the laboratory.

Total estimated time to develop the program is 4 years

(8) Source

-Dr. William Severi, University of Mato Grosso,

-The Centro para Pesquisa em Aquacultura e Ambiente (CPAA/IAP), Toledo, PR.

-COPATI and the State University of Londrina

7.4.2 Program for the Assessment of the Fish Population Dynamics.

(1) Introduction

The study of the fish population dynamics becomes highly desirable at the time when no physical barriers (dams), and no mayor hydrological change(damming and reservoir formation) has occurred yet in the river. See Fig.6.11

Results obtained from this study will be highly significant for the knowledge of the natural behavior of existing populations, and will provide a solid data base for the mitigation and/or prevention of detrimental impacts to the resource and it's habitat. At the same time, it will provide the baseline to select commercially viable and ecologically endangered species subject to further efforts in artificial reproduction for re-population of rare specie, aquaculture and fisheries.

(2) Objectives

1) To study the population dynamics of the main fish species

2) To define among the main species those in need of reproduction and repopulation because of their endangered or rare status.

3) To define among the main species those which offer positive characters for commercial aquaculture and fisheries.

(3) Items to be covered

a) Feeding habits and diet according to season

b) Reproductive habits, habitat, sexual maturity and seasonality

c) Territorial habits and habitat

d) Social and migratory habits

e) Growth curve of main species

(4) Sampling Stations

Sampling stations are the same indicated for the fish population inventory, since out the inventory, selected species will be studied on their population dynamics. See Fig.6.3

(5) Sampling Frequency

Sampling frequency, same as in the population dynamics study should be done every 3 months, to cover all stations during the year.

(6) Staff Requirements and Indicative Cost

Assuming 20 stations show fish species which are rare, endangered or of economic interest to be further studied in their population dynamics, the following costs are extrapolated from real experiences by COPEL and the University of Maringa.

Staff Requirements	Indicative Cost (US$)
Laboratory Personnel for	
Limnology and Ichthyology	124,149
Total	US $ 124,149

(6) Equipment and Supplies and Indicative Cost

Equipment & Supplies	Indicative Cost (US$)
Laboratory Materials	39,000
Larvae/Egg analysis	80,168
Total	US $ 119,168

The estimated cost for the 2 year program is US $ 486,634

(7) Implementation Schedule

The implementation schedule should follow the end results obtained from the fish population inventory, which will provide the data base to select the fish species to be studied.

(8) Source

1) Dr. William Severi, University of Mato Grosso,

2) COPATI and the State University of Londrina

3) Extrapolation of real costs from NUPELIA/COPEL on reservoir limnological and ichthyological studies performed.

7.4.3 Program for the Artificial Reproduction of Native Fish with Ecological and/or Economic Interest.

(1) Introduction

The artificial reproduction of fish for commercial or ecological purposes is a viable means of producing vast amounts of offspring under controlled conditions by taking advantage of the natural abundance of eggs generated by the female fish.

(2) Objectives

1) To experimentally culture the main species of fish considered endangered, rare or of economic interest.

2) To systematize the hatchery techniques required for the artificial and massive reproduction of the above mentioned species.

3) To massively produce the above mentioned species in a regular basis.

(3) Staff Requirements and Indicative Cost

Staff Requirements	Indicative Cost (US$)
Aquaculture Consultant for 30 days/year x 2 years	30,000
Aquaculture Manager @ $ 30,000/year	60,000
Aquaculture technicians (5) @ $ 3,000/year x 2 years	30,000
Per-Diem	30,000
Training Courses	5,000
Total	US $155,000

(4) Equipment and Supplies and Indicative Cost

Equipment & Materials	Indicative Cost (US$)
4 WD-Vehicle	20,000
Boat, motor, trailer	12,000
Field & laboratory Equipment	35,000
Reproduction facility Equipment	23,000
Sampling Materials	15,000
Computer & Software	4,000
Feeds, Chemicals, Drugs, Fuel	172,000
Infrastructure Reforms at the UEL/Fish hatchery	57,000
Total	US $ 338,000

Total program cost is estimated in US $ 493,000 for a two year period.

(5) Implementation Schedule

Once the previous stages of fish population inventories, and fish population dynamics are completed, it is estimated that a 2 year interval should allow for the experimental artificial reproduction and production of fingerlings in the hatchery to be operational.

(6) Source

1) Dr. William Severi, University of Mato Grosso, and

2) Costs extrapolated from similar program budgeted by the IAP/CPAA, Aquaculture and Environmental Research Center in Toledo.

7.4.4 Program for the Upgrading of Management Plans for Existing Conservation Units

(1) Introduction

The total area of conservation units established in the Tibagi river basin is 412,678 ha divide between 12 conservation units (Gubert, F.1994), the main conservation unit reported is the Escarpa Devoniana Conservation Area, with 240,000 ha within the basin. See Fig.6.4

The main problems affecting the conservation areas according to IAP are summarized under Table-6.16. The present program aims at the assessment of each one of the conservation units, and the preparation of an action plan to improve the management condition of the conservation areas, and to establish their needs

(2) Objectives

1) To assess the specific problems being faced by the different conservation units of the basin.

2) To evaluate the ecotourism potential and the required management and infrastructure required for this purpose.

(3) Items to be Covered

1) Infrastructure needs, such as:

a) Fences,

b) Housing,

c) Potable water,

d) Solid waste disposal

e) Sewerage treatment

f) Trail conditions

g) Incompatible use of the land

h) Destructive activities